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Report 2310

CAMOUFLAGE AND DECEPTION TECHNIQUES FOR URBAN WARFARE

by
Thomas Steck

October 1980

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U.S. ARMY MOBILITY EQUIPMENT
RESEARCH AND DEVELOPMENT COMMAND
FORT BELVOIR, VIRGINIA

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: 2310	2. GOVT ACCESSION NO.: AD-A094677
3. RECIPIENT'S CATALOG NUMBER: [illegible]
4. TITLE (and Subtitle): CAMOUFLAGE AND DECEPTION TECHNIQUES FOR URBAN WARFARE.	5. TYPE OF REPORT & PERIOD COVERED: Final Report, 1974-1980
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Thomas T. Steck	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Camouflage and Topographic Laboratory; ATTN: DRDME-RT; US Army Mobility Equipment Research and Development Command; Fort Belvoir, VA 22060	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 6.27.33.A 1L162733AH20CC
11. CONTROLLING OFFICE NAME AND ADDRESS: Commander, US Army Mobility Equipment Research and Development Command; ATTN: DRDME-RT; Fort Belvoir, VA 22060	12. REPORT DATE: October 1980
	13. NUMBER OF PAGES: 81
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Camouflage	Urban Warfare	Camouflage Structures
Deception	Countersurveillance	Tactical Camouflage
Decoy	Urban Camouflage	Concealment

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A discussion of historical techniques and future programs dealing with camouflage in urban warfare. The report emphasizes current capabilities in camouflage and deception and concludes that camouflage and deception techniques when used properly can provide significant tactical results in urban warfare.

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

SUMMARY

The purpose of this report is to analyze urban warfare from a camouflage viewpoint, considering complex modes of detection and the intricate character of the urban area. The multiple methods of camouflage and deception have been compiled for use in urban warfare. The product is a guide for identifying needs for future techniques and equipment and their deployment.

A task of this work was to define the urban area, recognizing its important transportation and communications systems. Research included historical analysis, statistical study of urban growth, and an inquiry into the present worldwide doctrine dealing with urban warfare. Consideration was given to strategic points of view, concentrating on those tactics deemed relevant to urban warfare; e.g., aerial reconnaissance, direct sight, and ground line communications.

The report concludes that camouflage and deception can be tactically significant in urban warfare provided that effective materials are provided and that proper training is given to the using troops.

PREFACE

The investigation was conducted by Thomas T. Steck, Physicist, under the supervision of Allan T. Sylvester, Chief, Customer Assistance Branch. The overall supervisor was Henry R. Atkinson, Chief, Research Technology Division, Camouflage and Topographic Laboratory.

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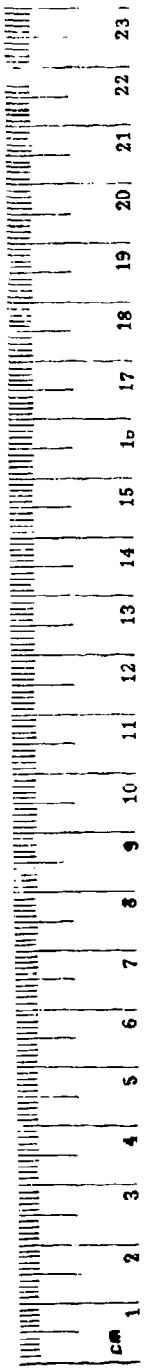
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

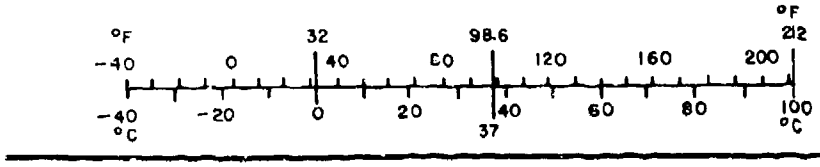
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric tons	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

* 1 in = 2.54 cm (exactly).



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric tons (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	f' oz
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



CAMOUFLAGE AND DECEPTION TECHNIQUES FOR URBAN WARFARE

I. INTRODUCTION

The problems inherent in urban warfare are as old as mankind; the city provided the defender an area for consolidation of forces and hopeful expulsion of the invader. With its narrow streets and interior lines, the city prevented the invader from using his mobile forces (chariots; cavalry; tanks) effectively, thus reducing the speed of the attacking forces to that of the infantry. In addition, every building became a fortress from which the defender held off the enemy and inflicted heavy casualties upon him. The inherent defensive advantage of a city has continued to the present. The overall effect has been to convince the strategists and tacticians to state in their Field Manuals "avoid combat within cities."

Nevertheless, combat in cities occurs because of overriding conditions: The cities are astride major communication, transportation, and fuel lines; cities occupy or control key terrain and mineral deposits; and cities are important as political or economic centers.

In addition, combat in a city may result from its occupation with such a large force as to enable the defenders to use the city as a stepping-off point for a counterattack. Likewise, the city may require such a large force and so much time for investiture and siege operations as to compel the attacker to eliminate the city as a threat. Furthermore, the city and its sprawling suburban area and nearby communities, have made the doctrine of "by-pass and isolate — avoid combat in the city" unrealistic and impossible to achieve. The end result, then, is combat in the city.

Since the city can be transformed into a fortress quickly, the combat frequently becomes a massive slugging match; a battle of attrition, consisting of a great number of individual combat actions. The height of the buildings prevents flat trajectory artillery, even howitzers, from being used effectively except as direct-fire weapons.[1] [2] [3] The streets can be criss-crossed with machine-gun fire of such intensity that infantry cannot move,[4] and tanks and self-propelled artillery become channelized into predictable points (i.e., intersections) where barriers and defensive firepower can be concentrated. In this type of battle, mass and firepower are difficult to apply or concentrate. There is no grand strategy, just a grim house-to-house struggle where victory is achieved by the sum of the individual battles.

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[1] A. K. Shoukilovich, MG; F. I. Konasow, COL; and S. I. Tach, COL; "Combat Actions of a Motorized Rifle Battalion in a City," Moscow (1971).

[2] P. Melnikov, LTC; USSR; "Self Propelled Artillery in Street Fighting," *Military Review* (Feb 46).

[3] G. Menshikov, MAJ, USSR; "Artillery in Street Fighting," *Military Review* (Apr 46).

[4] P. A. de Lara, CPT, Spain; "Attacking and Defending Populated Places," *Military Review* (Oct 44).

The subject of this report is the peculiar nature of camouflage within a city. Cover and concealment for the defending soldier exists almost everywhere within a city: only his fire or movement give away his exact location. For the attacking soldier, every time he moves into the actual attack, he must abandon the cover and concealment that his position offers and expose himself to hostile observation and firepower.

Whether he is the attacker or defender, what can be done to increase the camouflage effectiveness of the individual soldier in a city and what about his equipment and mobile vehicles? Cover and concealment for the soldier was considered previously, but do those statements hold true for his equipment? The consensus of military opinion shows that little in the way of cover or concealment exists in a city for large items of military equipment, unless they can be hidden in a building, garage, tunnel, or bridge underpass.

Structures of modern construction techniques (e.g., buildings of reinforced concrete and steel) are not readily usable to hide tanks or vehicles because of the size of the building entrances and the difficulty in changing these entrances to permit combat vehicles to enter. As these strengthening techniques are applied throughout the modern world, new camouflage techniques must be considered. In addition, basements are part of most modern buildings. A 60-ton tank driven onto the first floor could easily crash through into the basement.

The purpose of this report is to increase the survivability of men and equipment involved in urban warfare. Stated succinctly, the objective in conducting the research was to explore and subsequently propose various modern methods or techniques of using camouflage, cover, concealment, and deception and thus improve the combat effectiveness of US Army forces in urban warfare situations.

II. BACKGROUND

The European Theatre of Operations has experienced growth via urbanization for the past 20 years (see Table, p. 3). The spread of urbanization, marked by an increasingly large complex communication and transportation network has resulted in expansion of the areas occupied by cities. The city of today consists of many central cores and a multitude of suburbs (recently termed megalopolis). Since World War II, the overall effect of this expansion of cities within Europe has been to reduce the amount of land which can be considered rural and devoid of manmade works or structures, including a proportional and significant loss of forest and farm acreage.

Urbanization of Europe*

City	Geographic Location Country	Population in 1,000's 1950	1976	Increase (%)
Bremen	Northern West Germany	390	605	55
Hamburg and suburbs	Northern West Germany	1,682	1,826	9
	(1960)	1,800	2,335	29
Cologne	Western West Germany	768	1,014	24
Dortmund	Western West Germany	537	646	20
Essen and suburbs	Western West Germany	660	702	6
	(1960)	3,975	5,150	29
Frankfurt and suburbs	Central West Germany	547	661	21
	(1960)	975	1,520	56
Mannheim	Southwestern West Germany	284	324	12
Munich	Southern West Germany	828	1,315	37
Stuttgart	Southern West Germany	460	615	34
		1953	1968	
Amsterdam	Western Netherlands	855	1,049	23
Rotterdam	Western Netherlands	697	1,056	51
The Hague	Western Netherlands	584	737	26
Utrecht	Central Netherlands	197	441	124
Haarlem	Northern Netherlands	165	240	45
Eindhoven	Southern Netherlands	148	322	118
		1967	1976	
Danzig	Northern Poland	331	368	10
Warsaw	Central Poland	1,268	1,410	10
Wroclaw	Southwestern Poland	481	569	6
Krakow	Southern Poland	530	665	20

* U.S. Army Infantry School, *Combat in Cities Report, Vol. I and II* (October 1972).

Because of the transportation capabilities of the automobile and truck, the cities of Europe do not possess the high vertical population densities of the past. Instead, the population densities have spread horizontally. Once a city might have had a perimeter of 20 miles and an area of 25 square miles; today the same city, termed an urban area, could possess a perimeter of 60 miles and an area of 225 square miles.

Furthermore, the use of existing transportation routes through the city is of maximum importance when the state of modern high-speed, high-technology warfare is considered. Thus, much to the contrary of "Field Manuals," the city could be the important site in a future war.

Consequently, the NATO countries, with the US Army in particular, will find themselves forced to fight in an urban/suburban setting. Whether the US forces are attacking or defending, urban centers with large areas and perimeters cannot be avoided. No commander would allow a 50- or 100-mile gap between his forces; nor if two cities were close together would he permit his forces to be channeled into the remaining rural area between them. The risks for defeat simply would be too great. Accordingly, whether politicians like it or not, urban centers of Europe will be the site of future battle engagements.

Current NATO battle scenarios call for the allied forces to conduct defensive and delaying operations along the entire eastern front until such time as the mobilization of reserves and the arrival of additional US troops in Europe will permit the allied countries to assume the offensive. In consideration of defensive operations of this type, it becomes clear that, due to their size and their importance as political centers and communication and transportation hubs, the cites of Western Europe and the urban sprawl surrounding them must be incorporated into the defensive line.

In view of the facts, an examination of the potential use for camouflage and deception (in urban/suburan warfare) must be considered. With an accent on delay and defense, it seems appropriate to concentrate on tactical, non-nuclear warfare (including mini-nuclear warfare) in the air-to-ground and ground-to-ground modes instead of strategic warfare.

III. INVESTIGATION

The problem of camouflage and deception in urban warfare was not considered significant until 1974, at which time a potential task area under 1G762708AH67, Combat Support Technology/Camouflage for FY75 was assigned to MERADCOM. Accordingly, in July 1974 a preliminary research and program plan for camouflage in urban warfare was started. This report is a partial result of the research effort on urban camouflage.

Initial research centered on the MERADCOM Camouflage Library and was to identify camouflage and deception methods and techniques from World War II onward. This

research was expanded to include pertinent material such as Combat in Cities Reports and interviews with personnel who have conducted military operations in cities and those who have taught urban warfare courses. The information obtained from this research can be categorized into three historical camouflage and deception areas: Strategic-Aerial (Air-to-Ground Warfare), Tactical-Aerial (Air-to-Ground Warfare), and Tactical-Ground (Ground-to-Ground and Sea-to-Ground Warfare).

In the first category, Strategic-Aerial Camouflage and Deception, the United Kingdom and Germany provided numerous examples of what should or should not be attempted in regard to camouflage. The United States, except for some camouflage efforts in Washington, California, New England, and several states primarily on the East and West coasts, never had to fully develop or deploy strategic camouflage.

The United States' inaction stems from the fact that the continental United States was never attacked by air. Thus stragetic camouflage efforts of the Corps of Engineers[5] were never tested and by late 1943 were severely curtailed due to the absence of a realistic threat. Funding authorizations for the camouflage of plants and factories in the United States during World War II (primarily in 1942-43) amounted to $95 M of which $49 M was expended.

The camouflage effort of the United Kingdom was better documented than that of Germany. In fact, much of the German camouflage effort was actually reported by the British, thus, only the worst cases of German camouflage were regularly reported. The best of the German camouflage was not readily discovered; consequently, it is not discussed exhaustively in British literature. Fortunately, several documents discussing German camouflage efforts and philosophy were available.

The British in their report entitled, "Camouflage of Vital Factories, Key Points, and Landmarks, 1939-45," present a superb appreciation of the value of good camouflage versus ineffective camouflage. The United Kingdom in an effort to reduce wartime destruction of factories, surveyed all key production plants, then evaluated them as to cost of material necessary in achieving *effective* camouflage. The factories were divided into classes, as those requiring paint only, those needing paint and landscaping, those needing extensive camouflage including camouflage nets, and those impossible to camouflage because of size, configuration, or nearness to large natural terrain features.

The British camoufleurs placed strong emphasis on denying visual target acquisition and deceiving aerial reconnaissance. Thus much of the British effort in regard to factory camouflage was designed to defeat bomber attacks of World War II. The ideas presented in the discussion section of this report on flame and fire simulation and bomb damage simulation can be traced historically to British factory camouflage.

[5] U.S. Army Corps of Engineers, *History of the Development of Camouflage Equipment, Part IV, Camouflage of Air Corps and Industrial Installations*, Fort Belvoir, VA (1 Jun 47).

Part of the deception effort involved construction of decoy airfields[6] near real airfields. The decoy airfields were so realistic that friendly aircraft occasionally landed on them. Simulated activities were conducted on these decoy airfields to confuse the Germans into dropping more bombs on the decoys than on the real airfields. This deception is remarkable when one considers that given one target, 100 percent of the bombs dropped could fall on the target. (Of course, some bombs usually miss the target entirely.) When one additional target is added — a decoy of extremely fine deceptive quality — one of three occurrences can be expected:

- All bombs are dropped on the real airfield.
- All bombs are dropped on the decoy airfield.
- A percentage of the bombs are dropped on each airfield.

Depending on the number of airfields, the camouflage of the true airfield, and the realism of the decoy airfield, the course of operations will turn toward the third option with an expected 50 percent of the bombs dropped on each target. The British, however, conducted such simulation and deception efforts as to create a favorable 60- to 40-percent ratio (approximately) of bombs dropped on decoy vs real airfields. For night deception,[7] the U.K. created several decoy airfield landing light sets[8] and developed a system of bonfires near enough to a real target so German night bombing raids were not noticeably off course.

The German effort at industrial camouflage appears to have been more intense than the British effort. This was probably due to combined British/American aerial bombardment by long-range heavy bombers. The German camouflage attempt was large in scope and attempted some large projects (see Figure 1, Camouflage of Hamburg Habor Area). The German effort, however, failed on some of the largest projects because a clear delineation was not made between effective and poor camouflage. As an end result a large expenditure of paints, nets, and manpower resulted in little or no return in regard to reduced destruction of the facility.

The failure was caused by several reasons, such as nearness to large manmade objects and natural terrain features, plus a disregard for concealing the camouflage effort from aerial reconnaissance. The aerial reconnaissance thereby permitted the British to follow the German camouflage attempt from start to finish, negating much of the German effort.

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[6] U.K. Army, The Decoy Protection of Britain, *Military Review* (Sep 46).

[7] United Kingdom, Ministry of Home Security, "Camouflage of Vital Factories, Key Points, and Landmarks, 1933-45" (Aug 45).

[8] David P. Johnson, *Development of Simulation Decoy, Lighting Equipment Set No. 2, Generator Operated, Assault, Combat Engineer, 1500 ft, Portable*, U.S. Army Engineer Research and Development Laboratories (Oct 54).

Figure 1. Camouflage of Hamburg Harbor area.

Hamburg taken on 8.4.41 H/816. No 932. The whole of the Binnen Alster is being camouflaged to resemble a built-up area with a canal running through it; while a replica of the important rail and road bridge between the Burlon and Ausser Alster has been constructed about 600 yards north of the original bridge. The aim is to protect the bridge which forms the vital link between two main Hamburg marshalling yards. The camouflage consists of painted material sketched on rafts and the whole scheme effectively reproduced the Binnen Alster in the Aussen Alster.

Part of this failure was the result of German emphasis on decoying the visual target acquisition of the pilot or bombardier, with less emphasis on denying information to or deceiving enemy reconnaissance. Of course, some of the German camouflage attempts were primarily aimed at the psychological aspect: that is, to convince the people that active attempts were being made to prevent death or injury by aerial bombardment.

On the whole, however, it appears that many of the poor camouflage attempts were sincere efforts by personnel who only dimly understood the principles of camouflage. Therein, the Germans surfaced a flaw that still exists: The instantaneous camouflage expert, who with little or no training, starts designing camouflage and deception schemes with a total disregard for reason or common sense.

The German technique of dispersal seems to have outstanding deceptive results. Dispersal of industrial units into hidden or inconspicuous buildings created a shadow industry which was difficult to destroy by one air strike. (Of course, dispersion created its own problems of cross transportation and assembly for the Germans, but that is outside the scope of this report.)

A key lesson for the camoufleur to learn is that dispersion of key facilities is more effective than camouflage for *known* factory locations. Dispersion of key facilities becomes

more effective when conducted in conjunction with camouflage and deception. In this regard, the vital industry must be moved via deception and camouflage to dispersed buildings and locations. The old location must be maintained in its original condition via deception and the new locations must be camouflaged to conceal new missions. (By "camouflaged," in this context, we mean they should not become conspicuous in their new missions.)

Thereby, the enemy continues to perceive the target in its original location. Accordingly, the aggressor will concentrate air power on the acknowledged target and will not expand reconnaissance resources looking for a new target. Thus the aggressor will waste munitions and aircraft on a worthless target.

A prime example took place in the French theater from 1943 to 1944. After Penemunde, British reconnaissance detected and correctly identified the V-1 rocket bomb ramps in Northern France.[9] In the fall of 1943, the Allies began an intensified bombing effort that dropped over 31,000 tons of bombs during the period December 1943 to June 1944.

The German High Command realized the vulnerability of the old design V-1 rocket ramps and decided to construct new mobile launch ramps. However, to deceive the British and Americans, construction was continued on the old ramps with various appropriate but faulty camouflage efforts and concentrated air defense. The Allies[10] continued their air attacks on the old style ramps, realizing their mistake only a few days before the start of the V-1 attacks on London. Field Marshal Mil Kh, General Inspector of the German Army, remarked that "The British and American aerial attacks on the V-1 ramps were important to us because it relieved pressures on other vital war munition areas while failing to delay the real construction of the new V-1 ramps."

The smoke screen was another method of deception used to hide the target from aimed bombing attacks. Both the British and Germans used smoke extensively to conceal vital targets such as key buildings, bridges, oil storage depots, and military installations. The smoke generation units were of two types: fixed (semi-permanent) and mobile. The mobile units (such as the U.K. Haslar) were mounted on trucks and could be moved during a battle to new locations to concentrate their smoke in various areas or to take advantage of the wind.

The problem with smoke screen was that in terror or mass bombing raids, the smoke screen was ineffective. In these raids, where the city itself was the target, rather than a particular bridge or factory, the random nature of the bomb attack negates the ability of

[9] D. Sandy, MP, UK, "Report on the Flying Bomb," *Military Review* (Dec 44).

[10] COL A. S. Orlov, USSR, "Battle Against Winged Rockets," *Antiaircraft Defense Herald*, Moscow (May 71).

the smoke to deny visual acquisition of particular targets. The smoke, itself, if concentrated in one area of the city can be used as a guide by the bombing aircraft to concentrate on the most vital areas in the city. This could result in those areas with smoke screens receiving the heaviest bombing effort.

A continuing smoke screen, however, will make a damage assessment of the area difficult if not impossible by follow-up bomber or reconnaissance aircraft. The end result is the possible over-kill or under-kill of the target. Since smoke screens can be used by attacking aircraft to guide their attack, they can also be, and were, used as part of a deception plan to draw the bombers off target into non-vital areas.

The second category is Tactical-Aerial Warfare Camouflage and Deception (air-to-ground). During World War II, the Germans and Russians provided the preliminary examples of this type of camouflage effort, with the US, British (except for El Alamein), and others performing efforts of less frequency or scope. The most recent examples of the use of camouflage, camouflage patterns, nets, and decoys were observed in the Arab-Israeli wars.[11]

In tactical-aerial camouflage, we are still concerned with aerial reconnaissance, target acquisition, and air attack, but the potential targets have shifted from factories, oil production and storage facilities, and key manufacturing facilities to targets of a more mobile or transient nature such as military depots, artillery batteries, airfields, bridges, and various military units such as Armor, Infantry, etc. The destruction of these targets has a more immediate impact on the battle but not necessarily on the war. However, they can frequently spell the difference between local success or failure.

One interesting factor in regard to air-to-ground warfare is that the speed of the attacking aircraft in the visual attack mode has not changed significantly. The speeds of World War II aircraft were 250 to 450 knots when attacking ground targets. Although modern jets are capable of speeds far in excess of 450 knots, the capability of seeing small targets at speeds greater than 500 to 600 knots is very low. In addition, the reaction time to ground obstacles such as trees and hills is small. Conversely, at speeds below 200 knots, the vulnerability of the aircraft appears to increase and, of course, the jet aircraft become aerodynamically sluggish and approach stall speeds. Therefore, it appears that there is an aerial-attack speed window at which aircraft can engage ground targets with maximum effectiveness and minimum danger to themselves.

The British camouflage and deception effort at El Alamein is well documented and will not be repeated here. The British effort illustrates that camouflage and deception if used assiduously is possible in arid desert areas even when the reconnaissance possibilities are superb.

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[11] Central Intelligence Agency, *Camouflage in War and Intelligence* (Apr 68).

Tactical camouflage as practiced by the Germans and Russians emphasizes the denial of target acquisition. However, the documents and records illustrate that when counter target acquisition and camouflage were used in conjunction with deception in denying aerial reconnaissance, the success achieved in the ensuing battle was significantly greater.

The scope of tactical camouflage and deception operations as practiced by the Russians in World War II is attested to by one operation of the 2nd Ukranian Army Group[12] in the spring of 1945. In this operation, 2500 men were employed for 5 days and nights erecting 122 km of camouflage screens on lateral and radial roads, 55,000 m^2 of artillery drape nets, 100 dummy tanks, and 60 dummy artillery positions.

The size of this operation during World War II was not unique; however, in recent years little has been done on such a large scale. One exception is reports (unofficial) that in the 1973 Arab/Israeli War, a number of Arab aircraft and SAM decoys (Figure 2) were used to draw Israeli aerial attackers into anti-aircraft kill zones. (Note: The reported Arab use of decoys does not appear to have been coordinated into a deception plan or grand strategy; the decoys appear to have been used strictly to dilute the effectiveness of Israeli air power.)

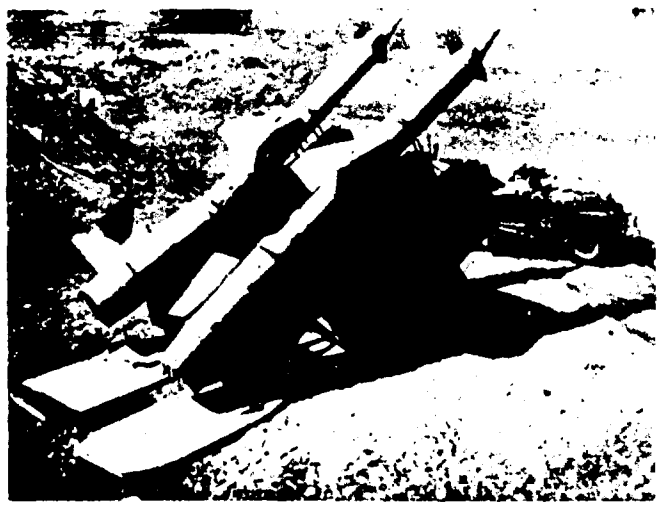

Figure 2. Arab decoy SAM site.

[12] LTC Minontsev, USSR, Tactical Division, Red Star, *Military Review*, Vol VI—No. 1 (Apr 46).

In regard to tactical camouflage, the Germans in World War II camouflaged their motor vehicles and tanks[13] in populated places by building extensions with overhanging roofs into the sides of existing buildings. The walls and roofs of these extensions were made of straw and wood or other natural construction materials.

Other examples of German tactical camouflage involved trains and oil storage cars disguised to look like boxcars and flak (AAA) guns hidden in haystacks, boxcars, and false buildings. The use of autobahns as runways for aircraft complete with hidden aircraft hangars and taxiways, plus the use of artificial spotting of airfields in arid, open fields creating dark areas where aircraft could be hidden among the many other dark spots (useful primarily against high-altitude bombing) and decoy aircraft.

The use of smoke was discussed earlier; however, with regard to mobile units a new turn is taken. Smoke canisters were attached to the vehicles themselves[14] and detonated upon command.

In the third category, tactical ground-to-ground camouflage, the effects of lateral line-of-sight and weapon blast must be considered. The ranges are usually short and are very short within the city. The primary method of target detection was and still remains the *visual* mode. This method of detection has recently been supplemented with thermal infrared (IR), passive night vision devices, active IR, and radar.

In World War II, the Germans were adept at camouflaging strong points in cities. These strong points were bunkers and pillboxes frequently camouflaged to look like buildings (Figure 3).[15]

Unfortunately, even though the literature discusses ground-to-ground camouflage, few pictures or reports exist on the topic. Two recent reports that go into some discussion on the topic are:

a. U.S. Army Infantry School: Combat in Cities Report; Vols. I, II, and III; Fort Benning, GA (1972).

b. U.S.S.R. report, "Combat Actions of a Motorized Rifle Battalion in a City," MG A. K. Shovkilovich, COL F. I. Konasov, and COL S. I. Tkach, Moscow (1971).

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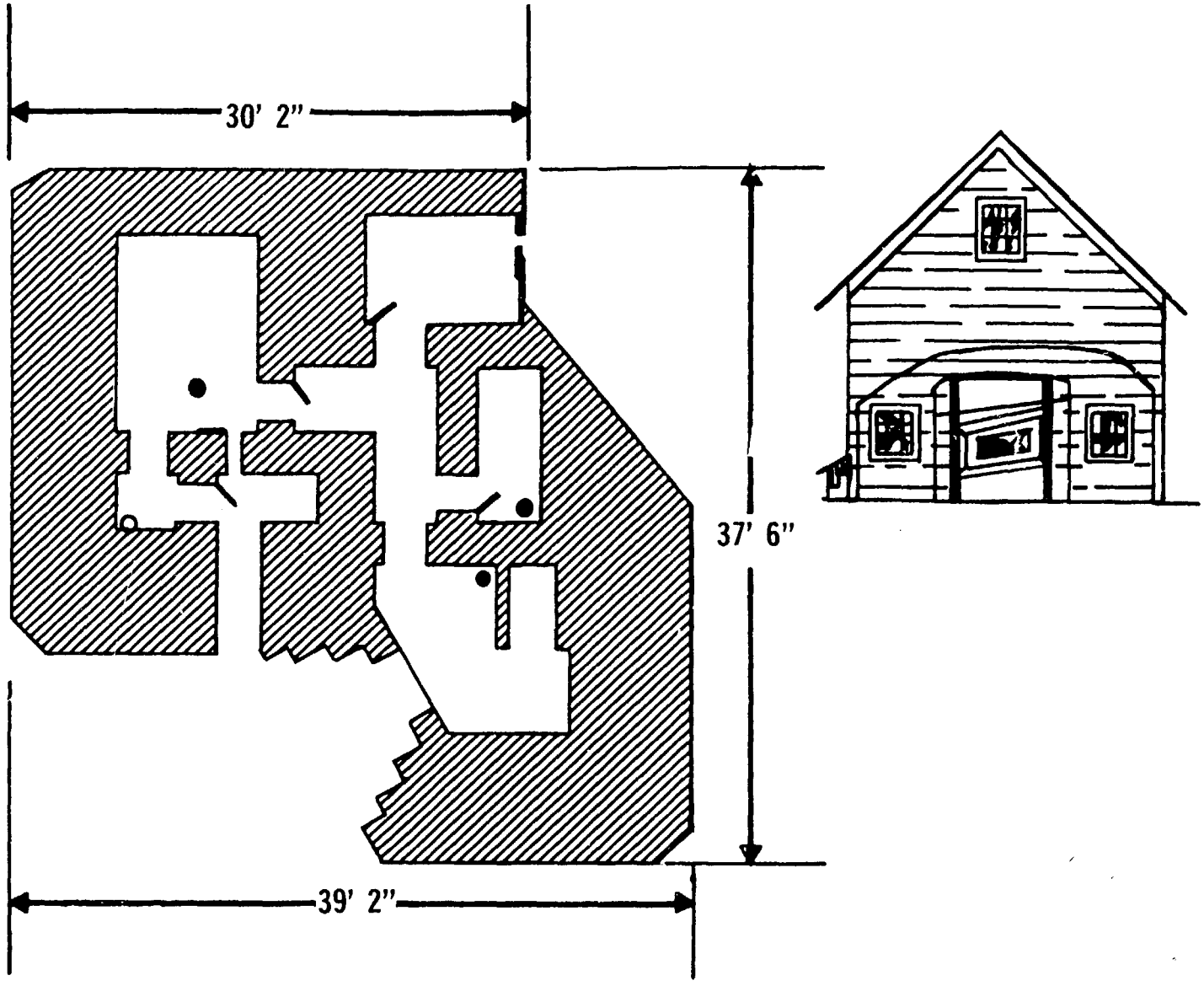
13 CPT L. T. Komenev, Camouflage Techniques of German Air Forces, Vestnik Vozdushnogo Flota (Aviation Journal), USSR, 1943, translated by C&GS, Fort Leavenworth, KA, *Military Review*, Vol XXIV — No. 2 (May 1944).

14 Region, G., New Developments in the German "Tiger" Tank, *Military Review* (May 1944).

15 LTC John E. Kelley, USA, "The Pillbox — A Trap," *Military Review* (Aug 1945).



GERMAN DECOY PILLBOX

Figure 3. Diagram of German pillbox disguised as a house.

These reports discuss such items as dummy positions, cover, multiple firing ports (so that the enemy will not know which hole the fire is coming from), and smoke agents. However, these reports do not provide significant detail with regard to the utilization of camouflage as a deceptive tactic.

The Germans[16] in World War II and, in particular, the Russians[17] [18] emphasized the heavy use of smoke in warfare. The smoke agents are used by the attackers or defenders to conceal the maneuver of men and weapons between strongpoints or, when placed on the enemy, to blind them from observing and conducting aimed fire on the attacking troops.

The use of special urban camouflage uniforms or items is not evident except for a reference to the World War II U.K. urban camouflage sniper's outfit. The Germans and Russians, however, did make use of body nets for summer and white camouflage uniforms with capes for winter. In addition, the Soviets used specially trained troops for urban warfare in the final phases of World War II. Decoy tanks[19] and artillery in defensive positions were occasionally used by all sides to make the defense appear stronger than it was and to draw enemy fire; however, decoys as such were mainly used to influence enemy aerial reconnaissance and attack. In this regard, decoy tanks, artillery, and trucks were made of all types of materials from rock, wood, and canvas to rubber[20] [21] [22] (see Figures 4, 5, and 6).

Recent decoy efforts have expanded upon the technology and techniques of World War II into hard-shell plastics and compressible foams while retaining the old standbys of wood, fabric, and inflatable rubber.

IV. DISCUSSION

A. Goals for Urban Camouflage and Deception. In view of the historical examples, certain deployment principles of camouflage and deception in urban areas are apparent:

- The camouflage must be effective.

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16 LTC Mirontsev, USSR, "Tactical Diversion," *Military Review* (Apr 45).

17 Kugelen (Germany), "Smoke Trail Mortars," *Military Review* (Nov 43).

18 LTC G. Khanat-ki, "Smoke Screens in Tank Operations," *Military Review* (Aug 45).

19 U.K. Army, "Dummy Tank," *Military Review* (May 46).

20 U.S. Army Engineers, "Rubber Decoys," *Military Review* (Aug 46).

21 Martin J. Damgaard, "Simulation Devices, Prefabricated, Pneumatic High-Fidelity, Tube Type HIRAM," U.S. Army ERDL Report 1251, Fort Belvoir, VA (Sep 52).

22 Jacob L. Barber, "Low-Fidelity Simulation Devices, Code Name, "Lois," U.S. Army ERDL Report 1375, Fort Belvoir, VA (Sep 54).

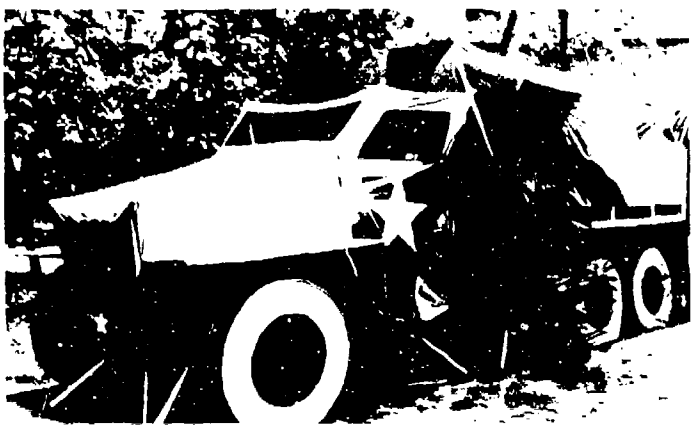


Figure 4. US Army simulation device, very low fidelity, pneumatic superstructure truck, painted canvas.

Figure 5. US Army simulation devices, low-fidelity, pneumatic, Howitzer, 105-mm with carriage, and tank, light with 76-mm gun.

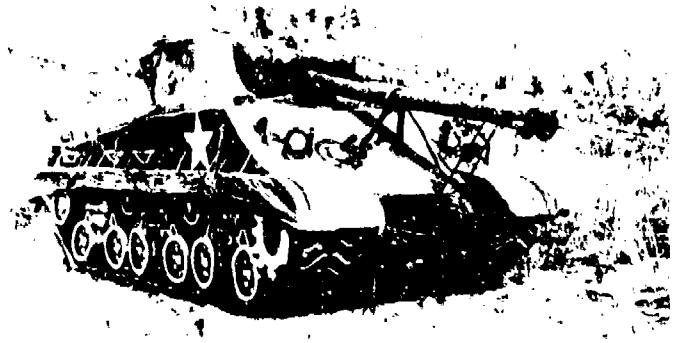


Figure 6. US Army simulation devices, pneumatic, high-fidelity, tank medium, M4A3, with 105-mm gun, and medium-fidelity, cannon 280-mm (atomic cannon).

- The camouflage or decoy used should be inexpensive compared to the real item of equipment.

- The camouflage or decoy used should require less material, time, and effort to set up or emplace than it costs the enemy in time and material to detect or destroy it.

The effectiveness of the camouflage or deception is of prime importance. Unless camouflage is effective it is worthless. In fact, it will spread a false sense of security and consume valuable time, effort, and materials. Examples cited earlier concerning German camouflage attempts for local political reasons are empty gestures which soon demonstrate the hypocrisy and foolishness of the authors.

Ineffective camouflage should never be allowed, even when it is part of a deception scheme. Troops should never be permitted to practice poor camouflage, because they will learn lessons that are difficult, if not impossible, to forget. Rather, if a particular deception scheme calls for poor camouflage or deception on the part of a unit, it must be planned. If a unit is to be detected on purpose, the camouflage mission must be to gain that detection by the enemy; it must not be left to chance.

The cost of the camouflage should be less than the cost of the real item, unless its *discovery* would materially affect the course of the conflict. For example, a $600.00 camouflage net should not be used to hide objects of less value than the net, unless those objects are of a critical nature or their discovery would lead to the detection of other nearby items of high value.

Likewise, a decoy should always cost less than the real item. This is particularly true in regard to decoy items specifically designed and emplaced to be fired on and destroyed by the enemy. In that instance, the decoy should achieve a deception in the mind of the attacker but should cost less (totally) than the bombs, rockets, aircraft, fuel, etc., used by the enemy force to destroy it.

B. Achieving Camouflage and Deception in Urban Areas. Achieving a good camouflage and deception posture in urban warfare depends on training and equipment. Unfortunately, in both of these areas the Army is unprepared. If certain units were designated in advance as urban combat units, their equipment and training and, in particular, their camouflage and deception equipment could be more specialized.

It is clear that Camouflage and Deception for Urban Warfare provides the defending or delaying force, with many opportunities to increase its combat effectiveness. This situation is particularly true for areas where some time is available to prepare the defense.

As stated previously, the individual soldier has more than adequate cover in a city. However, when he fires his weapons, he reveals his position. Therefore, a soldier's camouflage should be oriented toward diluting the effectiveness of the enemy's counter-fire and retaining a concealed position.

Dummy and decoy positions utilizing lightweight camouflage material must be developed for the soldier's use, causing the enemy to distribute his fire over several locations rather than concentrate it in one area. Likewise, specific camouflage gear must be provided to reduce or mask weapon noise, and the dust raised by firing in rubble-strewn areas must be eliminated. Glint and shine from equipment must be modified to blend into the the city's background. Glare from glasses, binoculars, or infrared or night vision devices must be eliminated. The soldier's uniform must be colored, patterned, and textured to match the type of building construction materials used in the city in which he is fighting.

An urban setting does not provide many areas for concealment of a tank, artillery piece, or wheeled vehicle. While some vehicles may be hidden in buildings or under bridges, etc., the number of areas suitable to hide a tank are small. Thus the tank in an urban area must carry its own camouflage net and must be supported with additional camouflage and deception equipment such as false buildings, false camouflage nets, and decoy tanks.

The basic purpose for a tank in the urban setting is to provide counter attack capability. Thus a tank's camouflage and deceptive gear initially must be oriented toward the static mode and provide protection against aerial reconnaissance, target acquisition, and attack. The survival of the tank, as the key element to be used in the land battle to come (ground-to-ground), must first survive the air-to-ground attack made by the enemy. Its survival should be a prime objective of urban camouflage. In the actual land battle, as emphasis shifts from the air attack to the ground attack the tank must be provided with sufficient smoke and noise camouflage to mask its approach into the immediate battle area.

In the Soviet concept of urban warfare, tanks and self-propelled (SP) artillery are used in the streets to speed up the attack and to help the infantry storm strong points. Barriers and the camouflage and deception of these barriers are needed to slow and channel the attacking armor and self-propelled artillery into selected kill zones. Landmines, particularly scatterable landmines, have a great potential for use in urban warfare, provided the depth and extent of the mined areas can be concealed from advancing enemy troops. In a similar manner, decoy landmines combined with real and decoy dragons teeth can effectively reduce enemy attack options.

Paragraphs C and D contain a number of ideas presenting camouflage materials and equipment or techniques for use in urban and suburban areas. These camouflage and deception ideas were derived from the historical records and from a study of the camouflage needs of today's Army equipment.

Some of the techniques and ideas have been nearly forgotten but are just as valid today as in World War II. Others are capable of new usage based on the advances of technology or are adaptations of old techniques to new materials and equipment. Still other ideas are original and have never been used. These ideas or techniques are described as projects, in that, a separate effort is envisioned as being necessary to bring each one to fruition.

C. Camouflage and Deception Materials and Techniques for Use in Urban/Suburban Areas. The following items are proposed for use in urban and suburban areas:

1. Urban Camouflage Colors. This project would develop paints suitable for use in an urban environment. Colors such as gray (several shades), dull brick red, sandstone, brown (several shades), and several tar/concrete shades would be produced in enamel paints. The paints would be produced with a tinting capability so that the paints could be recolored in the field to better match the terrain.

Tests would be conducted in several urban settings utilizing various vehicles to evaluate the value of urban camouflage colors vs field/forest camouflage colors. Aerial and ground observations would be made comparing the camouflage effectiveness of the various colors in hiding or reducing the detectability and vulnerability of the vehicles.

Upon conclusion of the tests, a recommendation would be forwarded to DARCOM and DA concerning their recommended use in urban areas.

The paint, as a minimum, would be added to the inventory of available camouflage colors.

2. Urban Camouflage Patterns. This project would develop various camouflage patterns for use in urban areas. Patterns would include harsh and soft geometric patterns as well as soft, random curves utilized in the current Army field camouflage patterns.

Aerial and ground observation tests would be conducted in several urban areas utilizing various vehicles (i.e., tank, APC, truck) to evaluate the value of the geometric vs random curve camouflage patterns. It is believed the value of the test would be enhanced by simultaneously testing urban vs field camouflage colors.

Upon conclusion of the testing, a recommendation would be made to DARCOM and DA whether to use urban camouflage patterns and colors on vehicles designated for defense of urban areas.

3. Urban Camouflage Net (Drape). This project would develop the coating and colors for an urban camouflage net. Prototype nets utilizing geometric and random patterns with urban camouflage colors would be produced. The lightweight camouflage net and base cloth would be utilized as much as possible. The present pole and support system would be utilized, modified to be free-standing with limited (no stakes) tiedown points (Figure 7).

Upon development of the prototype net and modified support system, tests would be conducted in several urban settings to test the value of the urban camouflage nets vs regular camouflage nets. Both aerial and ground observation would be utilized.

Upon conclusion of the test, a recommendation would be made to DARCOM and DA on whether to fully develop and field an urban camouflage net.

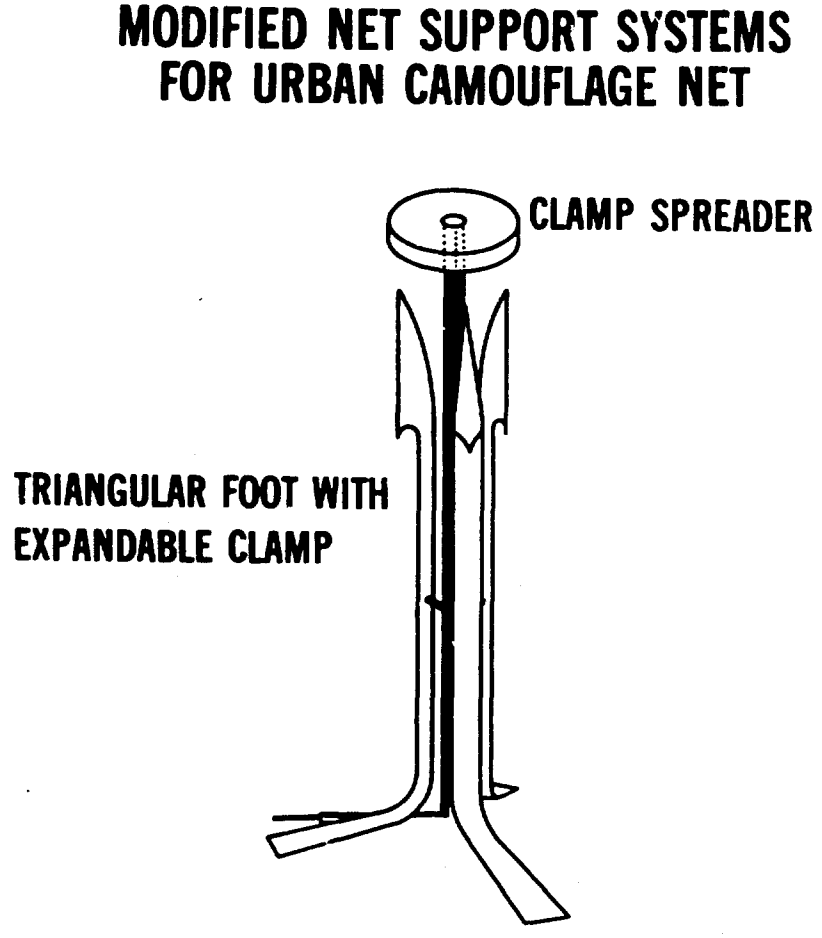


Figure 7. Modified net support system for urban camouflage net — triangular foot with expandable clamp — clamp spreader.

4. Urban Flat-top Net. This project would develop an urban camouflage net of flat-top design (Figure 8) with the camouflage material thinned on the edges. Prototypes of patterned vs solid colors would be utilized in the net material. The pole and support system will be modified to be free standing, with limited (no stakes) tiedowns.

Upon development of the prototype, aerial observation tests, *only*, would be conducted. The objective of these tests would be to evaluate the effectiveness of this type of net in an urban environment relative to no camouflage and to regular camouflage nets. A flat-top net shows great promise for use in an urban area because the height of buildings will preclude oblique aerial reconnaissance. Accordingly vertical photography and visual detection can be considered the primary reconnaissance threats.

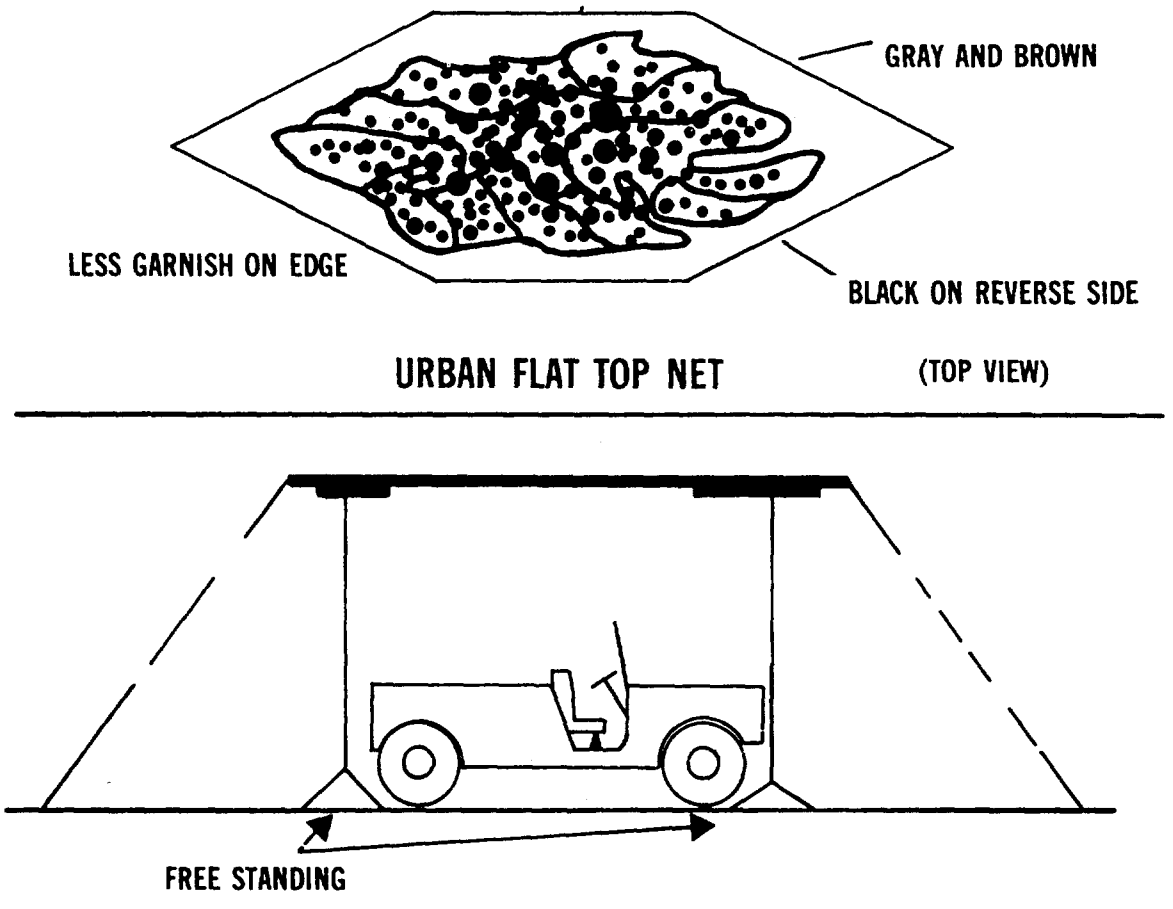


Figure 8. Urban flat-top net — top and side views.

5. Pseudo Masonry Landmine. This project would develop various coatings for use on antipersonnel and antitank landmines. The coating will give scatterable and other types of landmines the appearance of brick, cinderblock, or masonry.

Distributed semi-randomly on streets and highways among other real rubble, the pseudo masonry landmine (Figures 9 and 10) would create confusion in the mind of an enemy tank commander forcing him to go slow or use mine-clearing equipment/explosives rapidly.

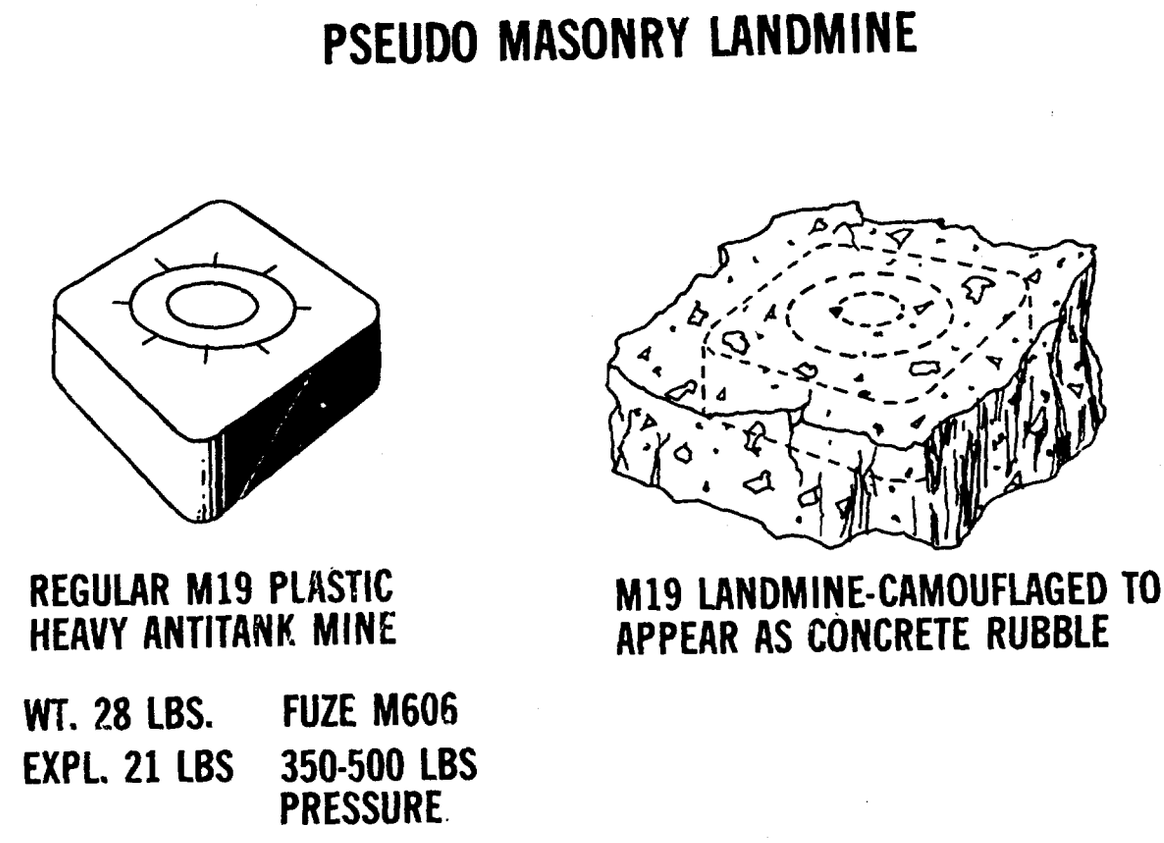
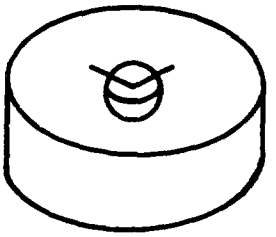


Figure 9. Pseudo masonry landmine M19.

PSEUDO MASONRY LANDMINE



REGULAR M6A2 MEDIUM METALLIC ANTITANK LANDMINE

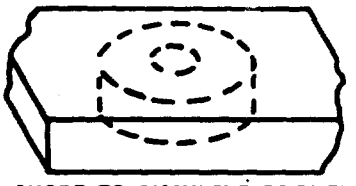
WT—20 LBS

EXPL—12 LBS

FUSE M603

FUNCTIONING 300 TO 400 LBS PRESSURE

PLASTIC-TEXTURED & COLORED TO SIMULATE CONCRETE



IRREGULAR SHAPE TO SIMULATE BROKEN CONCRETE

Figure 10. Pseudo masonry landmine M6A2.

6. Penlight Smoke Stick. This project would develop a penlight-size smoke canister. The smoke stick will utilize the methodology and technology presently developed for the beer-can-size instantaneous smoke canister. A size reduction to that of the average penlight flashlight would be made, the average size should be 6 inches long by ¾ inch diameter with a fuse at the one end. Upon arming the penlight smoke stick, the soldier would have 4 to 6 seconds to place the device before it ignited. The stick would put out an intense volume of smoke for 5 to 15 seconds without causing a fire in the building.

The penlight smoke stick would be used in urban warfare, that is, in building-to-building and room-to-room battles. It would be used to provide smoke cover to individual soldiers assigned the task of clearing the building of enemy soldiers. Due to the light weight and small size of the penlight smoke stick, several could be carried on each soldier. If the soldier needed to cross a hall or doorway where the security was doubtful, he could ignite a penlight smoke stick to provide cover. The present method of operation is to use a hand grenade or continuous rifle fire. Both of these current methods consume large quantities of ammunition and do not provide the protection from aimed fire that a smoke cloud would provide.

7. Decoy Building. This project would develop lightweight prefabricated decoy buildings of various materials such as metal, wood, and/or cloth over pipe. The decoy is envisioned as a one-story structure, designed to split open as illustrated in Figure 11 permitting rapid movement by a vehicle or firing by a AA or SAM unit from within the structure.

The decoy building would be used in an urban or airfield setting to conceal equipment such as tanks, self-propelled artillery, and antiaircraft weapon systems. In particular, VULCAN or CHAPARRAL air defense weapons could be concealed within the structure. Upon attack, the structure's roof and/or roof plus sides would slide open to permit the air defense system to engage the enemy aircraft.

DECOY BUILDING HIDING VULCAN

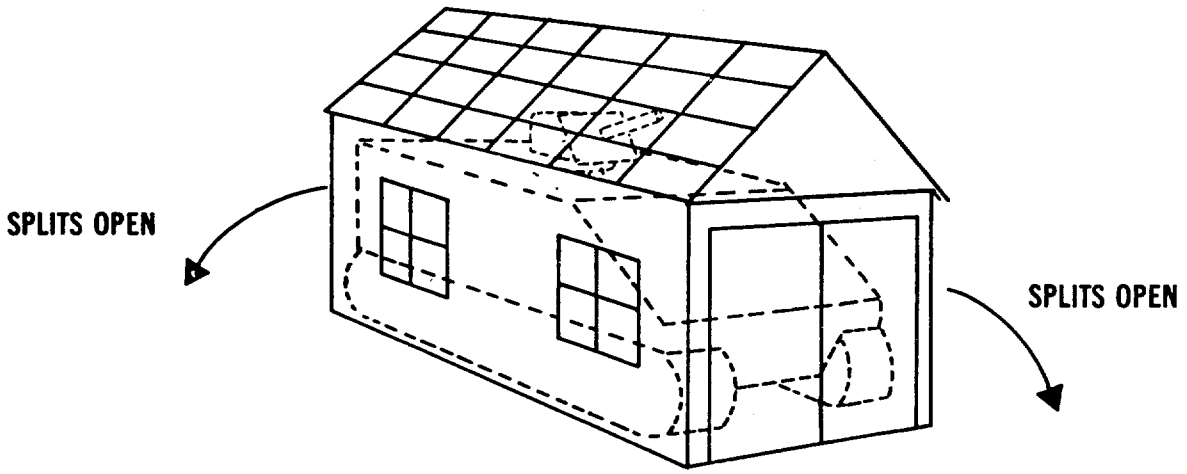


Figure 11. Decoy building — hiding Vulcan.

8. Camouflage Set/House Extension. This project is to develop a camouflage set to extend the side of a house. The set is envisioned as containing a free-standing support system and cloth roof and walls for up to three sides (Figures 12 and 13). The cloth roof and wall would be colored and textured to appear similar to real masonry walls and roofs.

The house extension camouflage set would be utilized in urban/suburban areas where buildings exist, yet where camouflage nets cannot be utilized effectively. This set would be used to hide items such as tanks, APCs, artillery, or trucks by extending the sides and roof of a building.

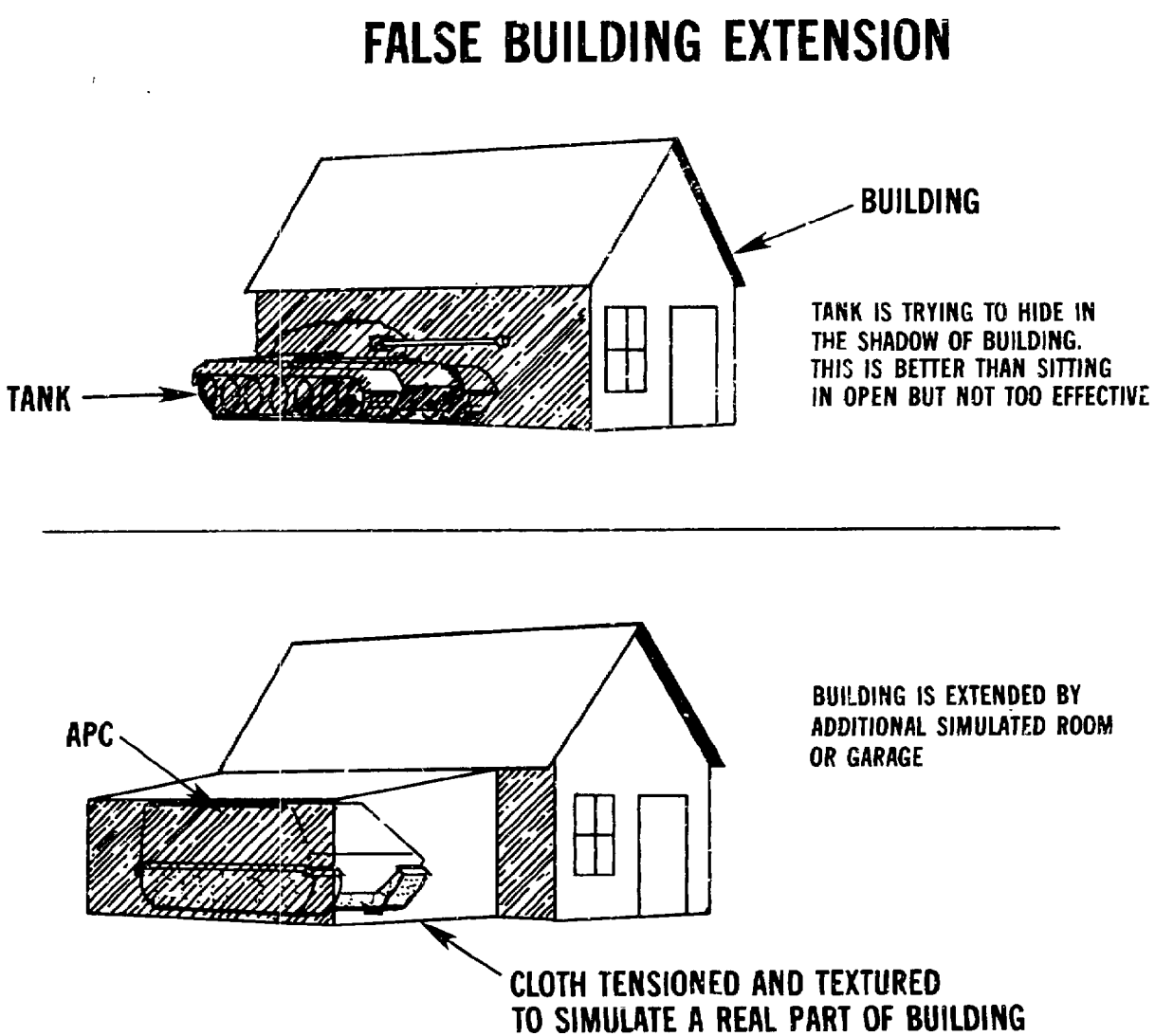


Figure 12. Camouflage set/house extension — oblique.

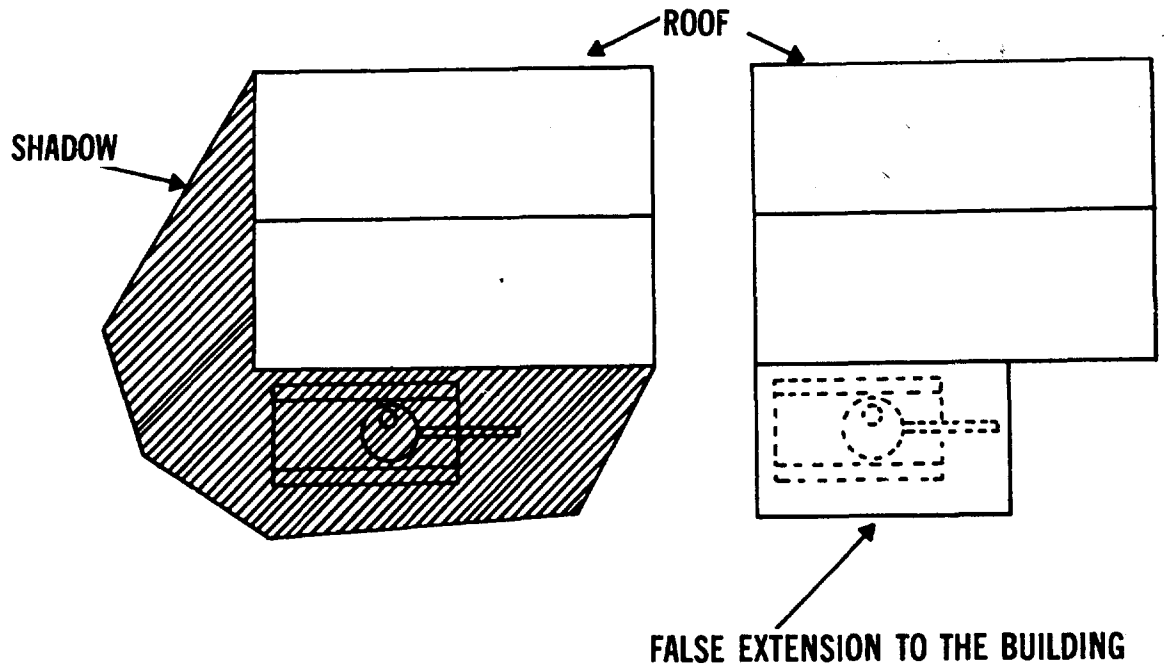


Figure 13. Camouflage set/house extension — vertical.

9. Brown (Dull) Coated Communication Wire. Communication wire is currently coated with a shiny black plastic coating. This project would develop a dull brown coating.

Communication wire has been used heavily in urban warfare where multistory structures interfere with military radio transmission. This wire has been primarily coated with black rubber/plastic sheathing. A dull brown coating will make detection of the wire much more difficult, a factor important in close-in urban fighting.

10. Foam Camouflage for Landmines. This project would develop a high-persistence, water-based foam and a portable foaming unit (Figure 14). The foaming unit would be trailer mounted and would be towed by a 5-ton water tanker. The portable foaming unit, utilizing water from the city fire hydrant system or the water tanker would provide water at operational pressure to the foaming nozzles. There the water would be mixed with detergent and made into a high-density foam. The foam would then be blown out by a directional fan/nozzle arrangement.

The high-persistence foam would be emplaced in city/urban area streets to cover (camouflage) scatterable antitank and antipersonnel landmines. Conversely, mines of the air-scatterable type could be emplaced after the foam was emplaced. The foam could be employed without landmines under it as a decoy device.

TRAILER MOUNTED FOAMING UNIT

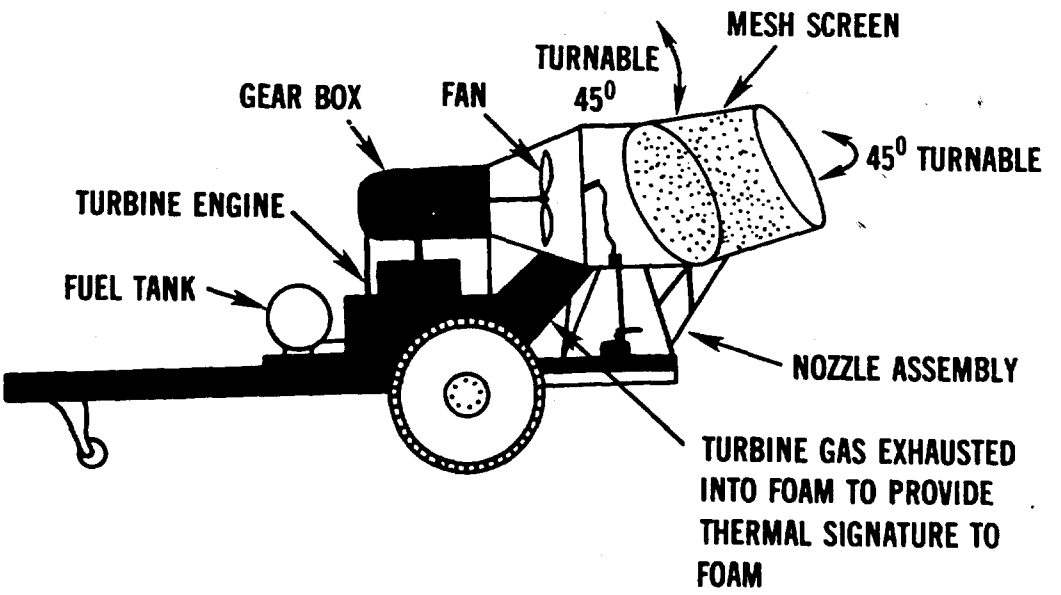


Figure 14. Trailer-mounted foaming unit.

11. Acoustic Grenade. The project would develop a small portable device which would emit intense sound. The device would be about the size of a hand grenade. The sound grenade would emit a continuous, selectively changeable, high-pitched sound (whistle) by means of a battery and motor or a fuel-propellant stick turning a siren-type noise emitter for up to 5 minutes. The sound intensity should be adjustable to as high a volume as required to disorient or damage an unprotected ear drum in an enclosed room.

The sound grenade would be used to cover by noise the movement of men and material (i.e., tanks, APC, etc.) in an urban environment. In addition, it could be used to draw attention to itself. Used as a strip flare or in conjunction with an acoustic or thermal sensor it could signal the entry of intruders into unguarded part of a building. The constant sound would be a means to aid the defensive forces to home in on the position of entry of the intruder.

12. Glue-on Rubble. This project would develop a glue to attach broken masonry to the metal surfaces of combat vehicles. The glue should have good metal-to-rock adhesion, be applicable in the temperature range of 40° to 120° F. The rubble would add color and texture to the surface of the vehicle. The glue should be removable by application of a proper solvent.

The glue would be used to attach rubble from the urban area to vehicles (in particular, tanks and APCs) operating in the city to increase their camouflage.

13. Decoy Urban Camouflage Nets. The project would develop a low-cost, super-thin, lightweight decoy urban camouflage net (Figure 15). This net is envisioned as being approximately 1/10 the weight, cost, and bulk of the present camouflage net. Coloration and texture would be similar to urban net. The support system would be reduced in weight by using air-inflatable poles. The net will consist of colored cloth with a border tie rope but no actual netting.

The decoy net would be employed in urban areas to dilute the effectiveness of enemy attacking aircraft. Based on analysis and availability, one to four decoy nets would be utilized for every real net. The decoy net would be used in areas where camouflage effectiveness against detection is low but where camouflage against identification is still desired.

The decoy net would be used in a situation where it is impossible to successfully hide equipment, such as an Armor Platoon (5 tanks) which would use 5 regular nets. With sufficient additional decoy camouflage nets (possibly 10), the enemy is presented with the problem of destroying 15 targetable camouflage nets, only 5 of which have real targets under them. If the enemy has unlimited offensive capability, all we have succeeded in doing is to cause him to expend valuable ammunition and waste time and effort. However, if the case exists where the enemy has a limited offensive capability, the additional decoy nets will substantially reduce the probability of destruction of all 5 tanks.

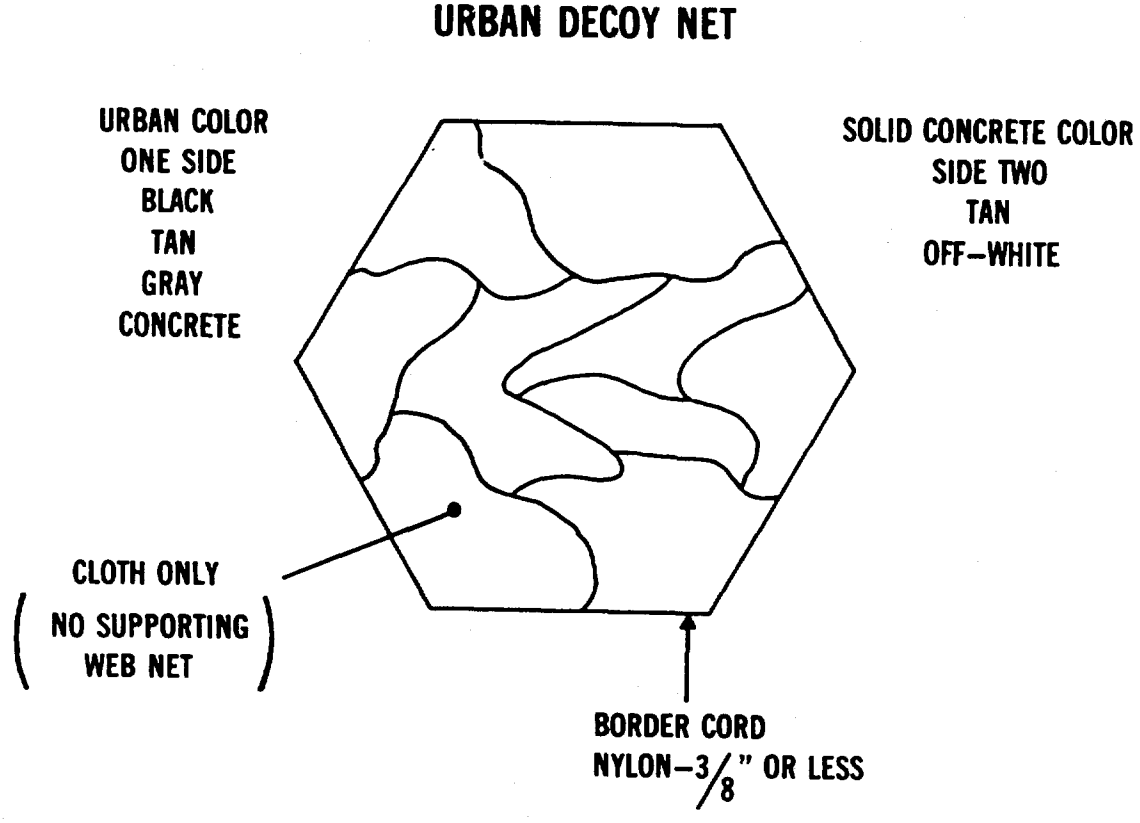


Figure 15. Urban decoy net.

14. Claymore Mine Camouflage Set. The project would develop a camouflage claymore mine set. The mine would be camouflaged to look like part of a wall or a advertisement sign and be attached to a business establishment (Figure 16). This mine would be command, trip-wire, or acoustic-sensor detonated.

In an urban setting a claymore mine camouflaged to look like part of a building wall or street advertisement sign would be placed in a suitable location for defense against enemy infantry.

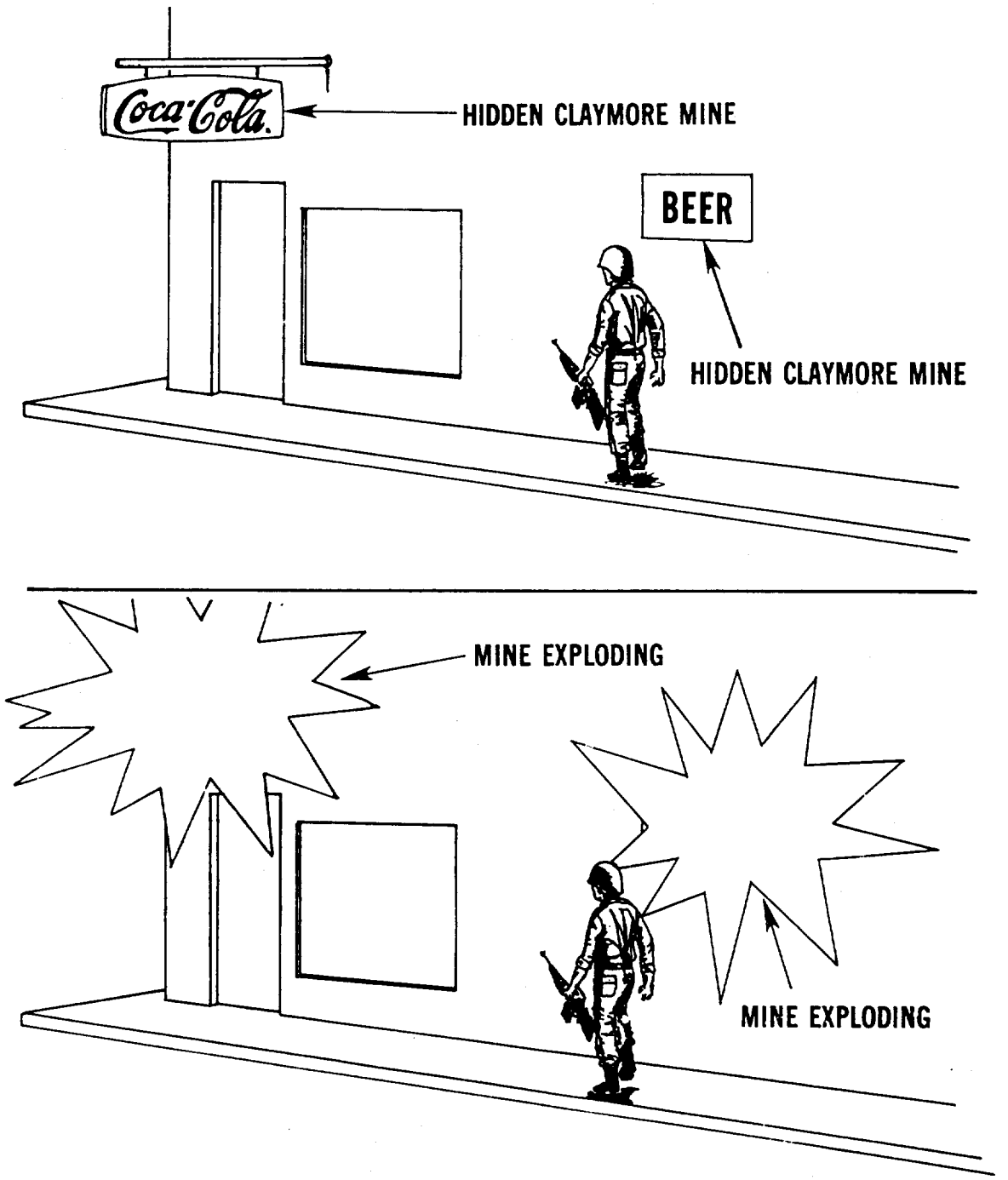
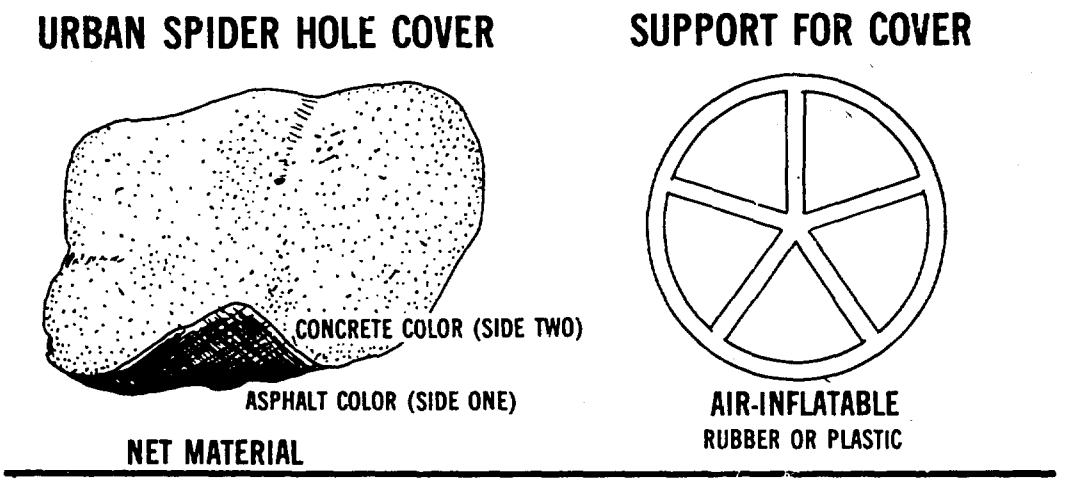


Figure 16. Advertisement-sign Claymore.

15. Urban Spider Hole Covers for Antitank Teams. This project would develop a small camouflage net for use over foxholes made in the street, etc., in urban area. The net would be irregularly shaped, colored tan/brown/black, textured, and supported by air-inflated tubular supports (Figure 17).



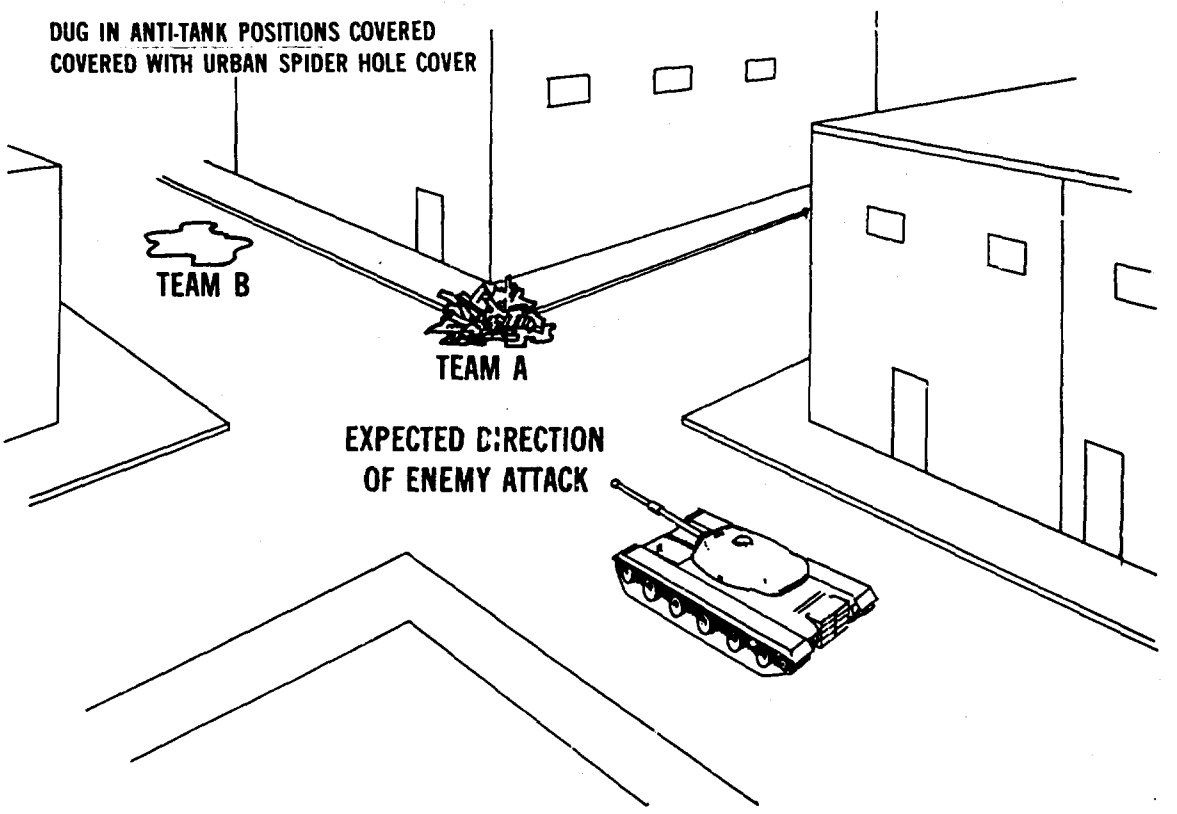


Figure 17. Urban spider hole cover net and support.

Weapons with a back blast cannot be used in buildings; accordingly, they must be deployed in the street or on roof tops. A small portable camouflage net for use in a street foxhole would aid in the protection of antitank teams. This type of camouflage was used extensively by the North Vietnamese Army and Viet Cong in the defense of Hue City, South Vietnam, and it proved to be effective.

16. Vertical Camouflage Screens. This project would develop vertical supports for use with urban or field camouflage nets or other types of screens. The object is to erect an opaque vertical screen perpendicular to the direction of a given street (Figure 18). The support system must be such that destruction of a single support role or wire will *not* result in the collapse of the screen.

The screen is to be of an interwoven material so that one hole or multiple holes will not result in a shearing or ripping of the screen. The screen material should be lightweight and flameproof (or retardant) and offer such little resistance that fused projectiles pass through the screen, making holes but not exploding.

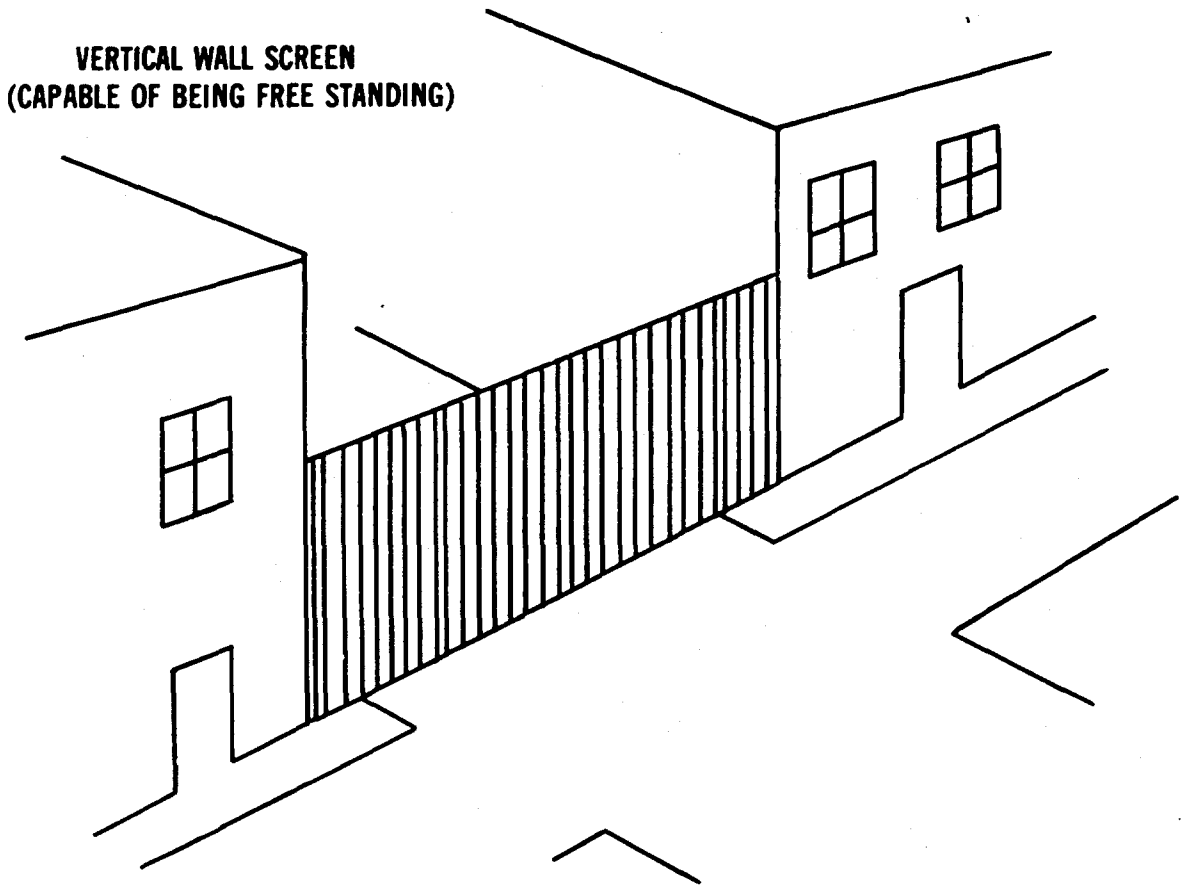


Figure 18. Vertical wall screen.

The screens would be erected in city streets to conceal movement. The screen would act as a visual and, possibly, a radar and infrared barrier to the detection of items behind the net. Although the enemy could fire projectiles through the screen, aimed fire would be prevented. In addition, other obstacles such as mines, dragon teeth, antitank weapons, etc., could be installed behind the screen without enemy observation.

17. Fake-Damage Kit for Buildings and Bridges. The project would develop a kit to be used to create evidence of severe bomb damage on buildings and/or bridges. The kit is envisioned as containing paint brushes, rollers, sprayers, cloth, powders, and instructions necessary to simulate holes and damage to the walls and roofs of buildings, and the superstructure of bridges (Figure 19).

The simulated damage would be installed on selected key installations and facilities in an urban environment to convince enemy reconnaissance and fighter bombers that the target has been severely damaged.

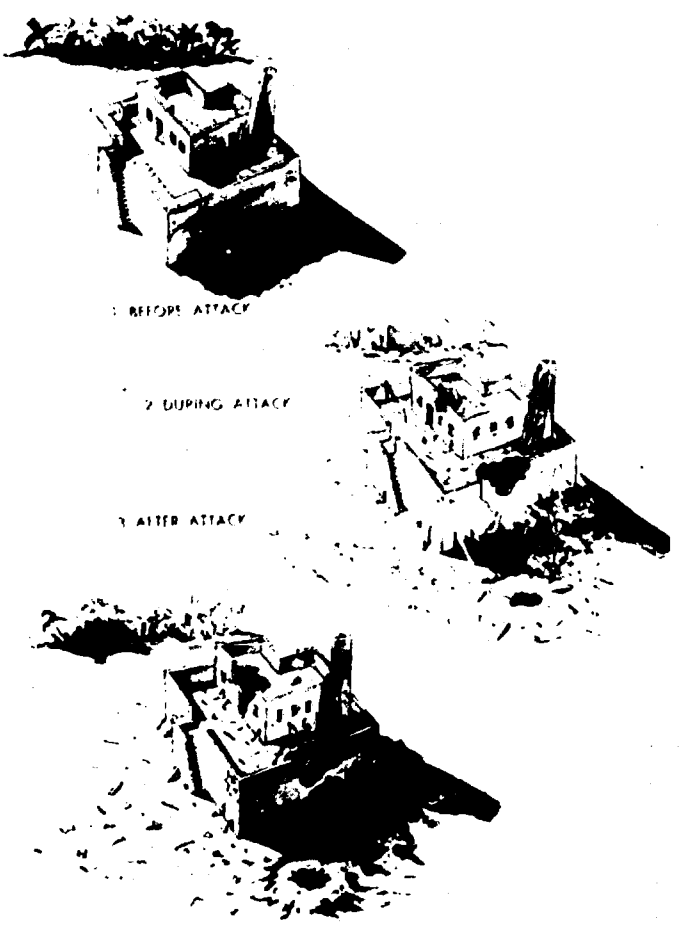


Figure 19. Steps in simulating damages to a building.

18. Street Sign Kit. This project will develop a kit with which the street signs in an urban area could be changed. The kit would include lettering sets, paints, and various tools for fabricating street signs. The German use of this deceptive ploy in the Ardennes offensive of World War II is well documented and caused tremendous confusion among the American forces.

In urban warfare considerable confusion can result from removing street signs. Even more confusion results from making new street signs and emplacing them in the old locations.

19. Urban Two- and Three-Dimensional Tank Decoy. This project would develop a two-dimensional cloth decoy tank (Figures 20 and 21). The cloth decoy would be colored and textured to simulate a real tank. The cloth would have a border cord of nylon, so that the dimension of height could be added if a third dimension was desired.

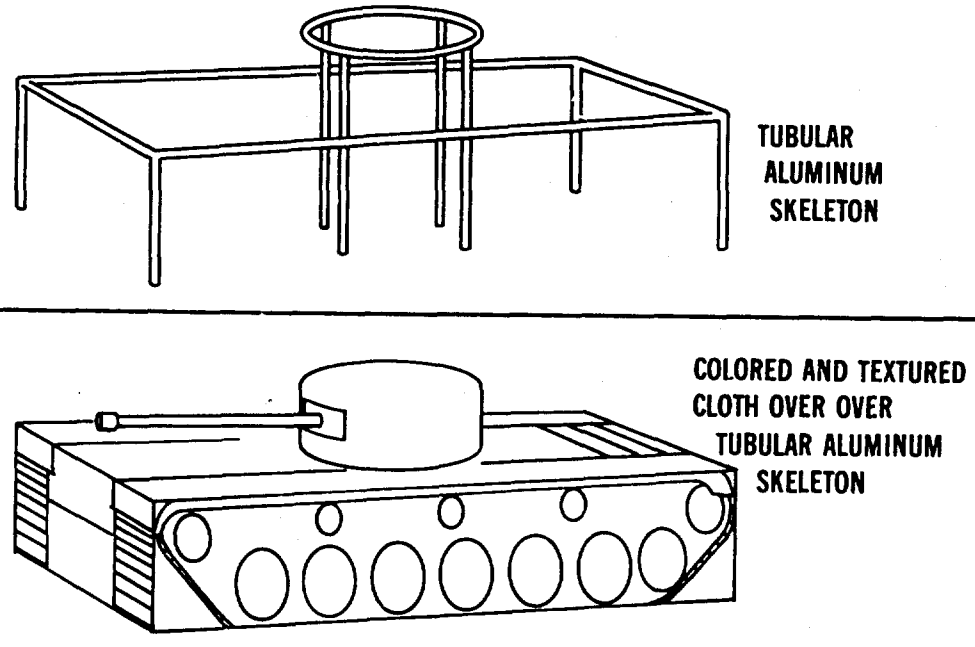


Figure 20. Cloth decoy tank — three dimensions by addition of supports.

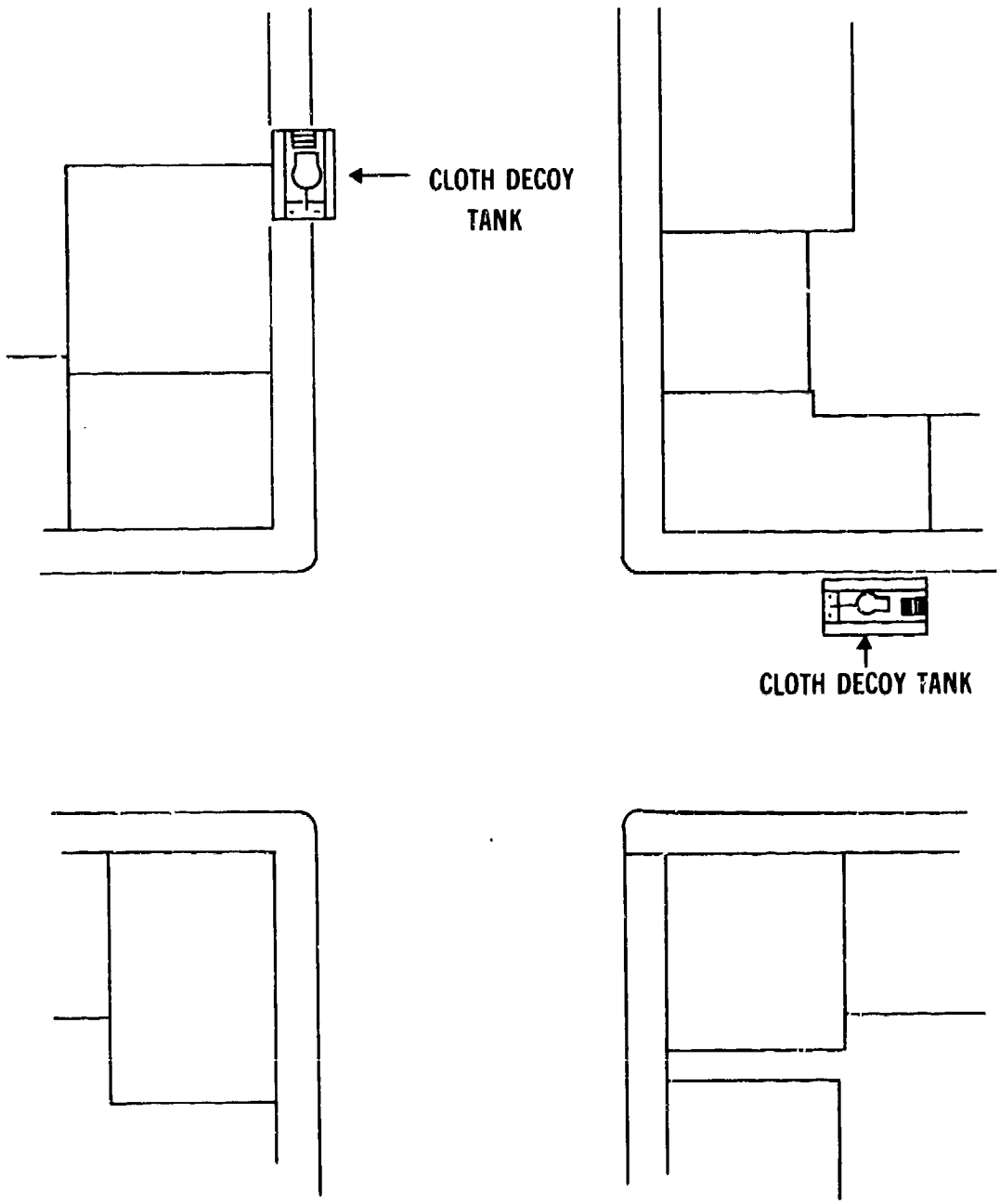


Figure 21. Cloth decoy tank — vertical view.

In cities, due to the height of the buildings, oblique photographic reconnaissance is not as useful as vertical photography; accordingly, there is a place for two-dimensional decoy items. The element of height could be added by means of air-inflatable poles or narrow-diameter aluminum or plastic poles to provide three-dimensional targets.

Fighter-bomber attack in urban areas is affected similarly. Visually, the cloth tank will present an identification problem to enemy aircraft resulting in the enemy's expending bombs and ammunition on decoy targets.

20. Rubble Net (Urban). The project would develop a new camouflage net and support system which would present the appearance of a pile of masonry rubble. The cloth of the net would be formed and shaped to simulate the depth and uneven texture of a rubble pile. The support system would be free standing without the use of tiedown points or stakes. As envisioned, the net would be modular, but not necessarily of a hexagon/diamond configuration and would present the radar cross section and absorption of a rock pile.

The rubble net would be used over tanks/gun positions in an urban area where masonry rubble existed. In a bombed city, piles of rubble will exist in various streets as a result of street clearing operations. Adding more piles of rubble to the existing piles would not attract the attention of aerial or ground observation and would make the enemy's target detection/acquisition task much more difficult.

21. Urban Camouflage Uniform. This project would develop and test various patterned and colored uniforms suitable for use in urban environments. The colors evaluated would be several shades of brown, black, gray, sand, etc. These colors would be combined into various random geometric patterns and printed on combat uniforms.

The urban camouflage uniforms would be evaluated in an urban environment and compared to the standard monotone olive drab uniform and the patterned camouflage uniform. Upon conclusion of the tests, a recommendation would be forwarded to DARCOM and DA concerning recommended use in urban/suburban areas.

D. Camouflage and Deception Materials and Techniques for Use in Rural and Urban Areas. The following items are proposed for use in the field as well as in urban areas:

1. Decoy Soldier, Inflatable. This project would develop an inflating/deflating, positionable decoy soldier. Using thin, lightweight rubber/plastic, a weighted-base decoy man would be fabricated. The decoy would be colored to resemble a man and would be inflated by means of a timed 12-volt d.c. miniature compressor or manually. Miniature compressors that fit in the palm of a hand are capable of 45 lb/in.^{2}. They cost less than $30 and run on 12-V d.c. batteries. The decoy's compressor would require substantially less power. The decoy could be designed to deflate/reinflate by means of a clock mechanism on the miniature compressor. The deflater/reinflater cycle could be utilized in (urban) building window areas or in field (foxhole) positions to create apparent movement. The rubber/plastic of the decoy man could be textured and colored to resemble a military uniform. The decoy in a nondeflatable state could also utilize cast-off military items, such as a real helmet, web gear, shirt, etc.

Upon fabrication of the prototype, tests would be conducted to determine the realism of the decoy. Operational evaluation tests would be conducted to determine the impact on troops in a war game situation. The decoy could be deployed in conjunction with machine gun or rifle fire simulators (Acoustic Grenade, described in paragraph IV C 11) for added realism. In addition, it could be deployed with real but spent equipment such as a used LAW or TOW in order to create an apparent target to attract the attention of a tank from a real antitank team. The decoy could also be used on live fire combat training or proficiency course where target variability is desired.

2. Fire/Flame Simulator. This project would develop various fire and flame simulators. A given simulator would consist of a fire pan where volatile fuel (primarily liquid) would be permitted to burn producing flame/smoke and the effect of a fire. Ignition of the flame simulator would be by electrical remote control using command detonation or unattended acoustic or IR sensors. Different types of simulators would be designed to simulate different types of fires. The simulators would be classified into two main types — fixed and mobile. The fixed types would be redesigned and improved World War II types such as (non-inclusive):

a. Vertical fire grid for simulating burning walls.

b. Horizontal fire grid for simulating burning roofs.

c. Oil-fed fire for long-duration fire.

d. Boiling oil/water fire for producing flashes and explosions.

The mobile type flame simulator would be designed to simulate, harmlessly, the flame and fire that would result when various mobile targets, both real and decoy, are hit by enemy gun or rocket fire. Typical examples of the mobile fire simulator are:

a. A 2½-Ton Truck Fire Simulator. This simulator would produce the smoke and flame that would result when a 2½-ton truck is hit by cannon or rocket fire from an aircraft. The simulator would be designed to work on real or decoy trucks and would be fired electrically by remote control.

b. A Tank/APC Fire Simulator. This simulator would produce the smoke and flame that would result when a tank/APC is hit by an aerial (primarily) or a ground antitank weapon.

It is important that all decoys explode and burn like the real equipment. By doing so, the deception as originally achieved by the decoy is carried to its logical conclusion. The value of a deception operation is made more effective if the enemy believes he has destroyed the target. His belief is reinforced by flame/smoke and secondary explosions.

Real items could carry flame and smoke simulators to help achieve deception. Activation of a simulator on a real vehicle after it has been attacked but not destroyed should result in the attackers moving on to another potential target rather than reattacking the original target. Consider an aerial attack by two fighter/bomber aircraft, the lead plane and his wingman. The first aircraft attacks the target, the wingman tightens the attack envelope with information supplied by the lead aircraft and initiates his attack. However, if the lead aircraft believes he has destroyed the target, his wingman will not reattack an already burning target thereby wasting ammunition. The attack leader and his wingman will regroup and attack another target.

3. Tank-Tread Simulator. This project would develop a lightweight tracked device for attachment to either a jeep, 2½-ton truck, or other vehicle. The device would be mounted on the rear of the vehicle and consist of wheels and tracks with interchangeable treads to simulate the track width and size of various tracked vehicles such as APCs, tanks, SP artillery, etc. The simulator would be designed to produce tracks of the correct depth, simulating the weight impression that a real vehicle would make.

The tank-tread simulator would be used in areas where armored vehicles are operating or where it is desired to have the enemy believe armored vehicles are operating.

In the first case, false tracks would be used to confuse enemy reconnaissance as to the number of real tanks by creating confusing multiple tracks. This type of device could be particularly useful in snow or desert country where false tracks could be made to lead up to snow mounds or unnatural looking clumps of earth. In the second case, when used in conjunction with decoys, nets, and flame simulators, the use of tracks would add realism to the deception operation.

4. Non-Reflective Coating and Attachments for Glasses, Binoculars, and Telescopes. This project would develop coatings and lens covers for eyeglasses, binoculars, and telescopes to decrease the reflection of light from their surface. For binoculars and telescopes, louvered-grid attachments would be made of coated plastic or aluminum. The louvered attachment would permit direct sight viewing but would trap indirect light from being reflected from the surface.

Reflection of incident light on optical lenses is frequently the cause for detection of personnel. By applying coatings and louvered attachments to lenses, in particular sniper telescopes, the probability of detection due to reflected light will be minimized. In addition, it is possible to scan an area rapidly with an IR laser and watch for the backscatter from potential targets that are optically reflective. By using coatings and louvered grids, the reflection from all angles except direct incidence would be reduced or eliminated.

5. Wood/Cardboard Box Decoy Manual. This project entails a survey of the types of packaging boxes of metal, wood, and cardboard used in the Army. Then, via a manual, it would show troops how to use such boxes to create decoy items of equipment such as APCs, trucks, and tanks by placing the boxes together and placing a tarp or camouflage net over the boxes in such a manner as to create the illusion of a real item under the net (tarp).

This manual would enable troops to create their own decoys from field expedient materials. While the concept is simple, the manual would provide the soldier with a detailed description of how to accomplish the task. Experience in regard to field pattern painting has shown that good instructions are superior than relying solely on the imagination and creative ability of the average soldier.

6. Gun-Blast Dust Apron. This project would develop a type of lightweight camouflage net material for use directly under the barrel of a gun/rocket launcher to suppress the dust stirred up by the firing of the weapon. The material must be lightweight yet strong enough to resist the effect of blast (i.e., flame, etc.) of the weapon.

The Gun-Blast Dust Apron is placed directly under the muzzle of the gun to suppress the dust cloud caused by the firing of the weapon. Two objectives are gained by suppressing the dust: Detection of the site due to localized dust positioning is reduced; visibility from the gun to the enemy is improved enabling the gun crew to fire a second shot without an intervening dust cloud.

7. Gun-Blast Dust Simulator. This project would develop a device to simulate the gun blast of recoilless rifles and other antitank weapons. As envisioned, the device would use dust/powder in a conical tube projector. This would be expelled by an explosive or compressed gas (similar to a large toy carbide cannon filled with dust). The device would be fired by remote control using command detonation.

This device would be used in conjunction with decoy antitank (AT) positions to simulate the dust and smoke of a real AT site. Used alone or in conjunction with a decoy inflatable man, the simulator would add realism to dummy AT positions and draw the fire of enemy tanks.

8. Decoy Dragon Teeth. This project would develop plastic or foamed concrete dragon teeth of the pyramidal and conical types (Figure 22). The objective would be to produce foamed decoy antitank obstacles. These obstacles could contain explosives, antitank or antipersonnel mines, or be totally inert. The decoy dragon tooth kit is envisioned as consisting of a mold, plastic (or foamed concrete), and pressurized foaming equipment. The technology for the device already exists. An optimum setup time for an inert dragon tooth decoy would be approximately 1 minute per decoy. Approximately 32.9 ft^3 of foam would be required for a normal size solid conical decoy with a lower base of 42 in. and an upper base of 6 in. with a height of 36 in. A hollow decoy, requiring two molds and having 2-in. thick sides and top would require 9.5 ft^3 of foam or foamed concrete. With a foam density of approximately 1 lb/ft^3 only 10 lb of material would be required to make one decoy.

The decoy dragon teeth would be employed with or without explosives in urban streets or rural areas. Used alone or in conjunction with real obstacles, the result would confuse and delay enemy tank forces. The enemy tank commander when he approached the dragon teeth would face several problems:

First: Are the dragon teeth real or decoys?

Second: If they are decoy, are they inert or mined?

Third: If mined, are they mined with

a. Antitank mines?

b. Antipersonnel mines?

c. Command detonation explosives?

Depending on the covering antitank fire by friendly forces, the problem to the enemy command is compounded.

DECOY DRAGON TEETH

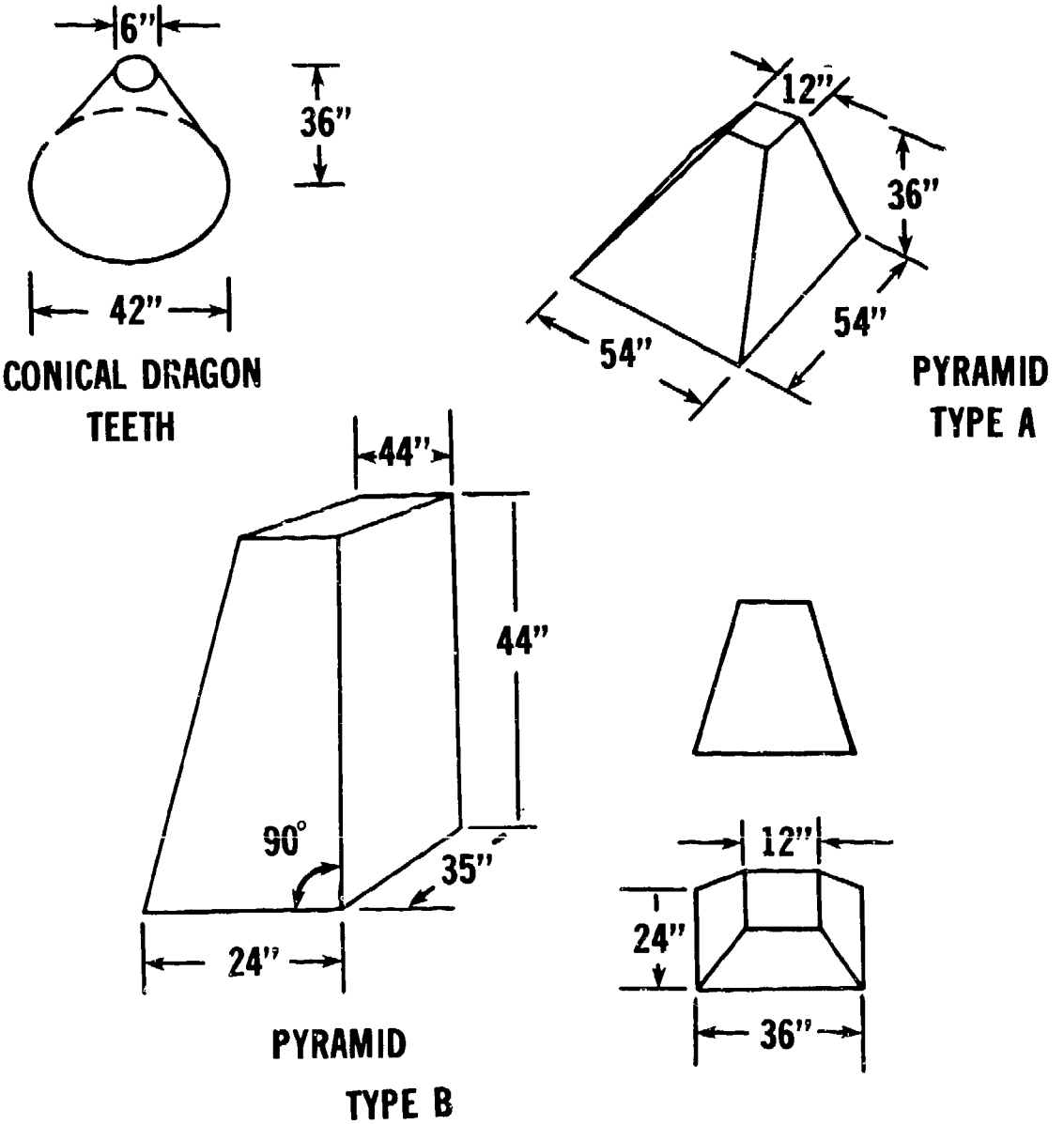


Figure 22. Decoy dragon teeth.

The standard tactic used against real antitank dragon teeth obstacles in rural environments is to use a dozer-blade-equipped tank to cover the dragon teeth with earth. In an urban environment, particularly in a concrete street, dirt with which to cover the dragon teeth is not readily available although rubble may be available. However, if this tactic is used against command-detonated or antitank-mined decoy dragon teeth, the dozer-equipped tank will be damaged and possibly destroyed. If the enemy commander uses sappers, again the command-detonated or antipersonnel mine decoy dragon teeth can reduce the threat effectively.

While it is recognized that any barrier, real or decoy or combined can be breached, the cost, installation time, and density vs delay caused for the enemy by a decoy/real dragon teeth barrier is estimated to be significant. Envision (as in Figure 23) an entire city street with emplaced decoy (mined and inert) and real dragon teeth. The enemy tank commander definitely has a problem.

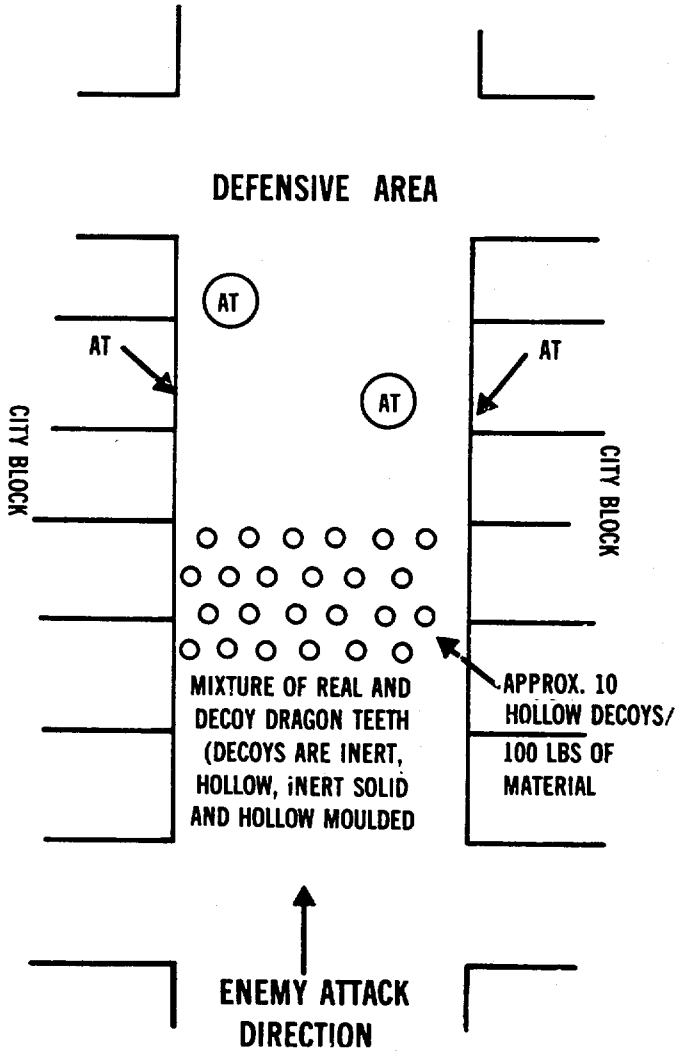


Figure 23. Decoy dragon teeth deployed in a city street.

9. Dummy Oil Drums, Blivets, and Pillows. This project is to develop oil drums for use in simulated fuel storage depots (Figure 24). Various types of oil storage facilities would be duplicated, starting with a simulated 55-gal. fuel drum and progressing to the large blivets and pillows. The decoy is envisioned as an air-inflatable thin-walled plastic for the large fuel blivets or pillows and foam for the 55-gal. oil drums.

Oil storage areas are key targets for attacking aircraft. A simulated oil storage area would induce the enemy to conduct aerial attacks on it. When used in conjunction with flame/fire simulators an effective deception could be achieved. In addition, the simulated area could be utilized as an enemy aircraft kill zone where inward concentrated antiaircraft fire could be used.

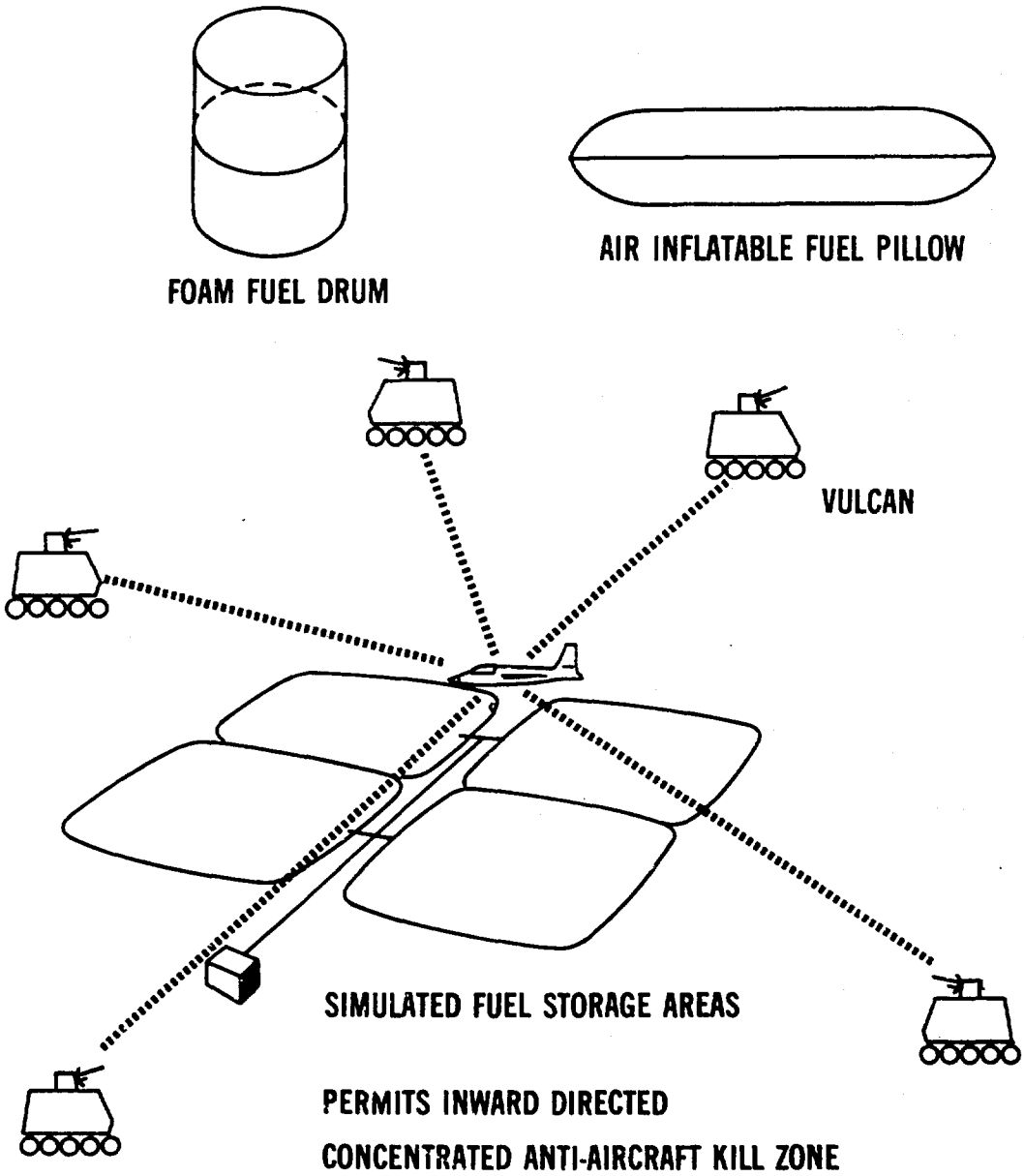


Figure 24. Decoy fuel drum and pillow; decoy fuel storage area with kill zone.

10. TOW Missile Simulator. This project would develop a TOW missile simulator (Figure 25). The device is envisioned as a pressed paper tube, expandable to the length of a real TOW. The tube would launch, via remote control, an electrically fired, unguided paper missile giving an appropriate smoke backblast and audio/visual signal. The missile would be pressed paper with a solid fuel propellant (similar to toy solid fueled rockets). Objective as to weight and cost are that the simulator be less than 1/10 the cost/weight of real TOW missile.

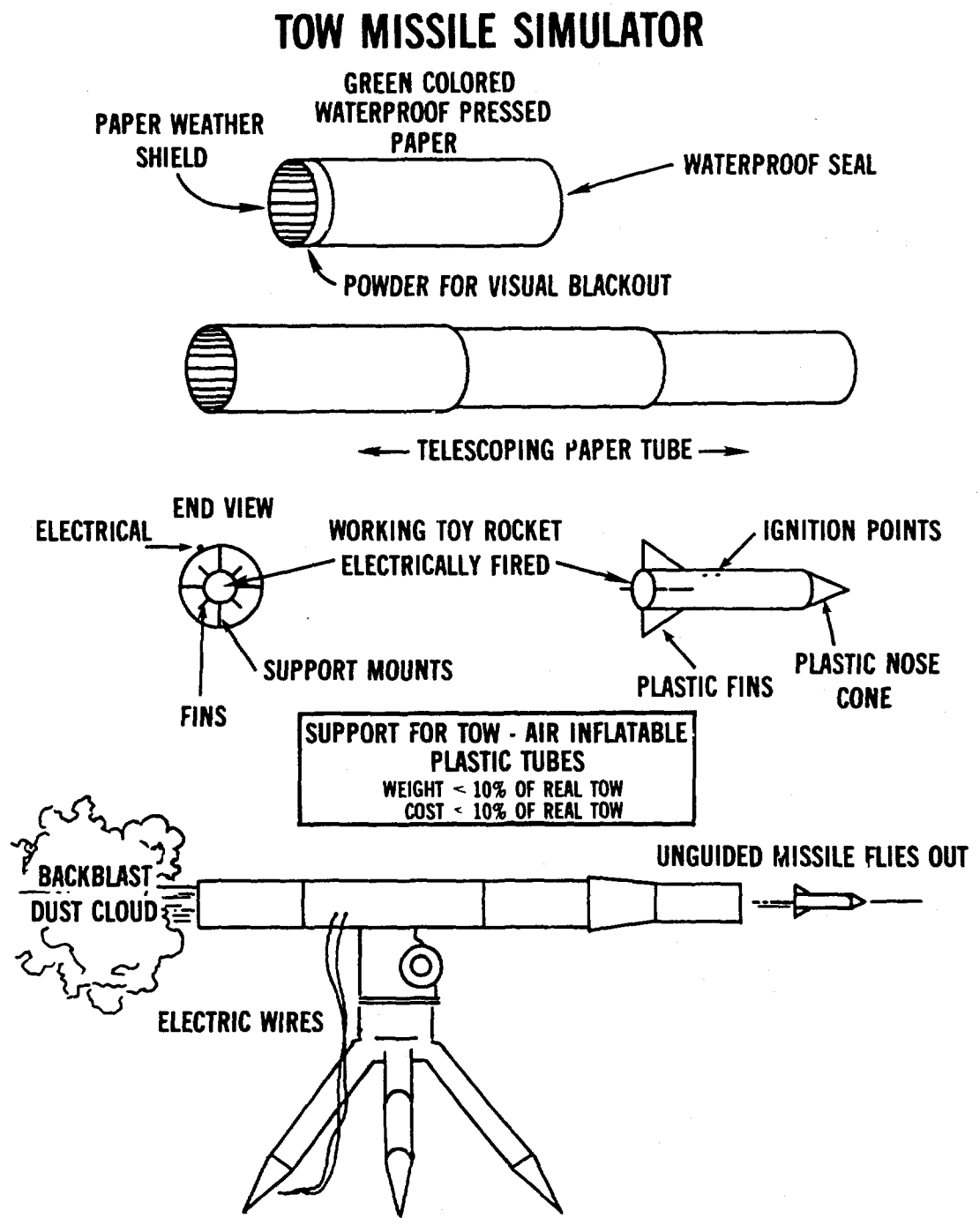
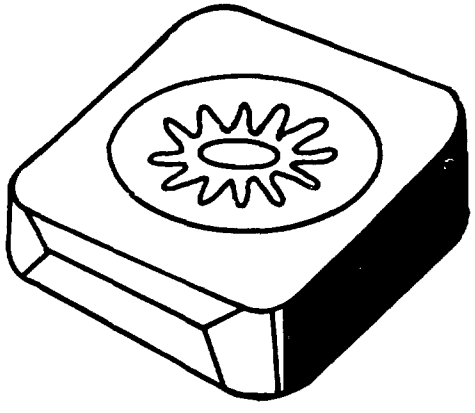


Figure 25. TOW missile simulator.

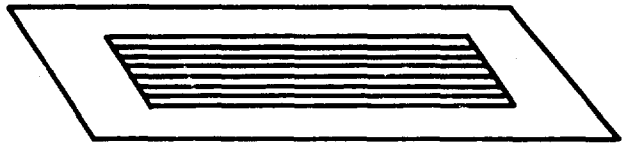
The TOW missile simulator is to be used by TOW gunners to set up a dummy position. The purpose of the dummy position is to draw enemy tank machine gun and cannon fire to itself, thereby, diluting the effectiveness of enemy weaponry used against the real TOW gunner. The TOW missile simulator could be used by itself or for added realism with the inflatable dummies. The TOW simulator could be fired simultaneously with the real TOW or it could be fired independently, either before or after the real TOW launch.

11. Decoy Landmine. This project is to develop a decoy landmine (Figures 26 and 27). The decoy is envisioned as a compressible foam in a vacuum-packed bag. Decoy mines would be packed approximately 10 decoys in the space of one landmine. The decoys would be made for all types of landmines, in particular, the air-scatterable type.

The decoys would be employed with real mines to increase the depth and size of the mine field. The decoy mines could be employed separately to create confusion.



M19 PLASTIC ANTITANK MINE (FOAM DECOY – EXPANDED)



DECOY MINE M19 COMPRESSED IN VACUUM PLASTIC BAG

FOAM DECOY, M19, PLASTIC ANTITANK LANDMINE

Figure 26. Foam decoy, M19, plastic antitank mine.

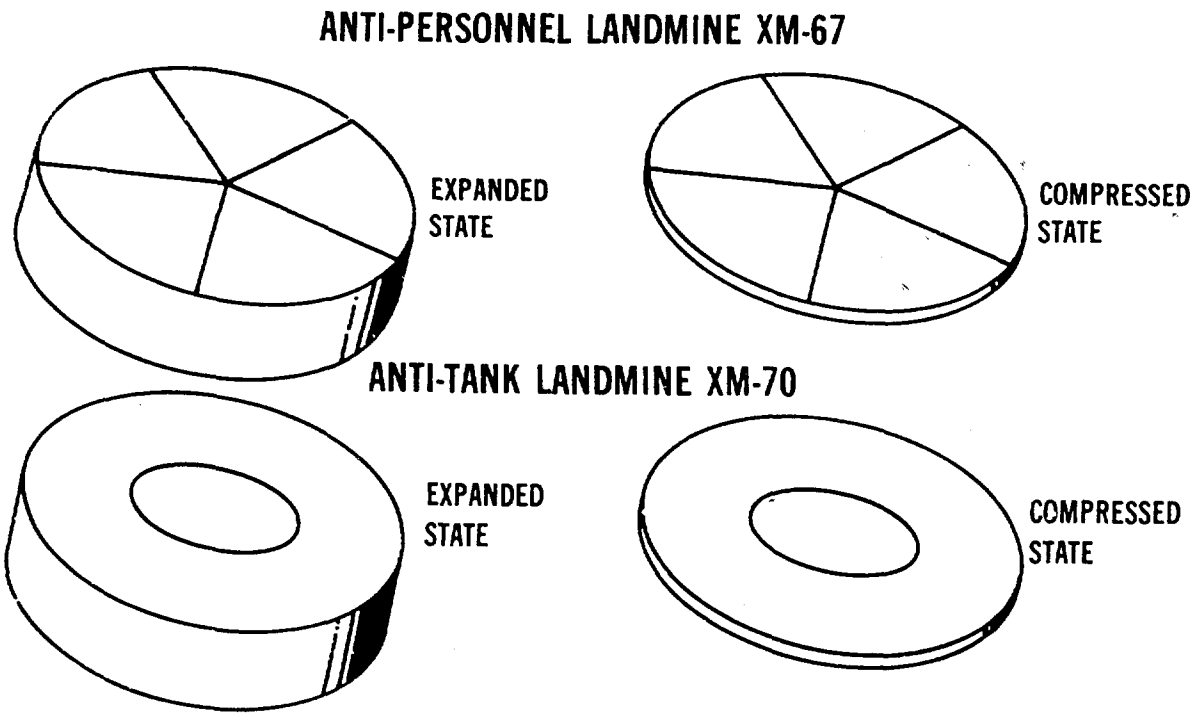


Figure 27. Surface landmine decoys, XM-67 and XM-70.

12. Machine Gun/Rifle Fire Simulator. This project will improve the devices in Figures 28 and 29. The caliber will be changed from .30 caliber to 5.56 mm (or 7.62 mm). Objectives include a weight decrease from approximately 15 lb to 10 lb or less, an ammunition increase from 18 rounds to 36 plus, a length decrease from 12 in. to 6 in. with a diameter increase (to accommodate more rounds) from 4½ in. to approximately 6 in. Approximately 8 in. of the present length of the device is due to the clockwork mechanism. Using modern electronics and electrically fired cartridges, a considerable weight and size reduction is possible. The simulator should be modular, permitting attachment of either a command actuator, an acoustic sensor, of a thermal sensor in place of the timing mechanism. A bimodal switch would be emplaced on the back of the decoy to change from the rapid burst of fire of the machine gun to the desultory fire of the rifle. This device would self-destruct after completion of its fire mission.

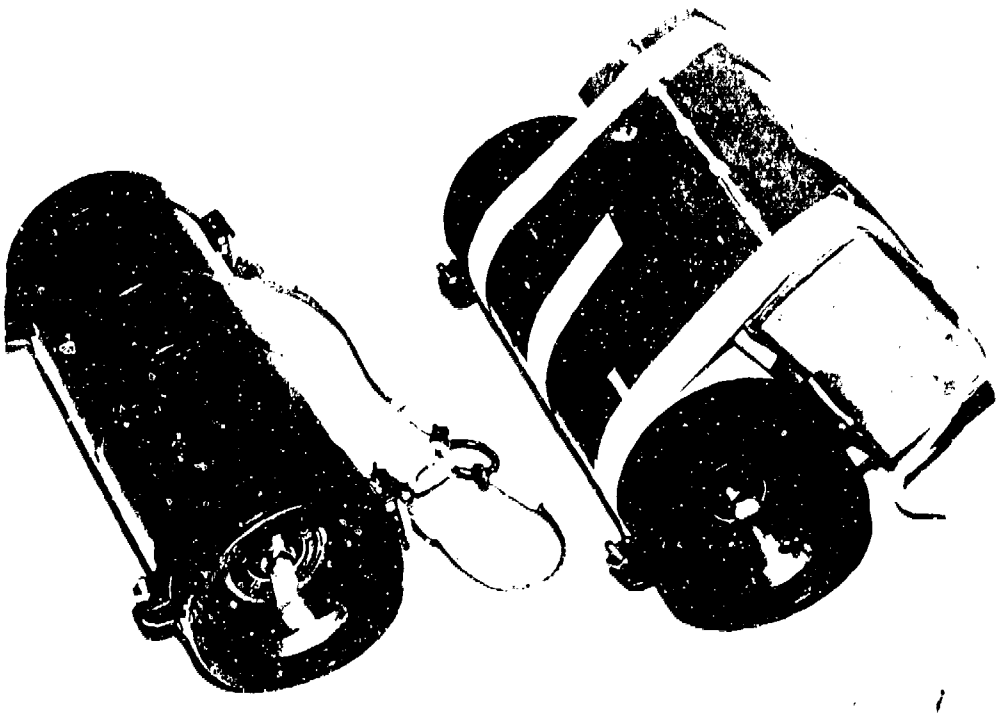


Figure 28. Old style MG/rifle fire simulator.

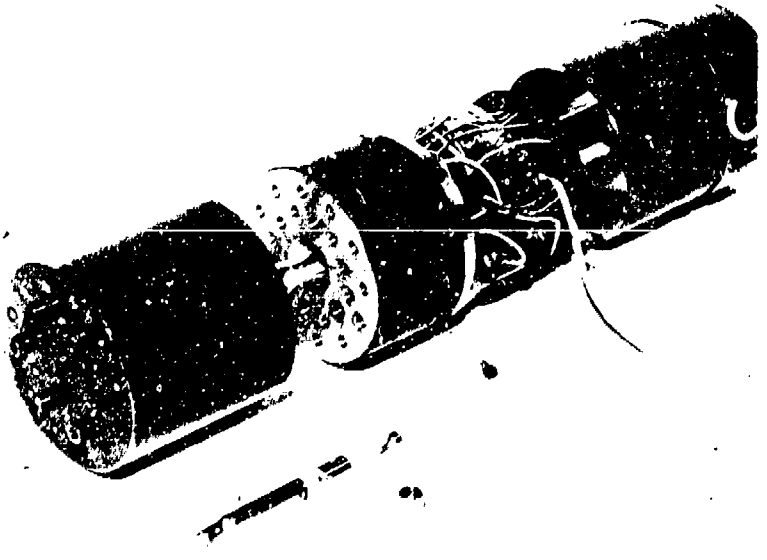
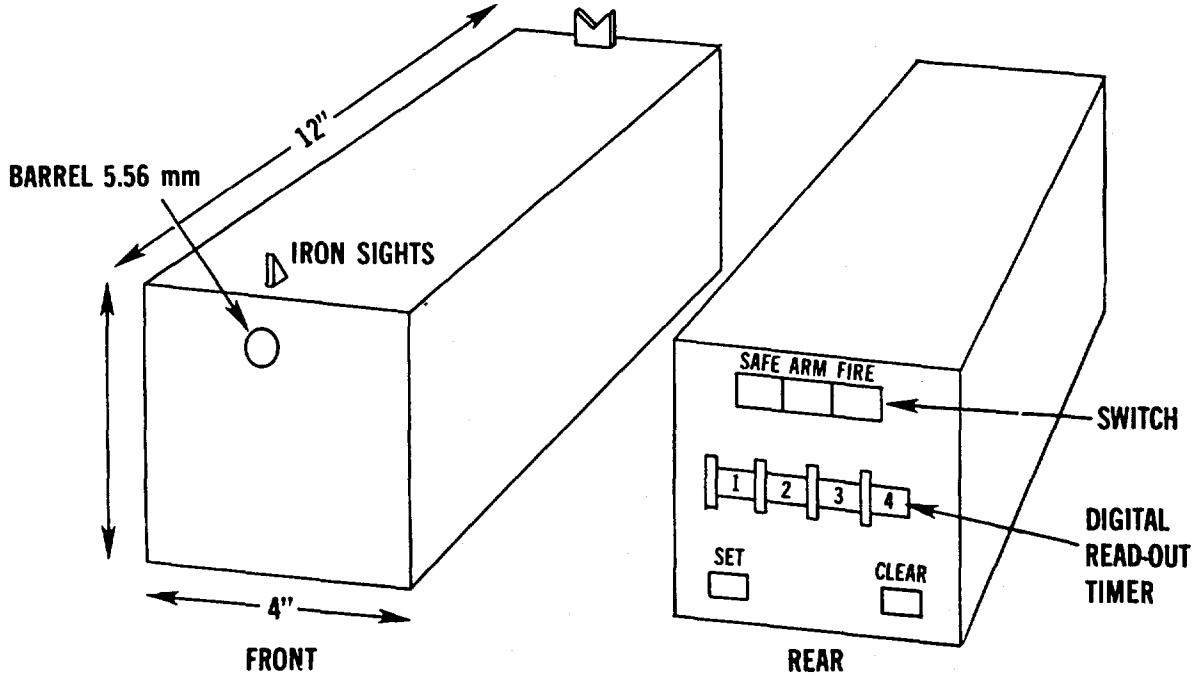


Figure 29. Old style clockwork and initiator mechanism for MG/rifle fire simulator.

The machine gun/rifle fire simulator (Figure 30) could be used as a decoy for urban defense (delay or withdrawal) or in a false attack (ruse) utilizing a decoy paratrooper to simulate the sonic signature of a machine gun/rifle. In that the machine gun/rifle simulator actually fires real ammunition, the effect and realism is very near that of an actual machine gun/rifle position. The simulator properly textured and camouflaged and with a timer could be placed in positions on buildings, window frames, and roofs. It could be aimed into the street to create havoc among advancing enemy troops. For example, due to its size it could be hidden in a defended building. Upon withdrawal of friendly troops from the building, the timer is set. The enemy will advance and clear the building using standard search and destroy methods. The enemy commander and troops after having cleared the building, continues the attack. Suddenly, machine gun/rifle fire starts coming from a supposedly cleared building. The enemy commander must stop the attack to reclear the building. Even if he realizes that simulators are being used, he must send his troops to investigate every burst of machine gun/rifle fire because he will be unsure as to whether the building has been infiltrated or decoys are used.



MACHINE GUN SIMULATOR

CALIBER 5.56 mm
WEIGHT 14 POUNDS
TIMES - UP TO 24 HOURS
MIN. LOAD 20 ROUNDS
CAPABLE ON SINGLE SHORT OR BURST
SELF-DESTRUCTS

Figure 30. Machine gun simulator — new type.

With a command remote control unit, the machine gun/rifle fire simulator can be used in dummy machine gun/rifle positions to draw enemy fire to itself and thereby reduce the effectiveness of enemy fire on the real machine gun/rifleman position. When used with a cheap thermal or acoustic sensor, it could be placed in such a manner as to be activated by enemy voice or thermal emissions. The device has other potential uses in covert or cover and deception operations which are limited only by the capability and innovative use of the planner.

13. Vulcan Simulator. The project will develop a plastic/metal Vulcan gun mount and cannon simulator. The decoy gun and mount (Figure 31) will be emplaced on the top of regular Armored Personnel Carriers (APC). The decoy mount will be capable of both traverse and elevation. The visual deception should be good at a distance of 100 yards.

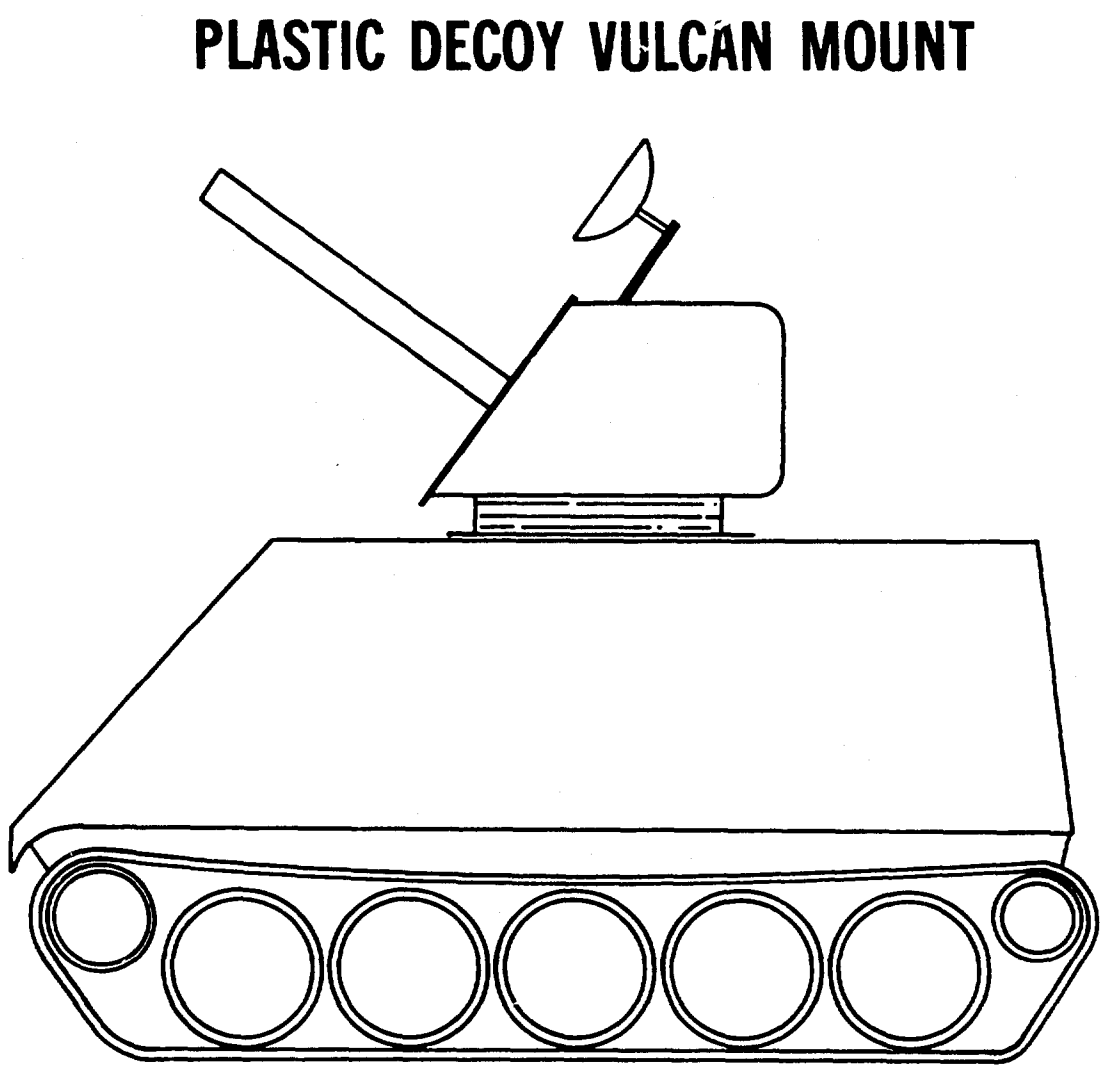


Figure 31. Vulcan simulator.

The primary purpose of the Vulcan simulator will be to confuse the enemy reconnaissance as to where the real Vulcan Air Defense Weapons are located since the Vulcan AD Weapon system will be subjected to reconnaissance, detection, and target acquisition on a priority basis. The enemy will then attempt to destroy all Vulcan weapons in the division area utilizing counter-battery fire and fighter/bomber aircraft. In that there are only two batteries of Vulcan Cannons per Division, the item is valuable and of critical importance on the battlefield.

In an Armored or Mechanized Infantry Division there are several APC equipped infantry companies; a number of the APCs in these companies would be equipped with decoy mounts. Vulcan cannons are frequently used with Armor and Mechanized Infantry lead elements; thus, having several decoy Vulcans among the real Vulcans would prevent the enemy from concentrating firepower on the real Vulcans.

In addition, the enemy would be unsure of the total firepower of the task force in that the Vulcan can be used in a ground support role. The enemy would be less enthusiastic in attacking an Armored/Mechanized Infantry Combat team possessing the added firepower of 5 to 6 Vulcan cannons than a team with only one.

14. Decoy Ribbon Bridge. This project would develop an air/foam inflatable decoy ribbon bridge. The bridge would be capable of visual and radar simulation at ranges in excess of 1,000 ft. The decoy bridge should be capable of carrying infantry by means of a small catwalk so that the bridge is functional to foot traffic. The bridge should be self-sealing (puncture proof) to the fullest extent possible. Up to five deflated decoys should be capable of fitting in one 2½-ton truck. An alternative storage location could be within the interior bay area of the real ribbon bridge; thereby, each real bridge would carry its own decoy. The decoy bridge should be capable of accepting foamed plastic or concrete in place of air to achieve rigidity as well as flotation.

The decoy bridge would be employed near real ribbon bridges in order to confuse enemy reconnaissance and fighter/bombers as to the exact location of the real bridge. The bridge would be placed near enough to the real bridge so that fighter/bomber visual acquisition occurs simultaneously but far enough apart so that explosives dropped on one bridge should not damage the second bridge. The decoy inflatable bridge when inflated with foamed plastic (or possibly low-density/quick-setting concrete) could be capable of supporting light wheeled vehicles.

15. Decoy Armored Vehicle Launched Bridge (AVLB). This project would develop a decoy AVLB unit. It would utilize foam and resemble a real AVLB unit from 100 yards. The bridge should be structurally strong enough to support foot traffic on small gaps.

The decoy bridge would be emplaced near a real AVLB in order to confuse enemy reconnaissance and fighter/bomber attack. The decoy unit would be mounted on a real APC but would be light enough to be lifted by two to four men and emplaced over a gap. The bridge then could be used for foot traffic.

16. Railroad Rolling Stock Camouflage. This project would develop methods to camouflage railroad engines and rolling stock to look identical at 1,000 ft (altitude) to box cars. Project is envisioned as producing a handbook describing how various materials and paints can be utilized to camouflage/disguise train engines and cars without impairing their operational capability.

In World War II, some of the key railroad rolling stock was camouflaged/ disguised as less valuable items. Since World War II, the types and kinds of engines and rolling stock have changed drastically. The camouflage patterns and disguises of World War II are no longer useful, and new instructions based on modern railroad equipment need to be developed.

17. Field Expedient Decoy Machine Gun (7.62 mm, .50 cal.). This project will develop a handbook showing several methods of making and using field expedient decoy machine guns.

Decoy machine guns can be used to simulate real machine gun positions thereby drawing enemy fire to themselves and lessening the effectiveness of enemy fire on the real position.

18. Camouflage Coloring Kit for Engineer Tape. This project would develop a fast-drying, indelible dye for coloring engineer tape to match the surroundings.

Engineer tape, used for making boundaries, mine fields, etc., is colored white. Frequently it is desirable to make the boundary with engineer tape, but to limit the visibility of that tape from medium to long distances so as to help conceal the marked area. This kit would be used to dye the engineer tape to match the surrounding background.

19. Textured Coatings for Rifle Barrels and Stocks. This project would develop a camouflage coating for rifle barrels and stocks presenting a textured, non-reflective surface. The coating would be available in several colors of brown and green. A white coating for use in snow environments would also be developed. The coating would be removable with the application of special solvent without damaging the rifle.

The coating is to be used to reduce the glint and glare off machined rifle parts such as the barrel and trigger housing and to camouflage the rifle. The white coating is for use in snow areas for camouflage.

20. Tone Down of Brass Cartridges. This project is to identify a suitable additive to color the brass cartridge case from yellow to a dull brown.

Infantry troops frequently carry belts of machine gun ammunition wrapped around their bodies. The high gloss and color of the brass cartridge cases significantly reduce the camouflage capability of the troops. Expended cartridges because of their color and gloss have a high signature; toning down the cartridge cases will aid in reducing the detection of troops who have used them. In this regard, all types of brass cartridge cases including those from 105-mm (115-mm) tank and howitzer ammunition would be toned down.

21. Decoy Reflecting Surfaces. This project would develop a cloth with a cheap, high reflective coating applied to it. The cloth could then be cut into various sizes for emplacement by troops.

The reflective cloth would be emplaced to simulate the glint and reflection from vehicle windshields and headlights. The objective is to deceive the enemy reconnaissance aircraft as to whether the glint and glare they detect is from a real vehicle or is just a decoy, thereby reducing the reliability of glint as a weapon signature cue.

22. Vehicles for the Radar Simulation of Weapon Systems. This project would develop a 2- or 3-page diagram for insertion into tactical field manuals showing how vehicles can be positioned to simulate the radar signature of various weapon systems such as Hawk, Chapparal, Vulcan, Pershing, Howitzer batteries, etc.

During periods of low visibility, synthetic aperature radar or side-looking airborne radar will become a primary reconnaissance method. Use of vehicles to simulate radar signatures has a definite, though limited, use. A 2- or 3-page diagram can be made for insertion in Army Field manuals showing how trucks can be positioned to simulate the patterns made by the weapon systems on a hostile radar screen.

23. Fuel Tank Truck Camouflage. This project would develop the attachments necessary to make a fuel tank truck simulate a cargo truck. The project is envisioned as having two phases. Phase I consists of a fuel tank mounted on 2½-ton truck bodies. These vehicles would be converted in 2½-ton cargo trucks by the addition of a canvas cover and bows. Phase II would deal with the large fuel tankers (i.e., tractor/trailers). These would be converted to look like cargo trailers.

Due to the individual design of specialized Army equipment, the enemy can selectively try to destroy certain items of equipment rather than others (when given the opportunity). For instance, depending on the circumstances, a fuel truck may be of more value than a cargo truck. A tank may have more value than an APC.* Accordingly, the enemy will instruct his pilots to search for and destroy one particular type of equipment if possible over another.

The more Army items that look alike, the more difficult it is for the enemy to be selective in his destruction and to know exactly what he has detected or destroyed.

24. Thermal Signature Modification Unit. This project would develop a heating/cooling unit mounted in a 2½-ton truck to change the thermal signature of a tank, APC, or other vehicle. The thermal signature would be changed quickly (cooled) by spraying a semi-frozen slush of water and/or dry-ice onto the surface of the vehicle. The system could be set up to decontaminate the vehicle simultaneously. The thermal signature could be raised in a similar manner by use of hot water.

The thermal signature of a vehicle is becoming a prime detection method. There is no current method of reducing the thermal signature of a hot vehicle. The thermal signature-changing unit would permit a hot vehicle to be cooled almost immediately, thus reducing its signature and making the detection problem more difficult. The cooled vehicle could then be emplaced under a thermal camouflage net thereby reducing the amount of heat that would have to be thermally shielded by the net.

With the addition of certain chemicals, the thermal signature-changing unit could decontaminate chemically, bacteriologically, and radiologically contaminated vehicles.

25. Drone Decoy Helicopter. This project, to be conducted in conjunction with AVRADCOM, would develop a drone decoy helicopter. The radio-controlled drone decoy would be less than 1/5 size of a real helicopter but would present the correct radar signature.

The decoy drone helicopter would be used in conjunction with passive helicopter decoys to more fully simulate an active helicopter site.

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* During the African campaign, one antiaircraft unit made a statistical study of targets strafed by German aircraft. They were able to determine that the German order of priority was: (1) watercarts, (2) staff cars, (3) trucks, (4) other. By disguising watercarts (very important in the desert) to resemble ordinary trucks they moved the watercarts in priority from No. 1 to No. 3.

26. Decoy Cloth and Paper. This project would develop thin, waterproof cloth and paper overprinted with camouflage patterns or in camouflage colors. The cloth/paper should have an adhesive backing and should remain strong and flexible in cold temperature down to -30°F.

The cloth/paper would be used on field fabricated decoys. The use of pre-printed cloth/paper would simplify the making of decoys.

27. Camouflage Tape. This project would develop a patterned, colored tape similar to adhesive or cellophane tape.

This tape would be applied to cables, wires, and anything that needed to be camouflaged such as rifles, helmets, etc.

28. Spray-on Radar-Reflective Plastic. The project would develop a spray-on colored plastic with a radar signature. The plastic would form a spider-web type appearance when sprayed on stems such as rocks or trees and would create a simulated target with the reflective signature of the metallic item.

The spray-on plastic would be used to create false targets within the battle area and would increase the radar clutter.

V. CONCLUSIONS

From this study of urban warfare, one can conclude that camouflage and deception (C&D) has a distinct part to play. Since camouflage has been utilized in the past, realistically one must assume that it will be used in the future. Historical references establish that early use of camouflage was haphazard: its use was limited by the imaginative use of the practitioner — the soldier. (Unfortunately, this is the type of individual who rarely publishes the fruit of his efforts.) Camouflage for urban warfare can procure positive results if an imaginative research and development program is pushed to develop new methods, techniques, and materials for the soldier to use.

Careful, applied development now can eliminate the guesswork and the haphazard "Rube Goldberg" approach to urban camouflage and deception operations. In this regard, providing the soldier with urban C&D equipment and training should stimulate new uses and ideas from the soldiers themselves by making them more aware of the possibilities and capabilities of camouflage.

While distribution of equipment will, no doubt, result in some standardization of employment, more will be attempted if some camouflage and deception material, principles, and techniques filter down to the troop level. Indeed, history[23] has shown that similar C&D plans and devices have worked time and again because the application is never identical, and the persons experiencing the cover and deception devices or techniques are rarely the same.

Camouflage and deception is a two-edged sword, the first time it is used the effect is frequently dramatic. But it requires the enemy to expect its use again, thereby forcing the enemy to consider that C&D is constantly being used and instilling doubt in his mind as to whether the intelligence information before him is true or false.

Currently, there is nothing in the U.S. Army inventory that could be strictly defined as urban camouflage and deception equipment. All of the present equipment has been developed for field use and little of the equipment beyond smoke has ever been used in a tactical urban warfare situation where air-to-ground and ground-to-ground combat was occurring. While all of the ideas presented in this report appear practical and feasible, further research may show that material or design capabilities are not capable of achieving the performance desired; the prototype may work well but the cost, logistics, or tactical usage may place the item in the unwanted category.

The ideas described are mainly oriented toward air-to-ground and ground-to-ground operations of a tactical nature rather than strategic air-to-ground operations. In this regard, however, most of western Europe should be considered within the tactical range of modern aircraft. The material items described were considered with a view toward the amount of time available for emplacement, assuming the materials are in depots or in the hands of the tactical units.

Due to the specialized nature of some of the camouflage and, in particular, the deception equipment, the only realistic approach would be to assume the formation of some special engineer or intelligence cover and deception team to properly use the equipment. While regular line troops could use and deploy much of the camouflage devices presented, it is not possible for them to also have time to deploy the deception equipment unless that equipment directly pertains to their line function, such as the TOW Decoy Man and Launcher. Given the line troops' mission and their C&D requirements, it is evident that in the face of time and mission urgency, C&D deployment will not always be accomplished. Accordingly, strong consideration should be given to trained Division or Corps Camouflage and Deception Teams. The details of such a team, however, are far afield from the scope of this report and the DARCOM mission of materiel design. Consequently, this issue will not be addressed further, except to point out that a flag is raised to the potential solution of urban camouflage organization.

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[23] Barton Whaley, "STRATAGEM, Deception, and Surprise in War," Unpublished, Massachusetts Institute of Technology (1969).

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