
Home and Recreational Use of High Explosives
and Homemade C-4
by Ragnar Benson
Transcribed to the electronic media by Swedish Infomania

Home and Recreational Use of High Explosives

Homemade C-4

WARNING: Ragnar Benson is a weapon fetischist, and do not always know what he is talking about. The making of "C-4" DOES produce a good compound, safe and usable for experiments, but is not real C-4. His "Improvised detonation cap" procedures should NOT be carried out. They are too downright dangerous.

INTRODUCTION

The American Civil War had been over for only two years in 1867 when an otherwise obscure Swedish chemist discovered that mixing capricious, powerful, and dangerously unstable nitroglycerin oil with inert, otherwise innocuous, diatomaceous earth produced a reasonably stable material of immense benefit to mankind. The world named the stuff dynamite.

A highly unpredictable substance, nitroglycerin had been around since its discovery by Ascanio Sobrero, a ho-hum Italian chemistry professor who, in 1846, treated common glycerin with nitric acid. To produce an explosive, the challenges were to make the explosive substance pure enough so as not to self-detonate on the shelf and to stabilize it to the point that the explosive could be transported safely to the work site, where it could be detonated on command.

Because of its vastly superior explosive qualities vis-a-vis black powder, heroic attempts were made to use raw nitroglycerin oil for mining and, to a limited extent, for various uses during the American Civil War. The substance, however, had a maddening habit of going off prematurely without immediate, apparent cause other than a slight warming of the weather, and of being so sluggish at temperatures under 55øF that it could not be detonated under any circumstances.

Alfred Nobel's fortuitous mixture, in addition to numerous tangential discoveries he also made in the field of explosives engineering, led to the technological shifts that, in economic terms, were of equal importance to the power loom, iron plow, or even the steam engine. In an economy that increasingly eschews the use of dynamite, a surprising 50 million pounds were used in the United States as late as 1985.

At this point, a good definiffon is in order. All chemical explosives are divided into two classes, high and low. Low explosives include black blasting powder of various types, chlorate powder, and other similar products that burn rather than detonate. Low explosives are seldom used to do commercial blasting.

High explosives decompose with high reaction rates having significant pressures. Conversion from solid to gaseous state is almost instantaneous. As a result, their shattering force is great. High explosives are used whenever large amounts of force are required. Dynamite is the best, most common example of a high explosive.

Without the shocking, tearing effect that is at least twenty times as great as that of dynamite's weak sister (black powder), societies and cultures cannot build roads, bore tunnels, extract minerals from deep in the earth, dear harbors, build railroad beds, or even perform such mundane tasks as laying sewer lines, digging foundation trenches, or excavating holes for outhouses.

Eight ounces of high-tech dynamite stores the potential of about 600,000 foot-Pounds of energy. Properly harnessed and directed, that is enough to throw a ten-pound projectile eleven miles, or represents the total muzzle energy of two hundred 30.06 rounds fired simultaneously.

There is a modem tendency to dismiss the productive use of dynamite as unimportant in our society. From some perspectives, this assumption is understandable.

Substitutes such as ammonium nitrate and others have taken over much of the market for commercial, dynamite-type explosives. In another regard, the older high explosives have been dwarfed into obscurity by their super-powerful nuclear relatives. The Hiroshima bomb, for instance, contained in a cylinder ten feet long by little more than two feet in diameter, the explosive equivalent of a single stick of dynamite twelve yards in diameter and one hundred yards long.

A relatively small five-megaton nuclear weapon has the explosive equivalent of a fifty-story building covering a city block and crammed full of dynamite.

With competition like this, it is little wonder Americans forget about the role dynamite plays in our economy. Yet it is still true today that explosives use acts as a lagging indicator of economic activity. When the economy is buoyant, mines are busy, roads are being built, and airfields leveled. Explosives consumption is up. When the economy is in the doldrums, the line on the graph plotting consumption of powder angles sharply down.

By 1875, Alfred Nobel perfected the principle of initial ignition, wherein he used a small, protected charge of easily degraded black powder to detonate a more stable main charge comprised of high explosives. We use the concept every time we set up a cap and fuze to produce a detonating stick. The concept is revolutionary in its significance but was completely unknown before Nobel's time. He actually pioneered the concept of initial ignition before he developed dynamite!

Early explosives engineers even thought in terms of rigging up a mechanical hammer with which to detonate a primary charge. Like many simplistic technological jumps, the discovery of initial ignition tends to be lost in history.

Alfred Nobel made millions in his lifetime supplying good, reliable explosives to the world's economies. He was popularly pilloried as a "merchant of death," but contemporary records indicate that little use of dynamite was made in a military context.

Perhaps in response to the adverse PR, Nobel funded the now widely recognized Nobel Peace Prize. Few realize the source and background of the prize that rewards outstanding work in the fields of physics, chemistry, medicine, literature, and fraternity between nations. Ironically, Nobel predicted that high explosives would eventually make wars so costly that they would cease to occur. Technological advances in the field of high explosives in the late 1800s had a high price. Alfred's older brother was killed April 12, 1888, in an explosion at their dynamite factory at Helenborg, a few kilometers from Stockholm, Sweden.

The blast was the second death-dealing event in the Nobel family history. In September 1864, Nobel lost his younger brother Emil when his nitroglycerin factory went up, taking four employees and the young man with it.

Under pressure from the Stockholm city fathers, Nobel moved his factory onto a raft that he floated on a nearby lake.

The explosion was the first of many worldwide. Nitroglycerin factories are known to have blown up in Panama, New York, San Francisco, and Sydney. This did not seem to deter a rapidly industrializing world that saw these explosives as a good answer to reaching low-grade ore deposits deep underground and for ripping rock with which to surface carriage and railroad rights-of-way.

Managers of existing nitroglycerin factories that did not detonate prematurely quickly saw the value of the new Nobel process. By mixing nitroglycerin oil with commonly available diatomaceous earth, they found it absorbed three times its own weight of the hostile liquid Only the most determined blow, or a most intense heat, could detonate the new form of high explosive.

Factory owners quickly added dynamite-processing lines on to their nitroglycerin factories. By 1873, there were at least thirteen major producers throughout the world, ranging from Japan to Finland.

Problems with the end product persisted, however. Watery sets tended to kill the early nitro dynamite by driving the oil out of the diatomaceous earth. Also, the product froze solid at 55øF and was extremely difficult to detonate.

The water problem was solved by judicious use of additives and by better use of cartridge wrappers. Modern dynamite is wrapped with a double layer of heavy bag paper impregnated with materials that keep water out and which assist with the overall detonaffon.

Ammonium nitrate, among others, was blended into the formula to give the cartridges an almost waterproof quality that is still in use today.

The problem of nitroglycerin's high freezing point was never really overcome. The solution that eventually emerged involved mixing ethylene glycol dinitrate, an antifreeze compound that is molecularly similar to pure nitroglycerin oil, with pure nitro. The result was a mixture that was much more usable at low temperatures.

There is no dynamite today that is pure nitroglycerin. Other compounds, such as calcium carbonate and nitrocellulose, were added to increase dynamite's stability as well as lower its freezing point.

Dynamite became so safe and so well accepted that virtually every rural hardware shop had at least a few sticks, a box of caps, and some fuze in its inventory. Farm-supply stores sold it by the piece to those who were too poverty-stricken to buy more than that for which they had an immediate need.

The first year Nobel sold dynamite, he peddled about twenty-two thousand pounds of the stuff. The price was $1.75 per pound. On a relative productivity scale, it was much cheaper than black powder, so marketing the product was not a particularly difficult chore.

By the 1950s and '60s, annual consumption of dynamite in the United States alone was hovering around the 1-billion-pound mark. The price had fallen to ten cents per pound or, if one bought in fifty-pound case lots, the price was four dollars total.

The Romans knew how to build roads and, to an extent, how to surface them with an asphaltlike material. It took Nobel and his invenffon, however, to produce cement (dynamite was necessary to blast huge stones out of the Earth in small enough pieces to crush to make the cement). At the time, the United States was starting in on the largest road-building program ever to be undertaken in human history.

During the '50s and '60s, this country was evolving out of being a rural society. It was during this time that America learned to be afraid of explosives. That fear has been translated into vendor regulations and restricffons that have raised the price of powder dramaffcally.

Modern explosives cost about one dollar per pound or fifty cents per stick. Unfortunately, there is no longer a single-stick price. Fifty-pound cases run a minimum of fifty dollars!

To some extent, dynamite is priced on the basis of grade and strength. The strength of straight nitro dynamite (of which there is virtually none remaining today) is evaluated by its explosive oil content. For example, if the dynamite contains 40 percent explosive oil by weight, it is said to be "40-percent dynamite." Mixtures are graded by tests that establish their strength as compared to an imaginary benchmark of straight dynamite.

Grades range from the relatively tame 20-percent stuff all the way up to 85-percent dynamite, known as Hy-Drive. Hy-Drive is used to detonate blasting agents such as ammonium nitrate.

Lower-strength powder in the 40-percent range is used to push and throw, as in removing stumps and rocks from the Earth. The plan with this material is to keep the object being shot intact so it can be hauled away after it is torn loose from its mooring. Finishing the work with as small a crater as possible is another advantage of lower-strength powder.

Higher-strength 60-percent and 70-percent grades are used to shatter rock into pocket-sized pieces and to reorganize ice jams.

Some very high grades of dynamite are used to blast channels in wet marshes because these grades will propagate, meaning that, set in a row, one charge will set off another on down the line by hydraulic shock.

It does not take a huge amount of expert ence to learn what strength is proper for a given application.

In the final analysis, doing the work was what Alfred Nobel had in mind when he first perfected his blasting systems. With them, a single individual can dig a disposal pit or dry well in otherwise impenetrable ground, set posts, remove large boulders, redirect creeks, cut drainage ditches, unclog duck ponds, or blow up bad guys, as well as perform a host of otherwise impossible chores of immense benefit to mankind.

BASIC PROCEDURES

Detonating dynamite is relatively simple. Getting it to go off at the time and place one desires is a matter of straightforward training combined with a modest amount of self-discipline.

Capping a dynamite cartridge is the first, most basic skill that the would-be blaster must master.

Before proceeding, users who have never examined dynamite before should open the end of a cartridge for a firsthand look. They will find that the tan to tan-grey mixture looks like old chewing gum. The white prills (spherical pellets), if included in the mixture, should be round and firm. Mushy, distorted prills are a sign of old, going-out-of-condition powder. Don't buy this kind if you can help it. If you have it already, use it up. If the cartridges are weeping or leaking, carefully dispose of them by burning.

Cartridges come in a great variety of sizes and shapes. Nine hundred and ninety-nine times out of a thousand they will be half-pound sticks that are about one-and-a-quarter inches in diameter by eight inches long. I have occasionally used some twelve-inch-long sticks and some three-pound canisters, but only a handful of times in forty years of blasting. The three-pound canisters were special orders that I lined up for dealing with an especially dreary stump-removal project.

Approximately thirty-five fresh oak stumps dotted the middle of a fifty-acre field. We had cut out the logs the previous winter. Some of the logs were forty inches on the butt end, which gives the reader some idea of the size of the stumps. All the logs were cut into one-inch boards. Any limbs bigger than three inches were stacked up by the stove. Other than the stumps, we were ready to farm the ground.

Usually a blaster would use a hand auger to dig down under the stumps, fire a springing charge, and then blast the stumps out with a heavy main charge. Because the stumps were so large and green, it was a tough project. The sandy, dry soil and the incredibly hot, muggy weather added immeasurably to our grief. It took immense willpower just to go out to the humidity-sodden work site, where the last fresh breeze had blown months ago.

Lightening the work load became a priority item. The plan we worked out did the job very nicely. By connecting a rotating six-foot length of cold, rolled-round steel stock to the drawbar of our D-8 Cat, we fashioned a punch that took the place of the auger. One drum of the machine's winch raised and lowered the bar, producing a very workable, power-punching dynamite tool.

By lowering the pitch of the punch to a 45ø angle, we were able to back up the Cat onto the bar and drive it down under the stump. The hole it produced was just right for the three-pound canisters. We routinely pushed four or five of the cylinders of 40-percent powder down the hole with our rake handle and let'em rip.

When we had eight or ten sets batched up, we lit them all en masse. The little dozer operator, who had just returned from a government-sponsored hunting trip in Korea, jumped two feet every time a charge thumped. A couple of times the blasts were so close together that he didn't get to touch the ground between thumps.

Unlike regular cartridges, the three-pound canisters were packed in what appeared to be common cardboard tubes. Dynamite cartridges are wrapped in tough, deep brown paper. The slick paperlike material of regular half-pound charges is specially treated so that it will enter into the detonation. The paper ends and the seam along the cartridge are sealed with wax. Dynamite cartridges are compact and tough. As many miners can attest, they will withstand a fair amount of rough handling bordering on abuse.

Powder users will commonly encounter two types of detonating caps. Electrical caps are easily distinguished by their two red-and-white or green-and-yellow wire leads. The cap itself will be a natural aluminum color. It will have a watertight rubber plug securing the wire leads to the cap body.

The 2 1/4-inch x 3/8-inch caps are marked "Dangerous Blasting Cap Explosive" on the body. Several different styles of electrical caps are available, providing for a time lapse between firing and actual detonation. These are used in mining and quarrying to allow multicharge sets to be set off in proper sequence. Standard industry codes for these caps are as follows:

Delay Period (code)	Time in Seconds to Actual Detonation
0	0.008
1	0.5
2	1.0
3	1.5
4	2.0
5	2.5

6	3.0
8	4.0
9	4.5
10	5.0

Delay-action electrical caps are manufactured by putting a delay element with a closely controlled burn time between the ignition element and the primer charge. The primer ultimately deteriorates the cap. Standard delay caps are designed to fire at intervals of from one-half to five seconds after they are electrically "set off."

Codes used to designate the type of cap one is dealing with are fastened to the lead wires. These range from 0 (virtually instantaneous detonation) to 10 (five seconds). The delay caps are used in a way that the outside charge blows first, relieving the outside wall so that the inner charges will then in sequence crack the material being blasted free in the correct direction.

As a general rule, the hobby blaster will use only the instantaneous varieties of electric blasting caps. The only exception might occur if one buys supplies from a quarry operator or other secondary source.

Caps used with fuze were, in times past, most common because they were generally less expensive and less cumbersome to use than their electrical counterparts. Lately I have had trouble buying fuze and caps in anything but very limited quantities, dueðin part, vendors tell meðto a government drive to make these easier-to-use explosives more difficult to obtain.

Fuze caps are thin, hollow aluminum cylinders one and one-half inches long and about one-quarter inch in diameter. Fuze caps are much smaller than electrical caps, even excluding the wire leads.

Unlike regular dynamite (which burns without incident for a minute or two when torched), the mixture that fills the cap up to about two-fifths of its capacity is fire-sensitive. When the fuze burns to it, an explosion about the intensity of a healthy firecracker results.

Fuze comes in white, red, and black colors depending on the whim of the maker. The feel is stiff and slick. Coils can be from four to nine inches in diameter, with lengths from fifty to one hundred feet. The fuze core burns with a hissing, spifflng, smoking flame. Surrounding the core is a sticky, tarlike layer that is, in turn, covered with a wrapping of light thread that is lightly painted.

It doesn't happen easily, but the fuze should be protected from kinking. Old timers sometimes knot the fuze around the dynamite to hold the cap in place. This procedure is a definite no-no if one wants to avoid adrenalin-inducing rushes while cleaning up messy misfires.

The correct procedure when attaching a cap to the fuze is to always trim about one-half inch from the end of the coil of fuze. Do this to expose a clean, fresh, right-angle cut to the cap.

The cut can be done with a knife but is best accomplished with a nonsparking combination cutting tool made specifically for this purpose. Dynamite combination tools are made by Diamond Tool and others, and are available for about eight dollars from dynamite distributorsðusually without filling out forms.

One handle of the tool is a punch and the other is a screwdriver, which is useful when connecting drop wires to a power box. The tool is principally useful when crimping the cap to the fuze and for cutting fuze.

Crimping can be done with common gas-pipe pliers butðlike many, many things in life is best done with the correct instrument.

Knife cutting distorts the fuze a bit, especially on a hot day when the tarlike fuze is more pliable.

Insert the fresh-cut fuze end firmly into the cap. I perform this part of the sequence well away from the box of cartridges, although I have never had a cap go off prematurely.

Crimp the thin aluminum skirt of the cap securely onto the fuze. Considering that the fuze will burn at the rate of one foot per minute, that no fuze should ever be less than a foot in length, and that the extra time the extra fuze provides is always worth the price, cut a proper length off the roll of fuze.

Always be very cautious about the springy fuze snapping the cap around into a rock or other hard object and detonating it.

Using a one-quarter-inch wooden stick as the pick, or the dynamite tool, push a diagonal hole down through a dynamite cartridge, starting about one-third of the way down the stick.

Be cautious not to run the hole through both sides of the cartridge. Some blasters run the hole in from the end, but I have always run the hole in the side. There is no reason for preferring the side-pick system other than this is how I was originally taught.

Insert the cap on the fuze snugly into the hole in the punched cartridge. I use a precut eight-inch length of baler twine to tie the capped fuze securely in place. Place the knot over the pick hole to protect it a bit.

This package constitutes the cap charge.

It is much easier to light fuze if it is sliced back about an inch, exposing the inner powder train. Otherwise, the tar coating may bum with a weak, yellow flame for a minute or two before the fuze itself sputters to life, giving the neophyte apoplexy in the process.

Electrical caps are inserted into cartridges much the same way fuzed caps are installed. In the case of electrical caps, the leads can be knotted around the cartridge to hold the cap in place without compromising safety.

Electrical caps are most practical when multiple charges are shot. It is possible to shoot a number of charges simultaneously using match cap and fuze with detonating cord, but if the charges are very far apart, the cost becomes prohibitive.

The first time I used det-cord was to take out a number of six- to ten-inch hawthorne trees. A covering of long, very sharp thorns virtually precluded cutting them with a saw.

I tightly wrapped three winds of det-cord around the trunks two feet above ground level, slipped a fuze cap between the trunk of the tree and the det cord, and shot them individually. In spite of a seemingly minimal amount of exposure, I pinched up my hands and arms doing even this much work around those damn trees.

Detonating cord looks like heavy, poly-plastic clothesline. It is fairly flexible, coming in ten-inch, one-thousand-foot reels. The explosive component of det-cord is extremely fast and powerful. It will take an eight-inch green tree and splinter the trunk through to the core.

I had all the trees lying over in an hour.

The principal use of det-cord, other than placing it in ditches and holes the enemy might use during an ambush, is to connect multiple match and fuze charges together. The material runs forty cents per foot, precluding one from getting too carried away with this use.

To obtain more or less simultaneous detonations, you can wrap a turn of det-cord around each cartridge in a set running from the main charge that was capped conventionally to the side charges.

Match- and fuze-capped charges are fairly reliable in about ten feet of water. When going deeper or using electrical caps, I place the capped charge in a thin-plastic bag. The water pressure will collapse the bag, which helps seal out harmful moisture.

Besides the combination tool and a pocket knife, the blaster will need a long-handled shovel. The wooden handle is good for poking the cartridges down the bore hole, especially the first charge (called the spring or springing charge), which is used to create the main powder chamber under the stump or rock.

I have marked my shovel handle with pieces of tape spaced every eight inches to quickly indicate how many charges can be placed in the hole. Some blasters use a separate tamping stick. I don't find this necessary.

When I was a young man, we often saw dynamite augers being sold at farm auctions. After a few years they all disappeared ð I suspect into the hands of antique collectors. To make do, we purchased some of the many one-and-one-half-inch-diameter wood augers that barn carpenters used. By welding a five-foot-long, three-eighths-inch steel rod to them, we had a reasonably good dynamite drill. Now even the large-diameter bore carpenter bits are tough to find. An auger with flights rather than a flat-spoon cutting edge is needed to pull the dirt out of the hole. New or used, these tools are virtually unfindable.

By whatever means, a good bore-hole auger is invaluable when doing serious work with commercial explosives. The flights must be wide enough to pull out small stones, the cutting edge sharp enough to cut small roots, the handle long enough to reach under the designated object, and the turning handle long enough to torque the rig through common obstructions.

Powder monkeys shooting mostly electrical caps will also need an ohmmeter to read the resistance in the electrical sets, a minimum of 250 feet of drop wire and up to 500 feet for heavier charges, such as that used for blasting duck ponds or drainage ditches.

After learning to make blasts with cap and fuze that allow the user to retreat as far as his legs and discretion take him, the user will also learn how to make sets that merely whoomp and do not throw rock and debris all over the state. Having learned to contain the blast by using the correct type and amount of powder, the blaster can feel more confident regarding the use of the shorter 250-foot drop wires.

Drop lines should be heavily insulated 14-gauge wire. The ohmmeter can be a simple instrument purchased from Radio Shack.

I have never used a blasting machine. Instead, I relied on a lantern battery for single charges and truck batteries for multiples under five caps. I try to limit my electrical sets to five charges. Casual dynamite users will seldom be called on to make sets larger than could be handled by five caps.

Larger sets, in my opinion, defeat the safety argument in favor of electrical capsði.e., when they are touched off, they either go or don't go. With match and fuze there is always a question until the moment of detonation. Sometimes detonation takes what seems like forever between lighting the fuze, the retreat, and the whoomp.

Electrical blasting is not a mysterious process. It does, however, require a knowledge of the most basic laws of electricity.

Electric current flowing through a conductor such as a wire is comparable to water moving through a pipe. Voltage is the pressure of the water (electricity). Rate of flow through the wire is measured in amperes. In a pipe, it is gallons-per-minute.

The diameter of a wire influences the rate of flow of electricity much the same as the diameter of a pipe influences the rate of water flow. The cross section of either (or lack thereof) opposes the flow or creates resistance.

The three factorsðvoltage, current, and resistanceðare related in a formula known as Ohm's Law. Ohm's Law is probably the most basic piece of electrical physics.

Every schoolboy reams the formula at one time or another

Pressure/Resistance = Rate of Flow
or
Volts/Ohms = Amperes

These terms relate to the three elements of an electrical blasting circuit, including the electrical cap itself, the source of energy, and the drop wires that carry the electrical current.

The electrical blasting cap transforms electrical energy into heat, which starts an explosive force strong enough to detonate the main charge.

Like a filament in a light bulb, the electrical charge heats a bridge wire embedded in a flash compound. The flash compound detonates an intermediate charge in the cap that is actually the primer. This small but powerful charge has enough strengthto detonate the dynamite cartridge.

It takes an extremely short time for the electricity to heat enough to flash the compound. This time can vary, depending on the amount of electrical energy going to the cap. To a point, increasing the current lessens the irregularities among caps.

A minimum current of 0.3 to 0.4 amp will fire a commeroal electrical cap, but safety and consistency dictate that a charge of 0.6 to 0.8 amps be used. Cautious blasters usually figure on a minimum of 1.5 amps of direct current (batteries) and at least 3.0 amps of 60-cycle alternating current from a wall socket or a portable qenerator.

Power sources for a shot can be delivered by blasting machines, commercial power lines, motor-driven generators, and storage and drycell batteries.

Most blasting machines, including the old rack-bar-type push boxes used in the movies, are portable electric generators designed to have high voltages. Newer blasting machines are sometimes the condenser-discharge type. Some machines that are more than adequate for ten simultaneous shots can be carried in one hand. They are discharged by a quick twist of the wrist.

Because of the high cost, I have never purchased a blasting machine. When hooked up in series or used while the engine is running, standard 12-volt truck batteries will usually fire more charges than I have the energy to install in one set.

For safety's sake, every charge set in a day should be fired that day. Do not allow a charge to stand overnight or even leave the site for lunch or a break.

No blasting should be attempted with vehicle batteries that are not fully charged or that show signs of any deterioration or weakness. The engine should be on fast idle when the shot is made to ensure that enough amperage is available.

Three types of wire are used in the blasting circuits:

Leg wires are the thin, insulated wires that run from the cap itself. They range in length from six to fifty feet. It is important to know the resistance of these caps, including the leg wires, so that accurate calculations can be made regarding the adequacy of one's power supply.

Resistance of Copper Wire
Electrical Blasting Caps

Length of Leg Wires (feet)	Average Resistance (ohms)
6	1.53
8	1.66
10	1.72

Length of Leg Wires (feet)	Average Resistance (ohms)
16	1.91
20	2.04
24	2.17
30	2.00
40	2.20
50	2.40

Resistance can be extrapolated from six to twenty feet and from twenty-four to fifty feet At twenty feet, the wire size in caps jumps from 22 gauge to 20 gauge. The heavier wires are needed for lower resistances over longer distances.

Connecting wires are those insulated wires run through the shot region that may be torn up at detonation. They are usually 20 gauge, ultimately connecting to the drop wires from the caps.

Drop wires are those that connect the basic set to the power source. If at all possible, these wires should be 14-gauge copper.

One must know the resistance of connecting and drop wires to calculate how many caps can be fired from a given power source. Use the following chart, along with an ohmmeter.

Gauge	Ohms per 1,000 ft. of drop wire
4	0.248
6	0.395
8	0.628
10	0.999
12	1.59
14	2.52
16	4.02
18	6.38
20	10.15
22	16.14

There are three types of circuits commonly used: single series, series in parallel, and parallel. Many times, the nature of the shot will dictate the type of circuit that must be used.

If there were fifty electrical caps rather than the six shown. the blaster would compute the circuit as follows:

50 electric caps with 20-ft. leg wires =
50 x 2.04 = 102.0 ohms

Resistance of 100-ft. No.20 connecting wire =
1.0 ohm

Resistance of 250-ft. No.14 drop wire = .5 ohm
Total Resistance of Orcuit = 103.5 ohms

If the current were supplied by a 220-volt
AC generator, the current supplied would be:

220 volts/103.5 ohms = 2.12 amps

This is not enough power supply to power the necessary 3.0 amps of alternating current per cap that is considered a safe standard. To be entirely safe, the blaster would have to cut the set down to fifty charges. These readings can be verified by using the ohmmeter.

For example, fifty caps have a resistance of 51.75 ohms.

220 volts/51.75 ohms = 4.25 ohms

A partial solution ð if a larger set must be used, or if one is working with a smaller power source such as a vehicle battery ð is to connect the caps in a parallel circuit.

The resistance in this case is only the resistance of each cap. Using a parallel circuit or a parallel-series circuit, a huge number of caps can be fired. Some sets containing more than one thousand caps are made using a variation of a parallel series.

Parallel Series Circuit Example

200-ft. No.20 connecting wire = 1.0 ohm

4 caps in parallel series = 8.12 ohms

250-ft. No. 14 drop wire = .5 ohm

Total = 9.62 ohms

12 volts/9,62 ohms = 1,24 amps

Note that, with direct current from a battery only, 1,5 amps is required to set off a single cap safely, In parallel, only the resistance of a single cap between the connecting wires is used in the computation, Very large sets are made by placing more caps in a series between the parallel lines, but the computation does not change,

Going back again to the five-shot series (which for me is the most common multiple shot), we have:

1OO-ft, 20-gauge connecting wire = 1,0 ohm

250-ft, 14-gauge drop wire = ,5 ohm

5 caps with 8-ft, leg wires = 8,3 ohms

12-volt truck battery/10,4 ohms total resistance = 1,15 amps

Again, this is not enough direct current to meet the 1,5 amps of direct current criterion, However, with the engine running, I have found that the setup always fires properly, The following example, while not perfect, illustrates a relatively easy method of using common equipment to do some blasting, Parallel-Series Circuit Example:

Resistance of each series of 4 caps = 4,0 x 2.04 = 8,16 ohms

Resistance of 10 series in parallel = 8,12/10=,81 ohm

Resistance of 200-ft. connecting wire = 1.00 ohm

Resistance of 250-ft, No, 14 drop wire = .50 ohm

Total = 2.31 ohms

Assuming one used a 12-volt battery, the computation would be as follows:

12/2,31 = 5,19 amps

Each series would receive 5,19/10 = ,52 amp, which is not enough to take us up to the 1,5-amp safe level required, The 5,19 amps must be divided by 10 because there are ten series of four in the string,

Using a portable generator:

220/2,31 = 95.6/10= 9.56 amps

A portable power generator would probably be adequate in most situations, but vehicle batteries, even wired in series, would not be. The only exception might be to power the charge from a large bulldozer battery while the machine is running and the battery charging, Test all multiple shots with an ohmmeter, and use short leg wires and heavy drop wires to minimize wire-resistance problems.

In the cases above, the examples are very conservative, They probably do not reflect the average day-to-day needs of the home and recreational blaster, As I mentioned previously, I have always powered my little four- and five-cap sets with a 12-volt car battery or even a 6-volt lantern battery, Remember, the rule of thumb is 1.5 amps per cap for DC and 3,0 amps for AC.

Electrical splices on blasting lines are critical. Most experienced blaster' prefer the twisted-loop splice. This and an equally acceptable telegrapher's splice are illustrated below. Your ohmmeter will quickly tell you if all the splices are sound, making good electrical contact.

Be sure to keep all splices tight and practice good housekeeping with the connecting wires. Neat, taut runs are likely to cause fewer problems. All open-wire splices should be raised up off the ground, away from puddles or wet grass, using dry rocks or pieces of cardboard as props.

Again, be sure to test each circuit with an ohmmeter to be certain the power source you intend to use is adequate. All drop and connecting lines should be wound (shunted) together securely until they are connected. Connecting should be the last step as the user retreats from the blast site. Keep the drop wires shunted and the power source well out of any possible reach until the moment you are ready for the shot.

For God's sake, cease all operations if an electrical storm comes up.

Even miners working a mile underground do something else till an electrical storm has passed over.

One thing to keep in mind is that not all charges go off according to the user's prearranged plan, as evidenced by the following tale.

I was waiting in front of the low, white, wooden, houselike structure that serves as the consulate in Chiang Mai, Thailand. Suddenly a wind-shock thump, strong enough to take out exposed windows, hit me. A long, low rumble followed, echoing up the Ping River, which runs near the consulate. I ran out the gate and onto the street, where I could see to the north a kilometer or two. It was possible to make out a black, swirling cloud of dust over the trees and houses.

The detonation was deep and gutsy enough to get our serious attention but distant enough not to cause real alarm. My first reaction was to look for aircraft.

It took what seemed like an inordinate amount of time before some sirens began to wail in the distance. We jumped into a friend's Land Cruiser and headed out for a look. Obviously, something was going on that we should know about.

A line of police and military vehicles, many with flashing lights, was converging on one of the rather nondescript yet more exclusive neighborhoods of north Chiang Mail

We followed discreetly until we started to get walled in by hundreds of people walking down the street. Without an escort or a flashing light, we could not proceed. I asked a police officer what was going on. He just shrugged. Either he didn't know or he wasn't going to tell a farang (foreign devil).

By now an hour had passed since the blast, but still no one on the street knew what had happened except that there had been an explosion. Just before dark, we finally threaded our way through the little narrow streets to the remains of a palatial home.

Leaves on the palms in the garden hung in tatters, shredded into threads. Several buildings nearby lacked roofs. A school half a block away was windowless on the blast side. A harried police officer told us no children were at the school when the blast hit.

Dozens of uniformed men poked around in the piles of debris. The front of the massive house hung in tatters. One wall of a former garage leaned sloppily amidst the mess. There might have been other damage, but a twelve-foot cement block wall around the property limited our ability to see everything that was in the compound.

"Looks to me like a commercial dynamite blast, " I told the consular official. "The trees and bushes aren't blown away enough for it to have been a faster, much more powerful military-type explosive." No one seemed to know whose house had been hit or if anyone had been injured. Gossip spread through the crowd to the effect that no one had been home at the time of the blast.

After a day or two, some information filtered out about the incident.

The house, we learned, was the secret retreat of General Li, a notorious Kuomintang Chinese drug lord. General Li, who originally came from northern China to Thailand at the time of Mao, was so reclusive that no one was aware he lived ð at least part-time in Chiang Mail

It was not entirely true that nobody was home when the blast occurred. A bathtub salvaged from the carnage became the repository used by the police. It was filled with body pieces they collected. A cook and driver were never seen again, but were never identified among the pieces, either.

The theory on the streets was that some of General Li's drug-dealing enemies had tried to assassinate him, but that their timing was bad. A truck that allegedly had contained the explosives had been vaporized in the blast. The police didn't even try to find a bathtub full of parts from it.

My theory is somewhat different. It seemed obvious that we were dealing with a relatively large quantity of commeroal dynamite rather than military explosives. I knew that people in the Chiang Mai region often illegally traded commercial explosives for raw opium with the jade miners who used the explosives to get rocks out of the ground. I reasoned that perhaps we were dealing with an accidental detonation. Assassins almost certainly would have used military explosives.

The theory is reinforced by the fact that one of General Li's drivers appears to have been wiped out in the incident, that Thais are awfully cavalier about explosives, and that an assassination attempt was not logical. No one in the region had an overt motive for doing the general in. If they had, it seems logical that they would have planned the whole thing a bit better.

My accidental discharge theory apparently has gained some credibility, because many Burmese jade smugglers have come forward in the last year since the incident to complain that their source of explosives has dried up.

More significantly, no one among the drug lords has come forward admitting to perpetrating the incident. If it had been intentional, General Li would have retaliated. Open warfare did not break out among the drug lords.

Knowing the Thais, they probably stored the caps with the powder.

Later, when they snuck off in the truck to have a smoke, disaster struck.

DOING THE WORK

Novices who work with dynamite for the first time are often surprised to discover that commercial explosives are very precise in nature. They expect to encounter an uncontrollable, unpredictable force that promiscuously rends the Earth. Instead, they find they are working with a tool that can be likened to a hugely powerful precision instrument.

One of my earlier jobs as a powder handler involved placing charges for a neighbor who wanted to excavate the ground under his standing home. The guy was determined to have a basement under his houseðdespite the fact that the original builders one hundred years ago had not seen it that way at all! We had a small four-foot by four-foot root cellar to start with. As a plus, the stairs going down were already in place. Lack of moisture for one hundred years, however, had set up the soil under the house like concrete. Digging could not be accomplished via traditional pick and shovel methods because of limited space and the hardness of the earth.

Using mud and wet burlap bags to cap the charges, we shot half sticks of 60-percent dynamite to break up the existing pavement and walls in the root cellar. The cement was not particularly thick but had been placed back when it was de rigueur to do a very good job. The breakup would have been impossible if it weren't for the larger rock they mixed with the concrete in an attempt to save on material costs.

After the concrete was cleared out, I used a 1 1/2-inch hammer driven mason's hand drill to bore a hole back into the century-old hardened clay. The material was so consolidated and brittle that a half stick of 60-percent shattered a cone-shaped hole to dust.

I carefully worked the charges back to the area below the house's rear support beam. We shoveled the now loose material into a conveyor belt that moved it upstairs and deposited it in a dump truck parked at the rear of the house. By nightfall, we had excavated an area large enough to build a frame for a foundation wall.

I let the owners spend the next day completing that work, as well as shoveling out the remaining loose material I had shaken loose.

While the new cement was hardening, I worked back in the other direction with my explosives. By week's end, the back wall was in place as well. Although I fired possibly twenty-five shots, nothing in the house above was damaged. The lady of the house said she was surprised that the blasting produced very lithe dust and no damage. We usually warned her before the shots, but otherwise the work failed to disturb her routine.

Precision blasters have shot holes in solid rock within inches of high-pressure gas lines. They have opened trenches so that telephone lines could be laid right through the heart of large cities and have spectacularly demolished great buildings that stood within inches of other - treat buildings that were not even scratched.

Although it is the wrong end of the spectrum on which a novice should start, propagation sets used to cut ditches illustrate the precise nature of dynamite nicely.

Because a field drainage ditch is seldom if ever blasted through regions where one must be concerned about coming too dose to buildings, gas mains, power lines, or other works of man, blasting one is a good project for someone who wants to test the precision of explosives. The technique is not, however, one the novice should start with if he has any choice in the matter. It is so difficult to master ditching with powder that the neophyte can become discouraged easily.

Ditch building by propagation is done using regular ditching powder. Your local explosives dealer can assist you in choosing the correct explosive material. This will be either a 60- or 80-percent matefial that is more sensitive to shock than regular powder and is of itself powerful enough to throw out a large quantity of material. Other powder may push rather than shock and throw, and will certainly not be sensitive enough to propagate. The concept is to use one cap charge to set off up to hundreds of shock-sensitive cartridges, all placed in a predetermined grid.

Unlike 40-percent dynamite, which is so sleepy it often cannot be detonated even by a direct hit from a high-power rifle, ditching powder is very shock-sensitive.

When I first used it, I carried the cartridges around in a sawdust-filled box. This seemed to be more paranoia than I am accustomed to accommodating, so I decided to experiment.

A half-pound stick thrown as high as possible from the top of a twenty-four-foot barn did not detonate on hitting the frozen clay drive below. Eight additional attempts failed to produce a bang. I therefore concluded that the material was safe enough under normal circumstances.

It does, however, go off rather resolutely when hit with a bullet. Through the years, I have spent a considerable number of pleasurable hours on my range plunking off dynamite. There is never a question as to the placement of the shot. If it is good, everybody in the county will know.

Shooting dynamite is a bit tougher than it first seems. Targets little more than an inch wide are tough to hit, especially if one places them out far enough so that the blast does not constitute a danger to the shooter.

One time when such things were sffll permitted, I bought a 25mm French Peteau cannon home with me. It came right from the World War II Maginot lineðeight hundred pounds, rubber tires, etc. By tinkering with the firing mechanism, I was able to bring the monster back to life. We spent many an enjoyable afternoon firing that cannon. Factory ammo costs about $32 per case of thirty-two rounds!

Eventually the thrill wore off. We went back to using ditching powder for targets, set off by more conventional firearms, but the neighbors never knew the difference. They thought we fired that antitank cannon one hell of a lot.

The best way to proceed with ditching powder is to run a couple of trial sets. In places where the ground is consistently wet, grassy, and marshy, the charges can be placed up to two feet apart. Should one be working with ground that is only very damp and not wet, the spacing may only be four to eight inches. Old logs, rocks, and roots mixed in the material to be ditched may require that one cut the distance between charges down even further.

It is impossible to tell what spacing to use, even by looking, much less make a valid recommendation in a book. The only way to find out what will work is to try an experimental shot.

Only one cap charge is used to set off all the charges. Be careful to note whether the shot detonates all the charges placed in the stfing. Some borderline cartfidges may be thrown out undetonated. No matter how ideal the conditions, the maximum spacing will never be more than two feet. Generally you will end up setting up the shot grid on about one-foot centers unless the ground is virtually saturated with standing water.

Before starting in earnest, run a cord and post line down through the region you want ditched. Unlikely as it seems, running a straight line of cartridges without a physical line staked out is incredibly difficult. A nice, straight ditch that the powder monkey can be proud of will result if such early precautions are taken.

Experimental shots are done not only to determine at what spacing the shot will propagate, but also to determine how much powder is needed to produce a ditch of the necessary depth and width. Obviously the depth at which the charges are placed is extremely critical if proper drainage is to result. As a general rule, a charge set three feet deep will cut down to about four feet if enough powder is placed above to move away the overburden material.

This may require stacking two or even three sffcks in the same hole.

Ditching powder is usually placed using a hollow-core punch bar. The punch bar is made out of common water pipe with an outside diameter of one and a half inches. If the swamp through which one is blasting is so soft that the punch hole caves in immediately, the pipe must be fitted with a removable core. This pointed core can be withdrawn and the dynamite slid into the hollow outer shell and held in place with a wooden tamping stick as the punch is withdrawn.

It is helpful to fit the punch with a handle to facilitate pulling, and it is essential that deep, easily seen notches be ground in the probe's outer shell showing the depth of the tool in dynamite cartridge lengths.

Every cartridge must be idenffcally placed through material that is idenffcal in makeup.

Sandbars or subsurface loglams through which the dynamite will not propagate can be handled by placing the charges in their regular predetermined grid and firing them with primer cord or by electric detonation. Determining exactly how much powder to use in this circumstance is a bitch. Because the ground is not wet and lubricated, it would seem as though it would take less explosives. This, however, is not necessarily true. As no set rule exists that I know of, the best thing to do is to make sure to use plenty of powder. It is always tough to go back and hit the area again.

If there is doubt and experiments are not practical, use at least twice the amount that you originally estimated would do the job when crossing a dry bar or other obstruction.

In all cases, mark out the ditch with posts and a string with a great deal of precision. Use small wire flags to indicate the location of the charges if there is danger of them being lost or misplaced in the marsh as you work around your grid line. The grid of charges must be very accurately placed according to a pretested, predetermined plan.

When a ditch set is detonated, there is a very nice ground-shuddering thump. When enough powder is used and the grid is correct, the work accomplished is very gratifying as well as being most spectacular. The material from the ditch is thrown out and away without forming a costly-to-handle spoil bank. Spoil banks would be there if the ditch were dug mechanically. Often the dirt and water are thrown two hundred feet into the air, negating any need to bring in a dozer with a blade to smooth things over.

Other advantages to cutting ditches with explosives include the fact that men and horses can pack explosives into places otherwise inaccessible to backhoes and power shovels. Much smaller jobs can be undertaken profitably due to economies of scale. Mechanical equipment requires a much larger job to be profitable. Using explosives is also often much faster than hauling in power shovels.

At the time the charges are placed, it may seem as though costs are going through the ceiling. But in most cases, when everything is added in, expenses are far less than when using other means.

Clearing grass and other material out of an existing but silted-in ditch is virtually always faster and easier with explosives. In this case, a single string of cartridges is run down through the existing ditch line. If the cartridges are buried at least three inches beneath the surface, as they should be with any propagation set, clay and plastic field tiles emptying into the ditch will not usually be harmed.

There is no limit to the number of charges that can be fired using one capped charge as the explosive impulse through the moist soil. Using three helpers, I have set almost a ton of dynamite in one day. The only practical limit is the amount of territory available on which to work and the amount of energy and drive one can muster to put out the explosives.

All charges placed in a day should be fired that evening. Ditching powder is not particularly water-sensitive, but many other factors could lead to a potential misfire or an unsafe adventure if the charges are left unfired overnight.

Field conditions, vis-a-vis the season of the year, are important whenever one uses explosives. When blasting ditches, wet ground condition is one of the primary considerations. It may be necessary to either wait for a hot spell to dry up the ground or, conversely, for spring rains to bring enough moisture to allow the system to work. Only shooting a trial charge will provide the necessary information.

Clearing out stumps comprises the other end of the spectrum of work with which a powder handler will probably involve himself. Stump removal is not only common, it is reasonably easy to master. Most blasters will do as I did and learn the ropes of the business in the field actually doing the work.

Stumping is both easy and yet quite a challenge for those given to thinking about such things. Like cutting a diamond, every situation is a liffle different. Some varieties of trees (such as Norway pine, hickory, white oak, elm, and gum) have massive, deep penetrating roots referred to as tap roots. Others (such as white pine, fir, maple, box elder, and cedar) have heavy lateral root structures. There is no tap root in this second case, but rather large branch roots extruding out to the side in all directions. Removing these stumps can be a real problem. If they are not charged correctly, the dirt will be blown away from the base of the stump, leaving a wooden, spider-like critter standing in the field that is very difficult to cut away.

Unless one is a trained forester, it is impossible to tell for sure what kind of a stump one is dealing with a couple of years after the tree has been cut. The most certain plan is to use the dynamite auger to bore a hole under the stump and do a bit of exploring.

If the auger hits a tap root on a 30ø angle down under the stump, it's safe to assume it's the kind with big, vertical roots. Sometimes, however, that pronouncement is premature. Hit it once with a springing charge, which will throw away the dirt and soil around the root. If the stump has a tap root, it will then be obvious.

I do not like to try to bore a shot hole into the tap roots to save powder. What I save in powder breaking the root off underground, I lose in Wheaties trying to force the auger into the punky, tough-as-wang-leather wood.

Instead, clean out a space next to the tap root about the size of a small pumpkin. Pack in eight to tenðor more if the stump is still large and greenð40-percent cartridges against the tap root and let'em rip.

Stumps with massive lateral roots require about the same procedure. Dig the auger in under the main stump mass, fire a single holing charge, and then hit it with the main charge. The essential element is knowing how many cartridges should comprise the main charge. Conditions change from day to day and from soil type to soil type. Try using the following guidelines for starters:

Do not, under any circumstances, allow your mind to go into neutral while stumping with dynamite. The result can be a bunch of thundering roars that throw pieces all around or, even worse, a blast that simply splits the stump while leaving it firmly anchored in bent, broken sections in the ground.

Blasting stumps quickly teaches novice powder monkeys the importance of adequately stemming their charges. Shot holes that are solidly packed with mud or wet soil contain the explosion in a much more satisfactory manner than if this chore is neglected. The difference can add up to a case or more of powder by the end of the day.

Start tamping the charge by dumping some crumbly soil down the shot hole on top of the cartridges after they are in place. Do this with the wooden handle of your tamping stock or shovel. Keep working the hole until it is plugged up with tightly tamped soil. It also helps immeasurably to pile a few shovels of dirt on the hole after it has been filled to ground level.

At times when the ground does not adequately contain the first springing shot charge or when the powder monkey inadvertently overcharges the set, the blaster will find that he must move in quite a bit of material with which to tamp the hole under the stump. Best to fire up the long-handled shovel and move in whatever it takes to do the job properly. Usually, if this happens, the surrounding soil will be loose and easily shoveled as a result of being torn up by the sprung hole charge.

As previously mentioned, some people who work with explosives make a practice of boring a hole into the tap root under large stumps. The procedure saves powder but is such hard work that I never became enamored with the concept. In the case of a very large stump with corresponding tap root, I will either pack the tap root on one side with an unusually heavy charge or split the charge into equal parts and fire the two simultaneously with electric caps or primer cord.

Some stumps with many lateral roots can simply be chopped off at ground level using faster powder. Pick a fold in the stump into which several sffcks can be packed. Cap them over with a heavy layer of mud and fire them off. If done properly, the stump will be rent into little pieces, leaving the bigger subsurface roots at ground level to rot.

The most difficult stump to take out is one that is burnt or has been already shot, with only the heart taken out. The various secffons must either be shot electrically with two or more charges or, in some cases, the shell can be wrapped with a chain and successfully shot out in one piece (see illustration). It sffll may be necessary to use multiple charges but the chain will tend to hold the stump together and pull it all out in one piece. Use plenty of chain along with slower 40-percent powder or less when employing this method.

Removing stumps with explosives works especially well if one can combine the work with the efforts of a bulldozer as mentioned earlier. The dozer can be rigged to punch the charge holes. It can grub out those stumps that are not sufficiently loosened by the dynamite and it can fill in excessive holes made by using too much powder. It's an ideal combination if the novice powder handler can put it together.

Stumping with dynamite was, in the past, the most common nonprofessional use for explosives. Stump removal is no longer a big item with farmers, most of whom are currently working fields that have been cleared for more years than the farmers are old. I don't know which use is currently in second place, but for us it was removing and breaking stones, old foundation footings, and cement pads.

Huge stones, many as large as cars or pickups, can be thrown free of the ground, mudcapped, split, and hauled away using a few sffcks of easily portable powder by one skilled powder monkey.

One monster stone on our farm had maliciously and mercilessly torn shares from our plow for years. It lay about one foot below ground level and was flat as a dining room table and just as big if one added all the extra leaves. One day it ate two of my shares simultaneously. That was absolutely it. I went straight back to the shop for the dynamite. My brothers depreciated my determination.

"That stone is so big and mean", they said,
"you don't have enough powder to get it out."

How words are sometimes so prophetic. It was not immediately obvious what I was working with A five-foot auger did not reach to the bottom side of the rock. One stick fired as a springing charge did very little. I dropped in a bundle of seven and threw out a nice hole that I could get down into with my shovel. Again using the auger, I went down under the monstrous piece of granite. Another charge finally poked an adequate cavern under the rock.

I filled the hole under the rock with approximately thirty sticks of 40-percent powder. Not many rocks require that much powder, but this was not an average rock. By now I was so pissed off, I would have used three hundred if that's what it took. My brothers wanted to split it in place but, in my eyes, that would have been a cop-out.

The thirty sticks thumped about hard enough to be felt in the county seat fifteen miles away. El Rocko pitched out on the ground, leaving a gaping hole that eventually filled with water and mired our tractors every year we worked the field till we sold out. It had to be the biggest rock anyone in the county had ever tried to contend with in one piece. Two of our biggest tractors could barely pull it away.

Even normal, garden-sized rocks are best handled by a variation of the technique we used. Get a springing charge hole under them and throw them clear with lots of 40-percent powder. The technique requires quite a lot of digging and augering, but it's the only way I know of for one man to remove boulders economically.

Rock outcroppings can be removed nicely with dynamite. The technique is similar to breaking up large rocks for transport.

Old, rotten stumps can oflen be blown offar ground level with a mud-cap charge.

Large boulders such as the plow-eating monster are usually mud-capped and split into hundreds of easily handled pieces. It's better to haul them away whole, if you have big enough machinery, rather than pick up all the pieces. But in cases of very large boulders, that is often not possible.

Mud-capping consists of placing a number of sticks of fast 60-or 80-percent powder on top of the victim rock.

Cover the cartridges with four to six inches of very wet mud and touch it off. Apparently, shock waves from the sharp, fast detonation fracture the rock. It is the one case when a powder handler can experience a nice, audible explosion as a result of his labors. The mud vaporizes. There is no throw-rock danger from mud-cap charges.

At times, powder handlers will use a large masonry drill to bore a hole into an offending rock. After filling the hole with powder, they shoot it much the same way a miner would shoot a working face.

Driving a steel drill into a solid rock is a poor substitute for convenffonal, easy-to-set-up, effective mud caps, but it is necessary if one wants to take out a rock ledge or outcrop.

Home builders sometimes find underground ledges through which they must cut for footings or which are otherwise in the way. When the job is too small or too remote to bring in a ripper, there is no alternative to trotting out the rock drill, hammers, and powder. Use fast powder if it is easier to clean up with a scoop shovel and wheelbarrow. Slow powder creates bigger chunks that are best pulled away with a tractor.

Old footings and cement pads can be broken into large chunks by placing fast 60-percent charges a foot or so under the material. The shock will tip up the slab or fooffng as well as breaking it at the point of impact. If the cement contains reinforcing metal, it must be further cut mechanically. Metal is usually too tough and flexible to be cut with explosives except in special military situaffons.

Road building through hilly terrain is nicely done with explosives. Start by bofing down into the ground between the rocks with your auger. Place as much explosive in the hole as possible. This will loosen the rock and soil so that it can be moved. Keep working down in and around whatever obstacles exist until the roadbed is about as wide and deep as needed. Even a farmer with a small tractor can cut a road through a rocky hill using this method along with a relatively small amount of explosives.

Several other chores that are a bit obscure are possible with dynamite.

Springs that are leaking water onto one's property and creating bog holes can sometimes be shut off permanently by shooting a large charge of fast powder deep in the ground above the hill where the water surfaces. Not every attempt is successful but, given the modest cost, it is worth a try

Small potholes are often drained by shooting a charge of fast, shocking-type powder deep in the underlying hardpan that forms a water barrier for the hole. This must be done at a time when the hole is dry and the hardpan barrier becomes brittle.

In both cases, bore down with a post-hole digger and set the charge at the very bottom of the hole. Tamp the set shut nicely. In the case of the pothole, it may be spring before it is obvious whether the shot was successful in breaking the clay barrier.

Other workðsuch as blasting out duck ponds, tunneling through rock, or cutting down a rock hill for a roadðcan be done with a combination of dynamite and ammonium nitrate.

Building a tunnel is not usually work that the casual home and recreational user will do. This generally is left for the miners who do that work. Like stumping, tunneling through rock is best learned by trial and error. The trial involves finding a seam soft enough into which you can sink a hammer-driven star drill. with a bit of practice, it is possible to determine what drill grid will allow the powder to do its best work.

Usually it is advisable to fire the outer charges first, releasing the wall so that the inner charge can dislodge the most rock. Hardened rock drills can be purchased from specialty hardware stores.

Another common category of working uses for dynamite is taking out ice.

The farm on which I grew up was surrounded on three sides by a fairly large river Our most productive riverbottom field was once threatened by a huge ice jam causing floodwater to cut across the field. Our neighbor on the other side of the water watched jubilantly as Mother Nature prepared to~hand him an additional forty acres of prime farm ground. (Land titles at that time specified that ownership ran up to the high water mark of the river, wherever that might be.)

Dad asked me if I could help him do something before the new channel got deep and permanent. I said I could, but that it would cost as much as twenty dollars or more for dynamite. In retrospect, the amount was so trivial it is embarrassing, but at the time, having money for two or three cases~of dynamite seemed horribly extravagant.

Dad immediately took the truck down to the hardware store. He bought two fifty-pound cases of 60-percent, plus a coil of fuze and a half box of caps.

I didn't know how much powder to use or how long to make the fuzes. The rule of thumb when hitting ice is to use three times as much powder as seems necessary. Length of time on the fuze could only be learned by experimenting.

I cut two identical lengths of fuze six feet long, capped them to two different sticks of dynamite, and put them back in the box. We tied the box shut securely with baler twine.

At the river I lit both fuzes at as close to the same time as possible and pushed the case into the freezing, ice-swollen current with a long stick.

A full case of dynamite in water doesn't really sink or float. It kind of bumps along half under the surface. We kept track of its progress by watching for the smoke from the fuze. Unless it is put in the water too quickly or goes too deep, dynamite fuze will burn pretty well under water.

Driven by the current, the case bumped along under the great ice pack. Huge chunks of floating ice, backed up perhaps two hundred yards, soon obscured the progress of the drifting bomb.

After about five minutes, the case went off about one-third of the way down the ice pack. It sent huge chunks flying nicely into the trees standing ankle deep along the swollen river bank. A shock wave rippled downstream, almost taking out the jam, but mostly the log and ice pile-up stood firm.

We rigged the second case. I cut the fuze off at ten minutes (ten feet) and double-capped it again.

This time the charge took so long it was at first monotonous and then scary as we began to think we had a misfire. It finally went with a nice roar, fight at the head of the jam.

After about ten minutes, the river started to move again in its traditional banks. The stream across our river-bottom field diminished in intensity. Thanks to the explosives, our property remained intact.

Dynamite is, of course, useful when one is after large numbers of fish. The fact that fuze will burn up to ten feet under water is very helpful when one is pursuing that activity.

If there is a question, at times I will place the entire cap charge and coiled fuze in a thin plastic bag. Water pressure collapses the bag, protecting the burning fuze and cap charge a bit. I am not absolutely certain that this allows me to go deeper with my charges, but I think it does.

No particular care need be taken with cap charges set for regular propagation sets when ditching with powder. The water is never deep enough to be of concern.

We used dynamite to clean out drainage tiles, blast holes for end posts or fence lines, clear log jams, and knock the limbs from old, dead, "widow maker" trees we were clearing before we cut them with a chain saw.

Using dynamite greatly expands one person's ability to accomplish uncommonly difficult tasks. This list may be a bit archaic, and is certainly not all-inclusive, but it does illustrate to some extent the range of activities that can be undertaken using common explosives.

IMPROVISED DETONATING CAPS

Alfred Nobel's discovery of the principle of initial ignition (blasting caps) in 1863 may be more significant than the work he did pioneering the development of dynamite itself. Without the means of safely detonating one's explosives, the explosives are of little value as I demonstrated in the chapter on ammonium nitrate, it is not particularly difficult to come up with some kind of blasting agent. Making it go boom somewhat on schedule is the real piece of work in this business.

Finding something to use for a cap is a different kettle of fish. Usually under the facade of safety, blasting caps are the first item to be taken off the market by despotic governments.

There are at least two reasonably easy, expedient methods of making blasting caps. The formulas are not terribly dangerous but do require that one exercise a high degree of caution. Caps, after all, are the most sensitive, dangerous part of the blasting process.

Improvised caps have an additional element of risk due to the fact that they are sensitive to relatively small amounts of heat, shock, static electricity, and chemical deterioration. The solution is to think your way carefully through each operation and to make only a few caps at a time. By doing so, you will limit the potential damage to what you hope are acceptable levels.

Fuze and electric-sensitive chemical mixtures are best put in extremely thin-walled .25 ID (inside diameter) aluminum tubing. If the tubing is not readily available, use clean, bright, unsquashed, undamaged .22 magnum rimfire cases. Do not use copper tubing unless the caps will be put in service within forty-eight hours of their manufacture. Copper can combine with either of the primer mixtures described below, creating an even more dangerous compound.

For fuze-type caps, empty .22 mag brass should be filled to within one-quarter inch of the top of the empty case. This unfilled one-quarter inch provides the needed "skirt" used to crimp the fuze to the cap.

Fuze can often be purchased. If not, make it yourself out of straws and sugar chloride powder.

Two mixtures are fairly easy when making the priming compound for blasting caps.

Crush to fine powder two and a half teaspoons of hexamine (military fuel) tablets. Make sure you use hexamine. Sometimes hexamine is confused with trioxcine, a chemical that is used for basically the same purpose.

Often, but not always, hexamine is white, while trioxaine is bluish.

Hexamine is available at many sporting goods stores and virtually all army surplus shops. Many of the survival catalogs also carry it, often in larger quantities at reduced prices. I personally favor ordering my hexamine from survival catalogs to be more certain of what I am geffing.

Many clerks in sporting goods stores seem to have under-tone lobotomies as a qualification for the job. In my experience, they will either try to talk you out of hexamine if they don't have it, or try substituting something else (suppositories, for instance) if they can't determine for sure what it is they have or exactly what you want.

As of this writing, a sufficient amount of hexamine to make two batches of caps costs from $.75 to $1.50.

Place the finely powdered hexamine in a clear glass mixing jar. A pint-sized jar with an old-fashioned glass top is perfect for the job.

Add four and a half tablespoons of citric acid to the two and a half teaspoons of crushed hexamine. Stir with a glass rod until the mixture is a slurry. The citric acid can be the common variety found in the canning department of the grocery store. It is usually used to preserve the color of home-frozen and canned fruit and sells for about $1.59 per bottle.

The final mix involves pouring in a tablespoon of common peroxide. Use the stuff bottle blondes are famous for that is 20- to 30-percent pure by volume, available from drugstores. This material is the cheapest of the ingredients, costing roughly one dollar per bottle.

Shake the mixture vigorously for at least ten minutes, until everything appears to be in solution. Set the mixing jar in a dark, undisturbed spot for at least twelve hours. Be sure this place is somewhat cool as well as dark. Don't put it in the basement on top of a heat duct, for instance.

After a few hours of undisturbed, cool shelf sitting, a white, cloudy precipitate will begin to appear. At the end of twelve hours, there should be enough to load three blasting caps. Making enough chemical for three caps is just right, in my opinion. Anything more in one batch is too risky.

Filter the entire mix through a coffee filter. Run four or five spoons of isopropyl alcohol through the powder to clean it.

Spread the wet, filtered powder on a piece of uncoated, tough paper. Don't use newspaper or magazine covers. Notebook paper or a paper bag is ideal.

Allow the powder to dry in a cool, dark place. The resulting explosive is very powerful. It is also very sensitive, so use caution. In my opinion, the concoction is about three times as powerful as regular caps of the same size.

Using a plastic spoon, fill the presorted and precleaned .22 mag cases with the powder. Pack the powder down into the case with a tight-fitting brass rod. I have never had an incident, but for safety's sake I still use a heavy leather glove and a piece of one-quarter-inch steel clamped in a vise to shield me when I pack in the powder. The end result is a very nice cap, ready to clamp on the fuze in the customary fashion.

If a piece of tubing is used in place of a mag case, securely crimp or solder one end shut. It will not do to have the powder leak out of the cap. Powder contact with the solder should be kept to a minimum. Fingernail polish can be used to seal the lead away from the chemical.

It is possible and perhaps desirable to continue on and turn these caps into electrically fired units, but more about that later. First we'll discuss another good formula that uses equally common materials. This one is a bit better because the mixture involves all liquids, but it is temperature critical and should therefore be approached with special care.

Mix 30 milliliters of acetone purchased from an automotive supply house with 50 milliliters of 20- to 30-percent peroxide purchased from the corner bottle blonde. There are about 28 milliliters per ounce. Adjust your mix on that basis if you have nothing but English measures to work with.

Stir the acetone and peroxide together thoroughly. Prepare a large bowl full of crushed ice. Mix in a quart or so of water and about one-half to two-thirds pound of salt. Place the pint jar with the acetone and peroxide in the salt ice cooling bath.

Measure out 2.5 milliliters of concentrated sulfuric acid. Sulfuric is available from people who sell lead acid batteries. Using an eyedropper, add this to the mixture one drop at a time. Stir continually. If the mixture starts to get hot, stop adding acid and stir as long as it takes for the temperature to start to drop again.

After all the acid has been added, cover the jar and set it in the refrigerator for twelve hours. Try not to disturb or shake the jar by opening the refrigerator needlessly.

Again, a white, cloudy precipitate will form in the bottom of the pint jar. As before, filter through a coffee filter, but wash it with a couple of spoons of distilled water.

Spread on paper and dry. Like the first material, this batch will produce enough powder for about three caps. These are pretty hefty caps, having about three times the power of regular dynamite caps.

They should set off ammonium nitrate, but don't be surprised if they don't. I have never tried it, but making two caps from a batch rather than three might create a cap with enough heft to detonate ammonium nitrate reliably. The problem then is that .22 mag brass does not have enough capacity. You will have to go to a hardware store to find suitable aluminum tubing.

Electrical caps, because of the fact that bridge wires must be included in the package, must be considerably larger than fuze caps.

For making electrical caps, use any fine steel wire that is available. I use nichrome .002 diameter wire purchased from a hardware specialty shop. Hobby shops are also a source of this wire. Copper wire is easiest to obtain but should not be used because of its possible reaction with the blasting material.

I strongly urge that an experimental piece of proposed bridge wire be placed in a circuit with a 12-volt car battery, a wall outlet, or whatever power source will be used. The wire should burn an instantaneous cherry red when the current is applied. If it doesn't, use a smaller diameter wire.

Having located a usable wire, cut the thread-thin material into six-inch pieces. Bend these into a U and place them in the bottom of the tubes. Pack the recently manufactured cap explosive in around the wire. Seal the cap off with silicon caulk. Allow the cap to cure for several days. The last step is to attach the lead wires to the thin bridge wires. The job can be tougher than one would suppose because of the thinness of the bridge wires. Be sure the connection is secure and solid. Use tiny mechanical clamps as necessary and, of course, do not even think about soldering the wires after they are embedded in the primer.

For some unknown reason, some of my mixtures have not detonated well using a heated bridge wire. To get around this, I have occasionally loaded two-thirds of the cap with hexamine or acetate booster and one-third with FFFF6 black powder or sugar chlorate powder, whichever is easier and more available.

The chlorate or black powder ignites much more easily, in turn, taking the more powerful cap mixture with it. Concocting this combination is, of course, dependent on having the necessary materials.

If black or sugar powder is not available, the caps can usually be made to work reliably using only the original cap powder.

Making these caps requires more than the usual amount of care and experimentation. The procedure is workable but dangerous. Blasters who can secure commercial caps are advised to go that route. But if not, these caps are workable and, in total, not all that tough to make.

INTRODUCTION

Survivors generally agree that commercial explosives lend themselves best to commercial applications. Paramilitary survival explosives, as a general rule, need to be more powerful. For instance, store-bought dynamite will not cut steel or shatter concrete (usually).

Many survivors believe that there are times ahead when they will need an explosive equivalent of military C-4, or plastique. However, as with the lottery, fire department, and post office, which are monopolized by various government agencies, the federal government monopolizes C-4, making it next to impossible to purchase. Survivors can't count on buying and caching military explosives against the day of need.

According to standard military charts, straight 60-percent commercial dynamite, the most powerful grade generally available to the public, has a detonation velocity of approximately 19,000 feet per second (fps). Military TNT detonates at about 22,600 fps. TNT is considered to be the minimum grade of explosive required by survivalists and paramilitarists who want to cut steel and shatter concrete.

C-4, the acknowledged big-league explosives benchmark, detonates at a speedy 26,400 fps. C-4 may seem to be ideal for your survival needs, but, as with many somewhat worthy objectives, the game may not be worth the candle. Mixing up a batch of C 4 may not be worth the risk. It is both dangerous and illegal.

Seymour Lecker, in his excellent book, Improvised Explosives, quotes the famous paramilitarist Che Guevara: "Fully half of me people we assigned to explosives-making were eventually killed or maimed." Even the best, simplest formulas are dangerous. The one mat follows is no exception. It is the safest formula that I know of, but even at that, a certain percentage of those who try to make this explosive will end up as casualffes.

Federal laws regulating explosives manufacture are extremely strict. Home manufacturers can receive penalties of up to $10,000 and/or ten years' imprisonment. If personal injury to other parties results from me experiments, fines and jail sentences can be doubled.

Although there are ominous signs on me horizon, the United States does not yet seem to be part of a completely totalitarian society. In that regard, anarchy may be premature. However, this is purely a matter of personal perspective. Times and events can change quickly. Processes that may now appear unduly risky from a chemical, legal, and socopolitical standpoint may soon be entirely acceptable. Each reader should know the risks and then apply his own standards.

If you think that you would like to have C-4 now (or possess the capability of making it at some later date), this book is for you. What follows appears to meet most survivors' specifications for a military-grade explosive. If you follow instructions carefully, the material is relatively safe to manufacture, but, of course, making or having it was illegal at the time this book went to press. To solve this dilemma, you may choose to master the necessary skills and store this knowledge away with the necessary ingredients in case you need them later.

AMMONIUM NITRATE

One may be amazed to find that something as common as agricultural-grade ammonium nitrate (NH4NO3) is the basis for a huge number of explosives Ammonium nitrate is readily available on a year-round basis. Farms of every size regularly use hundreds of tons of this fertilizer.

Ammonium nitrate is often the preferred source of nitrogen for such crops as corn, wheat, beans, and barley. Farmers use it whenever they need a source of relatively stable, long-lasting agricultural nitrogen. This is especially surprising since the concentration of nitrogen per bag is relatively low, making this nitrogen source expensive for many cost-conscious farmers. Ammonium nitrate costs as much as $9 per 80-pound bag in farm supply stores and up to $15 per 60- or 80-pound bag in garden-supply stores where profit margins are steeper.

Ammonium nitrate was first produced in the early 1860s by Swedish chemists. The process they developed is the same one used today by major fertilizer manufacturers. The process entails putting natural gas under great pressure, mixing it with superheated steam, and injecting the mixture into a conversion chamber lined with a platinum catalyst. After the reaction is underway, the generated heat causes the process to be self-sustaining.

Pure liquid ammonia produced by this process is combined with nitric acid, which is also produced by most ammonium-nitrate manufacturers. (Many producers sell nitric acid to other manufacturers for use in their manufacturing operations. Although U.S. production of nitric acid and ammonium nitrate is now virtually absorbed by agribusiness, most of the plants were started with government subsidies as explosives manufacturers.) Combining nitric acid and ammonia produces salts, which after being dried and prilled should be 34 percent nitrogen.

Some fertilizers marked ammonium nitrate may actually be something else. Manufacturers often add a calcium coating to ammonium nitrate because it is deliquescent, which means it pulls moisture out of the air. Uncoated, unprilled ammonium nitrate will quickly harden into a substance resembling green concrete. Anything more than a slight calcium coating, however, will keep the activating liquid (in this case, nitromethane) from soaking into the ammonium nitrate, just as it prevents the absorption of water. If the manufacturer adds more than a minute coating of calcium, he must mark the bag appropriately. Don't use this material.

Although fertilizer-grade ammonium nitrate can usually be purchased from nurseries and garden-supply stores, a better source for explosives manufacture is farm-supply stores. Garden-supply outlets often stock fertilizers that are blends of ammonium nitrate and other fertilizers. Blends are absolutely unacceptable even if they claim to contain a base of ammonium nitrate. Buy only pure ammonium nitrate because any other additives dramatically reduce its explosive effectiveness.

Sales clerks often will try to get you to substitute urea or ammonium sulfate for ammonium nitrate. They point out that the substitute is less expensive, more stable, has just as much nitrogen, and is a prettier color. (I customarily explain that I need pure ammonium nitrate because I intend to blow up the material. This approach works best in rural stores. Urban clerks, used to supplying yuppie rose growers, may look askance at this sort of honesty.)

Would-be home-explosives manufacturers must learn to read fertilizer bags, at least in a superficial sense. The figures listed on the bag refer to the ratio of nitrogen, phosphorous, and potash contained in the product. Ammonium sulfate will be listed as 21-0-0 or something close. Urea, which can contain from 46 to 48 percent nitrogen, would read 46-0-0. Blends such as 21-44-8 contain 21 percent nitrogen, 44 percent phosphate, and 8 percent potash. These and other similar substitutes are worthless for anything other than fertilizing. Only ammonium nitrate contains a ratio of 34-0-0.

On arriving home with the 34-0-0 fertilizer (if you're not planning on using it right away), seal the unopened bag (ammonium nitrate is properly sold in plastic-lined bags, not from bulk bins) in at least two heavy-duty plastic garbage bags. Of course, any partially full bags should also be sealed thoroughly to prevent moisture absorption. Under many circumstances in the United States, it is virtually impossible to store ammonium nitrate for any length of time and still maintain usable ingredients.

Ammonium nitrate has been involved in some spectacular explosions during this century. Well over 3 million pounqs of ammonium nitrate accidentally detonated in the harbor at Texas City, Texas, in 1947. Oppau, Germany, was blasted right off the map in 1921 by a free-roaring ammonium nitrate blast. (For more information about these and other great explosions of history, read Fire, Flash, and Fury by Ragnar Benson, Paladin Press.)

However, in spite of these notable accidents, ammonium nitrate is relatively safe to handle.

Many farmers store it in barns just a few feet from the house. An unlikely combination of heat and contamination by oils or coal dust can cause problems, but as a general rule, I would not be fearful of keeping the material under my bed. It is inert, as road builders, quarry operators, farmers, contractors, and others who use it as an inexpensive blasting agent find out. Ammonium nitrate must be soaked with fuel oil and/or mixed with powdered walnut hulls, coal dust, or another source of carbon to make it active. Even with these combustible additives, I find it terribly difficult to make ammonium nitrate detonate.

Officially, ammonium nitrate is considered only a blasting agent, but it does have some explosive applications.

During World War I, the British, who were low on military explosives, used a million pounds of ammonium nitrate laced with TNT and powdered aluminum to stage a successful sapper attack against the German lines at Messines Ridge in Belgium. Later on, continuing through World War II, the French and Germans both loaded their high-explosive artillery and mortar rounds with ammonium nitrate explosives.

Although many countries around the world now prohibit the sale or possession of ammonium nitrate, it is commonly available in the United States and will probably continue to be for the foreseeable future. At this time, buying an 80-pound bag should be no problem for anyone (even city dwellers) with ten dollars and a means of cartina it off.

NITROMETHANE

Nitromethane is the second of three chemical components needed to put C-4 together in one's home chemistry lab. The material is somewhat obscure, expensive, and at times desperately ffme-consuming to obtain. On the other hand, it is reasonably safe to handle and can be located if one applies oneself to the task.

Nitromethane (CH_3NO_2) is used in many organic chemistry laboratories as a washing solvent and is found in virtually every college chemistry lab. Industrial firms use it to dissolve plastics, clean up waxes and fats, and manufacture numerous chemical-based products.

More commonly, nitromethane is used as a fuel additive. Model-plane enthusiasts mix it with castor oil and alcohol to power their miniature engines. It is also used to fuel small indoor race cars and go-carts. But the largest group of consumers commonly available to survivors is drag racers. It is sot uncommon for quarter-milers to burn gallons of this expensive fuel on every run.

As a result, the best place to look for nitromethane is at drag strips and stock-car races. Often a local petroleum dealer will bring a 55-gallon barrel of the fuel to the track and sell it by the gallon to the drivers and mechanics. As a result, those who can't afford 55 gallons can buy enough to compete that night.

In some larger cities, petroleum dealers handle the fuel on a limited basis. An hour or two on the phone may uncover a dealer who will sell it by the gallon. Most bulk petroleum dealers will special-order a full barrel, but at $1,925 per barrel (based on $35 per gallon), few survivors would be interested.

Another likely place to look for nitromethane is in hobby shops. Most carry premixed model engine fuel, containing up to 40 percent nitromethane. Theoretically, this fuel mixture should acffvate ammonium nitrate, but my experience using it is mixed at best. Perhaps if the fuel is fresh and dry, it might work consistently. Yet, in spite of extensive testing, I have not achieved even a 30-percent success rate using high-concentration model fuel. The problem appears to be the alcohol which, when mixed with the fuel, pulls moisture out of the air even when the bottles are well sealed.

A few well-stocked hobby shops carry six- or eight-ounce bottles of nitromethane. Most will special-order it by the gallon at considerably more than $35 per gallon. Model-plane enthusiasts usually do not use fuel containing more than 15 percent nitromethane because it will burn up their expensive little engines. So survivors probably won't find more than a gallon or two of the high-concentration, 40-percent fuel even in well-stocked hobby shops. If they do find it, it probably will not work consistently.

If all else fails, nitromethane can be ordered at extremely high prices from chemical supply houses. Most will sell it to individuals since nitromethane does have a number of valid "civilian" uses. Check survival magazines for addresses or borrow a Fisher or Sigma catalog from the local high-school chemistry department. It may be possible to locate local industrial or commercial users who are willing to sell a few spare gallons.

Officially, nitromethane is categorized as a Class 3 conflagrant, meaning it reacts to open flame on about the same level as gasoline. It is not highly sensitive to shock. At drag strips, dealers drop barrels of nitromethane off their trucks or roll them around with impunity. They seem little concerned with the consequences of rough handling.

However, nitromethane is moderately toxic if ingested or inhaled. People who have ingested the material may suffer from nausea, vomiting, and/or diarrhea. Heavy or regular ingestion can result in permanent damage to the kidneys. Nitromethane is about as toxic and explosive as leaded gasoline in its original state.

Nitromethane is much less costly today than when it was developed at the turn of this century. Initially, it was made by reacting methyl iodide with silver nitrite. The resulting product was combined through the Kolbe reaction method, using chloracetic acid. At the time, nitromethane explosives were considered effective but far too expensive to merit large-scale production.

Today, nitromethane is manufactured by injecting nitric acid into a high-pressure chamber containing superheated methane gas, a relatively inexpensive process At temperatures of 400øC the reaction becomes selfsustaining. Because its price has decreased so dramatically, nitromethane is encountered more frequently today as a fuel additive and in laboratories.

Pure nitromethane is a thin, syrupy, yellow liquid. It smells a bit sweet, but the odor is subtle enough that it is not readily recognized.

Food coloring can be safely added to camouflage the liquid, if you desire. When lit, nitromethane burns brightly with considerable heat and force until the fuel is consumed. In its pure, unmixed form, it has a shelf life of about four years before moisture destroys it.

As with ammonium nitrate, possession of nitromethane is not controlled except perhaps in isolated local instances. Nitromethane can be stored by survivors for relatively long periods in plastic or steel containers. If one does not spill large amounts of the substance in an unventilated space or suck one's thumb after using it, nitromethane is relatively benign.

The challenge for survivors entails finding a source of affordable nitromethane, which may mean putting a long-term, well-programmed procurement plan into place.

HOME MANUFACTURE OF C-4

Making homemade C-4 requires one more chemical: denatured ethyl alcohol. This ingredient is so common and so safe that no further discussion is requiredðexcept to emphasize the importance of using fresh alcohol, preferably purchased from a paint-supply store.

Having come this far, most readers will agree that we are dealing with some fairly benign chemicals. Now the trick is to combine them in an effective and reasonably safe manner. As with most things in life, there is a downside. The process is not nearly as simple as one would hope, but it is possible, even for chemists with only high school training, to carry it out.

My strong suggestion remains that anyone contemplating home manufacture of C-4 think through both the process and the consequences thoroughly before proceeding. The following procedure yields an extremely powerful explosive. It dwarfs anything available on the commercial market. Even 80-percent Hy-Drive dynamite pales into firecracker class compared to the explosive you may produce.

Those who decide to proceed are also reminded that 1) they are probably violating federal law, and 2) they should already know how to handle conventional commercial explosives competently before attempting this procedure. Experimenters should start with small test batches, remembering that those who fail to use caution, common sense, and care could face disastrous results.

Compared to manufacturing some other explosives, producing this C-4 substitute is not particularly difficult or dangerous. What danger does exist comes when combining the materials, which can be done at the last moment immediately preceding actual use.

Nevertheless, the procedures are exacting. Those who are untrained in chemistry or who are sloppy or careless will not succeed. Now that my warning is complete, let's begin.

The first step is to dry the ammonium nitrate and keep it dry. Where the humidity is high, this is a difficult to virtually impossible task.

Start by taking a one-pound coffee can or its equivalent from a freshly opened bag of ammonium nitrate. The coffee can will hold one-and-one-half to two pounds of prilled ammonium nitrate. A one-pound can provides a greater height relative to diameter, which makes the volume less dense and aids in its drying. Seal the unused bag of ammonium nitrate away in double plastic garbage bags immediately after removing the amount needed.

Place the can in an electric oven set at the lowest possible setting and dry in the oven for a minimum of three hours. Be careful that the temperature never goes above 150ø F. (Doing this properly will require a good-quality, lab-grade, dial-read thermometer available from chemical supply firms or catalogs.)

Ammonium nitrate liquefies at about 170 F and will blow at about 400 F. Before it explodes, it will bubble and smoke, providing adequate warning to remove it from the heat.

On completion of the heating cycle, seal the dried prill in the coffee can and place it in double, sealed plastic bags. At most, this material will last ten to twelve days before absorbing too much moistureðeven though it is triple-sealed. Always make sure the seals are completely zipped and airtight.

Place about 250 milliliters (about 430 grams) of this oven-dried material in an oven-proof glass dish. Cover the prill with the type of denatured ethyl alcohol used to carry moisture out of gas lines (available from paint and automotive supply houses at about seven dollars per gallon).

Stir this mixture around for about three minutes or until the alcohol turns a muddy, cloudy brown. Drain off the alcohol by straining through a seine or screen; Dump the 430-gram sample back into the dish and gently heat over low heat. (I use a stainless-steel wok at the lowest heat setting, but you could also use your stove top or a hot plate.) Use a thermometer to be certain the sample stays below 150øF.

Immediately after the alcohol wash, grind the prill to avoid moisture absorption. Various methods can be used to do this. Some survivors use two flat hardwood boards, a mortar and pestle, or even an electric coffee grinder. By whatever means, reduce the prill to talcum-powder consistency. (If the prill is not ground finely enough, it may be necessary to sieve the powder. It is hoped this step will be unnecessary. Makers will note that the ammonium nitrate begins to cake and lump from moisture when removed from the grinder. Sieving only exacerbates this situation.)

Quickly tamp or pack the powder into a container. This must be done before the ammonium nitrate begins to reattract moisture, so it isn't always possible to do a thorough job. Preventing moisture absorption is your primary concern, so work quickly.

When selecting a container, make certain that it is airtight. Old medicine or spice bottles work nicely. Some commercial makers use custommade, thin-walled aluminum cylinders that look much like containers for high-priced cigars.

Although the finished product is doughlike and can be put in a plastic bag to mold around a girder or squash into a crack, it seems to have considerably more power when packed tightly in a rigid cylinder. I did not have a chronograph or any other means of measuring speed of detonation so it is impossible to make the above claim with certainty. However, the packed material produced larger holes in the ground because it apparently cakes better with the nitromethane when held tightly in a rigid configuration.

Whatever container is used, the maker must know exactly how many grams of ammonium nitrate it will hold. Also, there appears to be a minimum amount of powder that can be detonated. With less than 300 grams (about 10 ounces), it is tough to bury the cap thoroughly and secure a good detonation.

When deciding on container size and the amount of ammonium nitrate to use, remember to leave a small space at the top of the container for the liquid nitromethane. Using the correct amount of nitromethane to sensitize the ammonium nitrate is much more critical than one would first suppose. I avoided the need for scales by using metric measurements wherein weight and volume using specific gravity become identical.

Despite almost driving our family into poverty by my many costly experiments, I still do not feel I have all of the answers pertaining to this process. My experiments indicate that one should use slightly less than one-third nitromethane by volume, but this seems to vary from one gallon of nitromethane to the next and from one bag of ammonium nitrate to the next. Too much nitromethane will kill the mixture, while too little will not sufficiently sensitize the ammonium nitrate.

When dumped on the powdered prill, the proper amount of nitromethane will cause the powder to bubble slightly. It is almost as if there were live clams in the container, blowing in the sand after the surf rolls over them. After about two minutes of soaking, the nitromethane ð if the correct amount is added ð will saturate the powder and turn it into a thick, porridgey mass. Too much nitro will produce a gruel that is too thin to fire.

I used plastic pill bottles that contained about 430 grams (about 11 ounces) of powdered ammonium nitrate, and they produced very powerful blasts. A hit from this much explosive is awesome and probably sufficient to demolish small bridges and trucks, and maybe even to knock tread off a tank. Certainly in groups of two or three fired together, it would do the job.

To this 430-gram container, I added about 75 to 80 milliliters of pure nitromethane. Getting just the right amount will require experimentation. Unfortunately, I know of no formula that states precisely how much nitromethane to use. As a rough starting point, try one part nitromethane to three parts of ammonium nitrate by volume or two parts nitromethane to five parts ammonium nitrate by weight. Theoretically, the material should sensitize in five minutes, but I get better results by waiting twenty minutes.

Once the nitromethane is poured into the ammonium nitrate, there is no need to be overly concerned about moisture getting into the powder. Water would, of course, wash the mash away if it were exposed, but the plastic bottle should solve that problem. This explosive would not be the first choice for those undertaking underwater demolitions work, but it could be used if no other explosive material were available. When mixed, the shelf life seems to be a couple of weeks or more.

At this writing I am not aware of any reason ð other than psychological ð why this material could not be combined and sensitized ahead of time. Storing the mixed explosive does not seem any riskier than storing commercial dynamite. This mixture may deteriorate in time, but my experiments did not indicate this.

Although the combined material seems safe to handle, it is definitely exciting when detonated with a number six or eight cap. Commercial dynamite detonated on bare, hard ground will skin it up a bit. This explosive will dig six- or seven-inch holes without top tamping of any kind.

I estimate the velocity of detonation to be about 21,000 fps or slightly less than TNT, which detonates at about 22,600 fps. C-4, the explosive benchmark, roars out at an incredible 26,600 feet per second. The additional speed between commercial dynamite at 19,000 fps and C-4 is what cuts steel and shatters concrete. One is for homeowners, the other for survivors.

Recounting, to make C-4:

1. Use fresh NH_4NO_3.
2. Dry the NH_4NO_3 in an oven at low heat(less than 150 F) for three hours or more.
3. Wash the NH_4NO_3 in alcohol until the alcohol turns muddy brown.
4. Dump the prill in a metal container and dry them thoroughly over low heat (less than 150 F).
5. Grind the NH_4NO_3 as fine as talcum powder.
6. Pack a premeasured amount in a rigid air-tight container.
7. Pour in one-third nitromethane by volume.
8. Wait twenty minutes.
9. Shoot with a cap similar to dynamite.

It is important that all of the steps be undertaken carefully and methodically, and that one experiments before going out in the field with military objectives in mind.

THE FINISHED PRODUCT

We stood back about 90 yards from the small 11-ounce dab of explosive as the fuze slowly burnt its way down to the cap. In our experience, 90 yards was more than sufficient to protect us from such a small amount of explosive.

My many failed experiments with this material had left me uncertain as to whether we had anything more than another dud. The mountain meadow behind my cabin was strewn with ruptured plastic containers, left by dynamite caps that failed to detonate the explosives.

This time when the detonation hit, it was spectacular. A successful blast at last! The last time I experienced anything similar, I was firing LAW rockets at Fort Benning, Georgia. I vividly remember when the concussion from the three-pound warhead thumped us, even at 200 meters. I also remember a similar reaction while running through the army's live-fire tank-commander school south nf Boise, Idaho.

Although I lacked sophisticated test equipment to measure its impact, the explosion undoubtedly had sufficient brisance to cut steel and shatter reinforced concrete. Several observers with military experience agreed that the homemade C-4 was formidable.

The afterglow from my original success kept me going when my next few attempts turned out to be duds because my ammonium nitrate had become water-soaked. I blew my materials budget, but eventually the results became consistent. The process produces the followinq reaction:

NH4NO3 + CH3NO2 => H2O + CO2 + NO2

As a practical explosive, this material seems ideal. Two shots fired from a high-power rifle do not tell the entire story, but smacking the explosive with my .223 at 45 yards did not produce a detonation. To further test its sensitivity, I set a batch aside for a week. Then I threw it down a rocky ledge and later burned it on a bed of logs without any apparent effect. Even the burning itself was not particularly notable.

This explosive is remarkably similar to genuine C-4ðparticularly in its stabilityðbut it lacks one of C-4's more desirable attributes. The brisance of this improvised C-4 was not as great as that of the genuine article. It wasn't off much, but the last 5,000 fps might mean the difference between a good and an excellent explosive. Boosting this material into the C-4 class became my goal once the secret of consistent manufacture was in hand.

The tip-off to a possible solution came while I was researching World War I's Messines Ridge sapper attack. Messines Ridge was the only actual trench-warfare offensive sapper action during a war that was fought almost entirely as a set-piece contest. After 18 months of preparation, the nine tunnels filled with almost one million pounds of explosives were detonated on June 7, 1917. The resulting blast was heard by British Prime Minister David Lloyd George from his home in London 200 miles away.

Britain's World War I explosives manufacturers added finely ground aluminum powder to this explosive, called ammonal, to boost its brisance. Ammonal was used because two years of protracted warfare had consumed virtually all of Britain's conventional explosives. It was manufactured using 72 percent ammonium nitrate, 12 percent TNT, and 16 percent finely ground aluminum powder.

Having made that discovery, I began to experiment with powdered aluminum. I added it to the ground ammonium nitrate before adding the nitromethane. At a level of about 5 percent (or about 20 grams) mixed thoroughly into 430 grams of NH4NO3, the effect was dramatic. Instead of seven-inch holes in the earth, I was gouging out nine-inch craters with less than three-fourths of a pound of explosive! Fine-ground aluminum powder is available from well-stocked paint stores and chemical supply houses, but the best place to buy it is from an automotive-parts shop. It is used to plug leaky radiators and is sold in 21-gram tubes.

Some aluminum powder is too coarse to enter into the detonation reaction. But most samples are finely ground and, for the price, work quite well (about $13.85 per pound). Purists can obtain very finely ground aluminum flakes from chemical supply houses if use of this relatively expensive (from $30 to $40 per pound) material seems warranted.

Theoretically, it would be advantageous to pack the explosive in small plastic bags that could be molded around a piece of steel or other object that one wished to cut. What scant printed information is available on this explosive suggests that the material should remain undisturbed and unmixed after the addition of the nitromethane.

Without careful, controlled testing, we do not know if the combined materials become dangerously sensitive after mixing So as a precaution, take to the blast site carefully premeasured amounts of aluminum powder in small sealed tubes and similar containers of premeasured nitromethane to pour into the powder Inserting the cap and placing the charne should take about twenty minutes, and the charge should then be ready to do its work. Although this process is not unduly threatening to those who have handled explosives, it is an exacting and mostly untested one. Those who do not carefully follow all instructions should expect dangerous or poor results. Those who proceed with intelligence, caution, and diligence can expect to produce an explosive that will make despots tremble in their boots.

CONCLUSION

Other materials exist that can be combined with ammonium nitrate to produce high-grade explosives. Some quite powerful ones aren't as deliquescent as nitromethane, giving the impression that they might be more desirable than nitromethane. One formula that is currently making the rounds among survivors involves mixing two parts of NH4NO3 with one part hydrazine. The resulting liquids reportedly make up the most powerful chemical explosive known to manshort of an actual atomic reaction.

An almost insurmountable problem with this explosive is the fact that anhydrous hydrazine is extremely corrosive and therefore desperately difficult to handle. It will blister an animal's lungs with just one diluted whiff. Professional industrial chemists use moon suits, respirators, and supplemental air sup- plies and still are very reluctant to do any more than a minimum amount of work with this chemical. Eventually it will eat through virtually anything metallic, making it almost impossible for survivors to store it at home. Unvented hydrazine fumes kill very cruelly in a matter of seconds.

As a result, the material is almost impossible to ship. Most carriers justifiably do not want to handle it, and partly as a result, it is also extremely expensive to purchase. It usually costs about $100 per pound, but that does not include shipping. Furthermore, it cannot be sent by United Parcel Service, Federal Express, or parcel post. So home chemists must drive hundreds of miles to pick it up personally or pay trucking charges of up to $25 or more per shipment.

It is quite possible that three pounds of finished explosive using hydrazine could cost $150 or more. When combined, the resulting liquid is extremely corrosive, toxic, and shock-sensitive. I know of no storage container that would hold the material. It can't be metallic and, if a glass jar ever broke or spilled, cleanup might assume catastrophic proportions.

As a result, it doesn't take a Phi Beta Kappa in chemistry to conclude that the ammonium nitrate/nitromethane mixture is superior for survivors' purposesðdespite a slightly diminished brisance. In addition, hydrazine products require the use of sophisticated laboratory equipment not usually available to survivors. Buying this equipment could make the overall cost of the project prohibitively expensive for most budgets.

For the process recommended in these pages, one needs only common household items: a set of ovenproof glass dishes; a standard measuring cup; a standard probe thermometer; a coffee grinder; an electric wok; and a tea sieve. There is no need for extra-large glass beakers to handle the reacting chemicals, lab-accurate stainless thermometers, ice baths, air-evacuation equipment, or moon suits and respirators.

After nitromethane and ammonium nitrate are combined, the mixture is reasonably safe and can be handled by most people, whereas hydrazine is too unstable to carry around or combine at the job site. Fumes from the reaction could poison everything downwind for several hundred meters. It also might arouse people's suspicions to see survivors running around in moon suits and respirators.

Other formulas for making C-4 substitutes abound, such as mixing pure nitric acid with glycerin to yield nitroglycerine. Nitric acid is obtainable and can be handled by amateur chemists, but it is somewhat risky.

Homemade nitroglycerine must be washed and purified to an extent that taxes the skills of sometimes chemists. Impure nitroglycerine grows increasingly sensitive on the shelf until simply moving the container could cause premature detonation. After my reading through detailed manufacturing instructions, it was easy to conclude that this process is unnecessarily difficult and dangerous.

In summary, the explosive made by mixing ammonium nitrate with nitromethane seems to possess all of the desirable characteristics of highgrade military explosives that are otherwise unavailable to survivors. The process has few disadvantages that I have been able to identify.

Note: Readers will note that throughout this discussion I have assumed the use of commercial safety fuze and caps or standard electrically fired dynamite caps. This book assumes that makers already know enough about explosives to know where to purchase the necessary caps and fuze.

This text is a chapter in the book "Ragnar's Big Book of Homemade Weapons"
and the ISBN # is 0-87364-660-6 if you would want to order it.
