1-1946

Handbook on USSR Military Forces, Chapter VI: Fortifications

War Department (USA)

Robert L. Bolin , Depositor
University of Nebraska-Lincoln, rbolin2@unl.edu

Technical Manual, TM 30-430
Handbook on USSR Military Forces
Chapter VI
Fortifications

Robert L. Bolin, Depositor
University of Nebraska-Lincoln, rbolin2@unl.edu

Technical Manual, TM 30-430, Chapter VI
1 January 1946

Handbook on USSR Military Forces
Chapter VI
Fortifications

War Department
Washington, DC

Comments

Abstract

TM 30-340, Handbook on USSR Military Forces, was "published in installments to expedite dissemination to the field." TM30-430, Chapter VI, 1 January 1946, "Fortifications," is a detailed discussion of earthworks and structures used for defensive purposes. . This chapter is illustrated with numerous drawings, diagrams, and charts.

This manual is listed in WorldCat under Accession Number:
OCLC: 19989681

CHAPTER VI

FORTIFICATIONS

TABLE OF CONTENTS

List of Illustrations

CHAPTER VI

FORTIFICATIONS

Section I. FORTIFICATIONS DOCTRINE

1. GENERAL

The length of the U. S. S. R.'s frontiers and the size of her territory have precluded the construction of a continuous, permanent system of frontier fortifications such as the Westwall or the Maginot Line. Shaped and developed by the impetus of modern armored and motorized warfare, the Soviet system of defense is primarily an antitank defense capable of rapid development. It is based on natural and artificial obstacles covered by and coordinated with an elaborate system of fire from field fortifications grouped into centers of resistance. Its purpose is to delay and channelize the enemy advance, thus facilitating destruction of the enemy by artillery and air counterpreparations and by counterattacks.

Properly sited and effectively developed systems of obstacles are the foundation of Soviet fortifications. These obstacles bar the enemy from access to tactical objectives. A system of fire is built up to defend the obstacles. Machine guns and individual antitank guns provide local cover. Artillery and mortar defensive barrages supplement the obstacles and interdict secondary approaches independently (figure 1).

With the development of the defensive system in depth, the obstacles form a more and more cellular system containing individual centers of resistance.

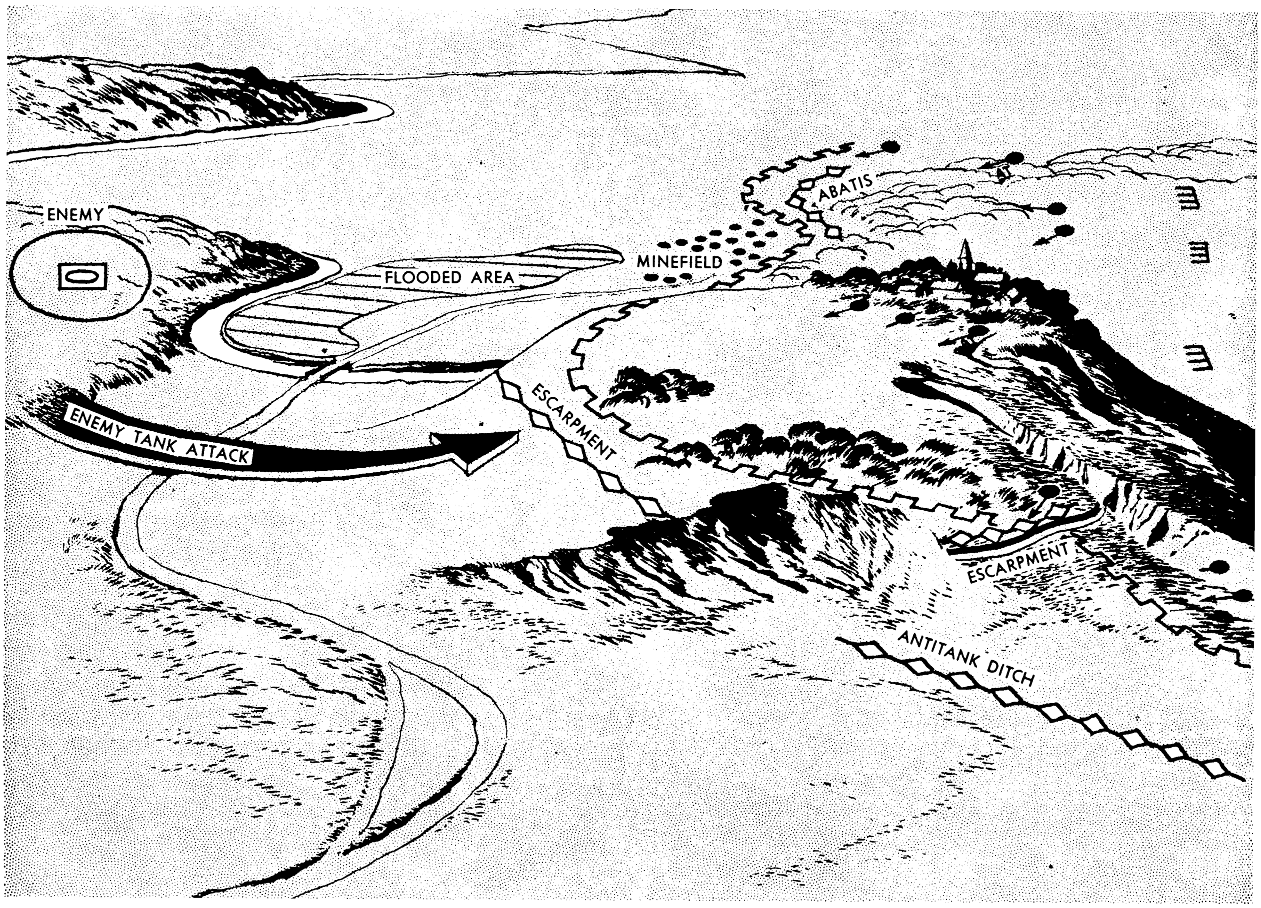


Figure 1.—Organization of antitank defenses.

In planning the cellular system, it is essential that friendly counterattacks against terrain seized by the enemy not be impeded. As a result, the Soviets do not employ complete all-around defense of a strongpoint, but provide a lane through which supporting strongpoints can lay down fire on a lost strongpoint without endangering counterattacking friendly troops. Similarly, switch positions are designed for effective resistance in one direction only, when natural obstacles cover other approaches.

The Soviets stress the importance of providing an adequate reserve of fire in fortified areas. Key areas must be covered by several types of weapons—artillery, mortars, and automatic weapons. Local over-saturation of defensive weapons must, however, be carefully avoided since it discloses the system of defense, is vulnerable to artillery fire, and leads to unnecessary losses. On the other hand, a reserve of weapons in protected positions must be available to replace losses from enemy fire.

The construction of shelters, particularly of a permanent type, for large numbers of troops is contrary to Soviet doctrine. No more personnel is maintained within the defensive zone than is essential for the conduct of local defense. Mobile reserves are maintained under centralized control for general counterattacks supported by powerful artillery counterpreparations.

The Red Army also stresses the necessity for deception in a defensive system. Camouflage techniques and discipline have been highly developed. Dummy positions of the most elaborate description are often constructed and may be defended by small garrisons with equipment to simulate intensive fire. Generally, the dummy positions, particularly the dummy forward lines, are sited so as to induce enemy attack in a direction flanked by the actual positions. Forward slopes are often used for dummy positions, with the main positions on reverse slopes. Crests are frequently integrated within the boundaries of the main positions. Soviet communication trenches are usually covered; vertical masks provide concealment from ground observation.

The Soviets make extensive use of small concrete or steel pillboxes and emplacements, often prefabricated. These are used integrally with field fortifications, especially in key or exposed positions. Elaborate systems of permanent fortifications were originally constructed along parts of the 1939 U. S. S. R. boundary, but proved to be defensively inadequate. In general, heavy permanent works play a very minor role in Soviet fortifications doctrine at the present time. Important strategic centers and naval bases are protected by forts, often old, with armored turrets housing heavy guns. These must be supported by field works and minefields to make possible their close-in defense.

Experience of the war has shown that populated centers, especially large cities, can be developed into extremely formidable fortifications (see City Warfare, chapter V). Houses provide excellent defensive positions, particularly in basements. Rubble serves for camouflage and protection against blast action. In addition, field fortifications of normal types are readily constructed in parks and streets. Sewers and subways afford unusual possibilities for unexpected counterattacks, shelter, and mining.

2. ORGANIZATION OF A DEFENSIVE SYSTEM

Soviet defensive positions are designed to stop the enemy in front of the main line of resistance, to localize the enemy's penetration, and to prevent his expansion frontally or in depth. The organization of defensive positions is ordinarily based on an interconnected system of defensive cells, often arranged in a staggered, checker-board pattern.

a. Army defensive zone. An army defensive zone (figure 2) includes an outpost zone; several zones echeloned in depth, of which the first is the main zone of defense; switch positions; and an obstacle system (minefields and antitank areas) to fill the gaps between individual defense zones and link them together into a single operational system. An Army defends a zone 18 to 30 miles deep and 30 to 50 miles wide. An infantry divisional defensive zone is 2½ to 3½ miles deep and 5 to 7 miles wide. Within the division, two regiments normally defend on line with three battalions abreast; the third regiment is held out as a mobile reserve or to man the rear defensive position, and to provide troops for the outpost zone of defense. Each battalion position is 1,500 to 2,000 yards deep and about as wide; of this area about half serves as a delaying position and about half as a center of resistance.

Greater depths and greater widths of defensive positions with relatively uniform distribution of strongpoints characterize the decentralized system of defense (see chapter V). Centralized defensive systems, on the other hand, are characterized by greater over-all density and by sharp contrasts in the distribution and concentrations of strongpoints and obstacles. Primary enemy approaches are heavily defended. Secondary approaches are covered chiefly by fire and mobile units.

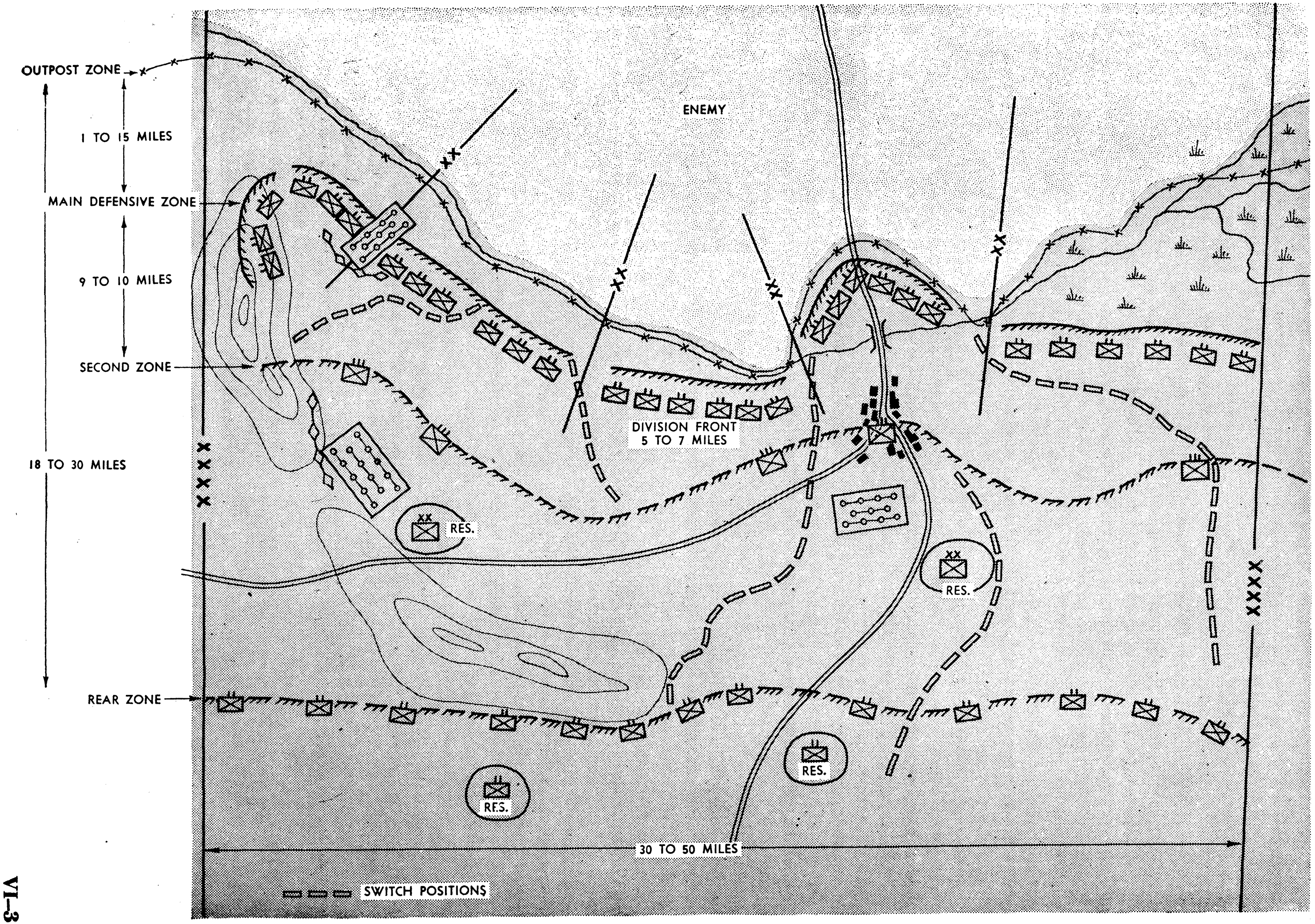


Figure 2.—Organization of an army defensive zone.

The flanks of strongpoints are often reinforced by emplacements for tanks and self-propelled guns which fire from concealed positions until the approach of the enemy forces their mobile action.

OUTPOST ZONE. The outpost zone must be organized before contact with the main enemy forces. Its missions are to facilitate observation and fire direction, to destroy small advance enemy elements, and to delay the advance of the enemy main body. It includes advanced and intermediate positions reinforced by obstacles blocking principal enemy approaches, especially for armor. The density of the obstacles increases toward the main zone of defense. The outpost zone ranges from 1 to 15 miles in depth, depending on terrain. Where surprise attacks by the enemy are likely, as in the mountains and in country accessible to armor, the outpost zone must be deep and capable of independent local action. Within the outpost zone a dummy forward edge for the main zone of resistance is often built.

MAIN ZONE OF RESISTANCE. The main zone of resistance is the basis of the defense system. Its forward edge is organized as the main line of resistance with a maximum concentration of fire and obstacles against the attacking forces. Provisions are made for the all-around defense of individual sectors of the main zone of resistance in the event of enemy penetrations. The zone consists of a series of battalion or, more rarely, regimental centers of resistance containing company and platoon strongpoints. The centers of resistance and strongpoints are so sited as to be protected by natural and artificial barriers, and to cover these barriers by fire. Trenches supplemented by pillboxes and open or covered artillery emplacements are the main types of strongpoint fortifications. Tactical intervals between strongpoints form pockets in which a penetrating enemy may be trapped under observed fire.

The relative strength of the main zone of defense depends upon the over-all tactical plan of centralized or decentralized defense. In centralized defense the bulk of the artillery remains massed behind the main defensive zone. The conduct of the defense is elastic. Secondary positions are abandoned under strong pressure. Chief emphasis is laid on maintaining a continuous defensive line and on channelizing the enemy attack in preparation for a decisive counterattack. In decentralized defense, artillery is assigned to individual centers of resistance and even company strongpoints. Consequently, a high density of direct fire exists, although control of massed fire is rendered more difficult. Individual centers of resistance are held to the last.

SECOND ZONE. From 9 to 10 miles behind the forward edge of the main zone of resistance a second zone is organized, normally by the reserve regiment of each division in line. In general, the fortifications system of the second zone is similar to that of the main zone. Primary emphasis, however, is laid on the creation of obstacle systems and centers of resistance protecting principal enemy approaches, rather than on continuous lines of defense. The second zone of resistance is used as an assembly area for counterattacking forces, which employ centers of resistance and switch positions as lines of departure. Intervals between centers of resistance in the second zone and between the main and second zones are covered by switch positions and by antitank defensive areas at critical points. Care is taken in the disposition of switch positions and obstacles not to hamper the movement of counterattacking forces. If the enemy breaks through the main zone of resistance, a new main zone can be created from the second zone or from sections of the second zone in conjunction with switch positions. A third or fourth intermediate zone of defense may be created as dictated by terrain; for example, in the defense of mountain valleys.

REAR ZONE. The army rear zone of defense usually follows the second zone, although other intermediate zones may be present. Its mission is to contain the penetration of enemy armored spearheads, the main bodies of which are destroyed within the second zone. In case of a major rupture of the second zone, the rear zone conducts a delaying action (decentralized defense), permitting the army to regroup its reserves and launch a decisive counterattack or to form a new defensive zone based on the changed tactical situation. Fortifications are similar to those of the first zone rather than those of the second zone. The density of forces and fire power is lower, fewer reserves are available, and obstacles and field fortifications are less developed. In case of emergency, the rear zone serves as the main zone of defense.

SWITCH POSITIONS. Switch positions stretch to the rear from the main zone of resistance perpendicularly or at an angle. Their missions are to localize enemy penetrations to one sector and to prevent enemy outflanking operations along the rear of the defensive zone; to permit effective delaying action pending the arrival of reinforcements; to serve as transit positions from the main to second or rear zones of resistance; and to serve as lines of departure for counterattacking forces.

Switch positions are classified as transverse or connecting. Transverse switch positions do not reach the second zone of defense. They serve to protect the main zone of resistance from enemy flanking attacks and to force the enemy to carry out deep enveloping movements. Connecting switch positions tie one defense zone with another and facilitate withdrawal of sectors adjacent to the areas of penetration, thus enabling the defending forces to limit the enemy advance and trap the enemy forces.

Army group switch positions are an integral part of the strategic defensive plan, and their layout, manning, and development are dictated by army group or higher headquarters. Army switch positions are designed particularly to cover lines of communication and service areas, as well as to facilitate the action of reserve divisions. Divisional switch positions are laid out, manned, and developed under divisional control for the primary purpose of facilitating the action of the reserve regiment.

Switch positions are normally designed for defense from one direction only, although the presence of other approaches, terrain conditions, and other special factors may dictate the construction of local all-around defenses. In open country, the defensive system of switch positions is mainly based on strongpoints and centers of resistance which are mutually visible and which sometimes support each other by fire. Intervals between strongpoints are mined. Emplacements are provided for armored and motorized equipment.

Antitank ditches and other elaborate systems of local defense are usually not provided for the protection of switch positions. Instead, mines and lines of tank traps are prepared in key sectors. These may be ultimately developed into complete obstacle systems.

b. Use of terrain. In general, Soviet doctrine governing the use of terrain for fortifications is identical to that of the U. S. Army. Primary stress is laid on the availability of natural or artificial obstacles, fields of fire, and observation. Other factors are secondary.

One special use of terrain by the Red Army has been the development of defenses in marshy regions. Such defenses are primarily designed against infantry and consist mostly of breastworks or, if the level of ground water permits, semisubterranean defenses. The breastworks stretch in line with distinct gaps for fire from rear positions. Parallel lines of breastworks are connected by camouflaged communication passages. Vertical masks of branches, twigs, and other natural materials are extensively used for camouflage. Artillery is emplaced on any available firm ground. Where ground water prevents deep digging, earth works are built above ground.

c. Fortifications in offensive combat. The Red Army emphasizes that the success of offensive operations depends, to a great extent, on the skillful employment of fortifications to reduce the danger of enemy counterattacks. Fortifications in offensive operations include the construction of defensive works in the assembly areas and along the line of departure, and the hasty fortification of seized areas. In the fortification of assembly areas, primary emphasis is on the development of peripheral positions to prevent enemy attacks against, or infiltration into, the assembly areas, and on expensive construction of dummy works to deceive the enemy regarding the sector and scope of the main effort.

In the assault of fortified positions, the construction of approach trenches and emplacements for direct-fire artillery as close as possible to the enemy is also stressed.

Hasty fortification during the course of the offensive must be undertaken with light equipment and with the greatest possible speed. Consequently, specialized materials must be provided, such as antitank and antipersonnel contact mines, concertina rolls, and wire and detonators for the construction of controlled antipersonnel mines from captured shells. These materials are brought up on tank-drawn or manhandled sleds or trailers by pioneers (combat engineers) immediately following the assault infantry. Hasty minefields are installed within 15 to 20 minutes after the capture of a position. Successive echelons carry forward prefabricated steel or concrete pillboxes on tank-drawn sleds or trailers; these are installed within a few hours after the seizure of a position. For maximum economy of matériel and transport, the obstacles and prefabricated pillboxes erected in rear positions are taken up as soon as they are no longer needed and are moved forward as required. Extensive use is also made of adaptable enemy defenses and of local terrain features, such as shell craters and the ruins of houses.

The purpose of such hasty fortifications is to delay enemy counterattacks and to permit the deployment of direct-fire artillery, which plays the primary role in covering the reorganization of infantry during operational pauses. Consequently, close liaison between fortifications pioneers and direct-fire artillery units is mandatory.

Section II. DELIBERATE CONSTRUCTION OF FORTIFICATIONS

1. ORGANIZATION OF A STRONGPOINT

Deliberate construction of fortifications is normally planned and carried out before contact is made with the enemy. During prolonged defensive operations, permanent defenses are developed from hasty fortifications. The nerve center of every defensive zone is the strongpoint, the effectiveness of which depends upon an adequate coordination of defense works with tactical requirements. The usual procedure is first to protect the positions against enemy tanks by mines and obstacles; then to provide fire protection for the obstacles; and finally to construct shelters for supplies and personnel (figure 3).

The Soviets stress camouflage of defensive positions as a principal requirement. The work of camouflaging is reduced by the concentrated form of Soviet strongpoints. Skillful use of dummy strongpoints helps to conceal the true positions from enemy observation. A few dummy defense works are sometimes scattered inside the actual strongpoints to distort its outlines.

The normal elements which constitute a strongpoint are trenches, machine-gun emplacements, mortar and antiaircraft emplacements, tank and self-propelled artillery emplacements, and antitank and antipersonnel obstacles and mines (figure 4).

a. Trenches. In selecting sites for trenches, chief consideration is given to fire and concealment. Clearly outlined landmarks are avoided. As a rule, trenches follow one elevation contour along gentle slopes. The Soviets cover trenches built near topographic crests. Occupation of reverse slopes for flanking and oblique fire is recommended in most cases.

Fire and communication trenches are built along the front and in the depth of strongpoints. The purpose of the trenches along the front is to connect separate firing positions and their elements (figure 5). If the strongpoint is small, fire trenches along its edge form practically one continuous line. Reserve fire trenches on or in front of the forward edge of the main line of resistance provide support in initial defensive action and during the repulse of attacks. Security of withdrawal from a strongpoint is ensured by covered communication trenches and underground passages leading from the position to a concealed area in the rear. Communication trenches connect all fire trenches, gun emplacements, shelters, and observation posts to permit maneuverability within the strongpoint. For communication and maneuver along the forward edge of a strongpoint, a parallel trench is built which may also serve as a fire trench. Easy communication with the rear is organized. Tunnels are built if terrain conditions are favorable and sufficient time is available. A widened communication trench parallel to the front in the rear of a strongpoint is recommended to permit rapid transfer of units. This wider trench in the rear constitutes an additional antitank ditch. It may be built rectilinearly and is covered for camouflage.

Normally, a battalion defense zone has three lines of trenches and three communication trenches connecting the defensive zone with the rear. The first trench runs along the forward edge of platoon strongpoints. Usually it is not continuous and is sited on the military crest. The second, basic trench is, as a rule, continuous and follows the second line of platoon strongpoints and centers of resistance. The third, broken trench is dug on reverse slopes of elevations and runs along the third line of platoon strongpoints or along the rear boundary of the second line of platoon strongpoints. Sufficient space is left between the trenches for the organization of a dense fire system in front of the forward edge of the defensive position and for fire cover of obstacles. These distances are usually 650 to 1,300 feet between the first and second trench and 500 to 650 feet between the second and third trench.

Red Army trenches are deep and narrow. Stakes driven into the trench sides provide sortie steps at intervals of 25 to 30 feet. Exit to the rear is provided in trenches and communication passages by ramps or steps dug in the earth at intervals of 65 to 100 feet. On the average, trenches completed to a full profile are from 3.2 to 5.2 feet wide at the top and 1.6 to 2 feet at the bottom; their depth is 3.2 to 6.5 feet (figure 6). Fire pits for riflemen and machine-gun positions are built at close intervals—about 13 to 16 feet between riflemen and 65 to 130 feet between machine guns. Communication passages are of sufficient width (6 feet) for the transportation of heavy machine guns and, when necessary, antitank guns. Such wide communication passages are considered especially important between the main and reserve gun positions in open terrain.

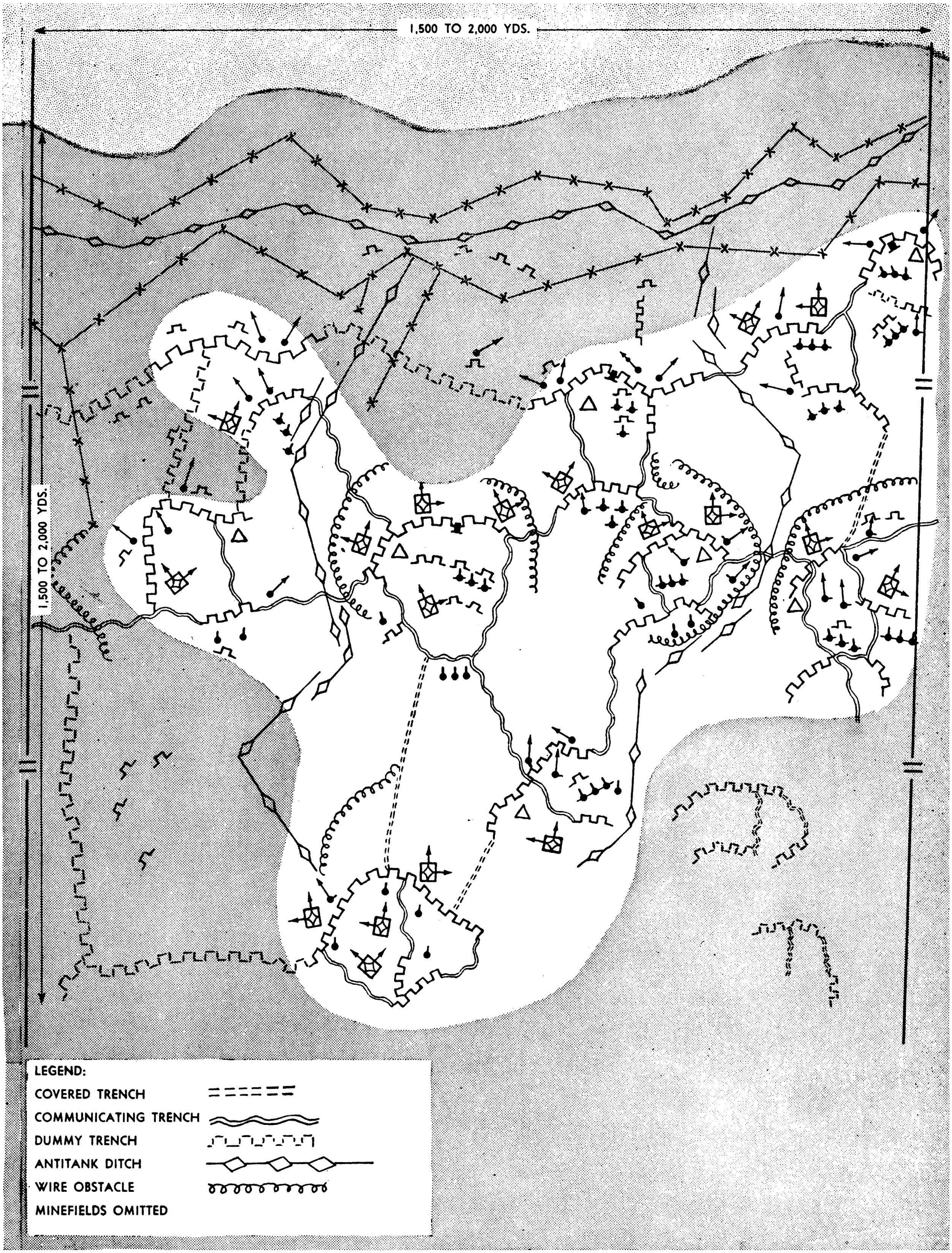


Figure 3.—Fortification of a center of resistance.

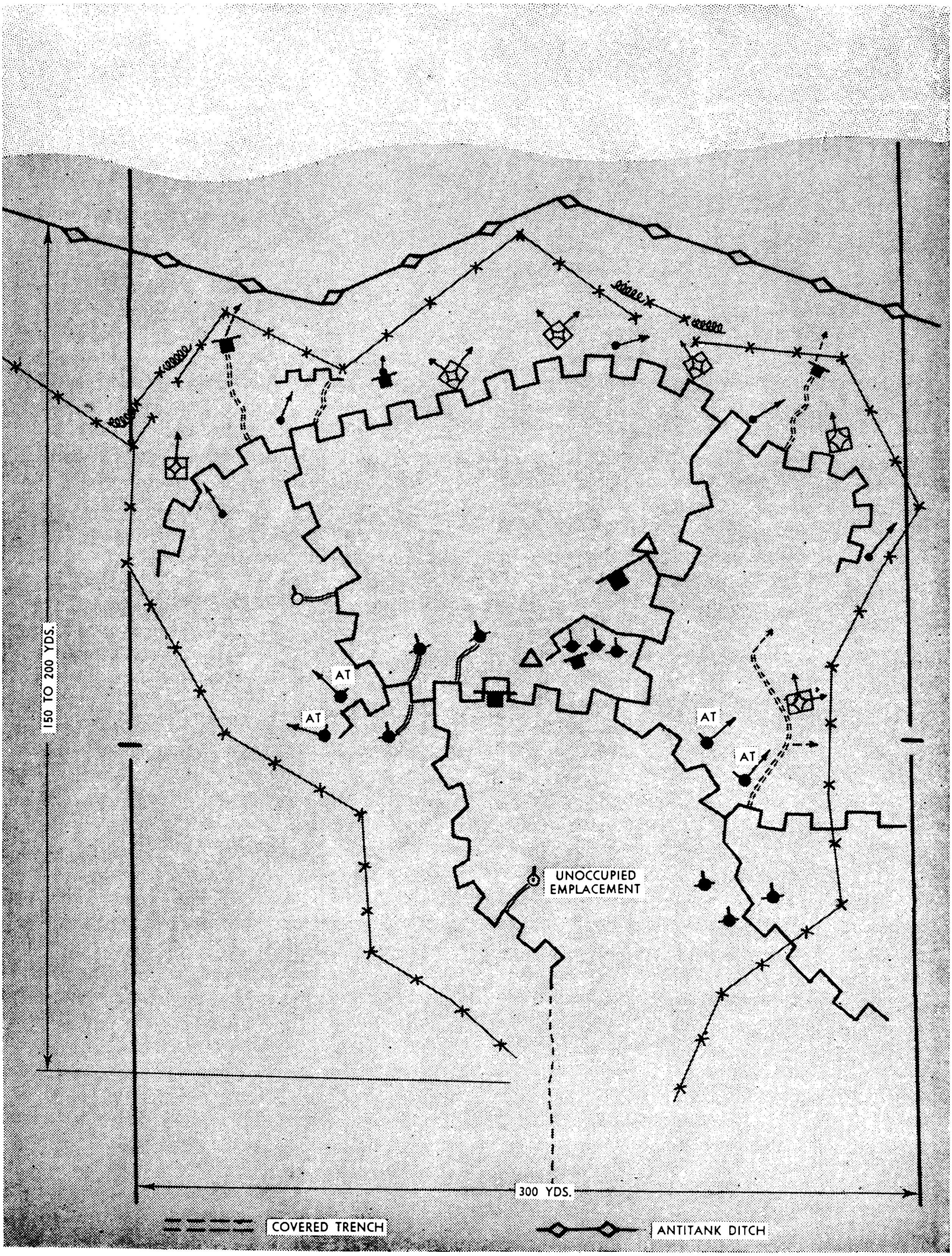


Figure 4.—Fortification of a strongpoint.

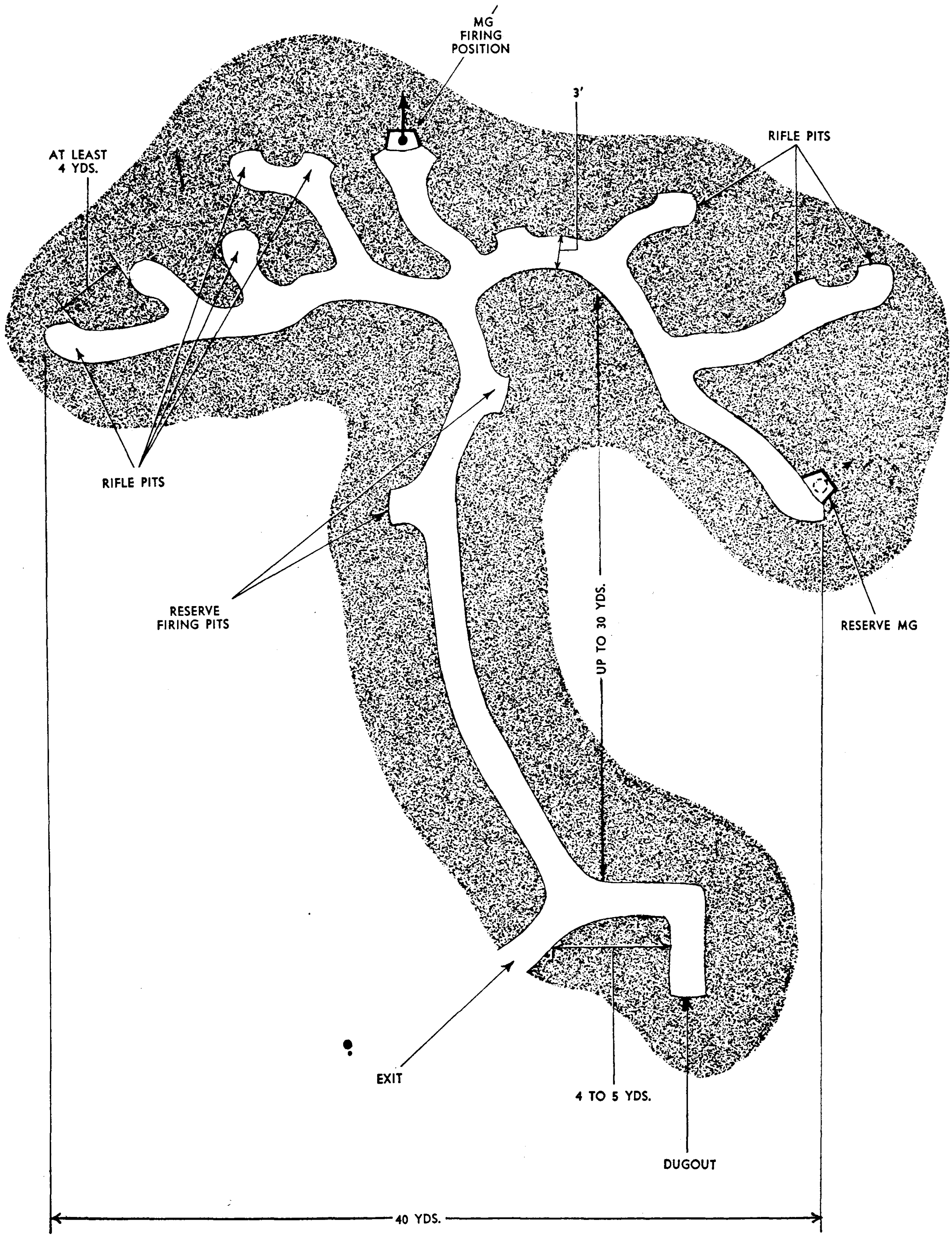


Figure 5.—Squad trench.

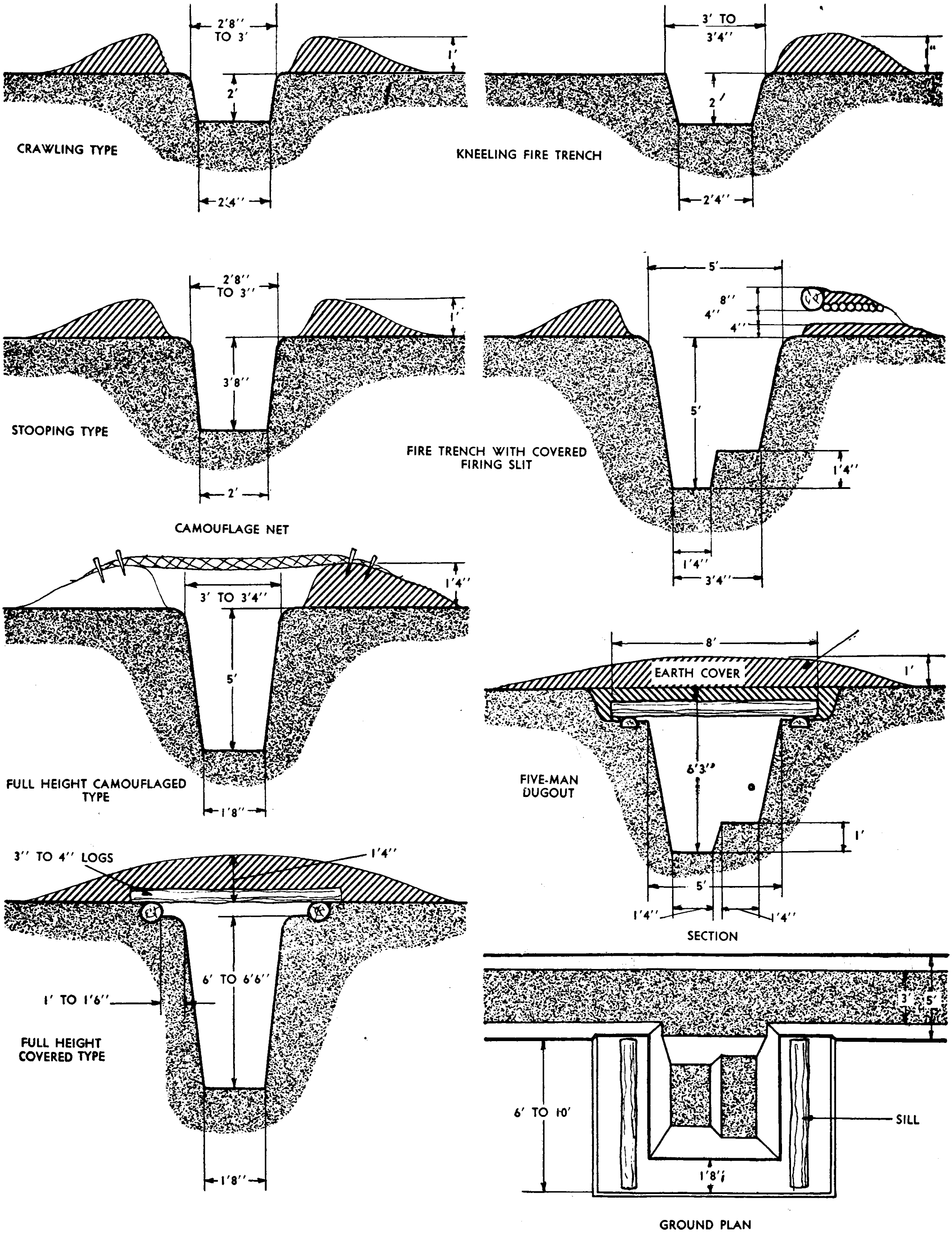


Figure 6.—Standard trench profiles, showing development of a communication trench.

Overhead cover of trenches consists of one or more layers of round logs with a layer of earth on top. Grass, bushes, or trees are planted on the cover for camouflage. In open, woodless terrain, flat overhead cover is used.

During prolonged periods of defensive warfare, trenches are further developed and improved. Recesses are built for men and supplies; light personnel shelters are constructed under the breastworks; provision is made for drainage; embrasures are provided; revetments are installed and overhead covers built (figure 7).

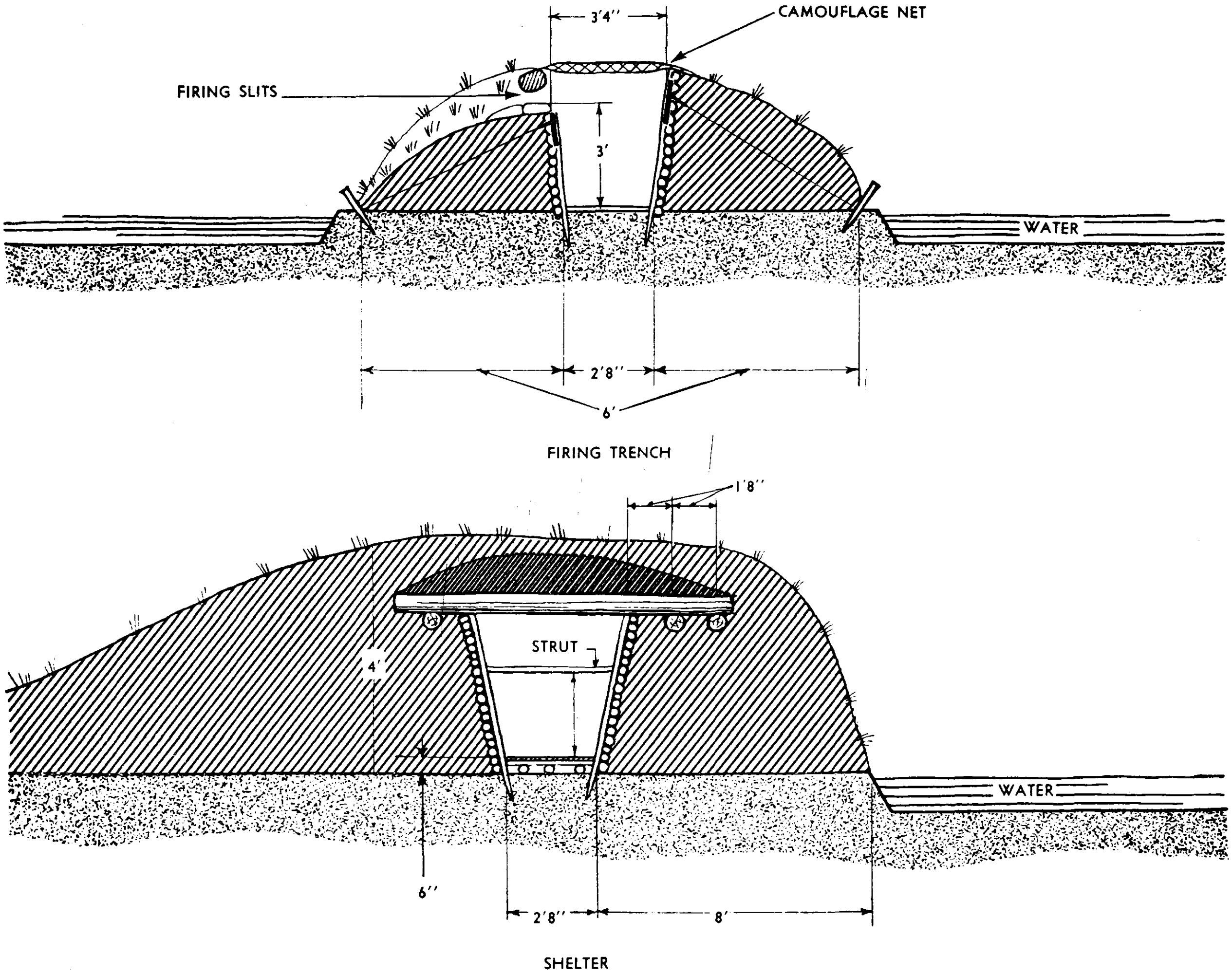


Figure 7.—Built-up fortifications in swampy terrain.

b. Machine-gun positions. To provide supplementary fire protection during initial action against separate, advancing enemy elements, machine-gun emplacements are built on, or in front of, the forward edge of the strongpoint. Flanking machine-gun nests are provided for converging, flanking, and oblique fire to repulse frontal attacks. Reserve and supplementary machine-gun emplacements are located close to the main firing positions. Their mission is to open fire on threatened areas in the event of enemy flanking attacks through gaps between strongpoints.

In the order of development, the known types of machine-gun emplacements include open machine-gun positions, covered machine-gun trenches, semicovered timber-and-earth structures (*polukopanir*), covered timber-and-earth structures (*kopanir*), and reinforced rock-fill wall and heavy concrete pillboxes (figures 8 and 9).

c. Personnel shelters. In the field, the Soviets provide shelter for about two-thirds of the personnel of a defensive position. In addition to recesses and light personnel shelters in trenches, separate shelters are built near firing positions, close to command and observation posts, and in the rear of defensive positions.

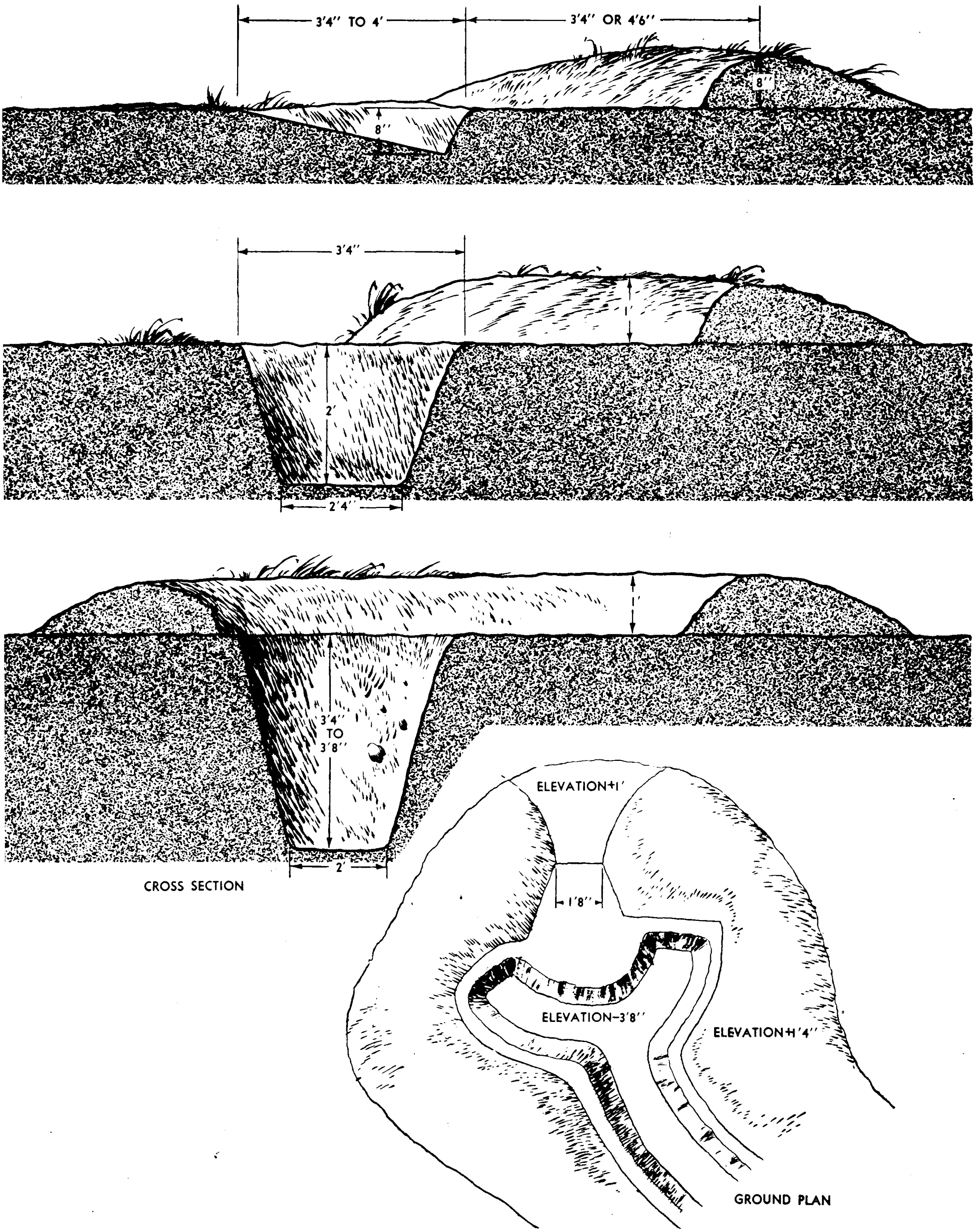


Figure 8.—Open machine-gun emplacements.

The most elementary type of shelter is a covered slit trench, which affords protection from air bursts and fragmentation. A slit trench is 6 to 6.5 feet deep and the space per man is computed at the rate

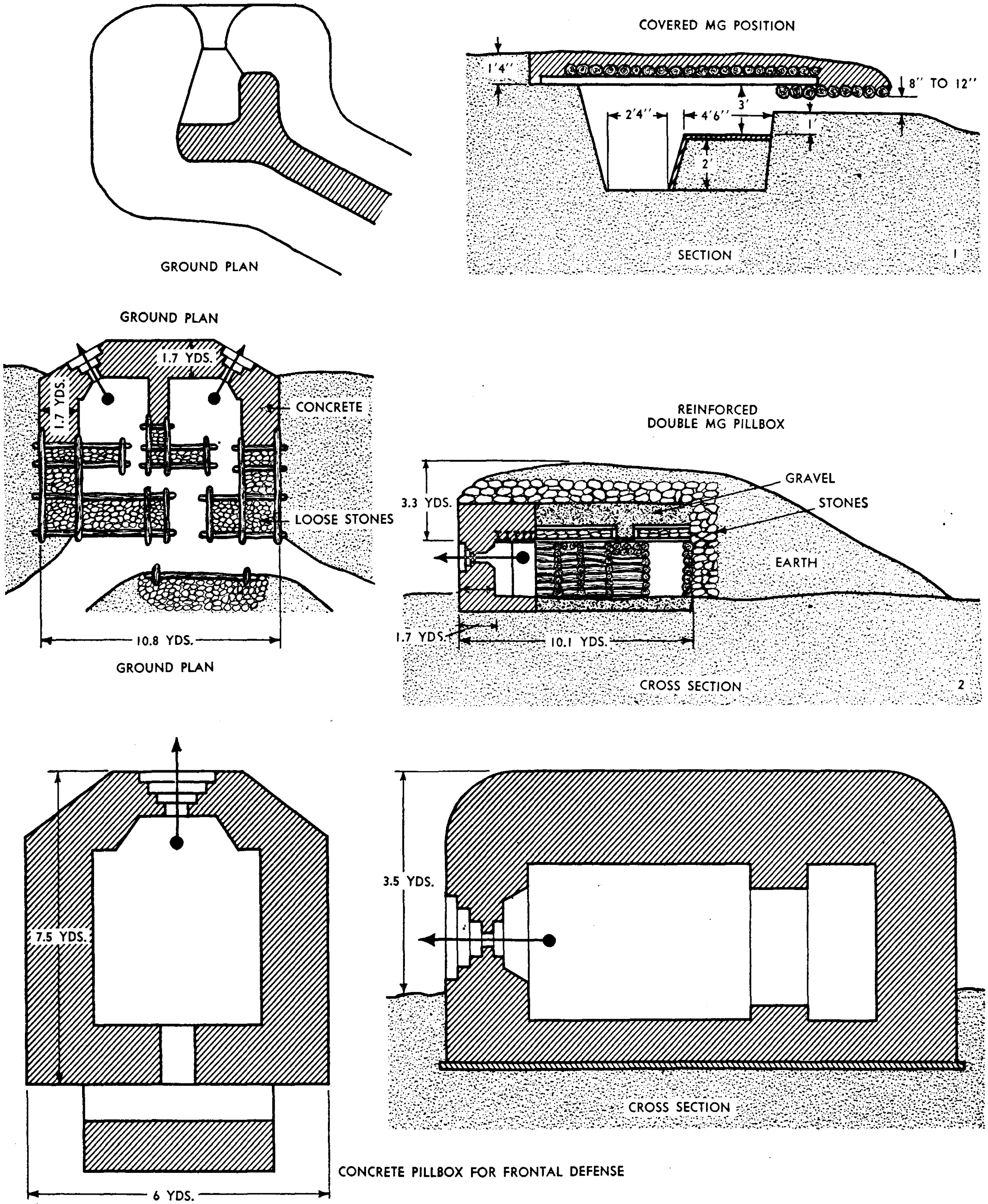


Figure 9.—Covered, reinforced, and concrete machine-gun emplacements.

of 2.3 to 3.2 feet in length. Slit trenches with double roofs resist the crushing effect of tanks (figure 10). Covered dugouts are built 32 to 65 feet from firing positions and observation posts for protection against aircraft machine-gun fire, aerial bombs, blast splinters, and artillery shells up to

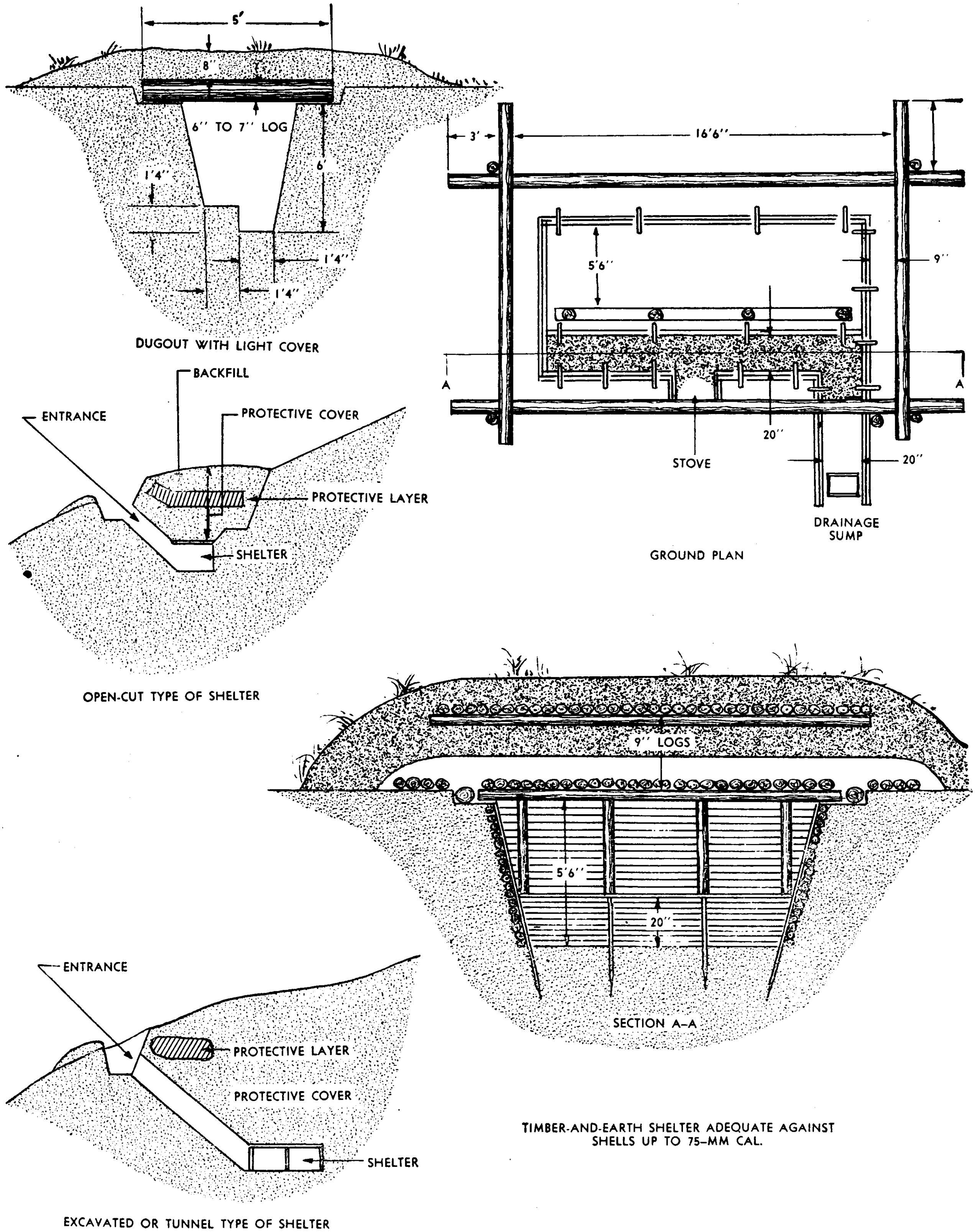


Figure 10a.—Development of personnel shelters.

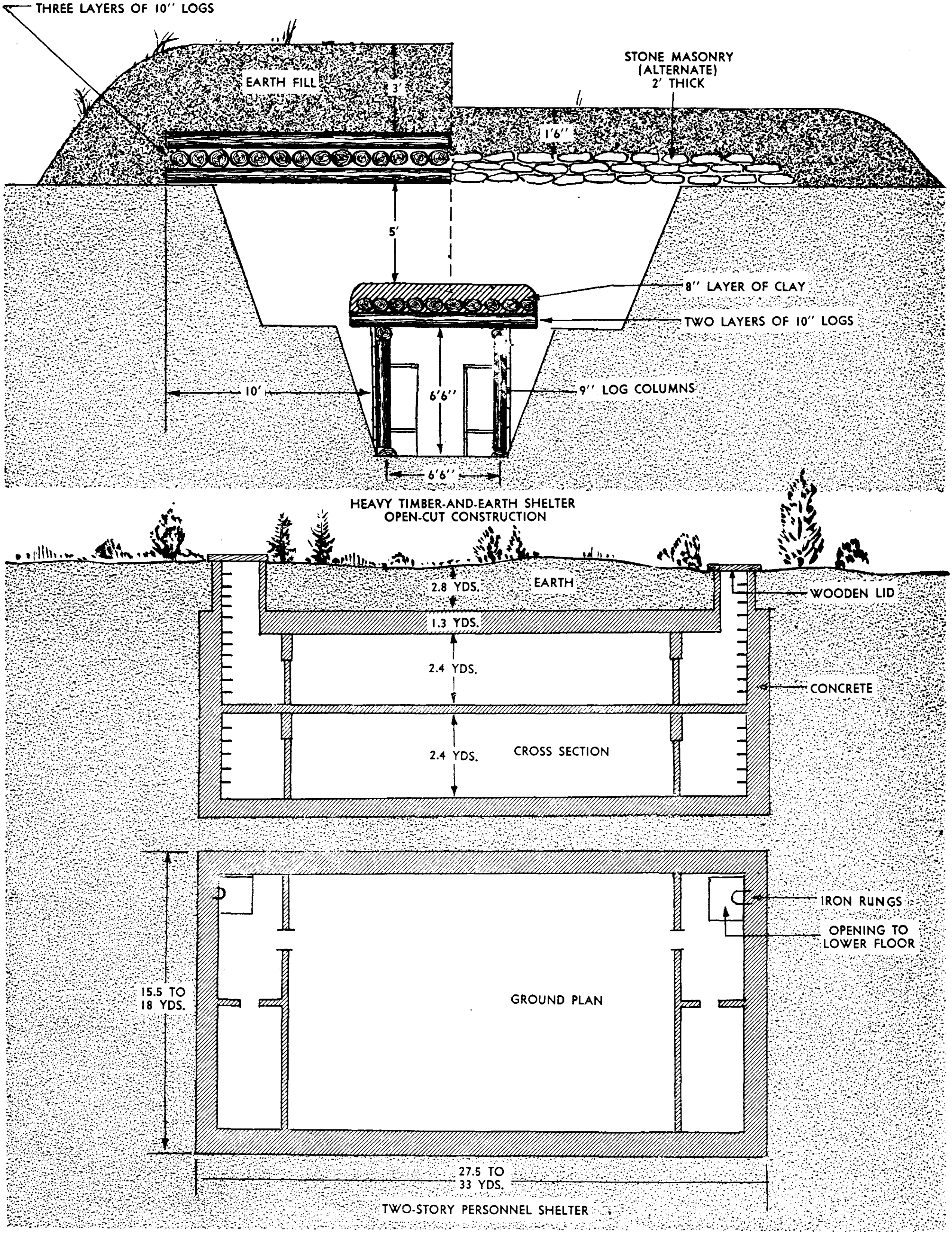


Figure 10b.—Development of personnel shelters.

75-mm. Reinforced shelters provide protection against shells of 75-mm guns and 122-mm howitzers. Heavy-type shelters provide protection against 105-mm gun and 155-mm howitzer shells and 110-pound aerial bombs. Staff and command posts housing about 10 men are built 13 to 16 feet underground depending on the level of the water table, with an overhead cover 8 to 10 feet thick. Superheavy two-story underground shelters, absolutely invisible on the surface, have entrances at opposite ends with flat wooden covers, and iron rungs set in concrete serving as steps. The arrangement of lower and upper floors is similar. The total height of the structure is about 33 feet. Individual compartments inside are about 7 feet high. The shelter has a surface of about 3,500 to 5,000 square feet.

Artillery and antiaircraft artillery observation posts are sited to permit good visibility of enemy positions or of the sky were desired. They are usually located on inconspicuous high ground, in ruins of inhabited places, or at the edge of a large forest. Locally available material is used for camouflage. The Soviets emphasize that observation posts should not be crowded into one area and that concentrations of men, horses or motorcycles, or any visible movement of messengers should not be permitted in the immediate area of an observation post. Observation posts for antitank defense are located behind natural or artificial obstacles (figure 11).

d. Supply shelters. Supply shelters provide protection for transport equipment and facilitate the distribution of ammunition to individual firing positions. To provide protection for transport against artillery fire, the Soviets build covered sheds on steep reverse slopes of elevations and gullies. The slopes are cut at nearly a right angle, and platforms are built for the transport equipment. A ditch above the shelter drains off rain water running down the slope. In open terrain, shelters for bulky transport are dug in at intervals of 100 to 200 feet.

Ammunition dugouts are usually placed 50 to 65 feet from the guns. They are built in communication trenches connected with the left side of gun emplacements.

e. Artillery emplacements. The primary mission of direct-fire artillery is to stop and destroy attacking enemy tanks. For this purpose, the artillery is massed in principal tank-endangered areas and is emplaced behind natural or artificial antitank obstacles. For concealment from enemy observation, artillery positions are sited on reverse slopes or in broken terrain covered with shrubbery and high vegetation. The basic artillery emplacement is sunken, with slit-trench shelters for the crew, ammunition recesses on both sides of the emplacement, and a ramp for the gun in the rear. The design undergoes minor variations in covered and reinforced structures (figure 12).

A sunken antitank-gun position for all-around fire consists of a gun platform connected with a shelter for the gun, a small slit trench for the crew on the right side, and one or two ammunition storage recesses. The depth of the slit trench is not less than 5 feet; its width is about 1.3 to 3.2 feet at the top; its length is 10 to 13 feet. Parapets about 1 foot high are built of spoil in front and to the rear of the slit trench. Approaches to the position, especially on the flanks and in the rear, are protected by antitank obstacles.

The gun emplacement for all-around fire is circular, with a diameter of 13 feet. It is dug in to a depth of about 1 foot. A ramp leads from the platform to the gun shelter. The shelter is square and about 3.5 feet deep. Along each side of the shelter special 3.2-by-1.6-foot steps are cut in the ground to support the gun wheels. Gun shelters are usually placed on the left side or in front of the platform. If the shelter is in front, the height of the front parapet does not exceed 8 inches. A space of about 1 foot 8 inches is left between the platform and the descent to the gun shelter to provide support for the trail spade.

If all-around fire is not required, platforms for antitank guns firing on a narrow sector are built as small as possible—about 10 feet long, 5 to 6.5 feet wide in front, and 10 feet wide in the rear.

Sunken emplacements for field-artillery guns consist of a gun platform dug in to a depth of about 2 feet and two small slit-trench shelters at the sides of the platform for the protection of commander and crew. The shelters are in line, the right one being at a small angle to the basic direction of fire to provide maximum protection for personnel against shells, grenades, and bombs exploding on the gun platform. A ramp for the gun is built in the rear of the emplacement. There is no parapet in front of the gun.

When time and materials are available, covered timber-and-earth artillery emplacements are built for protection against bullets and splinters. These emplacements are dug to a depth of about 2.5 feet. The walls are revetted with stakes. Ammunition storage recesses are built in the sides of the walls. The emplacement has a width of 6.5 feet in front and

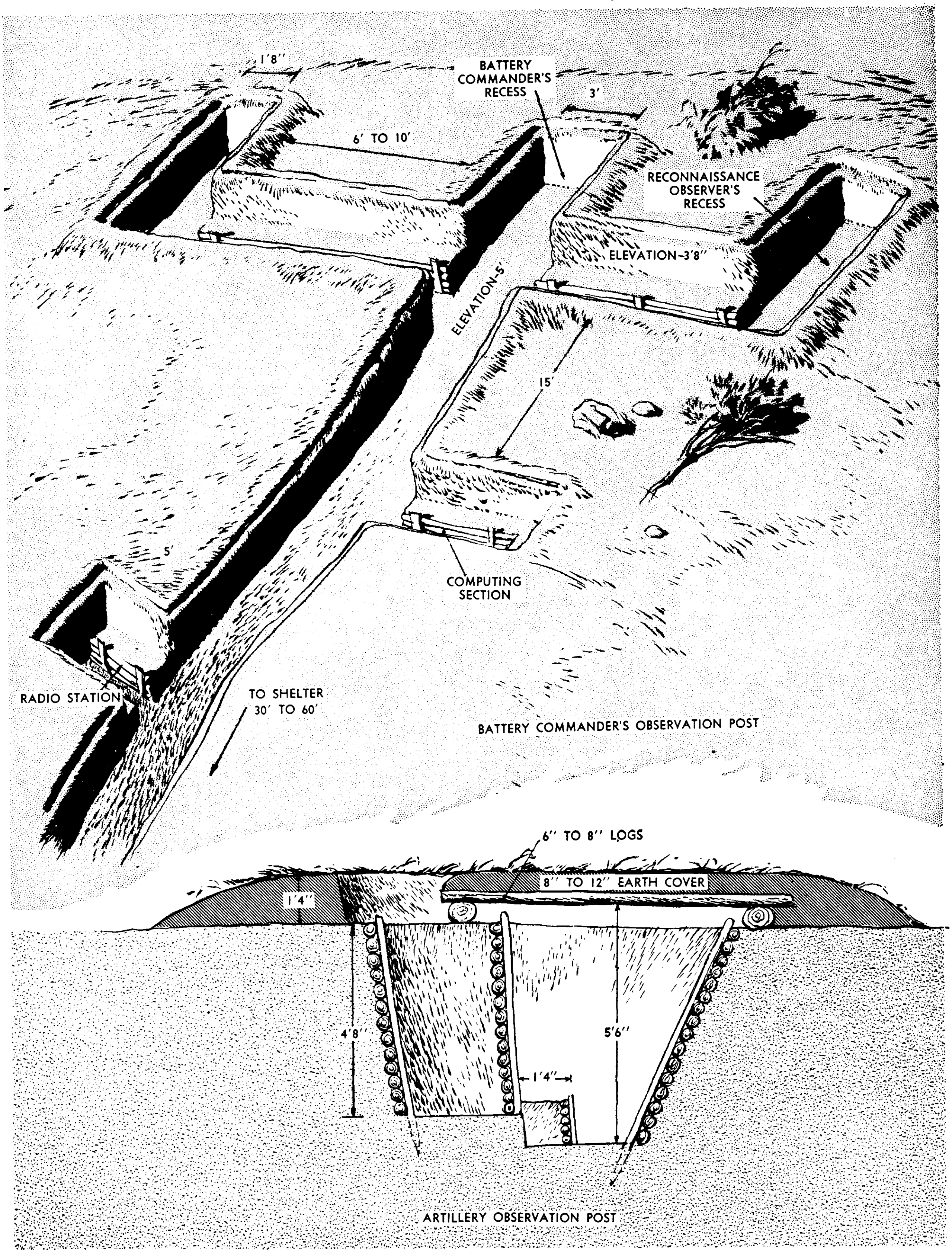
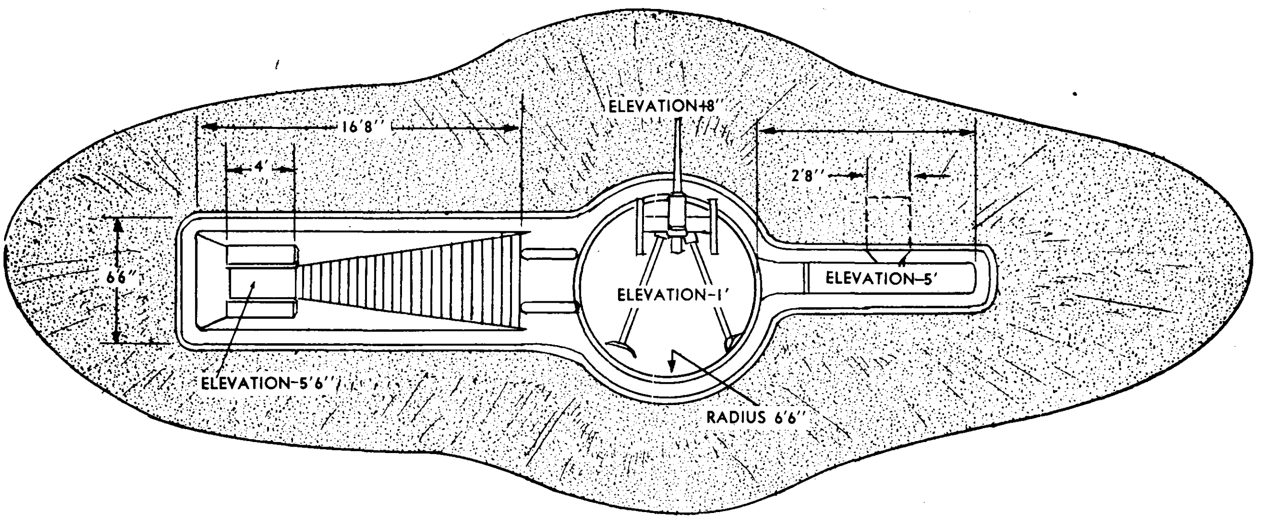
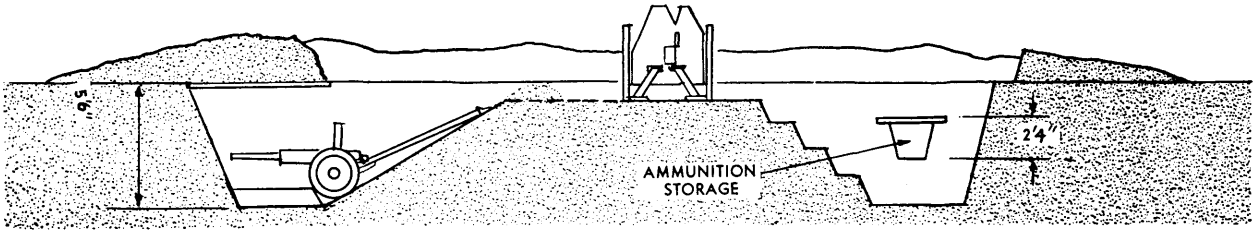


Figure 11.—Observation posts. Camouflage is not shown in upper drawing.

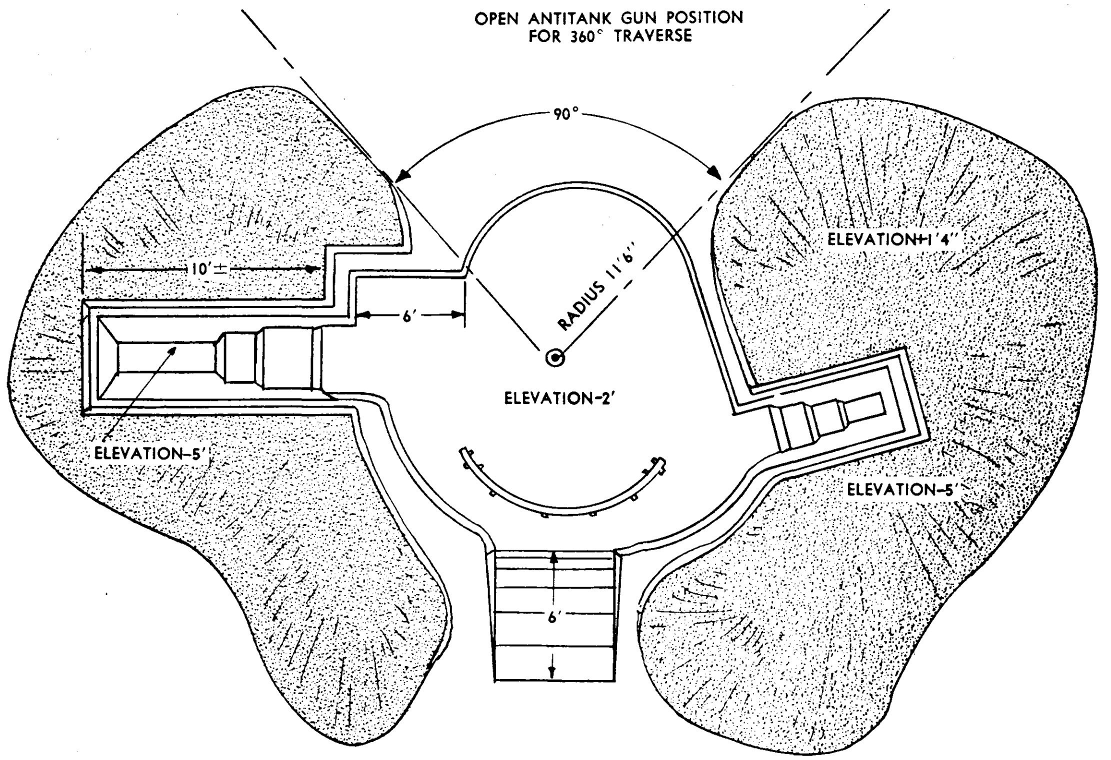


GROUND PLAN



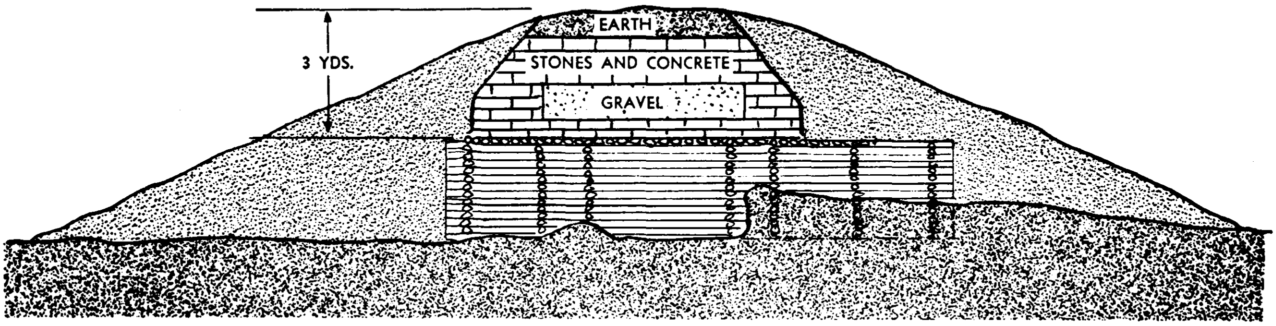
SECTION

OPEN ANTITANK GUN POSITION
FOR 360° TRAVERSE

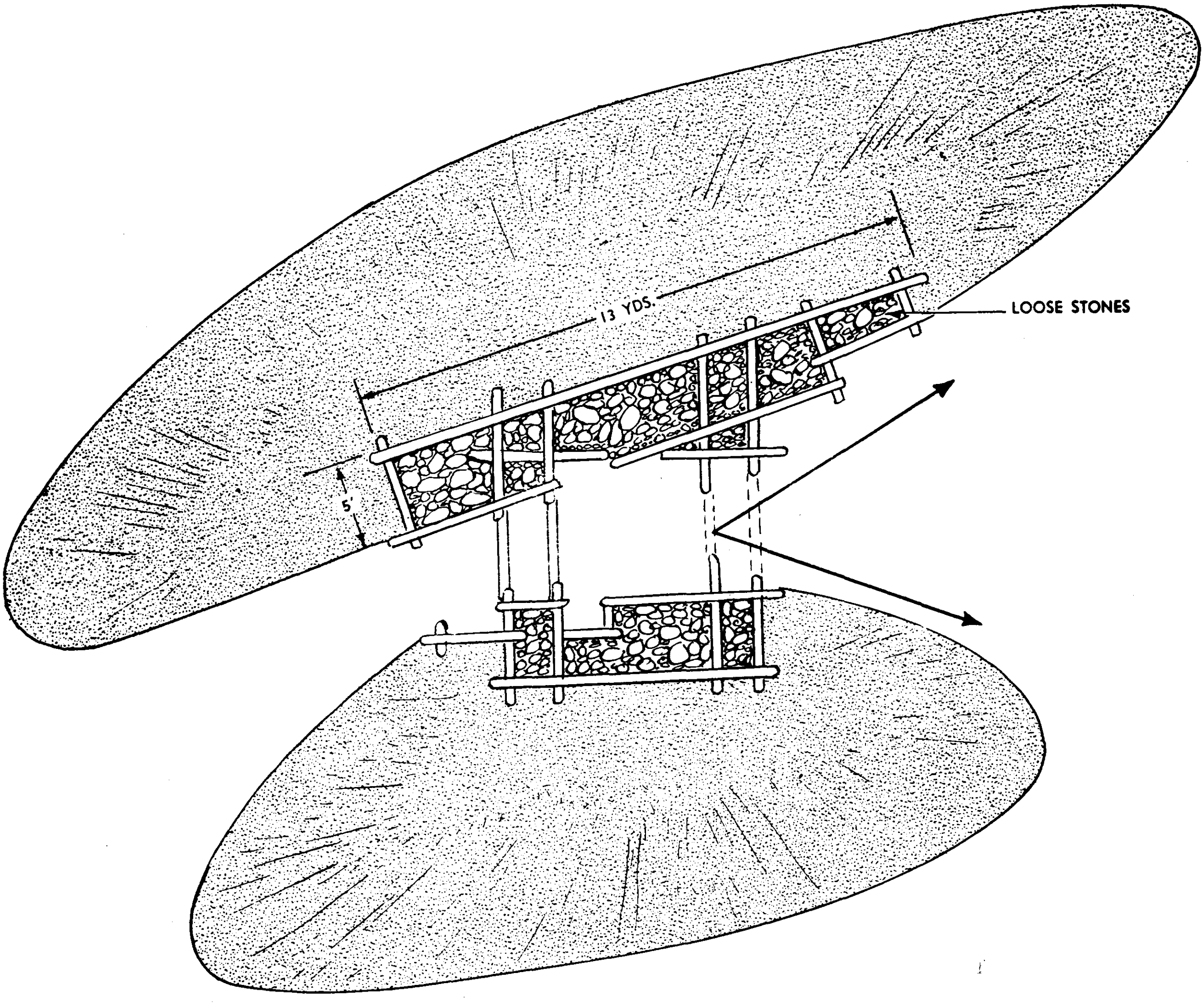


76-MM GUN OPEN EMPLACEMENT

Figure 12a.—Development of artillery emplacements.



CROSS SECTION



GROUND PLAN

COVERED EMPLACEMENT

Figure 12b.—Development of artillery emplacements.

11.5 feet in the rear; it is 15 feet long and at least 5.7 feet high inside. The front wall is revetted up to ground level, above which a firing embrasure allowing a traverse of 60 degrees is left open. A ramp is provided in the rear. The entire timber construction is covered with earth and camouflaged.

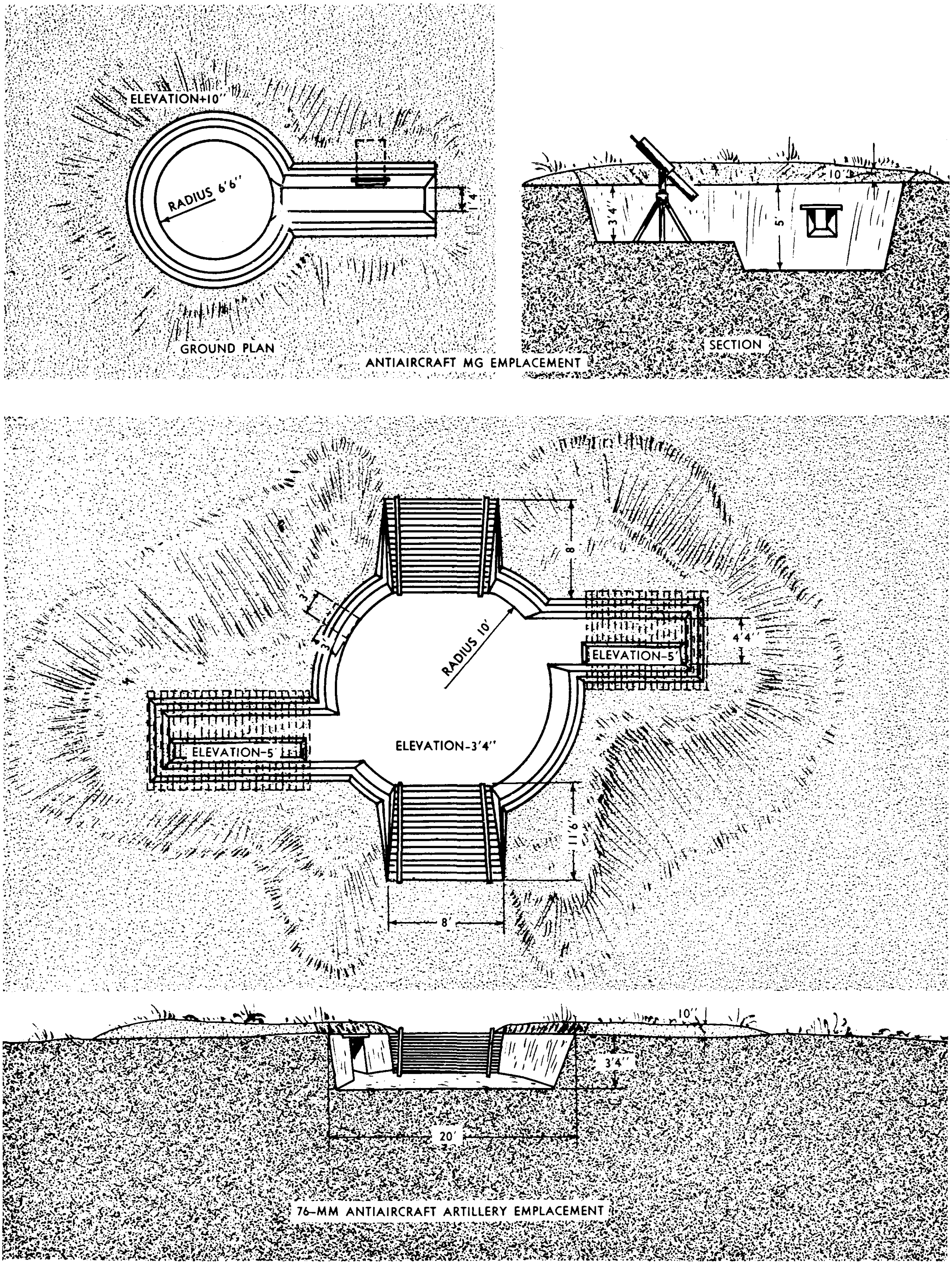


Figure 13.—Antiaircraft emplacements.

A further development of artillery emplacements are timber-and-rock fill structures, the design of which does not differ substantially from that of the timber-and-earth structures.

f. Mortar and antiaircraft-gun emplacements. Reverse slopes of elevations, deep undulations, gullies and ravines, glades, or far edges of groves are used as sites for mortar emplacements, since they provide natural concealment for weapon, crew, and flash. During combat, bomb craters, ditches, and defiles serve as emplacements. In populated areas, mortars are sited in buildings, basements of ruined houses, debris, etc.

A full-profile trench emplacement for mortars has a depth of at least 3.6 feet. It is provided with a communication trench containing dugouts for crew and ammunition. Slit-trench shelters at the sides of mortar platforms and the communication trench of reinforced mortar emplacements are provided with timber-and-earth overhead cover.

Antiaircraft artillery positions are prepared for all-around fire and sited behind elevations or forests with a view to concealing the flash from enemy ground observation. Antiaircraft artillery must be prepared for defense against tanks and therefore is grouped primarily in antitank areas.

Emplacements for antiaircraft artillery are provided with circular gun platforms. The platforms are surrounded by a parapet which is not over 10 inches high so as not to impede fire at ground targets. An exit for the gun is built in the rear. Two slit trenches with light overhead cover on both sides of the platform provide shelter for the crew. There are one or two recesses in the trench for ammunition storage (figure 13).

g. Emplacements for tanks and mechanized equipment. In the initial phases of defensive operations, tanks may be employed in the capacity of self-propelled artillery for mobile or stationary fire in cooperation with the infantry of the first echelon. Dug-in emplacements are provided for both tanks and self-propelled artillery (figure 14). Antitank strongpoints and flanks of switch positions are reinforced by entrenched tanks used as artillery. Camouflaged emplacements are provided for tanks protecting important approaches. Disabled tanks are also used as artillery in open, cemented emplacements, or are dug in and covered with earth and sod, leaving only the turret above ground.

h. Obstacles. In combating the German mechanized "blitz," the Soviets developed a great variety of highly effective antitank obstacles adapted to

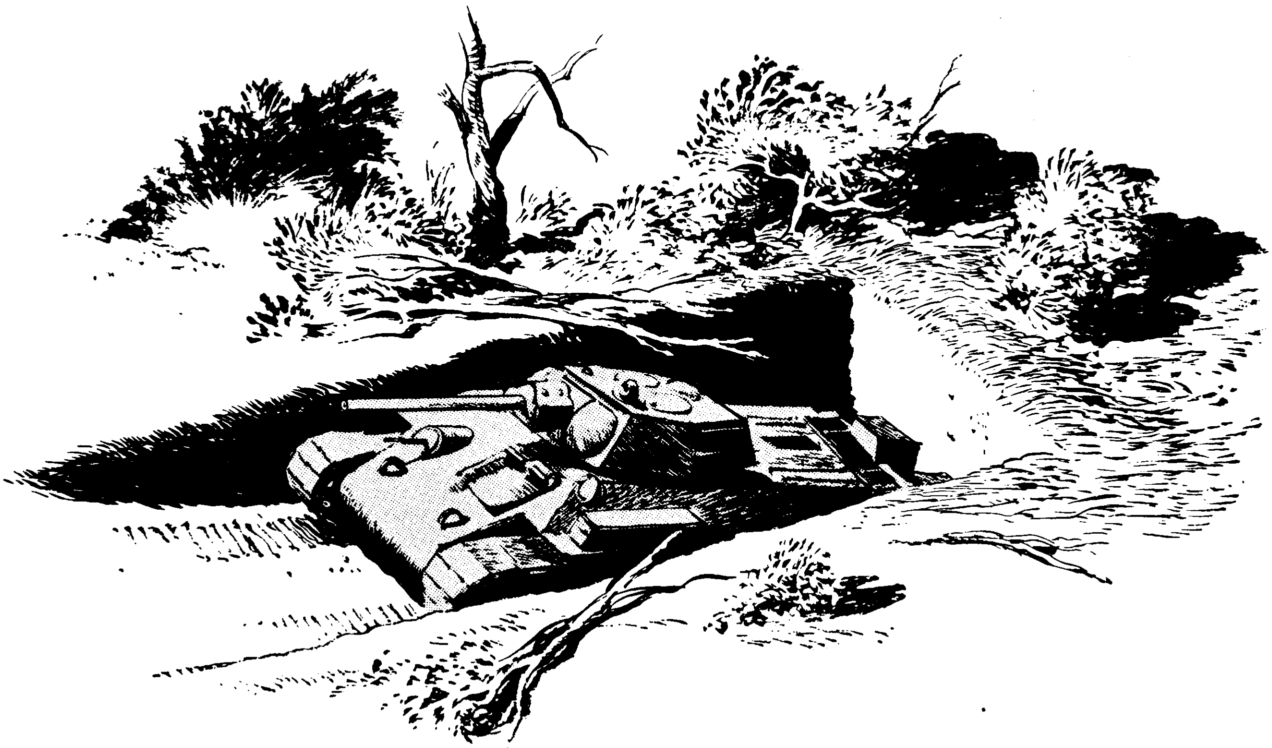
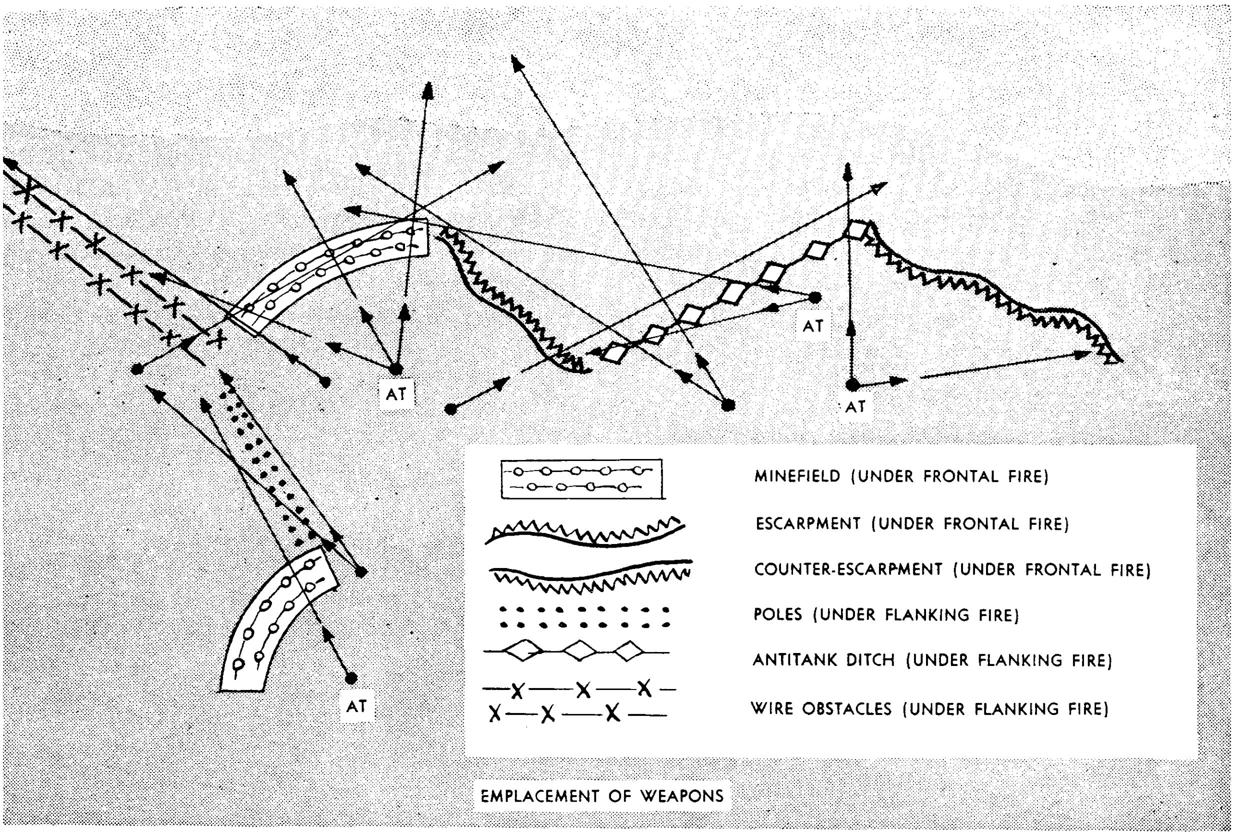


Figure 14.—Tank emplacement with camouflage removed.



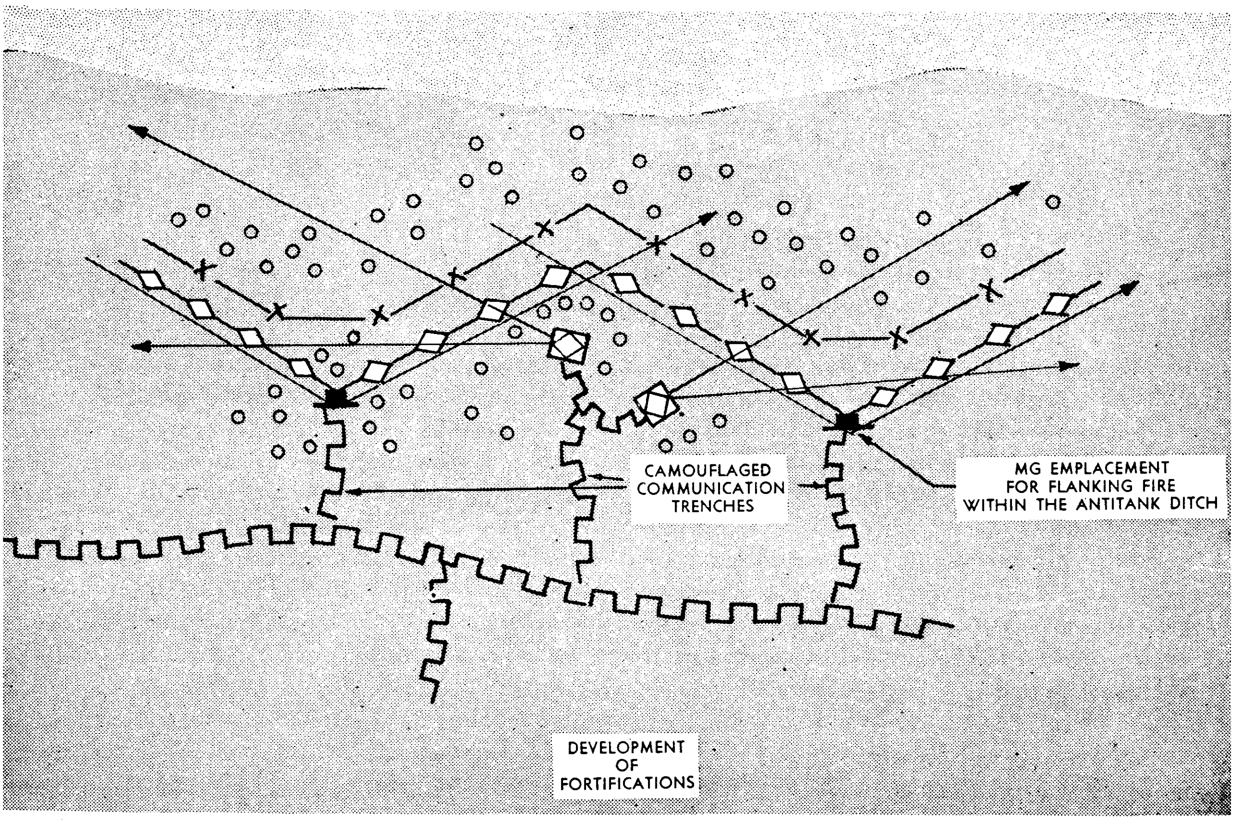


Figure 15.—Fire protection of obstacles.

conditions of terrain and availability of time and materials. Among their most effective types of antitank obstacles are ditches, escarpments, and counter escarpments, as a rule installed in front of the main line of resistance or used to protect the flanks and main approaches into the defensive depth. Locations and types of antitank obstacles are selected to ensure fire protection and the best possible vision and field of fire in front of the barriers as well as concealment from enemy observation (figure 15). In the event that fire protection for antitank obstacles is not practicable from the main firing positions, special firing positions are built for this purpose in the rear wall of an antitank ditch or escarpment (figure 16). To provide protection by flanking fire, the obstacles are built in a staggered (zigzag) pattern in single stretches up to 2,300 feet long.

Where natural water barriers do not exist, the Soviets build antitank ditches of various types (figure 17). Dimensions of antitank ditches may reach 10 feet in depth and 23 feet in width. Antitank barriers are built of various materials, such as earth, stones, trees, railroad ties, rails, and concrete. To reduce the dimensions of barriers, the Soviets recommend the construction in front of the barriers of speed-impeding ditches 3 feet deep (figure 18). Escarpments and counterescarpments are constructed in extensive stretches where terrain slopes are over 1: 5 (figure 19).

One type of barrier consists of tree trunks suspended horizontally between trees, high enough to deny cover to enemy infantry (figure 20). An effective obstacle in forested terrain is built of felled trees which are not detached from their stumps, making removal more difficult. The depth of such an abatis area is usually not less than 165 feet. It is frequently reinforced by mines and barbed wire. In thick forests, traps of fallen trees bar the advance of enemy columns. Iron hedgehogs are used either to reinforce other artificial or natural obstacles, or by themselves, arranged in three or four rows across secondary approaches and for rapid blocking of narrow gaps and defiles. In accordance with the character of terrain, the Red Army combines various types of obstacles. To protect possible tank approaches in mountainous terrain, stone blocks, stone fields and stone slides are constructed (figure 21).

Antitank obstacles are frequently combined with antipersonnel obstacles. The principal types of Red Army antipersonnel obstacles consist of barbed wire used with mines. When combined with antitank obstacles in front of the main line of resistance, antipersonnel obstacles may be either in front of or behind antitank obstacles. When placed in front,

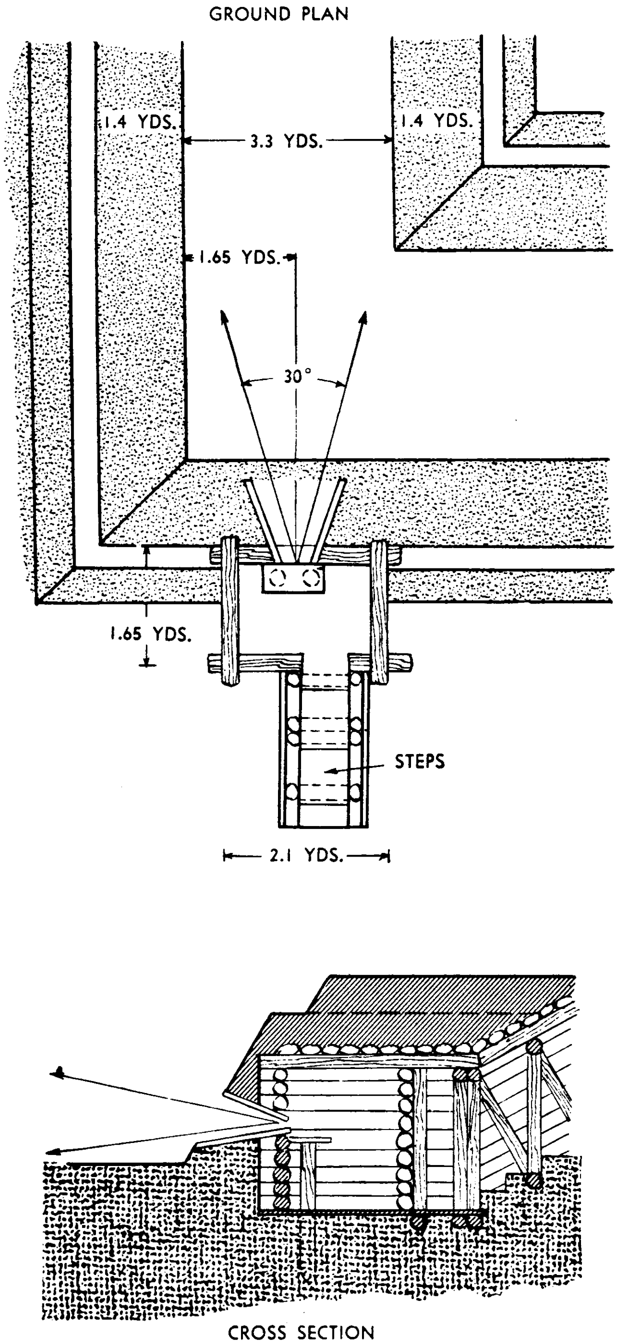


Figure 16.—Machine-gun position covering an antitank ditch.

they are in the form of reinforced barbed-wire fences or concealed obstacles; when placed behind the antitank obstacles, they form the main barrier which

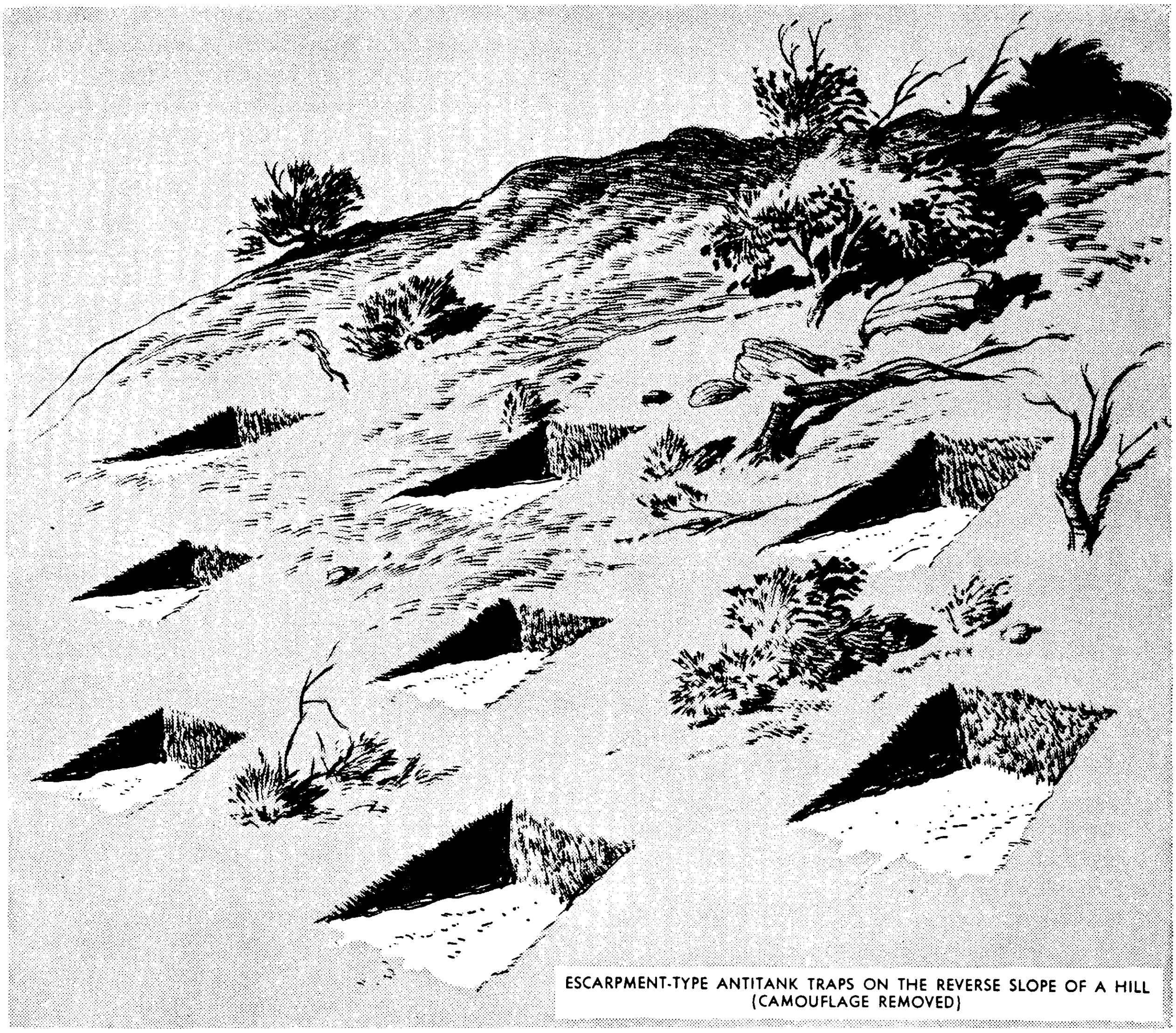


Figure 17.—Antitank trap pattern.

consists of two or three belts of wire. If construction time is limited, antipersonnel obstacles on the flanks, in switch positions, and in the defensive depth are restricted to one row of barbed wire. The length of a barbed-wire fence section may reach 440 yards.

Protection of antipersonnel obstacles is provided by enfilade fire from positions of the main line of resistance or from special firing positions flanking the antitank obstacles. It is stressed that salients of antipersonnel obstacles should not coincide with salients of antitank obstacles. For rapid reinforcement of a position under enemy fire and replacement of destroyed obstacles, portable obstacles are used, such as "Bruno" (concertina) wire entanglements, "pioneer" wire nets, knife rests (*chevaux-de-frise*), hedgehogs, and combinations of these. Concealed obstacles, including various types and patterns of trip wires, are used mainly in open country.

In forested terrain, in addition to barbed-wire entanglements, obstacles of felled trees, branches, and poles are constructed. In mountainous terrain, in addition to the obstacles already mentioned, stone slides, knife rests, and hedgehogs on escarpments are used.

i. Mines. Soviet antitank mines are considerably heavier than U. S. antitank mines. As a result, Red Army antitank minefields are less densely laid than U. S. minefields. On the other hand, Soviet antipersonnel mines weigh much less than U. S. antipersonnel mines, and the density of the Red Army antipersonnel minefield is higher (figure 22).

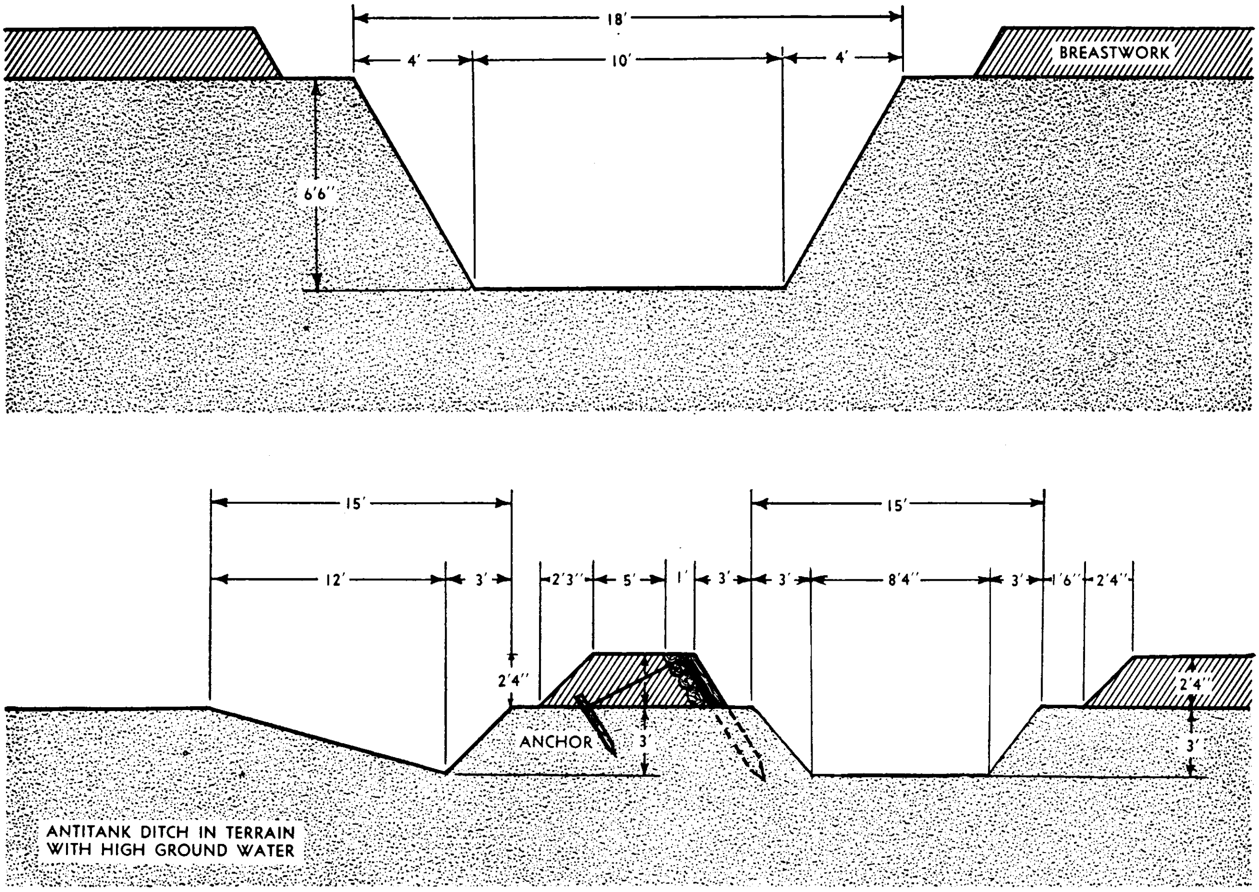


Figure 18.—Profiles of antitank ditches.

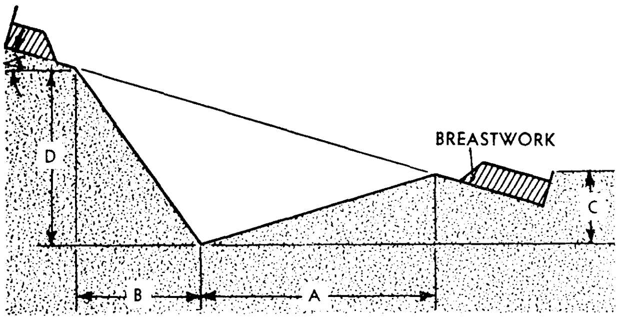
The basic type of antitank mine used is a simple wooden-box mine (*YaM–5*) which is difficult to detect. Antipersonnel mines are prewar types (*POMZ* and *PMD–6*), several modifications of which exist.

The enormous extent to which mines are used by the Red Army may be illustrated by the German claim of having cleared 137,000 mines during their attack on Sevastopol. The mines in this area were either dispersed or laid in irregular checkerboard pattern with 3 to 8 feet between mines. About 2,500 mines were cleared by the Germans in front of a regimental position in one day. Approximately 20,000 mines were located in front of a divisional zone.

Forward edges and flanks of defensive positions and gaps between strongpoints are protected from enemy tanks and infantry by deliberate minefields. In laying deliberate minefields, distances between mines are accurately measured and recorded. A special measuring cord marking spaces between mines is recommended for the mining of roads. This cord is used from one side of the road, with the cord's perpendiculars of varying length stretched at right angles across the roadbed. If an ordinary measuring cord is used, it is applied alternately on each side of the road.

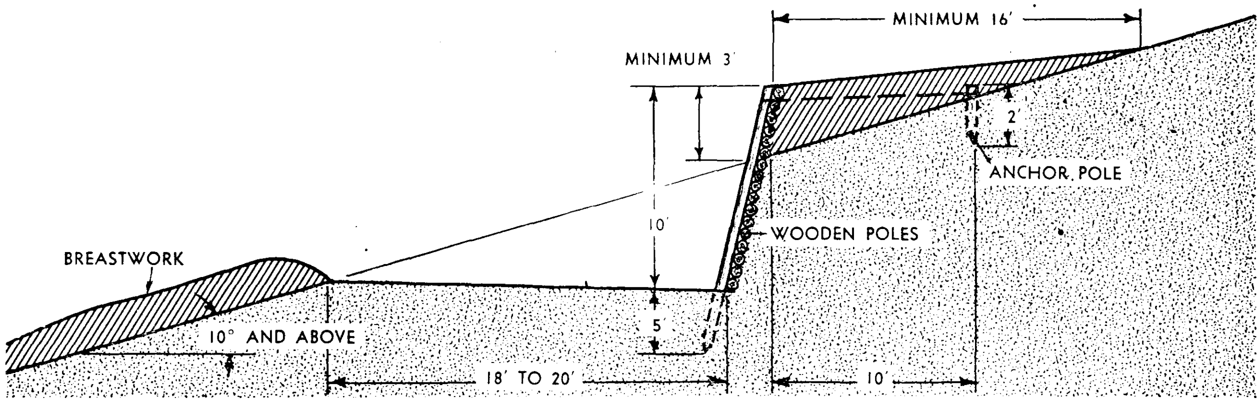
Hasty minefields are largely used in offensive operations for the protection of flanks against enemy counterattacks. They are also laid in front of seized enemy positions and in the enemy's rear. Mines are used to disrupt enemy communications; broken road sections are mined to impede their reconstruction, and delayed-action mines further interrupt road traffic after repair. Hasty minefields are laid in somewhat irregular checkerboard patterns, mostly measured by pacing.

In mining roads, the dispersal of mines in space and time (delayed-action mines) is recommended. Antitank mines on roads are 30 to 80 feet apart; their density is one mine per yard of the road width. Thus, a 30-foot-wide road has ten mines on a stretch of 300 to 800 feet. Figures 23, 24, 25, and 26 represent patterns of hasty antipersonnel and antitank minefields and deliberately and hastily mined roads.



ESCARPMENT WITH BREASTWORK
(USED ON SLOPES 10° TO 30°)

TABLE OF DIMENSIONS (in feet)				
∡	A	B	C	D
10°	11	7	5	8
15°	11	6	3½	8½
20°	11½	5½	3	9
25°	14	7	2½	10½
30°	11½	8	1	12



COUNTER-ESCARPMENT WITH BREASTWORK

Figure 19.—Escarpment and counterescarpment.

2. CONSTRUCTION STANDARDS

Russian field fortifications are classified, according to strength and material, as splinterproofs, light, reinforced, heavy, and superheavy.

a. Splinterproof construction. The splinterproof type is designed to afford protection against individual rifle bullets and splinters. This type of construction is primarily used in hasty fortification of localities during offensive operations and in defense. With the stabilization of a position, splinterproof constructions are gradually improved and reinforced to the strength of the light-construction type.

b. Light construction. Light construction includes the basic types of field fortifications affording protection from mass automatic fire of rifles, mortars, infantry antitank weapons, and machine guns. Light fortifications are designed to resist enemy infantry weapons, such as the German *MG–42* machine gun, the 7.92-mm antitank rifle and the German 81-mm mortar. Walls consisting of tamped gravel or crushed rock placed tightly in a casing made of boards, with voids filled by sand, are considered by the Soviets to be very effective for light defense works. This type of construction has proved to be more resistant to concentrated machine-gun fire than reinforced concrete of the same thickness.

c. Reinforced construction. Reinforced structures are designed to resist direct hits by 105-mm howitzers, 120-mm mortars and six-barrel mortars. As a rule, fortified structures with walls which are vulnerable to direct hits of tank guns are built exclusively in mountainous or forested terrain, where tank maneuver is difficult and where only 75-mm infantry or mountain artillery, 105-mm mountain or field howitzers, and sometimes antitank guns may be used against fortified positions. Practice has shown that even without the use of concrete, walls

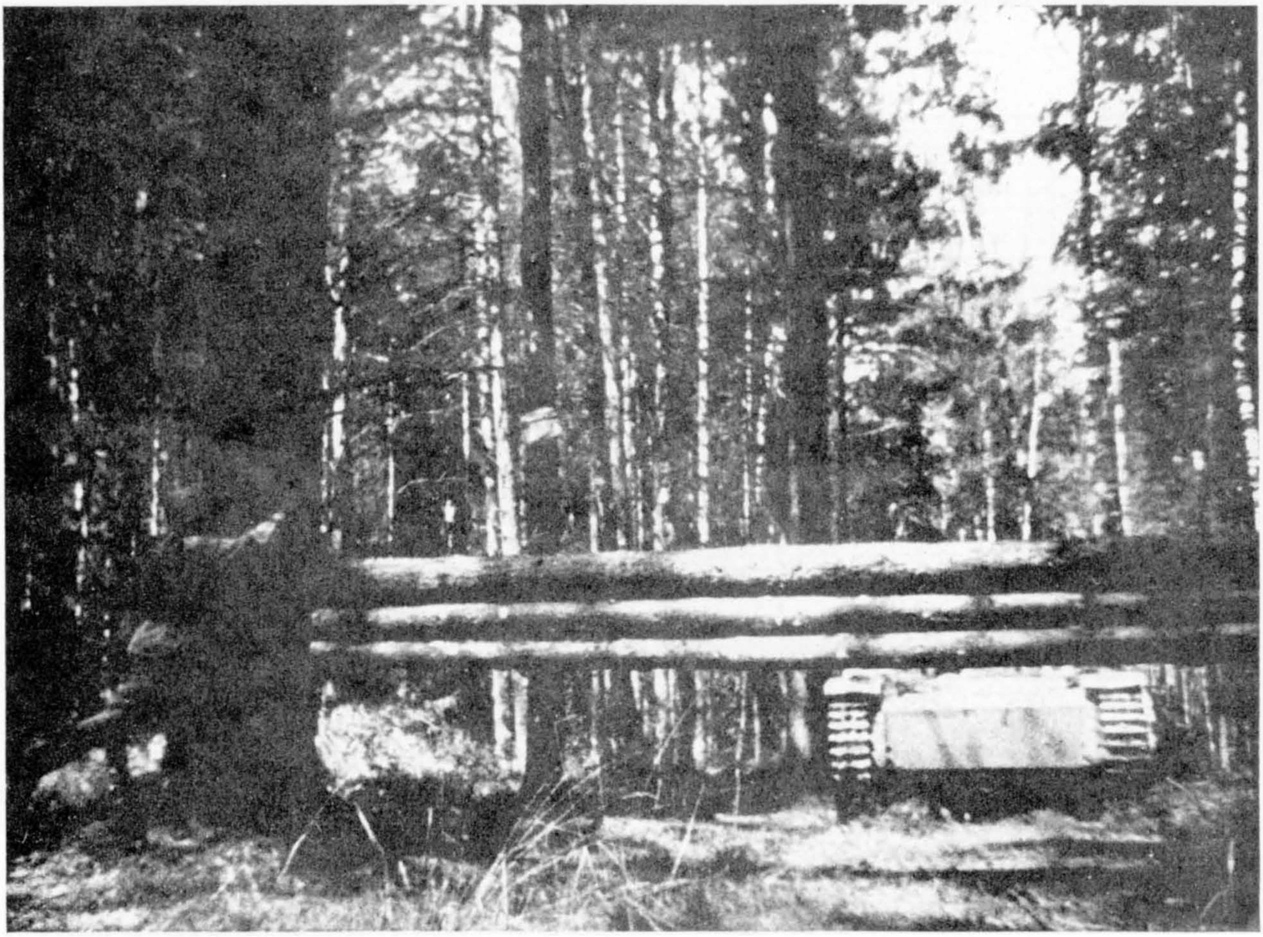


Figure 20.—Antitank log barrier.

of defense works can be secured against the effect of fire of all the above-mentioned artillery weapons, but afford no protection against direct hits of 75-mm antitank guns.

d. Heavy construction. Heavy construction affords protection against 75-mm and 88-mm tank guns with a muzzle velocity of 3,300 feet per second, and against 150-mm howitzers. Protection against direct hits from these weapons can be provided only by reinforced-concrete casemated works and underground shelters. Timber-and-earth constructions are vulnerable to hits of modern tank and antitank guns.

e. Superheavy construction. Specially reinforced heavy construction is used mainly for high command shelters and other buildings of similar importance.

3. PREFABRICATED PILLBOXES

The use of prefabricated material facilitates rapid construction in the field, decreases the number of qualified workmen necessary, raises the output of work by 500 to 600 percent, and materially lowers the cost of construction due to economy in material, labor, and transportation.

a. Timber-and-earth structures. Individual parts of Soviet timber-and-earth structures are standardized and prefabricated. The weight and characteristics of each part are calculated to permit handling by one or two men and to permit its use under summer and winter conditions without any alterations. The elements of all types of structures include a frame, four shields, and a cover. The principal timber-and-earth structures are of the following types: emplacements for 50-mm, 82-mm, and 120-mm mortars; emplacements for 45-mm and 76-mm guns with sectors of fire of 100 degrees and 360 degrees; splinterproof pillboxes; antitank rifle positions; and antitank rifle shelters.

b. Concrete pillboxes. Prefabricated concrete pillboxes have an above-ground elevation of up to 8 feet. Pillboxes for machine guns have a circular shape; those for field guns are rectangular. The pillboxes for machine guns have two large em-

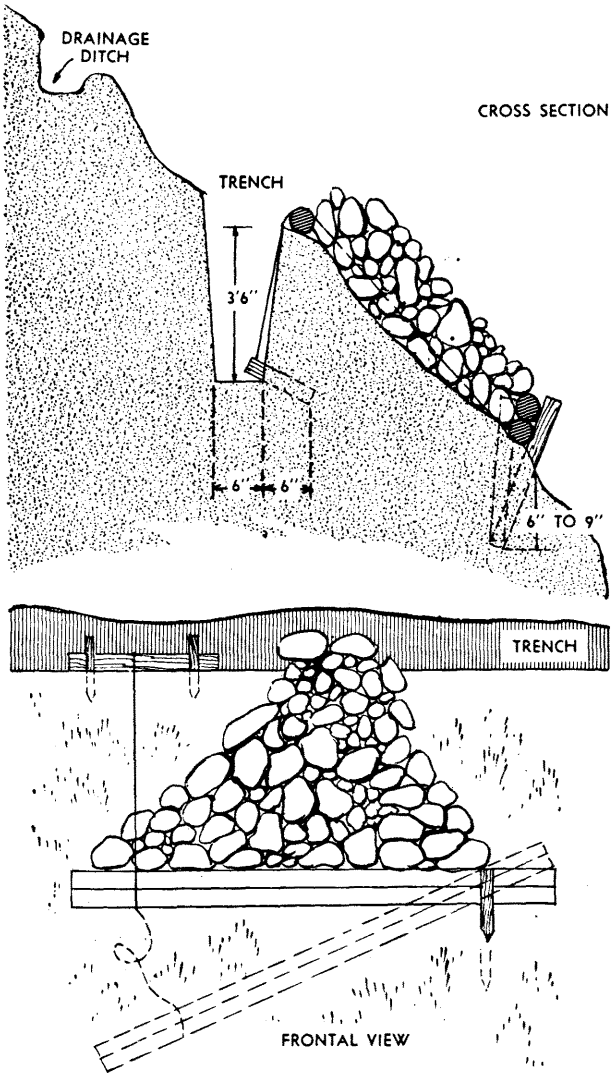


Figure 21.—Stone slide.

brasures which also serve as entrances. Those for artillery are provided with one embrasure which is protected by an overhang. The wall of the circular type usually consists of 16 reinforced concrete blocks. Each block weighs 33 pounds and has two openings for anchor bolts by which four rows of blocks and the top cover are held together. The cement used to fasten the blocks forms vertical and horizontal seams $2\frac{1}{2}$ inches thick. The cover of the circular pillbox is made of eight parts which are bolted to a special crossbeam and to the wall. The total weight of the cover is 1,302 pounds. All blocks are made of reinforced concrete. The reinforcing rods have a diameter of $\frac{1}{4}$ inch; spacing between rods is $2\frac{1}{2}$ to $2\frac{3}{4}$ inches; percentage of metal is 1.1 percent. The total weight of the circular pillbox is 3,580 pounds. Total volume of concrete used for the circular type amounts to 1 cubic yard. This type of pillbox is installed on a special wooden frame. The concrete top of the pillbox is covered with a 1-foot layer of earth, then by a second layer of logs 10 to 12 inches in diameter, and a third 20-inch layer of rock which is camouflaged by a coat of earth. The walls of the pillbox are also protected by a 20-inch layer of rock covered with earth.

The Soviets used prefabricated concrete pillboxes principally in front of main lines of resistance and found their service satisfactory. Due to their comparatively light weight, the individual concrete blocks can be brought by hand to the place of installation and the construction work can proceed inconspicuously (fig. 28). These pillboxes are bulletproof and splinterproof and are not highly vulnerable to artillery fire. The main disadvantages of this type are the high elevation above ground, large embrasures, lack of blast walls, and the comparatively weak bond between blocks. The circular construction is more resistant than the angular.

4. PERMANENT FORTIFICATIONS

There appears to be no essential difference in the construction of Red Army permanent defense works and that of similar works in other countries. While one-story structures are most common, the Soviets also have two- and three-story pillboxes and casemates.

TYPE OF MINES	SPACING IN YDS.	DENSITY PER 1,000 YDS.	TIME IN HOURS TO LAY A 1,000-YD. MINEFIELD BY ONE ENGINEER COMPANY
ANTITANK MINES	$6\frac{1}{2}$ TO 11	1,000	3–6
ANTIPERSONNEL MINES	1 TO $2\frac{1}{4}$	2,000 TO 3,000	3–6

Note.—The density of American minefields equals $1\frac{1}{2}$ mines per yard

Figure 22.—Density of minefields and time required to lay minefields.

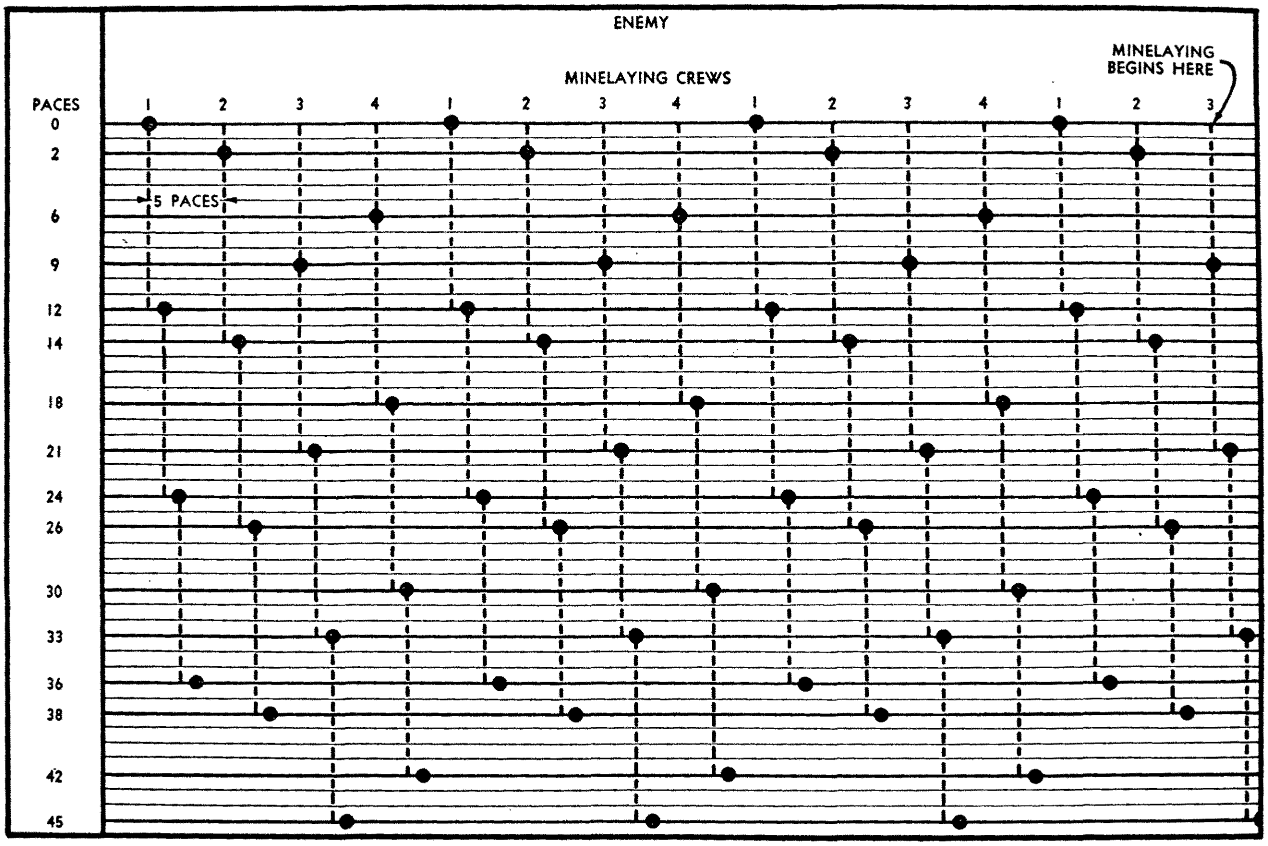


Figure 23.—Hasty antipersonnel minefield.

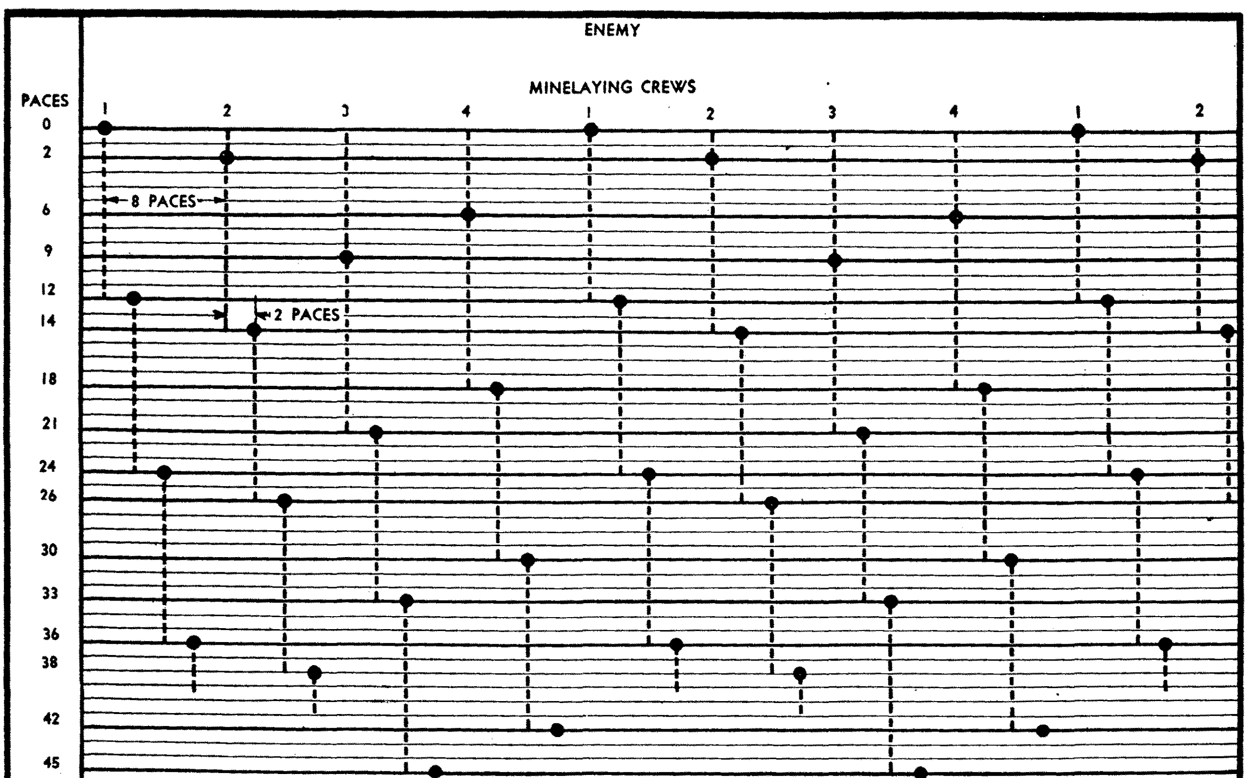


Figure 24.—Hasty antitank minefield.

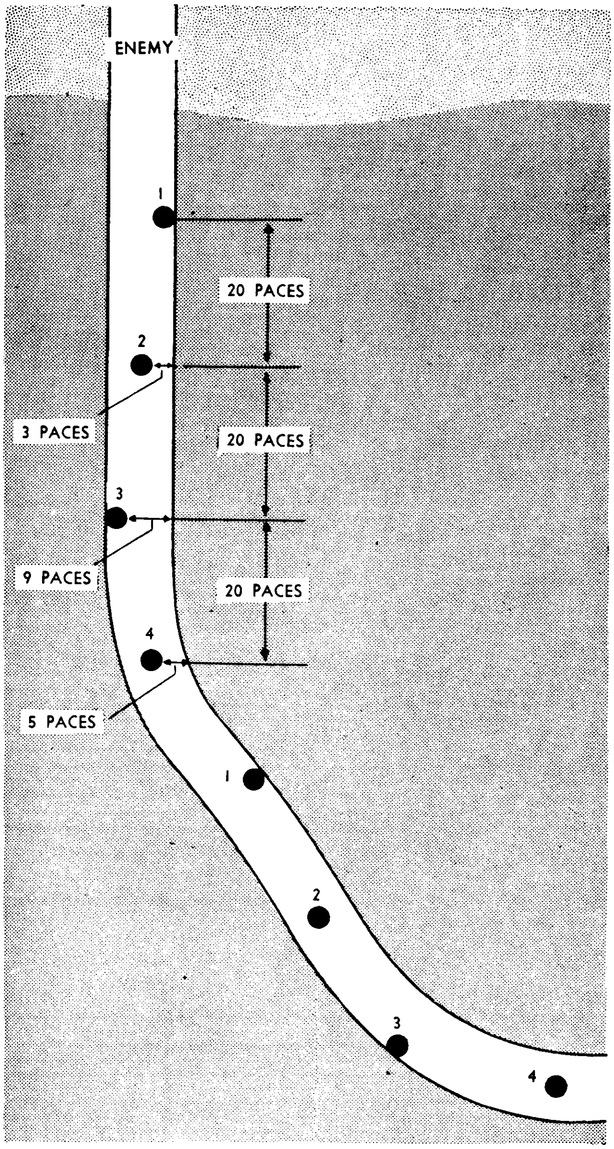


Figure 25.—Hasty mining of a road, ravine, or gully.

In general, quality of the Soviet concrete is good. Its resistance, however, is not very high, due to light reinforcing. The outer surface of ceilings and walls is usually more densely reinforced than the inner surface (figure 29). The following approximate thicknesses of concrete are used for various structural parts of defense works:

Ceilings	3.3 to 6.6 feet.
Front and side walls	2.3 to 7 feet.
Embrasures	4 to 6.6 feet.
Interior walls and ceilings	8 inches to 2.5 feet.

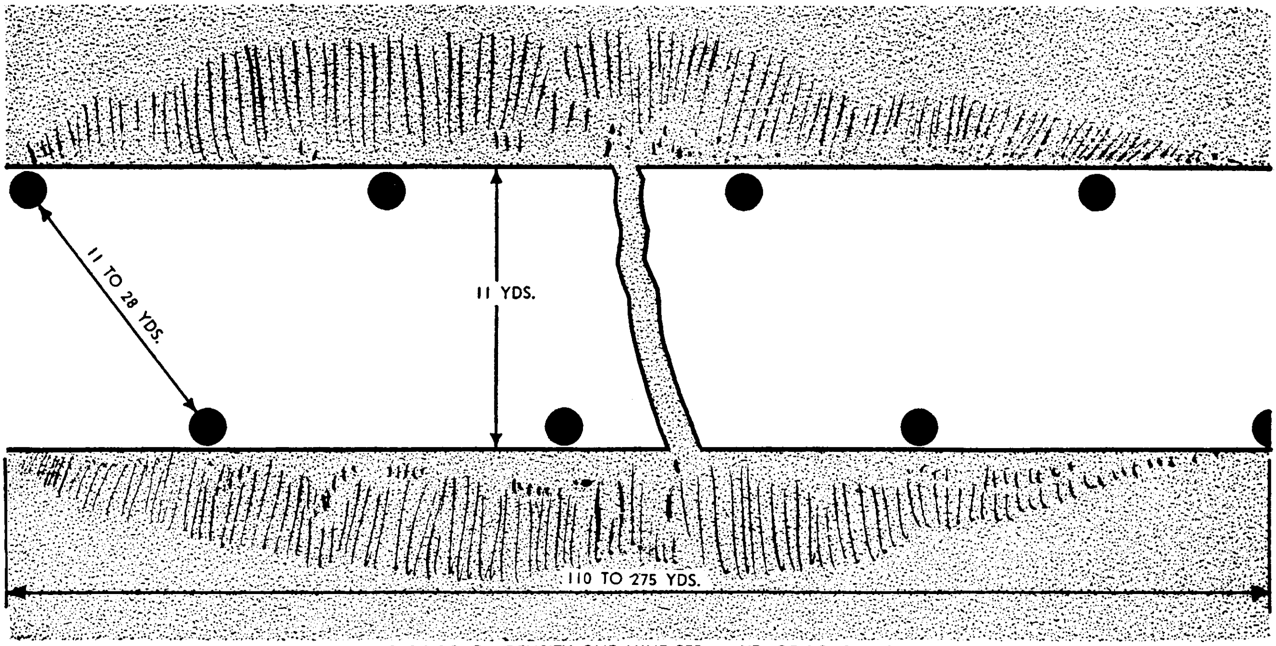
Rods for the reinforcement of concrete are about 3/4 inch in diameter.

Turrets for machine guns and observation posts are not frequently used. Thickness of armor is from 5 to 7 1/2 inches. Earth-covered walls of pillboxes usually have a protecting layer of loose rock or masonry under the earth cover which extends from the top of the structure to the ground level or deeper. The resistance of permanent works of a later date has been increased by adding burster layers about 3 feet thick of resilient asphalt. The asphalt is delivered in 2 1/2-cubic-inch blocks which are melted for use.

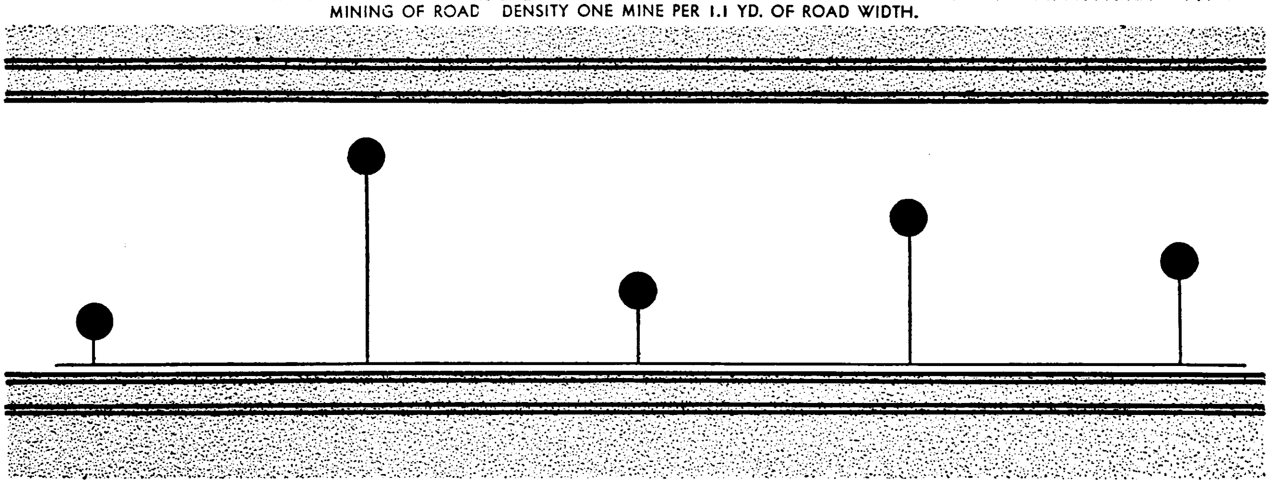
Compartments in casemates are approximately 7 feet high or higher; in pillboxes, 6 to 7 feet high. Embrasures for artillery are either 6.6 by 4.6 feet or 4.6 by 2.6 feet. Embrasures are closed by sliding 4-inch steel plates measuring about 10 by 6.6 feet. Embrasures for heavy machine guns are rectangular in shape, tapering back from the outer to the inner face at varying angles in accordance with the field of fire of each machine gun. Outer dimensions of embrasures vary from 35 by 78 inches to 16 by 32 inches. Inner dimensions vary from 16 by 27 inches to 9 by 12 inches. Wall thicknesses are not less than 8 inches. Embrasures are closed by sliding steel plates 39 inches by 39 inches, at least 1 1/4 inches thick. Embrasures for light machine guns are approximately 5 by 20 inches or 8 by 16 inches. These embrasures are closed by sliding steel plates slightly smaller than those for heavy machine-gun embrasures.

From the outside, embrasures are covered with camouflaged wooden shutters which are either painted or covered with sod. As a rule, below the machine-gun embrasure there are two openings, 2 3/8 to 2 3/4 inches in diameter, which serve as water and steam run-off drains. Machine guns are mounted on special fixed pedestals facing the embrasures. These pedestals are integral with the gunner's seat.

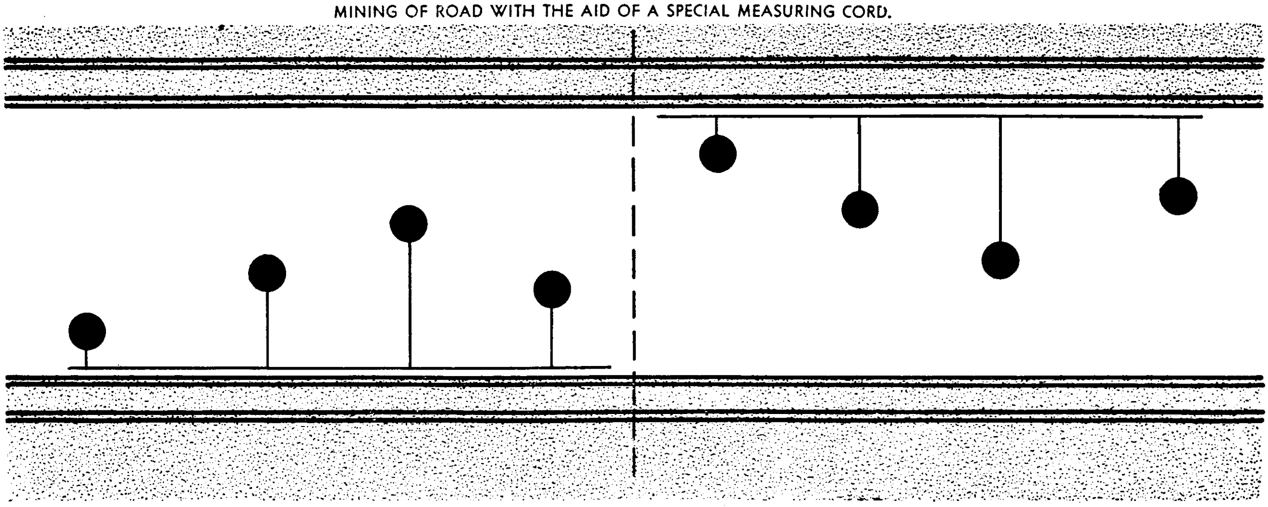
Normally, concrete pillboxes have only one entrance, shaped in a broken line. Slits about 8 to 20 inches wide and 80 inches high near the entrance facilitate natural ventilation. These slits may also be used for close combat. Some pillboxes have openings near the entrance for throwing out hand grenades. Doors are usually placed in the rear of pillboxes or, in some cases, in the side walls. Outer openings have either steel doors or iron gates about 5 to 6 feet high and 27 to 32 inches wide. Steel thicknesses vary from 7/8 to 1 1/4 inches, 7/8-inch iron bars having a spacing of 4 1/2 inches. The entrance is protected by light machine guns which fire either through embrasures about 4 by 9 inches on both sides of the entrance door or through a



MINING OF ROAD DENSITY ONE MINE PER 1.1 YD. OF ROAD WIDTH.



MINING OF ROAD WITH THE AID OF A SPECIAL MEASURING CORD.



MINING OF ROAD WITH THE AID OF AN ORDINARY MEASURING CORD.

Figure 26.—Deliberate mining of a road.

Type of construction	Span (feet)	Material	Thickness (inches)
Light construction			
Walls		Peat soil	82
		Clay or loose earth	47
		Sandy soil	35
		Tamped clay soil or black earth packed in a wooden casing.	16 to 20
		Tamped sand packed in a wooden casing	12
		Tamped gravel (crushed rock) with sand packed in wooden casing.	8
		Brick laid with cement	15
		Reinforced concrete	8
		Longitudinal layer of pin logs or boards	40
		Armor plate	3.5
Overhead cover			
Not vulnerable to crushing effect of tanks.	Up to 8	Logs, one layer	6 to 8
		Clay	4
		Soil	12
			22 to 24 Total
Vulnerable to crushing effect of tanks.	Up to 8	Woven brushwood	--
		Clay	4
		Soil	12
			16 Total
	Up to 6½	Fascines	10 to 12
		Clay	4
		Soil	12
			26 to 28 Total
Splinterproof			
Overhead	Up to 8	Poles, one layer	3 to 5
		Clay	8
		Soil	--
			11 to 13 Total
	Up to 6½	Boards	2
		Clay	--
		Soil	8
			10 Total
Reinforced construction			
Overhead cover for shelters	Up to 10	Logs, two layers	20
		Clay	4
		Earth	8
		Logs, four cross layers	40
		Soil	12
			84 Total
	Up to 8	Logs, one layer	10
		Clay	4
		Earth	20
		Rocks or brick, laid dry	24
		Soil	12
			70 Total
	Up to 8	Logs, one layer	10
		Clay	4
		Earth	20
		Reinforced concrete blocks	12
		Soil	12
			58 Total
Heavy construction			
Overhead cover for shelters		Logs, two layers	20
		Clay	4
		Earth	31
		Rocks or brick, laid dry	35
		Soil	12
			102 Total

Figure 27.—Protective thicknesses of various materials used in Soviet fortifications.

Type of construction	Span (feet)	Material	Thickness (inches)
Heavy construction—Continued.			
Overhead cover for shelters—Continued.		Logs, two layers	20
		Clay	4
		Earth	31
		Concrete blocks	18
		Soil	12
			85 Total
		Steel rails	6
		Clay	4
		Earth	20
		Concrete blocks	18
		Soil	12
			60 Total

Figure 27.—Protective thicknesses of various materials used in Soviet fortifications.—Continued.

Figure 28.—Prefabricated pillbox.

single embrasure located inside the pillbox opposite the entrance door, through which the entrance and adjacent corridor may be covered. Inner doors are gasproof and are made mostly of wood.

Pillboxes which have no entrance are connected by underground passages with adjacent structures. The cover of such passages is 3 to 10 feet thick and the walls are made of reinforced concrete, 8 inches to 1 foot thick. One floor of a multiple-story pillbox is connected with another by a ladder or through an opening. Normally, there are no stairs.

Pillboxes usually have camouflaged emergency exits immediately underneath or to one side of the entrance, from which a short tunnel leads to a con-

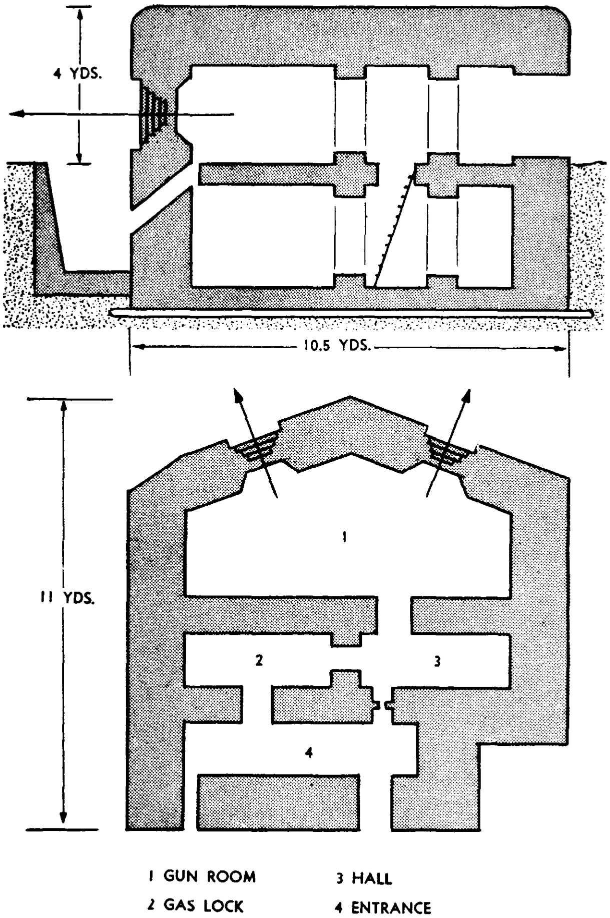


Figure 29.—Typical permanent casemates.

cealed exit 35 to 165 feet from the pillbox. Electrically or hand-operated air pumps are provided for the ventilation of pillboxes. Higher air pressure inside the pillbox prevents penetration of chemical agents from the outside. Water is provided by wells or water pumps inside the structure. Pumps are electrically operated in structures which are connected with an electric plant. Electric lights, candles, or oil lamps are used for illumination. Small coke stoves are installed in niches with flues built in the concrete walls. Electric heaters are used in structures which are connected with an electric plant. Walls inside pillboxes and casemates are covered with wood or $\frac{3}{16}$-inch sheet iron. Telephone and radio connect command and observation posts with artillery and machine-gun emplacements. Observation is mostly by periscope through openings in the ceilings of pillboxes and observation shelters. Observation shelters may have two periscopes.

The armament of pillboxes ordinarily consists of a heavy machine gun, a 45-mm antitank gun, and usually a second heavy machine gun which fires through the same embrasure as the antitank gun. Cables for electricity and telephones are laid in wooden or concrete tubes having a diameter of about 8 inches. These tubes are placed in ditches about 6 feet deep, 20 inches wide at the bottom, and 40 inches wide at surface level. Near defense works, the depth of cable ditches increases to 10 to 13 feet.

Defense works are usually painted to match the color of the soil and are provided with an earth cover. Depending on surroundings, sod or plants are placed on top of the earth cover. Frequently the works are disguised as huts, sheds, stables, barns, and the like.

Concreted ditches built in front of some pillboxes afford defense against close attack. Such ditches are protected by hand grenades launched through special apertures of the pillbox.

Permanent works of an earlier date appear to be less resistant than the later structures built after the autumn of 1939. One-gun pillboxes for frontal defense are common. Their height above ground is 5 to 6.6 feet. Thickness of walls and ceilings averages from 3.3 to 5 feet. Embrasures are not armored and can be closed by $1\frac{1}{2}$-inch steel plates. These pillboxes are equipped with periscopes, hand-operated ventilation devices, running water, and telephones. They are well camouflaged. Entrance is by wooden stairs.

5. ORGANIZATION AND PRIORITY OF FORTIFICATION WORK

Orders for the fortification of a position are issued by army or division staffs simultaneously with the order to defend a locality or zone, or, in offensive operations, at the time when an attack is halted.

The commanding personnel of individual army units are responsible for the fortification of defensive positions or of captured enemy positions by their troops. In the infantry, the company commander and his technical assistant, the regimental engineer, are in charge of defense work; in the artillery, this is the duty of the battery commander. Three to four pioneers and a section of regimental pioneer instructors assist the battalion commander in the supervision of fortification work. Complicated tasks, such as mining, construction of reinforced shelters and pillboxes, etc., are performed by divisional engineers, one or two platoons of which are attached to infantry regiments. Regimental and divisional engineers are technical advisors of regimental and divisional commanders.

CONSTRUCTION WORK FOR DEFENSE OF A STRONGPOINT	QUANTITY	LABOR		
		MAN-HOURS PER UNIT	TOTAL MAN-HOURS	
			FIRST PRIORITY	SECOND PRIORITY
TRENCHES, CAMOUFLAGED AND ADEQUATELY ORGANIZED				
FIRE TRENCHES	350 YDS.	2.7	640	320
COMMUNICATION TRENCHES [1]	770 YDS.	0.9	300	400
MACHINE-GUN NESTS	8	30	120	120
PILLBOXES, PARTLY COVERED	1	900		900
REINFORCED MACHINE-GUN EMPLACEMENTS	1	40		40
OPEN EMPLACEMENTS FOR AT RIFLES	9	8	72	
EMPLACEMENTS FOR 45-MM. AT GUNS	2	50	100	
OPEN OBSERVATION POSTS	2	7	14	
REINFORCED SHELTERS	2	1,500		3,000
DUGOUTS	2	40	80	
ANTITANK OBSTACLES [2]	175 YDS.			
ANTIPERSONNEL OBSTACLES [2]	950 YDS.			
CONCEALED PATHS	220 YDS.	0.5	110	

[1] Including widened communication trenches.
[2] Due to presence of natural obstacles, the number of mines and extension of artificial obstacles were reduced.

Note.—Labor required for the construction of artificial obstacles is not furnished by the garrison of the strongpoint, but by detailed engineers or by a special detachment from the rifle battalion.

Figure 30.—Time and labor required for the organization of a strongpoint.

They participate in the preparation of plans and orders issued in connection with the fortification of defensive positions, and are responsible for the supply of engineering materials and tools.

During the first 2 days' work on a position, troops use light entrenching tools. Regimental tools are usually distributed among machine-gun and mortar sections and the reserve units which are assigned to fortification work. At the end of the second day, all troops of the defensive positions must be supplied with heavy entrenching equipment from divisional and army dumps. Unit commanders decide on the type and priority of defense work to be executed. Their decision depends on the nature of operations, on local conditions of terrain, soil, and ground water, and on the availability of time and equipment. Hasty fortification of a position ordinarily takes 96 hours (4 days); deliberate fortification of a locality is carried out within 168 to 336 hours (7 to 14 days). The fortification of an army defense zone requires from 20 to 30 days (figure 30). Under conditions of mobile warfare, urgent fortification work is done as required. As a rule, fortification work is done by night; it begins at about 1900 or 2000 and is interrupted at daybreak.

The following order and priority of work is recommended: During the first day, trenches are dug for all sections garrisoning the defended area. Emplacements are prepared for machine guns, mortars, and artillery; command and observation posts are camouflaged and lightly covered; fire trenches are dug; light ammunition dumps and medical shelters are established. Reserve units construct the fortifications on the forward edge of the position, erect obstacles, clear fields of fire, and dig main communication trenches to secure ammunition supply. Highest priority is given to mining important approaches which may be threatened by tank attacks; this is done by regimental and divisional engineers.

During the second and third days, fortifications are developed and completed. At the end of the third day fire trenches including shelters and recesses must be completed. The fourth and subsequent days are mainly used for the development of obstacles and communication trenches and for the improvement of fire pits and trenches. Mining in front of the main line of resistance must be completed by regimental and divisional engineers.

On the fifth day, units commence construction of timber-and-earth works, erect prefabricated concrete pillboxes, and construct obstacles inside the defensive positions. They also begin the organization of fortified strongpoints. On the sixth day, reserve units are shifted to construction work on the second line of defense. By the end of the seventh day, the hasty fortification of the main and second lines of resistance must be completed. By the end of the fourteenth day, both lines of resistance must be fully equipped with defense works, command and observation shelters, and a system of covered communication trenches. Further improvements are dictated by combat conditions. However, fortification work in a defensive zone continues indefinitely without interruption.

Section III. WINTER FORTIFICATIONS

Winter conditions, which cause the transformation of many natural obstacles such as lakes, ponds, rivers, and swamps into dangerous approaches and render useless many artificial obstacles, create the necessity of adaptations in the organization of defensive positions. This involves, chiefly, the reorganization of antitank and antipersonnel obstacles, the subsequent readjustment of the fire system and of firing positions, the modification of existing works, and the construction of special winter defenses.

1. WINTER MODIFICATION OF FIELD FORTIFICATIONS

Existing structures may be adapted to winter conditions by various methods. The Soviets adapt splinterproof field works of the light type and specially prefabricated metal and concrete pillboxes by raising their zero or sighting line. To facilitate the use of fire trenches, observation posts, and machine-gun emplacements, the floors are raised by additional loose ground, sandbags, and available timber. This may be done gradually, as the snow cover increases in depth (figures 31 and 32).

For protection against snow, trenches are covered by special shields with spaces left open for observation, launching of grenades, and exit. Recesses in trenches, after necessary provisions for heating, are used as shelter for crews and weapons. At a distance of 10 to 16 feet from such shelters, one or two open machine-gun emplacements are provided for flanking and oblique fire. Low-set pillboxes, especially concrete or metal works with sufficiently high casemates, are adapted for winter conditions by raising the entire structure. Some gun emplacements used as shelter for weapons and crews are protected by one or two open firing positions usually built on the overhead cover of the structure and cut into its top layer. Such an arrangement provides flanking and oblique fire protection and facilitates rapid occupation of the firing position by the crew. The loose-earth cover of the construction affords protection against enemy frontal fire.

Trenches, gun emplacements, pillboxes, and observation posts which cannot be adapted to winter conditions and used for their normal function are converted into shelters. Embrasures and entrances of pillboxes are closed by shields or straw mats; doors or curtains are provided; bunks and tables made; heating arrangements installed; and all inside surfaces insulated with available material (straw, hay, canvas, blankets, etc.). Recesses and niches in trenches and such communication and fire trenches as are not used for their original function but utilized for shelter, are kept warm in a similar manner (figure 33).

Special attention is paid to the shape of overhead cover of defense works to avoid accumulations of drifting snow. Soviet experience has shown that the accumulation of drifting snow is encouraged by steep slopes, while surfaces with slopes of not over 1:4 do not obstruct the drift of air and therefore do not accumulate snow.

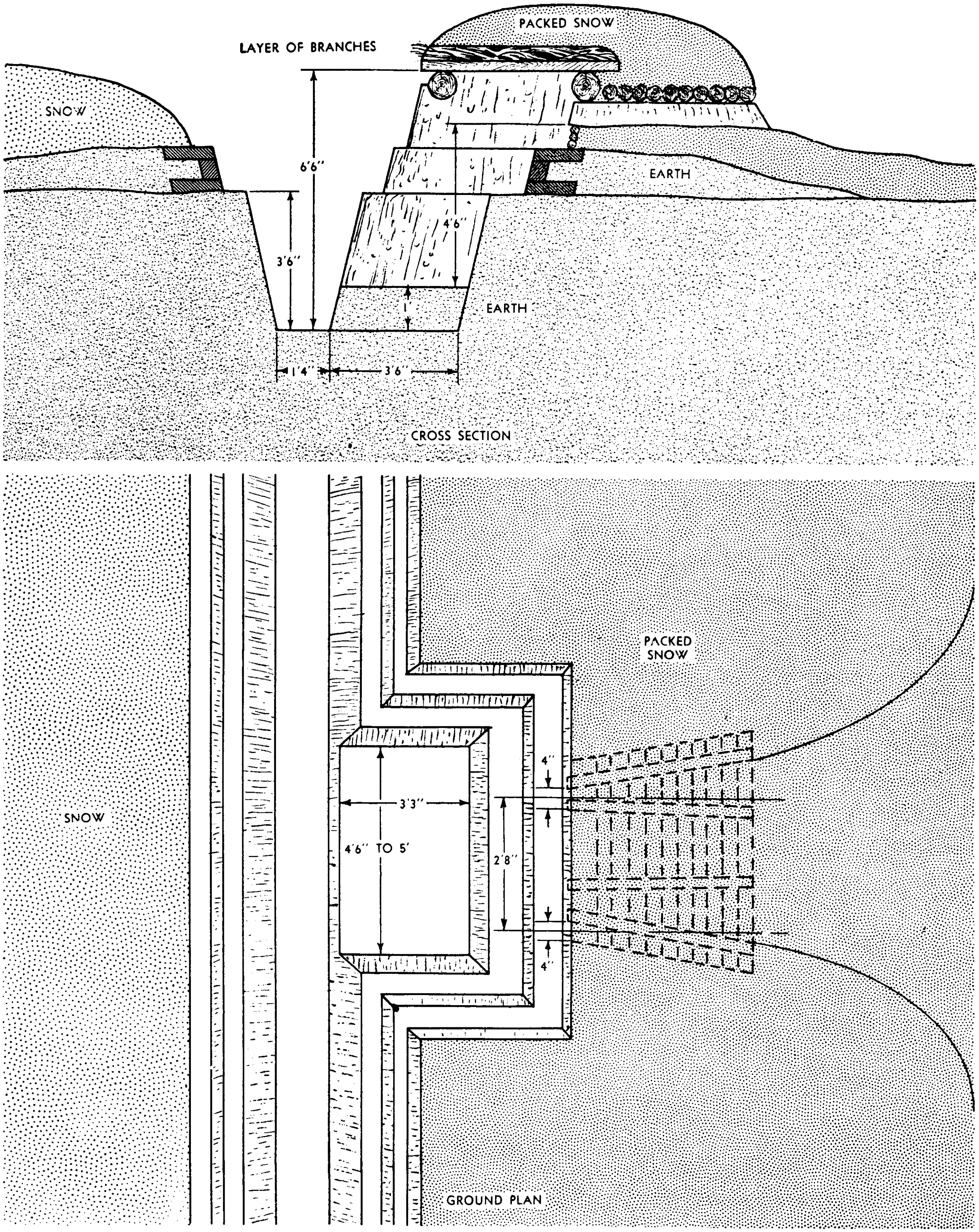


Figure 31.—Winter modification of a firing position.

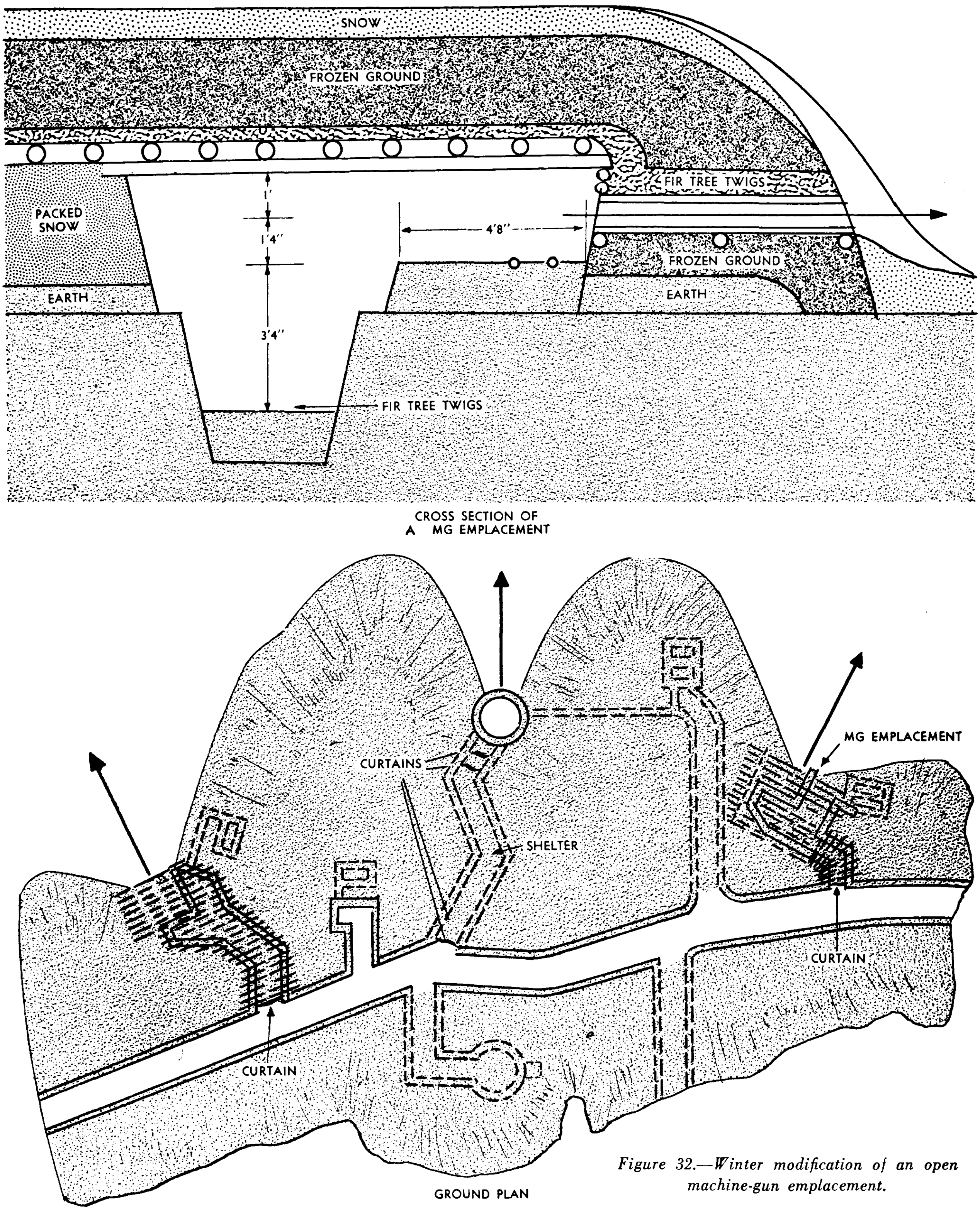


Figure 32.—Winter modification of an open machine-gun emplacement.

2. EMPLOYMENT OF SNOW, ICE, AND FROZEN GROUND

a. Defensive work. Existing defense works modified for winter conditions are largely supplemented by special winter fortifications built of snow, ice, and blocks of frozen ground. Field works are reinforced with loose-snow covers, packed layer by layer, which afford protection against antitank

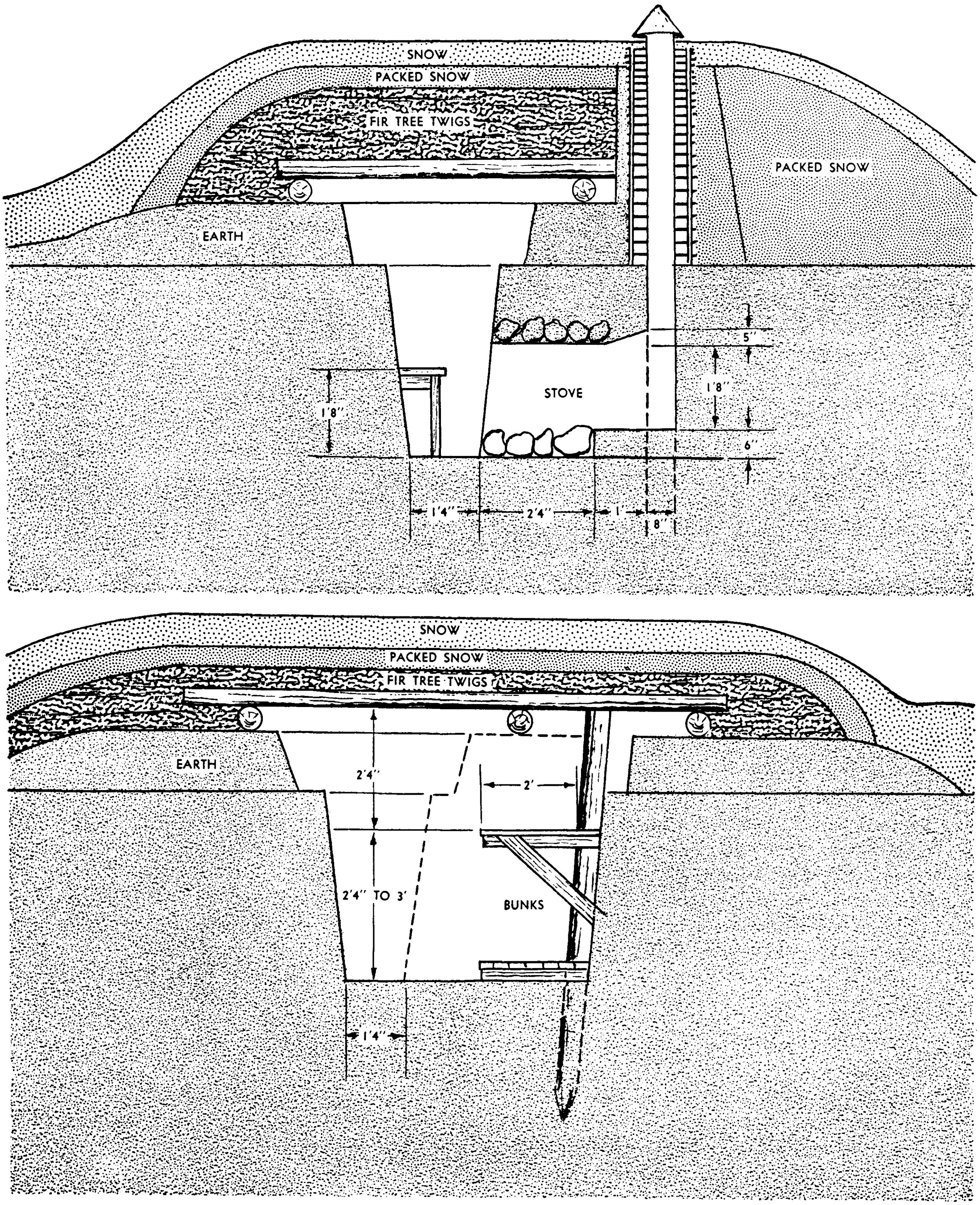


Figure 33.—Reconstruction of a trench into a shelter in winter.

grenades. When the snow cover is 4 inches deep or less, fire and communication trenches are dug to their full depth in the ground, and snow is used for camouflage. If the snow cover reaches a depth of

10 inches, fire and communication trenches are dug in the snow with only partial excavation of ground. When the snow is over 10 inches deep, fire and communication trenches are built entirely in the snow. Various available materials are used for revetment. A variety of shelters constructed of snow, or dug into ground frozen to sufficient depth, are built to meet the increased demand for shelter during winter. Observation posts are built of well-packed snow with walls 4 to 5 feet thick and a diameter of 3.3 feet. The false work inside, made of brushwood, is left in place to give additional protection from splinters. Such shelters resist penetration of ordinary and armor-piercing bullets.

Pillboxes for one machine gun are constructed of frozen blocks of sand and crushed stone. The wall blocks are fastened together with moistened snow. A 6-inch layer of logs supports the roof. Outside, the walls are covered with loose sand or packed layers of snow. This cover is 5 feet thick at the foundation, and 18 inches at the top. Individual blocks are carefully prepared, tamped until moisture appears on the surface, left in forms for a day, and then taken out at temperatures under 14 degrees F.

An effective antitank and antipersonnel obstacle used by the Soviets is an iced slope. The Red Army recommends the spraying of terrain having slopes up to 1:1½ when the ground is frozen but not yet covered with snow. The spray of water is directed from the top of the slope downwards, and kept as long as possible in the air. The preparation of an ice crust over snow requires a great amount of water and time. When the temperature is very low (5 degrees F.), it is preferable to pour water from buckets by hand. An ice surface of 7 to 9 square yards can be prepared by one man in 12 hours.

Excellent antitank obstacles are camouflaged openings, 13 to 22 feet wide, in frozen surfaces of rivers, lakes, and ponds. They are covered with insulating material to prevent their freezing over. A 6- to 7-inch layer of hay or straw, a 10-inch layer of fir branches, or a 10-inch layer of branches combined with a 4-inch layer of hay, provide such insulation which, in addition, is covered with loose snow. Traps of this kind are usually arranged in checker-board fashion along the near shore of frozen rivers, lakes, or ponds located in front of defensive positions. If an opening or thaw in the surface of a frozen water obstacle is covered by a 4-inch layer of ice, it can be maintained in this condition by an 8- to 10-inch cover of loose snow. A possible increase in the thickness of ice of 1 to 2 inches will not prevent a tank from breaking through. Swamps are prevented from freezing in a similar manner.

Individual sectors in the rear of defensive positions, roads, and road sections are blocked by snow barriers formed by the placing of special snow fences against the wind. The use of several rows of snow fences permits formation of the desired wall width. Vertical and slanting snow fences are installed in various combinations in order to obtain the desired mass of snow. Such snow walls are used as a protection against tanks and mechanized vehicles.

The Soviets are very inventive in utilizing various materials for winter antipersonnel obstacles. Stockades 5 to 7 feet high made of poles 3 to 5 inches in diameter are set in ice in a checkerboard pattern inclined toward the enemy, with intervals of 10 to 12 inches along the front and of 12 to 16 inches in depth. Abatis of trees and branches attached to poles are also set in ice. Stumps of trees 8 to 16 inches in diameter, or logs, set in ice are found to be very effective. These types of obstacles on ice are also considered effective in preventing hostile aircraft from landing on frozen lakes or large rivers. When the ground is covered with loose and shallow snow, antitank mines are placed directly on the ground. If the depth of snow exceeds 10 inches, mines are installed on tamped snow or on pads made of boards or stakes at a depth of not over 4 to 6 inches from the surface of the snow.

b. Structural characteristics. If thoroughly protected by heat-insulating material of sufficient thickness, such as sawdust, wood shavings, peat moss, finely chopped fir twigs, dry conifer needles, and the like, structures of snow, ice, and frozen ground can remain structurally sound indefinitely at low temperatures. The principal advantages in the use of these materials for defense works lie in the general and immediate availability of the material, the comparative rapidity of construction, the facility with which such works can be repaired, the durability of such structures, and their noninflammability.

STRENGTH AND DURABILITY. Snow, ice, and frozen ground are highly plastic even when not under load. Continuous loading causes considerable and rapid deformation, especially at temperatures close to freezing. The strength of frozen ground to a great extent depends on the moisture content at the time of freezing and the cementing together of solid particles by ice. The low tensile strength of snow, ice, and frozen ground is given primary consideration in planning permanent structures. This applies particularly to overhead cover. Theoretical calculations, confirmed by practice, indicate that vaulted overhead cover is not subject to such effects and may stand indefinitely without suffering any deformation.

Snow. Flat overhead cover made of snow will not last long and is possible only if the span does not exceed 3 feet. Flat cover of ice and frozen ground with a span of 10 to 13 feet may last several months if the cover is not less than 2.3 feet thick and if its temperature can be maintained below freezing. Usually flat cover must be supported by a layer of logs or similar material.

The durability of dry, compact snow is materially increased by adding water up to 25 percent of the weight of the snow. This raises the compressive strength of frozen snow to 17 pounds per square foot. The accepted working strength of dry, compressed snow at 14 degrees F. is 10 to 16 pounds per square foot and that of frozen snow is 20 to 30 pounds per square foot. The allowable tensile strength in structures made of pressed snow is 0.2 to 0.4 pound per square foot; that of frozen snow, 1 to 2 pounds per square foot.

Ice. The structural strength of ice and frozen ground is much higher than that of snow. It increases with the decrease in temperature, especially within the range between freezing and 14 degrees F. when most of the mineral solutions contained between the particles of ice or frozen ground congeal. Salt-water ice is structurally weaker than fresh-water ice, but its elasticity is greater under continuous loading and it is less brittle. The compressive strength of fresh-water ice fluctuates between 30 and 125 pounds per square foot, with 60 pounds per square foot at 14 degrees F. The permissible tensile stress in ice structures is 4 to 6 pounds per square foot. A typical feature of ice in defense works is its high fragmentation in the event of direct hits or explosions.

Frozen ground. Frozen ground is three to five times stronger than ice. Its strength increases with decreasing temperatures. The resistance of frozen ground to blast action is greater than its resistance to continuous loading. The strength of frozen ground, like that of ice, depends not only on the quality of separate particles and crystals but also on the cohesion of ice crystals.

Sand and similar types of soil with a low moisture content are the most resistant and have high tensile and compressive strengths. The temporary compressive strength of such ground may reach 400 pounds per square foot and, in this respect, it equals good cement concrete or high grade brick.

Frozen clay is the weakest of all ground material, but while its temporary compressive strength is inferior to that of sand, it is not as fragile and is less subject to fragmentation by direct hits.

Ice concrete. Experiments carried out by Soviet specialists have shown that the compressive strength of ice concrete, a mixture of water and frozen sand, gravel, or crushed rock, equals the strength of good concrete or high grade brick, while its bending strength is from 2 to 4 times higher. The following table gives the average compressive strength of reinforced ice concrete:

Ice with dry sand	300 pounds per square foot.
Ice with crushed rock	350 pounds per square foot.
Ice with frozen sand	270 pounds per square foot.
Ice with frozen crushed rock	210 pounds per square foot.

One and one-third cubic yards of ice concrete made with dry sand and crushed rock contains 1,540 pounds of sand, 375 pounds of water and 3,485 pounds of crushed rock. The bending strength of beams made of ice concrete with timber reinforcing was tested with a continuous load of 880 pounds, which equalled approximately one-third of the allowable load. With air temperature at 5 to 15 degrees F. for 72 hours, the deflection was 0.65 inch or 1/675 of the span. After a month under the same test load, deflection increased to 1.56 inch or 1/275 of the span.

The chief disadvantages of ice concrete are the comparatively complicated process of preparation and the necessity of using definite proportions of the aggregates in order to obtain a uniform mass. The strength of ice concrete does not differ much from that of frozen sand, and it takes less time to build defense works of frozen ground. The Soviets recommend the use of ice concrete for the construction of defense works only when sufficient time is available for its preparation, and when sand, crushed rock, or gravel is locally obtainable.

PROTECTIVE QUALITIES. Structures of ice, frozen ground, and ice concrete, due to their hardness, resist penetration of bullets and shell splinters, but their brittleness makes them vulnerable to blast. This is particularly true in regard to ice. For this reason ice is not used in the construction of pillboxes but may serve as material for obstacles.

Frozen sand or gravel and ice concrete are less brittle than ice. Soft frozen ground (clay, dry soil, or peat), though less hard than sandy ground or ice concrete, gives more resistance to blast action and fragmentation.

Fortifications of frozen ground and ice concrete must be provided with a protecting layer of brushwood, stakes, poles, or boards within the structure. Frozen ground should be reinforced with branches, straw, or similar material. The reinforcing must be placed in all directions and not in layers. Blast action causes fractures along planes of weakness in layer reinforcing, thus weakening the structure. Based on their experience, the Soviets list the effects of direct hits on various types of frozen ground as follows:

Frozen clay soil shows the best resistance to penetration (bullets and shell fragments) and blast.

Ice concrete with crushed rock offers better resistance to penetration than any other ice concrete. However, if it lacks vertical branch reinforcing, it is subject to destruction by blast and splits off along planes of weakness.

A recommended composite ice concrete in which the inner layer is made of frozen ground, the intermediate layer of ice concrete, and the outside cover of loose frozen ground, reduces the destructive effect of bullets and blast to a minimum. An inner layer of dry branches, poles, or boards is used as protection against splinters. Loose frozen earth cover on concrete pillboxes considerably reduces the destructive effect of direct hits.

Frozen ground is recommended for splinterproof construction. Ice taken from water reservoirs does not resist penetration and therefore is not recommended for covered fortifications. Walls of winter structures are built of blocks of various types of frozen ground. Blocks of frozen sand, 39 inches thick, are composed of one part crushed rock and two and one-half parts sand. Blocks of frozen clay ground, 47 inches thick, are composed of one part clay and two parts sand.

The protective thickness of frozen materials against penetration of bullets varies:

Snow, loose	120 inches.
Snow, packed	80 inches.
Snow, with ice crust	40 to 60 inches.
Ice	28 inches.
Frozen ground	20 inches.
Ice concrete	12 inches.

c. Ground water and thawing problems. Structures of snow, ice, and frozen ground which are planned to last until spring should be built on foundations not subject to thawing nor exposed to surface waters. The presence and level of underground water is given primary consideration, and sites with high ground-water tables are avoided. If conditions require the erection of defense works in areas with a high ground-water table, the process of freezing the structure is accelerated, or, if possible, dry earth is used as material. If time is available, acceleration of the freezing of the upper layers of the soil on which the structure is to be erected is recommended. For this purpose the snow is removed from the surface of a slightly larger sector than required for construction. With a temperature of 5 to 14 degrees F., 2 to 3 days are sufficient to freeze the base of the structure to protect it from the effects of high-level ground.

To protect ice or frozen-ground structures from melting during temperatures above the freezing point at the beginning of spring, the walls of such works are insulated with available material, such as peat, sawdust, straw, and fir twigs. Before insulating a snow, ice, or frozen-ground structure, thorough freezing should take place in order to increase its durability and thermic stability.

Peat is recommended as the best insulating material, since straw and hay are subject to decay with the resultant release of heat at temperatures above 50 degrees F. The best insulating effect is obtained when the insulating layer is moistened and thoroughly frozen. When the temperature is above freezing, the insulating material should be as dry as possible, and may be moistened when the temperature drops below freezing. By covering the insulating outside layer with 4 inches of snow, the effect of insulation will be increased. Surfaces inside a frozen-material structure should be insulated by dry material to protect them from the radiating warmth of stoves and human bodies. The thickness of insulating layers depends on the length of time the structure is to be used. An 8-inch layer is found sufficient for two or three weeks. The most effective insulation is afforded by interior walls made of stakes, poles, brushwood, canvas, bagging, etc., with an air space 4 to 8 inches wide between the inner wall and the frozen ground or snow structure. If no insulating material is available, the frozen structure should be covered with as thick a layer of snow as tactical conditions permit, although snow insulation will protect the structure from thawing for a few days only. Drainage must be provided for melting snow insulation.