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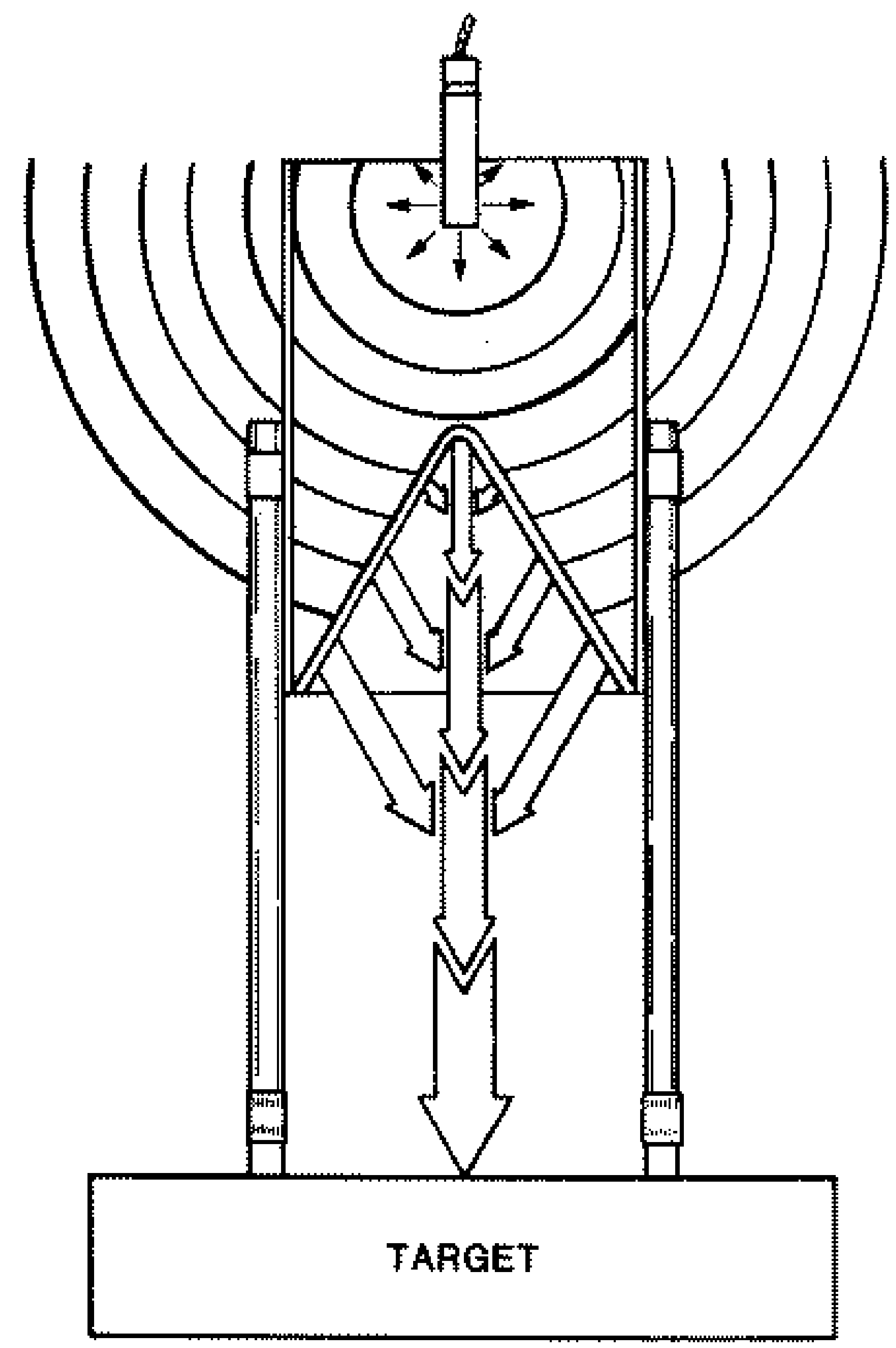
IMPROVISED SHAPED CHARGES



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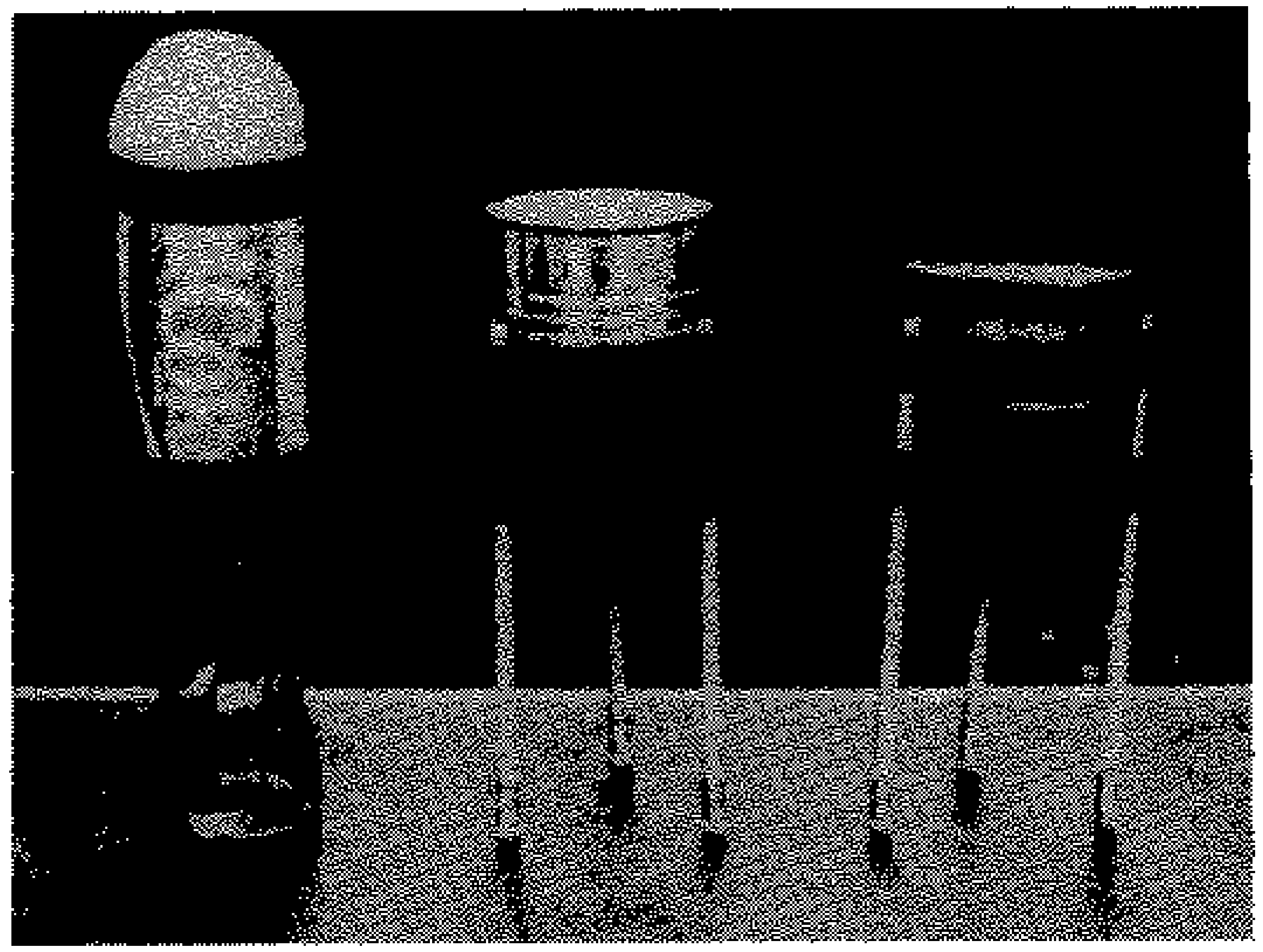

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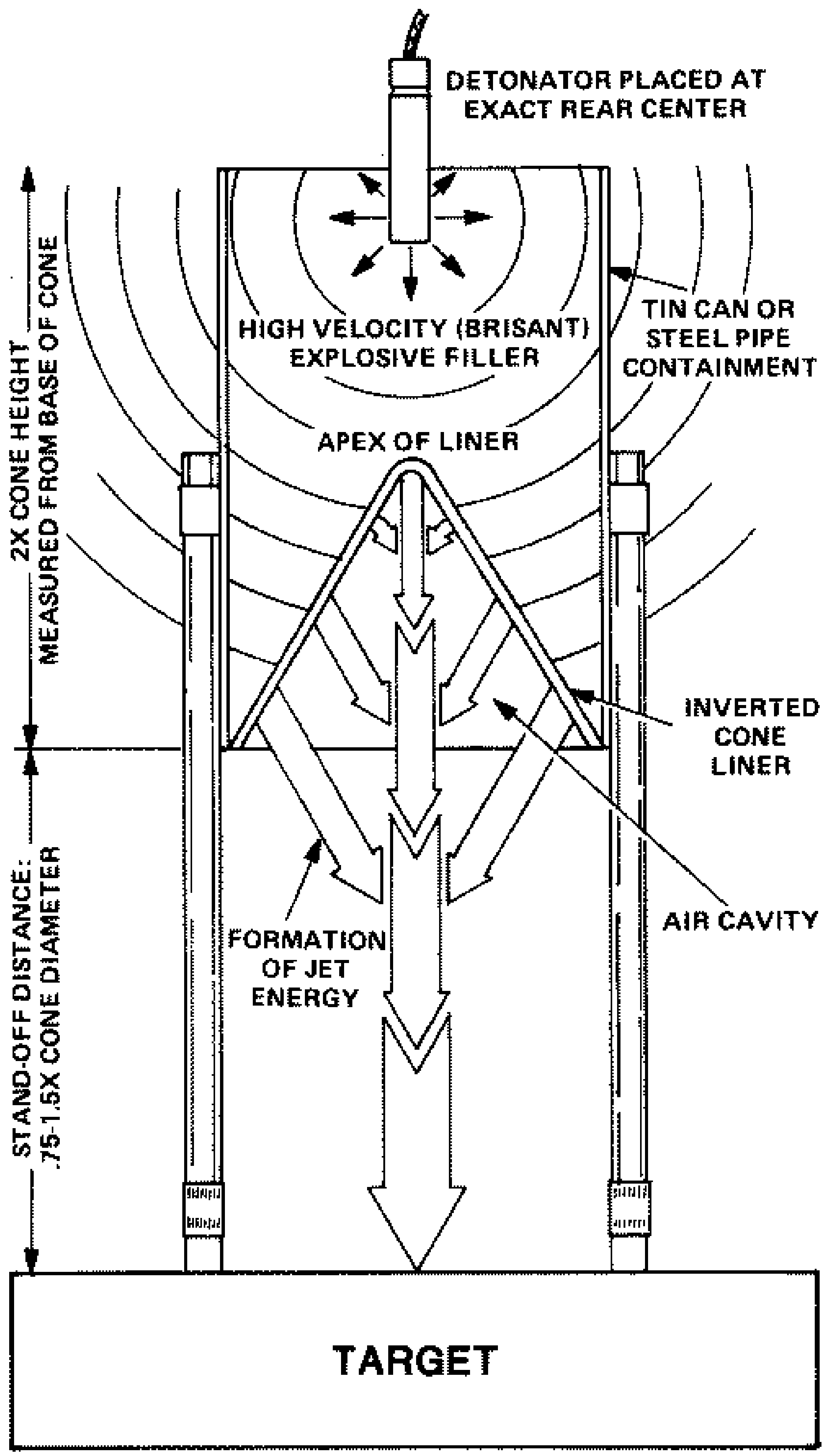
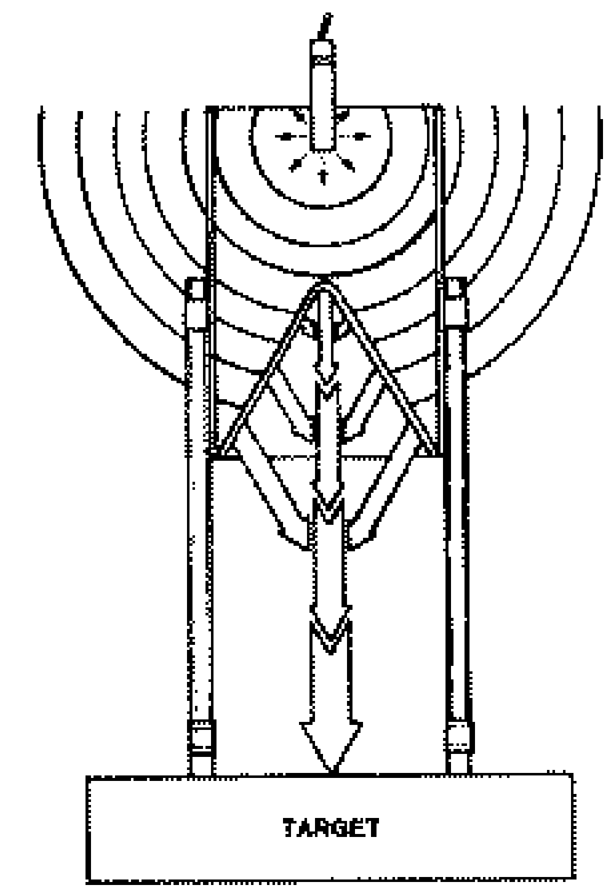


FIGURE 1
Shaped Charge



I. General Information

A shaped charge (Figure 1) is an explosive mass which is so shaped that when detonation of the charge occurs the explosive energy is concentrated in one direction. This feature gives the shaped charge greater penetrating effect than ordinary charges and thus makes it most useful for the blasting of holes through hard targets such as automobile engines, steel-encased transformers, etc.

Any flat-sided charge which is detonated while in contact with steel produces a basin-shaped indentation (Figure 2).

If a simple cavity is fashioned in the target end of the same charge, it will cause an increase in penetration regardless of the geometric shape of the cavity (Figure 3).

When the cavity is lined with a material which has a low melting point (e.g. copper or glass), penetration is increased further (Figure 4).

Maximum penetration results when the shaped charge with cavity liner is detonated a short distance from the target. This distance is called standoff distance (Figure 5).

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Table Of Contents

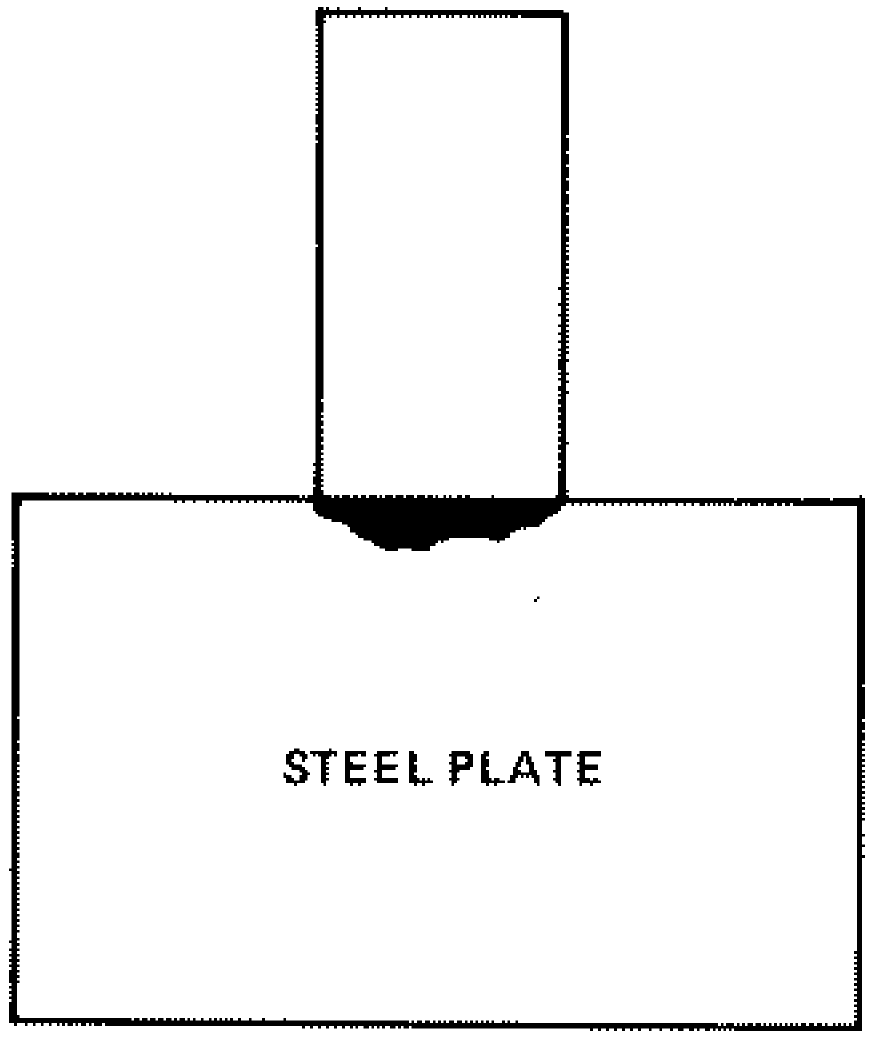


FIGURE 2
Plane Ended Charge

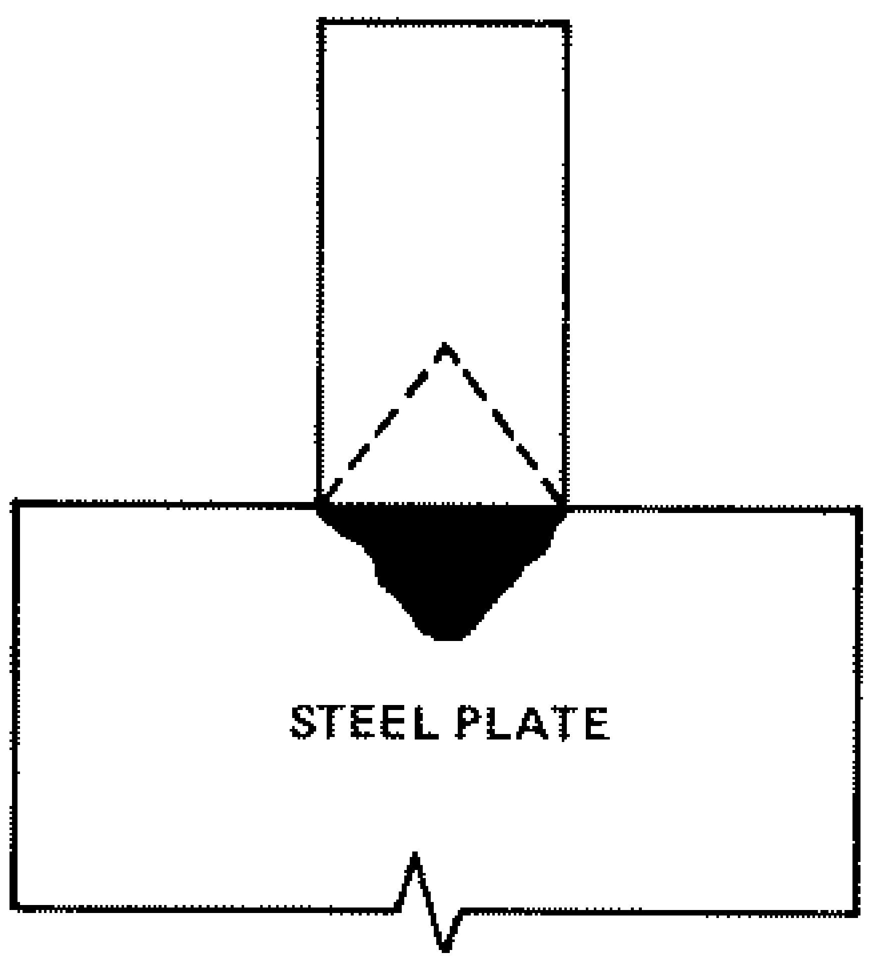


FIGURE 3
Shaped Charge Without Liner

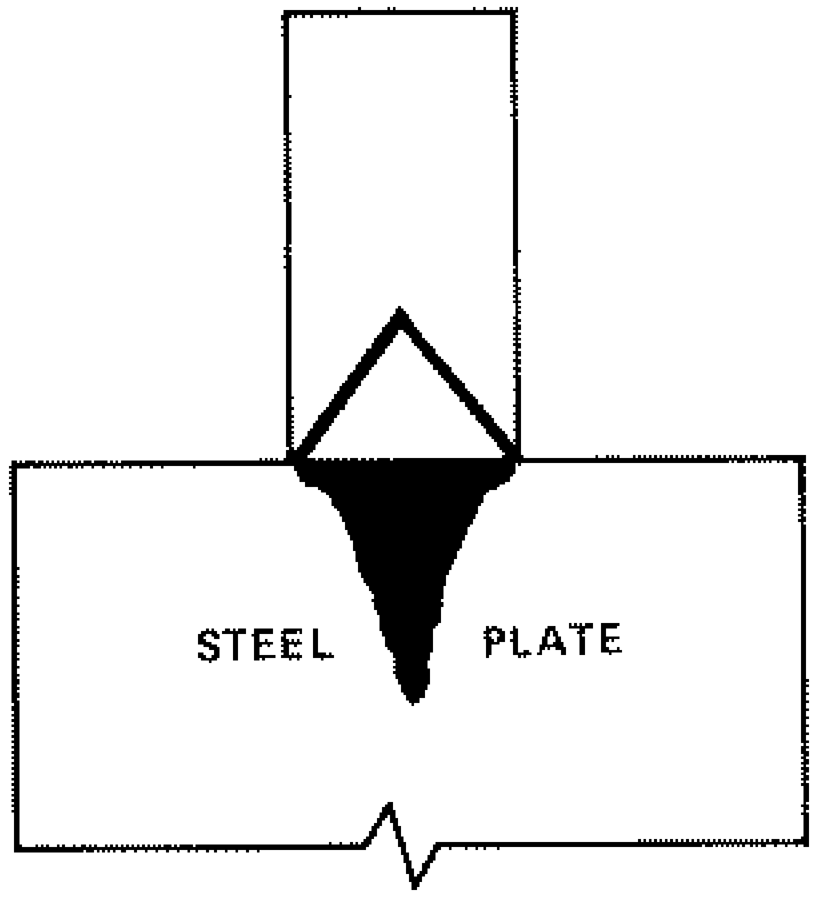


FIGURE 4
Shaped Charge With Liner

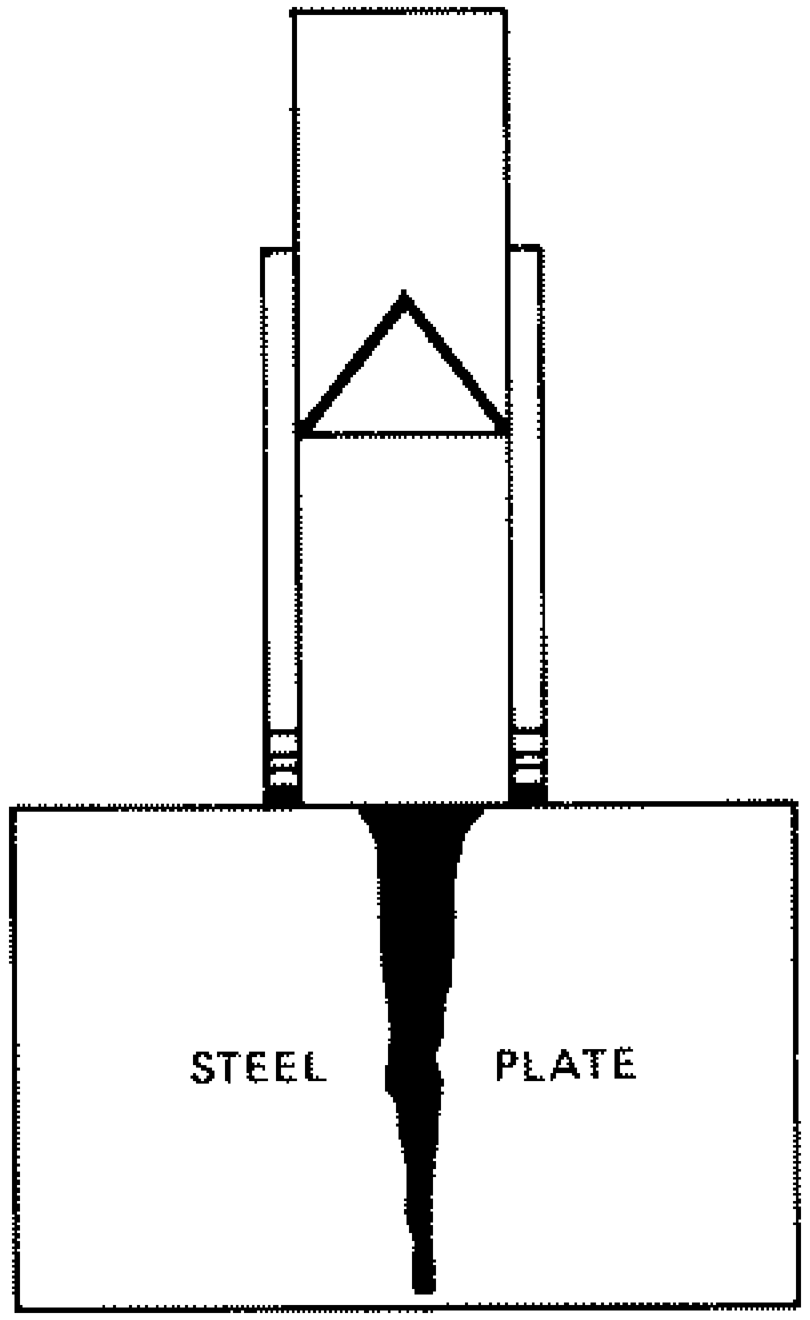
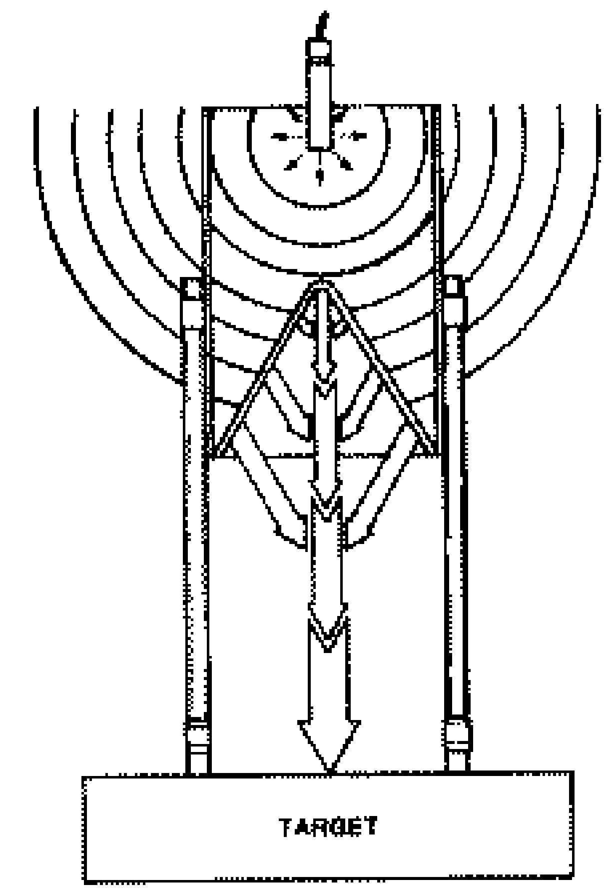


FIGURE 5
Shaped Charge With Liner And Standoff

Each of the charges shown in Figures 1-5 consists of the same weight and type of explosive. Since one of the most important concepts to bear in mind when using improvised explosives is to always try to "limit the amount and maximize the potential", shaped charges are excellent examples and should be used on targets such as electric motors, generators, transformers, steam turbines and various types of pumps as well as other targets that may be irreparably damaged by small shaped charges.



II. Theory Of Shaped Charges

The existence of a shaped cavity in one end of an explosive charge causes a directional development of explosive energy which occurs simultaneously with detonation. This directional force results from the high velocity of the gaseous and semigaseous molecules within the cavity. The force leaving the surface of any detonated explosive falls off rapidly at even a short distance from the explosive. This is not the case within the cavity of a shaped charge, where there is an actual increase in velocity of the expanding gas.

A logical assumption as to why this occurs is that the shock wave transmitted to the shaped charge explosive by a blasting cap causes a detonating wave to proceed downward and outward through the explosive at uniform speed. The descending detonating wave-fronts first come in contact with the cavity liner apex. The temperature at the cavity liner during detonation is normally from 1,800 to 3,600 degrees F.; the velocity of the explosive normally ranges between 20,000 to 28,000 feet per second. Confronted by the extremely hot

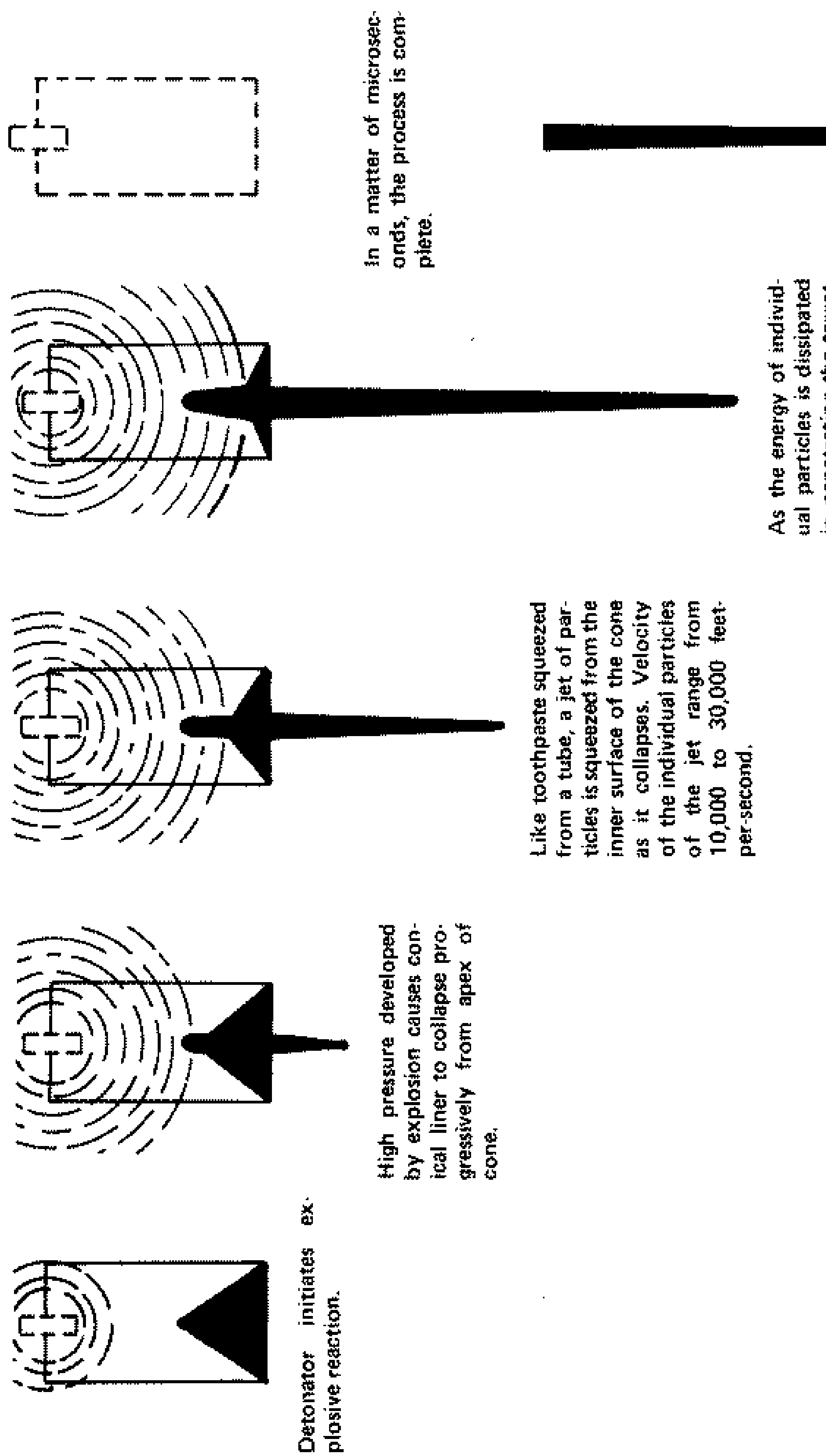
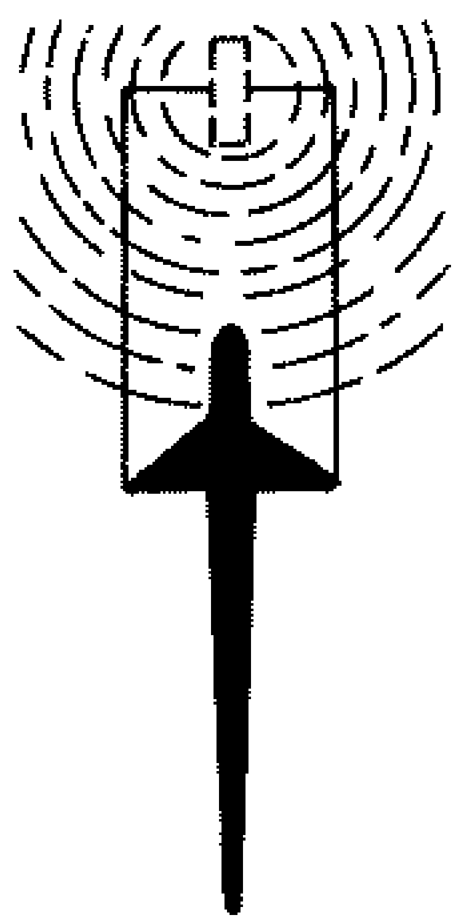
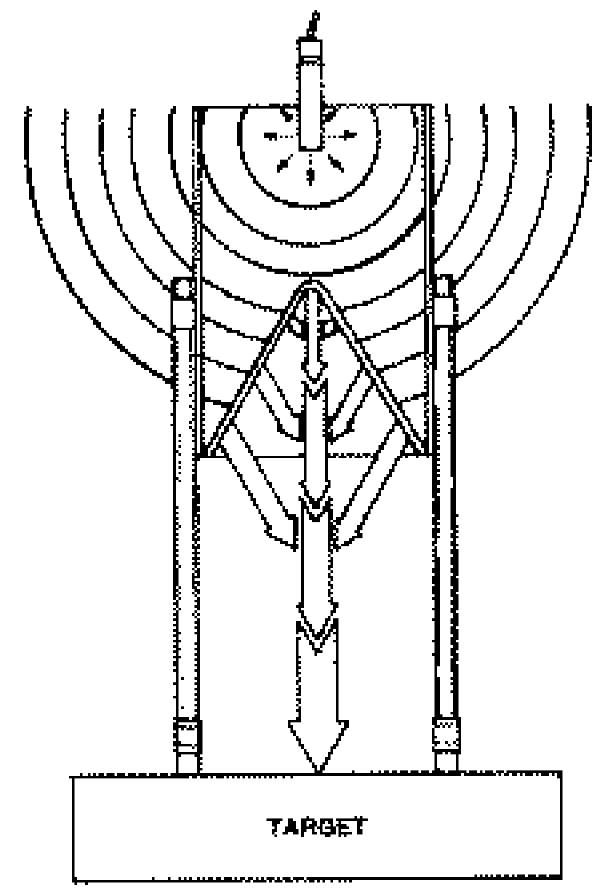


FIGURE 6
Explosive Action Of A Shaped Charge

and rapid detonating wave-fronts, the portions of the liner nearest the apex squirt forward as minute fragments, molten matter and even vapors. Coincident with this action the ever-descending detonating wave-fronts reach lower and lower planes of the cavity liner (Figure 6). This tends to cause compression toward the center of the cavity, thereby adding to the impetus of the jet. The front of this jet is composed of highly dense gas and solid particles moving at speeds in excess of the detonating explosive. This is followed by slower-moving fragments, the residue of the highly compressed liner and fragments torn from the skirt of the liner.

Penetration is achieved when the high velocity jet gases and particles strike the target. Stated technically, the concentrated force of the jet makes an indentation in the target which is enlarged by radial pressure. This causes detrusion or plastic deformation of the target. Unless the jet penetrates the target there is no loss of target weight and the material is merely pushed out of the jet's path. On the other hand, if the jet is capable of penetrating the target, the pressure will at some point be sufficient to force out a plug of target material. The jet, after it has pierced a target, may still exhibit considerable residual energy and cause further damage to the target.





III. Characteristics Of Shaped Charges

The design of a shaped charge is complicated by the interdependence of several factors which are discussed below. In many cases, particularly in homemade shaped charges, jet efficiency must be compromised by considerations involving one or more of these factors, with a resultant reduction in performance.

The interdependent factors which must be kept in mind are:

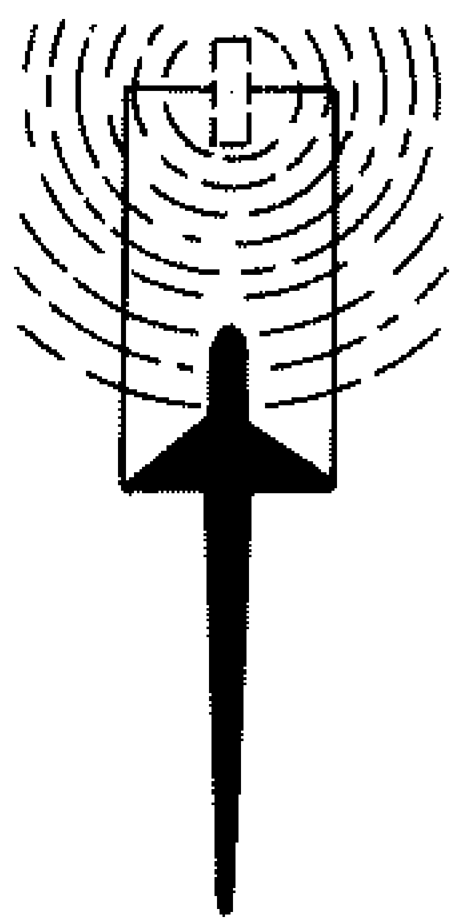
1. Uniformity: The uniformity of a shaped charge about a central axis is of great importance and of equal importance is the uniformity of the explosive which has an effect upon the uniformity of detonation. If a solid explosive is used it should be packed evenly (uniformly) around the inverted cone without lumps or air pockets and the explosive should be

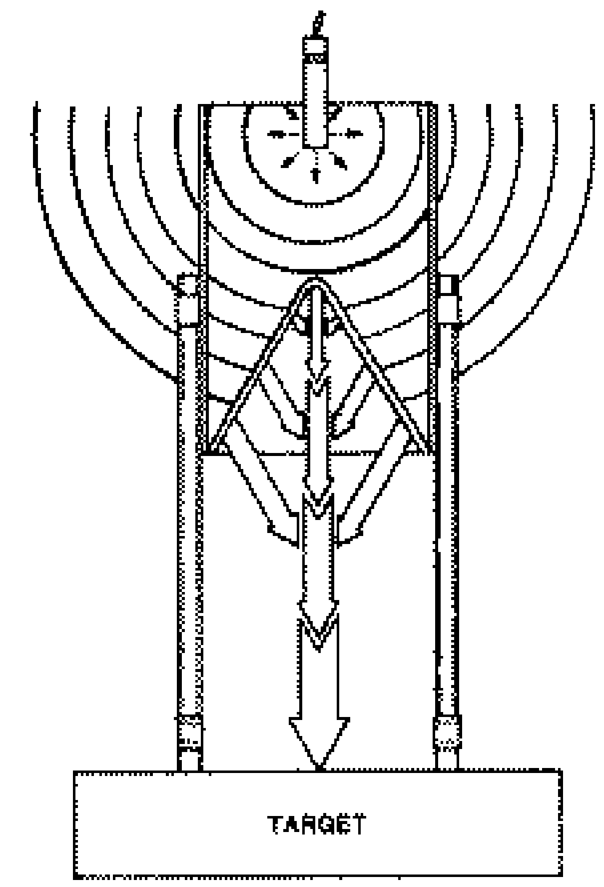
detonated at the exact rear center, directly opposite the apex of the cone. Thickness of the explosive between the apex of the cone should be equal to at least the height of the cone. Homemade liquid explosives, because of their uniform density, make excellent explosives to be used in any improvised shaped charges.

2. Liner Considerations: Shaped charge liners have been fabricated in many shapes and of a great variety of materials. For deep penetration, copper linings give maximum performance. Cadmium, zinc, mild steel, aluminum and glass also assure satisfactory results. Most cavity liners are of a conical shape and have apex angles of 30 to 60 degrees. The thickness of the cavity liner should be uniform and should be proportional in shape from the apex to the mouth of the cone.
3. High Explosive Fillers: Generally speaking, the more brisant explosives are the best for shaped charges. Explosives with velocities of detonation greater than 6,000 meters per second (MPS) should be used. However, improvised explosives with velocities as low as 3,000 MPS can be used. For the purpose of this text C-4 plastic explosive (8,000+ MPS) was used to show maximum results with homemade liners. However, explosives such as potassium chlorate/nitrobenzine (82%/18% at 3,500 MPS) can be used with approximately 50% reduction in penetrating ability.
4. Containment: Containment applies to the outer container which houses the explosive around the cone. When using high velocity explosives (6,000+ MPS) strong confinement does not enhance the over-all penetrating effect to any great degree and thin-walled containment can be used. However, when

using improvised explosives with low detonating velocities (3,000 to 6,000 MPS) confinement becomes critical to their performance and strong-walled containers such as steel pipes should be used.

5. Standoff distance: Standoff is the term used to define the airspace between the base of the shaped charge liner and the target. This space is necessary to allow formation of the jet and any hindering material in this space will markedly reduce penetration. In shaped charges with conical liners, standoff for optimum performance increases in direct proportion to increases in the apex angle. For homemade shaped charges the standoff distance can be anywhere from 0.75 to 1.5 times the cone diameter. For the purpose of this text we used the greater distance of 1.5 times the cone diameter with extremely effective results.





IV. Improvising Shaped Charges

Any symmetrical glass utensil will serve as a suitable cavity liner for improvised shaped charges. Generally speaking, the more conical the shape the better the resulting penetration. Therefore, an inverted martini glass (with stem removed) would be better than an inverted water glass.

In the photos accompanying this text we used three ordinary, commonly available glass cones (Figure 7) to form the liners for three improvised shaped charges (Figure 8) used against two inch thick armor plate (which happened to be the door off an explosive storage bunker).

COKE BOTTLE IMPROVISED SHAPED CHARGE

A 16 ounce Coke bottle was used for test purposes, but a 6½ ounce bottle will work just as well, giving the same penetrating ability with the expenditure of a lesser amount of explosive.