MILITARY DEMOLITIONS

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PREFACE

This paper is intended to deal with the subject of military demolitions only in its relation to the work of tactical troops, mainly the infantry and cavalry, and omits all treatment of more systematic and extensive operations of technical troops along the same lines.

As an accessory of active operations, the value of demolitions cannot be overrated. In the Civil War such efforts were extensively employed on both sides to frustrate military movements. The most notable examples were the destruction of the Louisville & Nashville and Nashville & Chattanooga Railroads, in rear of the Army of the Cumberland, by the Confederate cavalry commanders Forrest and Morgan in 1.862-63, thus interfering with the supply of the Union Army, and preventing any forward movement; the destruction of the resources of the Shenandoah Valley, Virginia, by General Sheridan in 1864, to prevent its future use as a line of operation by which the Confederate Army might invade the Northern States; "the destruction of the railways in his rear by General Sherman in his "March to the Sea'', thus. preventing pursuit, and also cutting the connection between the Seaboard and the Gulf States; and the complete destruction of the resources of that portion of the Confederate base of operations formed by the Gulf States east of the Mississippi, by General James H. Wilson in'l865.

And it is certain that in future wars, even more than in the past, endeavors will be -made by every possible means to prevent or delay the march of the enemy's troops by throwing obstacles in the way and by cutting such lines of communication as they might use.

Conversely, in order to reach an objective, it will be necessary to overcome or destroy obstructions to the movements of troops and to re-establish the continuity of highways and railroads in the most rapid and practical manner.

Troops of all arms will be actually employed in demolition during a campaign, and it is therefore desirable that every officer who may have command of a detachment should be thoroughly acquainted with the means for destroying obstacles as well as methods of using them, particularly as time is short under such circumstances and action must be quick and intelligent. In other words, all detachment commanders should be in a position to solve a problem such as the following: Given certain tools, explosives, and men, and a certain amount of tirne for the destruction of an obstacle, what should be done to obtain the best results?

The great advances in recent years in the sphere of high explosives have rendered more easy the execution of demolitions on a very large scale. But as yet. unfortunately, the necessary steps have not been taken for the proper dissemination throughout the service of a working knowledge of this important branch of military art.

It is essential that all officers should be theoretically as fully informed as possible upon the effects of explosives, and the methods of executing demolitions, but it is still more important that they should have such practical experience in this work as will create a personnel thoroughly trained in its execution as well as in its supervision. Operations of this character should. be as familiar as any other drill.. They will occur almost every day during a campaign and it is necessary that they should be executed readily, and with the widest possible previous study of all of such circumstances as are apt to be found in actual service.

In time of war it is hardly possible to limit the rights of the victor or to discuss the legitimacy of the measures taken by the vanquished for the defense of the country. It is generally admitted, however, that the only permissable demolitions are those required by military necessities.

It is difficult to define' accurately the scope of this phrase, of which the interested parties are them: selves the sole judges. It may be laid down as a general principle, however, that all measures should be excluded that have for their object only the spreading of terror among the people or making reprisals for defeats or checks that have been suffered. As the extensive destruction of lines of communication has a considerable influence on the operations of armies from both the strategic and the tactical point of view, the only judge of the nature and the extent of such demolitions, must be the military commander who alone can be held accountable for the -resulting consequences. So far as concerns railroads, the rule is absolute that bridges, viaducts, tunnels and culverts are not to be destroyed or rendered unserviceable without the formal written order of the Commander-in-Chief of the army or of the generals or other officers to whom he has specifically delegated such authority.

The decision of the Commander-in-Chief depends much on circumstances and prospective movements. Above all it is necessary to consider the extent and importance of demolitions both as to their immediate results and as to their possible future effects upon the army causing them.

The ill-timed or premature destruction of a highway, railroad, or especially of a bridge may deprive an army of a valuable means of passage and have extremely serious consequences, resulting under certain conditions, in cutting off the retreat of many troops, as in the case of the destruction of the bridge of Lindenau, over the Elster, at the battle of Leipzig,

On the other hand, the Commander-in-Chief who fails to have made in time such demolitions as are necessary, furnishes the enemy with an easier. way of reaching him and thus deprives himself of a chance for success; as for example, the failure to destroy the bridges over the Mozell above Metz, the bridge of Donchery over the Meuse, or the Saverne tunnel, in the France-German War.

Demolitions may have to be carried on in the presence and under the fire of the enemy or at a distance from him, depending upon circumstances.

In the latter ease, the cavalry may be charged with the most urgent work of this character, particularly during the period of mobilization, and upon lines useful to the enemy for concentrating his troops. This may also be the case in the attack of a fortified place in order to cut its lines of communication preliminary to its investment.

Infantry will, in general, be required to carry out only such hasty demolitions as the opening of breaches, the removal of obstacles, the disabling of war material, artillery and railroads and the destruction of telegraph lines and bridges of minor importance.

Whenever necessary and possible, the actual operation of destruction should be preceded by a reconnaissance made as carefully as circumstances will permit for the purpose of ascertaing exactly what provision, both of men and material, will. be required.

Demolitions may be made by mechanical means, using ordinary trenching or working tools, but such work requires considerable time for accomplishing any serious damage, and cannot be done in the presence of the enemy. Under such conditions and for rapid progress, resort must be had to explosives.

Artillery may be used to demolate, but it is a well established fact that much time and an excessive expenditure of ammunition are necessary to so reduce the accessory works and other objects of the defense as to render them incapable of resisting an assault. Moreover, artillery has no appreciable effect upon many structures, such as heavy masonry bridges.

Fire. may be used to destroy harvests, houses and wooden bridges, but it should be resorted to only in special cases and under particular conditions.

Demolitions Without Explosives

When explosives are not available the following methods of demolition will be found most advantageous.

Timber bridges should be burned as being usually the quickest method of destruction. For this purpose petroleum or tar should be sprinkled on the principal truss members.

Ponton bridges may either be burned by placing inflammable material in the boats, or sunk by loading them with stone after making holes in their bottoms, breaking the roadway and cutting anchor. cables as the bridge sinks.

The cables of suspension bridges may be cut with an ax or cold chisel. Masonry and iron bridges can be quickly destroyed only by explosives.

Highways and roads may be blocked with trenches. These should be distributed from point to point along the road and should be not less than 30' feet in width and from 6 to 10 feet in depth. Much time and work are- necessary to accomplish serious damage in this manner, and if possible resort should be had to a mine.

Damage to railroads may be Cone either to the track, stations or rolling stock. According as more or less time and means are available, the work becomes either' a methodical demolition or is confined merely to hastily cutting the line and interrupting traffic.

In all cases, in addition to the picks and shovels necessary for uncovering the ties, the men should be provided with special, tools that may be obtained from the stations or requisitioned from the inhabitants. The most necessary instruments for such work are common or monkey wrenches for removing fish-plate bolts, spike mauls, claw bars, hammers and' sledges, cold chisels and axes.

Methodical demolitions should be extended over a considerable length and include both lines of a double track road. It is generally better to cut at several points than concentrate all the work at one place. Curves, high embankments, viaducts, tunnels and deep cuts should be selected as the points fordestroying the track

Rails may be torn up in two ways, depending on the system followed in buildingthe road. When they are double-headed, as on'most continental roads, the wedgesare driven out with a hammer and the rail may be forced from the chair by using the claw-bar as a lever. Or preferably the external jaw of the chair may be broken by striking it with a sledge perpendicular to the rail, which can then easily be withdrawn. (Fig. 1.)

If the rails are tee-headed which is ordinarily the case in this country, the fish-plate bolts are removed with a wrench or broken with a hammer. (Fig. 2.) The rail bolts are then drawn out with the claw-bar or broken off, and the rails lifted out, using a man per linear yard. One hundred and fifty men and a train of twenty five ears are required for tearing up and loading a thousand yards of track per hour. The ties are loosened, placed in a pile and burned after the rails have been removed. The rails themselves are rendered useless by heating them over a fire. They will then bend of their own weight.

To make a quick cut in a line, a rail is removed from each end of the section to be destroyed and the ballast taken out from the ties. A number of men, placed all on one side of the track, then lay hold of the rail and the ends of the ties and turn the section upside down. An embankment should be selected for this work and the track thrown down the slope.

A hasty obstruction may be made by removing the fish-plates from two joints opposite each other and then shifting the two ends of the track laterally in opposite directions.

Switches are destroyed by breaking the lighter parts and especially the operating levers and stands.

For the derailment of a train, a point should be selected in a deep cut at a distance from a station. Derailments may be accomplished in 'various ways.

1. If pressed for time, it will be sufficient to remove the chair wedges or the outside bolts of "T" rails for a distance of about fifty yards.

2. The track may be obstructed on a curve, at night, by heaping up fallen trees, timbers or stones so as to cover a space of at least ten feet to a depth of three feet.

3. .The surest way is to make a false switch on the main line. To do this the upper layer of ballast is removed from the track for a rail's length and two opposite joints are disconnected. The disconnected lengths are then swung out of line laterally about a foot, pivoting upon the two adjacent joints,. and the

ballast is replaced in order to leave as little trace as possible of the work.

4. The removal of a rail may be sufficient and is quick and easy of execution, but is not certain in results on account of the visibility of the break.

5. An Italian inventor, Pascoli, has devised an appliance that is designed to interrupt traffic on a railroad without destroying the track. This is simply a derailer, which, when placed astride upon the head of the rail, furnishes the thread of the wheel an inclined path and the flange of the wheel a groove that carries it to the outside of the track; that is, in the direction that will not be resisted by the flange of the other wheel on the same axle. (Fig. 3)

The derailer is of steel, has a height above the rail of four inches, and weighs 26.5 pounds. The setting can be done so quickly that a man can put it in place immediately before the arrival of a train and thus avoid detection by the track inspector. Moreover, with the ordinary locomotive headlight, the engineer cannot detect it at a distance of more than forty yards, which is insufficient for stopping a train having a speed of even fifteen miles an hour.

At stations the switches are broken, the mechanism of signal towers destroyed, the gearing of turntables smashed and the essential parts of the water supply removed.

A locomotive may be disabled by breaking or dismantling the feed-water connections and injectors and by destroying the connecting rods and cylinders. To do more serious damage, the fire-box is burned by forcing the fire with no water in the boiler, or a shot may be fired through it from an artillery piece.

To render a tender unserviceable, the stem of the feed-water valve is removed or broken. It should not be forgotten that each tender is supplied with a set of tools including jack-screws, monkey wrenches, and miscellaneous wrenches for the nuts on connecting rods, cylinders, etc., and that these can be used advantageously for demolition.

Water tanks and all the appliances used for supplying water to engines are destroyed as completely as possible, since a railroad is rendered useless when locomotives cannot get water.

The destruction in railroad yards may be completed by burning such rolling stock as cannot be removed, together with all stores of coal, grease, oil, etc. The burning of stations themselves should not, however, be permitted, since no military advantage is gained thereby.

For the destruction of telegraph lines, the only tools necessary are iron nippers, cutting pliers, picks and shovels. At stations the instruments are removed or demolished, the batteries broken, and the records, including copies of messages, seized. Along the line, the poles (preferably around curves) are thrown down. The wire is cut with axes or pliers and removed as far as possible and insulators broken., To produce a temporary interruption all the wires may be connected together by another. that is grounded in the earth. This may be quickly done, but it permits of the easy re-establishment of communication.

It is sometimes more advantageous to nullify than to destroy certain obstacles, especially those that form accessory defences such as abatis, sharpened stakes, harrows, etc. The work necessary for their destruction, while very simple, would require considerable time and be very deadly, as it would be executed' under the rapid and effective fire of the defense. It will therefore often be better to overcome such obstacles by covering them with boards, hurdles, fascines and bundles of straw or grass. It is true. that -a large quantity of these materials would be required to render passable a zone of such obstacles of any considerable width and length, but troops should be trained to use this expeditious method if sufficient means are available.

With palisades and various stockades too much time would generally be required to uproot the posts, but breaches may be made by breaking down with axes and picks the planking and cross pieces that support it. It is better however to use explosives.

In abatis, the stakes that fasten it together and to the ground should be withdrawn after which tree trunks may be removed either by hand or with the aid of ropes. A passage may also be made by cutting out the most troublesome branches with axes. Fire may be resorted to under some circumstances.

With wire entanglements the simplest method is to cut the wires with nippers or pliers. This may also be done with axes and bill-hooks but the wire in this case must be supported on a block of hard wood. If wires are tightly stretched they may be cut next to the post with a single stroke of a machete. This method is the quickest but requires skill and practice. Good results cannot be had by merely uprooting the posts. Explosives cannot be used to advantage (Plate 1).

Chevaux de frise may simply be disconnected and removed or the pikes may be cut with an axe. Crowsfeet may be gathered up.

Ordinary harrows, planks armed with nails and other obstacles of this character are removed after breaking their fastenings with axes or bars.

Military pits are made passable by covering them with hurdles, planks or gates. It is moreover, easy to cross them without any preparation if the artillery has even slightly disturbed the ground where they have been placed.

To disable cannon the breech blocks or their most important parts should be carried off or destroyed.

The sights, both on the gun and its carriage, are also demolished.

Walls may be leveled with the ordinary tools, or when such are not available, may be overthrown by using a heavy beam suspended horizontally above the ground from an extemporized gin or tripod as a kind of battering ram. Isolated houses or groups of houses may be fired.

Explosives

Explosive substances may be defined as those which have the property of decomposing suddenly from shock or from their reaction upon each other, liberating enormous quantities of gases at a high temperature.

This phenomenon which is called explosion results in giving to the gases, if confined, very high pressures, productive of violent mechanical effects. Such agents have the advantage of developing great power with a minimum of weight and volume.

Explosives may be classed into:

1. Explosive mixtures.
2. Explosive compounds.

Explosive mixtures are intimate mixtures of certain substances which are in themselves inexplosive, and which undergo no chemical change till the moment of explosion. They consist generally of a combustible body, such as carbon, and an oxidizing agent such as potassium nitrate. The best example is gun powder.

Explosive compounds are chemical compounds the molecules of which are explosive in themselves, They contain one or more combustible elements, such as carbon and hydrogen, together with the oxygen necessary to oxydize these elements.

Explosive compounds are usually of organic derivation and like the substances composing them, are grouped into series, the fatty and the aromatic.

The fatty series includes the hydro-carbons, sat-' urated or not, that produce the following explosives, viz:-fulminates, gun cotton, nitro-glycerine, dynamite, etc.

The aromatic series, of which the hydro-carbon, benzene, is the 'base, furnishes the explosives, picric acid and the picrates (melinite, cresylite, etc.,) and the panclastites.

In general, the explosives of the fatty series contain more oxygen than is necessary for the oxidation of their combustible elements while the hydro-carbons of the aromatic series are not saturated, and have always an excess of carbon, making it difficult to be certain of the manner of their decomposition.

As a matter of practical interest explosives may be divided into three classes, namely:

1. Progressive or propelling explosives. (Low explosives'.)

2. Detonating or disruptive explosives. (High explosives.)

3. Detonators or exploders. (High explosives; fulminates.)

The first class includes all those explosives used as propelling agents in guns; the second, those used in shell, torpedoes, mines and for demolitions of all kinds; the third, those used to originate explosive reactions in the first two classes.

Each of these classes is distinguished by the character of the explosive phenomenon it produces; and' it may be said 'that corresponding to these characteristic phenomena explosions may be divided into three classes, namely:

1. Explosion 'proper; explosion of low 'order; progressive explosion; combustion.

2. Detonation; explosion of high order.

3. Fulmination; the characteristic type of explosion produced by the fulminates.

Explosion proper is marked by more or less progression. The time element is involved as a controlling factor, the time required to complete the explosive reaction being large compared with that in the other forms of explosion. In this class the time may to some extent be controlled by varying the physical characteristics of the explosive, the explosion being of the nature of an ordinary combustion. The mass is ignited at one point and the reaction proceeds progressively over the exterior exposed surfaces and then at right angles to these surfaces until the entire substance is consumed. The explosion of a charge of black, brown or smokeless powder, is the same in principle as the ordinary combustion of coal or wood.

An explosion of the second class is of a totally different character. In this case the chemical reactions are not confined to the surfaces of the substances exploded but appear to progress in all directions radially throughout the mass from the initial point. The time is very short. The breaking up of the first molecule and the ones adjacent to it gives rise to a wave-like action which is transmitted throughout the body from molecule to molecule, and these, in succession, giving way, their atoms combine according to the newly existing affinities. This phenomenon is known as the explosive wave.

The effect. is to transfer the explosive in an almost inappreciably brief time from the solid or liquid to the gaseous state, the gases being greatly increased in volume and pressure by the heat of combination attending the reaction.

Experiment has shown that the velocity of propagation’ of the explosive wave throughout a mass of gun cotton is from 17,000 to 21,000 feet per second.

Fulmination is still more brusque than detonation, As in the last ease the initial molecule is broken up by heat or shock and the molecular energy thus applied is transmitted by the disruption of the first molecules to those adjacent and so on throughout the mass.

A satisfactory explosive for the purpose of military engineering must be:—

1. Stable as to its constitution and characteristics for a long period.

2. Unaffected by ordinary variations of temperature and moisture.

3. Insensitive to shocks of handling, transportation and neighboring explosions.

4. Not difficult of detonation,

5. Quick enough to give good results when confined.

6. Convenient in form and consistency for packing and loading and for making up into charges of different weights.

These conditions point to a high explosive of medium strength, of granular or plastic consistency, put up in water proof cylindrical cartridges of standard size and length. A number of explosives meeting these requirements fairly well are on the market. No one of them is so distinctly superior as to warrant its adoption to the exclusion of the rest, and the most easily procured at the time and place of need will probably be used.

The principal explosives in use for military purposes are : —

1. Gun cotton.
2. Nitro-glycerine.
3. Dynamite.
4. Picric acid and picrates.
5. Fulminates.
6. Sprengel safety mixtures.
7. Gun powder and smokeless powders.

Dynamite is the most common of these for commercial use, and supplies of it will usually be found in all settled or mining communities.

Gun cotton is formed from cotton wool by the action of strong nitric acid. It has been extensively employed in military operations in the past and has some advantages. It is dangerous, however, except when kept wet on account of its liability to spontaneous decomposition. Its use is not specially recommended. If the cotton is dry and unconfined, the application of flame will cause it to burn quickly. If the mass is large an explosion may occur. When wet, it is perfectly safe, but can be fired only by a primer of dry gun cotton or other high explosive. Dry gun cotton is detonated by a fulminate fuse.

Nitro-glycerine is formed by the action of concentrated nitric acid upon glycerine. If unconfined and subjected to a blow, the particle struck will explode and scatter the remainder. If confined and struck, it will detonate: when unconfined in small masses the application of flame causes it to burn rapidly without explosion. It is detonated by mercurie fulminate, and the detonator should be placed in the liquid. If frozen, it may also be detonated, but the action is generally less violent.

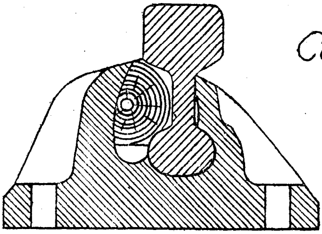
Nitro-glycerine is one of the strongest of the high explosives, possessing great force, potential and rapidity of reaction. Owing to its liquid form it can be poured into holes of any shape, provided they do not communicate with fissures, and from its great rapidity of reaction the depth of the hole may be decreased. No tamping except water is necessary. Owing to its liquid form, however, it is unsafe in handling as it is liable to leak and thin films of it may be easily exploded.

On account of the dangers involved in its transportation, handling and storage, efforts were made to find an absorbent for it, so that it could be given solid form. The addition of these absorbants has produced dynamite and its derivatives. This absorbent or base is usually called "dope" in the trade.

Dynamites are classed according to the percentage by weight of the nitro-glycerine contained, as 75 per cent dynamite, 60 per cent dynamite and so on. The grades No. 1, No. 2 and No. 3, often used, refer to 75, 50 and 25 per cent dynamite, respectively.

The dope may be an inert substance having no function except as a vehicle for the glycerine, or it may be and usually is, a combustible contributing to the chemical reaction and improving the strength and character of the explosion. Dopes öf this kind are usually nitrates of sodium or potassium. All American dynamites are of this class.

At extremes of temperature high or low, an exudation of free nitro-glyeerine is likely to occur, making the dynamite' extremely sensative and dangerous. This danger increases with the degree of saturation. Dynamites higher than 60 per cent are not suitable for military purposes for that reason. This tendency to leakage is greater when cartridges stand on end. and care should be taken to keep them on the side in storage and transportation. Dynamite freezes at 40° F. and if no exudation has taken place becomes comparatively free from danger of explosion by concussion and is considered perfectly safe to handle. It is very difficult to explode when frozen, has less strength, and is not considered fit to use in that condition. In the frozen state it is easily exploded by heat and the operation of thawing, if carelessly conducted, is one of great danger, a large majority of accidents with dynamite occuring from this cause. It should never be taken near a fire or very hot metal, but should be thawed in a mild, diffused heat, acting for a considerable time. The cartridges should never be placed on end during this operation. Packing in fresh manure or inclosing in a chamber with cans of hot water are the safest methods.



Continental System.
Rail and Chair.

Fig. 1.

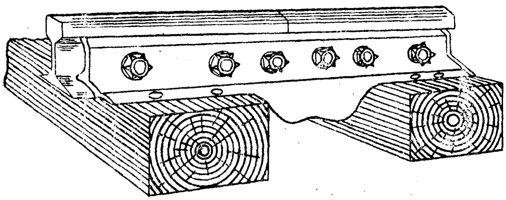
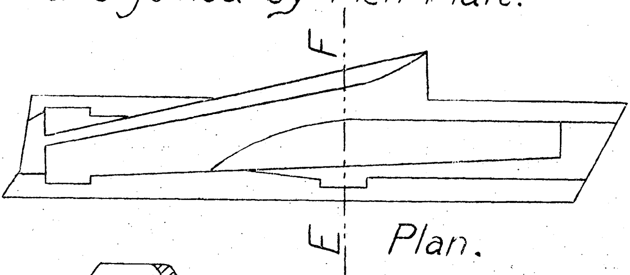


Fig. 2.

American System.
Rails joined by Fish Plate.



Plan.

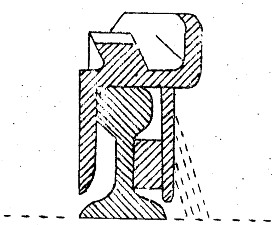


Fig. 3.

Pascoli Derailer.

Section E-F

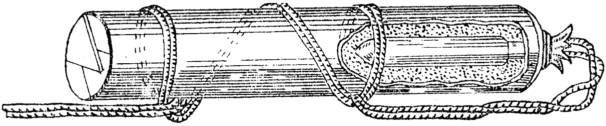


Fig. 4

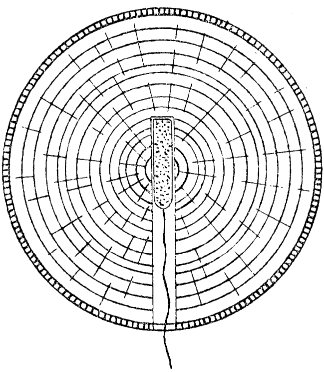


Fig. 5.

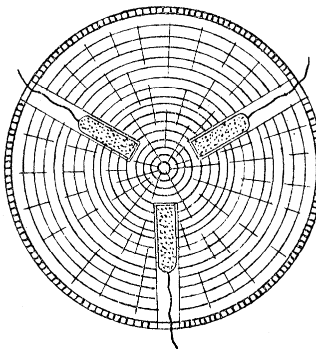


Fig. 6.

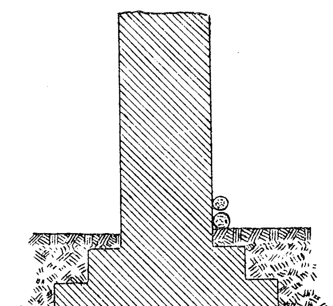


Fig. 7.

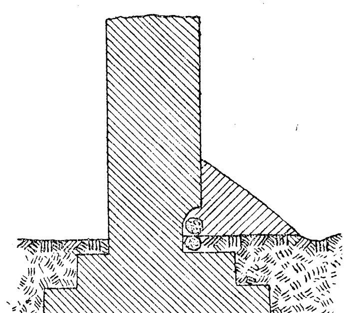


Fig. 8.

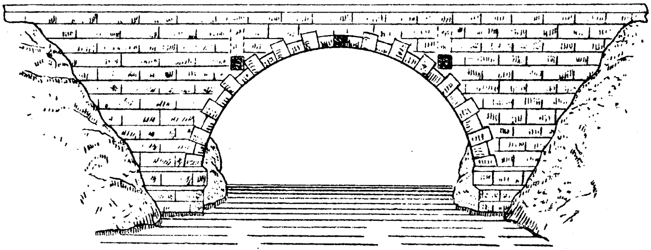


Fig. 9.

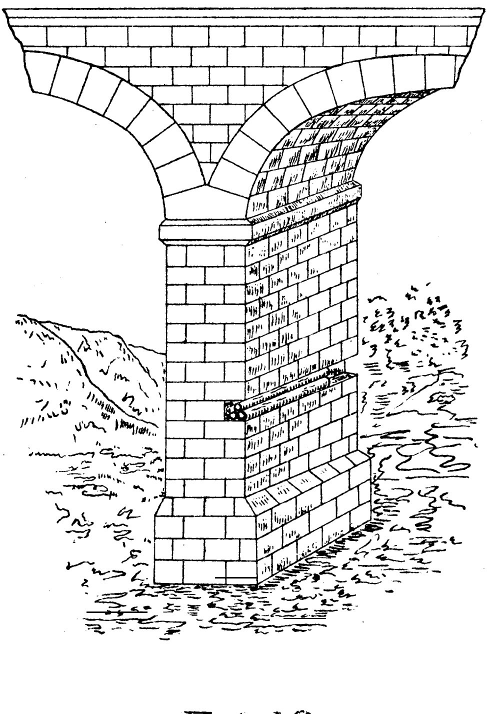


Fig. 10.

Plenty of time must be given. A cartridge soft on the outside may be frozen in the middle. None of the dynamites is fit for use as a military explosive in a cold climate.

Dynamite is a substance of the consistency of brown sugar, should not be greasy, nor should there be any oily appearance of the packages. It is apt to cause a severe headache when touched with the hands. It is usually packed in paraffined paper cartridges, an inch or more in diameter and of varying lengths. A very common size is one and one-fourth inches by eight inches containing about six-tenths of a pound.

Picric powders consist of pure picric acid, or that acid combined with a non-metallic base. They are non-sensitive to shock, unaffected by heat or cold, and can be produced in a granular form or fused into solid shapes. Their characteristic color is a yellowish sulphur tinge, and if pulverized they have a strong tendency to eseape from their packages and discolor everything around them, men included.

Nevertheless, the most successful military explosives thus far introduced being to this class; for example, the French melinite, the English lyddite, the Austrian ecrasite, the Japanese shimose, and others.

Combinations of picric acid with metal bases, especially lead, iron, and potassium, or with oxides or nitrates of these metals, are dangerously sensitive. Premature explosions have resulted from handling iron shells loaded with picric acid. A special neutral coating is now used to prevent contact of the acid and the metal.

Jovite, an American powder of this class,, seems to come as near meeting all military requirements as any explosive now known. It is unaffected by heat, cold, concussion or water. The gases of explosion are less deleterious than those of dynamite and produce no headaches. A recent authority on explosives says:

"Jovite has been tested by the ablest explosive experts and has never proved unsafe or unreliable. It would seem to fulfill all the requirements of an ideal explosive:" It may be had of strength equal to 20, 40 and 60% dynamite.

Fulminates have the property of initiating detonation in the other explosives and for this purpose are used in caps and primers of all kinds. The abruptness of their discharge and the consequent sharpness of the blow, combined with the concentration of exceptionally great heat at the point of ignition, cause their efficiency as originators of explosions.

The most important is mercury fulminate which is formed by the action of alcohol upon mercury nitrate. When dry it is very sensitive to a blow and detonates with violence, and also when heated to 182° C, or when subjected to friction, to any ignited body, or to the action of an electric spark. It should be kept under water for safety, and must not be allowed to come in contact with a metallic surface as it then tends to decompose. For this reason percussion caps are varnished before it is placed in them. It must never be stored with high explosives.

The class known as Sprengle explosives consists of separate constituents, each non-explosive, which are combined at the moment of use. The most common is rack-a-rock, which is composed of potash, a dry crystalline substance, and nitro-benzol, a liquid. The chlorate is in linen tubes which are dipped into the liquid when ready to be loaded. This explosive has been extensively used for military purposes in the Philippines and has given good satisfaction. The dipping requires but a few seconds, after which the excess liquid is allowed to drain back into the containing vessel, about 15 minutes being required for this part of the operation. The cartridges may be had of any length and diameter desired. This explosive was used at Hell Gate in 1885, 240,000 Ibs. of it being exploded together with 42,000 lbs. of . dynamite.

In using detonating caps with Sprengel Mixtures in which nitric acid enters as a principal ingredient, it is absolutely necessary to prevent the copper case of the cap from coming in contact with the acid; otherwise, a premature explosion is almost sure to occur. To effect this the cap should be dipped in melted paraffin before use, and carefully examined to see that an unbroken coating is secured.

Gunpowder is composed of saltpeter about 75 parts, sulphur about 12.5 parts and charcoal about 12.5 parts. Its combustion produces a large quantity of gas whose expansion results in combined efforts of projection and demolition. This action is progressive and requires an appreciable time for completeness. In order to obtain its maximum effects, a charge must therefore be tamped, that is, it must be enclosed by a resisting mass that will permit of the gradual production of the gas in an enclosed space until its full expansive effect is generated.

The damage by gun powder is small compared to that by high explosives, particularly if it is not well tamped. Untamped powder charges have practically no effect on iron and steel. Great care is necessary in its handling in order to avoid accidental explosions, Al1 the hammers, funnels and other tools used must be of copper or bronze to avoid sparks. It must be protected from-all moisture, the least amount of which will cause great deterioration. Its application is in mine chambers,. closed by tamping.

All of the powders described are of the class which can be fired by detonation only. And all the methods of firing involve the explosion of a small quantity of fulminate inclosed in a cap or fuse and placed in the charge. These caps or detonators are of two forms adapted for firing by powder fuse, or by electricity.

When a powder fuse is used it is cut off square, care being taken that the powder at the end does not sift out, and the cut. end is inserted into the cap and pressed down snugly on the fulminate. If a twisting motion is necessary to insert the fuse into the cap, it must cease immediately when entrance is secured, as danger results from any friction on the coating of the fulminate. The case is then crimped around the fuse and the cap is ready for use. The other end of the fuse, to secure ease in lighting, is usually cut on a long bevel and the outer layers of tape spread with the thumb naii or a knife blade.

In the electric cap, which is commonly called a fuse, there is a bridge of fine platinum wire which is embedded in the fulminate, the heating of which by the current causes ignition. The lead wires are thirty inches to several feet in length as may be ordered. For firing by electricity a magneto-electric machine is used, the one most commonly employed being a Laflin & Rand Exploder. The handle is raised to its full height and depressed as forcibly as can be done with the hand. By a rack and pinion it gives rotation to an armature revolving in a magnetic field. At the end of the stroke, when the armature has its maximum velocity of rotation, the handle closes a contact which shunts the current through the leads connected at the binding point. The lead wires should be insulated.

When electricity is not available, Bickford or safety fuse is used to ignite the fulminate. It consists of a powder thread wrapped with a waterproof tape, a double wrapping of tape preferred. This fuse may be used in wet holes, but for under water firing should have a continuous rubber coating. There are two types, known as time and instantaneous.

Time fuse burns at an average speed of 3 ft. per minute, but the rate is not regular, and when this element is important should be tested. Instantaneous fuse burns at a rate of 120 ft. per second.

When it is necessary to splice different pieces of fuse of either kind the ends to be joined should be cut obliquely. Care must be taken that the powder at the end of the cut does not fall out. The cut ends are placed carefully in juxtaposition and before closing a few grains of powder should be dropped in and compressed between them. The splice is completed by wrapping with rubber tape if available, otherwise with any material at hand which will keep the ends in contact in their proper position. It is obvious that this splice must be completely protected from strain.

When a line of fuse is to be branched into two the same principles are followed, and the same precautions taken in making up.

Caps and fuses must be carefully handled, must not be assembled in considerable quantites and must be kept away from the other explosives.

Caps are of different strengths, depending upon the amount of fulminate they contain. Those of single strength have 3 grs. ; of double strength, 6 grs. ; of triple strength, 9 grs. ; and so on. The strength of the cap makes a difference in the force of the explosion. It is very important to prevent deterioration of caps and also to know whether they have deteriorated or not. Caps stored in a damp place fall off rapidly. With more than 25 per cent. of moisture they will not detonate dynamite, though they may still explode themselves. Single and double strength are best for mining. Triple and quadruple for demolitions. They may be tested by exploding them in a confined space and noting the report and the effect on the copper shell. If practicable each fuse to be used should always be tried with a circuit detector to verify a complete electrical connection.

When a total blast is divided into a number of charges, it is important that all should go at the same instant. With time fuse this will not be easy. Necessity may demand it however, in which case caution must be observed to avoid total failure. The fuse should be so laid that the total length from the firing point to each charge will be the same. It will be better to use time fuse to a common point near the charge and instantaneous from there on.

In simultaneous ignitions by electricity, the fuses are connected in series; that is to say, they are all placed in the same circuit. A lead from the firing apparatus is connected to one wire of a fuse on one flank. The other wire of this fuse is connected to a wire of the next fuse, and so on until the last fuse is reached, the second wire of which is ‘brought back by a lead to the firing point. The ends of the wires must always be brightened by scraping with a knife or otherwise.

With high explosives it is customary to insert the fuse and cap in a small integral part of the charge to insure close contact and thorough detonation. This portion of the charge is called the primer. With dynamite it consists of one stick or one half stick. The best method is to open the wrapper at the end, scoop out a hole for the cap, draw in and tie the wrapper around the fuse and lead wires and take a half hitch or two around the‘ primer to prevent tension from drawing out the cap. (Fig. 4.) With compressed gun cotton it is difficult to make a receptacle for the cap. Dry gun cotton must be used for the primer and the best method is to split a block in two or use two blocks, place the cap between them and tie securely together with a string.

Whenever explosives are used in or near water it is to be understood that under all circumstances the cap and primer must be kept perfectly dry. If but one primer is used, it should be placed near the center of the charge when the size and shape of the latter will permit it. If the cartridges are placed near a drill hole, as in rock blasting and some demolitions, the primer is put in last with the cap end down.

Primers must be kept at a safe distance from the charge and from the store of caps, and should be placed as short a time as possible before firing. In case of misfire there is danger in approaching the holes for several minutes if electrical firing is used and for several hours in case of firing by fuse. Rules to this affect are laid down where safety to human life is a paramount consideration. They should be recognized in military operations to the extent which circumstances permit. There is also danger in attempting to reprime a charge, especially if tamping must be removed. The liability of accident is reduced by care and by avoiding hard metal tools and appliances. In any ease, leave a few inches of tamping above the charge undisturbed, then place several sticks of powder and a primer on top of the first charge and fire again. When conditions permit, it is better practice not to attempt repriming, but to place a new charge in a position to do all or a part of the work of the first.

The causes of misfire are various; with electricity, if none of the charges explode, it is probably due to overloading the machine, or to a short circuit in the leads, or to a complete break. An effectual but less probable cause is deterioration of all the primers. If part of the charges. fire and the others do not, it will generally be found to be either a defective cap, due to moisture or a broken bridge, or a short circuit in the fuse wires which prevents current going through one fuse but not the others; or the sensitiveness of the caps may not be uniform and one or more may explode and break the circuit before the bridges of the others have become heated to the point of ignition.

The following general rules must be carefully followed in handling high explosives :

Gun cotton should be kept saturated with 30 per cent of its weight of water. If not hermetically sealed, the packages should be examined once a month or oftener and resaturated. The cotton required for primers must be stored dry and kept free from moisture. The cakes may be dipped in melted parrafine. The dry gun cottonmust be kept well apart from any other explosive and from caps. If dry primers are not at hand, wet cakes must be dried at a temperature not exceeding 120° F.

All other powders should be stored in a cool, dry, shaded and well ventilated space. The main supply must be well removed from the working points.

Avoid all unnecessary accumulation of powder at any other place than the magazine provided for it, and especially do not allow any powder to be stored near where caps or primers are kept.

Keep fire away from powder and powder away from fire. Do not use hard metal tools in manipulating cartridges. Copper is the only metal that should be used. Wood is better.

Keep cartridges free from sand or any gritty substance. Do not bend, strike or heat a cap or primer.

The exploder should not be connected to the leads, nor a fuse lighted until everything is ready for firing, warning has been given, and time allowed for everyone. to reach safety. As a rule, the exploder should be used or the fuse lighted under the personal supervision of the responsible officer.

Demolitions With Explosives

The next phase of the subject relates to the application of the preceding general rules to particular cases and is intended to permit the complete solution of the question as to the most practical and exact method to be followed in any particular instance. Circumstances, however, may be such as to require demolitions to be made under the fire of the enemy or when all the means necessary for the work are not available. In such cases substitutes must be used for the supplies th.at are wanting and the simplest and quickest way must be employed in placing charges. Improvised methods vary with the conditions of the case and require considerable experience that can be acquired only by study and practice.

Calculations of weights of charges are based on the use of an explosive equal in strength to a 50 per cent dynamite. A stick will be understood to mean a cylindrical cartridge one and one-fourth by eight inches, which will weigh approximately 0.6 pound per running foot. The cartridges of a string will usually be attached to a rope or pole. When two or more strings of cartridges are to be used they may be lashed to the same support.

Timber.-A charge of one-half pound per square foot of sectional area placed in holes in the same cross section, will cut off trees and round or squared timbers of usual proportions. The holes should be tamped with clay behind th.e cartridges. 1, 2, 3 and 4 sticks will cut trees or poles 13, 19, 23 and 27 inches in diameter respectively. The center of the charge should be at the center of the section (Fig. 5). If the holes meet, one primer. at the middle will do.

If they do not, as usually will happen in large trees, a fuse for each hole is required and simultaneous ignition (Fig. 6). If firing must be done with time fuse, it may be well to charge and fire one hole, then bore another in the soundest part remaining, charge and fire it, and so on until the tree falls (Plates 2, 3, and 4). A round timber not over 12 inches in diameter may be cut by a chain practically encircling it (Plates 5 and 6). It must be set snugly against the wood and should be tamped. Such a charge fired 3 feet under water will cut any pole or trestle leg likely to be encountered. Close contact is not so necessary under water, and it is convenient to lash the charge to a wire ring or to a band or hoop and slide it down. It may be necessary to cut bridge timbers when there is no time to bore. The charge required is four pounds per square foot of section and may be placed as a chain around, if square or nearly so, or if the piece is thin as compared with its width, across one long side.

Stockades and stockade walls or palisades are destroyed by strings of cartridges covering as much of their length as it may be necessary to break down. The cartridges cannot be placed snug to the wood except in square timbers and a greater number is required than the actual cross section of wood calls for, The charge is laid along the foot of the wall and should be tamped, especially in the interval between timbers. If proper close tamping cannot be employed for lack of time, the effect of explosion is greatly increased by simply placing a board over the explosive. If the demolition is deliberate and the structure can be examined, 1 or 2 strings well placed and tamped will throw down a single wall or one side of a double wall. If the work is to be done under fire, determine the minimum length of breach actually required and place and fire a charge of 4 strings tamped as well as conditions will permit.

Masonry. -For ordinary walls the charge per run.ning foot varies with the square of the thickness. The charge should be laid in chains along the foot of the wall (Fig. 7). If a tamping equal to its thickness is placed, the amount may be reduced one-third. If beside the tamping a groove is cut to hold the charge, the amount may be reduced one half (Fig. 8). For a 13 inch wall use 1 chain; 18 inches, 2; 22 inches, 3; 26 inches, 4.

In blowing down houses it is sufficient to charge the walls between the windows only, preferably inside and with tamping. In haste, one or more charges of 50 lbs. in a central position will demolish the whole structure.

Retaining walls and bridge abutments should be charged at the back or a shaft may be sunk and a gallery driven. The charge is tamped with part of the excavated material. In case of a retaining wall it may be found easier to mine under it and place the charge from the front. When a retaining wall supports a road both may be demolished by a mine,

Locks should be attacked at the miter sills, the lower first. Start the gates open slightly and place a concentrated charge between them and the upper edge of the sill.

A single arch masonry bridge is charged across the extrados at the haunches, or across the crown (Fig. 9). The charge should be ½ more than for a wall of equal thickness. Both methods require digging, and if the spandrel filling is of masonry, the former is scarcely practicable. Both methods also interrupt traffic on the bridge which it may be important to use until the last moment. In this case a thin arch may be broken by a heavy charge exploded on the roadway at the crown. It should be tamped by throwing a mound of earth over it. The charge should not less than T^2 lbs. per running foot, T being the distance in feet from surface of roadway to soffit of arch. The charge may be placed in a trough and suspended under the crown. Planks 12 inches wide, making with each other a 60 degree angle form a trough capable of holding 36 chains of $1\frac{1}{4}$ inch cartridges or 36 lbs. to the running foot. The trough must not be allowed to sag away from the arch at the middle. If necessary, truss it up.

Primers should be placed three or four feet apart in the middle chain of the top tier and the wires or fuse led out through notches in the sides.

A bridge of more than one arch is usually attacked at the piers. The destruction of one pier throws down two arches. The charge should be placed where the pier is thinnest and should extend across the face. If possible, a groove should be cut, or irregular voids made by prizing out stones from the same course (Fig. 10). This partially tamps the charge, and furnishes a convenient support which must be otherwise provided in the shape of a shelf, trough or other device.

Metals. -As soft steel so greatly predominates in structural work, statements under this head will relate to that metal. All charges will be external as drilling or boring is not practicable. The charge must extend entirely across the plate or sheet. A single chain will cut a plate up to five-eighths inches thick; two, three and four chains will cut plates of seven-eighths, one and one-eighth and one and one-fourth inches thickness, respectively. The charge must be held snugly by a piece of plank, lashed or wedged, and whenever possible must be tamped. For structural shapes it should be in parts, one on the web and one on each flange. For channels, angles and Z bars it may be on continguous surfaces, and one primer will suffice. For I beams, flange charges should be used on the outside and three primers are necessary. As one chain will cut up to five-eighths inches thickness and two chains up to seven-eighths inches thickness, the choice will usually lie between the two, as few pieces of structural steel will be found with greater thickness than seven-eighths of an inch. For lattice girders, diagonals and posts all the longitudinal members should be cut; for plate girders, the web and both flanges. If short of explosives, cut the lower flange and lower part of the web. For box girders, all four sides are regarded as plates. If powder is scarce, omit the top. For a beam girder, figure the flange charges for the combined thickness of beam, flange and plate. (Plates 7, 8, 9, 10, 11, 12, 13, 14, 15.)

Wooden trusses are best charged near the middle of the lower chord. Steel girders and trusses, if a complete fall is desired, should have every member cut on the same cross section. Continuous girders or trusses must be attacked near the end of the short spans near the abutment.

Metal girders and trusses are better cut near the abutment where the cross sections of chords and flanges are smaller. Where members meet or cross, as at panel points, it is usually possible to place charges in a more or less acute angle and then tamp by throwing earth upon them. The effect of the charge in such a situation is always greater than if placed against the side of a single member.

A cantilever bridge should be cut over the towers with especial attention to the complete rupture of the top chords. Wire cables of suspension bridges are difficult to cut. The best place to work is between the cable and the top of the tower near the saddle. There are no reliable data as to the charges required.

To interrupt traffic on railroads, rails may be cut and frogs and other. parts of switches broken. A stick fastened against the web of a rail up to 70 lbs. will cut a gap in it about a foot long; if the charge is tamped, a heavier rail may be cut. Such a cut may be made to produce derailments, but for other purposes two charges should be fired on the opposite sides and a few feet apart, which will blow out a piece and distort the ends. (Plate 16).

Land Mines--This is a term applied to mines or groups of mines usually formed by excavation from the surface and designed to be exploded at the moment the enemy is near them. Such mines are employed in front of defensive positions and in connection with visible obstacles. It is not permissible to plant them in any ground which is not obviously prepared for defense. Any person who ventures on space so treated does so at his peril, but if there is a road or path open to passage through it, ground mines must not be placed therein or in a place where the explosion would injure persons occupying the road. If any defensive works or recognized obstacles are thrown across, indicating that traffic is closed, the road may be mined to a reasonable distance in front of them. The charges are placed deep enough to avoid artillery projectiles. If no artillery fire is to be expeeted they may be located just under the surface. If a bored hole is sufficient the charge is placed at the bottom and well tamped. If an open pit is dug the mine chamber should be in firm ground and at one side and the hole back-filled and well rammed.

The mines may be placed in one or more rows. Two rows 30 to 40 yards apart is a good arrangement. The interval between mines in a row should be such that the craters will nearly but not quite join. The positions of the mines should be concealed as completely as possible and further sophisticated by disturbing the ground slightly at points where there are no mines and so situated as to suggest a systematic arrangement (Plates 17, 18, 19,). To secure a large charge chamber without excessive digging "springing the hole" is resorted to. This operation is as follows: -a small hole, about 3" diameter, is sunk with long drills or an earth augur to the depth of the charge. A stick of dynamite with fuse and detonator, arranged as for a primer, is pushed to the bottom of the hole, and a pail of water poured on it for tamping. This stick is then fired creating by compression a commodious mine chamber in which a large charge can be placed. For blasting out earth, as in the destruction of railway embankments, causeways, ect., powder is usually preferable to high explosives, and is almost universally used on civil work.

A Fougasse is a land mine in which the volume of the crater is artificially prepared to increase its range and effect. The usual form has an inclined axis. The earth excavated must be piled around the pit and well tamped to prevent the charge blowing out behind the stones. If the soil will not stand it may be thrown out to its natural angle and back-filled and rammed against the stones. A charge of 25 lbs. should scatter a cubic yard of stone over an area 200 by 100 yards (Plate 20). This type is difficult to conceal and very easily destroyed by the enemy's fire. Another and better form has the axis vertical. It is possible of concealment by sprinkling earth over it, and an automatic firing device may be used, which is not practicable with the inclined form. The igniting means may be instantaneous fuse or electricity. Fuses or wires should be laid in trenches 1 to 3 feet deep.

Mines are classified with respect to the method of firing as judgment and automatic. Judgment mines are controlled from a firing point and can be exploded only at the will of the operator. Automatic mines are. arranged to be fired by the disturbance of some apparatus in or near them. The two methods are often combined for the same mines. In firing by cap, the automatic firing device takes the form of a mechanical trigger which may be operated by pressure on the ground over it, or by the pulling of a wire stretched along the line at such height as to be tripped by the feet. With electrical firing this device is called a circuit closer, and the actuating force operates to close a contact which completes a metallic circuit containing the battery and the fuse.

Planting and operating of land mines will ordinarily be the work of technical troops supplied with approved apparatus.

In all uses of explosives for military demolitions, the maxim for the first charge should be, do not spare the powder. It is the most important rule of all, and when in doubt should always be applied.

It will sometimes be necessary to destroy large quantities of explosives. If deterioration has occurred such as the exudation of nitro-glycerine from dynamite, great care must be used in handling the explosive to avoid shock. Explosive mixtures may be disposed of by depositing them in bodies of water. With both explosive mixtures and compounds, the best method is to burn in small quantities, not exceeding 25 lbs., in the open air at a safe distance from the point of storage. In large quantities, dynamite is likely to generate sufficient heat in burning to cause explosion.

GENERAL REMARKS

During the fire at San Francisco dynamite was extensively and recklessly employed by inexperienced persons resulting in much damage. The main difficulty seemed to arise from using too large charges and from a lack of knowledge of what dynamite will do when properly placed and fired. After the third day General Greely turned over the work of destroying dangerous buildings still standing. to Major Harts of the Engineer Corps.

Ordinary commercial fuses were used and 60 per cent dynamite. In all cases firing was accomplished by means of electricity. In no other way could shots be fired simultaneously, and the force of one charge be thus supplemented by another. One fuse in each charge was generally used although for greater safety in avoiding misfire two were sometimes inserted. In blowing down walls of masonry an effort was made to always place the dynamite so that the supporting portion of the work would be shattered, leaving the building to fall by its own weight, rather than to attempt to destroy it by the force of the charge alone. No time was available for much tamping and practically none was employed. Far greater effect was produced by a number of small charges properly placed and well distributed, when fired simultaneously, than by much larger charges not so well arranged. In placing the dynamite it was found most effective to locate it in the crevices, removing brick if possible, or otherwise preparing a lodgement so that a charge might not be exploded simply against a surface. In cutting steel columns great-difficulty was encountered especially when filled with concrete or brick masonry, and charges had to be increased three or four fold over those necessary for cast iron or granite pillars. The cartridges were usually placed on one side of the steel columns and covered with sand bags.

In the principal European armies pioneer detachments of cavalry are regularly organized and equipped.

Austria has a pioneer platoon for each regiment; Belgium a pioneer squad to each troop; England a pioneer outfit on pack mules for each squadron but has no separate detachment for this duty; France a pioneer squad for each squadron; Germany a pioneer platoon for each cavalry division and carries a demolition outfit by wagon for each regiment; Russia a pioneer section for each regiment and trains the pioneers in a special school.

In our army this duty has heretofore been allotted 'to Engineer troops and each company has one section mounted and trained for pioneer work with cavalry commands. The section consists normally of:—

1 Lieutenant
. 2 Sergeants
3 Corporals
18 Privates
1 Cook

Total, one officer and twenty-four men. One of the corporals acts as chief packer, and three of the privates are packers. The equipment of the section is carried by a pack train, of eight mules with:—

1 Carpenter Pack.
2 Pioneer and Intrenchment Packs.
1 Demolition Pack.
1 Supply Pack.
1 Cook Pack.
2 Saddle Mules.

The mules are taught to either follow or lead. The section is trained in the duties of reconnaissance and road sketching, road building and repairing, bridge building and in demolitions, and is prepared to accompany a cavalry command in the screen, in the independent cavalry, in the advance guard or in raiding.

In conclusion it may be said that with proper care and attention there is little danger in handling high .explosives. But it must always be born in mind that dynamite and its kindred are practically instantaneous agents and allow no margin for ignorance, carelessness or neglect. In their use there will be no small accidents. One man will have but one accident.

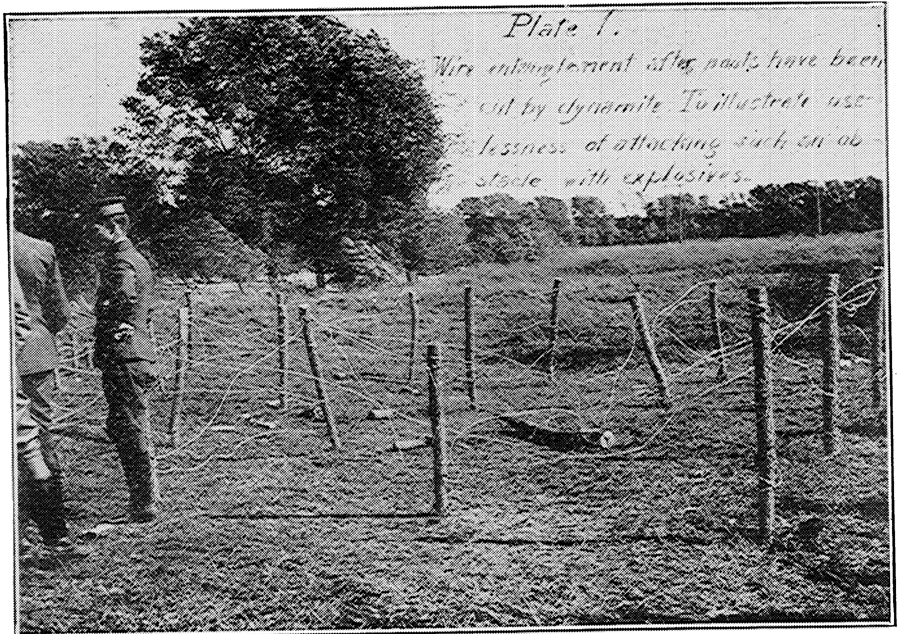


Plate 1.

Wire entanglement after posts have been cut by dynamite. To illustrate uselessness of attacking such an obstacle with explosives.

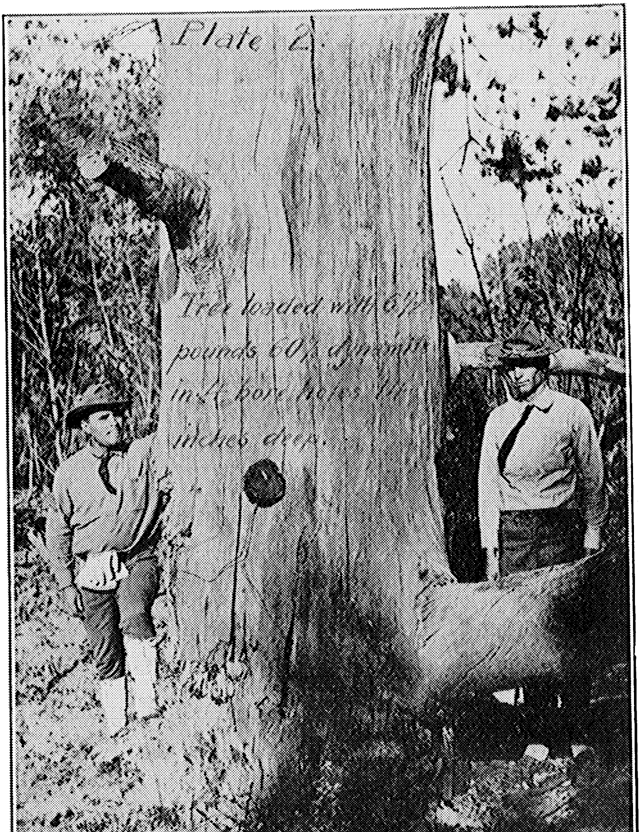


Plate 2.
Tree loaded with
pounds 60% dynamite
bore holes
inches deep.

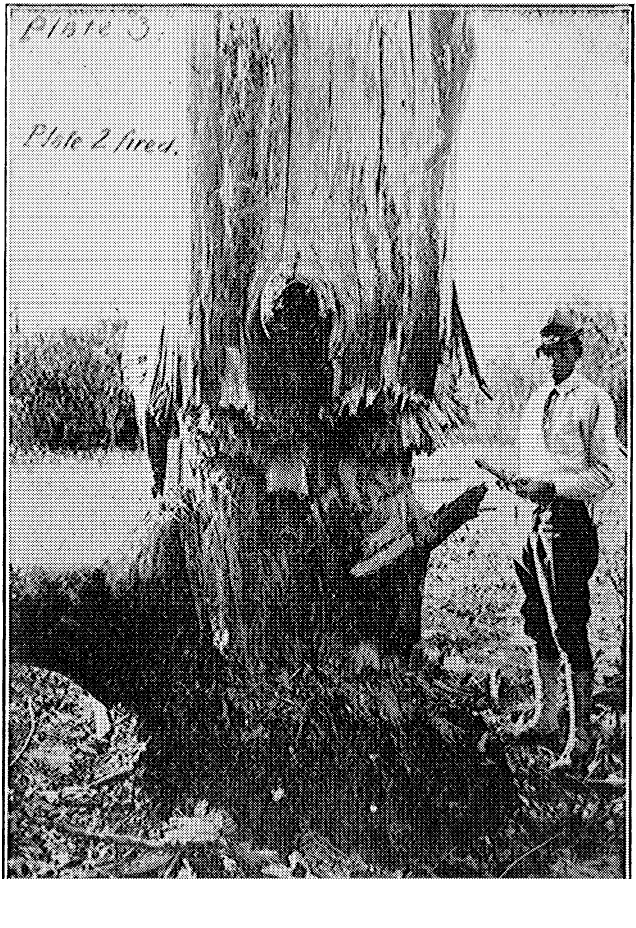


Plate 3.
Plate 2 fired.

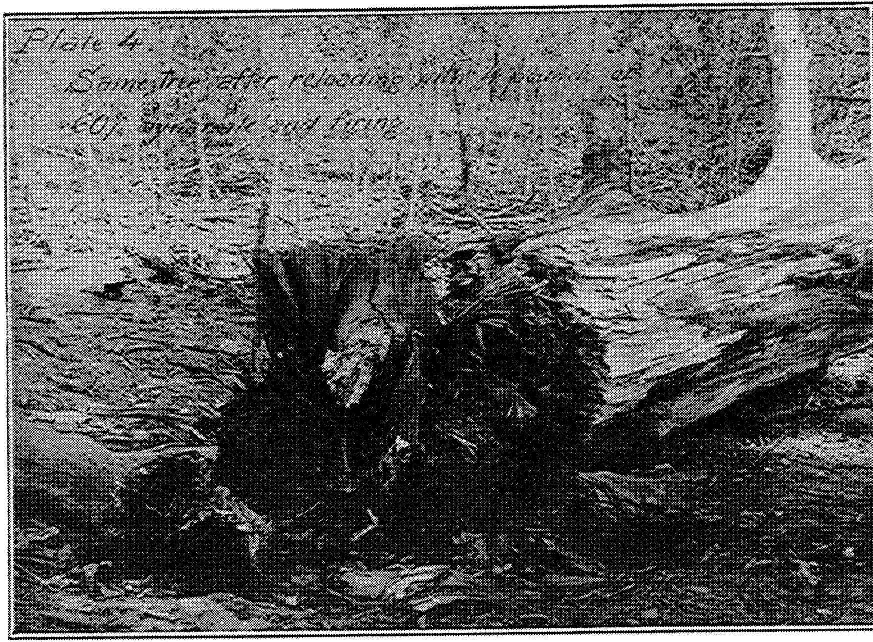
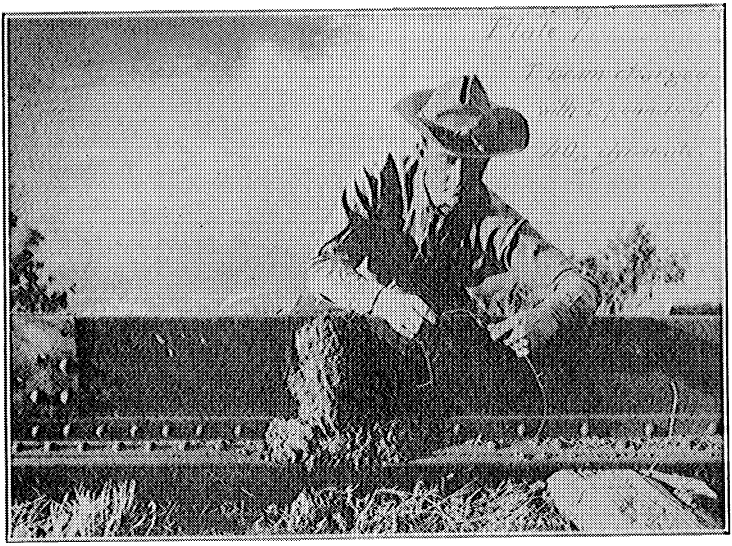
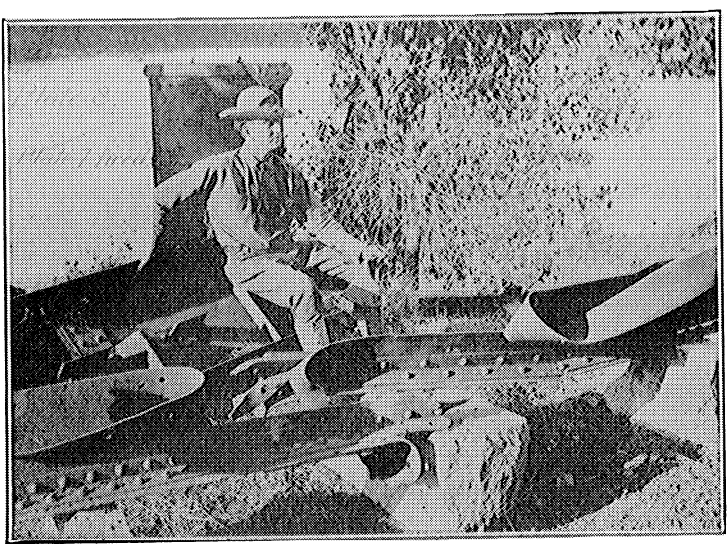


Plate 4.
Same tree after reloading with 4 pounds of 60% dynamite and firing.


Plate 5.
Tree charged with 2½ pounds 60% dynamite





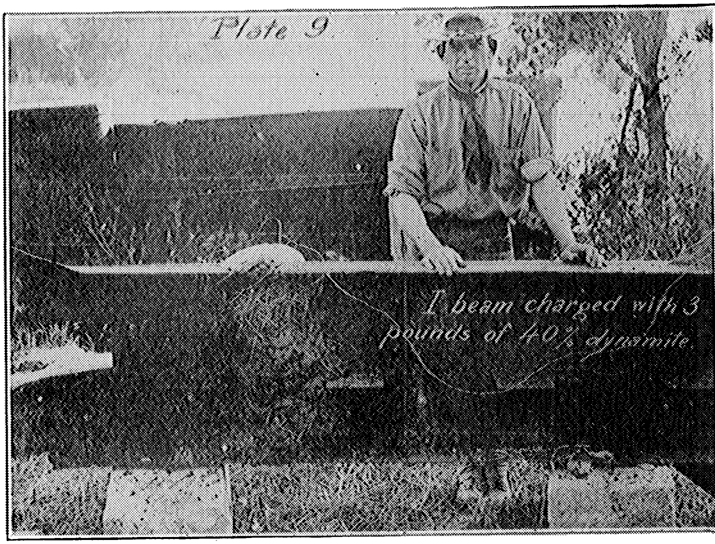


Plate 9
I beam charged with 3 pounds of 40% dynamite.

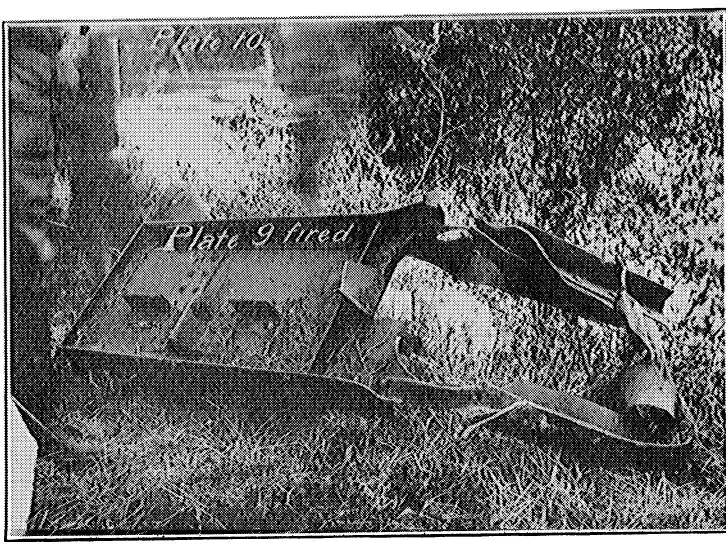
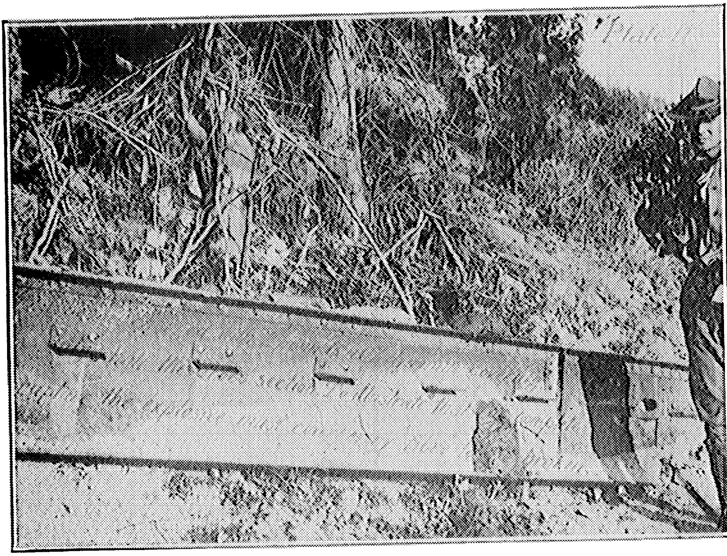
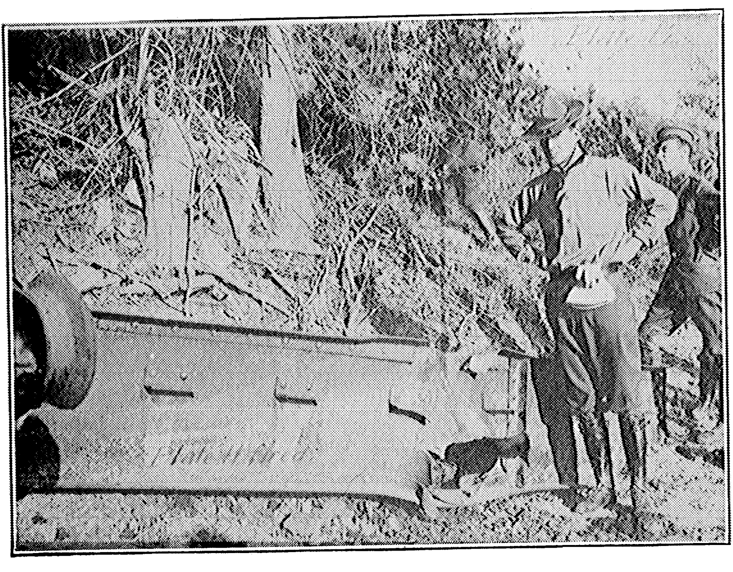


Plate 10.
Plate 9 fired





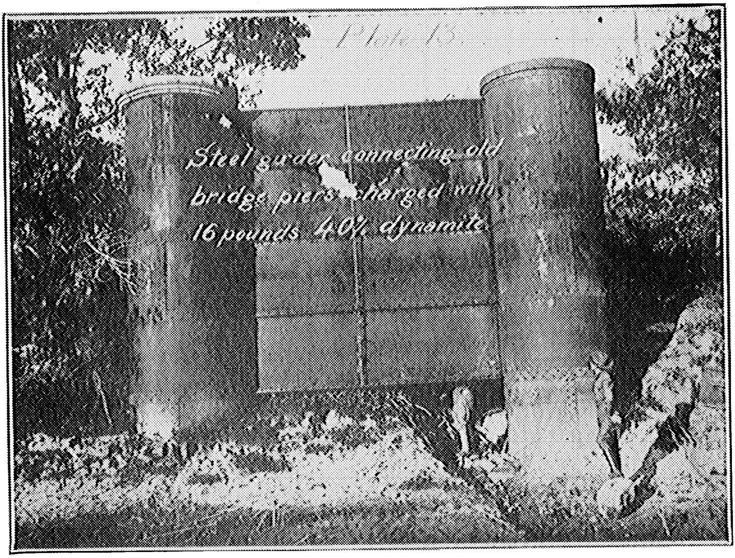


Plate 13.

Steel girder connecting old bridge piers charged with 16 pounds 40% dynamite.

Plate 14.

Piers after firing Plate 13.

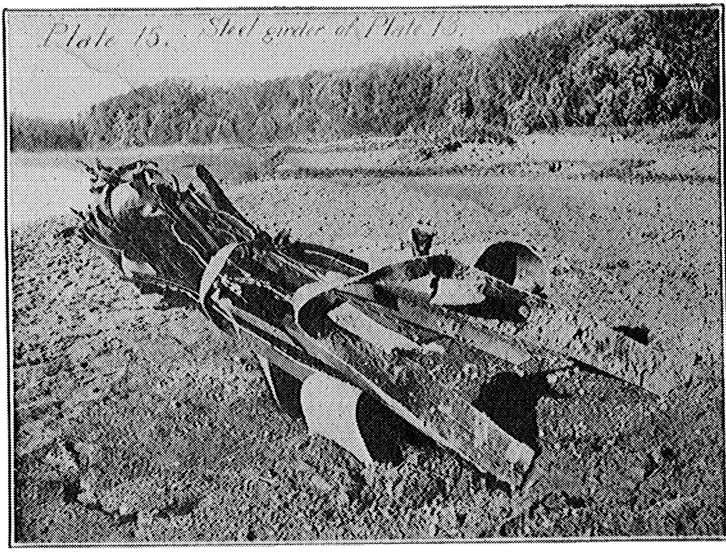


Plate 15. Sled grave of Plate 17.

Plate 16.

Plate 17. Explosion of seven ground mines each charged with 20 pounds of 40% and 60% dynamite

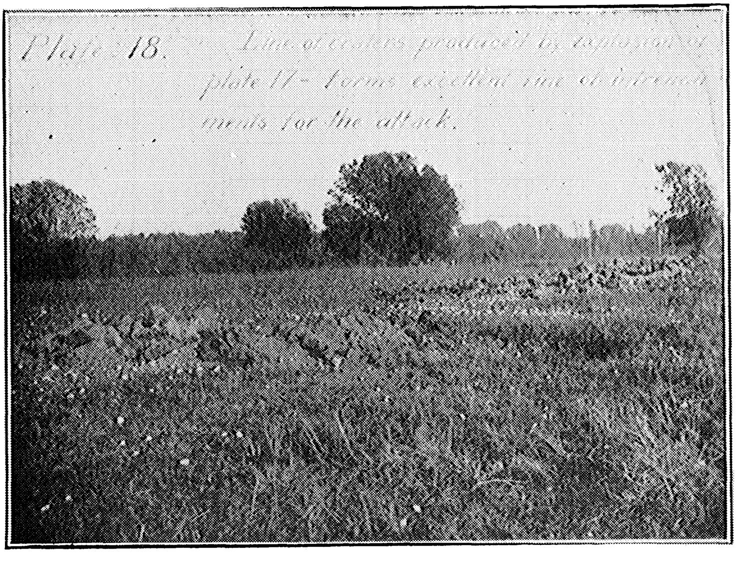
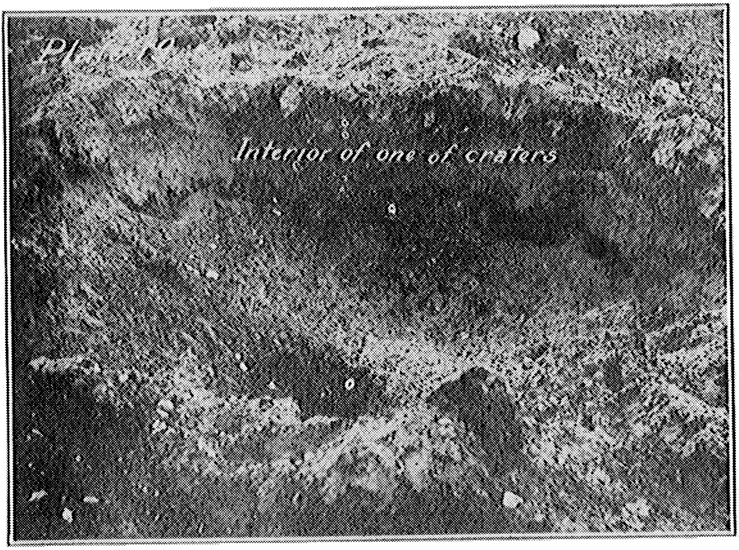


Plate 18. Line of craters produced by explosion of plate 17 - forms excellent line of intrenchments for the attack.


Interior of one of craters

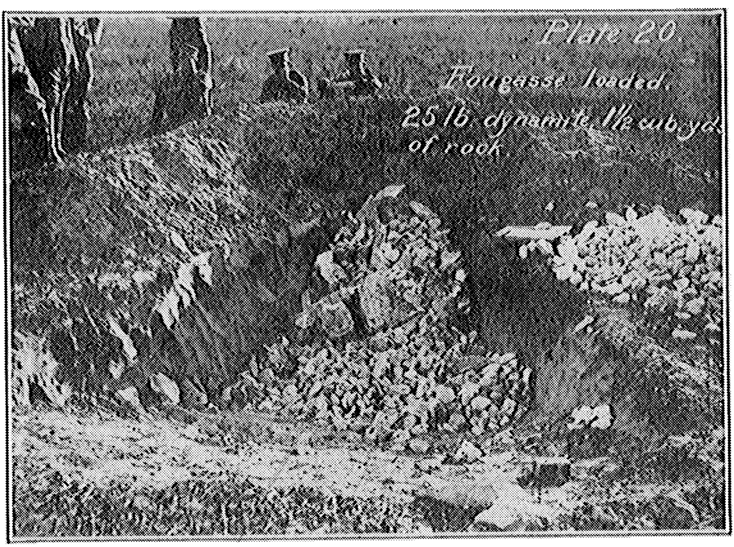


Plate 20.
Fougasse loaded.
25 lb dynamite 1½ cub yd
of rock