# The FARMER'S HANDBOOK OF EXPLOSIVES

DU PONT

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# FARMER'S HANDBOOK

INSTRUCTIONS
IN THE USE OF
DYNAMITE
FOR
CLEARING LAND
PLANTING AND
CULTIVATING
TREES, DRAIN-
AGE, DITCHING
AND SUBSOILING



E. I. du Pont de Nemours Powder Co.
Established 1802
Wilmington, Delaware

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# EXPLOSIVES

EXPLOSIVES are solids or liquids which can be changed almost instantaneously by a spark, great heat or powerful shock into gases having many hundred times the volume of the explosive in its original form. Coal and wood are changed slowly into large volumes of gas by burning; water is changed slowly also into a large volume of gas (steam) by heating it. This is the whole theory of explosives, and much in their use, which would otherwise seem difficult to explain, is easily understood if this theory be borne in mind.

Blasting Explosives are divided into two classes—Low Explosives, or Blasting Powder, which are exploded by a spark, and High Explosives, commonly known as dynamite, which are exploded by a hard, sharp shock.

## BLASTING POWDER

Blasting Powder is black and is produced in granulations or grains of various sizes. It is packed in bulk in steel or pulp kegs containing twenty-five pounds. Although it is invaluable for many kinds of coal mine, quarry and general excavating, it is not generally applicable to any blasting about the farm except for splitting logs, as described on page 42.

## DYNAMITE

There are numerous kinds of high explosives or dynamite, each having some particular property which makes it different from every other kind. Almost every kind is made in several different strengths. Some kinds lose strength very quickly when they are put in water and especially in warm water. Other are affected very little by water unless it is quite warm. Some kinds will burn if a spark falls on them and most kinds can be burned if put in a fire. It is exceedingly dangerous therefore to leave dynamite where it can be ignited in any way, because when hot or burning it is very sensitive and often explodes.

When dynamite is handled with bare hands it nearly always causes a headache. Old gloves should therefore always be worn when using it and they should be destroyed and clean ones provided before they become damp and sticky. A pair of gloves will remain in good condition for a long time if the dynamite is handled carefully.

There is a popular misconception of dynamite in the public mind. Newspapers in reporting outrages such as bomb throwing by anarchists, safe cracking " jobs " by burglars, etc., incorrectly report them as perpetrated with " Dynamite." The result is an erroneous, widespread impression that a dynamite cartridge will explode if dropped on the ground or thrown against the body of a person.

As a matter of fact, safe breakers and bomb throwers do not use dynamite cartridges at all; they would not be suitable for their purpose because it is so difficult to explode them. What these criminals use as a rule is nitro-glycerin. This dangerous explosive is used commercially for shooting oil wells, etc.

True there is a certain proportion of nitro-glycerin in dynamite cartridges, but that dangerous liquid is scientifically compounded with wood pulp, and other ingredients in such a way that dynamite can be absolutely depended upon not to explode accidentally if our simple and plain instructions for its use are complied with.

Responsible people can use and handle dynamite just as safely as they can handle gasoline, matches, or coal oil. The energy of dynamite can be directed in the work to which it is adapted nearly as well as the energy of steam can be directed in the work for which it is used.

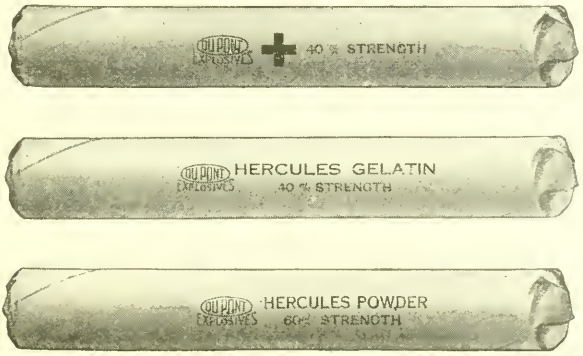
The different kinds of dynamite principally used in farm work are nitro-glycerin dynamite, Extra dynamite and gelatin dynamite. Gelatin dynamite in bulk has somewhat the appearance of moderately stiff putty. The others look like very fine damp sawdust. For convenience in handling, dynamite is made up into cartridges or " sticks " by packing it firmly into paper cylinders. The standard cartridges are 1¼ inches in diameter and eight inches long. Gelatin dynamite cartridges of this size weigh about nine ounces each and those of the other dynamites about a half pound each. Dynamite is also put up in cartridges ⅞ inch, 1 inch, 1½ inches and

1¾ inches in diameter—all 8 inches long. Dynamite cartridges are packed with a little sawdust in neat and substantially made wooden cases containing fifty pounds of dynamite.

**TABLE SHOWING THE AGRICULTURAL WORK IN WHICH THE USE OF DYNAMITE WILL SAVE MONEY AND TIME, AND THE MOST SUITABLE BRAND AND STRENGTH OF DYNAMITE FOR IT**

| KIND OF WORK | BRAND AND STRENGTH OF EXPLOSIVE |
|---|---|
| Boulder Blasting | Hercules 60% Dynamite |
| Cellar and Foundation Excavating | Red Cross 40% Extra Dynamite |
| Ditching | Atlas or Hercules 60% Dynamite |
| Fruit Tree Planting and Cultivating | Red Cross 25% Extra Dynamite |
| Hardpan or Subsoil Blasting | Red Cross 25% Extra Dynamite |
| Log Splitting | Red Cross 40% Extra Dynamite or Du Pont Blasting Powder |
| Log or Ice Jam Starting | Red Cross 40% Dynamite |
| Pipe or Tile Line Trenching | Red Cross 40% Extra Dynamite |
| Pole or Post Hole Digging | Red Cross 40% Extra Dynamite |
| Road Grading | Red Cross 40% Extra Dynamite |
| Swamp Draining | Red Cross 40% Extra Dynamite |
| Stump Blasting | Red Cross 40% Extra Dynamite, or Hercules Powder-Stumping, L. F. or Judson Powder R. R. P. |
| Tree Felling | Red Cross 40% Extra Dynamite |
| Well Sinking | Hercules 40% Gelatin Dynamite |

For other blasting about the farm, as in grading for dams and bridge piers, breaking stone for concrete, opening failing springs, loosening flood gates, opening frozen log rollways, opening frozen water holes for stock, etc., it is a good rule to use Red Cross 40% Dynamite in very wet work and Red Cross 40% Extra Dynamite if the work is not wet.



BORING HOLES FOR HARDPAN BLASTING NEAR LA HARPE KANSAS, NOVEMBER, 1909

## PRINCIPLE OF BLASTING

When dynamite explodes, that is, when the small mass of dynamite is changed into a very large volume of hot gases, these gases exert a strong pushing force equally in every direction because they require a much larger space than the dynamite which produced them. If the dynamite is shut up in a space just large enough to hold it, that is, if it is closely confined before it is exploded, the gases in escaping to the open, force out and carry along with them the material which shuts them in.

These gases, pressing equally in every direction, will escape principally where there is the least pressure to hold them in, that is, along the lines of least resistance, and will force out the material confining them more in that direction than in any other. If the back pressure holding them in is about the same over the top and on all sides, then they will carry with them, or break up as they escape, a large amount of the material which shuts them in, but if one place in the earth or rock around them is much weaker than all of the rest then the pressure will force through there and the gases will escape without doing as much work as they should.

It must be remembered, then, that in order to have a charge of dynamite do good work it must be so placed that the holding-in pressure is as nearly as possible the same on top and all sides of it. If a charge of dynamite explodes properly the change into gases is almost instantaneous, although some time is always required and some kinds of dynamite explode—or "detonate," as it is often called—more rapidly than others.

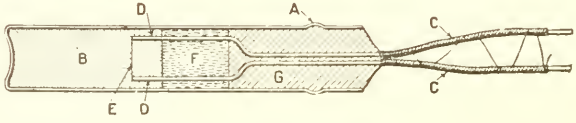
Sometimes a charge of dynamite explodes imperfectly or may even burn partly or entirely. When only part of the charge explodes so little work may be accomplished that it will have to be done over again. The gases given off by burning dynamite are quite different from those of properly exploded dynamite and are often very poisonous. Imperfect detonation is usually caused by the use of weak detonators or dynamite that is insensitive because of being frozen or chilled.

Chilled or frozen dynamite will never do good work. The other principal causes of poor results in blasting are insufficient tamping or the improper location of the charge. Poor results may also be due to too large or too small a charge or to the use of the wrong strength or wrong kind of dynamite.

Dynamite when used for blasting is exploded by a detonator. There are two styles of detonators, one known as a blasting cap and the other as an electric fuze (pronounced fu-zee). Both are small copper cylinders about a quarter of an inch in diameter and from one and a half to two inches long, which contain a small quantity of very powerful explosive. This explosive is quite sensitive to shock and a

BLASTING CAP AND FUSE

hard, sharp blow may explode it, so detonators must be carefully handled. This explosive can also be detonated by heat and this method is employed to detonate it when using blasting caps or electric fuzes. The heat to detonate a blasting cap is provided by the spark from a piece of fuse, one end of which has been pushed into the open end of the blasting cap, and fastened there by squeezing the blasting cap on to it with a cap crimper. When the other end of the fuse is lighted it burns slowly through and when the fire reaches the blasting cap it explodes.




ELECTRIC FUZE CROSS SECTION

"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 have two insulated copper wires sealed in the cap. The tips of these wires inside of the cap are bare and joined together by a platinum wire finer than a thread. When the electric current passes through the electric fuze it makes the platinum wire hot enough to detonate the explosive in the copper cap.

Although No. 3, No. 4 and No. 5 detonators may be bought, nothing weaker than the No. 6 (red label) can be depended on to properly explode dynamite.

When more than one charge of dynamite is to be exploded at the same instant, the blasting must be done electrically. If the charges are too far apart for the electric fuze wires to be connected directly together it is necessary to use connecting wire to join them.

The electric current for detonating electric fuzes is produced by a blasting machine and is carried to the electric fuzes through leading wire.

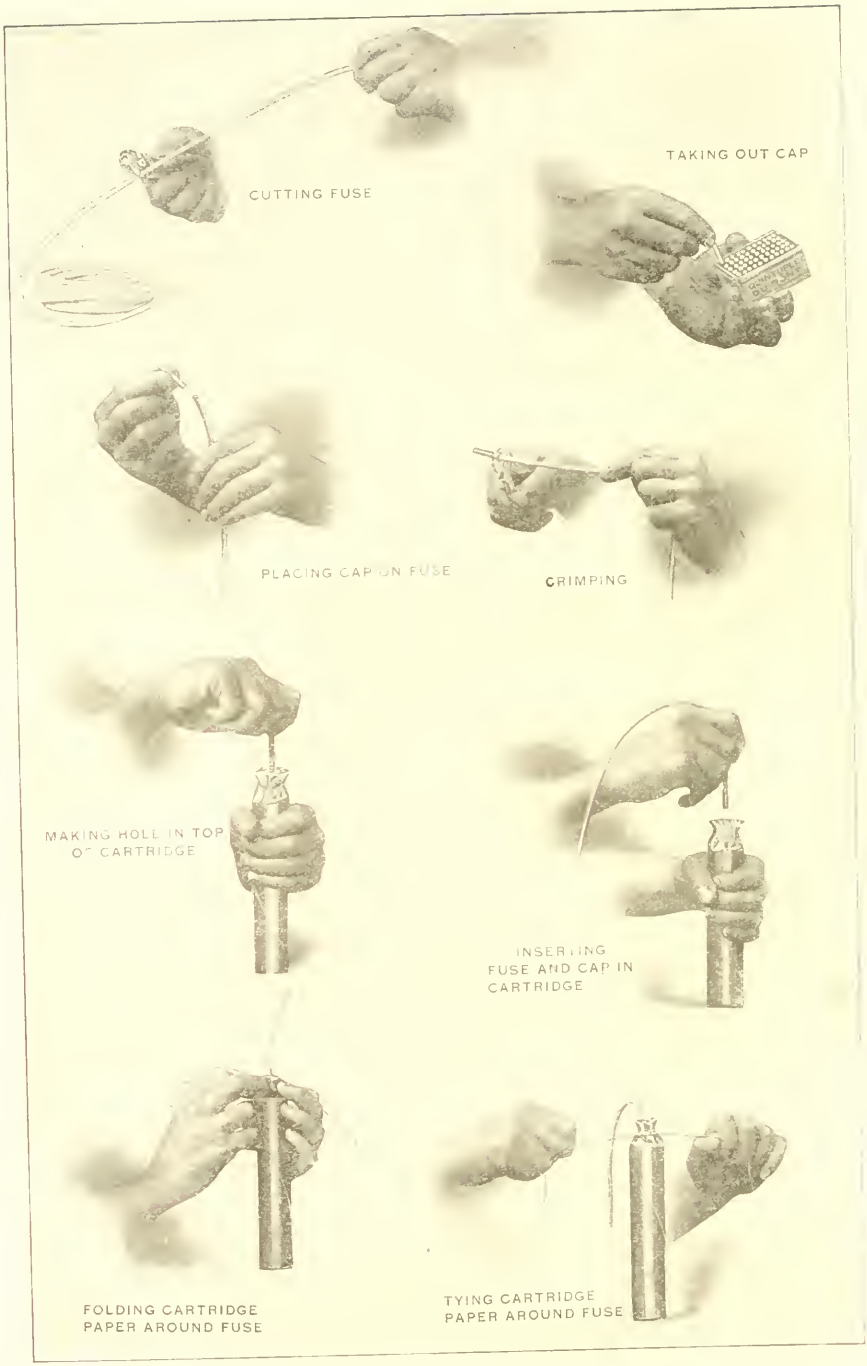
## METHOD OF EXPLODING DYNAMITE

The charge of dynamite is exploded by the shock and heat caused by the bursting detonator, and the detonator, to do its work properly, must be closely surrounded by the dynamite, because the air in the open space between the detonator and the dynamite acts as a cushion when the detonator explodes and lessens the shock to the dynamite. This may result in an imperfect explosion of the dynamite with but little work done. When the charge of dynamite is all pressed together in a mass one detonator is sufficient to explode it. If it is strung out for fifteen or twenty feet in a deep bore hole it is generally best to use two detonators.

## PRIMING

Placing the detonator in the cartridge of dynamite is called priming it, and the cartridge with the detonator in it is called the primer cartridge or primer. When the charge consists of more than one cartridge the primer should generally be loaded last.

The first step in the preparation of the primer, when using fuse and blasting cap, is to cut the necessary length of fuse from the roll, cutting it squarely across and not diagonally. After carefully inserting the fresh cut end as far as it will go into the blasting cap, the latter should be securely fastened to the fuse with a cap crimper. When crimping the blasting cap to the fuse, the crimp should be made near the end which the fuse enters so as not to disturb in any way the explosive which the blasting cap contains. An attempt to crimp the blasting cap near the other end would be likely to cause it to explode. The crimp should be made secure enough to prevent




METHOD OF MAKING A PRIMER WITH BLASTING CAP AND FUSE

the fuse from pulling out of the blasting cap, during the charging and tamping of the bore hole, and, what is quite as important, particularly in wet work, the crimp should be tight enough to keep water out of the blasting cap. A coating of soap, tallow or thick grease spread over the fuse where it enters the blasting cap will help greatly to keep the water out. This grease should not be applied until after the blasting cap has been crimped to the fuse. Oil should not be used for this purpose as it may soak into the fuse and damage it.

Be sure to cut the fuse long enough to allow it to extend several inches from the mouth of the bore hole when the primer is in place, and also long enough for the blaster to reach a place of safety before the charge explodes. Fuse burns from two to three feet per minute.

Next take the dynamite cartridge and unfold the paper at one end. Then make a hole with a sharp stick, about the size of a lead pencil, or with the rounded handle of the cap crimper, straight down in the dynamite. This hole should not be any deeper than the length of the blasting cap. Into this hole push the blasting cap attached to the fuse, and press the dynamite closely around it. Then gather the paper around the fuse and tie it securely with a piece of strong twine, and the primer is made. When the detonator is an electric fuze the primer is made exactly the same way, but no fuse is used, the electric wires already sealed in the copper cap taking its place.

When a half cartridge is enough for the charge, each end of the whole cartridge should be primed as described above and it should then be cut in two in the middle with a case knife, not with a folding pocket knife. This does not mean that a charge of half a cartridge should be primed at both ends, but simply that in preparing two charges of a half cartridge each, it is better to do the priming for both charges before cutting the cartridge in two.

## CHARGING

Having primed the cartridge in the manner described, insert it in the bore hole and push it carefully home. Putting the explosive into the bore hole is called charging or loading the bore hole. It is sometimes well in **dry ground** to slit the paper shells lengthwise on one or two sides with a sharp knife before putting the cartridges into the

PLACING THE DYNAMITE CHARGE

bore hole, as a slit cartridge will spread out in the bore hole better. The primer should not be slit. Push the cartridges, except the primer cartridge, firmly into place with a **wooden stick** so that they will expand and fill up the diameter of the hole, for crevices or air spaces greatly lessen the power of an explosive. The primer is loaded last and is pushed down only hard enough to be sure that it touches the preceding cartridge. Each cartridge must touch the one previously loaded, for if any space between the cartridges occurs through falling dirt or stones, or through the sticking of a cartridge in the bore hole, a part of the charge may fail to explode.

## TAMPING

After the charge is pressed home, as directed, put in two or three inches of fine dirt or sand, and with a **wooden stick** press it gently on top of the dynamite. This is called tamping the charge. Then fill up two or three inches more of the hole, packing it in a little more firmly. After five or six inches of tamping covers the charge, it may be pressed firmly into place without danger of premature explosion. The tamping material should be packed as firmly on top of the charge as can be done without moving the electric fuze or blasting cap, in the primer, but it is not safe to tamp by a blow any stronger than can be given by hand. Fill the bore hole up with tamping until even with the surface. The firmer and harder the tamping can be made (without overlooking the above precautions) the better will be the results. If the bore hole is not properly tamped, the charge is likely to "blow out," or at any rate some of its force will be wasted.

Be sure the tamping is done with a wooden stick. **Never use a metal bar or anything having metal parts.**

HOME MADE TAMPING STICK

## FIRING

Exploding the charge is called firing and there are two or three important points to remember about firing. The principal one is never to light the fuse or operate the blasting machine until after an unmistakable signal has been given, warning everybody near that you are about to fire, or until you know everybody is far enough away not to be injured by the material thrown into the air by the blast.

When firing electrically make it a rule never to connect the leading wire to the blasting machine until everything else is ready for the blast. This will prevent some inexperienced person from accidentally operating the blasting machine and exploding the charge before the person doing the blasting has had time to get away from the bore holes. Another important rule is to never hurry about investigating a misfire. Sometimes the charge does not explode exactly when it should, but does explode a little later. This rarely if ever occurs when firing electrically, but is not so infrequent when fuse is used, because careless tamping sometimes tears or abrades fuse so that it will burn very slowly. A misfire with fuse should not be investigated for half an hour and it is much better to wait a full hour. Always fire just as soon as possible after tamping. In fact, priming, charging, tamping and firing should be done as quickly as it is possible to do them thoroughly, because wet or even damp ground may injure the dynamite or even the detonator to at least some extent, and in cold weather the dynamite may become chilled or frozen which makes it insensitive.

## TABLE OF FUSE LENGTHS

This table is based on an average burning speed of Crescent Fuse of 3 feet per minute. However, fuse that has been loosely rolled—thus admitting more *air* to the powder train inside the fuse, will burn more rapidly. Also, fuse in tightly tamped holes, being under pressure, burns more rapidly. In extreme cases the speed reaches 5 feet per minute. In subsoiling, as there is very little material thrown up, the fuse may safely be cut just long enough to reach from the primed cartridge of dynamite to a few inches above the surface of the ground. But in stump blasting, ditching and especially in boulder blasting, it is necessary to use a fuse long enough to allow the blaster plenty of time to run far enough away to be out of reach of flying stones or sections of stumps. When a safe distance has been reached keep the eyes on the stump or boulder until the blast occurs, then look up for falling pieces.

| Stump Blasting | | | Mudcapping Boulder | Snakeholing Boulder | Blockholing Boulder | Ditching | Subsoiling Tree Planting |
|---|---|---|---|---|---|---|---|
| Distance to run | Time Required | Least Fuse Length | | | | | |
| 200 ft. | 1 min. | 3 ft. | 200 1 min. 3 ft. | | | | 25 ft. * * |
| 300 ft. | 1½ min. | 4½ ft. | | | | | * The length of fuse in subsoiling and tree planting is determined solely by the depth of the hole. |
| 400 ft. | 2 min. | 6 ft. | | 400 2 min. 6 ft. | 400 2 min. 6 ft. | 400 2 min. 6 ft. | |

## HANDLING

Du Pont Dynamite is not so sensitive to shock that it is likely to explode from a jar or even from dropping it a considerable distance. It is made just as insensitive as practicable so that it will be comparatively safe to handle and use, and this is why a strong de-

tonator is necessary to explode it properly. Nevertheless it should be handled sensibly and carefully and only by responsible persons.

*Detonators are more sensitive than dynamite* to shock, friction and heat and must always be handled carefully. Fuse does not explode.

## STORING

As soon as explosives are received they should be stored in a dry, properly ventilated building, far enough away from dwellings or roads to prevent loss of life if they were to explode accidentally. They should be kept under lock and key and where children or irresponsible persons cannot get at them. If large quantities are to be stored, a dry, well-ventilated, fire-proof and bullet-proof magazine, located in an out of the way place should be provided. Detonators must never be stored in the same building with dynamite because they are more easily exploded than dynamite and it would be possible to explode them accidentally by a shock or jar which would not explode dynamite. If detonators were to explode by themselves they would be unlikely to do much damage unless there were a great many of them, but if they were to explode in the same room with dynamite they would probably cause the dynamite to explode too, and this might do very serious damage.

## THAWING

Most dynamite freezes even before water does and will not explode at all, or only very imperfectly, when in that condition. Even if chilled it cannot be depended on to work well. Red Cross Dynamite is an exception to this rule, for it does not become insensitive until the weather is cold enough to freeze water and often not until it is much colder than that. Other dynamite usually chills or freezes at temperatures of 45° to 50° F.

Frozen dynamite is easily recognized because it is hard and rigid, but in cool weather when the dynamite is not frozen it is sometimes difficult to be sure whether it is not too much chilled to explode properly. It is necessary, therefore, when using dynamite in cold or even cool weather, to be sure that the cartridges are warm and soft clear through when the bore hole is charged.

If, after the thawed dynamite is ready to use, something causes a delay and it becomes chilled or frozen before it can be put into

the bore hole, it should be thawed again. It does not harm dynamite to thaw it many times, provided this is done in the right way.

Red Cross Dynamite, if loaded in the ground below the frost line and properly tamped, will not freeze again, but other dynamite will chill or freeze almost immediately when loaded in cold ground, so that it is absolutely necessary to fire it immediately after charging and even then it is probably too insensitive to explode with full force. It is this that makes Red Cross Dynamite so valuable in cold weather. Although it may freeze when the weather is cold enough to freeze water, it freezes very slowly and sometimes it will remain unfrozen indefinitely even in much colder weather.

The best way to thaw dynamite, and to keep it thawed until it is to be loaded, is in a thawing kettle made for the purpose. Dynamite may be thawed by leaving it spread out on a shelf in a warm room over night, or by burying it, while in the case, in manure. It may also be thawed by putting it in a covered, water-tight pail and hanging this pail in warm water, and it may be carried to the work in any kind of dry bucket or box if covered with an old coat, piece of blanket, or something similar to keep it warm. It is exceedingly dangerous to try to thaw dynamite in front of an open fire, or in hot sand, or on hot stones, or metal or steam pipes, or in an oven. It is in attempting to thaw dynamite in some of these ways that accidents frequently happen. It is also dangerous to thaw dynamite by putting it in hot water or by turning a jet of steam on it, and besides both of these make it practically useless for blasting.

The thawing of dynamite should always be done slowly and carefully. This makes it tedious work and the fact that but little thawing is often necessary when using Red Cross Dynamite makes that brand of great advantage to the farmer. Hercules Dynamite and Hercules Gelatin Dynamite usually have to be thawed when the temperature is lower than 45° F. or 50° F., but they are used only in blasting ditches through wet ground, and in sinking wells, so if this work is done in summer and Red Cross Dynamite is used for all other blasting, but little thawing will be necessary.

BLASTING STUMPS ELECTRICALLY

## BLASTING BY ELECTRICITY

Large boulders and large stumps with spreading roots can often be blown out and broken up more thoroughly and with less dynamite if it is distributed in several charges in different places under the boulder or stump and all of these charges exploded at one time. Groups of stumps standing close together can also be blasted best in this way. In order to dig a ditch satisfactorily in light, dry soil, with dynamite, it is nearly always necessary to also explode a number of charges simultaneously. In well sinking and other kinds of blasting it is of advantage to explode a number of charges at one time, as each tends to help the other. The only way in which several charges some distance apart can be exploded at exactly the same time is by the electric method of blasting. Electric blasting may, of course, if so desired, be applied to all of the work described in this Handbook, but it is generally unnecessary except in the blasting just described and is more expensive than the use of fuse and blasting caps.

The equipment for blasting by electricity, in addition to dynamite, consists of

| | |
|---|---|
| Electric Fuzes | Leading Wire |
| Connecting Wire | Blasting Machine |

When the charges of dynamite have been primed with electric fuzes and tamped as already described, the two electric fuze wires extend from the ground over each charge. These two wires should be separated and one of them connected to one of the wires of the

electric fuze on one side and the other one should be connected in the same way to one of the wires on the other side. This should be continued until all of the charges are connected in a row with one free wire extending from the first charge and another extending from the last charge. This is called "connecting in series." If the holes are too far apart for the electric fuze wires to reach between them, pieces of connecting wire will have to be cut from the spool and, after scraping the insulation from the ends, used to connect the electric fuze wires in adjoining charges.

Connections are all made by twisting bare wire ends securely together. All wire ends should be scraped with an old knife so that they will be free from grease or corrosion when connections are made.

PROPER WAY TO MAKE CONNECTIONS

All bare joints or other uncovered places in the wire must be kept away from water or damp ground. This can be accomplished by putting a stick, block of wood or stone under the wire on each side of the bare place.

The Du Pont Company manufactures an instrument for testing blasting circuits, called the Du Pont Galvanometer. This is a very ingenious and useful instrument where much blasting is done by electricity. Complete description and instructions for using will be sent on request.


DU PONT No. 6 BLASTING CAPS

## DU PONT BLASTING SUPPLIES

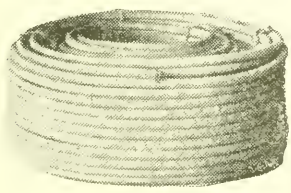
**Du Pont Blasting Caps** are made in several different grades, but nothing weaker than the No. 6 (red label) grade can be depended on to develop the full force of dynamite.

Du Pont Blasting Caps are put up 100 to the tin box and from five to fifty boxes are packed for shipment in a wooden case. Blasting caps may be exploded by shock, heat or sparks, so must be handled carefully and kept away from fire. They are weakened by moisture and must be stored in a perfectly dry place and be kept dry until they are used. It is dangerous to store them or carry them with dynamite.

**Fuse** or Safety Fuse, as it is sometimes called, is a fine train of powder wrapped in jute and cotton yarn and sometimes in tape. Many kinds are made, but either the Crescent or Single Tape grades are good enough for most work about the farm. Cotton and hemp fuses are not reliable unless the work in which they are used is perfectly dry, and sometimes they are not satisfactory even then. When blasting a ditch through wet ground Triple Tape Fuse is recommended, but must be lighted just as soon as the charge is in place, because the best fuse may fail to burn through after it has been under water some little time.

Sometimes, especially in windy weather, it is hard to light fuse because the powder in the open end may have become damp or a little of it spilled out. When this happens it is well to cut off an inch or so in order to be sure that the powder is dry. It is also a help to split a half inch of the end with a sharp knife and to spread out the two halves.

Fuse should always be kept dry and should be stored in a cool, dry place. If stored in a damp place it becomes damaged after a time and may fail to burn through. If stored in a hot, poorly ventilated place as, for example, close under the roof of a small shed in summer time, it may be damaged either by becoming soft and oily or by drying out and becoming so hard and brittle that it will break when unrolled. Fuse also may become stiff and brittle in cold weather and when in this condition should be warmed before being unrolled.



COIL OF FUSE

Fuse is put up in a double roll, one fitting inside the other, each 50 feet long. Each double roll of 100 feet is wrapped separately. It is packed for shipment in wooden cases containing from 500 to 6000 feet and in barrels containing 8000 feet.

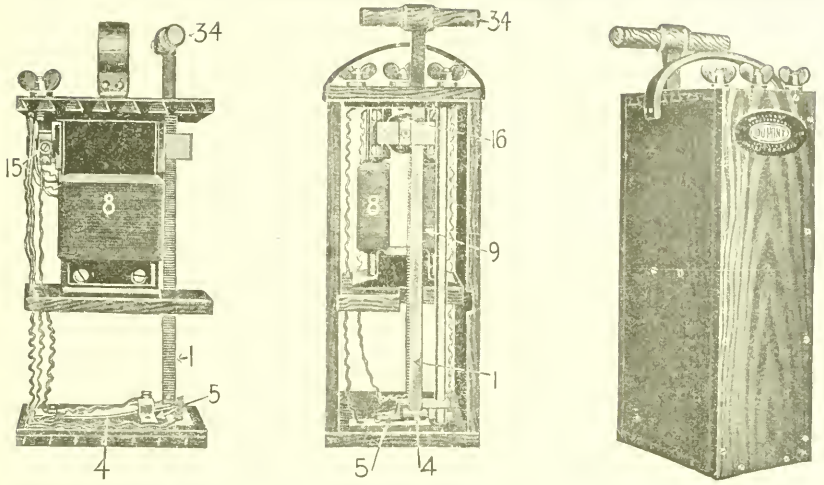
DU PONT CAP CRIMPER

**Du Pont Cap Crimpers** are necessary wherever blasting is done with fuse and blasting caps. Without a cap crimper it is impossible to attach the blasting cap securely or safely to the fuse. The Du Pont Cap Crimper has besides the crimping jaws two shears for cutting fuse and a straight arm to make the hole in the primer for the detonator.

**Victor Electric Fuzes** are made with double copper wires 4 feet, 6 feet, 8 feet, and so on up to 30 feet in length. There are three grades, No. 6, No. 7 and No. 8, but the No. 6 (red label) grade is strong enough for work about the farm. Electric fuzes, like blasting caps, can be exploded by shock or heat, so must be handled carefully and kept away from lights and fires. As they can also be spoiled by dampness they should be stored in a dry place. It is dangerous to store them or carry them with dynamite. They are put up in pasteboard cartons or boxes containing 25 or 50 each. The cartons are packed for shipment ten to the wooden case.


VICTOR NO. 6 (RED LABEL) ELECTRIC FUZES

**Reliable Blasting Machines** are made in two sizes, No. 2 and No. 3. The No. 2 size will explode at one time as many as ten, and the No. 3 as many as thirty Victor Electric Fuzes connected in series. The Reliable Blasting Machine is operated by lifting up the handle of the rack bar as high as it will reach, then pushing it down as far as it will go with all of the force possible. The rack bar should be pushed against the bottom with all of the force that can be

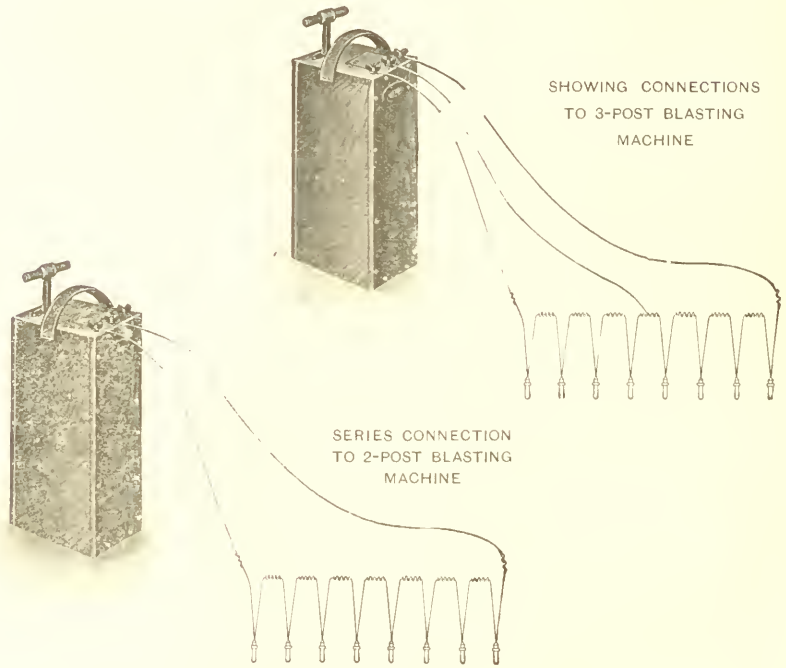



INTERIOR AND EXTERIOR VIEWS OF 3-POST BLASTING MACHINE

given it and the nearer it comes to the bottom the quicker and harder should be the push. When the rack bar strikes the bottom the electric fuzes will explode.

Reliable No. 2 Blasting Machines have two binding posts and the No. 3 size also has two posts unless specially ordered with three. Three-post blasting machines will explode at one time nearly 50% more electric fuzes than two-post blasting machines of the same size. The leading wires are connected to the blasting machine by pushing the well-scraped bare ends through the small hole in the binding posts and screwing the wing nut down firmly on them. When a three-post blasting machine is used with three leading wires, the ones from the two outside posts are connected to the first and the last electric fuzes in the circuit, and the one from the middle post is connected between the two middle electric fuzes in the circuit. A three-post blasting machine may be used with two wires only by connecting these wires to the middle and either one of the outside binding posts—not the two outside ones. Reliable Blasting Machines, if properly used, will wear for many years. They must be kept out of the wet and mud and must not be thrown about carelessly. If it is necessary to use them in wet weather or on wet work, they should be carefully wiped off before putting them away. A blasting machine should not be put in a hot place to dry out if it has become wet, but after being wiped off should be put away in a cool, dry place until it has had time to dry out slowly.

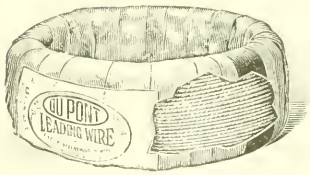
Blasting machines should be tested occasionally with a Du Pont Rheostat to be sure that they are up to standard capacity. A description of the Rheostat and instructions for using it will be forwarded on application.




Series connection with blasting machine. The break in the wires is merely to indicate that any required length of wire may be used between electric fuzes and blasting machine. There must be no break in the actual circuit.

**Leading Wire** is sold in coils of 200 feet, 250 feet, 300 feet and 500 feet. There are two kinds, Single and Duplex. In the Duplex Wire, the two wires are bound together, which usually makes it more convenient to handle. Single Leading Wire weighs about two pounds to the hundred feet, and Duplex Leading Wire weighs four pounds to the hundred feet. Leading Wire is sold by the pound.

**Connecting Wire** is sold in 1-lb. and 2-lb. spools. A 1-lb. spool of No. 20 Connecting Wire holds about 210 feet.

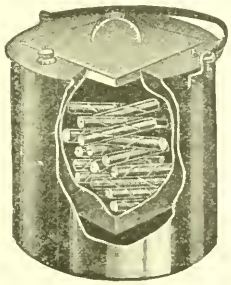



COIL OF LEADING WIRE

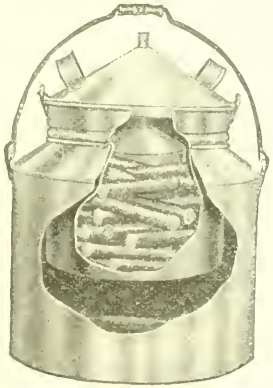
SPOOL OF CONNECTING WIRE

**Thawing Kettles** are made in two different styles. The Bradford Thawing Kettle has two separate pails, the one for the dynamite fitting tightly into the one for the water. It is made in two sizes, the No. 1 size holding 22 pounds and the No. 2 size 60 pounds of dynamite. The Catasauqua Thawing Kettle is made in one piece with an outside jacket for the hot water all around the dynamite section. The No. 1 size holds 30 pounds of dynamite and the No. 2 size 60 pounds.

The water must never be heated in the Catasauqua Kettle, but must be heated in some other vessel, and when not too hot to burn the hand, poured into the water compartment provided the dynamite compartment is empty. It is dangerous to heat the water in the Catasauqua Kettle even when the dynamite section is empty, because there may be a little nitro-glycerin in it which has soaked out of the dynamite previously thawed. Water may be heated in the outer pail of the Bradford Kettle if the inner pail has been removed. The dynamite pail must not be put into the water pail unless the water is cool enough to put the hand in without burning it. Dynamite should not be put into either of the thawing kettles without first wiping out the dynamite compartment clean and dry.



CATASAUQUA THAWING KETTLE



BRADFORD THAWING KETTLE

## WHAT TO DO WHEN WANTING DYNAMITE

In the foregoing, dynamite and blasting supplies have been carefully described, and the way to store and use them explained. Farther on will be found directions for each kind of blasting and the brand and strength of dynamite to use. When blasting is to be done refer to the chapter on the kind of work to be done and find the kind of dynamite recommended for that work and about how much will be required.

If the dynamite is to be used for blasting stumps, multiply the number of stumps to be blasted by the number of cartridges for a stump the size they will average and divide the number of cartridges by two to get the number of pounds required. Remember that dynamite is packed in 50-lb. cases, each containing from 90 to 100 1¼ x 8-inch cartridges, and order accordingly.

Write the nearest dealer exactly the number of cases you want, giving him the brand and the strength and do not accept anything else, for there is nothing more trying and unsatisfactory than to attempt to blast with dynamite which is unsuitable for the work you are doing.

If there is no dealer in your locality, or if the ones there do not keep the exact brand and strength that you want, a letter explaining this should be written to our nearest branch office, as shown on the back cover of this Handbook, and they will either ship you what you need or tell you where to get it.

Dynamite and detonators should not be hauled together from the dealer's or the railroad station. The detonators do not weigh much and can be brought along on some other trip. If blasting caps are purchased from a dealer in the tin boxes separate from the wooden shipping case it is a good plan to put these boxes in a basket or wooden box with a horse blanket, coat, hay or anything else that would keep them from being roughly jarred and shaken on the way home.

When the dynamite arrives lock it up securely in some dry, out of the way shed or smoke house, which will not be likely to be set on fire

or shot into. Fuse, wire, thawing kettles and blasting machine may be stored in the same shed with the dynamite, but blasting caps and electric fuzes should be put in some other dry place under lock and key.

When ready to use the dynamite open the box or case with a hard wood wedge and a mallet and take to the work in a dry box or pail the number of cartridges required immediately. Never take more than the day's supply even in warm weather, and in cold weather take only what can be kept thawed until it is to be used, unless there are arrangements for thawing it where the blasting is being done. Let somebody else carry the tamping stick, fuse and detonators to the work. As soon as holes are ready for the dynamite—and when possible the holes should all be ready before the dynamite is brought to the work—the priming, charging, tamping and firing, as already described, should be carried on as rapidly as possible without becoming careless. A very little practice will put you in the way of doing blasting quickly, systematically and economically, and you will wonder how you ever got along without dynamite.

## TOOLS USED IN AGRICULTURAL BLASTING

Tools necessary in connection with farm blasting are to be found on almost every farm or can be easily made there or at the nearest blacksmith shop. The holes for blasting stumps, boulders, trees, subsoil for post holes, road grading, trenches, etc., can all be made with a crowbar having a point at one end and a flat chisel edge at the other. The wooden tamping stick can be made in a half hour by dressing down a hard wood sapling, or, if the holes are shallow, an old broomstick will do. A long handle shovel and a grub hoe or mattock are always serviceable when blasting stumps and boulders. Although a crowbar is very satisfactory for making a moderate number of holes, it will usually be found of advantage, if the work is extensive, to secure augers or bars especially made for the purpose. Sometimes a steel rod ¼ inch in diameter and 5 feet long with a sharp slender point at one end and a ring on the other is serviceable for probing under a stump to find out the size and position of the main roots.

When draining swamps by shattering the impervious subsoil under them it is sometimes necessary to make the holes for the dynamite much deeper than can be done with a crowbar. For this work rod or pipe extensions for the augers are used. In subsoiling, a bar a little heavier and shorter than a crowbar is also used. This subsoil bar can be removed when it becomes fast by means of a trace chain and a lever. Augers specially made for agricultural work can be obtained from Job T. Pugh, 31st and Ludlow Sts., Phila., Penn. We will advise interested parties where the other tools may be purchased.

FUGH WOOD AUGER

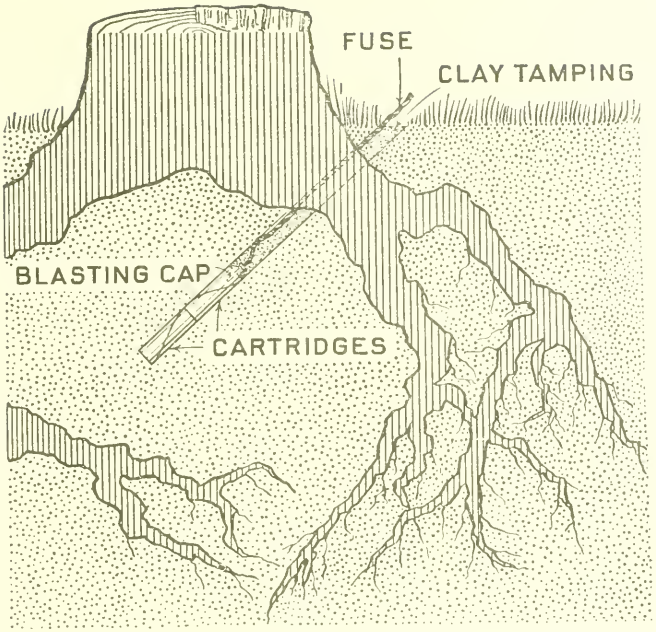
EXTENSION ROD

INTERMEDIATE EXTENSION ROD

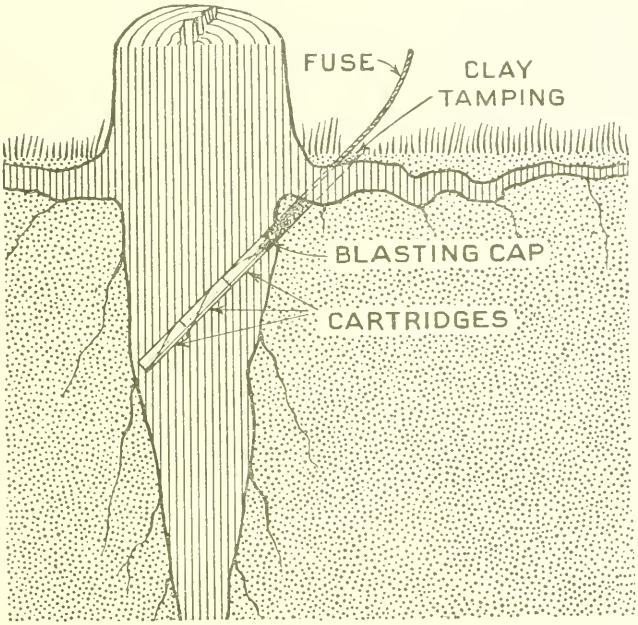
PUGH EARTH AUGER



SUBSOIL BAR




SPREADING ROOT CHARGE




TAP ROOT CHARGE

# INSTRUCTIONS FOR AGRICULTURAL BLASTING

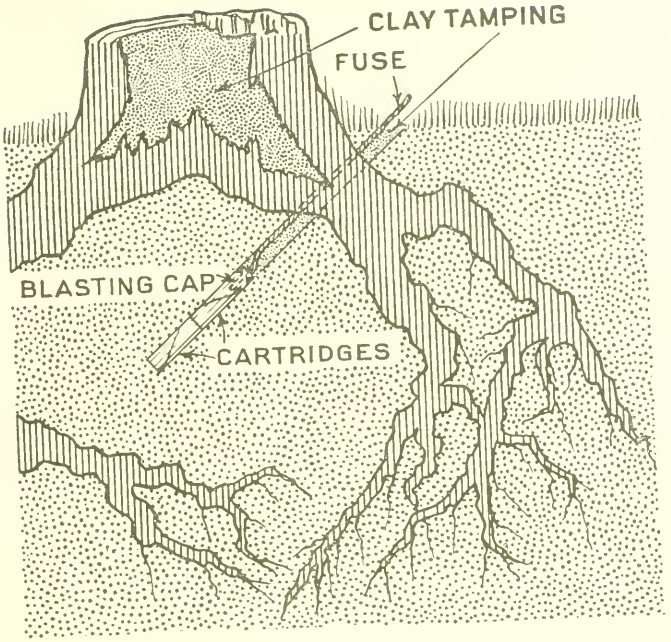
In the following pages are given general instructions as to how to do different kinds of blasting about the farm. It must be remembered that the exact quantity of dynamite to use and the very best spot to locate the charge must depend on local conditions, that is, the way the stump's roots lie and the kind of ground under them, the position and grain of the boulder, the thickness and quality of the subsoil or hardpan, etc. It can be easily understood, therefore, that the directions given are only general and that it may be found of advantage, after a few trials, to modify or change them a little. If they are carefully followed in a general way it will be found easy and profitable to use dynamite in the work for which it is recommended, but a little experience will probably enable the user to do the work even more quickly and at less expense than when first he attempts it.

## BLASTING STUMPS

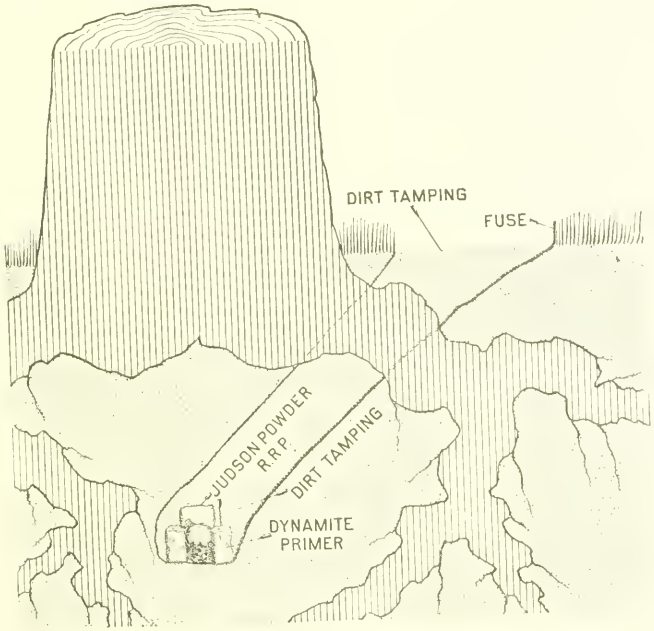
It is usually necessary in blasting stumps to place the charge under the center of the stump, so that the part offering the greatest resistance will be hit first and hardest. Generally this spot will be directly under the middle of the stump, and it is sometimes necessary to bore into the tap root. Where a very big stump is rotten at the middle, but has several large branches, it is better to increase the charge a little and locate it deeper in the ground or to place a small charge under each of the large roots and explode them all together with a blasting machine.

In order to keep the dynamite from splitting the stump, and wasting a part of the force which should be used in lifting it out, some blasters wind a stout chain around the stump several times.

With some large stumps it is better to spread out the charge under them. This is done by boring holes from different sides so that they will meet under the middle of the stump and charging each hole with two or more cartridges. In this case it is necessary to prime only one cartridge, but that should be loaded first and pushed back




ROTTEN STUMP CHARGE




BIGTREE TUNNEL CHARGE

to the place where all of the holes come together, then the next cartridge loaded in each hole must touch the primer. It is not easy to bore the holes and charge properly under this system, and it should only be used after some experience and when the condition of the ground and stump is such that the work cannot be satisfactorily done in any other way.

The best general instructions that can be given are: observe carefully the way the stump stands, the location and size of the roots, the nature of the soil and the size of the stump. The probing spear described on page 28 is often of great service in determining just what kind of roots a stump has.

The kind of wood is important, principally in its bearing on the probable size and position of the roots. Some kinds of trees, such as Southern Yellow Pine, Swamp Cypress and the Pines, Firs, Cedars, Redwoods and Bigtrees of the Pacific Slope grow principally in the same kind of soil and generally speaking have similar root growth. With trees of this kind it is possible to give relatively accurate instructions as to the quantity of explosives necessary to blast stumps of a given size, but for the stumps of those trees which grow on either clay or on light sandy soil, which may be found in swampy country, or on high, dry ground and which develop entirely different root systems, there is no way of closely estimating the charge without examining each particular stump.

Stumps of Oak, Pine, Chestnut, Walnut, Hickory, Gum, Poplar, etc., in various parts of the country will be found with entirely different root systems and standing in different soil according to the locality, and a charge of dynamite which would be just large enough to blast out one of them of any given size in one place might be very much more than necessary for a stump of the same size and same kind of wood in some other place.

When starting in to blast stumps the size of the charge may be regulated according to the following table until experience shows what changes should be made. The table is based on sound stumps and average conditions of roots and soil. If the stumps are of a variety that come out of the ground easily and the soil is of heavy clay, the charges for each diameter can be considerably reduced. If, on the other hand, the stumps have unusually strong root development, or if the soil is very light and sandy, more dynamite may be required. Sometimes, under favorable conditions, it is more eco-

nomical to use Red Cross 25% Extra Dynamite, or again in very light soil Red Cross 40% Extra Dynamite will be best.

| Diameter of Stumps in inches | 12 | 18 | 24 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Approximate No. of 1¼" x 8" cartridges Red Cross 40% Extra Dynamite | 1½ | 2 | 3 | 4 | 5 | 6 | 8 | 10 | 12 | 14 | 16 |

Stumps standing in light, open soil can be blasted better when the ground is wet, because then it resists better the force of the dynamite. Stumps in swamps or on swampy ground should, however, be blasted in dry weather.

The proper way to prepare the charge and to place the dynamite under the stumps is described on pages 11 to 16.

As already stated Red Cross Dynamite cartridges 1¼ x 8 inches weigh about a half pound each, so the approximate cost of blasting stumps of different sizes can be easily calculated from the above table when you have the price per pound. Prices for the different strengths will be given you by your dealer or by the nearest Du Pont office.

The stumps of some kinds of trees require special treatment for best results, and instructions in regard to these follow:

## Southern Yellow Pine Stumps

Southern Pines growing on deep, open soil have a very strong tap root, but those growing in thin, open soil over a hard subsoil either have no tap root at all or only a small one. Southern Yellow Pine stumps without tap roots are blasted in the same way as other stumps with lateral or spreading roots. When blasting those with tap roots the dynamite should be in the tap root directly under the center of the stump. The tap root is exposed by digging an opening one or two feet deep under the smooth side of the stump. A two-inch auger hole is then bored about three-quarters of the way through the tap root on an angle of 35 to 45 degrees. If the hole is bored entirely through the tap root a good deal of the force of the dynamite when it explodes is wasted in the soft ground beyond the tap root.

The charge should be from one to six cartridges, depending on the size of the stump, of Red Cross 40% Extra Dynamite. The explosion of the charge will cut off the tap root twenty-four to thirty-six inches below the surface and will turn out the stump in pieces. The trouble of boring into the tap root when blasting these stumps can be avoided by pressing the charge of dynamite firmly against the side of the tap root and, after tamping it thoroughly, exploding it. Considerably more dynamite is required, however, to blast in this way. The opening down along the tap root can be dug with a shovel or bored with a three-inch post-hole auger. See pages 11 to 16, and 29 for proper methods of priming, charging, tamping and firing.

### Western Fir, Pine and Cedar Stumps

In the States of Washington, Oregon and California, where the rainfall is large and the ground in the forests is always damp, many of the trees grow to great size—some being eight or ten feet in diameter. The roots of these trees usually spread out near the surface and do not grow deep into the ground, as might be expected, tap roots being extremely rare. The object when blasting these stumps is not to split them, but to bring them out entire at one blast, with all of the roots possible, because if the charge of explosives is so gauged and located as to split the stump, it generally fails to bring out all of the pieces. As the principal object is to get out as much of the stump as possible at a minimum cost, it is better to blast it out first and then it can be easily split afterwards, by means of a small quantity of dynamite exploded in auger holes.

The common rule in blasting these stumps is to use one and one-half pounds of Hercules Powder-Stumping L. F. per foot of diameter, with stumps up to four feet, when the subsoil is clay. For larger sizes two to two and one-half pounds for each foot in diameter should be used. Stumps in gravelly or loose ground require one pound more for each foot in diameter.

The charge of explosives is best placed when there is sixteen to twenty-four inches of earth between it and the bottom of the stump. This results in the force of the explosion radiating to all sides, lifting the stump clear of the ground, and bringing with it the greatest length of roots. If the charge is placed too close to the stump, the effect is to split it, leaving the roots to be dug out at extra labor and expense.

A CALIFORNIA REDWOOD STUMP, EUREKA, CALIFORNIA, FEBRUARY, 1910— BEFORE THE BLAST

The circumference of this stump at the ground line was 75 feet. It was a *single* stump in the ground, but divided into two just above the surface

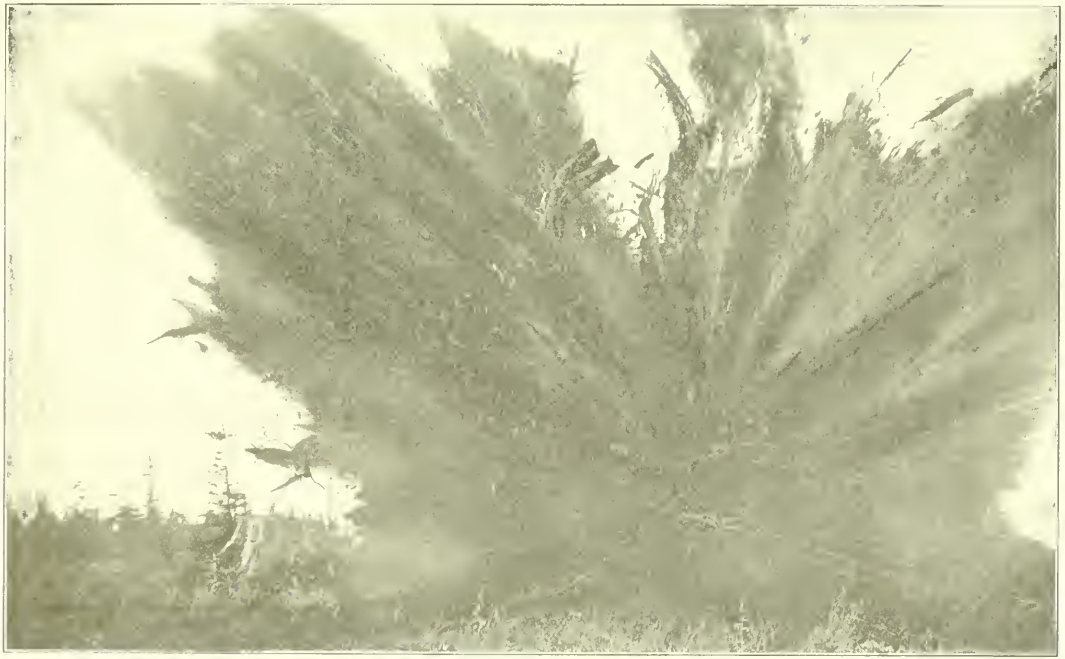
When these stumps are large the bottom of the bore hole is " sprung " or chambered until it is so large that the increased charge required can be concentrated under the center of the stump. The chambering is done by exploding, without tamping, first a half cartridge, then several successive charges of from one to five cartridges each, in the bottom of the bore hole. When the hole is large enough it is given time to cool off and is then charged with the necessary quantity of Hercules Powder-Stumping L. F. to bring out the stump. See pages 11-16, and 31 for proper methods of priming, charging, tamping and firing.

### Redwood and Bigtree Stumps

The best explosive for these stumps is Hercules Powder-Stumping L. F. or Judson Powder R. R. P. The latter is comparatively slow-acting and has more of a lifting and heaving than a shattering effect. It is granular and is packed in twelve and one-half pound paper bags which are enclosed in wooden cases similar to those in which regular dynamite is packed.

The way to estimate the quantity of Judson Powder R. R. P. necessary to blast out stumps larger than eight feet in diameter, is to square the largest diameter in feet, the result being approximately the number of pounds required. For example, if a stump is eight feet in diameter the charge of Judson Powder R. R. P. should be about the square of eight, or sixty-four pounds. Stumps less than eight feet in diameter require a little greater charge for their size than do the larger stumps, and the rule with them is to use as many pounds of Judson Powder R. R. P. as eight times the largest diameter in feet. On this basis a stump six feet in diameter would need about forty-eight pounds of powder. However, the successful blasting of these large stumps depends greatly on the judgment of the blaster, and these rules can only be considered as a general guide. This can easily be understood when it is remembered that, owing to difference in soil or some peculiarity in the growth of the tree, it sometimes requires the same quantity of explosives to properly bring out a stump six feet in diameter as it does another one eight feet in diameter.

In blasting these stumps a trench is dug large enough to permit placing the entire charge of explosives directly underneath the center of the stump. A little dynamite blasted in holes punched with a crowbar will prove of great assistance in digging this trench.



A CALIFORNIA REDWOOD STUMP—THE BLAST

Note that the main part of the stump is split into several pieces and lifted straight up, while the smaller sections, which were blown out first, are already falling to the ground. This shows that no more explosive than necessary was used in this blast

If the ground is wet, the charge should be placed in waterproof bags, as Judson Powder R. R. P. is not waterproof and is quickly damaged by water.

Judson Powder R. R. P. can be properly exploded only with a primer of 40% (or stronger) dynamite. The sizes of the primers required for different charges of Judson Powder R. R. P. are as follows:

| Charge of Judson Powder Pounds | Primer of 40% Dynamite Number of 1¼" x 8" Cartridges |
|---|---|
| 10 | 1 |
| 20 | 2 |
| 50 | 4 |
| 300 | 25 |

When several cartridges are used as a primer, they should be tied in a compact bundle with a primed cartridge in the center. If blasting cap and fuse are used in the priming cartridge, care should be taken in placing the primer to prevent any contact between the fuse and the Judson Powder R. R. P., as the latter is very inflammable. The charge should be firmly tamped.

Avoid being on the same side of the stump as the trench when the blast is fired, as fragments, etc., are thrown with more violence and to greater distances on that side.

The illustration on page 35 shows two large redwood stumps which had practically one root below the surface, the two trees having stood so close to each other that they grew together in the ground. The circumference of the stump just above the surface of the ground was seventy-five feet. This stump was completely removed, as shown on pages 37 and 39, with ninety-three pounds of Hercules Powder-Stumping L. F. Six trenches were dug under the stump at different points, five of these being loaded each with twenty-five 1½ x 8-inch cartridges of this explosive, and the sixth with thirty 1½ x 8-inch cartridges. These charges were then connected up electrically and the trenches were thoroughly and compactly tamped above the dynamite to the surface of the ground. The six charges were then fired simultaneously with a blasting machine. The illustration on page 35 shows the blasting machine used and the cartridges of Hercules Powder-Stumping L. F. on the ground preparatory to charging the trenches.

A CALIFORNIA REDWOOD STUMP—AFTER THE BLAST

The tree had been cut from this stump for twenty-five or thirty years, but the stump was perfectly solid. It made about thirty-five cords of wood

This stump had stood from twenty-five to thirty years, but was perfectly solid. It made about thirty-five cords of wood after it was blasted. See pages 11-16 and 31 for proper methods of priming, charging, tamping and firing.

### Cypress Stumps

Cypress stumps are found, as a rule, in swamps where the soil is a soggy muck often covered with water. These stumps have no tap root, but have large " spreaders " reaching out in all directions to such an extent that they are interwoven with those of neighboring stumps, forming a tangle of roots that never rot. Strong and quick dynamite gives the best results when blasting them. The common practice is to place 1¼ x 8-inch cartridges under each of the principal spreaders, and fire all simultaneously by means of a blasting machine. The cypress wood, being extremely soft, splits easily, and the dynamite shatters and releases the entangled roots.

Hercules 60% Dynamite is recommended for blasting cypress stumps. As the charges under the different roots should be exploded together for best results, electric fuzes and a blasting machine should be used. Many of the cypress swamps in the south have been drained by land reclaiming operations. When the stumps are blasted after the swamps are drained the explosive best suited for the work is Red Cross 40% Extra Dynamite. See pages 11 to 16 for proper methods of priming, charging, tamping and firing.

### Second-Growth Stumps

There is often directly under a second-growth stump the decayed remains of the original stump; this is soft, and the force of the explosive when placed on it seems to merely scatter this dead wood and has no marked effect upon the stump above. To overcome this difficulty, it is a good plan to dig under the stump and place a good-sized flat stone between the roots, leaving only room on top of the stone for the dynamite. Damp clay should then be firmly packed around the dynamite. This gives sufficient resistance to the explosive to enable it to lift out the stump. Red Cross 40% Extra Dynamite should be used. See pages 11 to 16 for proper methods of priming, charging, tamping and firing.

## FELLING TREES

Occasionally when clearing land of growing timber, it is of advantage to blast out the entire tree and saw off the root afterwards.

FELLING A TREE—THE BLAST

The process here is exactly the same as in stump blasting, but a little more dynamite is required to bring out the tree, roots and all, than to blast the stump after the tree has been cut. The blast lifts the tree straight up a foot or two; then it falls, generally with the wind. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## SPLITTING STUMPS AND LOGS

When stumps, particularly large ones, are blasted out whole or nearly so, it is usually necessary to split them up so that they can be conveniently handled or burned. This can be readily accomplished with dynamite; only a small quantity of explosives being required if the charge is properly tamped in auger holes bored part way through the stump.

In the South the pine stumps are very large producers of turpentine and by-products. Nothing is so effective as dynamite for breaking up a stump for this purpose. Charges of a few inches of Red Cross 40% Extra Dynamite, exploded simultaneously in several auger holes bored in the stump, will shatter it up into exactly the size required.

When logs are split up to be burned quickly, the same method is used as when splitting stumps; but if they are to be split for fence rails, cord-wood, charcoal, or other purposes where comparatively even and regular sections are required, Du Pont Blasting Powder should be used.

This explosive is so much slower in action than dynamite that a series of properly gauged and properly placed charges will split a log along the grain, just as evenly as if a number of wedges were used.

This method of splitting logs is so much quicker, cheaper and easier than any other, that those who have once become proficient at it never give it up. Auger holes are bored along the line of the grain, about one-quarter to one-half of the way through the log, the depth of the holes and the distance between them depending on the kind of wood, the grain, and the diameter of the log. A few ounces of FF Blasting Powder are put into the bottom of each hole, care being first taken to see that the hole is dry, then wooden plugs are driven firmly into the tops of the holes to tamp or confine the charge.

In some kinds of wood it is best to leave a considerable air space between the bottom of the plug and the powder. The plugs must have a groove in the side large enough to admit the electric squib

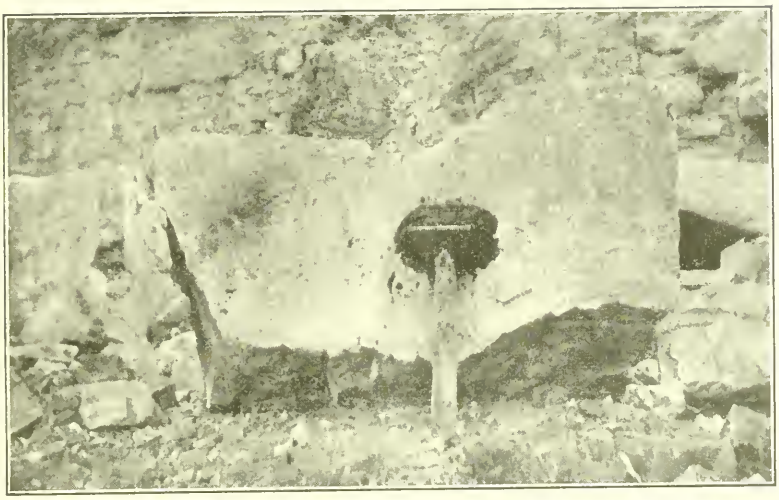
DU PONT DEMONSTRATORS BLASTING BOULDERS AT BENNINGTON, VERMONT, MAY, 1910

wires or the fuse. As blasting powder is exploded by a spark or flame it is not necessary to use a detonator with it. Electric squibs are similar in appearance to electric fuzes, except that they have a paper capsule instead of a copper cap. They do not explode when the electric current passes through them, but ignite the blasting powder by a flash. If electric squibs and a blasting machine are used for exploding the charges, they can all be fired simultaneously. This usually is the best and cheapest way, as a little less powder is required than when the charges are exploded separately with fuse. When using electric squibs, it is only necessary to have the groove or channel in the sides of the wooden plugs large enough for the two small wires to run through them, if the cap of the electric squib is put in place before the plug is driven in. When driving the plug care must be taken that the wires are kept free, and that the insulation on them is not damaged. If it is not convenient to provide wooden plugs in this work, damp clay tamping may be used on top of a wad of newspaper. A log two feet in diameter, and four or five feet long, can usually be split in two with one two-ounce charge of FF Blasting Powder. Longer logs require two or more holes, and logs of greater diameter require heavier charges. The holes should be from one and one-eighth to two inches in diameter.

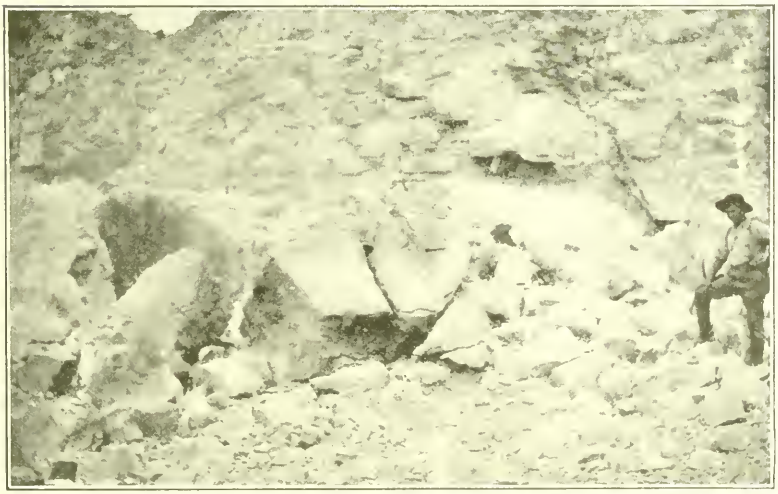
Logs may all be split into fairly regular sections with dynamite if care is taken not to use too much. To split a solid oak log ten feet long and four feet in diameter, two or two and a half 1¼ x 8 inch cartridges of Red Cross 40% Extra Dynamite are exploded in a hole drilled halfway through the log, midway between the ends. This will sometimes split the log in quarters if the charge is properly confined with tamping. Only about half as much dynamite is required to split a poplar log of this size. A two-foot pine log twenty feet long can be split in halves with a single 1¼ x 8 inch cartridge or less of Red Cross 40% Extra Dynamite exploded as described above.

## BOULDER BLASTING

There are three ways in which boulders can be blasted. These are known as "Mudcapping," "Snakeholing" and "Blockholing." "Mudcapping" and "Snakeholing" are the easier and quicker methods, but require more dynamite. It is almost impossible to shatter large round boulders of hard rock by either of these methods, without using an excessive quantity of explosives. See pages 11 to 16 for proper methods of priming, charging, tamping and firing.



THE MUDCAP IN POSITION



THE EFFECT OF THE BLAST

### MUDCAPPING

When blasting boulders by mudcapping them (also called "doby shooting" or "blistering") the charge of dynamite is packed closely against the surface on the top or side of the boulder, covered with mud and exploded. The charge should be placed on the spot which would be struck with a sledge if the boulder were small enough to be broken in that way and should be packed in a solid mass by slitting the paper cartridge shells, but not spreading them over the surface of the boulder any more than absolutely necessary. A blasting cap crimped onto fuse should be placed in the middle of the charge, and the whole covered with six inches of damp clay or sand. This should be pressed firmly over the mass of dynamite, care being taken not to cover the outer end of the fuse. If the boulder is deeply imbedded in the ground, it is best, before blasting, to dig away or loosen some of the earth surrounding it.

If the boulder is cracked or seamy, the charge should be placed in some depression and covered with a quantity of clay or sand. This will furnish more resistance and secure greater force from the explosives.

The quantity and strength of dynamite required naturally depend on the size and shape of the boulder. The "grain" and kind of rock are also important points. Hercules 60% Dynamite is best for mudcapping boulders. The following table gives approximately the number of 1¼ x 8-inch cartridges to mudcap boulders of different sizes, so that they will be broken into pieces small enough for one man to handle, provided the boulders are mostly above the surface of the ground.

| WEIGHT OF BOULDER | APPROXIMATE NUMBER OF 1¼" x 8" CARTRIDGES |
|---|---|
| 100 lbs. to 500 lbs. | ½ to 1½ |
| 1000 lbs. | 2 |
| 2000 lbs. | 3 |
| 3000 lbs. | 3½ |
| 4000 lbs. | 4 |
| 5000 lbs. | 4½ |
| 7500 lbs. | 6 |
| 10000 lbs. | 8 |

If boulders are largely buried in the ground they may be broken by doubling or trebling the above charges, but it is better under these conditions to lift the boulder out of the ground by snakeholing and then break it in pieces by mudcapping.

### SNAKEHOLING

In this method of breaking boulders the dynamite is placed in holes underneath them just as in stump blasting. The hole is made with a crowbar or dirt auger in such a direction that the charge of dynamite will be against the center of the lower side of the boulder. If the boulder is hollow or flat underneath, the explosion of the charge will break it in pieces and throw it out of its bed. If the lower side is round or bulging the boulder will be heaved out, but will not be so well broken. When this occurs the large pieces may be broken by mudcapping. Care should be taken when the charge is placed to leave no means by which the force of the dynamite may escape. If it has not been thoroughly tamped, or if it is too near the surface of the ground and not in the proper position beneath the boulder, the dynamite may blow the dirt out and leave the boulder untouched.

Hercules 60% Dynamite should be used when breaking up boulders in this way. Only from one-half to two-thirds the quantity that would be required to mudcap the same boulder is needed, provided it has a hollow or flat side underneath. The results are better in damp, heavy soil than in light or sandy soil.

### BLOCKHOLING

This is the most economical way to use dynamite in breaking up boulders, although it takes some time and labor to drill the one or more necessary holes in the boulder. The holes in large boulders should be an inch or more in diameter, while three-quarters or seven-eighths of an inch will answer for the smaller ones.

A boulder weighing from eight to ten tons can be well broken by drilling a one-inch hole in it near the center from eighteen to twenty-four inches deep, as the shape and grain of the rock may demand, and exploding in the hole two or three 1¼ x 8-inch cartridges of Hercules 60% Dynamite. As it is best to have the dynamite well down in the hole so that as much tamping as possible can be packed above it, the dynamite should be poured out of the shells and packed down into the hole with a stick. When it is all in place

a hole is made in it with a sharp stick and the blasting cap, crimped to the necessary length of fuse, is pushed down into this hole and held in position by carefully packing the clay tamping about the fuse.

To break up a boulder weighing approximately a ton a one-inch hole, eight inches deep, charged with from two-thirds to one cartridge of the same size and grade of dynamite, is required. Smaller boulders require holes from four to six inches in depth, which, if necessary, can be filled full of dynamite, and no tamping used.

## DITCHING

When properly used dynamite will excavate ditches entirely, cleaning them out to grade, giving the sides the correct slope and spreading the earth excavated over the land some distance away. In the same way much valuable land can be saved by blasting straight channels to straighten and shorten the course of creeks and streams. It is not necessary in this work to blast a large ditch or channel, for if the current is once started through a small one it will soon wash it out to the proper size.

The most satisfactory place to use dynamite for ditching is in wet heavy soil, even though it should be covered with several inches of water, and the best time to do this work is in warm weather. Ditches can, however, be dug economically and satisfactorily through dry ground.

To blast a ditch through swampy ground punch a row of holes with a bar an inch and a half in diameter down to within four inches of the grade of the ditch, spacing them from eighteen to twenty-four inches apart, and in such a position that the bottoms of the holes will follow the center line of the ditch. Some authorities put the holes straight down while others believe it best to have them on an angle of 45 to 70 degrees, all pointing toward the same side of the ditch. It is probable that the latter plan usually cleans out the ditch better. It also throws most of the earth in the direction that the holes are pointed. When the holes have been punched for four or five hundred feet, or for the entire ditch if it is shorter than that, from one-half to one 1¼ x 8-inch cartridge of Hercules 60% Dynamite should be dropped into each hole and pushed firmly to the bottom with a wooden stick. The charging of the holes should be started at the ends of the ditch and finished at the middle. The three last holes

1. BORING THE HOLES FOR A DITCH

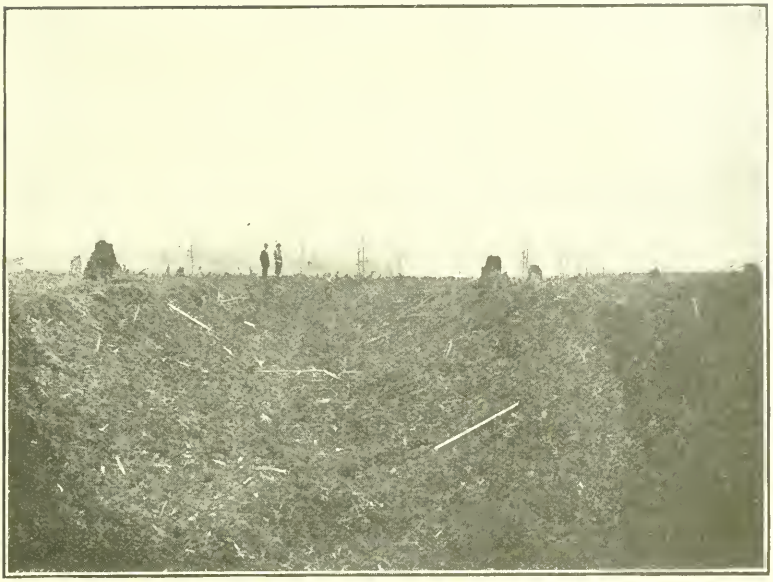
2. THE BLAST

should be charged with two cartridges each and the last cartridge loaded in the middle hole should be primed with a blasting cap, carefully crimped to the proper length of waterproof fuse. No tamping is required. Just as soon as the primer is in position everybody should be warned off the ditch and the fuse lighted, the blaster, of course, retiring to a safe distance. The charge in the middle hole explodes those in the holes on either side and the effect of these two is carried to the next ones and so on almost instantaneously to the opposite ends at the ditch. In this way ditches can be dug up to seven feet wide at the top, three and a half feet wide at the bottom and four feet deep, the width and depth depending on the depth and distance apart of the holes, whether each charge consists of one-half, three-quarters or one cartridge and the kind of soil and how wet it is. Cold weather also checks the action of the dynamite and it is necessary to use larger charges and put the holes closer together then than in warm weather. It is also necessary to use heavier charges and put them closer together when the ground is only moderately wet and heavy.

For ditches with a width at the top of from eight to fourteen feet, two rows of holes are necessary, all of the holes in both rows being pointed at an angle of 45 to 70 degrees toward the same side of the ditch. The holes should be the same distance apart in the rows, the same depth and charged with the same quantity and kind of dynamite as for the narrower ditches. The rows should be spaced as follows:

| TOP WIDTH OF DITCH | DISTANCE BETWEEN TWO ROWS OF HOLES |
|---|---|
| 8 ft. | 30 in. |
| 10 ft. | 36 in. |
| 12 ft. | 42 in. |
| 14 ft. | 48 in. |

Ditches from sixteen to twenty feet wide require three rows of holes with three to four feet between the rows and the holes the same distance apart in the rows as with the narrow ditches. In these wide

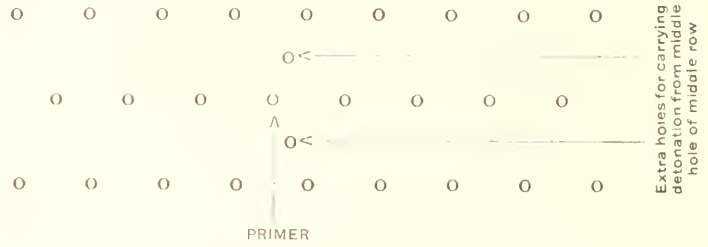


3. A MOMENT AFTER THE BLAST

4. THE COMPLETED DITCH

ditches it is generally necessary to load one and a half or two cartridges in each hole in the outside rows and two or three cartridges in each hole in the middle row. When there are two or three rows more than two feet apart the charges in the middle hole of each row should be primed with an electric fuze and exploded together with a blasting machine or else an extra hole should be put down midway between the middle holes of each row so that the effect of the explosion of the charge with the primer cartridge would not have to carry more than two feet.

When there are two or three rows of holes they are sometimes alternated or staggered as follows:




The entire cost, including labor and dynamite, of ditches from three to four feet deep, three feet wide at the bottom and five to seven feet wide at the top, is two cents to four cents per lineal foot or an average of about six and two-thirds cents per cubic yard excavated. Ditches requiring two or three rows of holes and those from four to six feet deep will cost one-half more to twice as much per cubic yard as the narrower and shallower ones.

Ditches through dry and light soil cost more than those in wet, heavy ground, but even then can often be dug cheaper with dynamite than in any other way. The effect of the explosion of one or two cartridges of dynamite cannot be depended on to carry for any material distance through dry ground and it is accordingly necessary in this work to prime each charge with an electric fuze so that as many as possible may be exploded together. When each charge is to be primed they can be spaced farther apart, the distance being regulated by the amount of ditch each cartridge will excavate. This is usually about two and a half feet and the holes are accordingly spaced that far apart in the rows. When more than one row of holes is necessary the distance between the rows should be the same as

when the work is in wet ground. In dry ground slower and weaker dynamite does the best work and for this ditching Red Cross 25% Extra Dynamite should be used.

If the line of the ditch is covered with a thick turf, sod or matted growth of any kind, the dynamite will do better work if this is first turned up with a plow for the full width and length of the ditch.

In most cases it will be found that the costs given above are rather higher than the average and that they can be materially reduced after some practice and experience. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## DRAINING SWAMPS AND PONDS

Swamps and ponds, except where they are close to rivers, lakes or the ocean, are caused by spring or surface water collecting on low ground without a lower outlet and which is underlaid by clay or other subsoil that the water cannot sink through. When it is not practicable to drain these swamps by ditching they can often be permanently dried up by shattering the impervious subsoil in the lowest places with dynamite. It is generally best to blast in three or four places and sometimes a row of holes spaced twenty to thirty feet apart, across the pond or swamp where the water is deepest, will give the best results. However, the number of holes necessary depends on the area to be drained and the thickness of the impervious soil or clay underneath. This is sometimes many feet in depth, but is usually from two or three feet to thirty or forty feet. To satisfactorily drain away the water above it is necessary to break this subsoil entirely through and to do this the holes for the dynamite should be drilled almost through it—say within two feet of the bottom—if gravel, sand or other open earth lies below the clay. In order to do this, a test hole to determine the exact thickness of the clay is of course necessary. The clay will not be properly shattered if the charge of dynamite is placed in the open ground below it as the explosion of the dynamite would then be more likely to make a large chamber or cavity in the sand or gravel than to shatter the clay above.

If the clay is underlaid by rock the holes should be bored down to the rock so that the force of the exploding dynamite will open fissures between the clay and rock or in the rock itself.

The holes are drilled with a two-inch dirt auger with pipe or rod extensions two or three feet long. If the place where the holes are

to be put down is covered with water too deep to work in, the boring should be done from a raft anchored in the proper position. It is much easier to operate the auger through a hole in the middle of the raft than over the side. When the impervious subsoil is thick, one extension after another should be added to the auger until the hole has reached the proper depth. Then the auger is withdrawn and a piece of two-inch pipe long enough to extend above the surface of the water is forced five or six inches into the top of the hole. Through this the dynamite cartridges are dropped, one or two at a time, and then pushed to the bottom of the hole with a wooden loading stick. A good firm push will hold each cartridge in position. The cartridge primed with the Victor Waterproof Electric Fuze is loaded next to the last, one cartridge being put on top of it to hold the primer in place, as it is not advisable to give the cartridge containing the detonator too hard a push with the loading stick. When the hole has been charged the loading pipe is withdrawn and slipped over the ends of the electric fuze wires, the leading wires are connected on to the electric fuze wires, the joints being carefully protected with insulating tape and the raft is poled to the shore or a safe distance away from the hole while the leading wire is carefully paid out. The outer ends of the leading wires are then attached to the blasting machine, the operation of which explodes the charge. It is unnecessary to do any tamping in this work if the holes are filled with water. The cartridges should not be slit. The best explosive to use is Red Cross Extra 40% Dynamite. The following table gives the approximate charge for holes of different depths:

| DEPTH OF HOLE | APPROXIMATE NUMBER OF 1¼" x 8' CARTRIDGES |
|---|---|
| 5 ft. | 4 |
| 10 ft. | 7 |
| 15 ft. | 12 |
| 20 ft. | 17 |
| 30 ft. | 25 |
| 40 ft. | 35 |

Where the ground is swampy or ponds form in the wet season only and dry up later in the year, the blasting should be done in the dry season when a raft will not be required. This blasting should be

GRADING A ROAD—THE BLAST

done just as described above except that it is necessary to tamp the charge thoroughly unless the bore hole fills up with water. In this work it is sometimes of advantage to make a chamber in the bottom of the hole by first exploding a single cartridge in the bottom. This makes it possible to get more of the main charge in to the bottom and break the rock or subsoil better. The explosion of the single cartridge may close the hole a little, but it can easily be opened again with the auger or an iron rod. The main charge must never be loaded immediately after chambering, but a half hour or more allowed for the bottom of the bore hole to cool off. This plan of chambering the bottom may also be followed when water fills the bore holes.

See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## ROAD BUILDING

Road grading and ditching always take more or less digging, but by using dynamite to loosen up the hard ground or shale, and to blast out the rock they can be built quickly and at comparatively little expense.

To blast cuts not more than five feet deep through hard earth or shale a bar should be driven down to within six inches of grade and one or two 1¼ x 8-inch cartridges of Red Cross 40% Extra Dynamite be exploded in the hole thus made. Be sure to first tamp the charge properly. Holes should be spaced five to eight feet apart. In this way the material to be removed is not only broken up so that it can be shoveled very easily, but a good portion of it is spread over the surrounding land and does not have to be handled.

Roads can be ditched with but little shoveling, by exploding about half a cartridge of the same dynamite in holes along the sides a foot deep and two to three feet apart.

If it is necessary to cut through rock, the holes should be drilled closer together and charged heavier. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## EXCAVATING CELLARS AND TRENCHES FOR FOUNDATIONS

If the work is in rock, drill holes four feet deep and two and a half to three feet apart. Charge with one or one and a half 1¼ x 8-inch cartridges of Red Cross 40% Extra Dynamite. As hand drills are not often larger than one inch in diameter it will be necessary to

pour the dynamite out of the shells and pack it in the bottoms of the holes with a wooden stick exactly as when blockholing a boulder as already described. The priming and tamping are also done as when blockholing boulders. After one cut or bench has been taken out in part or over the entire surface of the cellar or trench, the second cut of three or four feet may be commenced and the excavating continued in this way until the proper depth is reached.

When the cellar foundations are to be in earth or shale the blasting is done as in road grading already described. A small shallow cellar not larger than fifteen by twenty feet nor deeper than four feet can be economically excavated in earth almost entirely and with practically no shovelling by drilling holes three feet apart each way and three feet nine inches deep and exploding in each one a 1¼ x 8-inch cartridge of Hercules 60% Dynamite. The explosion spreads practically all of the earth excavated over the adjacent ground for some distance.

The charges should each be primed with an electric fuze, should be well tamped, and be all exploded together with a blasting machine. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

### TRENCHING FOR TILING AND PIPE LINES

This work can be done by using dynamite as when blasting ditches. The holes should, however, always be pointed straight down and the charges should be slightly reduced so as to prevent throwing the earth, required for filling the trenches, too far away.

## SINKING WELLS

Wells are generally sunk through rock or ground which cannot be dug to advantage without the aid of explosives. In well sinking, when rock is reached and the earth or sand above is properly shored, a circle of four or five drill holes should be started about half-way between the center and the sides of the well and pointed at such an angle that they will come close together near the center when they are three or four feet deep. These holes should be loaded about half full of Hercules 40% Gelatin Dynamite, with damp clay tamping packed firmly above to the top of the hole, and then exploded all together from the surface by electricity. The result of this shot will be to blow out a funnel-shaped opening in the center, and the bottom

can then be squared up with another circle of holes drilled straight down as close to the sides as possible. If the well is large it may be necessary to drill a circle of holes between the inner and outer circle. The above process should be repeated until the well has passed through the rock or has been sunk to the necessary depth. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## DIGGING HOLES FOR POLES AND POSTS

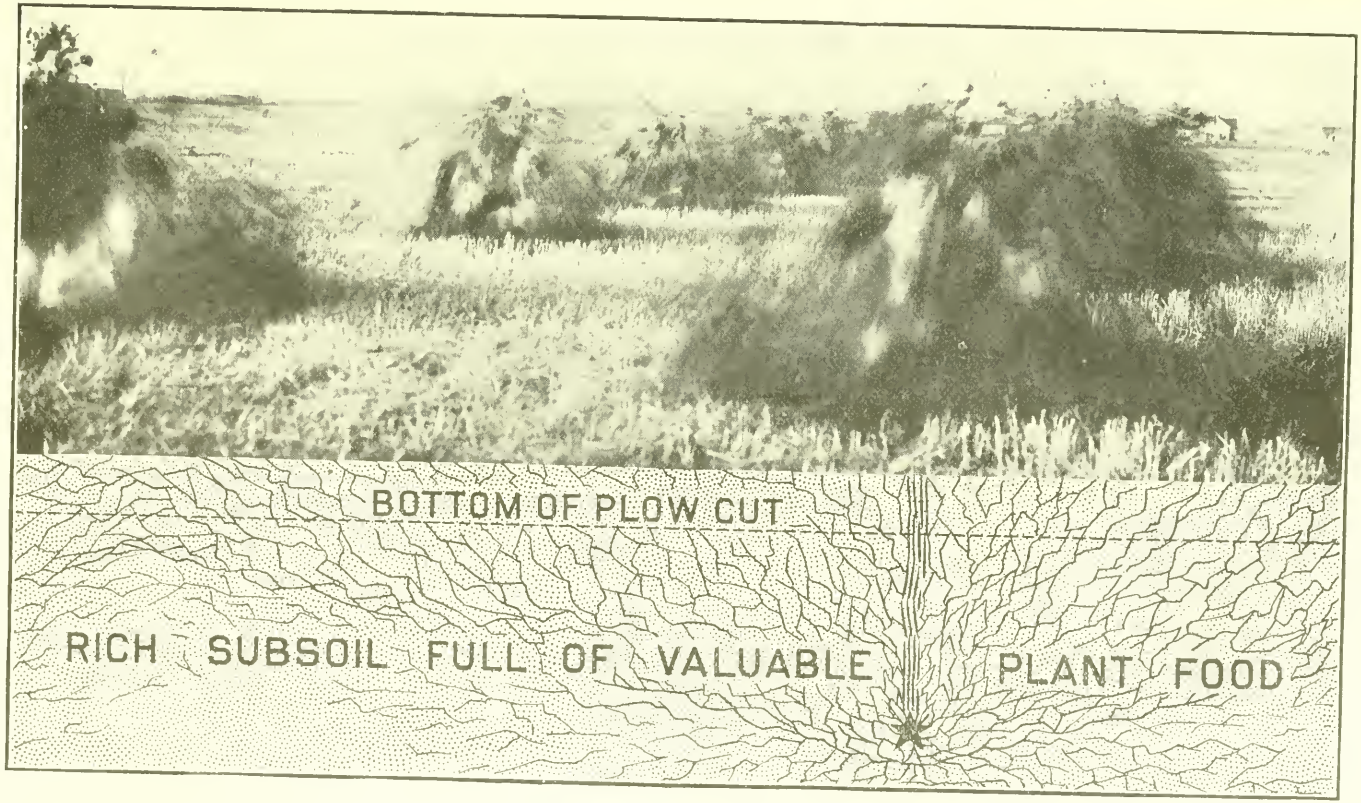
Only enough dynamite should be used in this work to make the digging easy because larger charges loosen the ground to such an extent that it is difficult to make the poles or posts as firm as they should be. This applies particularly to large poles.

To do this blasting a hole is bored into the ground within six inches of the desired depth of the hole. In the bottom of this hole from one-quarter of a cartridge to one cartridge of Red Cross 40% Extra Dynamite is exploded. No tamping should be done, as this would cause the dynamite to lossen the ground too much. See pages 11 to 15 for proper methods of priming, charging and firing.

## SHATTERING SUBSOIL AND HARDPAN

In the ordinary clay subsoil and in plow soil holes should be spaced fifteen to twenty feet apart each way and drilled from two and a half to three feet deep. Each of these should be charged with a half of a 1¼ x 8-inch cartridge of Red Cross 25% Extra Dynamite primed with blasting cap and fuse. The holes should then be filled compactly with tamping to the surface. Holes may be put down either with the subsoil bar or with a dirt auger. The explosion of the charge should not affect the surface much because most of the force of the dynamite is given to breaking and shattering the subsoil from seven to ten feet around the hole.

When blasting hardpan the holes should be bored to within about six inches of the bottom of the hardpan and the charge of dynamite placed at that point, the object being to shatter the greatest area possible and not to merely make a chamber in the ground underneath it. The spacing of holes and kind of dynamite should be approximately the same as when blasting ordinary subsoil. In some places, however, where the hardpan is unusually thick and deep, it is necessary to use two-thirds of a cartridge or a whole one in each hole.




SUBSOIL CROSS-SECTION ELECTRIC BLAST

In some kinds of hardpan, like cemented gravel, it may be necessary to vary a little the instructions given above. These instructions will, however, answer for a guide until practice shows that some slight changes in the way of blasting these irregular hardpans will be of advantage. If properly done it may not be necessary to blast subsoil or hardpan more often than once in ten years.

The results are better if subsoil blasting is done when the ground is fairly dry because wet subsoil is not so easily cracked and shattered as that which is dryer.

Table Showing the Approximate Number of Pounds of Dynamite Required and the Approximate Cost, Including Explosives, Blasting Supplies and Labor, to Blast an Acre of Subsoil or Hardpan.

| Distance Between Holes Each Way | No. of 1¼" x 8" Cartridges of Red Cross 25% Extra Dynamite | Approximate Number of Pounds of Dynamite per Acre | Approximate Cost Including Dynamite, Blasting Supplies and Labor |
|---|---|---|---|
| 20 ft. | ½ | 27½ lbs. | $ 9.00 |
| 15 ft. | ½ | 50 lbs. | 16.00 |

See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## PLANTING AND CULTIVATING TREES, GRAPEVINES, ETC.

The principal object when using dynamite in planting and cultivating fruit and other trees, grape-vines, etc., is to open up the subsoil so as to make room for root growth, conserve moisture and to properly drain the surface. This work is, therefore, very much the same as subsoil blasting. When preparing the ground for new trees the holes are generally bored about thirty inches deep on the spot where the tree is to stand and are charged with one cartridge each of Red Cross 25% Extra Dynamite primed with fuse and blasting cap. In many places it is the custom to shovel off the fertile top soil in a circle about the hole before blasting and to pile this to one side for filling up the blasted hole to the proper level.

When cultivating orchards by blasting between the trees the spacing of the holes depends on how far apart the trees are planted and the condition of the subsoil. In California and other States where many orchards grow over hardpan, holes are often drilled

from three to five feet deep and sometimes only six feet away from the trees. When the holes are within six feet of the trees the charge is reduced to three-quarters or a half of a cartridge. The general rule, however, when cultivating fruit trees, is to bore the holes three feet deep midway between the trees on diagonal lines when they stand fifteen to twenty feet apart, midway between them on square lines when they are twenty to thirty feet apart and on three sides of each tree ten feet away from it when they are more than thirty feet apart.

## CHART I

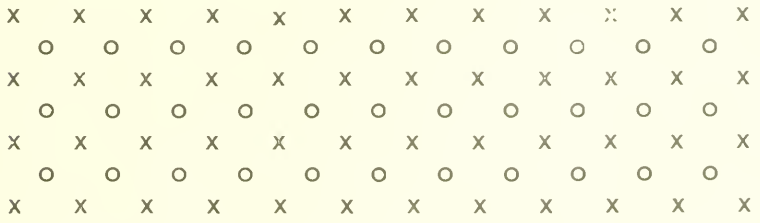


Diagram showing location of holes for blasting when trees are 15 feet to 20 feet apart
X = tree; O = hole for dynamite

## CHART II

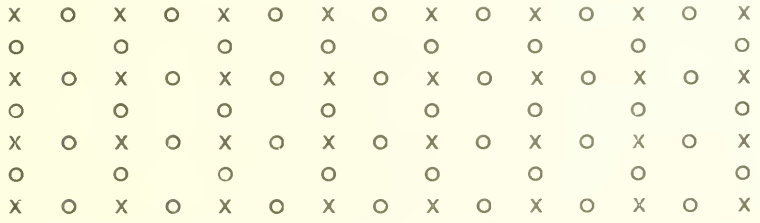


Diagram showing location of holes for blasting when trees are 20 feet to 30 feet apart
X = tree; O = hole for dynamite

## CHART III

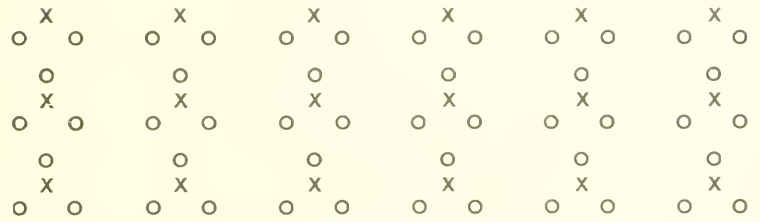


Diagram showing location of holes for blasting when trees are more than 30 feet apart
X = tree; O = hole for dynamite

Table showing Location of Holes, Average Number of Holes per Acre, Average Amount of Red Cross 25% Extra Dynamite 1¼" x 8" per Acre and Approximate Cost of Cultivating an Acre Including Dynamite, Blasting Supplies and Labor, when Trees are Planted at Different Distances.

| Distance of Trees Apart | Location of Hole for Dynamite | Number of Holes per Acre | Amount of Dynamite per Acre | Cost of Blasting an Acre Including Dynamite, Blasting Supplies and Labor |
|---|---|---|---|---|
| 15 ft. | Midway Between on Diagonal Lines | 194 | 97 lbs. | $25.00 |
| 18 ft. | " " " " " | 134 | 67 lbs. | 18.00 |
| 20 ft. | " " " " " | 109 | 55 lbs. | 13.50 |
| 25 ft. | " " " Square " | 140 | 70 lbs. | 19.00 |
| 30 ft. | " " " " " | 96 | 48 lbs. | 12.50 |
| 35 ft. | Ten Feet from Tree on Three Sides | 108 | 54 lbs. | 13.50 |
| 40 ft. | " " " " " " " | 78 | 39 lbs. | 10.50 |
| 50 ft. | " " " " " " " | 51 | 26 lbs. | 7.00 |

When an old tree is to be blasted out to make room for a new one, proceed as explained on page 40. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## BLASTING ICE

Ice gorges are prevented by shattering the large floating cakes with dynamite so that they will not lodge at dams or in the narrow parts of the stream. To break these cakes several cartridges of dynamite tied together in a bundle are laid on the ice and exploded. This is repeated until the cake is thoroughly shattered and broken up. The size of the charge and the number of times the blasting must be repeated depend altogether on the thickness of the ice and the size of the cake. One cartridge of the bundle is primed with blasting cap and fuse and the dynamite must be thoroughly thawed when it is laid on the ice. This blasting can be done best along broad, slow-moving parts of the stream where it is easy to get on to the ice cakes either from the shore or from boats. When the streams are narrow the charges of dynamite may be thrown on to the ice from the shores or, if the ice is running swiftly, they may be dropped on to the cakes from the down-stream side of bridges. When the charges, consisting

of two or more cartridges tied together in a bundle, are to be thrown on to the floating ice either from bridges or the shore a block of wood, piece of board or something of that kind should be tied to the charge to keep it from rolling out of position after it lands on the ice. As it is necessary when blasting ice in this way to light the fuse while the dynamite is in the hands of the blaster, particular attention must be given to having the fuse plenty long enough and the charge must be thrown just as soon as the fuse is lighted.

The following table gives the approximate quantity of Red Cross 40% Dynamite required to break floating ice cakes of different thickness when the dynamite is exploded on the surface of the ice. The number of charges necessary depends on the size and extent of the ice cake:

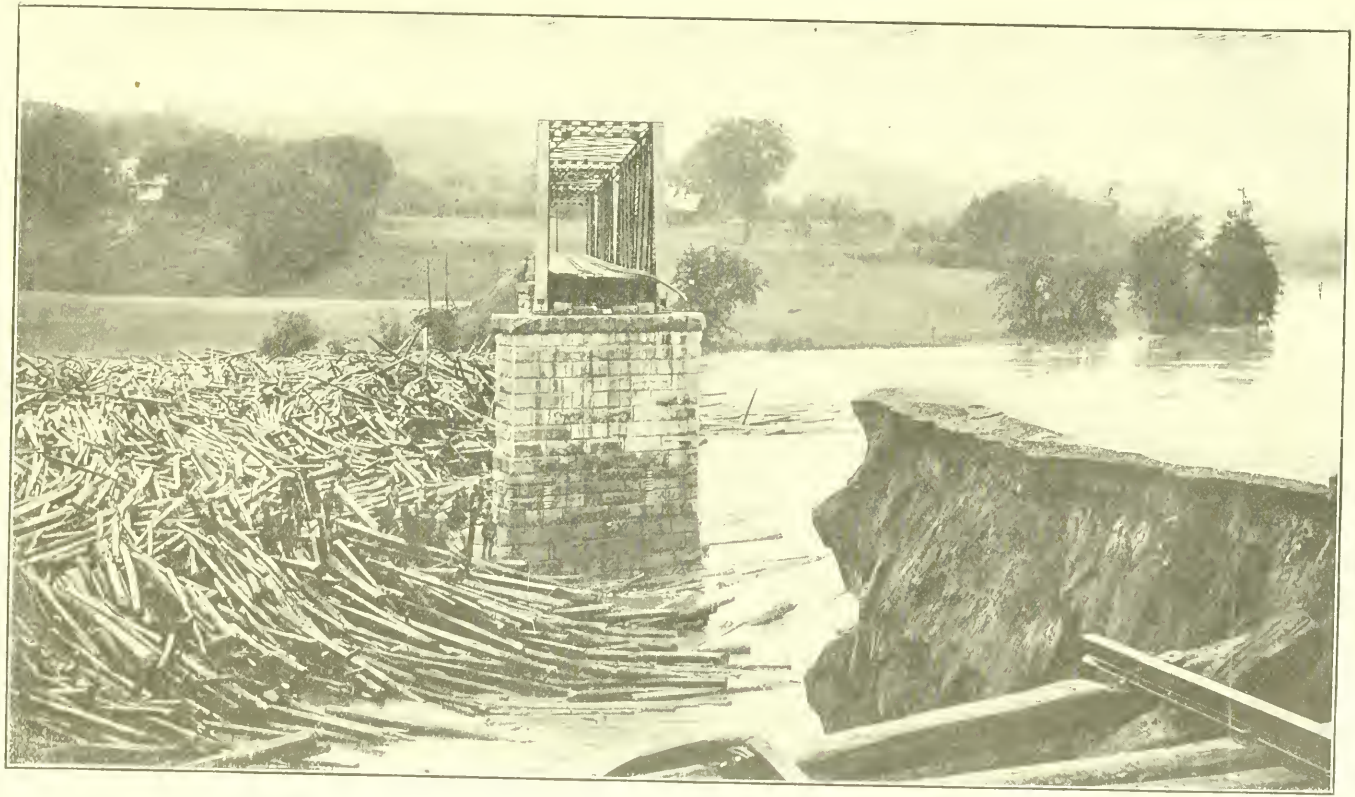
| Thickness of Ice Cakes | Approximate Number of $1\frac{1}{4}$" x 8" Cartridges |
|---|---|
| 12 in. | 2 to 3 |
| 24 in. | 6 to 8 |
| 36 in. | 10 to 12 |

To open ice gorges already formed, a channel should be cut through them beginning on the down-stream side and working up stream along the line of the strongest current. This channel should be about fifty feet wide, and if the gorge does not move after the channel has been cut through, it will then be necessary to begin at the down-stream side of the gorge again and widen the channel until the ice has been carried away.

To cut the channel, holes are cut with an ax or bar through the ice twenty to thirty feet apart. These holes are laid out in a semi-circle with the two end holes about twenty to thirty feet back from the open water and fifty feet apart.

DIAGRAM SHOWING LOCATION OF ROW OF HOLES FOR BLASTING AN ICE GORGE

The charge, consisting of several 1¼ x 8-inch cartridges of Red Cross 40% Dynamite, is tied securely together with string, one of the cartridges having been primed with a Victor Waterproof Electric Fuze. When the charges for all of the holes are prepared they are connected together and to the leading wires. Each charge is then lowered by the electric fuze wires into the water and pushed under the down-stream ice with the tamping stick. If the current is strong enough to carry the charge down stream the electric fuze wires should be long enough to let it float six or eight feet below the holes. The explosion of all of these charges simultaneously by the operation of the blasting machine, will break up the first fifty or sixty feet of the channel and the broken ice will immediately float away unless the current of the stream is very sluggish. In that case the broken ice should be pushed out with poles into open water before it has time to freeze in place again. This same operation is repeated, cutting out fifty or sixty feet or more of the channel with each blast until the gorge has been cut through. If the ice is from two to four feet thick the charge in each hole should be from two to five 1¼ x 8-inch cartridges of Red Cross 40% Dynamite. In ice six to eight feet thick, each charge must be increased to ten or twelve cartridges. When the ice is thick, and large charges are necessary, the holes have to be from six to twelve inches in diameter in order to get the bundle of cartridges through them. These large



A PLACE WHERE A FEW DOLLARS' WORTH OF DYNAMITE USED AT THE RIGHT TIME MIGHT HAVE SAVED THOUSANDS OF DOLLARS

holes can be cut through the ice more easily by exploding half cartridges of the dynamite in small holes made with bars.

In this work particular attention should be given to having the dynamite in a well-thawed and soft condition when it is used.

Ice is blasted from watering places for stock either by exploding the dynamite on the ice or in the water under the ice. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## STARTING LOG JAMS

To start log jams with dynamite the charge of several cartridges or in some instances of many pounds of dynamite is exploded on or under the logs forming the key of the jam. If smaller charges are enough, the cartridges are tied in a bundle as when blasting ice. If charges of fifty pounds or more are necessary the dynamite may be put in a bag or left in the original wooden cases. The charge is primed with a Victor Waterproof Electric Fuze and after being firmly secured in the proper position is exploded from the shore with a blasting machine.

Blocks in log rollways caused by rain and snow freezing and binding the logs together are broken up by exploding charges of dynamite in different places under the logs until they are loosened and can be rolled apart.

Red Cross 40% Dynamite is recommended for starting log jams and for opening the rollways. See pages 11 to 15 for proper methods of priming, charging, tamping and firing.

## OTHER USES FOR DYNAMITE ON THE FARM

After becoming thoroughly acquainted with the use of dynamite for any or all of the work described in the previous pages many other uses for small quantities of it will arise from time to time. If the instructions already given do not appear to cover the situation a letter addressed to Agricultural Department, E. I. du Pont de Nemours Powder Co., Wilmington, Delaware, explaining the work to be done, will be promptly answered, giving detailed instructions.

# SAFETY PRECAUTIONS

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, because a spark may ignite them.

DON'T shoot into explosives with a rifle or pistol either in or out of a magazine, for the impact of a bullet will generally detonate explosives.

DON'T leave explosives in a field or any place where stock can get at them. Cattle like the taste of the soda and saltpetre 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, because an accidental explosion might then cause great loss of life.

DON'T leave explosives in a wet or damp place, because dampness may quickly injure them. They should be kept in a suitable dry place, not too warm, 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 tamp with iron or steel bars or tools, because the metal tools may detonate the explosives. Use only a wooden tamping stick with no metal parts.

DON'T *force* a primer into a bore hole, because the detonator which it contains is somewhat sensitive to shock and might explode if pushed with much force against the side or bottom of the 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, because fuse sometimes burns more slowly than it is expected to.

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

DON'T cut dynamite cartridges with a folding knife. Use a sharp case-knife. A little dynamite might get into the joint of a pocket knife, and explode when the blade is snapped open.

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 frozen or chilled dynamite, because it is insensitive and may not do good work. 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, because we recommend all of the safe ones.

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, because dynamite explodes very easily when it becomes hot.

DON'T take dynamite into or near a blacksmith shop or near a forge on open work, because sparks may fall upon it.

DON'T put dynamite on shelves or anything else directly over steam or hot water pipes or other heated metal surface, because some of the nitro-glycerin in it might soak out and drop on to the hot metal and cause an explosion.

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 place a hot-water thawer over a fire, because there is usually some nitro-glycerin in these thawers which would be exploded by the heat, and never put dynamite into hot water or allow it to come in contant with steam, as this damages the dynamite.

DON'T allow thawed dynamite to remain exposed to low temperature, but use as soon as possible, for some kinds freeze again very quickly in cold weather.

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, because a lightning flash may explode the electric fuzes.

DON'T carry blasting caps or electric fuzes in your pocket, for if you do and they explode accidentally you will be badly injured.

DON'T tap or otherwise investigate a blasting cap or electric fuze, because they are quite sensitive to shock.

DON'T attempt to take blasting caps from the box by inserting a wire, nail or other sharp instrument, because the metal rubbing against the explosive in them might cause them to explode.

DON'T try to withdraw the wires from an electric fuze, because this might cause it to explode.

DON'T fasten a blasting cap to the fuse with the teeth or by flattening it with a knife, because this is dangerous and also makes a very imperfect joint. Use a cap crimper.

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

DON'T attempt to use electric fuzes with the regular insulation in very wet work, as they may become damp and fail to explode. For this purpose secure Victor Waterproof Electric Fuzes.

DON'T store or transport blasting caps or electric fuzes with dynamite, because they are more easily exploded by shock or heat than is dynamite, and when they explode will probably detonate the dynamite near them.

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 operate blasting machines half heartedly. If you do you can't be sure they will do the work required of them. They are built to be operated with full force. They must be kept clean and dry.

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

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

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

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 dynamite to do good work if you try to explode it with a detonator weaker than a No. 6 (red label).

## IS DYNAMITE DANGEROUS TO USE?

These numerous "DON'TS" are not intended to frighten anyone. If they are carefully read it will be found that there is nothing alarming about them. We simply aim to mention every possible danger connected with the use of dynamite. There is no part of our instructions, however, that is not very simple and very easily followed, and when these proper precautions are taken no one need have any more fear of working with dynamite than with gasoline, steam or any other similarly powerful agent.

One of the safest explosives manufactured by the E. I. du Pont de Nemours Powder Company is Red Cross Dynamite (Low Freezing) which is especially recommended for agricultural purposes. In practice this brand of dynamite is exploded by a powerful shock, such as is produced by a strong blasting cap or an electric fuze.

Approximately half a million people are using dynamite every day. These include miners, blasters employed on road and railroad construction, quarrymen, and many others. Careful record of all accidents to users of dynamite in the year 1910 show casualties of less than 1/8 of 1%, and most of these accidents are known to have been caused by failure to observe the simple and clear precautions such as we list in this book. The only reason so many people fear dynamite is because it is something that they do not understand. They are not accustomed to handling it or using it, but because they know of its power they fear it.

Mr. E. S. Harding of Amhurst, Va., had never used dynamite up to September 28, 1911. He was afraid of it, but after experimenting with it in the blasting of stumps on his farm, he wrote us as follows:

"I had always thought, with many others, that dynamite was only for experts, and dangerous to handle, but now realize that if your instructions are obeyed it may be safely handled by anyone having ordinary common sense."

Mr. B. P. Moats, President of the Rosemar Orchard Company of Parkersburg, W. Va., says:

"We used approximately a ton of dynamite this season without the slightest accident. The men become familiar with its use and do not consider the labor hazardous."

## HOW TO GET SPECIAL INFORMATION

In writing this Handbook, we have attempted to give all general information possible, and wherever possible have explained details of the approved methods of clearing land of stumps and boulders, subsoiling, draining swamps and ponds, digging ditches, etc. Nevertheless many unusual conditions in connection with these various kinds of blasting may be met with which are not covered fully enough to make it possible for the reader to proceed with the particular kind of blasting he desires to do, without considerable uncertainty. If this happens, we would be very glad to have you write us stating exactly what your difficulties are, and on receipt of your communication we will be glad to do what we can to help you out. In order to save writing we attach the following perforated sheets, one or more of which can be taken from the Handbook, filled out and mailed to us. The first of these is to be used if stump, tree or boulder blasting is to be done, the second for subsoiling, the third for draining swamps or ponds, the fourth for ditching, the fifth for tree planting or cultivating, the sixth for all other kinds of blasting.

# LEARN TRAP SHOOTING

## AN ALL YEAR ROUND SPORT

Closely parallels actual hunting conditions. The open air—the sudden, swift flight of the bird—the opportunity for quick, accurate shooting—all combine to make trap shooting

## Fascinating and Healthful

Quickly develops the new shooter into a skilled shot because of the opportunity for regular and continuous practice under favorable conditions and pleasant surroundings.

Trap shooting keeps the old hunter from getting rusty between game seasons. The clay pigeons fly every day in the year.

Join your local Gun Club—If there's none nearby, start a gun club. We will help.

Our Gun Club Booklet explains how to go about organizing a club, the rules of the game, etc. Write for it. It's free.

**E. I. du Pont de Nemours Powder Co., Wilmington, Del.**

DU PONT

# SPORTING POWDERS

## MAKE AND BREAK RECORDS AT THE TRAPS

— AND —

## ARE UNEQUALLED IN THE FIELD

DU PONT SMOKELESS SPORTING POWDERS ARE CHEMICALLY PURE AND WILL NOT PIT THE GUN BARRELS

"E.C." REG. U.S. PAT. OFF.

BALLISTITE
A PERFECT DENSE SMOKELESS POWDER

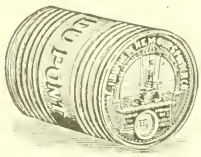
DU PONT

SCHULTZE

EMPIRE
A PERFECT BULK SMOKELESS POWDER

## BLACK SPORTING POWDERS

UNEQUALLED FOR SHOTGUNS AND RIFLES






Perfection in Sporting Powders is only obtained by the employment of the most skillful workmen, the operation of the most improved machinery and the exercise of the most scrupulous care in the selection and preparation of raw material.

Du Pont Sporting Powders are Fully Guaranteed by the Pioneer Powder Makers of America.

SPORTING POWDER LITERATURE SENT ON REQUEST

**E. I. du Pont de Nemours Powder Co., Wilmington, Del.**

# STUMP, TREE OR BOULDER BLASTING

Agricultural Department,

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

I am about to do some blasting under conditions which are not altogether covered in your Farmer's Handbook, and would like to have you furnish me with the technical information which I ask for below. I have filled out the answers to your questions on the back of this sheet describing my problem, and also give you additional information below.

## Description of my problem and what I want the Du Pont Company to tell me

OVER

## Questions that the Du Pont Company Wishes Answered

*Do you want to blast out Stumps, Trees or Boulders?*

*How many acres do you want to clear?*

*About how many Stumps, Trees or Boulders to the acre?*

*What is the nature of the soil?*

*Will the ground be wet or dry when you will do the blasting?*

*When do you expect to do this?*

*What is the average diameter two feet above the ground of stumps or trees?*

*What is the diameter of the largest ones?*

*What is the diameter of the smallest ones?*

*What kind of wood are they?*

*Are the principal roots spreading roots or tap roots?*

*How long since the trees were cut from the stumps?*

*Are the stumps solid, or hollow and rotten?*

*Are you going to burn the stumps after blasting them out?*

*How high are the trees?*

*What kind of rock are the boulders?*

*What size and shape are they?*

*Are they on top of the ground or partly buried?*

*What is your name?*

*What is your post office address?*

# SUBSOILING

Agricultural Department,

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

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OVER

## Questions that the Du Pont Company Wishes Answered

*How many acres do you want to subsoil?*

*When do you expect to do it?*

*What is the nature of the surface soil?*

*How thick is the top soil?*

*What is the nature of the subsoil or hardpan?*

*How thick is it?*

*What is under the subsoil or hardpan?*

*Is your land flat, rolling or hilly?*

*Is the ground well drained, or is it swampy?*

*Is the land irrigated?*

*What was the last crop?*

*Have your crops been suffering from too much or too little moisture?*

*What crop do you expect to plant first after blasting?*

*What is your name?*

*What is your address?*

# DRAINING SWAMPS AND PONDS

Agricultural Department,

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

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## Description of my problem and what I want the Du Pont Company to tell me

OVER

## Questions that the Du Pont Company Wishes Answered

*How large is the swamp or pond?*

*How deep is the water in the deepest place?*

*Is it fed by springs or by surface drainage?*

*How thick is the clay under the swamp or pond?*

*Is there rock, sand or gravel under the clay?*

*Is there a river, lake or other large body of water near?*

*If so, how much higher is the pond or swamp than the body of water?*

*Is the pond or swamp permanent or does it dry up at certain seasons?*

*What is your name?*

*What is your address?*

# DITCHING

Agricultural Department,

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

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## Description of my problem and what I want the Du Pont Company to tell me

OVER

## Questions that the Du Pont Company Wishes Answered

*How long are the ditches to be?*

*How wide and how deep must they be?*

*What is the nature of the ground?*

*Is it wet, damp or dry?*

*Is it covered with thickets, woods or other growth or is it open?*

*What is your name?*

*What is your post office address?*

# TREE PLANTING AND CULTIVATING

Agricultural Department,

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

I am about to do some blasting under conditions which are not altogether covered in your Farmer's Handbook, and would like to have you furnish me with the technical information which I ask for below. I have filled out the answers to your questions on the back of this sheet describing my problem, and also give you additional information below.

## Description of my problem and what I want the Du Pont Company to tell me

OVER

## Questions that the Du Pont Company Wishes Answered

*Are you going to blast between old trees or blast the holes for new ones?*

*How far apart each way are the trees?*

*What kind of trees are they?*

*How old are they?*

*Are they thrifty and bearing well?*

*If not, what is the matter with them?*

*How far apart each way will you plant new trees?*

*How deep will you plant them?*

*Have you planted trees in similar ground before?*

*If so, what per cent. lived?*

*Is the orchard on flat, rolling or hilly ground?*

*What is the nature of the soil?*

*Is the ground too dry or too wet?*

*What is your name?*

*What is your post office address?*

## Well Sinking, Opening Log Jams and Ice Gorges, Post Hole Digging, Road Grading, Cellar Excavating, etc.

Agricultural Department,

E. I. du Pont de Nemours Powder Co., Wilmington, Del.

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### Description of my problem and what I want the Du Pont Company to tell me

OVER

*NOTE:*—It is very necessary that a complete description of the conditions surrounding the work you desire to do be given us if we are to give you the information that you need.

*What is your name?*_____

*What is your post office address?*_____

DU PONT

# Branch Offices

Birmingham, Ala.
Boston, Mass.
Buffalo, N. Y.
Chicago, Ill.
Cincinnati, Ohio
Denver, Col.
Duluth, Minn.
Hazleton, Pa.
Houghton, Mich.
Huntington, W.Va.
Joplin, Mo.
Kansas City, Mo.
Memphis, Tenn.
Mexico City, Mexico
Nashville, Tenn.
New Orleans, La.
New York, N. Y.
Philadelphia, Pa.
Pittsburg, Kas.
Pittsburgh, Pa.
Portland, Ore.
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Seattle, Wash.
Spokane, Wash.
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St. Louis, Mo.
Terre Haute, Ind.

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