DU PONT

# Hand Book *of* Explosives

Instructions in the Use of Explosives

*for*

Clearing Land, Planting and Cultivating Trees, Drainage, Ditching, Subsoiling and other Purposes

E. I. du Pont de Nemours & Company
Established 1802
Wilmington, Delaware

A 540 (May, 1917)

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# The Under-Sized Farm

Every possible acre of the farm should be used to its maximum capacity. The few acres of waste land on one farm is a personal matter that deserves the immediate attention of the individual farmer. The total aggregate of these spots is enormous and of the most serious concern to the nation.

The causes of waste land usually are: stumps, boulders, wet spots, gullies and hardpan. The two accompanying sketches are to show how one or all of these troubles may reduce the workable size of the farm, and the farm after being made full size.

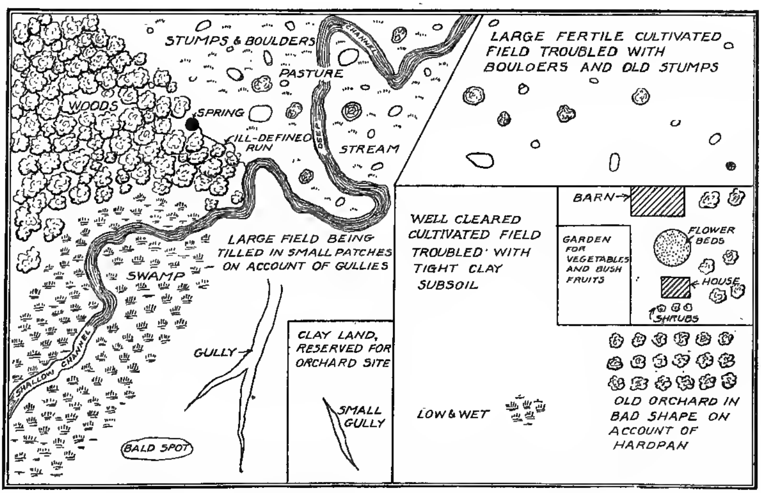
Stumps cause "Loafer Land" by taking up space in the fields, by prohibiting economical cultivation, by making breeding places for weeds and crop pests, and make the farm unsightly. Our sketch shows them encumbering the most fertile field on the farm, and preventing the bringing of the back pasture into the much needed rotation.

Boulders offer the same general troubles as stumps and are shown assisting the stumps in dwarfing our farm.

The overflow caused by the shallow, crooked stream channel takes away more good land and replaces it with a swamp that breeds disease and does not even afford good pasture. The spring and its shallow outlet make this condition still worse.

A part of the back fields are gullied and cut up into small patches that cannot be handled successfully. The fertile surface has been washed away. The bald or galled spots will not produce because there can be no storage of moisture and no humus.

The tight clay cuts off the under side of the farm and is always effective in reducing the productive size of the farm by taking from it the third dimension—depth. It reduces yields of field crops and kills or stunts the trees.




THE UNDER-SIZED FARM SHOWING HOW THE PRODUCTIVE AREA IS REDUCED BY DEFECTS THAT BLASTING WILL CORRECT

Our farm looks bad. It is not full sized, being only one-third efficient in crop production. It is typical in one feature or another of practically every farm.

The desire is for the use of all the land, large fields, good crops, a good orchard, a bounteous garden and an attractive house.

In changing this abject proposition to a full-sized farm we naturally want to begin on the easiest places.

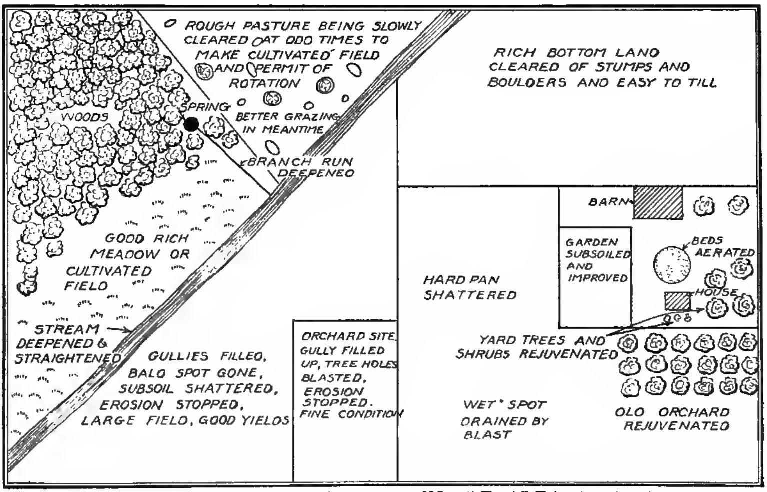
The otherwise good bottom has but to be rid of stumps to make it conform to the highest ideals of the owner. These stumps are old and dead, and but small charges of explosives are required to dispose of them.

The gullies and bare spots in the big field follow next, as a line of lightly loaded charges will tumble the gullies so near full of soil that they can be plowed across and brought into actual cultivation. Subsoil shattering and a coating of manure will revive the bald spots and the rest of the hardpan and the field is all ready for the green manure crop to fit it for a fruitful orchard and good staple crops.

With these two big fields in good condition attention is turned to drainage and the water from the wet spot back of the house disappears through crevices blasted into the underlying ground. A blast from a long line of loaded holes makes a fine straight channel for the creek and a line of lighter loads lowers the spring branch so that all of the fertile swamp becomes field or meadow.

Spare hours spent in blasting the yard, garden and old orchard enlivens flowers, trees and vegetables, and lays the foundation for future good years for each of them.

When all else is done the rough old pasture can be attacked as occasion affords. When the stumps and boulders are all gone the once unsightly spot can be brought into the regular rotation.




THE FULL-SIZED FARM, GIVING THE ENTIRE AREA OF PRODUCTIVE LAND AFTER IT HAS BEEN IMPROVED WITH EXPLOSIVES

# Saving Man Power

Lands have been cleared, drained and tilled for many years by the prodigal use of labor or Man Power.

Larger areas are yet to be cleared and further improvements must be made in millions of other acres in order to supply the ever-increasing demand for food and clothing.

Man is too intelligent and valuable in other ways to have his efforts and energy entirely consumed by the heavy forms of brute drudgery that can better be done by the employment of modern labor savers.

His knowledge, intelligence and energy are much more valuable to himself, the community and the country at large, when employed in directing the forces which have been placed at his disposal by nature and science.

The work must be done better than ever before, as the modern horse and power-drawn farm equipment cannot be used to advantage save on well-cleared lands.

Old methods of developing land by Man Power alone can be used no longer, for the greatest scarcity, at present, is labor.

It is indeed so scarce and, when available, so expensive, that it is becoming increasingly difficult to make developments or to install labor-saving devices in order to effect a saving in the future.

In many cases there seems no escape from the condition; but in developing lands, explosives, the modern conservers of Man Power, fill the needs and prove most efficient in doing the classes of work described in this book.

No matter how difficult it may be to get men, explosives are always available and the demand for increased amounts can be quickly supplied for the job.

A saving in Man Power is a saving in money. Explosives are now included with horses, steam and gasoline as conservers of manual effort.

# Explosives for Farm Use

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

Blasting explosives are divided into two classes: "High Explosives" and "Low Explosives." High Explosives, more commonly known as "dynamite," include all of the explosives which can be properly fired or detonated only by means of an intermediate agent such as a blasting cap or electric blasting cap and not by simple ignition. Blasting powders are classified as low explosives and are exploded by a spark.


Keg of Blasting Powder

### BLASTING POWDER

Blasting Powder is produced in granulations or grains of various sizes. It is packed in bulk in steel kegs containing twenty-five pounds. Although it is invaluable for many kinds of coal mining, quarrying and general excavating, it is not generally applicable to blasting about the farm except for splitting logs for timber or rails. For this work blasting powder is fired by means of safety fuse or electric squibs.

### DYNAMITE

Dynamite differs from blasting powder in that it is more powerful, detonates with much greater rapidity, and has a greater shattering effect.

The most important properties which contribute to the effect of dynamite are *strength or disruptive power* and *quickness or shattering power.*

Other factors in the usefulness of dynamite are its stability or keeping qualities and qualities that tend to make it safer to handle. The power to resist cold and water is also highly desirable.

These essentials can be secured and maintained only by the use of the highest quality of ingredients, greatest care and attention in manufacture, expensive and complicated machinery, skillful labor and supervision, long experience, and continued tests. The Du Pont Company fulfills all of these requirements. It has been engaged in the manufacture of explosives since 1802 and has factories in many parts of the United States. No other manufacturing concern in this country maintains a greater number of technical chemists than are engaged at the Du Pont laboratories to test daily the output of the factories to prevent deviation from standards, and to study and experiment with explosives in order to improve them. Much time is spent in developing explosives for special classes of work.

A corps of experts in the use of explosives is maintained, not only to study the exact requirements of explosives in the various fields and differing conditions, but to demonstrate their qualities, action and use.

In line with our established policy to promote safety in the use of our explosives, the word "DANGER" is printed prominently on every cartridge of dynamite made by us.

The aim is to protect all as far as possible and particularly those not familiar with the appearance of dynamite cartridges nor the precaution to be observed in handling them.

The millions of pounds of our dynamites used without accident testify to our constant effort to assure their safety.

Such marking, we feel, will promote careful handling because it will indicate to the general public as well as the regular user that there is an element of danger in the careless handling of cartridges of explosives.

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 as well as the energy of steam can be directed in the work for which it is used.

Dynamite is a solid closely resembling fine, slightly greasy sawdust, and derives its explosive power from different compounds of nitrogen. It is packed in cartridges of heavy, paraffin-coated paper. The standard size of cartridges is 1¼ x 8 inches, each cartridge weighing approximately a half pound. Shipment is made in tight wooden cases which contain either twenty-five or fifty pounds (net) of dynamite. Where possible, users should buy by the case, as a better price can be obtained.

Case of Dynamite

Shipments are made in 25, 50, 75, 100, or other multiples of 25 pound lots.

## KINDS OF HIGH EXPLOSIVES

There are many different kinds of high explosives adapted to uses in mines and elsewhere, but for agricultural work Red Cross Farm Powder, Red Cross Stumping Powder, Du Pont Straight Dynamite, Red Cross Extra Dynamite and Red Cross Gelatin are the kinds used for various purposes, as is explained in later paragraphs.

RED CROSS FARM POWDER—a slow-acting, low freezing powder especially adapted and manufactured for subsoil blasting, tree planting, gully filling, loosening soils for road grading and for stump and boulder blasting on heavy soils. It is not recommended for stump blasting on sandy and other loose soils. This explosive was developed especially for farm use.

CARTRIDGE OF RED CROSS FARM POWDER

RED CROSS STUMPING POWDER—is a stronger and quicker explosive than Red Cross Farm Powder. It is recommended for stumping, and boulder blasting on soils too light to permit the use of Red Cross Farm Powder, ditching with blasting machine, loosening heavy soil in grading, excavating cellars or foundations. It is low freezing.

RED CROSS EXTRA 40 PER CENT DYNAMITE—has the same desirable features of all the Red Cross brands and is suitable for difficult stumping, ditching in dry soil with blasting machine, boulder blasting, pond drainage, ice blasting, tree felling, road grading, digging post holes, blasting very hard subsoils; in short, it is a general all-around explosive that can be used for many classes of work. The special brands recommended for special classes of work are advised when they can be conveniently obtained. It is low freezing.

REPAUNO STUMPING POWDER AND DU PONT STUMPING POWDER—are low freezing explosives manufactured to meet the stumping conditions encountered on the Pacific Coast. They should be handled the same as the Red Cross Explosives. They are also recommended for shattering hardpan and planting trees on the Pacific Coast. They are not sold in the East.

DU PONT STRAIGHT 50 PER CENT. DYNAMITE—is quicker and more shattering in its action than are the Red Cross brands. Its special agricultural adaptation is for blasting ditches in wet soils by the propagated method (that is, without a blasting machine), for mudcapping hard boulders where there is a lot of the work to do, and for digging deep post holes. It is more sensitive to shock than are the Red Cross brands, and requires more careful handling. It is not low freezing. When frozen it must be thawed. It resists water well and can be used in wet work.

RED CROSS GELATIN—is more plastic than the other dynamites, is low freezing and resists water to a marked degree. The 40 per cent. strength is well adapted to blasting ditches in sandy or loose material, and to work where charges must be under water for a long time.

## SELECT THE RIGHT GRADE

In several cases it will be noted in the above that two or more explosives are recommended for the same class of work. This arises from the fact that practically all grades of Du Pont explosives are very elastic in their adaptations and can be relied on for many different classes of work. In selecting for a particular class of work use the explosive especially recommended, but where ordering small amounts for a number of purposes, get the one best adapted to them all.

## HANDLING, HAULING AND STORING

**Prompt Removal from Freight Station.**—The law requires prompt removal of explosives, including blasting supplies, from freight stations. Those expecting shipments should arrange with the freight agent or station master to give notification immediately on arrival of shipment, which must be removed within 24 hours.

**Hauling.**—When transporting explosives by team always keep the wagon boxes thoroughly swept. When using an open wagon protect the load from sparks and rain with a robe or canvas cover. Lay the cases of explosives flat and so that they *will not shift, and never haul detonators and explosives together.* 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.

**Handling.**—When high explosives are handled with bare hands, they nearly always cause headache. Cheap cotton gloves should therefore be worn and destroyed before they become damp and sticky and clean ones provided.

**Storing.**—As soon as explosives are received they should be stored in a dry, properly ventilated building, safe from fire and flying bullets, and far enough away from dwellings or roads to prevent loss of life should they be accidentally exploded. 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 for some time a dry, well-ventilated, fire-proof and bullet-proof magazine, located in an out-of-the-way place should be provided. Fuse, wire, thawing kettles and blasting machines may be stored in the same building with the dynamite, but blasting caps and electric blasting caps *must never be stored in the same building,* because they are more easily exploded than dynamite. It would be possible to explode them accidentally by a hard shock or jar which would not explode dynamite. If detonators were to explode by themselves, they would not be likely 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.

**Opening Cases.**—When ready to use the dynamite, open the box or case with a hardwood wedge and a mallet. Never take more than the day's supply to the work, even in warm weather. In cold weather, take only as much as can be kept thawed until it is to be used, unless there are arrangements for keeping it thawed where the blasting is to be done.

**Avoid Confusion.**—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 should be carried on as rapidly as possible without becoming careless.

A little practice will teach the blaster to do his work quickly, systematically and economically.

## THAWING

Some kinds of high explosives, such as straight dynamite, freeze at about 50 degrees Fahrenheit and detonate imperfectly, if at all, when in this condition. Even when chilled they cannot be depended on to work well. The different low freezing explosives described are exceptions to this rule, for they will not freeze until the weather is quite cold. Frozen dynamite is easily recognized because it is hard and rigid.

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 the work is correctly done.

Red Cross explosives, if loaded in the ground below the frost line and properly tamped, will not freeze again, except in extremely cold weather, but high freezing explosives may chill or freeze almost immediately when loaded in cold ground, which makes it necessary to detonate them immediately after charging. It is this power to resist cold that makes Red Cross explosives so valuable in cold weather.

Dynamite can be thawed by leaving it spread out on a shelf in a warm room (not in a dwelling) over night, or by burying it, while in the case, in green manure (see cut on page 13). It may also be thawed by putting it in a covered, water-tight pail and hanging this pail in warm water. It is exceedingly dangerous to try to thaw dynamite in front of an open fire, or in hot sand or ashes or on hot stones, or in an oven, or on hot pipes, or in hot water or steam. More accidents are caused by careless thawing than in any other way.

The best way to thaw dynamite, and to keep it thawed until it is to be used, is in a thawing kettle made for the purpose.

Du Pont Thawing Kettle

Du Pont Thawing Kettles are all made with a water-tight compartment for the explosives, which is surrounded by the receptacle for the hot water used to furnish the heat for thawing. This hot water must not come in contact with the dynamite. The entire kettle is made in one piece.

While Du Pont Thawing Kettles will retain their heat and keep the explosive thawed for a considerable time, depending, of course, on the nature of the weather, this effective period can be increased to about five times as long if the warm kettle is kept in a barrel or box with dry hay surrounding it. This hay can be held in place by a cylinder of wire screen, so that the thawing kettle can easily be removed and replaced. If the barrel be mounted on two wheels with a tongue attachment, it can be readily drawn from point to point about the outside work, so that it will not be necessary to expose the dynamite to the cold air until it is to be loaded in the bore hole. Somewhat similar benefits result from wrapping old blankets or sacks around the warm kettle.

Under no circumstances must the water be heated up in Thawing Kettles, even though the explosives be first removed, because nitroglycerin exudes readily from warm dynamite, and enough of it is likely to be found in the bottom of the explosives compartment of a thawing kettle that has been in use for some time, to cause a serious accident if the thawing kettle should be placed over a fire. It is necessary to heat the water in something else before filling the water jacket. *The hot water must always be tested before filling the dynamite compartment. If it is hot enough to burn the hand, do not put the explosives into the thawing kettle.* Never fill the water jacket unless the explosives compartment is empty. See that the explosives compartment is perfectly dry before it is filled.

Thawing kettles should be kept clean at all times. Should any of the explosive compounds leak out, the explosives compartment should be thoroughly cleaned with a solution of Sal Soda.

## TABLE OF SIZES OF THAWING KETTLES

| | Capacity | Weight Empty | Weight of Water | Total Weight Filled | Outside Dimensions |
|---|---|---|---|---|---|
| Du Pont No. 1..... | 30 lbs. | 12½ lbs. | 40 lbs. | 82½ lbs. | 14″ x 14½″ |
| Du Pont No. 2..... | 60 lbs. | 17½ lbs. | 77½ lbs. | 155 lbs. | 17½″ x 21″ |

The use of thawing kettles can, to a large extent, be done away with by using Low Freezing explosives, such as Red Cross Extra Dynamite and Red Cross Gelatin.

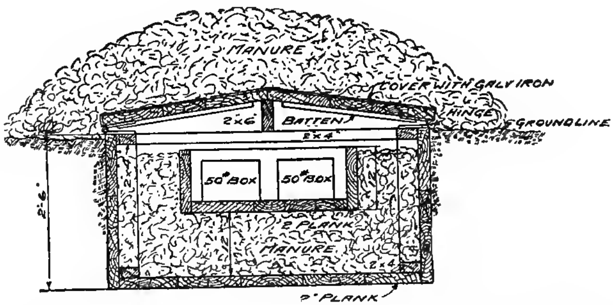



FIG 1. A PERMANENT MANURE THAWING BOX FOR DYNAMITE CAN BE EASILY BUILT ACCORDING TO THESE PLANS

# Blasting Supplies

For loading and firing charges of explosives certain accessories are needed. These are known as blasting supplies.

### DU PONT BLASTING CAPS

Du Pont Blasting Caps, used for firing or detonating charges of High Explosives, are the big brothers of the primers in a gun shell—many times bigger. The No. 6 cap, which is the size recommended for detonating most high explosives, is a copper cylinder 1½ inches long and a little less than ¼ inch in diameter, closed at one end and loaded with 1 gram of a fulminating mixture. The No. 8 size is longer and contains a heavier charge. Nothing smaller than a No. 6 should be used with any of the explosives used on the farm because strong caps

Insure complete detonation,
Increase the execution of the explosive,
Offset to some extent deterioration, due to improper storage,
Prevent the loss of the charge by burning.

A DU PONT BLASTING CAP

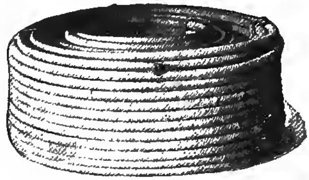
Blasting caps are packed in tin boxes containing 100 caps. From 5 to 50 boxes are packed for shipment in wooden cases. They may be exploded by shock, heat or sparks, so must be kept away from fire. They are weakened by moisture and therefore must be stored in a dry, cool place, and should always be carefully handled.


BOX OF DU PONT BLASTING CAPS

Caps are used only in connection with safety fuse, to which they must be securely fastened. This should be well done with an approved Du Pont Cap Crimper described on the following page.

### FUSE

Safety Fuse is a thin chain of powder, wrapped in a covering of jute or cotton yarn, or in tape. Its purpose is to bring a spark to a cap used for detonating a charge of high explosives. Many grades are made for different purposes. The ones most used for farm work are Charter Oak and Beaver for dry or moist work, and Crescent for wet work.



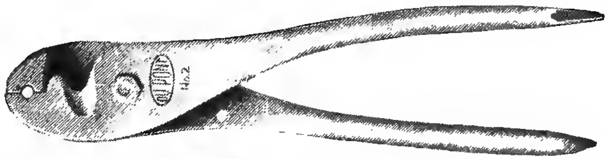
ROLL OF SAFETY FUSE

Fuse is packed 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 6,000 feet.

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. 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 may become stiff and brittle in cold weather. When in this condition it should be warmed before being unrolled.

## CAP CRIMPERS

Du Pont Cap Crimpers are made especially for securely fastening caps to fuse and are necessary wherever blasting is done with cap and fuse. The process of waterproofing is well started by the crimp made by these crimpers. Caps are often crimped by other means, which are




DU PONT No. 2 CAP CRIMPER

dangerous and unsatisfactory. The crimper now sold by this Company is the result of years of experimentation, and is the best ever offered the public. It is supplied with a pair of jaws for cutting fuse.

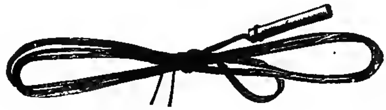
## DU PONT ELECTRIC BLASTING CAPS

These, like the cap and fuse, are for detonating charges of high explosives. The explosive charge is contained in a copper cylinder quite similar to the ordinary blasting cap, but the explosion is caused by an electric spark brought along a pair of small copper wires instead of a powder spark from fuse. In strength they are the same as the ordinary caps of the same number. The No. 6 strength is the one adapted to farm work.

It is only by the use of electric caps that a number of charges can be fired at the same time, so they must be used in ditching in dry ground, in blasting large stumps and boulders, or any other work requiring a number of simultaneous explosions.

Du Pont Electric Blasting Caps, like blasting caps, can be exploded by shock or heat, and therefore must be handled in exactly the same way. The same precautions regarding storage and handling as given for blasting caps should be strictly observed. Never attempt to pull the wires out of their setting or investigate the contents of Du Pont Electric Blasting Caps.

A DU PONT ELECTRIC BLASTING CAP, SHOWING WIRES



Electric Blasting Caps reduce the chances of misfires, save time, eliminate delayed or premature explosions and in a good many instances save dynamite.

The wires attached to the caps range in length from four feet to thirty feet, but it is seldom that anything longer than a four or six foot length will be needed in farm work. These lengths are packed in lots of fifty in strong paper cartons. Ten cartons are packed in a wooden shipping case.

## DU PONT BLASTING MACHINES

Du Pont Blasting Machines are small, portable electric generators* built for generating current to fire electric blasting caps. The mechanism is operated by a rack bar or plunger protruding through the top of the machine. When operating, this bar is pulled up as far as possible, and then forced down with a quick, hard thrust. This sets in motion the armature and builds up the current until the bottom is reached, when the connections are automatically completed and the current flows out through the leading wires to the electric blasting caps placed in the charges of explosives. In use the rack bar should be forced down as hard as possible, the operator using both hands and all his weight.

In practical operation the machine should be placed on a firm or solid place to prevent both machine and operator tipping over.

The current is conducted from the machine to the blast by copper wires attached to the two wing-nut binding posts on the machine. While the machines are built for rough use and every precaution is

* The pocket size is a magneto and is operated by twisting the handle.

taken to make all parts strong, they are likely to be damaged by exposure to the weather, and should be wiped off and put in a dry place when no longer in demand.

Pocket Size No. 3 No. 6

RELATIVE SIZES OF DU PONT BLASTING MACHINES

Blasting machines should be tested occasionally with a Du Pont Rheostat, to be sure that they are working up to standard capacity. A full description of the Rheostat and its use will be sent on application.

Du Pont Blasting Machines are built in six sizes so that a selection can be made to suit the demands of all classes of work.

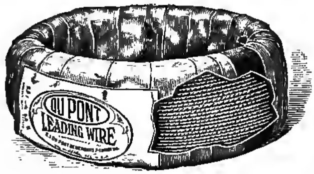
## SIZES AND CAPACITIES OF DU PONT BLASTING MACHINES

| Size of Machine | Capacity—Number of Electric Blasting Caps Copper Wires | Used For |
|---|---|---|
| No. 1 | 1 to 5 | Stumping and boulder blasting. |
| " 2 | 1 " 10 | Stumping, boulder blasting, and small ditch jobs. |
| " 3 | 1 " 30 | All classes of general work. |
| " 4 | 1 " 60 | Large ditches. |
| " 5 | 1 " 100 | Large ditches. |
| " 6 | 1 " 150 | Large ditches. |

For stumping, boulder blasting, loosening soils to assist digging and similar work the No. 2 machine will be found entirely satisfactory. Larger blasts having an increased number of charges will require a larger size, but those larger than No. 3 are seldom needed except on large contracting jobs. Even very long ditches can be blasted in sections with the No. 3 machine.

## LEADING WIRE

Leading wire is insulated copper wire for conducting the current from the blasting machine to the blast. The Du Pont leading wire has a strong insulation especially suited to the rough usage it must receive. It 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. 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. The double wire will be found most satisfactory for stumping and boulder blasting and the single wire for ditching.



Du Pont Leading Wire

DUPLEX LEADING WIRE (ACTUAL SIZE)

## DU PONT CONNECTING WIRE

Connecting wire is used to complete the circuit when the holes or charges are placed too far apart for the electric blasting cap wires to reach. It is sold in one and two pound spools. A one-pound spool of No. 20 wire holds about 210 feet.

Du Pont Connecting Wire

## USE OF THE GALVANOMETER AND RHEOSTAT

The Du Pont Company manufactures an instrument for testing blasting circuits, called the Du Pont Galvanometer. This is a very ingenious and useful instrument, and saves much time in locating breaks in electric circuits. For instructions as to its use ask for our Galvanometer Booklet. The Rheostat is a simple instrument used for testing blasting machines.

# Tools Used in Agricultural Blasting

The tools needed for agricultural blasting are very few and simple. They are often to be found on the farm, but if not they can be quickly made at little cost by a blacksmith. An elaborate outfit is seldom needed even on large jobs.

### TAMPING STICK

A tamping stick is used to try out the holes before loading to see that they are properly placed and to a sufficient depth, and not stopped up; to place cartridges of explosives in bore holes; and to tamp soil on top of the charges. It must be of wood, with no metal parts. Its length should be a little greater than the depth of the holes to be loaded, and its diameter not smaller than that of a cartridge of dynamite, 1¼ inches.

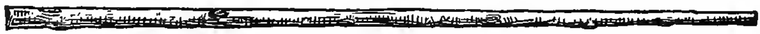


FIG. 2. HOME-MADE TAMPING STICK

An excellent one can be made of an old hoe, rake or shovel handle, or when a very long one is needed, from a sapling.

### SUBSOIL PUNCH

For driving holes for subsoil blasting, tree planting, for ditching in hard soil, and for road grading, a subsoil punch is needed. This should be of 1½-inch round or octagonal steel, and a few inches longer than the depth of the holes. The point should be drawn out in the shape of a rather blunt pencil point. This is driven into the ground by means of heavy hammers or sledges.

FIG. 3. STEEL SUBSOIL PUNCH

### CROWBAR

A crowbar will be found convenient for making holes under stumps and boulders, for ditch blasting, and occasionally for subsoiling or tree planting.

A satisfactory crowbar for this work can be made out of an old buggy axle by cutting off one spindle and forging a wedge or chisel point.

## SOIL AUGER

The soil auger is used for making holes for stump and boulder blasting, for deep drainage, and for other holes hard to make with a punch. While it can be used for subsoiling it is not as fast as the subsoil punch. It should be 1½ or 2 inches in diameter.

The bit may be welded to a solid steel shank that will make the auger at least five feet long, if for stump or boulder blasting. For deeper holes the shank can be made of ⅜ or ½ inch gas pipe in sections of 2 or 3 feet in length, so that it can be extended by adding more sections. The handle is made of a pipe "Tee" and two short pieces of pipe for grips.

A good type of auger head can be easily made by a smith. The shank is flattened out and welded into a sleeve socket. The handle proper should be of wood and only long enough to make turning easy.

Worn-out wood augers make fairly good soil augers for small jobs, but where there is much work to do it will pay to get the special soil augers shown below.

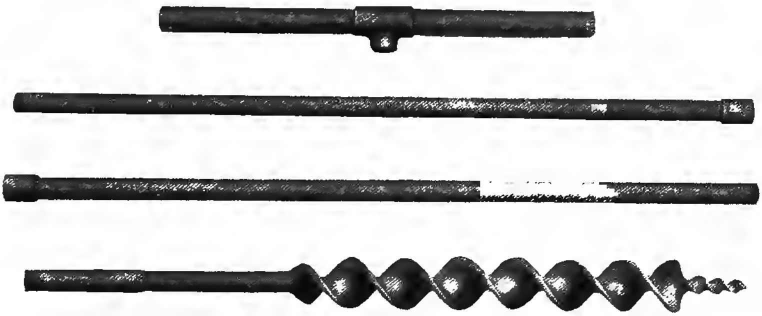


FIG. 4. SOIL AUGER WITH SECTIONAL HANDLE MADE OF ⅜-INCH GAS PIPE

## WOOD AUGERS

Wood augers are used by the blaster for boring into the tap roots of fat pine stumps, and for log and stump splitting. They should be both heavy and sharp. The shank for stump blasting should not be less than five feet long.

## OTHER TOOLS

Heavy hammers are needed to drive the subsoil punch, and a mattock and shovel can be used for a number of purposes. For blockholing rock a hand drill and hand hammer will be needed. For jobs where there is much rock drilling to do, the use of power drills is recommended. They are not needed, as a rule, on small jobs.

## SPOON

A blasting spoon made by flattening and cupping the end of a ¼-inch steel rod, as shown in the accompanying cut, is very convenient for enlarging bore holes, removing pebbles from holes, and for removing tamping from misfired holes.

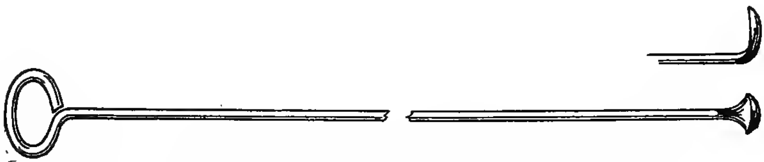


FIG. 5. A GOOD TYPE OF SPOON FOR CLEANING OUT THE BOTTOMS OF BORE HOLES

## MAKING BORE HOLES IN HARD GROUND

In performing his work, the agricultural blaster must make many holes in hard ground for subsoiling, tree planting, stumping, ditching, and other purposes. The subsoil punch is undoubtedly the best tool for holes not more than thirty-six to forty-two inches in depth. When deeper holes are needed, the punch can be used to start the hole, which can be deepened by means of a good soil auger. The use of a little water often facilitates punching and boring.

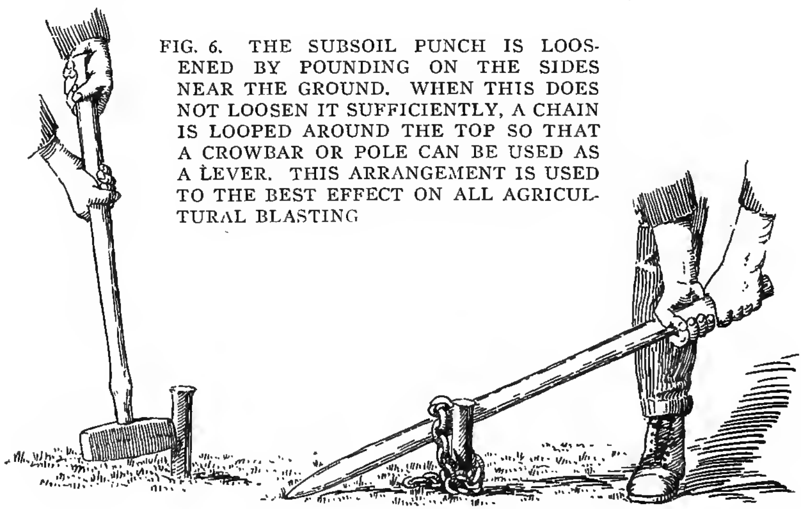


FIG. 6. THE SUBSOIL PUNCH IS LOOSENED BY POUNDING ON THE SIDES NEAR THE GROUND. WHEN THIS DOES NOT LOOSEN IT SUFFICIENTLY, A CHAIN IS LOOPED AROUND THE TOP SO THAT A CROWBAR OR POLE CAN BE USED AS A LEVER. THIS ARRANGEMENT IS USED TO THE BEST EFFECT ON ALL AGRICULTURAL BLASTING

# Blasting

When dynamite or other high explosives detonate, the small volume of solid is converted immediately into a volume of gas many times greater than the solid. If the explosive is unconfined the expanding gases will waste themselves in the air, but if it is confined there is a great pressure exerted on the holding material, which if not too strong, will be shattered or blown away.

The force of the gases is equal in all directions. If the desire is to blow a boulder or stump into the air the charge is placed below the object. The best shattering is obtained if the explosive is placed in the material to be broken so that the force is exerted on it equally in all directions. This is applicable in blasting soils and blockholing boulders or in splitting stumps.

While the gases exert an equal pressure in all directions they try to escape by the easiest route or along the line of greatest weakness. If the tamping is omitted or is insufficient the tendency will be to blow out through the bore hole. If a hole is placed to the side of a stump the tendency will be to blow out through the more easily lifted soil. The aim should always be to make the easiest way out directly through the material to be moved or shattered.

## DETONATION

As has already been explained, dynamite is fired or "detonated" by means of the shock from a blasting cap or electric blasting cap, either of which is known as a detonator.

In order that the detonation may be complete, or in other words, that the full strength of the explosive be developed, the detonator should be placed inside the charge, with its closed or "business end" pointed toward the main bulk of the charge.

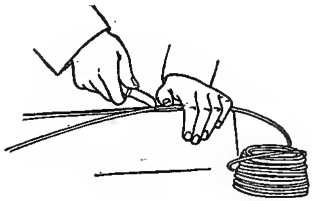
## PRIMING WITH CAP AND FUSE

The act of placing the detonator in the charge is known as "priming" and the cartridge of explosive with the detonator in it is called a "primer."

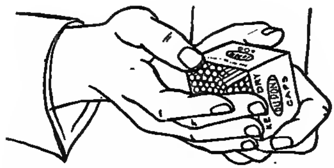
## ATTACHING THE BLASTING CAP TO FUSE

Examine your dynamite and see that it is not frozen. Frozen dynamite is hard and rigid, and dangerous to handle; when thawed it is soft. Next examine your fuse, see that it is not stiff and brittle; if in this condition it is advisable to warm slightly, and cut the required length from the roll with a sharp knife, hatchet or cap crimper. The cut should be made squarely across and not diagonally (1, Fig. 7). Sometimes in the cutting the end becomes flattened, thereby making the end of the fuse too large to enter the blasting cap. When this happens squeeze the end round with index finger and thumb. Open the cap box and allow one cap to slide gently out to be grasped in the fingers (2, Fig. 7); but, under no circumstance, pick a cap out of the box with a piece of wire, stick, or other hard substance. See that there is no grit or trash in the cap. Slip the end of the fuse gently into the cap until it is against the charge in the bottom (3, Fig. 7). Do not twist the fuse as the friction might cause a premature explosion. Then take the cap crimper and fasten the cap to the fuse with a crimp near the open end of the cap (4, Fig. 7). These operations are not dangerous but should be done carefully. If the primer is to be used in a wet hole smear a little hard tallow, soap or similar substance, around the top of the cap to insure against water leaking in and ruining the cap before it is fired. Never use oil or light grease as these will penetrate the fuse covering and ruin the powder. The cap is then ready to be inserted into the dynamite.

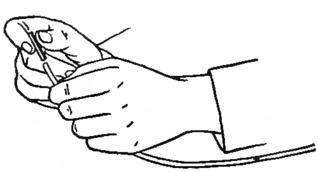
There are two reliable and satisfactory ways of doing this: *In the Side;* and *In the End.* Never lace the fuse through the cartridge when using either method.



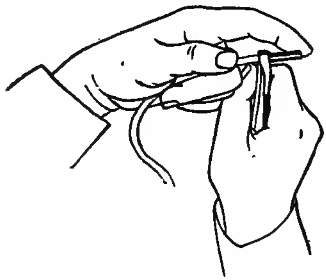
1. Cut off a sufficient length of fuse.



2. Take one cap from the box with the fingers.



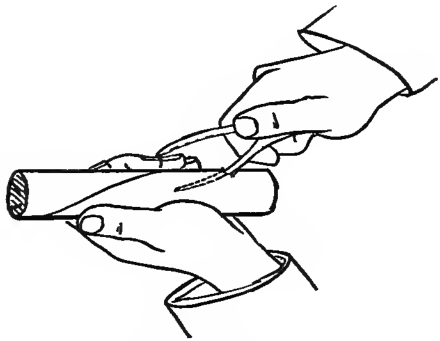
3. Slip cap on end of fuse.

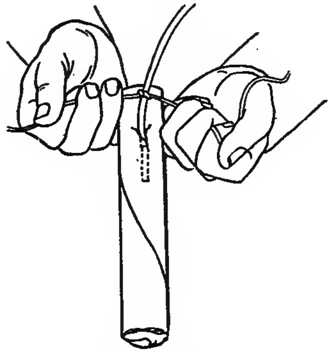


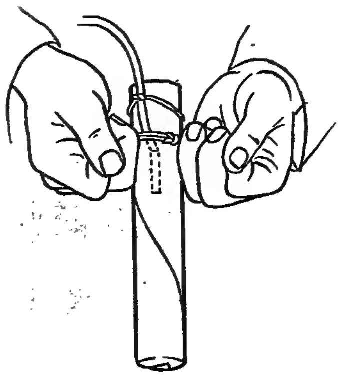
4. Crimp cap to fuse with cap crimper.

FIG. 7. ATTACHING A BLASTING CAP TO SAFETY FUSE

**Priming Cartridges in the Side.**—This is done by punching a hole diagonally into the side of the cartridge (1, Fig. 8) near the end and pointing toward the center, to a sufficient depth to receive the entire cap. Insert the cap with fuse attached and tie it there with a piece of cord, wrapping it firmly around both the fuse and the cartridge (2, 3 and 4, Fig. 8). This method has the advantage of leaving a good place to place the tamping stick in seating the primer in the hole, but, for small holes, has the disadvantage of a slight increase in size. This method is the one generally used by agricultural blasters.


1. Punch a hole in side of cartridge with handle of cap crimper.


2. Tie cord around fuse.


3. Complete by tying around cartridge.

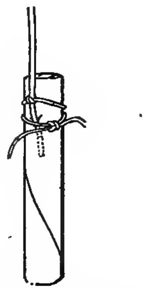
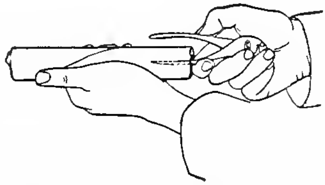
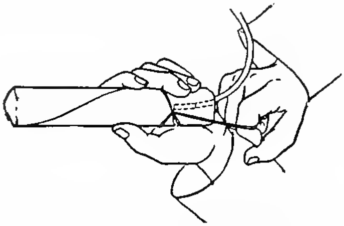

4. Completed primer ready to load.

FIG. 8. PRIMING A CARTRIDGE IN THE SIDE. (A HIGHLY SATISFACTORY METHOD FOR MOST CLASSES OF AGRICULTURAL BLASTING)

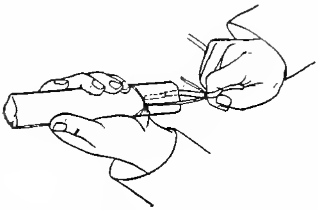
**Priming Cartridges in the End.**—This is done by punching a hole directly into the end of a cartridge (1, Fig. 9), through the paper shell and to a sufficient depth to receive the entire cap. Into this insert the cap with fuse attached and tie it securely as is indicated in 2 and 3, Fig. 9. This method has the advantage of the smallest possible diameter and places the cap in the best possible position; but has the disadvantage of leaving little room for seating the tamping stick. It is largely used in blockholing boulders and for other small bore holes.



1. Punching hole with handle of cap crimper.



2. Tie cord around cartridge and



3. Then around fuse.

FIG. 9. PRIMING IN END OF CARTRIDGE

The greatest care should always be exercised in making primers, for if the work is carelessly or incorrectly done, the best results cannot be expected and the danger of accidents is increased.

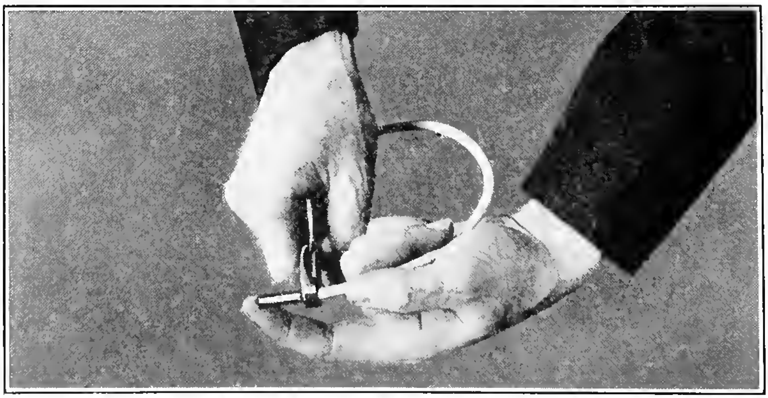


FIG. 10. CRIMPING A BLASTING CAP TO A PIECE OF SAFETY FUSE

## PRIMING WITH ELECTRIC BLASTING CAPS

When electric blasting caps are used they may be inserted into the dynamite as has been described for caps and fuse. Many blasters, however, prefer to use a slightly faster method, which has been found entirely satisfactory.

Punch a hole from the center of the end of the cartridge in a slanting direction so that it will come out at the side 2 or 3 inches from the end, insert the end of the doubled over wires of the electric blasting caps, loop these around the cartridge, after which another hole is punched in the top a little to one side of the first and straight down. The entire capsule is inserted in this last hole, and the slack taken up on the wires, with the result that you have a primer where the wires do not cross each other at any point and the capsule is lying nearly in the axis and the cartridge hangs vertically, so that it is possible to load in the bore hole without its being caught on any roughness.

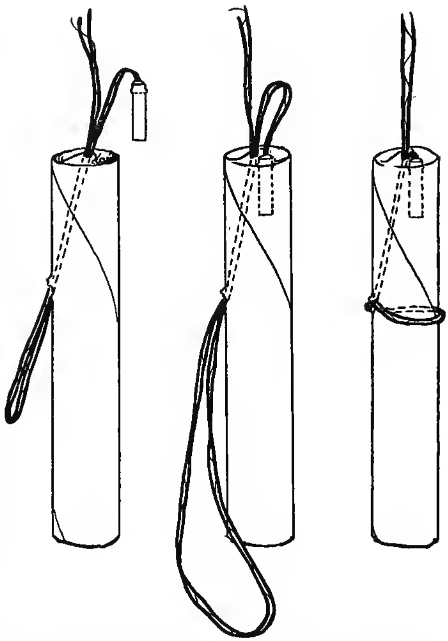


FIG 11. A QUICK METHOD OF MAKING PRIMERS WITH ELECTRIC BLASTING CAPS

Never half-hitch the wires around a cartridge of dynamite, for upon pulling the wires or lowering the primer into the bore hole, the insulation may become worn through where the wires cross, thus allowing the bare wires to come in contact, causing a short circuit and misfire.

* * * * *

The holes can be punched in the dynamite with the handle of the cap crimper, or with a wooden awl, and should always be about ¼ inch deeper than the length of the entire cap.

When the primer is to be of only half a cartridge, as in subsoiling, it is good practice to punch a hole in each end of the cartridge and cut the cartridge in two before inserting the caps.

The cap should always be firmly secured to the dynamite cartridge, otherwise they may become separated and a misfire result.

## CUTTING A DYNAMITE CARTRIDGE IN HALF

When small charges are desired it becomes necessary to cut cartridges in half. This should be done with a sharp knife. Hold the cartridge firmly in one hand and the knife in the other. Giving the cartridge a rotary motion, cut the paper all the way around and then bend the cartridge slightly, when it will come apart just where the paper is cut. Never try to cut a frozen cartridge.

CUTTING CARTRIDGE IN HALF

## MAKING BORE HOLES

The holes made for loading explosives are called "Bore Holes." These should be prepared before the primers are made. The tools described on pages 19 to 21 are found most useful for making the different kinds of bore holes. Specific advice with regard to their location and depth is given in the discussions of the different classes of blasting.

## LOADING

When the cartridge is primed and the bore hole made, the next thing to do is to load. First try the hole with the tamping stick to see that it is open and will permit the charge being placed at the desired point.

When loading small charges, as when only a full or half cartridge primer is used for subsoiling or tree planting, start the primed cartridge into the bore hole and press it gently into place with the tamping stick. See that it is firmly seated in the bottom of the bore hole.

In pressing a primer into place, do not handle it roughly, as it contains the cap and is, therefore, more sensitive and dangerous than an unprimed cartridge.

When the load is to contain a larger amount of dynamite, press the unprimed cartridges into place in the bottom of the hole first, and place the primer with the cap pointed toward the rest of the charge on top. When the bore hole is dry, and it is desirable to have the charge concentrated in one place, it is a good practice to slit the sides of the cartridges in two or three places and from end to end with a knife so that the dynamite can be compacted into a smaller space. The primer should not be split.

In all classes of agricultural blasting the charge should be pressed firmly into the bottom of the bore hole so that no air pockets are left as they weaken the action of the explosives. When bore holes are wet, it is not advisable to slit cartridges.

For most work it is necessary to determine the correct amount of explosives by a few test blasts. This is pointed out in the special paragraphs on the different classes of blasting.

## TAMPING

Closing the top of the bore hole after the charge is placed is for the purpose of more closely confining the charge to insure better work and is called "Tamping." It should be made as tight as possible, so that the gases will not blow out as through the muzzle of a gun.

To guard against danger of prematurely detonating the charge, the first 5 to 8 inches of tamping should not be packed with any considerable force, but should be gently firmed. When this amount of lightly tamped material covers the primer, the rest of the tamping should be made as hard as possible, using the wooden tamping stick in one hand.

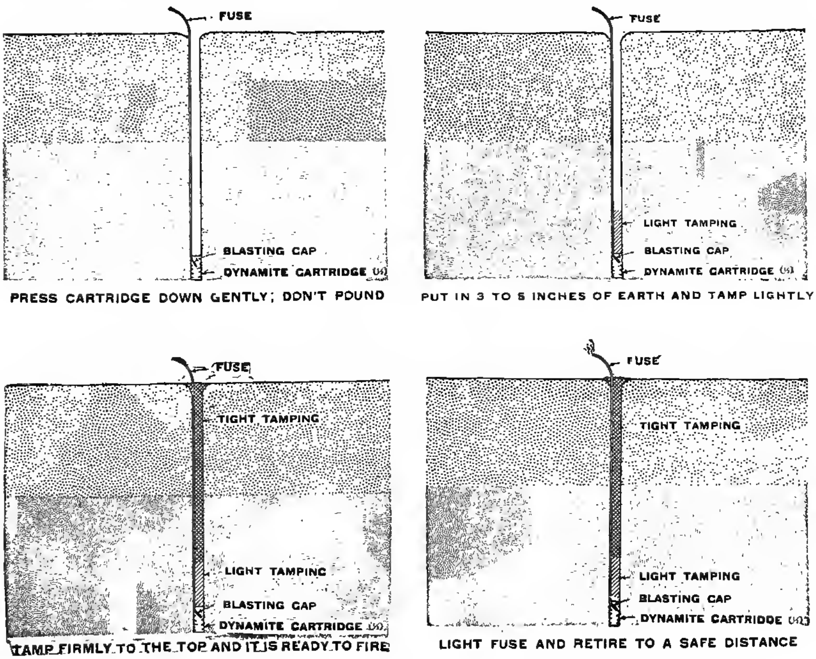



FIG. 12. DIFFERENT STEPS IN LOADING AND TAMPING A HOLE

Moist clay, free from gravel and clods, makes good tamping material. Free running sand or moist loam is also good. In wet work, when a foot or more of water covers the charge in shallow holes, it will not be necessary to add other tamping, as the water will hold the charge sufficiently tight. Loading and tamping should be done in such a way that no open-air spaces are left.

When using soil for tamping, the hole should be tamped full. Do not allow sharp pebbles or stones to fall in the hole during loading and tamping.

Before beginning tamping it is well to measure the depth from the surface to the top of the charge, so that if the tamping must be removed to get at a misfire there will be no danger of disturbing the primer. It is a good practice, especially where heavy charges are used, to place two inches of paper or dry leaves immediately over the primer, so that they can be used as a safety marker should the tamping need to be removed for any cause.

## FIRING

Exploding the charge is called "Firing," and can be done either by means of caps and fuse or by electric blasting caps with a blasting machine. When cap and fuse are used cut the fuse long enough to reach about 3 inches out of the bore hole and to enable you to retire to a safe distance. Fuse burns on an average of two feet per minute and a sufficient length should be used to permit of the blaster reaching a safe point before the explosion. When using electric blasting caps the leading wire should be long enough to enable the one who operates the blasting machine to be outside the danger zone. No blast should be fired until persons, animals and vehicles are well out of range.

When reliable explosives and blasting supplies are used, and the primers properly made and placed, misfires should seldom occur. When using cap and fuse, and a misfire is noted, do not return to examine it at once, as an injured fuse may be burning slowly and delaying the shot. It is better to wait until the next day, if possible.

When using electric blasting caps there is no danger of delayed shots and less likelihood of misfires. When one does occur, disconnect the wires from the blasting machine, and it will be safe to return immediately to the blast for investigation. Never connect the wires to the blasting machine until it is time to fire, and guard against a careless person tampering with the machine and leading wire while loading shots.

In selecting a safe place to watch a blast, do not get behind a tree or building, but stand in the open at a safe distance from the blast, so that you can see the flying fragments and dodge any that may come beyond reasonable bounds. Do not have the sun in your eyes, as it may obscure flying missiles.

**HANDLING A MISFIRE**

The use of high grade explosives and caps and careful loading will reduce the dangers of shots failing to fire. When a misfire does occur the blaster should be governed by conditions.

When electric blasting caps are used and one or all of the holes fail, disconnect the wires from the blasting machine, and it is safe to go back immediately to investigate the trouble. The investigation should first consist of a search for broken wires, faulty connections, or short circuits. If such are found, make the proper repairs, reconnect the leading wires and operate the blasting machine. Many so-called failures are the result of poor connections or connections being in contact with wet ground or other conductive material.

When caps and fuse are used greater care must be exercised. It is never safe to go back immediately to a delayed shot that is primed with cap and fuse. The fuse may have been injured in tamping, and instead of burning rapidly may smoulder for a long time, then reignite the powder in the lower end of the fuse and fire the blast. The interval of waiting should be as long as possible, preferably until the next day if the firing is done in the afternoon. In all cases it should be several hours. When lighting fuse be sure that the powder column is on fire shown by the "spitting" out of the flame, as time may be wasted in waiting for a blast whose fuse is not even lighted.

If the hole is untamped or is tamped with water, make up another primer, place it on top of the charge, and fire. If the ground is soft and wet put down another charge far enough away for drilling in safety, but close enough to cause detonation by concussion. When this is not possible there are two methods of relief. The tamping can be carefully removed almost down to the charge with a spoon and hardwood probe. Great care must be exercised, especially when the cap is in the top cartridge of the charge, to prevent danger of firing the cap by friction or impact.

When it is necessary to blast out a misfire by drilling and charging a second hole, great care should be exercised. Such a hole must be far enough away from the charge to make drilling and loading safe, but must be close enough to insure the old charge being blown out together with the rock or confining ground.

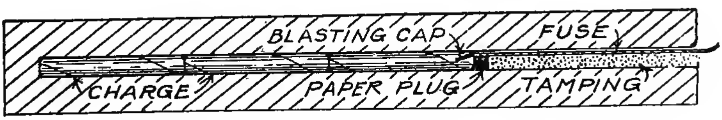



FIG. 13. USE OF A PAPER PLUG TO BEGIN TAMPING

When for any reason, misfires may be expected, a good practice is to use a wad of paper or dry leaves immediately over the charge of explosive and pack the tamping on top of this. If it becomes necessary to remove the tamping, this dry material makes an excellent index of just how far down it is safe to remove the tamping.

All misfires should be placed under the direction of a careful and experienced workman, who should make his examination in a slow, methodical manner before beginning the work of repriming, and no other person should be allowed to remain near him, as their presence or suggestions are likely to cause confusion.

As stated before, only the best explosives and supplies should be used, as they decrease the dangers of misfires, which always delay the work and increase the cost of the job.

The adoption of electric blasting will result in a decrease in delayed or missed fires, and is to be recommended on all road work and blasting where passing persons might be injured.

## BLASTING BY ELECTRICITY

Large boulders and stumps with spreading roots can be blown out and broken up more thoroughly and with less dynamite if the charge is distributed in several holes 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 in this way. In order to dig a ditch satisfactorily, it is always necessary to explode a number of charges simultaneously. In dry soils this can be done only by electric blasting. 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 be applied to all of the work described in this Handbook, but it is generally unnecessary and more expensive, except in the blasting just described.

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

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

When the charges have been primed with electric blasting caps and tamped, the two copper wires protrude from the ground over each charge. These two wires should be separated and one of them connected to one of the wires of the next electric blasting cap on one side and the other one should be connected in the same way to one of the wires of the electric blasting cap in the hole 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. These loose wires are connected to the wires leading to the blasting machine. This is called "connecting in series." If the holes are too far apart for the electric blasting cap wires to reach between them, pieces of connecting wire are used.

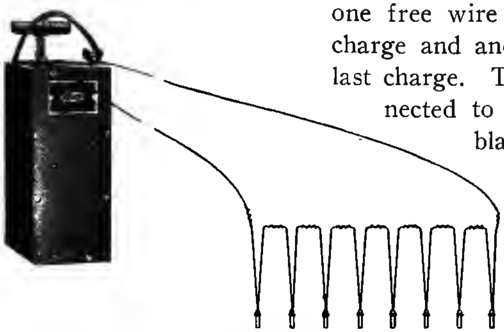


FIG. 14. METHOD OF CONNECTING WIRES FOR ELECTRIC BLAST

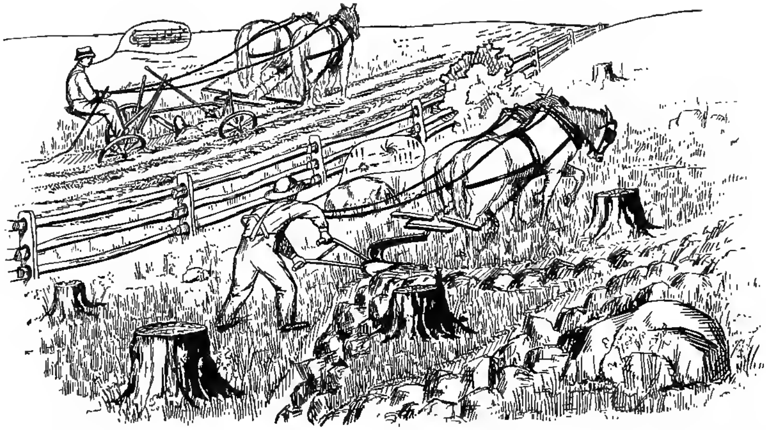
Connections are all made by twisting bare wire ends securely together. All wire ends should be scraped with a knife so that they will be free from grease or corrosion when connections are made.

All bare joints or other uncovered places in the wires 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 to hold it off of the damp ground.

Always be sure that there is a complete circuit of wire offered for the passage of the electric current, otherwise the blast will not fire, for the current must pass through each electric blasting cap in order to ignite it.

Should there be any bare joints resting upon damp ground or in water, or should one bare joint touch another, there is a likelihood of a short circuit through which the electric current will pass instead of around the entire blasting circuit where it encounters greater resistance to its passage.

A very convenient and accurate instrument for testing a circuit to ascertain whether there are any breaks in the connections or wires, and a great help and time saver in locating these breaks is the Du Pont Galvanometer mentioned on page 18.



For the best conservation of man power and the successful utilization of land, all fields must be cleared of stumps and boulders.

| **Well-Cleared Fields** | **Stumps and Boulders** |
|---|---|
| Have all the land open for the production of crops; | Occupy space and reduce the actual size of fields; |
| Permit the use of the heaviest and most effective labor-saving machinery; | Prevent the satisfactory use of modern farm machinery; |
| Reduce the cost of field operations to a minimum; | Increase the cost of field operations; |
| Are attractive in appearance and increase the interest of the owner as well as the selling value; | Are unsightly and reduce the actual producing and selling value of the farm; |
| Permit the destruction of weeds and crop pests by ordinary tillage operations; | Provide breeding places for weeds and crop pests; |
| Make possible the adoption of systems of tillage that will prevent erosion. | Increase the dangers of erosion by preventing satisfactory plowing. |

The conservation of Man Power finds most ready application in land clearing, provided logical methods are employed. The best methods of clearing are with explosives and pulling machinery. Each method has its advantages and is particularly adapted to certain classes of land or conditions. In many cases the greatest economy in clearing is by combination methods—or the use of both explosives and pullers. The following paragraphs cover these details quite fully.

# Blasting Stumps

The root systems of the different forest trees are subject to a considerable number of variations, due to the class of tree, the soil and the depth to sheet water. Ordinarily, forest trees are divided according to their root systems into three classes. These are: Those having tap roots; those having no tap roots, but only lateral fibrous roots; and those having both a small tap root and many lateral roots. When trees that normally develop heavy tap roots are grown on soils where the ground water level is very near the surface, the tap root will be materially shortened or entirely wanting. Lateral-rooted trees growing in loose soils not troubled by bad drainage, may send heavy lateral roots to considerable depths.

Several factors very materially influence the blasting of stumps, notable of which are:

The character of the root, whether tap or lateral.

The nature of the soil, whether sand or clay, as the kind of soil has much to do with the resistance offered to the dynamite.

The moisture content of the soil.

The state of preservation of the stump, whether sound or partially decayed.

Freshly cut or green stumps are much harder to blast than those from which the small roots and bark have decayed.

Success in stump blasting is a matter of common-sense and discretion, and the work may be undertaken by anyone of reasonable intelligence, who will first try a few experiments on the small stumps, and follow out carefully the rules laid down on the following pages.

## BLASTING TAP-ROOTED STUMPS

There are two distinct methods of blasting tap-rooted stumps. The charge can all be placed in a single hole bored into the root, or it can be placed in one, two or three holes alongside the tap root. When two or more holes are used, electric firing must be practiced. Each method has its advantages. Placing the charge in the stump requires more labor and a smaller charge, while the other method requires but little labor and a greater amount of explosives. The first method reduces the stump and tap roots to smaller fragments, and is generally used by those blasting stumps for distillation.

**Loading in the Tap Root.**—In placing the charge in the root a spade is used to remove a little soil so that the tap root is exposed to a depth of a foot or more. The hole is bored diagonally downward through the center of the root, using a heavy 1½ or 2 inch wood auger. This should reach well below any possible depth of subsequent tillage, and more than half way through the root.

In loading it is best to use a half-cartridge primer and remove the rest of the charge from the paper shell. Pack the charge firmly in the bottom of the hole and press the primer firmly against it. The hole should then be tamped tight up to the very collar. Better results will be obtained if the soil is pressed firmly back into the hole made to expose the tap root (Fig. 15).

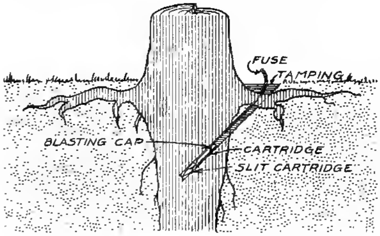
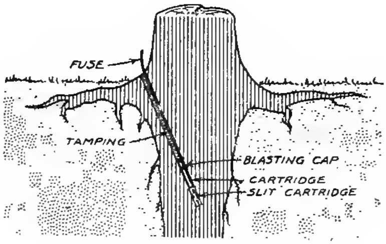



FIG. 15. METHOD OF BORING AND LOADING A TAP-ROOTED STUMP FOR A CAP-AND-FUSE BLAST. THIS LOCATION OF THE BORE HOLE IS BEST WHEN THE BORING IS DONE WITH HAND AUGERS

The charge will vary from a half-cartridge primer for small roots to three or four cartridges for very large solid stumps. Stumps having decayed or hollow tap roots should not be loaded in this way, as they can be gotten out better by two or more charges placed around the tap root.

FIG. 16. WHEN POWER BORING MACHINES ARE USED, NO EARTH IS SHOVELED, AND THE HOLE IS STARTED INTO THE WOOD SLIGHTLY ABOVE THE SURFACE OF THE GROUND




When electric boring machines are used it will not be necessary to use a shovel, as the hole is started in the root immediately at the surface of the soil, and can range almost straight down into the tap root (Fig. 16). This is the method of loading used by many who blast large numbers of pine stumps for distillation.

To split fat pine stumps to facilitate burning, the holes are bored and loaded as has just been described, but lighter charges of Farm Powder are used.

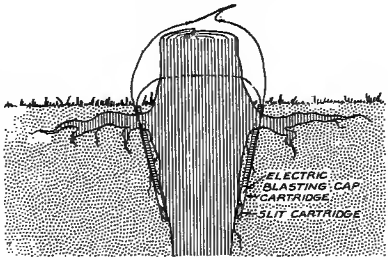
The explosive recommended is Red Cross Farm Powder.

**Loading Around the Tap Root.**—When placing the charge between the tap root and the subsoil, the wood auger will not be needed, as the holes can be made faster with a subsoil punch, crowbar or soil auger. (See pages 19 and 20.)

In this method much depends on the depth and location of the bore holes, which should be not less than three feet deep, and usually more. The charges should be snug against the tap root, so that they will lie immediately alongside the wood.

When but one hole is used for blasting small or old stumps, the charge should seldom be less than 1½ cartridges. If the holes are dry all the cartridges except the primer should be slit from end to end and packed tightly in the bottom of the hole. The tamping must be tight. Such a charge can be fired with cap and fuse. In clay and clay

FIG. 17. FOR BLASTING TAP-ROOTED STUMPS WITH DISTRIBUTED CHARGES AND ELECTRIC FIRING. TWO OR MORE HOLES ARE PUNCHED ALONGSIDE THE MAIN ROOT AND LOADED. ONLY ELECTRIC BLASTING CAPS CAN BE USED FOR THIS PURPOSE




loam subsoils Red Cross Farm Powder should be selected, but in light or sandy subsoils Red Cross Stumping Powder or Red Cross Extra 40 to 50 Per Cent. Dynamite will give better results. In light sand soils, loading in the tap root and firing with blasting cap and fuse is usually better.

When for large tap-rooted stumps that are so firmly brace-rooted that the single hole method of blasting is ineffective, two or more charges are distributed around the tap root. The same care should be exercised in putting down the holes, and if the stumps are large the holes should be not less than four feet deep. Only electric caps can be used. The charges will vary from 1½ to 2½ cartridges for each hole.

## BLASTING SEMI-TAP-ROOTED STUMPS

Where stumps have a tap root of medium size and a heavy set of lateral roots, the loading will be intermediate between the loading for tap-rooted and lateral-rooted stumps. This loading is practically the same as that shown in Fig. 17, the chief difference being that an occasional charge will be needed under the heavier brace roots. (See Fig. 19.)

## BLASTING SMALL LATERAL-ROOTED STUMPS

When stumps have no tap root, but only lateral ones, the loading will depend on the nature of the soil and the size and state of preservation of the roots. When they are small or the roots are partly decayed the charge can all be placed in a single hole started a little way back from the stump and sloped under the part of the stump that will be hardest to lift (Fig. 18). The charge will run all the way from less than a cartridge to several cartridges.

Where the subsoils are tight and offer good resistance Red Cross Farm Powder will prove itself to be the most satisfactory and economical explosive. In loose sandy soils 40 or 50 per cent. Red Cross Extra Dynamite or Red Cross Stumping Powder will be better.

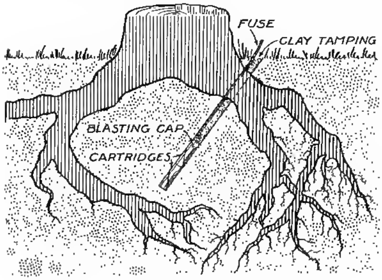



FIG. 18. CORRECT METHOD OF LOADING A SMALL STUMP FOR A SINGLE CHARGE BLAST. THE CHARGE MUST BE LOADED WELL UNDER THE HARDEST PART TO LIFT, AND WELL TAMPED

Here, again, the depth of the holes will play an important part. If they are too shallow the blast will only split the stump and fold the parts back without blowing them out. Shallow loading is advisable only when the stump is to be split and then pulled as is described on page 43. It is seldom for blasting the stump out entire, that the loading should be shallower than 30 inches, and, if the stumps are hard to blast, 4 feet is better.

The tool for making holes is a crowbar or a subsoil punch (Fig. 3). A soil auger (Fig. 4) is frequently needed for deepening the holes for blasting large stumps.

## BLASTING LARGE LATERAL-ROOTED STUMPS

The use of electric blasting is essential to the best success in blasting large stumps or those having wide-spreading roots. If the charge is confined in a single bore hole, as in Fig 18, the effect will be to split and not lift the stump, but if the same or a smaller charge is distributed in several well-located holes, the blast fired by electricity will lift the stump perfectly. The number and location of the holes must be governed absolutely by the individual stump. For stumps slightly larger than can be lifted by a single charge, two holes will usually be sufficient. These should be on opposite sides of the stump, and should be inclined under the stump. For larger stumps three or more holes should be used. One of these should be under the center of the stump and the rest so placed around the outer edge as to form a circle under and around the holding roots, as is shown in the two accompanying cuts (Figs. 19 and 20).

Care should be exercised to get the center or main charge well under the stump. This is needed for lifting and splitting the heavy part. The other charges should be distributed under the large roots, and may be some distance away from the stump. For this kind of blasting only electric blasting caps can be used.

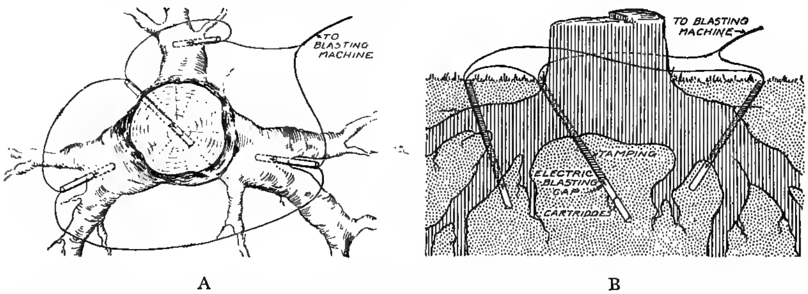
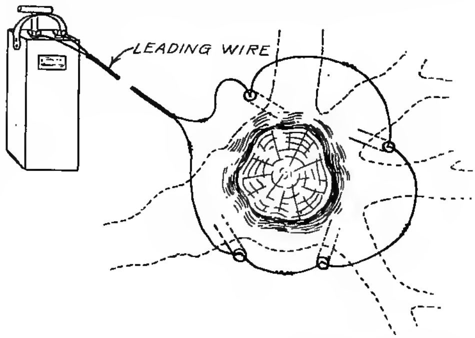



FIG. 19. METHOD OF LOADING LARGE LATERAL STUMPS WITH DISTRIBUTED CHARGES, FOR AN ELECTRICALLY-FIRED BLAST. "A" SHOWS WHERE THE HOLES SHOULD BE STARTED AND, IN A GENERAL WAY, HOW THEY SHOULD POINT, AND HOW THE WIRES ARE CONNECTED IN SERIES TO THE LEADING WIRE. "B" SHOWS THE LOCATION OF THE HOLES UNDER THE STUMP

FIG. 20. SHOWING FULL DETAILS OF LOADING DISTRIBUTED CHARGES, UNDER AND AROUND A LARGE STUMP FOR AN ELECTRICALLY-FIRED BLAST. THE LEADING WIRE SHOULD NOT BE LESS THAN 250 FEET LONG




As in all stump blasting, the holes should be well down into the subsoil—not close up to or in contact with the wood. The best tools for making the holes are the crowbar and the subsoil punch. Soil augers are sometimes used.

The best explosive for this work is Red Cross Farm Powder, unless the subsoil is loose and open, when Red Cross Stumping Powder or Red Cross Extra 40 per cent. will be found more satisfactory.

Each separate charge, or hole, is primed with an electric blasting cap. The wires to these caps are connected as is shown in Fig. 20, and to the leading wire which is in turn connected to the blasting machine. Several stumps can be wired into the same blast and fired together.

## BLASTING STUMPS FROM VERY SOFT SOIL

For cypress, willow or other stumps in very soft, swampy soil, modification must be made in the methods of loading on account of the poor resistance offered by the soil and the enormous number of spreading roots. The holes must be so distributed that not only the stump, but all of the main-spreading roots will be blown out down below plowing depth. The quicker-acting Red Cross Extra Dynamite of 40 or 50 per cent gives best results. To insure the most efficient use of the explosives the shots should be fired as soon as possible.

## BLASTING HOLLOW STUMPS

Many of the stumps are found to be only shells, the heart having been entirely rotted away. To blast these successfully drive a bar or rod into the soil down through the hollow, and tamp the stump full of moist soil, remove the stake and load in the hole left by the post and tamp solid. Additional charges placed under the spreading roots should be used, and fired electrically.

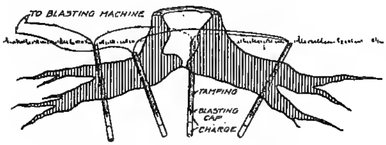



FIG. 21. METHOD OF LOADING A LARGE HOLLOW STUMP WITH DISTRIBUTED CHARGES FOR AN ELECTRICALLY-FIRED BLAST. THE ONLY VARIATION FROM THE ORDINARY LOADING OF LARGE STUMPS (FIGS. 19 AND 20) IS IN DRIVING ONE HOLE DIRECTLY THROUGH THE HOLLOW

## BLASTING STUMPS UNDER WEST COAST CONDITIONS

### Western Fir, Pine and Cedar Stumps

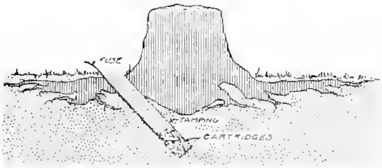
In the States of Washington, Oregon and parts of California, where the rainfall is heavy and the ground in the forests is always damp, many of the trees grow to great size—some being eight or ten feet in diameter. The roots of these trees usually spread out near the surface and do not grow deep into the ground as might be expected, tap roots being extremely rare.

The object when blasting these stumps is not only to split them, but to bring out the pieces 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.

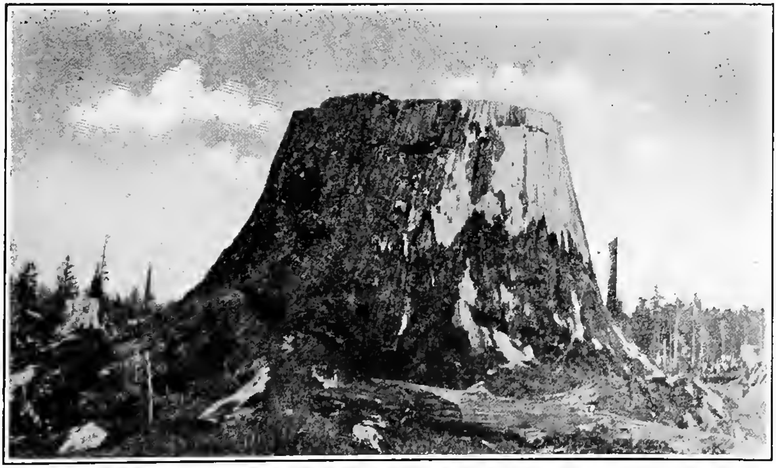
The common rule in blasting these stumps is to use one and one-half pounds of Du Pont or Repauno Stumping Powder per foot of diameter, with stumps up to four feet, when the subsoil is clay. For larger sizes from two to two and one-half pounds for each foot in diameter should be used. Stumps in gravelly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

The charge of explosives is best placed so that there will be from 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.

FIG. 22. SHOWING LOCATION OF A SINGLE LARGE BORE HOLE AND METHOD OF LOADING LARGE WESTERN STUMPS, USING BLASTING CAPS AND FUSE




As the large amounts of powder required to blast out a stump of this character cannot be contained in a bore hole such as is advised for small stumps, a larger bore hole is required. This is usually dug with a long-handled tiling spade. The earth is loosened by means of a crowbar or long chisel and cleaned out of the hole with a spade. The charge is loaded into this large bore hole in exactly the same manner as in other holes.



THE VACANT THRONE OF A DEPOSED MONARCH IN THE PACIFIC NORTHWEST

## REDWOOD AND BIG TREE STUMPS

The way to estimate the quantity of Du Pont or Repauno Stumping Powder 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 Du Pont or Repauno Stumping Powder 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 Du Pont or Repauno Stumping Powder 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 be considered only 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 powder blasted in holes punched with a crowbar will prove of great assistance in digging this trench, especially when the subsoil is clayey.

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, or stones may be thrown with more violence and to greater distances on that side.

* * * * *

Where there is much heavy stumping and means are available for purchasing the needed equipment, the combination methods described on pages 43 to 46 are recommended for West Coast conditions. See also pages 46 to 49 for methods of piling and disposing of stump fragments.

## SPECIAL BOOK FOR THE PACIFIC NORTHWEST

On account of the differences in explosives recommended for this region, and this book being prepared especially for the States lying east of the Rocky Mountains, those interested in developing land in Washington, Oregon or California should write for a copy of "Developing Logged-off Lands of the Northwest." It gives specific advice applicable to that part of the country, and should be in the hands of all interested in its development.

## APPROXIMATE CHARGES FOR BLASTING STUMPS

No absolute rule can be laid down giving the required charge for blasting stumps of different sizes, but the following, which is based on old but solid stumps in firm, dense soil can be used as a basis, making variations either way as may be required:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diameter of Stumps in Inches....... | 12 | 18 | 24 | 30 | 36 | 42 | 48 |
| Number of Cartridges of Red Cross Farm Powder.................. | 3 | 4 | 6 | 7 | 8 | 12 | 15 |

If the stumps are green, or if the soil is loose or sandy, these amounts must be increased, but if the stumps are partly decayed, lighter loading will do the required work.

These approximate estimates, of course, are based upon the idea that Red Cross Farm Powder alone is to be used and that the stump is to be blasted out entirely. If the object is to merely break or loosen the stump before or after pulling it with a stump puller, then, of course, these estimated charges can be reduced to one-third or one-half.

Each operator can easily determine for himself, by making a few experimental shots, what the proper charges will be. Of course, the aim should be to do the work with the least possible amount of Red Cross Farm Powder. As a starting point, we would suggest using the charges mentioned in the table above. They can be increased or decreased in keeping with the results of the test shots.

A TYPICAL PIECE OF WASTE LAND

## FELLING TREES

The loading for blasting down standing trees is the same as for stumping, with the important difference that heavier loading is required, because of the greater weight to be lifted. If this work can be done during a high wind, the wind load on the tops of the trees will materially assist in bringing them down. When a tree is valuable for saw stock it should not be blasted down, as the blast may split the trunk in such a way as to ruin it for the sawmill.

## COMBINATION METHODS OF STUMPING

Stump pullers are on the market operated by hand power, horse power, gasoline engines and steam. On clearing jobs large enough to warrant the investment in a puller, explosives and a good machine work nicely together. All men have their individual tastes and preferences. Some swear by explosives and others by stump pullers. A third class takes the middle ground, and uses both in conjunction. On the large jobs a saving in time and money is effected by the combination; the stumps are well shattered; the holes are small; and the final fitting of the land made easy.

This combination method makes use of dynamite for splitting the stump and freeing the roots of dirt either before or after pulling. The puller is used to draw the roots or stump, the final object being to clear the land and dispose of all stump fragments. A large number of tests, chief of which are those recently conducted under the direction of the University of Wisconsin, have proven that on large areas, the use of this method is better than either pulling or blasting alone.

The advantages of using a puller and explosives in conjunction are:

(1.) A saving in explosives;

(2.) A saving in time;

(3.) A saving in labor;

(4.) Less strain on machinery, horses and harness;

(5.) Greater ease in handling the stump after it is out;

(6.) Does away with the disagreeable and time-consuming work of clearing dirt off the roots;

(7.) Does away with a large part of the work of filling the hole.

**When to Pull Stumps.**—When horse or other power is available, and large numbers of small stumps are to be removed from sandy soils, the puller, alone or with a minimum of dynamite, is better and more economical than blasting.

**When to Blast Stumps.**—When the stumps are scattered, as in old cultivated fields; or when there is but a small amount of clearing to do in any one place, as in clearing up small wood lots or corners, the advantage is undoubtedly with explosives used alone. This use has also proven best for obtaining stump wood in the Stump Turpentine industry.

Dynamite, loaded well below the ground level, should be used without heavy pullers for clearing stumps out of orchards.

**When to Use Combination Methods.**—The use of combination methods is recommended for general clearing operations, not covered in the two general recommendations just made, where the stumps are either large or green, for under these conditions the most careful work must be done to get the desired results with either individual method. Occasional failures to blast the stump out entirely and the balls of earth on the roots lifted by the pullers are both objectionable.

A careful study of the local conditions should always be made before selecting the necessary equipment.

## BLASTING BEFORE PULLING

Perhaps the most satisfactory general application of the combination method is to blast the stumps and then pull the fragments. The loading is done in keeping with Fig. 23. The object is to split the main part of the stump and loosen the brace roots from the ground so that a minimum of earth is pulled out. The loading should be shallow, so that the hardest blow of the blast is directly against the forks where the roots branch out from the stump. The charge, which is usually fired with a blasting cap and fuse, should be just sufficient to split and loosen the stump.

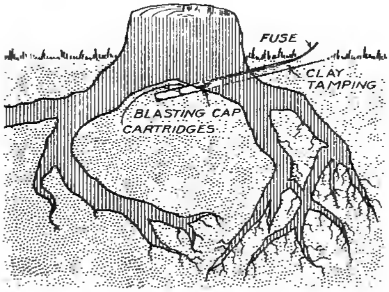



FIG. 23. LOCATION OF A SHALLOW BLAST FOR SPLITTING A STUMP FOR PULLING. THE CHARGE SHOULD BE PLACED CLOSE UP TO THE WOOD AND SHOULD BE JUST HEAVY ENOUGH TO SPLIT THE STUMP

This method is highly satisfactory for green stumps or those having heavy spreading roots, especially on silty loams and heavier soils.

Red Cross Farm Powder is recommended for heavy soils and Red Cross Stumping Powder or Red Cross Extra Dynamite 40 per cent. for light ones.

In this application of the combination methods the stumps are first pulled and then blasted to free the roots of dirt and to split the stumps so that they can be piled and burned or used for other purposes. It is not so well suited to extremely large stumps or those having heavy spreading roots as is blasting before pulling. It finds its chief use on stumps that have large single roots or on sandy land.

**Blasting Pulled Stumps.**—There are three methods of blasting pulled stumps:

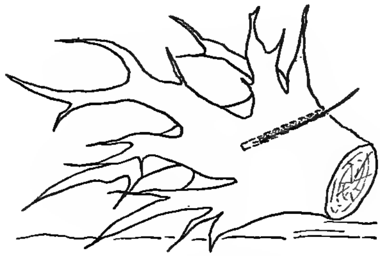
(*a*.) Any cavity or hollow in the stump can be loaded (Fig. 24). The hole should be well tamped.

FIG. 24. SHOWING LOCATION OF A CHARGE OF EXPLOSIVES IN A HOLLOW-PULLED STUMP

This method finds ready use when old hardwood stumps are being pulled. The charge should be kept down to a small amount of Red Cross Farm Powder.

GENERAL VIEW OF BLASTED STUMP FRAGMENTS ON LIGHT CLEARING (*b.*) A hole can be bored into the thick part of the stump near the original ground line (Fig. 25).

FIG. 25. LOCATION OF A HOLE BORED INTO A PULLED STUMP FOR SPLITTING. SOME PREFER TO BORE SUCH A HOLE IN THE SAME DIRECTION AS THE NATURAL HOLLOW (FIG. 24)



(*c.*) A hole may be punched through the mass of earth, on the bottom of the stump, to the forks of the main roots (Fig. 26).

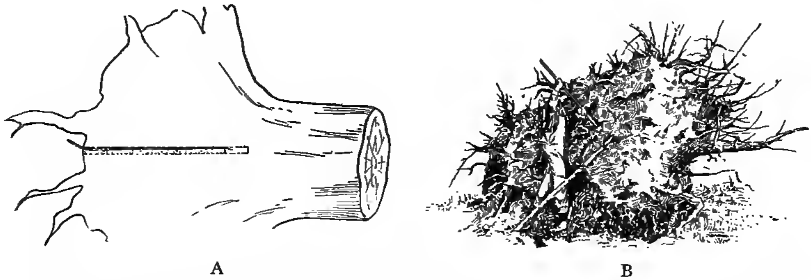


FIG. 26. PUNCHING A HOLE FOR A SPLITTING CHARGE THROUGH THE EARTH CLINGING TO THE ROOTS OF A STUMP. "A," LOCATION OF BORE HOLE; "B," LOADING THE CHARGE

* * * * *

Red Cross Farm Powder is recommended for all three methods. Good tamping is essential to success. (See pages 27 and 28 for methods of loading.)

### DISPOSAL OF STUMP FRAGMENTS

Land is not cleared when the stumps are simply out of the ground, for they are frequently more in the way when lying on the ground than they were when in the ground. All blasting tends to split stumps into fragments that can be more easily handled. If the stump wood is of value for fuel, or for distillation, it should be saved and hauled to market as soon as possible. Small fragments are naturally much easier to handle. Stone boats or sleds can frequently be used for short hauls and are easy to load and unload. For longer hauls wagons are better. Wagons can be loaded with the pilers shown in Figs. 27 and 28.

In many localities stump wood is simply waste, as there is no market for it either for fuel or for distillation. In such cases the easiest and quickest method of burning is to be desired. There are many methods of piling for burning. Each method has its advantages under peculiar circumstances. The selection of method should be made in accordance with the individual needs.

**Building Small Piles.**—On small stumping jobs, especially where there is a considerable amount of trash to be burned, the building of small piles, including only two or three stumps, is found very satisfactory. The largest stump fragments can be used for the base of the pile, and the smaller fragments piled on top by hand, or by means of teams or pullers.

**Building Large Piles.**—Frequently, especially on extensive clearing jobs, it is better to build large piles. When it is necessary to leave the stumps for some time to allow them to dry out, this is an excellent method. Some claim that the stumps burn much better when piled in this way.

The "mast," or "gin pole," is most largely used in the West, where it gives excellent satisfaction. It is used in connection with the donkey engine, but it can also be used to good advantage with heavy teams. The pole may be erected and secured by means of guy wires or ropes, or a standing tree can be used to good advantage. The pole is burned with the pile. A good idea of this method can be obtained from Fig. 27, page 48.

There are a number of patented as well as home-made "boom pilers" that prove very satisfactory. Some of these are quite heavy and hard to move, while others are lighter and can be easily pulled about the field. One of the simplest of these is the "Conrath Piler," which is shown in detail in the accompanying cuts. This outfit, which is not patented, can be built on the farm at a cost of about $25 to $30. This outfit can also be used for loading wood or stump fragments on a wagon. The following bill of material will assist in building the piler. The timbers can be of sawn lumber, but round poles, cut in the woods, are more generally used, as they are cheaper and just as good.

The use of a piler on large operations is almost imperative in order to clean up the scattered fragments and debris, so that a free space can be had in which to work, especially when teams and pullers are used.

It also allows the free cleared ground between the piles to be plowed and worked while waiting for the piles to dry out sufficiently to be burned.

FIG. 27. SHOWING PILING STUMP FRAGMENTS BY MEANS OF A GIN POLE. A HEAVY TEAM CAN BE USED IN PLACE OF THE DONKEY ENGINE FOR LIGHT WORK

BILL OF MATERIAL FOR CONRATH PILER (See Fig. 28)

(*a*) 2 skids, 8 x 8, 20 ft. long.
(*b*) 1 cross beam where boom sets on, 7 x 8, 9 ft. long.
(*c*) 2 cross beams for ends of skids, 5 x 5, 9 ft.
(*d*) 2 standards for A frame, 5 x 5, 14 ft.
(*e*) 2 brace poles for A frame, 4 x 4, 18 ft.
(*f*) 1 pole for swinging boom, 7 x 7, 22 ft.
(*g*) 110 ft. ⅜-in. steel cable.
(*h*) 40 ft. ½-in. steel cable for holding boom.
(*i*) 2 25-ft. pieces ½-in. guy cable.
(*j*) 1 shive fastened in end of boom, ¾ x 6.
(*k*) 2 steel blocks for piling cable.
(*l*) 2 double wooden pulleys for ⅝-in. rope.
(*m*) 2 single wooden pulleys for ⅝-in. rope.
(*n*) 2 strips of iron ½ x 1½, 18 in. long, to fasten A frame to skids.
(*o*) 1 plate of iron ¼ x 4 in., 12 in. (plate on cross piece at bottom of boom).
(*p*) 1 piece of iron ½ x 2½, 24 in. long, to fasten bottom of boom to cross beam.
(*q*) 1 bolt for bottom of boom to swing on, 1 in. x 4 in.
(*r*) 4 bolts ⅝ x 12 in. long.
(*s*) 2 bolts ⅝ x 14 in. long.
(*t*) 2 bolts ⅝ x 8 in. long.
(*u*) 4 bolts ⅝ x 8 in. long.
(*v*) 1 bolt 1 x 9 in. long.
(*w*) 1 bolt ¾ x 20 in. long, threaded on both ends.
(*x*) 4 bolts ½ x 8 in. long.
(*y*) 2 bolts ⅝ x 9 in. long.
(*z*) 2 single blocks for ⅝-in. rope, for changing elevation of boom.
(*az*) 2 single blocks for ½-in. cable for boom.

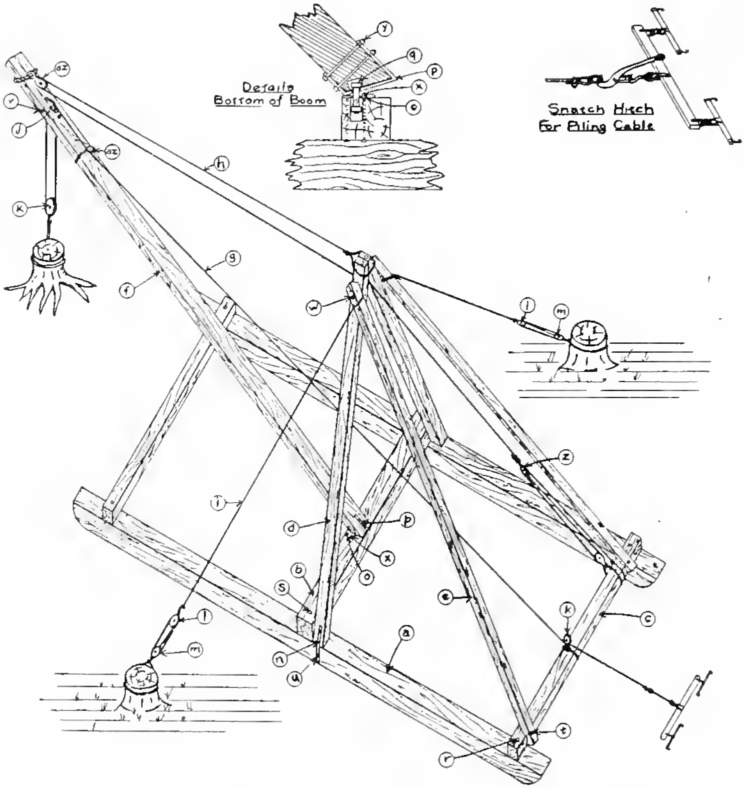



FIG. 28. DETAIL SKETCH SHOWING CONSTRUCTION OF THE CONRATH PILER

(See page 48 for Bill of Material. See Fig. 29 for photograph of finished piler.)

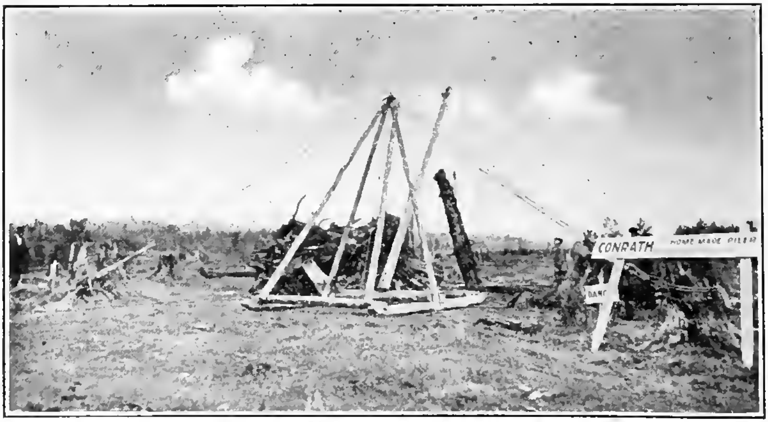



FIG. 29. SHOWING A COMPLETE CONRATH PILER BUILT OF POLES

# THE STUMP TURPENTINE INDUSTRY

## What It Means to Owners of Cut-Over Long Leaf Pine Lands

The manufacture of turpentine and rosin is a very important industry in seven of our Southern States. In 1909 there were 1,585 establishments engaged in manufacturing these products. The capital invested in the business was $12,375,000 and 41,959 officials and workmen were employed in the industry.

The supply of gum is becoming exhausted, so both turpentine and rosin are now being extracted from the wood.

Although it is a well-known fact that the stump contains a larger amount of turpentine, rosin, tar, wood oil and creosote than is contained in the trunk and branches of the tree, only the trunk and branches have been utilized by many manufacturers due to the excessive cost of getting the stumps out of the ground and breaking them into fragments suitable for retorts and "hogs." The use of improved hand augers and power boring machines and Red Cross Farm Powder has overcome these difficulties and thousands of cords of wood are now being blasted for the distilling plants.

Some of the stumps are blasted from land controlled by the distilling companies, some are blasted under contract, and some by farm landowners who are making the funds derived from the sale of the fat wood pay the entire clearing cost and are, by a little plowing and work, getting their fields cleared at no actual outlay.

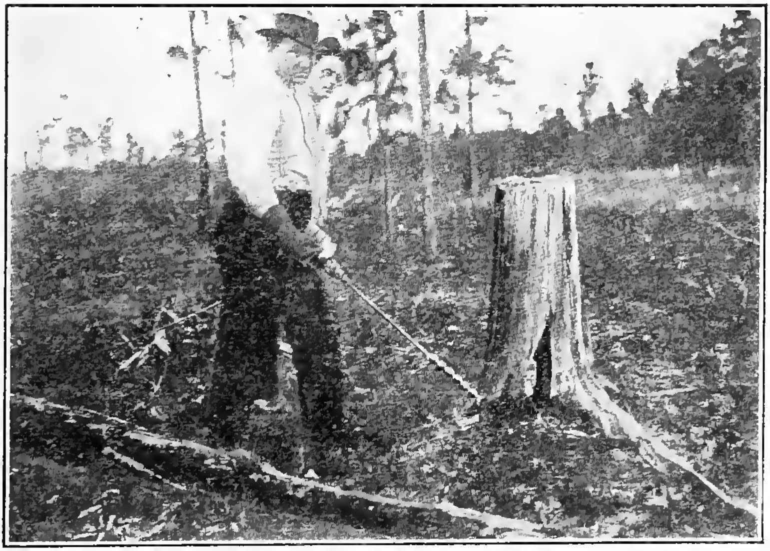


FIG. 30. TWO MEN OPERATING AN ELECTRIC BORING HEAD

The stump turpentine industry offers an excellent opportunity to all owners of Long Leaf Pine Stump Lands.

### Methods of Blasting Pine Stumps for Distillation

The methods used for blasting the stumps are exactly the same as are shown in Figs. 15 and 16, page 35. Red Cross Farm Powder is recommended on account of its low cost. Its strength and velocity make it admirably adapted for this blasting.

**Power Borers.**—The only power borer now extensively used in the stump turpentine industry is driven by electricity. A small dynamo and gasoline engine are mounted on a one-horse wagon. This is driven into the stump lands and supplies the current for driving one or two boring heads (Fig. 31). One boring head usually bores from 300 to 350 stumps per day. (See Fig. 16, page 35, for the location of the hole.)

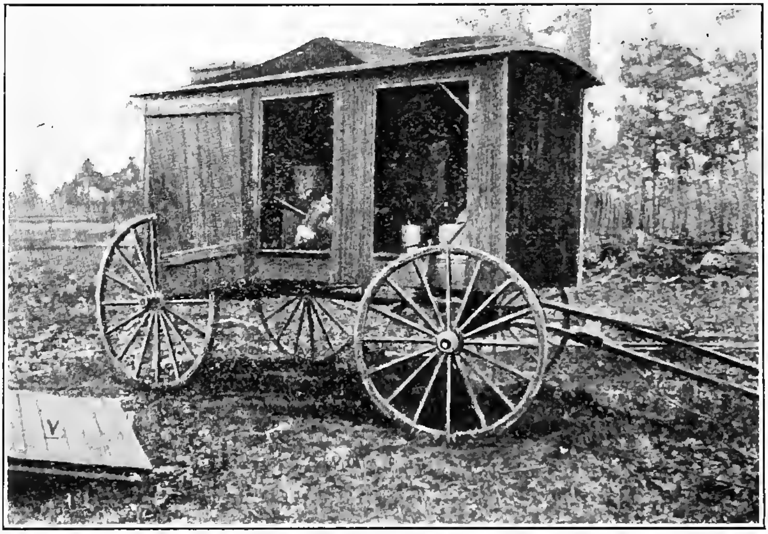


FIG. 31. PORTABLE GENERATOR FOR SUPPLYING CURRENT FOR RUNNING AN ELECTRIC BORING HEAD

# Boulder Blasting

Field boulders, whether loose rocks or solid ledges, present the same obstacles to cultivation as do stumps. (See again the drawing and remarks on page 33.) Their removal is just as necessary as is the removal of stumps. By a judicious use of explosives all classes of boulders and ledges can be successfully removed.

### METHODS OF BLASTING BOULDERS

There are three distinct methods of loading for breaking field boulders. These are: "Blockholing," "Snakeholing" and "Mudcapping." Blockholing requires the smallest amount of explosives, but the most labor; while mudcapping requires the smallest amount of labor, but a considerably larger amount of explosives; snakeholing is intermediate in both labor and amount of explosives required. Each method has its special use as is pointed out in the following paragraphs.

**Blockholing.**—Blockholing consists of drilling a hole into the boulder and charging it with a small amount of dynamite. It is the best method for breaking very hard or very large boulders, especially those of the "nigger-head" type that are so difficult to break by other methods.

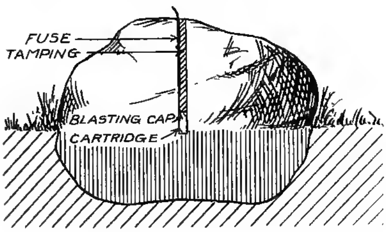



FIG. 32. PROPERLY PLACED BLOCK-HOLE BLAST. NOTE LOCATION OF EXPLOSIVE AND BLASTING CAP. TIGHT TAMPING IS ESSENTIAL

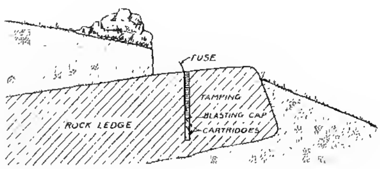



FIG. 33. CORRECT METHOD OF LOADING TO BLAST AN OUT-CROPPING LEDGE. IT IS USUALLY BEST TO REMOVE THE BURDEN OF EARTH. FOR LONG LEDGES, ELECTRIC FIRING IS BEST

The hole should usually be drilled about half way through the boulder and may be an inch or larger in diameter.

When the drill hole is smaller than the diameter of the dynamite cartridge the explosive should be removed from the shell and packed firmly into the bottom of the hole. When the entire charge is in, make a hole for the cap in the top of the powder with a pointed hardwood stick. Press the cap into the hole and tamp it in with moist soil. The hole should be tamped full.

When the drill hole is large enough to receive the cartridges, it is not necessary to remove the paper shell. For very large holes the cartridge shell should be slit several times from end to end.

As the confinement is perfect in such loading any of the Du Pont high explosives recommended in this book will give good results. Red Cross Farm Powder and the different stumping powders are especially recommended.

Blockholing is very effective in blasting out-cropping ledges that are too large to remove entirely.

See pages 22 to 26 for Methods of Making Primers, and pages 27 to 29 for Methods of Loading and Firing.

**Snakeholing.**—Snakeholing consists of punching a hole under, but immediately against the bottom of a boulder and placing the charge of explosives in as compact shape as the size of the hole will permit. A better idea of the method can be had by glancing at Fig. 34. The explosive being confined on the underside by the earth, can exert a powerful blow on the boulder and will roll it out, or if a sufficient charge is used will break it in fragments.

This is one of the easiest and most successful methods of boulder blasting. The best explosives for this work are either Red Cross Stumping Powder or Red Cross Extra 40 per cent. Dynamite. Electric blasting is not generally used unless the boulders are very large and more than one charge is used to blow them out. Many blasters prefer to lift boulders out with a snakehole shot and later break them with a mudcap.

Sometimes a mudcap is used on the top of a boulder in connection with a snakehole blast under it. Both charges are fired electrically. This method applies to large boulders only.

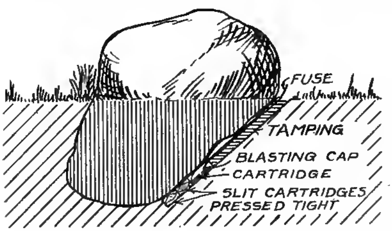



FIG. 34. CORRECTLY PLACED CHARGE FOR A SNAKEHOLE BLAST. THE CHARGE SHOULD BE IN CONTACT WITH THE BOTTOM OF THE BOULDER

See pages 22 to 26 for Methods of Making Primers, and pages 27 to 29 for Methods of Loading and Tamping.

**Mudcapping.**—Mudcapping is known by a variety of fantastic and expressive names, such as "Bulldozing," "Blistering," "Poulticing" and "Adobe Shooting," and is made possible by the fast, shattering action of the higher grades of dynamite. In practice it consists of removing the dynamite from the shell and packing it in a compact conical heap on the boulder, and after inserting a cap and fuse covering it with several inches of thick, heavy mud.

The explosive should be placed on the boulder at the place where it would be struck with a hammer were it small enough to break in that way (Fig. 35). This may be on the top or side. If the boulder is embedded in the ground, a snakehole shot to roll it out on the surface should first be made, because the confining dirt makes it much harder to break with a mudcap shot. The mud covering should be as thick and heavy as it is convenient to make it, not less than 5 or 6 inches, and should be free from stones, as the blast will throw them as though they were bullets. Never lay a stone on top of the mud for the same reason.

The explosives used are Red Cross Extra 40 per cent. for easily broken rock, and Du Pont Straight 50 per cent. for hard nigger-head boulders.

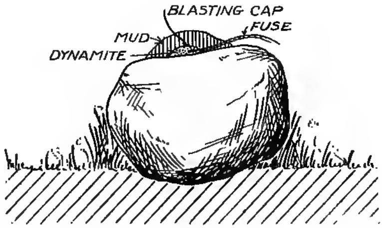



FIG. 35. A WELL-LOCATED MUDCAP. THE COVERING OF MUD SHOULD BE AT LEAST 6 INCHES DEEP AND FREE FROM STONES

**Seam Blasting.**—Frequently ledges and boulders have seams from which the mud or stone chips can be removed to a considerable depth. When such a seam is as much as one-half inch wide, successful blasts can be made by packing a reasonable amount of 40 per cent. or stronger dynamite into the crack and tamping it securely with moist clay. This method will require about the same amount of dynamite as snakeholing, but is more satisfactory for badly-seamed boulders or ledges. The greatest care must be exercised in placing and tamping the charge to prevent the expanding gases from escaping through the cracks.

## AMOUNT OF EXPLOSIVES REQUIRED FOR BLASTING BOULDERS

On account of the differences in hardness of rock in different places, and the variations in shape in a single field, it is impossible to give exact information as to the amount of explosive to use. The following table, which is based on stone of average hardness loaded with Du Pont Straight 50 per cent. Dynamite, will give some idea of the amounts to use in making test shots. It will be necessary to vary these amounts on account of the great variation in the hardness of stone. The recommendations are valuable only for making the first trial shots. After these are made the blaster should be governed by the results obtained.

| Diameter of Boulder in Feet | Number of Cartridges Required | | |
|---|---|---|---|
| | Mudcapping | Snakeholing | Blockholing |
| 1½ | 2 | 1 | ¼ |
| 2 | 3 | 1 | ¼ |
| 3 | 4 | 1½ | ½ |
| 4 | Don't attempt | 4 | ¾ |
| 5 | Don't attempt | 6 | 1 |

This is based on the use of Du Pont Straight Dynamite of 50 per cent. strength. If Red Cross Extra 40 per cent. Dynamite is used, increase the amounts by half, and if Red Cross Farm Powder is used for snakeholing or blockholing, double the amounts.

## EXPLOSIVES FOR BOULDER BLASTING

For boulder and other rock blasting, the recommendations in this book can be followed literally, because the grades of dynamite recommended can be obtained in West Coast States.

## DISPOSAL OF BOULDER FRAGMENTS

The accompanying cut shows a beautiful home built of fragments of field stones by a progressive blaster who was clearing up a large field. Other uses are for building foundations, walls, fences, roads, for making concrete, for filling gullies or discarded ditches and forming blind drains to remove excesses of rainwater.

Where large boulders leave deep holes much of the debris can be buried in the bottom of the holes, but care must be taken to keep it well below plow depth.

HOUSE BUILT OF FRAGMENTS OF BOULDERS BLASTED FROM ADJOINING FIELD

# Vertical Farming

### (Deep Tillage)

For satisfactory crop production the soils should be well drained, well aerated or ventilated, and well cultivated to a depth of several feet.

The chief troubles to be overcome in making soils conform to these specifications are hardpan, tight clay and poorly drained subsoils. Such subsoils

> Prevent the downward movement of water into the soil, and permit it to be lost by evaporation, or worse, by surface runoff, which causes erosion;
>
> Exclude the air needed by beneficial bacteria and for the preparation of plant foods;
>
> Seriously retard or absolutely stop the penetration of roots; and
>
> Absorb too little water for the maintenance of crops during the dry season.

## IMPORTANCE OF WATER STORAGE

The greatest limiting factor in the production of crops in the United States is the scant supply of soil moisture during the growing season. This is especially true of summer crops. There is a sufficient rainfall in most of the general agricultural sections to increase the average yields to much more than double the present figures. The greater part of this is lost either through bad drainage or by surface evaporation and is never used by the plants. The first great care of the grower should be to store every possible drop of the rainfall in a well-tilled subsoil and hold it there indefinitely so that it may be available to nourish the crops during the summer when the rainfall is light and irregular, and when there is by far the greatest demand for water. Instead of laying up money for "a rainy day," it is "storing water for a rainless day."

The position and character of the impervious material in the subsoil governs very largely the extent and character of the damage done by the faulty absorption of moisture. Over a great part of the United States we find a reasonably good surface soil underlain by a tight impervious clay to great depth. On such a soil the amount of moisture absorbed will be governed almost entirely by the surface, as the underlying material is too tight and close for the water to penetrate quickly to any considerable depth, and so it is lost by evaporation or by running off along the surface. This is illustrated in Fig. 36. The first rain soaks the few inches of surface to saturation, but cannot easily go deeper, and a very unsatisfactory as well as dangerous condition is produced. The good fertile top soil is held practically in suspension awaiting only a heavier rain to carry it off down the slope, leaving only the tight material that was below. Even if the condition does not become so extreme, and there is no loss by erosion, there can be but little absorption and storage of moisture; and crops will suffer.

## BLASTING TO LOOSEN TIGHT SUBSOILS

To improve the mechanical condition of such a soil the underlying material should be blasted to loosen it to a depth of not less than three or four feet. In some cases it is better to go deeper. When such a

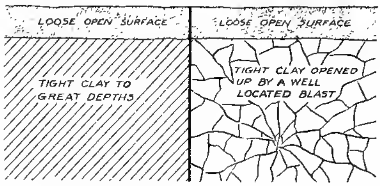



FIG. 36. FOR DEEP, TIGHT CLAY, THE BLASTS SHOULD BE NOT LESS THAN 3 FEET DEEP. THE BLASTING SHOULD BE DONE WHEN THE SUBSOIL IS DRY

treatment is given, the movement of moisture is at once affected. Instead of being checked at the bottom of the plowed furrow it penetrates immediately into the subsoil where it can spread out at will and where it will be absorbed and later used to supply the needs of the growing crop.

This work should be undertaken toward the close of the dry season, July to October preferably, when the subsoil is usually in the very best condition for shattering. It will then absorb the heavy winter rains and snows and hold them for future use. Impervious clay is usually plastic or sticky, and if blasted when wet will not be benefited and may even become more objectionable than before. When dry it shatters and pulverizes well and is converted into a cracked, porous mass that will permit the circulation of both air and water, and the deep downward growth of roots. It is in this cracked condition that it absorbs the maximum amount of water and produces the heaviest crops.

When sticky clay subsoils are blasted when wet, the effect is to produce or spring a cavity at the bottom of the blast and thus compact rather than loosen the soil. No general subsoil blasting should be done when the surface is frozen.

**One Blasting Suffices for Several Years.**—The duration of the benefits thus obtained is not as yet clearly worked out, but it appears from tests that they should be effective for a considerable number of years. So far they have been more marked during the second and third years after blasting than during the first. If proper attention is given to the surface it is quite likely that they will not return to their former state within the life of man. When heavy, deep-rooted crops such as alfalfa, for instance, are used to supply humus and increase the supply of nitrogen, the deep roots left to decay in the soil will guarantee the permanency of the benefits.

**Grow Deep-Rooted Crops.**—The growing of deep-rooted crops following subsoil blasting cannot be recommended too highly. The decaying roots leave humus down deep in the soil and subsoil. This keeps the soil open and assists in creating an ideal reservoir for the storage of moisture.

**Lime Valuable.**—On sour, wet land, where the clay is very sticky, it will be found an excellent practice to use considerable amounts of lime in order to sweeten the soil and to assist in the formation of an ideal crumb structure.

## HARDPAN

Another prevalent subsoil trouble is encountered in the layers of hardpan so often found within two or three feet of the surface. These act just as do the tight clays, already described, in preventing the absorption of moisture and are likely to be the cause of serious trouble from erosion, in addition to limiting the crop-producing capacity of the soil.

In blasting such a soil, to get the greatest benefits, the explosive must be placed in the layer of hardpan without reference to the exact

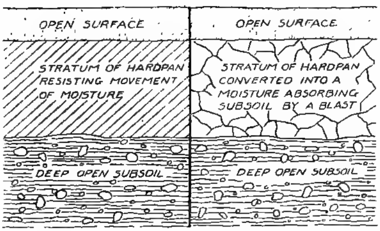



FIG. 37. A LAYER OF HARDPAN OVER OPEN MATERIAL IS EASILY DESTROYED BY BLASTING. THE CHARGES SHOULD BE PLACED IN, AND NOT UNDER, THE TIGHT MATERIAL

depth of the loading. Sometimes this may be not more than two feet in depth, and again it may be best to go as deep as three or four feet. The effect is to break up the hardpan and permit the moisture to move freely. This increases the amount that may be absorbed and permits the growing of maximum yields. The effect on root development is the same as when the deep clay is blasted.

In such a soil the blasting not only makes soil out of the hardpan, but opens up the way to the underlying good subsoil so that it, too, may assist in nourishing the crop.

## PLOW SOLE

Plow sole (Fig. 38) may be found either in connection with the other impervious conditions or alone. It lies closer to the surface and may not extend deeper than eight or ten inches. When such a condition is encountered the most satisfactory relief is by thorough and deep surface tillage. If it can be broken up by deep plowing, that is the best way to get after it. When this is not practicable, and the tillage must go deeper, a machine like the Spaulding Deep Tillage Machine offers the best relief, as it will not only break up the plow sole, but will

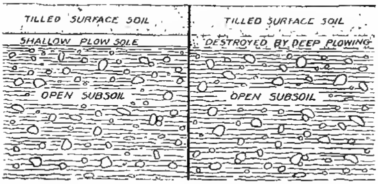



FIG. 38. PLOW SOLE OR SHALLOW HARDPAN IS MOST EASILY BROKEN BY PLOWING TO GREATER DEPTHS. THIS MAY BE DONE IN CONNECTION WITH BLASTING FOR PULVERIZING DEEPER HARDPAN

mix it with the better aerated surface soil, and materially hasten the preparation of an ideal cropping soil.

The combination of deep surface tillage and blasting becomes applicable when both shallow hardpan or tough plow sole are encountered in connection with deep hardpan or tight clay. When only one adverse condition is encountered, the treatment selected should be the one applicable to the condition.

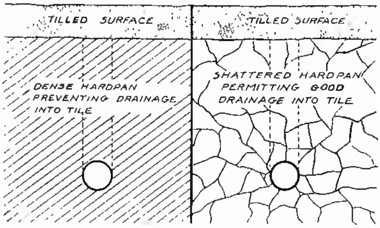
Sometimes a soil is found where the surface and upper sub-surface are well tilled to considerable depth and the tight clay is not found except at a depth of several feet. Such soils lend themselves readily to subsoil blasting, as the great benefits of the naturally deep soil can be materially increased by creating still more open material to absorb more water and to give better drainage in case of torrential rains. Such blasting must be deeper, and heavier loading may, in some cases, be found advisable.

## BLASTING TO ASSIST DRAINAGE

Aside from the benefits of explosives for shattering impervious subsoils as above described, this method of soil tillage finds ready application in shattering subsoils to assist other drainage methods that are not giving satisfactory results. Good drainage can be obtained only when the subsoil is loose and porous. The desired depth of tillage can be obtained by blasting.

**Tile Drains.**—Where tight clays and hardpan soils are found to function poorly, and establish drainage courses slowly, if at all, they can be greatly improved by shattering the subsoils between the lines of tile. The same is found to be true in soils that are but little affected by open drains, where the water is held in too large amounts over the

FIG. 39. OFTEN HARDPAN PREVENTS THE DRAINAGE WATER FROM PASSING INTO TILE OR OPEN DRAINS. THE RELIEF IS THROUGH BLASTING, WHICH OPENS UP THE NEEDED DRAINAGE COURSES




subsoil quite near the drains. Care, however, must be taken not to blast nearer than seven or eight feet to a tile drain.

The best practice is to thoroughly blast such soils before the tile is laid. This prevents all danger of injuring the tile.

* * * * *

It may be seen from the above paragraphs that subsoil blasting is advised for undesirable hardpan conditions, along logical lines. It is intended to open up the lower subsoil, for chemical analyses of soils down to a depth of twenty feet show that on the average acre there are tons of plant foods which become available only when roots can penetrate to them, or when ascending moisture brings them up to the roots that cannot get down.

## SOIL MAKERS

Alfalfa and other deep-rooted plants are called "soil makers" because they penetrate this compact soil, introduce humus and provide a passageway for the descent and ascent of water which carries with it the soluble, fertilizing elements; but many subsoils are so hard that it is practically impossible for any plant to penetrate them. Even when this is possible there is no use in putting such a burden on the plant, because whatever vitality is expended in making its own home beneath the surface is subtracted from the vitality of the plant above the surface. In other words, the plant that has to fight for its life beneath the soil has little energy left for fruition.

If we make root growth easy and quick by breaking up the subsoil, then we make the fertilizing elements of the subsoil immediately available and save the energy of the plant for fruition. We also create in the subsoil a porous condition favorable to the storage of water at a depth that will not keep the soil cold, and yet near enough to the roots to feed them through capillary attraction. Subsoiling also introduces air into the soil, and it is just as necessary for the roots of a plant to have air as it is for a human being to breathe.

The effect of subsoiling is to virtually change a farm from a six-inch layer of topsoil to a six-foot layer.

## THE USE OF LIME

In improving and reclaiming farm lands the use of lime must always be kept in mind, because it plays such an important part in the upbuilding processes.

In the reduction of tight, sticky clays to a well-granulated condition, the effect of generous applications of lime is quite noticeable, in that the fine, unmanageable clay particles are drawn together into crumbs or granules.

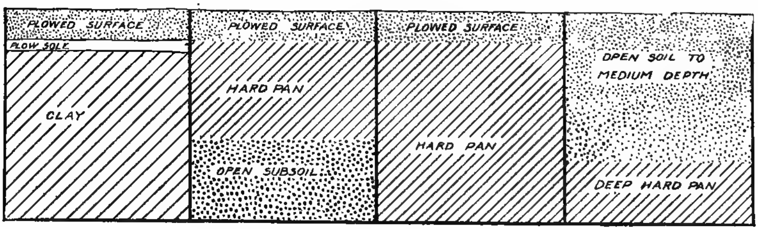
Lime sweetens the sour soils and permits a better growth of the leguminous green manure crops so much needed to supply humus. An increase in humus means that the soils can be more easily drained, will absorb more moisture, and, best of all, will produce more crop.

Another beneficial effect from lime is that it increases the activities of beneficial bacteria in the soil. Many of the most helpful forms will not grow in a sour soil, and may be replaced by harmful forms.

Write to your State experiment station for printed matter describing how and when to use the different forms of lime, and begin at the first opportunity the needed work of sweetening and otherwise improving the soil.

## HOW TO BLAST SUBSOILS

In doing this work the best results are obtained by spacing bore holes about fifteen feet apart to a sufficient depth to permit the shattering of the impervious material. In deep clays of uniform nature, such as are represented in Sections A and C of the accompanying sketch, the holes should be put down to a depth of about three feet. Where the hardpan material is similar to that in Section B the holes should be put




A B C D

FIG. 40. DIFFERENT TYPES OF HARDPAN

**down a little more than half way through the hardpan.** They should not go below the hardpan, as there is danger of the blast lifting the hardpan in large chunks, rather than shattering it. Where it is desirable to shatter soils similar to the one represented in Section D, the holes should be put well down into the deep hardpan, the depth being governed by the depth of the open surface soil. Each hole is charged with one-half cartridge of 1¼ x 8 inch Red Cross Farm Powder. Exact advice for putting down the holes and charging them is given in the text and illustrations on pages 70 and 71, and directions for making the primer are given on pages 22 to 25.

In some cases of hardpan like cemented gravel or hard shale, slight variations must be made in the method of loading. In such cases it will be better to materially increase the amount of explosive used or to use a half cartridge of Red Cross Stumping Powder or Red Cross Extra 40 per cent. Dynamite.

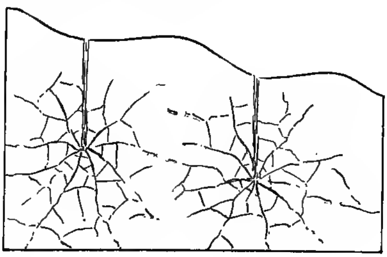
*Subsoil blasting should be done only when the subsoil is dry, because wet subsoils are difficult to shatter, and the tendency of the explosion is to create a large cavity or pothole at the base of the blast. This does not benefit the land. Where the soil, as in "A," has a loose subsoil instead of compact clay, destroy the plow sole by deep surface tillage and blasting will not be necessary.*

## BLASTING TO CONTROL EROSION

Millions of acres of valuable farm land are being damaged by erosion or washing. The use of explosives for overcoming erosion is proving very effective and is applicable in three ways: For subsoiling the entire area to increase the total moisture capacity; for subsoiling along the courses of shallow washes; and, for blasting above terraces to give the water held by the terrace a chance to strike downward. A later chapter will describe the methods of filling gullies that have already been established.

**Subsoiling Above Terraces.**—In many cases high terraces hold considerable amounts of water during heavy rains. This is dangerous because the standing water may either drown the growing crop or so saturate and weaken the terrace that a break is inevitable.

FIG. 41. CORRECT LOCATION OF BLASTS ABOVE WASHES TO CREATE VERTICAL DRAINAGE TO REDUCE THE DANGERS OF EROSION.



Correction is by subsoiling along the lowest part above the terrace, as is indicated in Fig. 41. This work should be done in keeping with the general advice on subsoiling given on pages 57 to 65.

**Subsoiling to Stop Washes.**—Subsoil blasting, slightly heavier and closer than is advised for general work, is effective in stopping shallow washes. The blasting should be started somewhat above the first show of the wash and should be violent enough to thoroughly shake the subsoil to a depth of at least 40 inches, and for at least 15 feet to each side of the wash, as is indicated in Fig. 42.

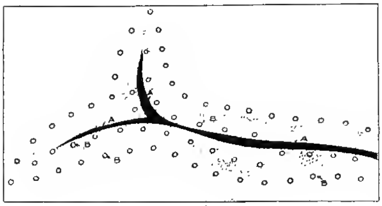


FIG. 42. SHOWING THE LOCATION FOR SUBSOIL SHOTS ALONG A SHALLOW WASH. THE SHOTS ARE INDICATED BY CIRCLES "B." THESE SHOULD COMPLETELY SHAKE THE CENTER OF THE WASH "A" AND BE LOCATED ALONG THE SIDES SO THAT THE SUBSOIL IS SHATTERED FOR AT LEAST 15 FEET EACH WAY. FOR NARROW WASHES TWO LINES OF HOLES ARE SUFFICIENT

## GULLY FILLING

When gullies are too deep to plow across, the banks or sides can be blown down by blasting. The loading can be in vertical holes (A, Fig. 43), or in snake, horizontal or flat holes (B, Fig. 43). Vertical holes are usually best for flat banks and snake holes for steep banks. They should be deep enough and charged with a sufficient amount of explosives to shatter and throw down the bank so that the work of leveling can be completed with plows or drag scrapers (Fig. 78, page 103). The exact loading must be determined by trial shots. For a gully six feet deep a good trial shot would be with holes 5 to 6 feet apart and about 5 feet deep. They should be loaded about half full of Red Cross Farm Powder. The effects of such a blast will indicate clearly how the next holes should be spaced and loaded. Correct loading should throw enough soil over into the gully to permit the use of teams in plowing and scraping down the banks, and the shock of the blast will be sufficient to shatter the deeper subsoil, so that it will absorb an increased amount of water and prevent further erosion, except under very trying conditions.

As there is sometimes danger of the freshly moved soil being washed away by heavy rains, a good precaution is to build an occasional dam of logs or boulders across the gully—to act as an anchor. Another good anchor is a woven wire fence stretched across the gully, having its top flush with the surface of the ground. A pile of cornstalks, old hay or brush above either type of anchor helps to guard against sloughing.

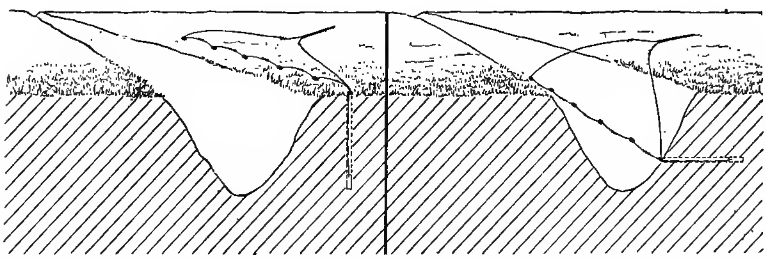
If broken boulders, stumps, logs or any other loose material is placed in the bottom of the gully before it is filled the effect will be that of a deep, well-laid tile drain. Through this the excesses of water will be discharged without injury to the surface. In many cases, it will be well to straighten up the bottoms of the gullies and lay permanent subdrains before the filling is commenced.

For wide shallow gullies, where the entire surface has been lost, but where the cutting has not been deep, the treatment is the same as deep subsoiling with the spacing of the holes decreased to ten or twelve feet. In filling gullies large amounts of unaerated subsoil are exposed, and care should be taken to add humus either in the shape of rank-growing green-manure crops, vegetable litter or rough manure. Old cornstalks, forest leaves, or mildewed straw can be used to good advantage.

Specific directions for electric blasting are given on pages 31 and 32.

* * * * *

To derive the greatest benefits from gully filling, the work should be done in connection with subsoiling and terracing along the slopes above the gully, for in this way the water from violent rains does not immediately rush to the lower slopes, but is held back and absorbed by the loose, well broken subsoil. Hence, the newly filled gully is not in danger of being again cut out and eroded by a too sudden flow of a large volume of water.



A B

FIG. 43. METHODS OF LOADING TO BLAST DOWN GULLY BANKS. "A" IS BEST FOR SLOPING BANKS, AND "B" FOR THOSE HAVING STEEP SIDES. ELECTRIC FIRING IS RECOMMENDED

# Blasting in the Orchard

### A Proven Proposition for Tree Planting

In 1910 the Du Pont Powder Company began to promote the use of explosives in planting new orchards and rejuvenating old ones. The idea was not original with us.

Nearly a quarter century ago, near La Mesa, Cal., ground was blasted for tree planting, because the orchardist found the work of planting with a spade in his hard soil too difficult. His experiment was a success. The trees lived, thrived and bore exceptional apple yields for many years.

Other orchardists and farmers in different sections of the country thought of the same scheme for preparing a home for the tree roots. We have records of such plantings, eleven, sixteen and twenty years ago, before the idea really began to spread.

After we began to advertise it extensively and sent out demonstrators throughout the country, many farmers and orchardists tried the new plan on a small scale. Now, because of the universal success of correct blasting for orchard planting, the majority of fruit trees are being planted in blasted ground.

There remains but three classes of fruit growers who still stick to the old methods:

1. Those whom we have not yet reached through our promotion efforts;
2. Those who have tried planting trees in blasted soil without knowing how to do it and hence failed to get satisfactory results, and
3. The class of farmers, orchardists and horticulturists who decry anything that is new, or which is being promoted by a business concern.

Millions of fruit, nut and shade trees and ornamental plants have been planted in blasted ground long enough to prove the great advantages of the method. America's leading orchardists and nurserymen now plant exclusively in blasted ground.

No one can afford to plant trees by any other method except in soil that is loose and sandy to a depth of several feet. In such soil blasting is not advantageous except for the elimination of fungus and nematoid troubles.

## WHAT BLASTING IN ORCHARDS ACCOMPLISHES

1. It mellows the ground to a depth of five or six feet and throughout a circular area ten to twenty feet in diameter, making it easy to dig the hole and plant the tree correctly.

2. It creates a porous, water-absorbing condition in the subsoil that makes the tree drouth-proof, stopping the big, first year loss, and invigorates growth.

3. It makes root growth easy and makes tons per acre of new plant food available, hence speeds up the growth of the tree and makes it fruit one to two years earlier.

4. It creates drainage and prevents stagnation of water on surface.

5. In old orchards that were planted by the old methods and have ceased to bear well, it is of great value in rejuvenating the old trees, causing them to yield heavily.

6. It destroys fungus, nematode, and other orchard soil diseases, hence makes it possible to plant new orchards where old ones have been removed without waiting several years to rest the land and get rid of the diseases.

7. At a cost little or no more than of old-style planting, it causes at least a year's earlier return on the investment in new orchards, and greatly increased returns thereafter as compared with spade-set orchards.

## PLANTING A TREE FOR KEEPS

In studying comparative costs of planting fruit trees, the investigator is confronted with widely varying figures and methods.

There seems to be no machine for planting fruit trees such as a corn drill, but the method of some planters approximates the work of a machine in speed, if not in efficiency.

They lay off the site of the proposed orchard in 20-ft. to 40-ft. checks, depending on the kind of trees to be planted. Cross furrows are plowed through the field, marking it off in squares.

One man drives along a furrow with a wagon-load of trees, another lays a tree near each of the furrow intersections, and a third stands the tree in the intersections, kicks some soil over the roots, tramps it down, and moves on to the next intersection. This method expresses a touching confidence in Nature, but results indicate such confidence is misplaced.

A tree that survives such treatment must have as many lives as the proverbial cat, and if it lives, how many years must elapse before it bears any fruit? What grade of fruit can be expected from a tree aged and bent with the fight for existence before it saves strength enough to bear at all?

Going to the other extreme we find a horticulturist advising: "Forget you are about to plant a tree and imagine you are going to bury a horse and dig a hole accordingly. Remember you can plant it only once, and its health and growth, the age at which it begins to bear, and the quantity and quality of fruit borne, depend chiefly on the care and thoroughness used in planting it."

Up to a few years ago, the method followed by most good orchardists was to dig a hole seldom as much as 2 feet in diameter and 18 inches deep, then plant the tree in top soil or a mixture of top soil and subsoil. Under this system the loss the first year ran from 25 per cent. to 50 per cent., depending on soil and weather conditions.

Then tree planting with explosives was taken up by a few orchardists who realized the shortcomings of the ordinary methods, and the necessity of cutting down first year losses, and speeding fruition.

The first objections to the new method were largely financial. The cost of explosives, blasting cap, fuse and labor ran from 8c. to 15c. per hole, whereas trees could be planted with a spade for 3c. to 5c. per hole. The trouble with this comparison is that the work performed is not the same, hence costs should not be compared.

The question involved is, how soon does the planter want a return from his investment and how large a return? The only way to compare costs is to consider the profit sought and which is the cheaper way to get it.

In the first place, the purpose of blasting is not to supplant the spade. It is possible to dig the hole with explosives, just as a hole may be excavated for a fence post. But the real object of blasting is to mellow the subsoil and make root growth and spade digging easy.

The orchardist must take into account the fact that by loosening the subsoil in a thorough manner, the moisture from the rains can soak in quickly, not only immediately around the spaded out hole, but the fine cracks radiating in all directions form passageways for the further absorption of water. They carry the life-giving moisture to great depths and store it there, to be brought out again by capillarity during the dry seasons for the sustenance of the tree. Our records show that the yearly saving in replacement and replanting costs in young orchards more than balance any expenditure for explosives.

## HOW TO DO THE WORK

**Laying Out the Orchard.**—The places to set the trees or other plants are selected and marked by a stake, or better, if the field is large, by furrows plowed to indicate the exact lines for the trees, and crossed at the proper intervals by other furrows to indicate the spacing in the rows. Sometimes a heavy cord or light wire stretched across the field will materially assist in laying out the orchard.

**When to Blast.**—Blasting for tree planting is best done in the late summer because it is easier to catch the subsoil in a dry condition, but blasting in the spring for spring planting, although the subsoil is apt to be wet or damp, is nevertheless much better than planting in dug holes. It should be done as many days ahead of planting as possible, to get the effect of air and sunlight in the hole.

**Examine the Soil.**—The exact nature and depth of the subsoil should be known in order that the explosive may be used to the very best advantage. The only way to know this is to go down and see. Do not stop at the surface but go down four or more feet. Using a good soil auger is the best and easiest way to test out a subsoil, but if one cannot be had, dig a hole. Another way is to blast out a test hole and examine each layer of the soil. This is not so good as the other methods as the blast so disturbs the subsoil that it is hard to tell just what the original condition was.

**How Deep to Blast.**—There are many different kinds of subsoil, but those illustrated by the drawings are the most common. If the arrangement of the soil is like that in illustration "A," Fig. 44, place the explosive well down into the clay and destroy any shallow plow sole with a good plow. The best depth for blasting in such soil is usually from thirty to thirty-six inches.

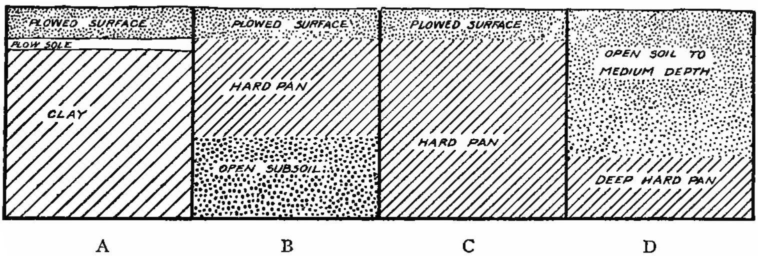



FIG. 44. DIFFERENT TYPES OF HARDPAN ENCOUNTERED IN THE ORCHARD

In soils like the one represented in "B," Fig. 44, place the charge toward the bottom of the hardpan so that the entire layer may be pulverized, but do not go below the bottom of it, as the force of the blast will tend to raise the hardpan in chunks rather than shatter it. The depth is governed absolutely by the depth of the hardpan.

Illustration "C," Fig. 44, shows one of the most common subsoil troubles. This type of hardpan or tight clay is usually too deep to blast through and relief is obtained by pulverizing several feet of the top, which if well done will be found to be sufficient to store moisture and furnish room for an ample root development. For such a condition the blast should be made not less than three feet deep.

Occasionally a soil is found like that shown in "D," Fig. 44, which will usually be found to require deeper blasting. The explosive should be placed well down in the hardpan—the deeper the better.

When very deep loading is practiced it is best to increase the amount of the charge, sometimes to more than double the amount normally used.

**Making Bore Holes.**—A number of different methods have been devised for making the bore holes for loading, but so far no other tool has given such good results as a heavy subsoil punch (Fig. 45). This

FIG. 45. PUNCH FOR MAKING THE BORE HOLES. THIS IS DRIVEN WITH A HEAVY HAMMER (See page 19)

tool is made of 1½-inch steel and should be not less than three feet long. Smaller drills will not be satisfactory, as the explosive cartridge is itself 1¼ inches in diameter and when primed with cap and fuse is difficult to load into a smaller hole. The punch is driven to the desired depth (Fig. 46) with a sledge, and loosened by pounding on the sides, after which it can easily be withdrawn.

A soil auger is quite satisfactory for making a small number of holes, but is too slow and expensive if there is much work to be done. However, for holes deeper than three feet, one can be used very satisfactorily to deepen the drilled holes. In some cases holes can be made with a heavy crowbar. Some soils are so hard, being in reality soft rock, that a rock drill is required to make the holes.

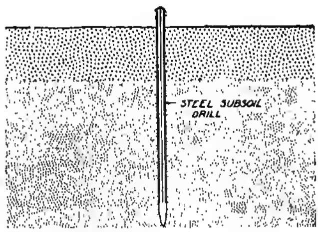



FIG. 46. PUNCHING THE HOLE

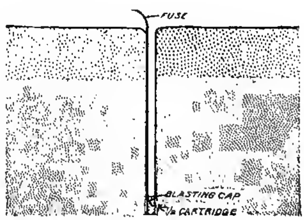



FIG. 47. THE CHARGE IN PLACE

**Preparing the Charge.**—The charge is prepared by cutting off a piece of fuse as long as the hole is deep, and crimping a cap on one end by means of a cap crimper. The cap with the fuse attached is inserted into the explosive used, and securely tied. (See pages 22 to 25 for Methods of Making Primers.)

**Loading the Hole.**—Start the charge into the bore hole and press it gently to the bottom with a wooden tamping stick (Fig. 47). Pour in four or five inches of loose dirt and tamp it gently (Fig. 48), then pour in more dirt, preferably slightly moist as it packs better, and tamp firmly (Fig. 49). When the explosive is covered with several inches of lightly packed soil the rest of the tamping should be made as hard and tight as is possible, using the stick in one hand. The hole should be tamped full.

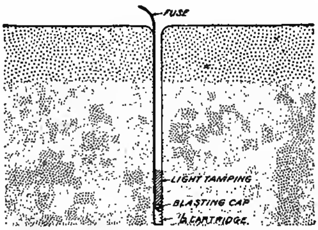



FIG. 48. LIGHT TAMPING OVER CHARGE

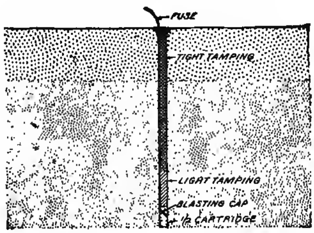



FIG. 49. TOP OF HOLE TAMPED TIGHT

**Firing the Blast.**—The next operation is to light the fuse and retire to a sufficient distance to avoid any loose material that may be thrown out. If the loading is properly done and at a sufficient depth there is usually only a thud and a cracking at the surface and no soil is thrown into the air.

**How to Treat Blasted Holes.**—If the holes are blasted in advance of the time of setting the trees they are left without further attention

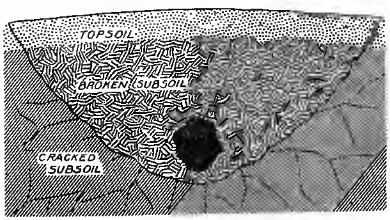



FIG. 50. THE BLAST THOROUGHLY CRACKS THE SOIL, BUT LEAVES A CAVITY OR POTHOLE AT THE BOTTOM. THIS MUST BE FILLED

until planting time, unless it is desirable to add some manure or fertilizer to be diffused through the soil. This is a good practice, especially on poor soil. If the soil is sour, sticky clay, a few pounds of lime scattered in the hole will materially assist in loosening the clay and keeping it permanently granulated and sweet.

**Setting the Tree.**—When the trees are to be planted shovel out the hole and locate the cavity that is usually sprung at the bottom of the hole (Fig. 51). Fill this with tamped soil to firm the base to prevent subsequent settling of the tree. The filling should be up to the level it is

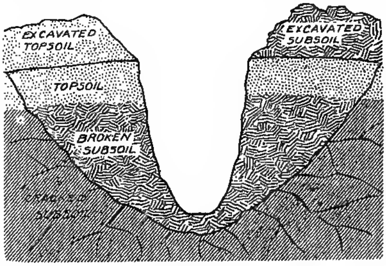



FIG. 51. THE BEST PRACTICE IS TO SHOVEL OUT THE LOOSE SOIL AND EXPOSE THE POTHOLE. THIS IS EASILY DONE IN THE FRESHLY BLASTED HOLES

desired to set the tree, taking care to keep the soil well tamped. Set the tree with the roots in as near their original position as possible and pack them with the top soil that has been shoveled out of the hole (Fig. 52).

When no attention is paid to settling or firming the soil in the bottom of the hole, trouble often results from the tree settling too deep after the first heavy rains, but this trouble has never been observed when the holes were properly examined and the described precautions observed in setting the tree.

Just before packing the soil around the trees be sure that they are in line with the rest of the row.

When trees are set as much as thirty or more feet apart it is an excellent practice to place blasts midway between the rows after the trees have been growing several years. These will open up the subsoil between the trees that was but slightly disturbed by the original blasts

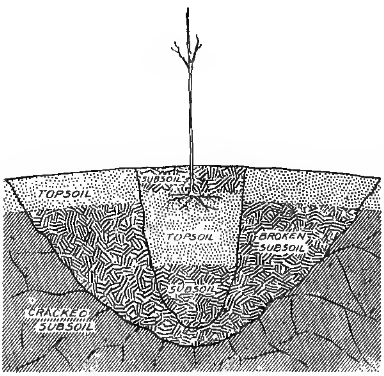



FIG. 52. AS MUCH OF THE HOLE AS POSSIBLE SHOULD BE FILLED WITH FERTILE SURFACE SOIL; THE REST CAN BE FILLED WITH THE SUBSOIL THAT HAS BEEN DUG OUT. THIS SHOULD BE WELL PACKED TO PREVENT SETTLING. THE TREE IS SET WITH THE ROOTS SPREAD OUT IN THEIR NATURAL POSITION

and will induce more vigorous root growth, and consequently better trees will be the result.

It should be remembered that this method of resetting applies not only to orchard trees such as the apple and peach, but to nut trees, shade trees, berries, vines, roses and all classes of ornamental and commercial trees and shrubs, and is proving a money-saver as well as a money-maker.

For blasting holes to set large trees additional benefit is derived by placing several blasts close together so that the subsoil is more thoroughly shattered.

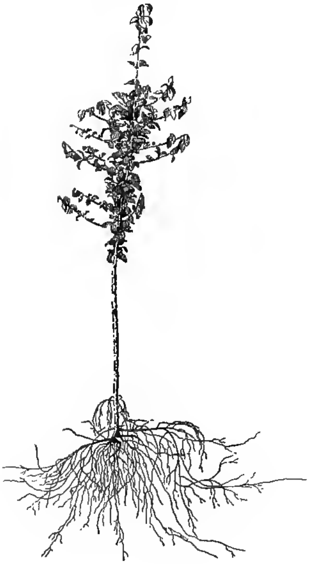
**Explosives Recommended.**—The explosives recommended for tree planting are Red Cross Farm Powder for all sections east of the Pacific Coast States and either Du Pont or Repauno Stumping Powder on the Pacific Coast.

Usually one-half cartridge charges are sufficient, except in the heaviest hardpan and where loading deeper than 40 inches is required.

UNBLASTED HOLE

BLASTED HOLE

# RESULTS SHOW ABOVE AND BELOW GROUND



A

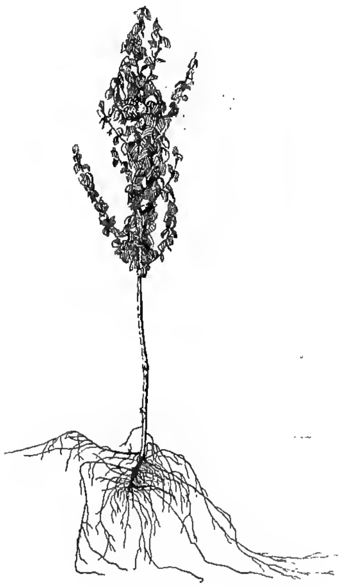
B

Trees "A" and "C" were planted in blasted holes.

Trees "B" and "D" were planted in unblasted holes.

All trees are the same age.

Even if the fruit from trees planted in blasted ground were not superior in size, color and flavor, the financial advantage derived from the earlier maturity of the trees should cause every orchardist to adopt the blasting method except those having a deep soil, mellow to a depth of five to six feet, in which case blasting will be of no benefit, except to destroy nematode and perhaps other root pests.



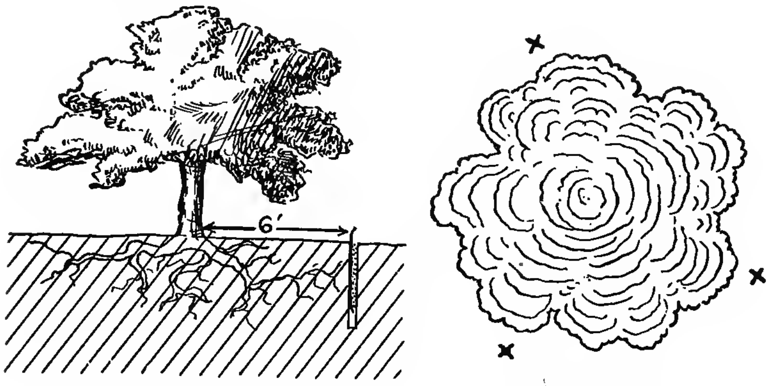
C

D

# TREE REJUVENATION

## Cultivating Old Fruit Trees, Shade Trees, Vines and Bush Fruits by Blasting

The object of blasting around old trees and vines is to open up the subsoil so that the roots may spread farther and go deeper, to increase the amount of plant food available for the roots, to establish better drainage and to increase the water-holding capacity of the soils. Blasting around root-bound trees or in resistant subsoils is strongly advised. The actual blasting is similar to the blasting for subsoiling and tree planting.

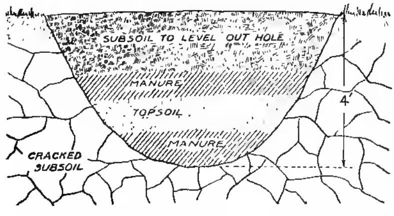



For Small Tree For Large Tree

FIG. 53. LOCATION OF CHARGES FOR REJUVENATING TREES

Ordinarily it is better to blast on one or two sides of a tree the first year and blast on the remaining sides one or two years later. The blasts should be placed not closer than six feet to small trees, and should be slightly beyond the spread of the branches for large trees.

FIG. 54. CRATERS SHOULD BE BLASTED IN POOR SOILS. THEY ARE FILLED WITH ALTERNATE LAYERS OF SOIL AND MANURE OR WITH SOIL MIXED WITH CHEMICAL FERTILIZERS




Where the subsoils are deficient in plant food or humus, excellent results are obtained by putting down holes a few feet beyond the spread of the branches to a depth of about four feet and loading them with a sufficient amount of explosives to blow out a hole. This should then be filled with alternate layers of manure and soil, or with a mixture of manure and a suitable fertilizer (Fig. 54).

Where trees tend to develop a strong tap root, but are stunted by a stratum of hardpan lying immediately under them (Fig. 55), relief can be had by starting a hole two or three feet away from the trunk and driving it diagonally under the tree into the hard material. Unless this hole is three or more feet deep the charge should not exceed one-third of a cartridge of Red Cross Farm Powder and not over one-half a cartridge if deeper. Great care must be exercised in this method of loading, not to loosen or blow out the tree. Except in extreme cases, loading to the side is better. Blasting the hardpan between the trees should be done at the same time as that under them.

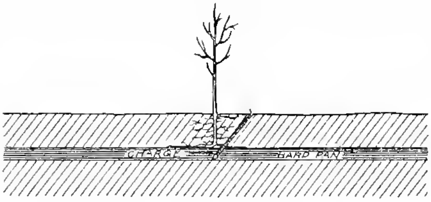
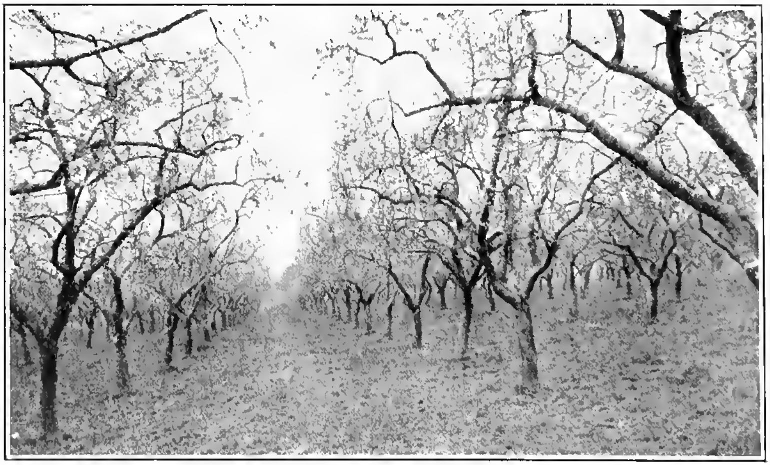



FIG. 55. THE CORRECT LOCATION OF A LIGHT CHARGE OF EXPLOSIVE FOR BREAKING THROUGH HARDPAN THAT IS DWARFING THE DEVELOPMENT OF A TAP ROOT. THE WORK MUST BE CAREFULLY DONE, AND THE CHARGE VERY LIGHT

When blasting around or under growing trees materially prunes the roots, the tops should be cut back to temporarily reduce transpiration to correspond with the reduced ability of the roots to obtain a sufficient amount of moisture. The roots will then put on vigorous growth and absorb increased amounts of plant food and moisture to nourish an increased growth of top, and, in case of fruit trees, an increased production of fruit will result.

(See pages 27 to 29 for methods of loading and firing.)



RESULT OF SUCCESSFUL BLASTING IN 1897

# Land Drainage

The drainage of the wet lands of American farms is more important and will develop greater wealth than would be possible by operating all the gold mines in the 48 States and Alaska. There are more than 75,000,000 acres of swamp and overflowed lands, and more than 100,000,000 acres need better drainage to bring them up to a satisfactory crop-producing condition.

The extent of the individual drainage proposition varies from a few square rods in the corner of the farm to tracts of several millions of acres. Practically every farm in the heavy crop-producing areas of the United States needs some ditching, and there is hardly a stream in the entire boundary of the Union that does not need to be corrected to give better service in discharging the large amounts of waste water from heavy rains, and to protect low lands.

Drainage does not simply mean getting the standing water off of the surface of the fields. It must include the lowering of the water table in the soil to a sufficient depth to allow the natural changes in the subsoil to take place without a check, and to permit the deep-rooting of plants. Neither is possible if the soil and subsoil are choked with water. Drainage performs the double purpose of storing the greatest amount of available soil moisture and disposing of all excesses.

The mosquito pests and the attending diseases are the result of poor drainage, which renders parts of the country almost uninhabitable. Relief in this particular alone will amount to an increase in land values to several times the present selling price.

Good roads are essential in any prosperous community, but cannot be maintained without good drainage, as wet roadbeds, no matter what the surface may be, will never stand traffic. In many cases the processes of ditching and road building are carried on hand in hand with the greatest success.

.Drainage includes everything from deep cultivation to permit the subsoils to absorb the maximum amount of water and hold it out of the drains, to the digging of ditches more than a hundred yards in width, and many feet deep.

## METHODS OF DIGGING DITCHES

The oldest and best-known method of digging ditches is with the pick and shovel, which requires much hand labor and is usually very expensive. Where very narrow ditches are needed, as for the laying of underground tile or pipes, where the ditches will later be filled with the dirt that has been dug out, either hand or mechanical diggers are used, though both methods are greatly impeded by wet soils, roots, and stumps.

For large, long ditches the floating dredge, drag-line excavator, or other heavy digging machinery finds unquestioned use, in connection with explosives for stumping and loosening heavily impacted soils and rock.

The newest method of ditching, and one that is growing in use on account of its speed and economy, is blasting. By this means ditches from 2 to 6 feet in depth and from 4 to 15 feet in width can be excavated most satisfactorily in every type of material except loose, dry sand. The adoption of this method of ditching means a saving in time and money and in getting ditches where no other method is practicable on account of the soil conditions. The method finds ready application in everything from clear muck or heavy clay, to the worst swamp conditions where roots, stumps and an excess of water render every other method impracticable except for very large ditches where heavy machinery must be used.

No expensive equipment is needed. The outlay for explosives can be made for the exact amount of work that is to be done, which relieves the need of a heavy overhead charge for money invested in equipment and tools. Ditch blasting is applicable on everything from the short ditch to drain the back field to the correction of miles of large streams.

Loading

The Ditch

BLASTING A DITCH THROUGH SWAMPY GROUND

The methods are simple and reliable, as will be pointed out in the following reports of work actually done.

The rational use of explosives will mean a saving of millions of dollars in the reclamation of the large drainage districts and in the perfection of drainage on individual fields.

## DITCHING COSTS

The growing interest in drainage and canal construction is increasing the attention paid to the actual costs of digging, and the methods employed. The inquiries have brought out interesting and instructive facts, which if made use of, will result in a material saving to those undertaking drainage propositions.

Ditching equipment now varies all the way from light spades to enormous dredges, tower excavators and explosives. The selection of the method of digging must be governed by the nature of the material through which the ditch is to be dug, the size and length of the desired ditch, and the comparative costs of the methods applicable to the condition. Despite the enormous array of equipment there should be no confusion in the selection made for any specific job or class of work, as each method has its own peculiar characteristics that adapt it better than others to certain peculiar conditions.

The practical range of the economic use of explosives in ditching is for open ditches ranging in size from shallow drains about four feet wide, up to the minimum sizes for which a floating dredge would be recommended, and for slightly larger ditches where the length is not

ANOTHER BLASTED DITCH

great enough to warrant the erection of a dredge. For ditches of these sizes blasting is recommended in hard, dry soil; loose and solid rock; muck and swamp soils; and, in fact, in all soils except loose sand. Its applicability is increased by adverse conditions, such as swamps, stumps and boulders that make conditions undesirable for hand or mechanical digging.

The use of explosives in connection with dredging operations is for stumping, boulder and ledge blasting, and for loosening material too hard or heavy for the dredge to handle economically. In ditching for laying underground pipes, the use of explosives is not recommended for removing the earth, but is useful for loosening hard material to reduce the cost of the hand work.

On account of the variability in the conditions encountered, it is rather difficult to give exact information with regard to cost, without having first made a careful examination of the soil and other conditions. The following paragraphs describe typical conditions and give the amount of explosives used in blasting ditches of the sizes mentioned and will be of considerable use in estimating final costs.

In swampy ground where the soil varies from muck to wet sand mixed with decaying organic matter, and where the heavy swampy growth of trees is but freshly cut, the use of between three and three and one-quarter cartridges of Straight 50 per cent. Dynamite, in propagated blasts can usually be depended on to dig one yard in length of ditch seven to eight feet wide and something over three feet in depth. This is a condition that usually prevails along small overflowed streams, and in permanent swamps. This size of ditch is one that is proving very useful in correcting the streams and for sub-mains in connection with larger drainage channels.

For ditches one to two feet narrower, under the same conditions the use of the same amount of 40 per cent. Low Freezing Dynamite or Gelatin, in electrically-fired blasts, will give a slight reduction in the cost of a running yard of ditch.

Under the same conditions, double the amount of Straight 50 per cent. Dynamite loaded in two rows spaced four feet apart, and fired by the propagated method, ordinarily digs a ditch from three to four feet in depth and from twelve to fifteen feet top width. By using three lines of holes with the same loading for each hole, or three times the amount of dynamite given for the small ditch, a ditch of the same depth and from sixteen to eighteen feet wide can usually be obtained.

It may be seen from these suggestions that the removal of a cubic yard of dirt from the larger ditches where two or three lines of holes are used, is slightly more expensive than from the small ditch loaded with one row of charges of Straight 50 per cent. Dynamite. For the small ditches blasted with a single line of holes, it has been found that the least cost, when based on the lineal yard of ditch, is with the lower strength of dynamite, but where larger ditches are needed there is a material saving when the stronger grades are used.

In digging through coarse, sandy loam in a dry section, or sand that is not too dry, two to two and one-quarter cartridges of 40 per cent. Gelatin fired electrically have in a large number of tests, excavated one running yard of ditch from two and one-half to three feet deep and from four and one-half to six feet wide. This soil condition is one of the hardest to blast, and the work should best be done after a period of rain, as the wet soil is blasted with a smaller amount of explosives, or else a larger ditch results from the use of the same amount.

In clay or heavy loam soils that are sufficiently moist to ball a little, the loading just described will blast a slightly larger ditch. For increasing the size of either ditch two or three lines of holes are used. The increase in the amount of work done and the size of the ditch will be in about the same proportion as that described for the use of additional lines of holes in swamp soils.

For digging very large ditches, as in the correction of large, crooked streams, the loading must conform to the work to be done, so that directions for loading are apt to be misleading. The work usually changes in character so rapidly that each blast is in reality a trial, and only the most careful loading should be attempted. Where the required width is such as has been given for swamp ditches, but slightly greater depth is needed, it is obtained by loading a little deeper with an additional cartridge in each hole. For depths as great as 6 and 7 feet it is usually best to make two blasts; the first to give a depth of three or four feet and the second or bottom one to clean out the bottom of the ditch. Three lines of holes spaced four feet apart each way are usually best for making the first shot; then use two lines of holes with the same spacing in the bottom of the excavation made by the first blast. The amount of explosives needed for a lineal yard of such a ditch will vary greatly with the soil. In easily lifted soil such a ditch will usually require about eight to ten cartridges per yard, while some of the more difficult soils to blast will require at least a half more.

## A TYPICAL EXAMPLE OF DITCH BLASTING

While it is the intent of this book to give advice with regard to the use of explosives, the following report of a typical ditch blast is not out of place as it is so characteristic of numbers of ditches that are being blasted all over the country.

An adverse condition was selected in the swamp land of Georgia for a demonstration of ditching with dynamite before the Georgia

Drainage Congress, at a recent annual meeting. The soil was a sandy muck saturated with water, and laced together with a luxuriant growth of roots. The surface was studded with large green gum and bay stumps. The location was selected because the managers considered it an impossible undertaking. An idea of the conditions can be gotten from the accompanying illustrations.

The line of the ditch was laid off with a light cord. Holes were punched along this, spaced two feet apart, to a depth of thirty inches. Each hole was loaded with two cartridges of dynamite; one 60 per cent. Du Pont Straight, the other 40 per cent. Red Cross Extra. A few extra cartridges were put directly under the larger stumps. The blast was fired by the propagated method, using only one cap to each section of ditch.

LOADING THE DITCH

The result was a clean ditch 9 feet wide and 3½ feet deep, with a bottom almost absolutely true to the desired grade, at a cost of less than 10½ cents the cubic yard. The minimum estimate for hand labor on this job was 25 cents the yard, and it is quite unlikely that the work could have been done at this price.

Following this demonstration the actual ditching, on a commercial scale, of neighboring land, was done with dynamite. The results were entirely satisfactory.

THE FINISHED DITCH

## METHODS OF LOADING DITCH BLASTS

There are two distinct methods of blasting ditches, the propagated and electric. The propagated method can be used only in wet soils, while the electric method can be used in either wet or dry soils. The explosives and blasting supplies needed and the methods of loading vary considerably in the two methods.

Among the most striking advantages of ditching with dynamite, as compared to other methods, are the reduction in cost, the absence of a large soil pile along the ditch, the little time required, the absence of overhead expenses for equipment, the ability to dig successfully where the conditions are too bad for other methods, the adaptability to both large and small ditches, and the simplicity of the methods. These have been pointed out.

## DITCHING IN SATURATED SOILS WITHOUT A BLASTING MACHINE—PROPAGATED METHOD

In wet soils, where holes two feet deep will stand half full of water, the quickest and generally the most economical method of ditching is with Du Pont Straight 50 per cent. Dynamite. *Only a straight dynamite can be used for this work, as other grades are too insensitive to be detonated by the shock from a single primer in a cen-*

*tral hole.* This can be practiced in the roughest of swamps, even where there are several inches of water standing on the surface or where the surface is covered with the heaviest of swamp stumps.

This class of ditch blasting should not be attempted when either the air or water is colder than 50 degrees F.

The simplicity of the method and the truly wonderful results obtained must be seen to be fully realized.

The course of the ditch having been decided on by a survey or close study of the slope, as indicated by the surface drainage and the trees having been chopped from the right of way, the work may be begun.

**Test Shots.**—The first thing to do is to try a few trial shots to ascertain the best depth and spacing for the holes. For ditches up to 3 or 3½ feet deep the depth of bore holes will usually be about 24 to 30 inches, and the spacing between holes from 18 to 24 inches, although it may be necessary to increase the depth and decrease the spacing in some cases. It is well to begin the test with holes two feet deep and 18 inches apart. Keep these in line and load about 10 of them with one cartridge each. If a little water covers the cartridges in the holes no further tamping will be needed. If not, tamp well with earth. After the entire line is loaded, one hole is charged with an extra primer cartridge (see pages 22 to 25 for Methods of Making Primers), and it is also well to put one additional cartridge in each hole adjoining the primer.

This loading should lift the soil at least two hundred feet into the air, scatter it over the adjoining swamp for a distance of 150 feet and leave a good, clean ditch. If it does not, try a different loading. It may be necessary to make the holes deeper in some soils and not so deep in others. Usually in swamp soils the ditch made is a foot or two feet deeper than the charge, but sometimes it is necessary to load to the full depth.

If the test shot makes too large a ditch, the spacing can be increased a little, but should seldom be greater than 24 inches, and then only in warm soil. For very small ditches less than a full cartridge of explosive may be used in each hole.

**Amount of Charge and Size of Ditch.**—Small ditches (for instance, about two feet deep and three feet wide) in such soils, when there is little trouble from roots, can be dug with half cartridge charges, but when using such small loads the spacing between holes can seldom be over 18 inches.

Larger ditches can be dug by using two or more cartridges in each hole, and a second, or even a third line of holes may be put down about four to five feet from the original line and loaded in the same way. When two or three lines of holes are used it will be necessary to use one electric cap in each line (Fig. 56), or to put in one or two extra charges between the rows to insure the simultaneous detonation of all the charges. (Fig. 57).

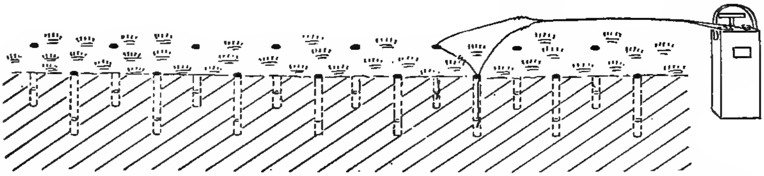


FIG. 56. SHOWING LOCATION OF TWO ELECTRIC BLASTING CAPS IN A PROPAGATED DITCH BLAST. THESE ARE TO INSURE BOTH LINES FIRING AT THE SAME TIME. IF THREE LINES ARE USED A THIRD ELECTRIC BLASTING CAP IS USED IN IT. THIS IS USED WHEN A BLASTING MACHINE IS AVAILABLE

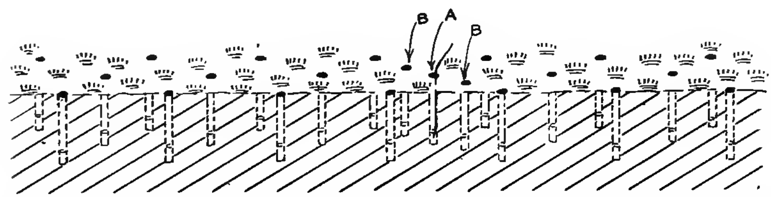



FIG. 57. SHOWING CORRECT METHOD OF LOCATING EXTRA CHARGES—"B" TO CARRY DETONATION FROM THE SINGLE PRIMER, "A" TO THE OUTSIDE LINES. THIS IS USED WHEN NO BLASTING MACHINE IS AVAILABLE

## APPROXIMATE TABLE OF CHARGES OF DU PONT STRAIGHT 50% DYNAMITE FOR BLASTING DITCHES WITHOUT A BLASTING MACHINE

| Top Width of Ditch | Approximate Number of Cartridges Per Hole Required for Ditches of Various Depths | | | | Number of Parallel Rows Required | Distance Between Rows in Inches |
|---|---|---|---|---|---|---|
| | 2½ to 3 ft. | 4 ft. | 5 ft. | 6 ft. | | |
| 6 | 1 | 2 | 3 | 5 | 1 | .. |
| 8 | 1 | 2 | 3 | 5 | 1 or 2 | 30 |
| 10 | 1 | 2 | 3 | 5 | 2 | 36 |
| 12 | 1 | 2 | 3 | 5 | 2 | 42 |
| 14 | 1 | 2 | 3 | 5 | 2 | 48 |
| 16 | 1 | 2 | 3 | 5 | 3 | 36 |
| 18 | 1 | 2 | 3 | 5 | 3 | 42 |

Distance between holes in rows 16 to 24 inches to be determined by 3 or 4 test shots. It is impossible to specify exactly, because soil conditions differ greatly, which makes a difference in spacings and loads.

## PUTTING DOWN THE HOLES

Ordinarily in swamp soils the bore holes can be put down with little effort. If the soil is at all hard, or has a heavy crust, the fastest tool is a good sharp crowbar, but if soft and mucky, a heavy tamping stick will suffice. The holes should not be left open, but should be loaded at once, as they cave in or become filled with floating slime.

## AMOUNT OF DYNAMITE REQUIRED FOR A GIVEN LENGTH OF DITCH

In order to enable the blaster to calculate the amount of dynamite required to cut various size ditches, the following table used in conjunction with the preceding table should prove very useful:

| Spacing between holes in row | 10 Rods | | | ¼ Mile | | | ½ Mile | | |
|---|---|---|---|---|---|---|---|---|---|
| | Number of holes | Dynamite required using charges per hole of | | Number of holes | Dynamite required using charges per hole of | | Number of holes | Dynamite required using charges per hole of | |
| | | ½ cartridge | Whole cartridge | | ½ cartridge | Whole cartridge | | ½ cartridge | Whole cartridge |
| 18 ins. | 110 | 28 lbs. | 55 lbs. | 880 | 220 lbs. | 440 lbs. | 1760 | 440 lbs. | 880 lbs. |
| 20 " | 99 | 25 " | 49 " | 792 | 198 " | 396 " | 1584 | 396 " | 792 " |
| 24 " | 83 | 21 " | 41 " | 664 | 166 " | 332 " | 1328 | 332 " | 664 " |
| 26 " | 76 | 19 " | 38 " | 608 | 152 " | 304 " | 1216 | 304 " | 608 " |
| 28 " | 71 | 18 " | 36 " | 566 | 142 " | 284 " | 1132 | 283 " | 566 " |

1 rod — 16½ feet.
10 rods— 165 feet or 55 yards.
¼ mile—1320 feet or 440 yards or 80 rods.
½ mile—2640 feet or 880 yards or 160 rods.

For larger ditches requiring heavier loading or several parallel rows of holes increase the total amounts accordingly. These amounts also apply to ditching with a blasting machine..

## DITCHING WITH A BLASTING MACHINE

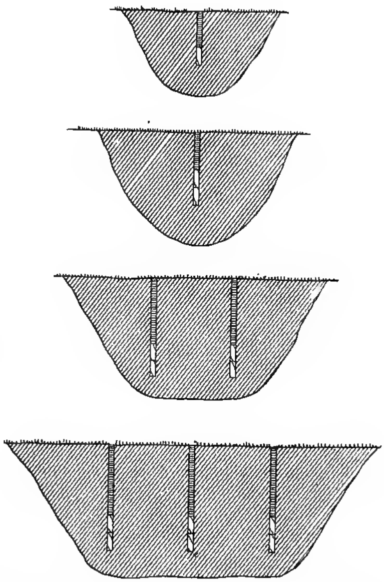
While it is possible to blast ditches by the propagated method, that is, without blasting machine, only in wet soils the electric method can be employed in any class of material, dry sand excepted, and low strengths of low freezing Red Cross can be substituted for the more sensitive Straight dynamite.

The layout of the ditch is exactly the same as for the other method, but as an electric blasting cap is used in each hole it is possible to space them farther apart in the row. The normal distances are from 24 to 32 inches for small ditches, and up to 48 and 52 inches for large ditches.

**Different Explosives for Different Classes of Work.**—The explosive selected for electric ditch blasting will depend upon the soil and size of ditch. In a medium loam, where only a small ditch (about two feet deep and three feet wide), is desired, the selection may be Red Cross Stumping Powder or Red Cross Extra 30 or 40 per cent. Where the material is very sandy Red Cross Gelatin 40 per cent. will give best results. It is practically impossible to blast ditches in dry sand.

For larger ditches, or where there is much trouble with stumps and roots, a stronger explosive will give more economical excavation, and Red Cross Extra 40 per cent. or Red Cross Gelatin 40 per cent. should be selected. Where the work is very wet, and the charges must be left in the water for a long time, the Gelatin should be selected, as it is more water-resisting than the Extra.

Red Cross Gelatin 40 per cent. also gives the best results in coarse sandy loam soils.



A—A SMALL DITCH REQUIRES BUT ONE LINE OF HOLES LOADED WITH LIGHT CHARGES—USUALLY ONE CARTRIDGE EACH

B—LARGER DITCHES ARE BLASTED WITH A SINGLE LINE OF HOLES CONTAINING INCREASED AMOUNTS OF EXPLOSIVES

C—FOR STILL WIDER DITCHES TWO LINES OF HOLES ARE USED. THE CHARGES MAY BE OF SEVERAL CARTRIDGES

D—DITCHES WIDER THAN 12 TO 14 FEET ARE USUALLY LOADED WITH 3 LINES OF CHARGES

FIG. 58. VARIATIONS IN THE NUMBER OF LINES OF HOLES AND THE CHARGES ARE MADE TO SUIT THE SOIL CONDITIONS AND TO EXCAVATE DITCHES OF DIFFERENT SIZES

## METHODS OF LOADING

After three or four trial shots similar to those described for wet ditching have established the proper depth and spacing of the holes, and the amount of dynamite per hole, the blaster is ready to begin actual operations. The holes may be put down with a subsoil punch, crowbar, soil auger, or any other tool suitable for the particular class of soil.

Unless water covers all charges they should be thoroughly tamped. It is best to punch only enough holes for one blast, load them and fire, before putting down more, as they are likely to be filled up or covered with trash thrown up by the blast. Do not overload the blasting machine. If its rated capacity is thirty charges, do not attempt to fire more than that at a time.

When only one cartridge is used in a hole it must contain the electric cap, and should be pressed well down to the bottom of the hole

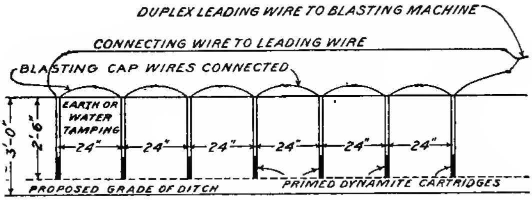
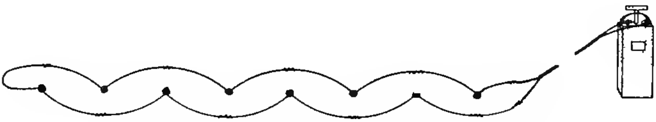
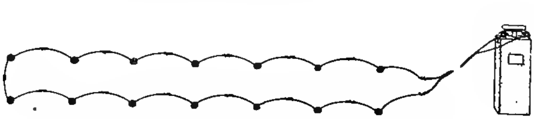



FIG. 59. LONGITUDINAL SECTION, SHOWING METHOD OF LOADING WITH ELECTRIC BLASTING CAPS FOR BLASTING A DITCH. THE DIMENSIONS GIVEN ARE RECOMMENDED ONLY FOR MAKING THE FIRST TRIAL SHOTS FOR DETERMINING THE REQUIRED LOADING


A—Method of connecting up one line of holes



B—Another method of connecting up one line of holes



C—Method of connecting two lines of holes

D—Method of connecting three lines of holes

FIG. 60. FOUR METHODS OF CONNECTING ELECTRIC BLASTING CAP WIRES FOR BLASTING DITCHES. THE BLACK DOTS REPRESENT LOADED HOLES. THE ELECTRIC BLASTING WIRES SHOULD ALWAYS BE LONG ENOUGH TO REACH FROM ONE HOLE TO THE NEXT, AS THIS OVERCOMES THE NEED OF USING CONNECTING WIRE

and tamped so that no air space is left to reduce the effect of the blast. When several cartridges are used in each hole, the primer should be on top, with the cap pointing downward. All holes, unless standing water covers the charge to a depth of several inches, must be well tamped. (See page 26 for Methods of Making Electric Primers, and pages 27 and 28 for Methods of Loading.)

As the work progresses the soil should be carefully watched, and any needed variation made in the loading so that it may always conform to the material to be lifted.

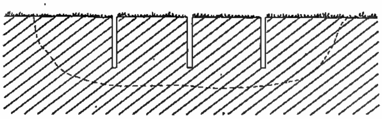
## BLASTING LARGE DITCHES WITH A BLASTING MACHINE

When larger ditches are desired the loading may be in deeper holes, using more or a higher strength of explosive; or one or two more parallel lines of holes may be employed, especially where wide but shallow ditches are needed. Where very deep ditches are needed, blast a wide, shallow ditch with two or three parallel rows of holes, and then load one or two rows in the bottom of the shallow ditch, and blast another ditch in the bottom of the first one. This latter method has been very efficient in opening large ditches eight or nine feet deep through heavy bottom lands for the correction of stream channels.

## LARGE DITCH SUCCESSFULLY BLASTED

At the 1913 meeting of the North Carolina Drainage Congress an effort was made to straighten a creek. The ditch needed was 8 feet deep and 18 feet wide. The surface soil was light and full of roots. The subsoil was a heavy, wet clay. Three rows of holes were put down to a depth of from 30 to 36 inches, spaced 4 feet apart and loaded with Red Cross 40 per cent. The blast removed the soil to a depth of about 30 inches. In the bottom of this shallow ditch two rows

FIG. 61. FOR EXCAVATING THE TOP CUT, THREE LINES OF HOLES WERE SPACED 4 FEET APART EACH WAY. THE DOTTED LINE INDICATES THE DEPTH OBTAINED BY THIS BLAST



of holes were put down, spaced 4 feet apart, to the desired depth of ditch and loaded a little more than half full of 40 and 60 per cent. Du Pont. This blast threw out the soil to the desired depth and left the completed ditch fully up to the desired size, 8 x 18 feet. The cost was between 12 and 13 cents the cubic yard, which was a little high for the work, as the loading was too heavy. For a larger job lighter charges would have been used and a net saving in cost would have resulted. Extreme care, in observing the first trial shots, should always be exercised.

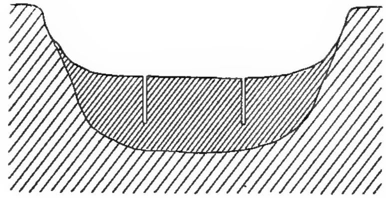


FIG. 62. FOR THE BOTTOM CUT TWO LINES OF HOLES, DOWN TO THE DESIRED GRADE, WERE SPACED FOUR FEET APART. THE HEAVILY SHADED PORTION REPRESENTS THE EARTH EXCAVATED BY THE SECOND BLAST

## TABLE OF CHARGES FOR ELECTRIC DITCH BLASTING

| Approximate Top Width of Ditch in Feet | Approximate Number of Cartridges of Red Cross Stumping Powder Required for Various Depths | | | Number of Rows of Holes Required | Distance Between Rows |
|---|---|---|---|---|---|
| | 2½ to 3 ft. | 4 | 5 to 6 ft. | | |
| 3 | 1 | .. | .. | 1 | 0 inches |
| 6 | 2 | 4 | 6 | 1 | 0 " |
| 8 | 2 | 4 | 6 | 1 or 2 | 20 " |
| 10 | 2 | 4 | 6 | 2 | 28 " |
| 12 | 2 | 4 | 6 | 2 | 36 " |
| 14 | 2 | 4 | 6 | 2 | 42 " |
| 16 | 2 | 4 | 6 | 3 | 42 " |
| Required length of No. 6 Du Pont Electric Blasting Cap Wires....... | 4 ft. | 6 ft. | 6 to 8 ft. | | |

Although this table is necessarily but an approximation, it will serve as a good basis for estimating ditch charges.

Practice makes perfect in ditch blasting the same as in anything else. The way to get the practice is by blasting short test sections of about ten holes each until the proper loading for the soil condition is determined. After blasting a few ditches, less experimenting in the beginning will be necessary.

### STREAM CORRECTION

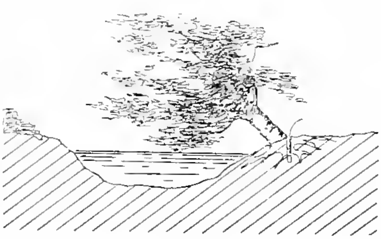
Each spring the big freshets in creeks and rivers are the cause of much property loss. Bottom lands are either washed away or covered with a layer of sand that is too thick to plow under, and the fertility of the soil is greatly reduced.

Permanent control of streams subject to overflow is expensive if undertaken in haste. Equally good results may be obtained with much less expense by undertaking the work in a slower but more systematic way, which will permit the stream to do most of the actual digging itself.

A great part of the filling up of stream courses is caused by logs and other floating material forming rafts and sand bars in the channels. Another fruitful source of trouble is from out-crops of rock which divert or impede the normal flow of the current. Overhanging stumps and trees along the banks lend still further obstruction. Sharp bends in the course of the stream check the current and cause trouble by forming sand bars.

Any and all of these troubles may be overcome quickly and at reasonable cost by the use of dynamite. Shoot out the raft and logs, and blast a sufficient channel through the confining rock. (See pages 52 to 56 for Methods of Blasting Boulders and Ledges.) A well-placed blast will cause the overhanging stumps or trees to immediately vacate. (See Fig. 63.)

FIG. 63. METHOD OF LOADING A STUMP OR TREE TO BLAST IT FROM THE BANK OF A STREAM. IT IS BEST TO FIRST CUT THE TREE OFF NEAR THE GROUND LINE AND LOAD THE STUMP HEAVY ENOUGH TO BLOW IT ACROSS THE STREAM. FOR LARGE STUMPS DISTRIBUTED CHARGES AND ELECTRIC FIRING ARE RECOMMENDED. THE USE OF TEAMS FOR DRAGGING LOGS AND STUMP FRAGMENTS OUT OF THE CHANNEL IS HIGHLY RECOMMENDED



The cutting off of sharp turns in the channel will take a little more time and should be well done in the beginning. Locate the line of the new cut-off and blast a ditch that will at all times carry a part of the

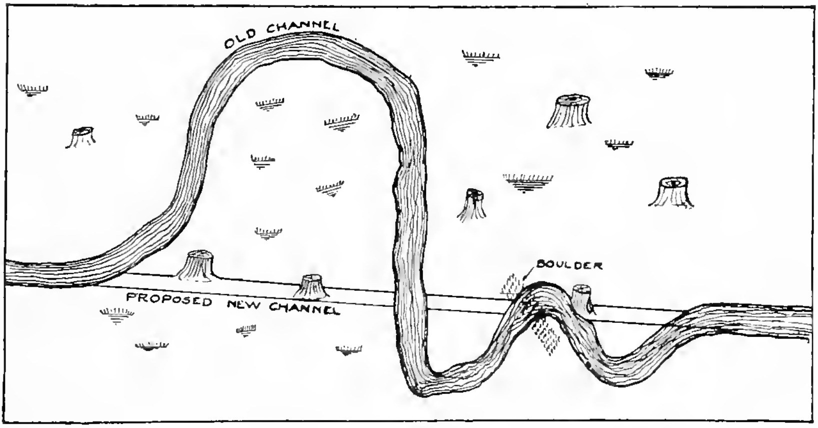
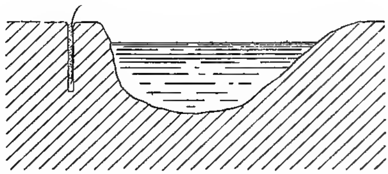



FIG. 64. DIAGRAM OF STREAM TROUBLES THAT MAY BE CORRECTED BY BLASTING

flow. When this is done and the rafts and logs are out of the way above and below, all there is left to do is to wait for the heavy rains to flood the streams. The increased rate of flow will cause the water to cut and wear away at the bottom of the channel as well as at the sides. From time to time it will be best to go over the stream and make sure that no new obstruction is being formed.

Small blasted ditches have been scoured out by the current until they are now carrying the entire flow of large streams. With a little help now and then any stream with a fair fall can be made to do wonders in making itself a permanent and suitable course.

FIG. 65. METHOD OF LOADING FOR WIDENING A STREAM CHANNEL. ELECTRIC FIRING IS BEST, UNLESS THE GROUND IS WET ENOUGH TO PERMIT FIRING BY THE PROPAGATED METHOD. THE LOADING SHOULD BE HEAVY ENOUGH TO BLOW ALL THE WASTE MATERIAL ENTIRELY OUT OF THE CHANNEL



For deepening stream channels, the bottoms of which are too hard to permit erosion, the loading is done exactly as in ditch blasting.

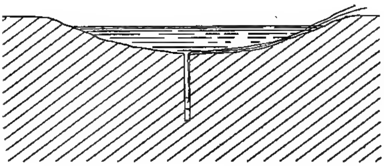


FIG. 66. METHOD OF LOADING, WHICH MUST BE HEAVY ON ACCOUNT OF THE BURDEN OF WATER, FOR DEEPENING A STREAM. EITHER ELECTRIC OR PROPAGATED FIRING CAN BE PRACTICED

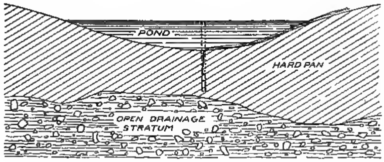
Either method of firing can be followed. The loading must be heavy on account of the added weight of water that must be lifted.

## VERTICAL DRAINAGE OF WET SPOTS

It is sometimes very difficult to devise a method of draining a land-locked depression. Generally speaking, ditching is the proper solution of the problem, but that calls for an outlet and at least some degree of slope, which are hard to locate under the conditions described.

Ponds and wet spots are caused by impervious soil beneath them. By blasting this impervious stratum, perfect drainage can sometimes be brought about. Certain conditions must exist, however. First, it must be ascertained by means of a soil auger that there is a stratum of gravel or sand beneath the impervious layer that will carry off the surface water if it is drained down into it.

FIG. 67. WHEN PONDS ARE CAUSED BY TIGHT MATERIAL OVER OPEN MATERIAL THEY CAN BE DRAINED BY DEEP BLASTING. NOTE THE LOCATION OF THE EXPLOSIVE CHARGE




The character of the soil forming the impervious layer must also be noted. If it is shale or a true hardpan that will remain broken up when blasted, the blasting alone, provided it breaks all the way through to the water-carrying stratum of sand or gravel, will prove sufficient to drain the surface.

On the other hand, if the impervious layer consists of a fine sticky clay, it will run together again, if blasted, and the drainage will stop because of the clogging of the outlet. Under these conditions a bore hole should be put down to within about a foot of the sand or gravel. If this stratum lies over thirty feet below the surface, this method of drainage is impractical. At the bottom of the bore hole a chambering shot should first be made by using a cartridge or two of dynamite. In the chamber thus formed a load of from five to twenty-five pounds of 40 per cent. dynamite (the amount depending upon the depth of the hole) should be placed. Cartridges should also be strung all the way up the bore hole to within about two feet of the top. As the cartridges will all be in contact, one primed cartridge at the top of the line will fire the entire charge. The object is to blast out a well or sink hole. Such a shot should form a rough well from the surface down to the sand. If the soil is of a wet, heavy, clay type, it should not cave much. This well or sink hole should then be filled with cinders, loose stone, stump fragments, or some other material that will prevent the clay from running together again. Such a sink hole should drain the pond or wet spot.

The hole should be put down at the lowest point in the surface; that is, the point to which surface water would naturally run. If the wet spot is a large one covering considerable area, it will probably be necessary to construct several sink holes in the bottom in order to get desired drainage.

In order to determine the depth required, a test hole is bored with a dirt auger, which should be pulled up from time to time in order to clean the hole out, and also to ascertain the nature of the soil encountered, which is readily seen on the spiral thread of the auger. Once the water-absorbing sand or gravel is reached the depth of the hole is noted on the auger shank. This test hole may be tamped full of soil to about 6 inches above the sand or gravel in shallow holes, and 12 to 18 inches in deep holes. This is done because it is not advisable to load the charges in the sand or gravel. They should be located in the hardpan stratum.

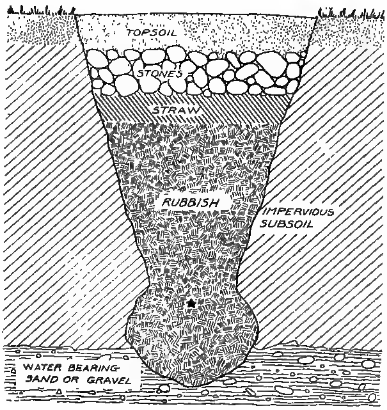



FIG. 68. DIAGRAM OF DEEP DRAINAGE HOLE, SHOWING THE USE OF TRASH TO PREVENT THE HOLE BECOMING CLOGGED WITH FINE CLAY. THE BLASTED CRATERS MUST EXTEND THROUGH THE CONFINING HARDPAN OR CLAY AND INTO OPEN WATER BEARING MATERIAL BELOW

It very often happens that holes have to be bored to depths averaging from 15 to 30 feet before the water-absorbing strata are reached and in order to do this it is necessary to use an extension auger or long churn drill. If the water is too deep to work in, the boring should be done from a raft. It is much easier to operate the auger through a hole in the center of the raft than over the side. As soon as the hole has been bored to the required depth the auger is withdrawn and a piece of 1½-inch pipe sufficiently long to reach the bottom of the hole and 5 or 6 inches above the water level is inserted. Through this the dynamite cartridges are dropped one at a time and pushed to the bottom with a wooden tamping rod. A good firm push will hold each cartridge in position. The last cartridge but one is primed with a Du Pont Waterproof Electric Blasting Cap and one cartridge is put on top of it to hold it in place, as it is not advisable to give the primed cartridge too hard a push with the tamping rod.

When the hole has been charged the loading pipe is withdrawn and slipped over the ends of the electric blasting cap wires, the leading wires are connected on to the electric blasting cap 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 explosive to use is Red Cross Extra Dynamite 40 per cent., or Red Cross Gelatin 40 per cent. The following table gives the approximate charge for holes of different depths:

| Depth of Hole | Approximate Number of 1¼″ x 8″ Cartridges |
|---|---|
| 5 feet | 5 |
| 10 " | 12 |
| 15 " | 20 |
| 20 " | 25 |
| 30 " | 40 |
| 40 " | 50 |

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 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 into 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.

It should always be remembered that the first and most essential feature of drainage is the control of the rainfall; that is, holding it in the subsoil by proper tillage where it can nourish the crops. If proper attention is paid to this feature better crops will be produced and the need of heavy ditching materially reduced.

## SINKING WELLS

Wells are often sunk through rock or ground which cannot be dug to advantage without the aid of explosives. When rock is reached and the earth above is properly supported, 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 closer together near the center when they are three or four feet deep (Fig. 69). These holes should be loaded about half full of Red Cross Extra

Dynamite 40 per cent., with damp clay or sand tamping packed firmly above to the top of the hole and then exploded all together from the surface by electricity. This shot will blow out a funnel-shaped opening

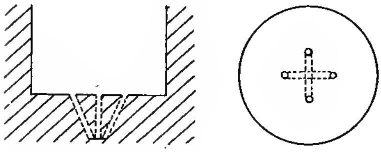
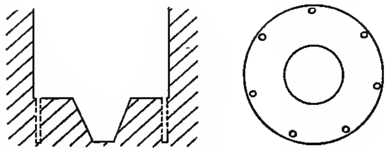


FIG. 69. THE FIRST OR CUT HOLES ARE DRILLED NEAR THE CENTER OF THE WELL, AND SHOULD NEARLY MEET AT THE BOTTOM

FIG. 70. WHEN THE FIRST HOLES HAVE BROKEN OUT A CONE-SHAPED CUT THE WELL IS WIDENED TO ITS FULL DIAMETER BY ANOTHER ROUND OF SHOTS DRILLED PRACTICALLY STRAIGHT DOWN



in the center, and the well can then be made full size with another circle of holes drilled straight down as close to the sides as possible (Fig. 70). 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. Do not in any case enter a well until all the fumes of the last blast have come out. If in doubt, lower a lighted candle to the bottom; if it continues to burn the well may be entered safely. Electric blasting caps will give the best results.

## SHOOTING WELLS TO INCREASE THE FLOW OF WATER

Often drilled or dug wells do not give a sufficient flow, the water being confined in a number of small veins or fissures that do not discharge into the well. The object of shooting a well is to open up these veins or fissures so that all of the confined water is brought together. Where such formations are found correct blasting will usually result in increasing the flow.

Where wells are drilled in dry, non-water-bearing rock, shale, clay or gravel shooting will not produce a flow.

The services of an experienced well shooter should always be secured, and well shooting should never be attempted by the novice in the use of explosives. The Du Pont Company will be glad to correspond with those having work of this kind to do and who cannot get the services of a competent shooter. In writing for information be sure to answer all of the following questions:

## FOR DRILLED WELLS

1. Location of well.
2. How many feet is well from nearest buildings?
3. Kind of buildings.
4. Diameter of well in inches.
5. Diameter of casing in inches.
6. Depth of well in feet.
7. Depth of casing in well in feet.
8. How many feet of water in well?
9. Describe the different kinds of soil, rock and other material you went through in drilling the well, and give the location and depth of each class of material.
10. Can the water be partially or entirely exhausted from the well?
11. What is the maximum number of gallons of water the well will furnish in an hour?

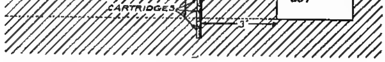
## FOR DUG WELLS

1. Depth of well.
2. Diameter of well.
3. Type of curbing.
4. Character of rock below the bottom of the well.
5. Has the well always given a poor flow or has the trouble developed recently?
6. Are there any neighboring wells on land as high as yours that are giving a good flow? If so, how deep are they?

## EXCAVATING CELLARS AND FOUNDATIONS

When it is necessary to make such excavations in rock, the first or "cut" shot should be made with a circle of holes running down to a point as has been described for well sinking (page 96). After one small section is down to the required grade the rest of the holes should be drilled straight down. These should be spaced back a distance equal

FIG. 71. METHOD OF LOADING FOR EXCAVATING CELLARS AND OTHER PITS




to the depth of the cut and spaced about the same distance apart. When the cut is more than six feet deep, the spacing should not be as great as the depth, as more than six feet is hard to blast off.

In reasonably hard rock the drill holes should be loaded a little more than half full of Red Cross Extra 40 per cent., removed from the shells and tamped tight. Better results will be obtained with electric blasting, because then several charges can be fired together, giving a cumulative effect.

In tight clay an opening can be started with a single hole not quite down to grade and loaded with enough dynamite to blow out a conical shaped section of earth. After this is cleaned out, the rest of the holes can be loaded with lighter charges.

See pages 27 to 29 for correct methods of loading and firing.

## ROAD BUILDING

A rational use of explosives in road building for clearing the right of way, blasting protruding stone from the surface or from the sides of cuts, making cuts through stone or tight clay, digging ditches, reducing grades, widening cuts, and various other purposes, will hasten the completion of the work and reduce the cost.

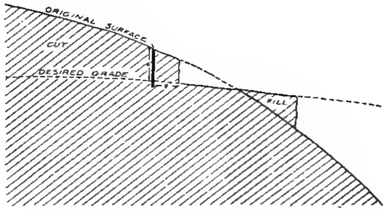



FIG. 72. LOCATIONS OF BORE HOLES FOR ROAD GRADING IN HARD GROUND. ELECTRIC FIRING IS RECOMMENDED

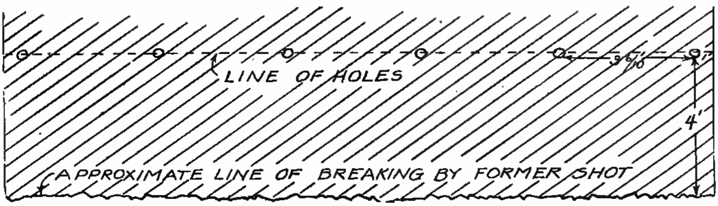



FIG. 73. PLAN OF APPROXIMATE LOADING FOR CUT WORK

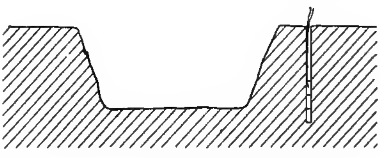


FIG. 74. METHOD OF LOADING TO WIDEN A ROAD CUT. ELECTRIC FIRING IS ADVISED

The methods already described for stumping, boulder blasting and ditching, are equally applicable to this class of work. The loosening of tight clays in reducing grades is done in exactly the same way as in digging cellars described under the preceding heading.

In starting in a rock cut the ordinary practice is to drill the holes a few inches below the desired grade. These holes should be spaced back and apart a distance about equal to the depth of the cut, unless the holes are more than six feet deep, when the spacing should be about six feet. Each row of holes should be fired simultaneously with electric caps and a blasting machine.

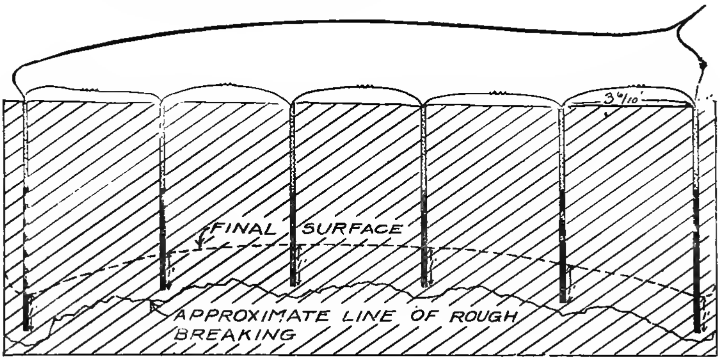



FIG. 75. ELEVATION OF APPROXIMATE LOADING FOR CUT WORK

Full directions for priming and loading are given on pages 26 to 28.

"Road Building and Maintenance" gives detailed information on Road Building. A copy may be had on application.

## ICE BLASTING

Often in Spring when ice in streams starts to move, it gets choked in narrow parts of the stream or by some natural or artificial obstruction. Then an ice gorge or jam is formed which causes the water to back up, flooding the surrounding territory above and often carrying away bridges and other structures and causing considerable damage.

By the use of explosives at the proper time the damage can often be averted. Ice begins to move out in various localities about the same time each year. Usually there is sufficient warning when to expect the break to occur, by several days' thaw or rains. It is a good plan to anticipate the moving out as soon as the Spring thaw begins, by blasting the ice while intact on that section of the stream where the gorge or choke usually occurs. The method of procedure is as follows: With ice spuds or cutters and bars, chop holes about six inches to eight inches in diameter through the ice to the water. Holes should be spaced from fifteen to twenty feet apart.

A charge of from six to eight cartridges (if the ice is thick this must be increased) of low freezing explosives 40 per cent. strength should be lowered in each hole so that the explosive is in the water and below the ice. The cartridges can be tied together in a bundle, and one cartridge of each bundle should be primed with a No. 6 Electric Blasting Cap. To prevent the loss of the charge the wires can be fastened to a stick of wood laid across the hole on surface of the ice. Several holes should be connected together in series and fired with a blasting machine and electric blasting caps.

It has been found that the ice is broken up more by the wave action of the water than when the charge is imbedded in cracks or holes dug in the ice. It is best to fire the holes electrically, but if no blasting machine is at hand a cap and fuse will answer, but then only one hole at a time can be fired.

If this is done all through the narrow section of the stream the ice is practically "honeycombed," so that when the water and ice from above comes down, it gives way readily and causes no damage.

If the gorge or jam has actually formed a charge of from five to twenty-five pounds (in some cases much more) of dynamite should be loaded in a crevice, or dug hole, at the key or pivotal point of the gorge. Several such charges can be distributed at various points in the gorge and connected and fired electrically. If the first blast does not start the gorge, the same process should be repeated with increased charges until it gives way.

To break up floating ice so that it will not bank up, forming a gorge, charges of dynamite can be exploded on the surface of the ice, the size of the charge depending on the thickness of the cakes.

If they are large blocks it may be possible to get on the ice from

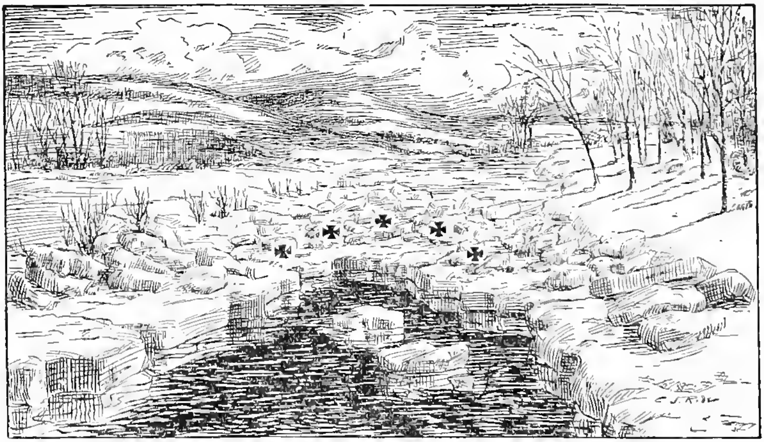


FIG. 76. DIAGRAM SHOWING LOCATION OF ROW OF HOLES FOR BLASTING AN ICE GORGE

shore or boats and successive charges of several cartridges can be exploded with fuse and blasting cap until the ice cake is properly broken.

If the stream is narrow the charge of explosives can be thrown on the ice from the shore, or, if the current is too swift the charge can be dropped on the floating cakes from down-stream side of bridges. The dynamite should be tied in a bundle and one cartridge in each bundle primed with a blasting cap and fuse. A block of wood or stone can be tied to the charge as an anchor to prevent its rolling off the cake of ice. The fuse should be lighted before being thrown and ample length allowed for a getaway. Fuse burns about two feet per minute, so from two to three feet is usually sufficient. The place where fuse enters blasting cap should be smeared with soap or grease to protect charge in cap from water.

Watering places for stock along the banks of streams can be easily kept free from ice in winter by the use of a little dynamite from time to time.

## 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. When small 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

BLASTING OUT A LOG JAM WITH DU PONT DYNAMITE AT BIG FORK, MONT.

put in a bag or left in the original wooden cases. The charge is primed with an Electric Blasting Cap 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.

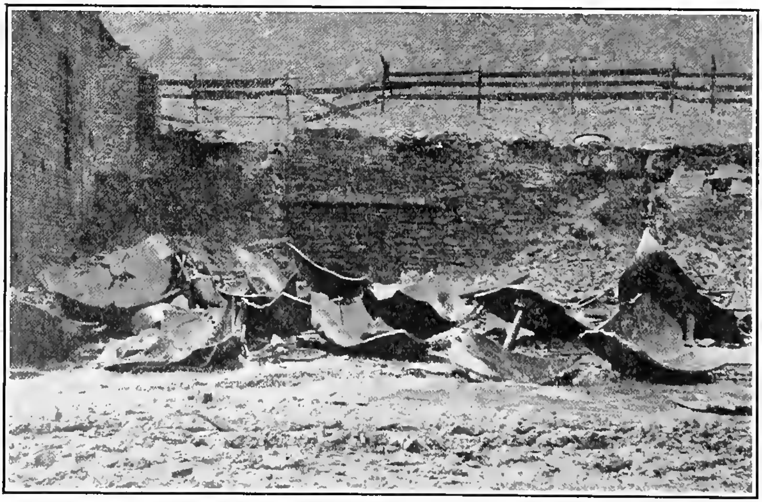
Red Cross Extra Dynamite 40 per cent. is recommended for starting log jams and for opening the rollways. See pages 22 to 29 for proper methods of priming, charging, tamping and firing.

## SCRAPPING OLD MACHINERY

Breaking up old machinery, such as heavy castings or steam boilers, can be readily done with dynamite.

For scrapping a boiler use only 40 per cent. or stronger explosives. Remove the dynamite from the shell and distribute in a continuous cord about half an inch in diameter all the way around the boiler, and secure it with a heavy mudcap. This can be placed along one of the seams more easily than on the smooth plates. When detonated such a charge will cut the plates almost as neatly as a shearing machine, and will reduce the cumbersome boiler to a size that can be handled.

For breaking heavy castings mudcapping is practiced the same as on boulders (Fig. 35). Sometimes a hole in the casting can be used for a block hole and loaded as described on page 52.



A HEAVY METAL RETORT THAT WAS BROKEN UP BY A BLAST

Large vessels and even boilers can be broken up by first filling them with water, and, if possible, closing all openings. The dynamite is primed and suspended in the water near the bottom or the thickest metal, but must not be in actual contact with the metal. The explosion of such a charge transmits a powerful blow to all sides and shatters them. (See Fig. 77 for diagram of loading.)

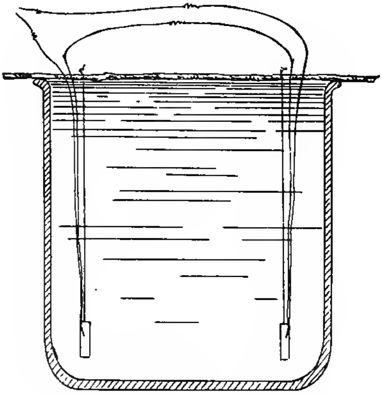


FIG. 77. SHOWING BURSTING CHARGES IN A LARGE VESSEL FILLED WITH WATER. THEY ARE SUSPENDED ON CORDS SO THAT THEY DO NOT TOUCH THE METAL. ELECTRIC FIRING IS BEST

## DIGGING ICE AND FISH PONDS

The growing interest in fish culture, one of the moves to provide a toothsome substitute for expensive meats, calls for the digging of fish ponds. These are generally located in low, wet lands where blasting has a great advantage over other methods of digging. The methods of blasting are exactly the same as for ditching (see pages 78 to 90). It is usually best to dig the ponds quite long and not more than 25 feet wide, as there is much difficulty in shooting the soil out of wider ponds. When greater width is desired, a part of the soil can be blasted out and the rest removed by small drag scrapers (Fig. 78).

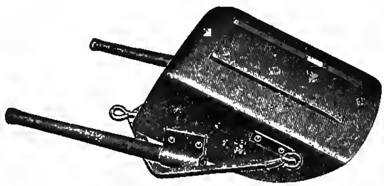


FIG. 78. DRAG SCRAPER SUITABLE FOR MOVING BLASTED GROUND IN FINISHING FISH PONDS, GRADING ROADS, FILLING GULLIES, AND DOING MANY OTHER CLASSES OF WORK

The methods of digging ice ponds are the same.

**Digging Ponds or Holes in Running Streams.**—Many shallow streams afford excellent locations for fish, duck and bathing holes. Improvement is by creating pools. This is done by blasting out the bottom of the channel as is shown in Fig. 66, page 92. This loading should extend along the stream only as far as it is desirable to make the pond. A log thrown across the stream just above the pool, in such a way as to cause a slight waterfall, will produce a scouring action and keep the pool well cleaned.

### DIGGING POST AND POLE HOLES

To speed up the work and decrease the cost, many post and pole holes are now blasted. The method employed will depend on the depth of the holes and the nature of the ground.

When hard ground is encountered and the location of the hole determined, first remove the soft surface to a depth of from 6 to 8 inches, or down to the hard ground, and to the full diameter of the desired hole. This will prove helpful even where there is but a few inches of soft ground and for deep and shallow holes. The hole is then ready for punching the bore hole for loading.

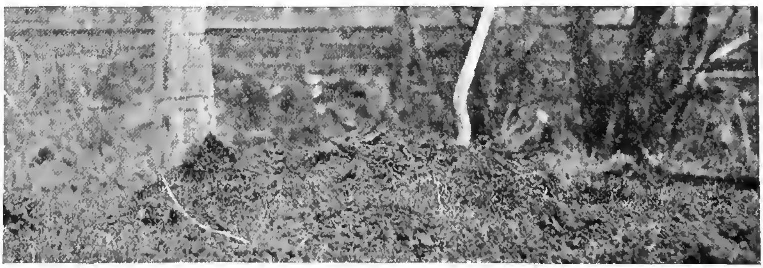
The bore hole should be located in the center of the shallow hole already shoveled out. It should be 1½ inches in diameter. Where deep holes are needed it should be 2 inches in diameter, as there must be room for loading the long charge of dynamite.

The method of punching the bore hole depends on the nature of the ground. In clay it may be easily put down by means of a long churn drill, using a little water. For harder ground a heavy drive point or drill can be driven down and loosened by pounding on the sides, so that it can be easily removed.

The use of a soil auger is often required for finishing the bottoms of very deep holes where churn drilling or punching is difficult.

Holes can be made entirely by the use of the auger, but this is usually more expensive than punching. When the soil is too dry to stick to the auger, a little water should be poured into the hole. This forms mud that can be easily lifted out.

Hard shale and rock require the use of rock drills.



RESULTS OF A BLAST FOR A DEEP HOLE. THE SURFACE WAS NOT BLOWN OUT, BUT WAS SLIGHTLY RAISED. BELOW A DEEP AND WELL-SHAPED HOLE WAS FOUND. THE COST REDUCTION, AS COMPARED TO HAND DIGGING, WAS ABOUT 50 PER CENT.

Frequently pebbles or clods fall into the bore holes before they are loaded. These, naturally, prevent the charge being correctly placed, and so must be removed. The best tool for doing this is a spoon, such as is shown in Fig. 5. This is useful for both deep and shallow holes.

**Blasting Shallow Holes.**—Shallow holes are ordinarily blasted by using a half, or, if the ground is very hard, a whole cartridge of Red Cross Farm Powder, Red Cross Stumping Powder or Red Cross Extra Dynamite 20 to 40 per cent. This is primed and loaded in the bottom of the bore hole, usually without tamping. (See pages 22 to 26 for Methods of Making Primers.) Either blasting caps and fuse, or electric blasting caps may be used.

The effect of such a blast is to force back the soil and form a "pot hole" at the bottom, and loosen the soil above so that it may be easily spooned or shoveled out. This avoids the necessity for using a chisel or other tools to loosen the hard ground.

The greater part of the ground is packed back into the wall and bottom, especially if it is wet or moist when the blasting is done. Some loose soil is usually left at the bottom of the hole.

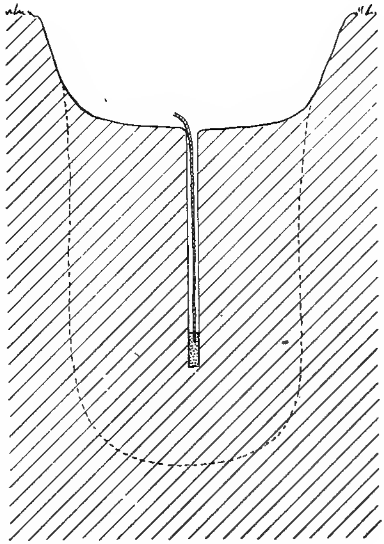


FIG. 79. LOADING FOR A SHALLOW HOLE

The primer is placed in the bottom and no tamping is used. The dotted line shows the approximate size and shape of the blasted hole

**Blasting Deep Holes.**—The method of loading must be changed for deep holes, or else a tight bridge or plug of dirt will be left at the top. To prevent this, the charge must be distributed along the hole as is shown in Fig. 80. This is done in order to get more uniform lateral expansion of the gases along the bore hole.

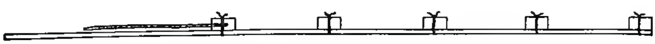


FIG. 80. DYNAMITE CHARGES TIED TO STICK AND READY TO LOAD FOR A POLE HOLE BLAST

The amount of dynamite in each charge must be governed by the strength of the dynamite and by the hardness of the ground

To get this distribution use a straight, narrow lath, reed, or stick, as long as the hole is to be deep. Cut the cartridges into two or three pieces. Tie one piece of dynamite to the side of the stick at one end, from 6 to 20 inches further up tie a second piece. Continue this to within 12 to 24 inches of the top, depending on the nature of the soil and the results of trial shots (Fig. 81).

The charge thus arranged is placed, with the primer end up, in the hole, and fired. The need of tamping above the primer will depend on the nature of the soil.

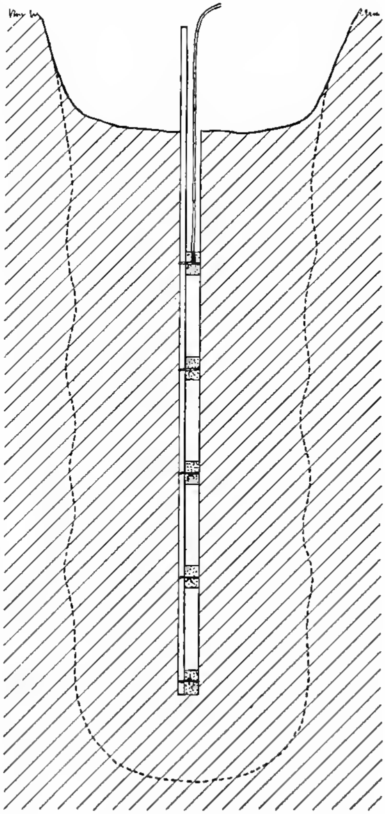
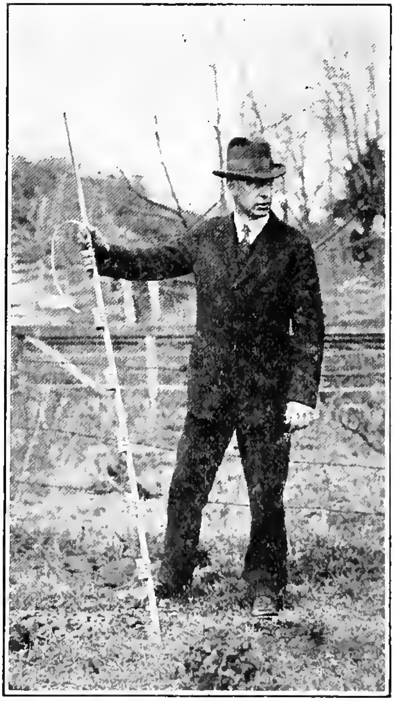


FIG. 81. METHOD OF LOADING FOR BLASTING A DEEP POLE HOLE, SHOWING THE DISTRIBUTED CHARGE IN PLACE. THE DOTTED LINE INDICATES THE APPROXIMATE SIZE OF THE FINISHED HOLE



CHARGE WITH PRIMER ON LATH FOR BLASTING A DEEP POLE HOLE

It should be remembered that this method is useful only on clayey or other soils that can be packed by the explosion. Shales must usually be blasted as is advised for rock.

**Blasting Holes in Solid Rock.**—As it is impossible to force back the sides of the holes in solid rock, as is done in blasting in hard clays, modifications in the method of loading are required. Ordinarily holes are not put down so deep in rock as in hard ground.

After excavating the hole down through the soil, if any is present, drill a hole from 12 to 18 inches (Fig. 82) into the rock. Load this with a full cartridge primer pressed well to the bottom, tamp the hole tight, and fire.

If the loading is heavy enough this will shatter the rock to the full depth of the blast. When the loose fragments have been removed, drill another hole to about the same depth and load as before.

The explosive used for this work should never be of a lower strength than Red Cross Extra 40 per cent. strength, and for hard rock 50 or 60 per cent. strength is often better.

Those desiring additional information on this subject, should write for "Blasting Pole and Post Holes."

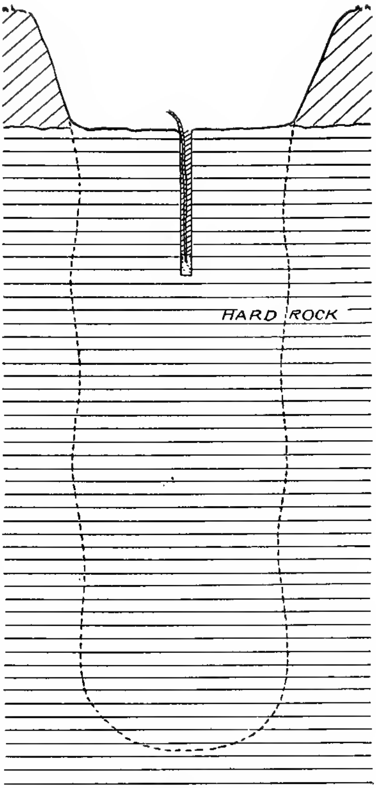



FIG. 82. IN HARD ROCK THE BORE HOLE MUST NOT BE DEEP. AFTER THE FIRST BLAST CLEAN OUT THE FRAGMENTS AND DRILL A SECOND HOLE. DOTTED LINE INDICATES THE SHAPE OF THE BLASTED HOLE

## PRECAUTIONS TO BE OBSERVED IN GENERAL WITH REGARD TO EXPLOSIVES

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

DON'T attempt to use electric blasting caps with the regular insulation in very wet work. For this purpose secure "Du Pont Waterproof" or "Gutta-percha Covered" Electric Blasting Caps.

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

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

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

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

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

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

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

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

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

DON'T leave detonators exposed to the direct rays of the sun.

DON'T leave detonators where the rays of the sun will strike them after passing through glass.

DON'T have matches about you while handling explosives.

DON'T store explosives so that the cartridges stand on end.

DON'T open cases of explosives in a magazine.

DON'T open cases of explosives with a nail puller, pick or chisel.

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

DON'T use a needle of iron or steel when firing by means of miner squibs. Use one of copper or brass.

DON'T keep blasting caps or electric blasting caps in the same box or container with other explosives in the field. Keep them separate.

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Explosives cannot be shipped by parcel post or express, nor can they be transported on a train carrying passengers for hire. They must be shipped as freight.

# Professional Blasters can find Profitable Employment

We should like to hear from men with blasting experience in mines, quarries or with contractors, etc.

Blasters can obtain profitable employment from land owners and fruit growers who have land to clear of stumps and boulders, ditches to be dug, ponds and low spots to drain, trees to plant or cultivate, roads to make, or fields to subsoil.

Hundreds of men scattered all over the United States are making a living by devoting their time to work of this kind, but there are not nearly as many men engaged in it as are necessary to take care of all of the work to be had.

**We do not employ agricultural blasters,** but we do everything in our power to assist those who take up the work to secure blasting jobs from parties in their locality who have replied to our extensive advertising. The parties employing them pay them for their work. We also give agricultural blasters attractive handbills and posters, advertising their business, booklets and other printed matter which, when properly distributed and used, assist them in securing work.

Our Agricultural Blasting Booklet tells what successful blasters are making in this work and describes their methods of securing it.

CUT THIS CARD OUT ALONG THE RULED LINES

BLASTER CARD

**IF YOU WANT TO TAKE UP AGRICULTURAL BLASTING—CUT OUT, FILL IN AND MAIL THIS CARD**

E. I. du Pont de Nemours & Company
Wilmington, Delaware

*Gentlemen*—Please send me your Agricultural Blasting Booklet describing the money-making opportunities in the profession and explaining the methods of successful blasters.

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# E. I. du Pont de Nemours & Company

Home Office—Wilmington, Del.

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