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GERMAN

MOUNTAIN WARFARE

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INTRODUCTION

The Germans believe that specially trained mountain troops (*Gebirgstruppen*) may influence decisively the outcome of a campaign, for mass armies must rely on specially trained small forces to secure their advance through the broader mountain valleys in order to reach the flat,[1] where the decision usually is sought. Small forces of mountain troops can prevent, impede, harass, or channel the movements of the main enemy force through the valleys, so that when the decisive battle takes place in the flat, the enemy's power is spent and he is compelled to fight under the most unfavorable conditions. When on the offensive, mountain troops can cover and protect the advance of their own main force, enabling it to reach terrain of its own choice in the highest state of readiness for combat. Thus their mission on the offensive is to secure the route for the advance of large units through the valleys, whereas their mission on the defensive is to deny the valleys to the mass of the enemy forces. In either case, mountain troops must gain control of the mountains.

The Germans hold that the basic tactics of warfare in mountains are the same as in the flat, but that the application of the principles must be modified to fit the high and rugged terrain. In mountainous terrain the movement of troops and the employment of heavy equipment are limited, and deployment is restricted to such an extent that only comparatively small forces can operate. Soldiers must be prepared to advance over narrow roads, tortuous paths, trackless terrain, steep and slippery slopes, ravines, precipices, and glaciers. Movement frequently is threatened by avalanches, rockfalls, landslides, and cornice fractures. Besides these special terrain factors, the weather also exerts a

[1] The "flat" (*Flachland*) does not necessarily mean plains. This term also denotes low, rolling country or any terrain in which troops may normally be employed without special training or equipment and without modification of general tactical principles.

great influence on mountain fighting. Meteorological phenomena, such as burning sun, heavy rain, and blinding snow coupled with intense cold, may occur in swift sequences.

In mountains, the Germans believe, the infantry-artillery team retains the ascendancy which on other fields of battle it yields in part to armor and air power. Relatively unimportant roles are played in mountain warfare by the tank and the airplane. The employment of heavy infantry weapons and artillery is hampered by their bulk and weight, by the considerable dead space, and by the difficulties of observation due to weather and intervening terrain features. It is the infantry, above all, that must bear the brunt of the battle. Consequently, the Germans stress the principle that the importance of shock action and close combat increases as the efficiency of other methods of fighting decreases, and that in some respects mountain fighting resembles guerrilla warfare.

Because of the narrow terrain compartments in mountains, unified control is possible only over small units. The Germans believe that the reinforced battalion is ordinarily the largest tactical unit whose movements a commander can effectively control during combat. In unusually rugged terrain the task unit must be even smaller. Therefore, greater responsibility is placed on officers of lower rank.

The focal points of mountain combat are the heights. Gun emplacements and observation posts on commanding heights can dominate the foreground and valley, making the task of the advancing infantry relatively easy. But of all mountain operations the seizure of heights is the most difficult. A well-defended height must be taken by surprise to avoid great losses. Only men skilled in mountaineering, who have developed stamina through long conditioning, who have the ability to maintain direction, and who have been thoroughly trained for combat, can effectively carry through an attack on a height in high mountains. This is a cardinal principle of mountain warfare which the Germans emphasize.

The following is a summary of basic characteristics of mountain warfare which are stressed in training by the Germans:

(1) Movement is much slower than in the flat, for it takes a long time to bring troops into position. Artillery and heavy weapons, particularly, move slowly. The deployment of infantry, especially units with heavy weapons, requires much time. The attack itself proceeds slowly, and the terrain prevents it from gaining the momentum that is possible in the flat; on the other hand, the large number of good defensive positions and the scarcity of roads facilitate delaying actions. Reserves have to be held very close to the front lines; otherwise, unpredictable conditions of terrain and weather may delay their arrival for the crucial phase of battle.

(2) Signal communication is less reliable than in the flat. The weather sometimes weakens the audibility of messages transmitted by wire or radio. Radio is faster than wire communication, but even less reliable. Reception may be affected by the weather and by the configuration of the mountains. Laying lines is a slow, arduous process, and maintenance and servicing of wire are difficult. Control of the battle by the higher commander is limited largely to a preconceived and thorough plan, since the uncertain channels of signal communication usually prevent him from intervening effectively in operations once the battle has begun. Consequently, the responsibility of subordinate commanders for independent action is greater than in the flat. Rarely can they expect aid from reserves, as the full force is likely to be committed all at once.

(3) The problem of supply becomes extremely acute in mountains, and the proportion of supply troops to combat troops increases. Supply routes are few; food, forage, and ammunition must be carried over narrow roads and mountain trails as far as possible by motor transport, then on mules and mountain horses, and finally on the backs of the soldiers. Economy of supplies is necessary because the danger of extending a unit beyond reach of its supply column is great, and, furthermore, it is impossible for an over-extended unit to live off the country in mountains.

Section I. GERMAN DOCTRINE OF MOUNTAIN WARFARE

This section is an edited translation of part of a German manual entitled ***Vorläufige Ausbildungsanweisung für die Gebirgstruppen (Provisional Training Instructions for Mountain Troops).*** *Although the manual is dated 1935, the fundamental German principles of combat in mountains have changed little in the interim. The German manual is not illustrated; the illustrations that appear in this section have been added by the editor.*

1. COMBAT IN HIGH MOUNTAINS

a. General

In high mountains officers and enlisted men have to overcome difficulties that are different from and generally greater than those encountered in the flat. More time is required to execute all movements, and plans for the disposition and commitment of forces must be adapted to the special problems of warfare in rugged terrain. The terrain limits the usefulness of some weapons, and the problem of supply is continuously critical. In general, the difficulties are caused by the steep terrain, the great variations in altitude in different parts of the mountains, the small number of roads and paths and their narrowness, the limited possibilities for movement off roads and paths, and the character and condition of the ground surface. Time of day, season, and weather also create special problems. Account must also be taken of the influence of terrain on the effectiveness of enemy weapons.

Difficulties presented by high mountains are most acute in areas of rock, cliff, and glacier. To overcome them, the officers must have mountain experience, and the troops must be care-

fully selected, specially equipped, and thoroughly trained in mountain operations. Even peacetime service in mountains requires great tenacity, strength, will, and courage; its conditions and dangers are often comparable to those of actual warfare.

The difficulties encountered in medium mountains are less than those in high mountains; nevertheless they are considerable, and they increase in winter. Even in medium mountains, a soldier cannot be fully effective unless he has proper training, clothing, and equipment. Inexperienced men will have great difficulty in effecting cooperation between the infantry and the heavy infantry weapons and artillery because of the difficulties of observation and the many unusual ballistic problems.

Winter, and the thaws before and after, greatly alter the conditions of march and combat in high mountains. During this time the activity even of excellently trained mountain troops is limited by the cold, new snow, snow storms, clouds, avalanches, and the increased difficulties of bringing up supplies and quartering troops. Consequently, important operations are exceptional in winter. Since frequent great and sudden changes in the weather affect the performance of troops in high mountains, mountain troops must learn in training how to protect themselves against the effects of weather; they must know how to make use quickly of all means of protection against cold, rain, and storms, especially at night and when they are tired.

In high mountains, only mountain troops can be used in all situations. For maximum combat efficiency, they must be trained to move with heavy weapons over any kind of terrain that is negotiable by highly skilled mountain climbers. The better trained and the more effective they are, the greater will be their prospects of surprise and decisive success. They must be able to move over difficult terrain surely and easily, even on moonless nights and in rain, fog, or heavy snowfall.

For bringing up supplies over valley highways, motor vehicles are preferable to animal columns because their capacity and speed

are greater and because they occupy less of the limited road space. Mules are the most useful pack animals; small horses are much inferior and fail even in the higher reaches of medium mountains.

b. Command

High mountains limit the use of large forces and greatly restrict deployment. Because access to some positions is difficult, adjacent units often cannot support each other, and reserves cannot be shifted rapidly. However, through deception and bold surprise action, the attacker often can gain success with smaller forces than the defender. In mountains the commander should not hesitate to put troops into action over a wide front in order to deceive the enemy into dispersing his forces and to achieve surprise by concentrating the bulk of his own troops at points favorable for attack. Such maneuvers necessitate careful planning and prompt decisions by the commander.

Mountains themselves are great obstacles to the quick personal intervention of the higher commanders because march columns, even of the smaller units, are extremely long, and combat generally takes place over a wide front and consists of many isolated engagements. For this reason, higher commanders, to carry out their plans, must depend to a great extent on subordinates of all grades, including the best enlisted men. Only if missions are assigned in detail and sufficient forces are allotted to carry out each mission, can the various combat groups work together toward a common objective. Combat in high mountains demands absolute thoroughness in preparation; superficial knowledge and ignorance or underestimation of mountain dangers may result in catastrophe. The commander, conscious of his well-considered plans, should remain calm and assured even in the face of the greatest difficulties and thus set an example for his subordinates. He must be tenacious in carrying out his mission and he must insist that his subordinates follow his orders strictly.

c. Effect on Firing

When there are great differences in altitude between the gun position and the target, firing is subject to special conditions, and the obstacles to consistent cooperation between the heavy weapons and infantry are more numerous than those met with in flat terrain. The mountain infantryman must be specially trained to fire his rifle and light and heavy machine guns both upward and downward in areas with steep slopes, to camouflage open fire positions, to occupy them rapidly, and to open fire at once. In high, open regions, however, firing presents fewer problems than in forested areas of low and middle altitude, where observation is difficult.

2. RECONNAISSANCE

In mountains, reconnaissance of routes and terrain suitable for marching and for combat is by no means less important than tactical reconnaissance. Frequently the plan of maneuver and the number of men assigned to advance over each route depend on the results of this reconnaissance. The commanders themselves rarely can make personal reconnaissance; they must usually depend on general surveys, studies of maps, and tourist guidebooks, but mainly on the information obtained by reconnaissance units.

Patrols reconnoitering routes and terrain follow close behind the scouts who are seeking the enemy. They mark the reconnoitered route and determine how far pack animals can march with heavy loads, and where they can march only without loads; they also determine where route improvement and security forces for men and animals are needed, where the troops must begin to manhandle heavy weapons, and what sections of the route can be seen by the enemy. Tactical reconnaissance of the terrain by scouts to find a way to carry out the commander's special instructions for disposition of the troops must go on at the same time as route reconnaissance. Only in urgent situations will the com-

Figure 1.—Mountain patrol. (The men are wearing two-piece white coveralls with recognition bands on their right arms.)

mander lead his men into enemy terrain without previous reconnaissance; when he must do so, he will try to send forward picked patrols without packs (fig. 1).

The combat performance of the artillery and the heavy weapons of mountain infantry (*Gebirgsjäger*) will depend heavily on hard work, knowledge of firing, tactics, and mountaineering of the scouts. Reconnaissance by artillery, infantry-mortar, and heavy machine-gun units generally starts at the same time as tactical and route reconnaissance. The force commander should decide early whether to send officers equipped with radios to points which give a good view of the terrain over which he plans to make the approach march. Both he and the commanders of the heavy weapons may benefit greatly from the use of observers sent well forward.

3. MARCHING; SECURITY; SHELTER

a. Marches

(1) *General.*—During a march in mountains, a prime consideration is to save the soldier's strength while he is loaded with weapons and pack, for the troops must be fit for combat when they engage the enemy. Scout parties and small detachments, without packs, are required only in exceptional circumstances to perform missions in which they must strain their physical resources to the limit.

A force usually marches in several columns to make use of all available routes in high mountains and to induce the enemy air force to dissipate its effort. Thus the readiness of the units for combat is increased, and there is a better possibility of quickly overcoming weak enemy resistance. The march is also expedited, and the troops are spared undue exertion. Furthermore, troops marching in several columns can make maximum use of the limited shelter available in mountains.

(2) *Order of march.*—The usual formation for marching in high mountains is mountain order, single file; the distance from man to man may increase from time to time, depending on the difficulties and the slope of the route, but there must be no relaxation of very strict march discipline. The road space of a unit is 4 to 6 times greater than in level country. Greater intervals are prescribed in places where there is danger of rockfalls and avalanches. Special measures and strict discipline are necessary in marches on moonless nights over difficult mountain terrain. Clouds or sudden storms affect marches in high regions very differently than in the flat,[1] and place a great burden on all personnel.

The ratio of strength between the advance guard and the main body, the distribution of weapons, and the order of march may vary greatly, depending on the situation of the enemy, the suit-

[1] In the German text, *Ebene*, which has the same connotation as *Flachland* (see p. VII, note 1). The term "flat" has been used throughout this study in translating both words.—EDITOR.

ability of roads for movement of heavy weapons, and the possibilities for maneuver. In mountains the advance guard often must dispense wholly or in part with accompanying infantry mortars and artillery, for the guard must proceed before it is decided whether these weapons can be taken along. Under these circumstances it should be proportionately stronger in machine guns. In such a situation infantry mortars and artillery, first from the valley and then from the lower mountain slopes, should try to protect the forward movement of the advance guard and to give it at least some support in combat.

The march intervals of advance and rear guards depend entirely on the situation and the terrain, which often give the enemy better opportunities for observation and effective fire than he has in the flat. In advancing toward a commanding pass over narrow valley roads visible at a great distance, the advance guard, motorized and protected, if possible, by tanks and motorized artillery, should move out many hours ahead of the main body. The main body should not start up roads or paths when the slopes on either side are bare and difficult to climb, nor should it descend bare slopes visible to the enemy until ridges in the direction of the enemy are in the hands of the advance guard. Frequently the main body can move up only at night.

Rules for forming the advance guard and for the approach march of the main body cannot be given; the commander must issue special orders in each instance. When, for example, heavily forested regions with hidden and inconspicuous roads make it difficult for the enemy to interfere with the march, smaller march intervals will suffice. Or if, during the advance, increased readiness for action is necessary, the main body may advantageously march in deployed formation. Like considerations determine the march intervals between the rear guard and the main body. Orders for intervals generally give the time interval between units.

If the commander assigns infantry mortars and artillery to the advance guard, he should consult the commanders of these weapons

on the strength of the detachment and the order of march; but the less mobile units should not precede the more mobile without some special reason, since it is usually very difficult to move rear elements past other troops. As a rule, the "combat staff" (*Gefechtsstab*), or commander's party, and the "combat staff" of the artillery and of the infantry mortars march in the advance guard. The commander himself generally marches well forward in the advance guard, accompanied by the commanders of the machine guns, mortars, and artillery.[2] Some signal troops are assigned to the "combat staff" of the force commander; those not otherwise employed usually march at the end of the advance guard. The position of the engineers in the column depends on their missions. They may march with the stronger reconnaissance units, or, more often, ahead of the artillery, with a detachment for special road improvement immediately behind the point of the advance guard.

In an advance through a broad valley where conditions are like those in the flat, the commander may well assign a heavy force of artillery to the advance guard, especially if the main body has to proceed for some time without support. Likewise, an advance guard moving forward to occupy a mountain mass, since it cannot expect relief for a long time, should have as many heavy weapons as possible.

(3) *Time factors.*—For the calculation of march time, no fixed rules can be laid down. The time will vary with the route, the slope, and the condition of the troops. It is well to add about 1 hour to the map distances for each 1,000 feet of ascent and 1,650

[2] The doctrine expressed in this sentence applied to German mountain-division organization at the time the manual was published. The infantry battalion then included a machine-gun company and a mortar company. With the inclusion of the 81-mm mortar platoon in the machine-gun company and the replacement of the mortar company by a heavy-weapons company (*schwere Kompanie*) (see par. 25, p. 98), the doctrine would read as follows: "The commander generally marches well forward in the advance guard, accompanied by the commanders of the machine-gun company, the heavy-weapons company, and the artillery."—EDITOR.

feet of descent. The selection of the hour of departure requires careful thought, account being taken of the situation, the time of year, the weather, the kind of terrain to be traversed, and the condition of the troops. When several columns advance into combat, cooperation should be assured by carefully scheduling the movement of each column. Columns moving over heights often depart 1 day or more ahead of those moving in a valley.

A 300-foot or 1-minute interval between companies and batteries will keep the column moving steadily. If several battalions move along the same mountain road, the distance between them should be determined by orders, with a 30-minute interval as the minimum. In deep snow, men with skis and snowshoes, who must be relieved frequently, go ahead to break trails.[3] Loaded animals cannot walk through snow that is more than 16 inches deep.

Orders for rests should be given by the force commander before the troops set out. The schedule of rests depends on the mission, the duration of the march, the difficulty of the terrain, the weather, and the condition of the troops. Soon after the beginning of an ascent there should be a short halt for adjusting saddle straps. After this halt, fresh, well-trained mountain troops must be able to climb for 3 or 4 hours without resting; they then need a rest of at least 1 hour. Shorter rests are worthless, because they do not compensate for the work of unloading and reloading. By means of map and ground reconnaissance a resting place should be selected where pack animals may be unloaded and the men and animals can rest. At all halts the men should seek cover from air attacks and protection against strong wind. In long columns, orders must be distributed soon enough to allow for their transmission.

(4) *March discipline.*—Marching in mountains requires the strictest discipline. All superiors must give continuous attention to keeping march formations closed to the proper intervals, and

[3] See "German Ski Training and Tactics," *Special Series*, No. 20 (31 Jan 1944), par. 14, p. 38.—EDITOR.

must enforce an even, rhythmical pace and a proper handling of the pack animals. Stragglers must not be tolerated. In ascent and descent it is forbidden to take short cuts or to stop for a drink or for any other reason, unless ordered. The troops must also be forbidden to eat snow or ice. When ascending they must not smoke, even when at ease. Every unit is responsible for maintaining contact with the unit marching ahead of it.

b. Security

To provide security for troops resting in a large mountain valley, the command first turns its attention to the roads and trails which the enemy has to use. Often the enemy can make use of observation posts and firing positions at points of vantage on flanking or frontal heights which friendly troops are unable to occupy; hence, to prevent surprises, it may be necessary to organize protective fires with heavy arms. Obstacles and antitank weapons can always give protection against enemy tanks on wide valley roads.

In forested or rocky regions, trails and roads should be guarded first of all, and then, for the security of troops at rest, patrols should be sent out as far ahead as possible. When the enemy is near, the terrain between the opposing forces, even if apparently impassable, also should be watched carefully, especially at night. When terrain conditions are simple, the security elements are organized as they are in the flat. In broken terrain where observation is difficult, the security units for retreating forces should take their rest in, or directly behind, the position which is to be held in case of enemy attack; at night, the position should be protected by combat outposts and scout squads. Insufficient security, particularly when the troops are very tired, is a false and dangerous economy of forces. Protection against surprise air attacks must be given special attention.

c. Shelter

In high mountain country it is difficult, even in well-settled valleys, to find permanent shelters where large forces can quar-

Figure 2.—Mountain troops resting in a snow shelter.

ter; outside the valleys the density of population and the amount of shelter available quickly decrease in inverse ratio to altitude. Huts in mountain pastures, hay sheds, and forest huts and shelters are a last resort, for they can accommodate only small units. Hence, especially in high places, the troops must know how to take advantage of the terrain so that by using their tents they can set up a weatherproof bivouac quickly. They must also know how to make shelters in deep snow as a protection against wind and cold (fig. 2). Mountain troops learn while in training to spend winter nights in bivouacs at high altitudes.

Commanders, however, should not overlook the fact that over a long period temporary bivouacs are not good shelters. The greater the physical demands upon the troops and the more severe the weather, the more necessary it is to replace the bivouacs by improvised shelters as soon as the situation permits. The comfort of the troops should be considered; tents, huts, and barracks ought to be heatable and windproof. So far as possible,

bivouacs and emergency shelters must be protected against enemy ground and air observation, enemy attack, and mountain dangers.

4. COMBAT

a. General

The significance of numbers should not be underestimated even in high mountains, but in such terrain superior leadership and morale, toughness, and mountain training will make themselves felt. With men able to move over all kinds of steep rock, snow, and ice, and adept at military skiing in high mountains even under the most difficult conditions, the command has a basis for remarkable achievements. The combat plan must always aim at surprise, but successful surprise action depends on efficient soldiers and a commander who knows how to use them. Although local superiority in numbers and matériel often suffices for small-scale attacks, an assault on well-prepared positions demands a considerable superiority of forces and a well-organized plan of supply.

b. Attack

(1) *Advance and deployment.*—Combat in mountains, like combat in the flat, usually is fluid in its early stages. The advance guard secures time and space to enable the main body to deploy or to occupy positions from which it can attack most effectively. Usually it takes a long time in mountains for the attack really to get under way. Until it does, the commander must see to it that the advance guard is strong enough to bear the whole burden of the battle.

When the disposition of the enemy is uncertain and the terrain is difficult, the advance guard must often go forward by bounds; that is, it advances from point to point under the protection of the heavy weapons and artillery. In open terrain, where lateral movements are risky, the advance guard may have to ad

vance while deployed in order to be better prepared for action in case of a surprise encounter with the enemy.

It is difficult to withdraw the advance guard, even before the enemy has actually pinned it down, without subjecting it to heavy casualties. It is possible to withdraw it with moderate losses only if orders can be distributed quickly and the terrain is suitable for a withdrawal.

Mountain infantry moving up to the line of departure must take full advantage of the terrain and deploy as quietly as possible. In difficult terrain the reinforced battalion is generally the largest formation that can attack as a unit. When the operation takes place at night, the routes of approach must be frequently and carefully marked by conspicuous signs; the men may not use lights, and they must relay orders in whispers. In the daytime they must use hand signals whenever possible. Crossing even short stretches under enemy observation betrays the plan of operations. Everything depends on the conscientiousness and self-discipline of each individual. Every assault soldier must receive information concerning the enemy and know his situation accurately.

Systematic measures of deception should veil the occupation of the line of departure for the attack, as well as the main thrust, so that the time, place, and direction of the attack will completely surprise the enemy. These deceptive measures must be of many kinds, must cover several days if necessary, and, taken together, must show a definite trend. Even though they do not always draw the enemy reserves to the wrong flank, it is important to keep the enemy in a state of uncertainty until the battle has been in progress for a considerable time.

(2) *Effect of terrain.*—A unit moving downhill has the advantage of being able to go into action rapidly, but ascending units often have opportunities to use heavy weapons against an enemy descending into open terrain. When two adversaries are both moving uphill to seize a ridge lying between them, the heights themselves become the focal point of combat, and the commander must guide the action and influence its development by the capture

of decisive points. An energetic leader often does not wait for precise information from combat reconnaissance, but bases decisions on his general impression of the terrain, gained from the maps, and on preliminary reports. The rest can be done by troops fit for mountain operations. The artillery commander must see to it that fire is immediately laid down where the advancing infantry needs it.

In steeply rising terrain the attacking force may often have fire support for a long time. Good gunners manning heavy machine guns can hold down the defender until the moment before the attacking force penetrates the enemy positions. However, poorly placed fire which strikes friendly troops just before they reach the enemy positions leads to serious reverses. Support of the attack by heavy weapons requires careful liaison with the front line and strictest attention to the ballistic characteristics of the weapons and the effect of the rounds in the terrain. The cooperation of infantry mortars and artillery in preparing the attack is particularly important when the terrain is difficult and the enemy has had time to organize his position and dispose favorably his heavy weapons. Troops threatened by the effects of the dispersion of artillery fire and the probable loosening of rocks must advance from the side so as to roll up the flank of the enemy thus held down by the artillery.

Often very small units succeed in penetrating the enemy position. The resolute exploitation of their successes is a matter of great importance; but if, after a successful penetration, there are not enough forces to exploit the attack further, then the ground captured must be held. For this purpose all the heavy machine guns come up first and dig in (fig. 3). Support by artillery at this time will be more or less interrupted, because many of the batteries cannot reach beyond the newly occupied heights without displacing forward. Even though the forward artillery observers reach their new positions quickly, the changing of a battery position generally requires considerable time. Meanwhile the mortars can provide support.

Figure 3.—Machine gun (*M.G. 34*) emplaced in snow. (The long-legged antiaircraft tripod is used instead of the standard mount so that the gun may be firmly emplaced in the deep snow.)

In an attack over a downward slope without special terrain difficulties, movements are easier for the assault troops, and such an attack often has the advantages of good observation. Dead spaces and masks, however, may diminish the chances of putting artillery in position if the batteries are unable to find positions on a plateau but have to fire from a deeply cut transverse valley.

These unfavorable conditions are often encountered in combat around positions laid out on reverse slopes by a skillful enemy. Then only part of the artillery and the other heavy weapons of the attackers can reach the target area, and observation posts have to be placed on crests where they can easily be put out of action. The defender can take full advantage of the favorable terrain that he holds. In such a situation a bold surprise blow by

mountain infantry frequently offers the best chances of success, but the commander should first determine whether an assault can be made against another part of the position which is more vulnerable to attack.

(3) *Types of attack.*—Attack against an enemy organized for defense can succeed only after systematic reconnaissance and orderly preparation. The troops must come up to the assembly area by echelon. This sometimes takes several days because of the difficulties of the terrain and the activity of the enemy. Because the terrain between the line of departure and the enemy position often is difficult and sometimes is swept by enemy fire, troops must deploy for attack as near the enemy as possible, in order to cross the intervening ground rapidly. The heavy infantry weapons and the artillery must in this case take positions where they can protect the advance of shock troops and support the attack by directing the heaviest concentrations of fire at the point of penetration until a break-through occurs. As a rule, if the advancing troops deploy in several stages, some of the artillery cannot give them protection without a time-consuming change of positions and shift of observation posts.

Strong attacking forces usually advance simultaneously along a valley and over adjacent heights. Whether the main effort is through the valley or over the mountains depends on circumstances. In large-scale operations, however, the main attack must always follow the general course of the valleys, where large forces can deploy freely, where fire power can be used efficiently, and where supplies can be brought up in quantity. The accompanying attack over heights may have various purposes: to destroy the effect of enemy weapons, to occupy flanking heights, to hold down a possible enemy flank attack, or to support the attack in the valley by an attack on the flank and rear of the enemy forces in the valley. The attack over heights may be decisive when the attack in the valley no longer has any chance of success; it then becomes the direction of the main effort. If, on the other hand, the attack in the valley makes rapid headway, it is all the more

important that the forces sent over the ridges hold the enemy in the mountains and prevent him from acting against the column in the valley.

In small-scale operations it is of prime importance to occupy heights and thus increase the effectiveness of observation, use of fire power, and commitment of forces, but the lower terrain should not be neglected. In all mountain operations, the most effective attack is against the enemy's flank and rear. Although difficult terrain often limits its effectiveness, such an attack, if it reaches the rear communications of the enemy—who is usually dependent on only a few routes—may lead to his destruction. An attack against the flanks and rear may develop from a penetration of the enemy's front or from outflanking or encircling a wing; it always calls for bold and energetic leadership. When such an attack is on a large scale, strong forces with well-organized and well-protected supply lines must make a deep penetration, because a determined enemy will fight fiercely to keep open his lines of communication.

Firing at a withdrawing enemy soon ceases to be effective, as does frontal pressure on him; the terrain always offers his rear guard favorable opportunities to resist and gain time. To be effective, pursuing forces must outstrip the enemy and, by attacking his route of retreat, quickly overcome rear-guard resistance.

c. Defense and Withdrawal

Defense demands a disproportionately large force, and in terrain where it is difficult to commit adequate reserves promptly at threatened places the defensive position must be made strong initially. High mountains with medium-mountain features such as wooded slopes and only moderately difficult cliffs call for a considerable defense force, because the enemy can make a decisive surprise attack at several points in such terrain. On the other hand, rifle units made up of skilled mountaineers can operate effectively in local defense, even with limited military training, although, as a rule, they cannot carry out even short counter-

thrusts except with further training and in combination with trained troops.

Small groups maintain the defense of the battle position. The points most threatened must be organized for all-around defense, and the groups must be so disposed that they can watch terrain that is apparently impassable, and, if necessary, cover it with fire. Commanders of heavy-weapons and artillery units make the careful reconnaissance needed to set boundaries within the main battle area and to work out a plan of combined defensive fires. The course of the main line of resistance will depend primarily on the tactical requirements of the mountain infantry and on the amount of cover it affords them.

All weapons should be organized in a unified fire plan to protect the front and to sweep with heavy and effective fire the areas in the foreground where the enemy is most likely to re-form before continuing the attack. Fire from the flank and rear must reach the gaps between the strongpoints on the main line of resistance. Sections hard to defend and particularly threatened must have support from reserves held nearby. Often the flank of the threatened sector offers protection against enemy fire for the reserve, as well as a favorable place for it to deploy. If for lack of a field of fire the defense of a narrow crest is difficult with the forces available, it may be best to leave only a line of battle outposts on or in front of the crest and place the main line of resistance on a favorable reverse slope. Such a location for the main line of resistance will put the enemy in an unfavorable position for observation, employment of heavy weapons, and deployment, and will give the defending weapons favorable positions in defilade and on the flanks.

The more difficult the defense of the battle position, the more important it is to have active patrols well forward to discover the disposition of enemy forces. If the defending forces are strong enough, their outposts block the enemy advance. The weaker the available forces, the more the combat outposts must rely on prepared positions, obstacles, and the denial of areas by

use of contaminating agents.[4] If the enemy pushes into the main line of resistance and a quick counterattack by the reserves fails to drive him out, his penetration must be contained as much as possible. Even outflanked or surrounded elements must fight for each foot of ground to gain time. They have the advantage of terrain and observation, and usually they are fresher than the attacking forces.

The conditions of combat in mountains usually favor delaying actions. Withdrawing forces can establish numerous strongpoints and firing positions on heights to enable them to withdraw to the next line of resistance unobserved by the enemy. The more difficult the terrain on which the enemy has to maneuver and use his weapons, the more effective the resistance can be. In operations on a larger scale, delaying actions will concentrate on the mountain depressions and valleys which are of particular importance to the enemy for his advance. By simulating occupation of heights, very weak forces, often mere patrols, can block roads and paths. As resistance becomes stiffer in the valley, stronger forces must be employed on the heights. Resistance in valleys may hold up strong forces for a long time, giving them no chance to deploy. During this time the main task of the force on the heights is to block the routes leading over the mountains to the flank and rear of the main body.

It is hard to maintain centralized command over forces retreating on a broad front on various roads and under widely different conditions of combat. To do so, the commander must be able to move about fairly freely, communications must be maintained and guarded, and subordinate commanders must be empowered to act independently for the good of the whole. To ensure this independence of action, missions must be assigned to the commanders of small units before the movement is attempted. Even

[4] The original text (sec. I. par. 35, p. 29) reads as follows: "Je schwächer die Kräfte sind, um so mehr ist von Geländeverstärkungen, Geländevergiftungen, Sperren und Hindernissen Gebrauch zu machen, an die sich die Gefechtsvorposten anlehnen."—EDITOR.

if conditions are otherwise favorable, to break away from the enemy is difficult if the troops must be withdrawn in the daytime through a pass under fire of enemy artillery and airplanes. An alternate route should be chosen, if possible, but sometimes there is none.

Systematic withdrawal on a large scale must be masked and the enemy deceived; otherwise he may cut off large segments of the rear guard, particularly when the withdrawing elements are moving toward passes and defiles over difficult terrain. To prevent this, a strongpoint must be established in front of the pass or defile. Although in mountainous terrain the enemy cannot readily get a general view of the situation, withdrawal from combat in terrain under his observation should take place only after dark. Because of the limited road net it is important to withdraw trains promptly, leaving stores of food and ammunition behind along the route for the combat troops withdrawing later. After a successful disengagement, troops covered by even a weak but well-deployed rear guard can easily fall back on a satisfactory new position.

5. MOTORIZED AND MECHANIZED OPERATIONS

The development of mountain road nets and the reinforcement of heavy-duty motor vehicles make feasible the use of motor vehicles of all kinds in mountainous regions. Motorized units are used in mountains on the same principles as in the flat, but limited space, steepness of roads, and weather conditions restrict their employment. Most motor vehicles have to stay in the large valleys and on highways, but lighter cross-country vehicles with sufficient ground clearance may go into the mountains. Tank reconnaissance units may operate successfully in large valleys (fig. 4), and machine-gun carriers and motorcycle units can execute reconnaissance missions particularly well. They can approach the enemy fast, reach important sectors quickly, and report at once by radio and motorcycle. Their great speed makes them par-

Figure 4.—Light tank (*Pz.Kw. I*) accompanying infantry in the Norwegian mountains (April 1940).

ticularly effective for surprise and for employment against the flank and rear of the enemy.

Combat vehicles can rarely be used in mass for decisive action in mountains. Light combat vehicles in small units can be used more often in valleys and on plateaus, and in surprise action they can render excellent service in reconnaissance, screening, pursuit, and attack against enemy flanks. They can be sent cross-country off roads and highways in winter if the terrain is not too steep and has a packed snow cover.

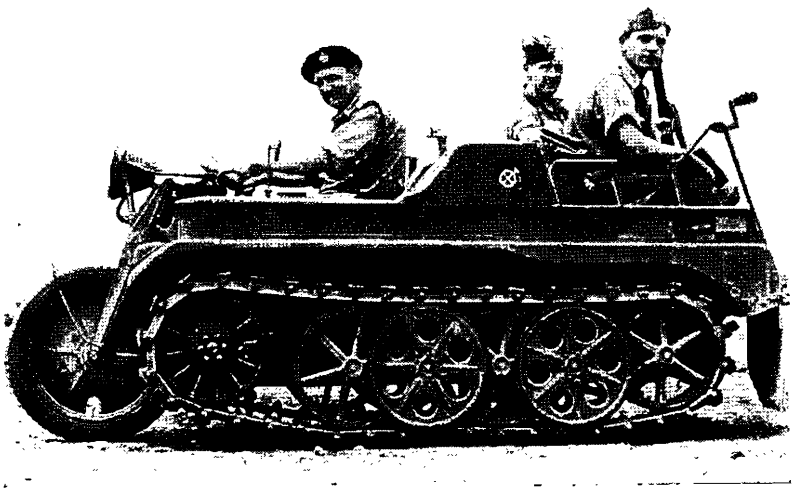

Figure 5.—Captured German half-track vehicle (*Kettenkrad*) frequently used for transport by mountain troops.

If properly adapted to the characteristics of mountain terrain, cross-country trucks and tracked vehicles (fig. 5) can facilitate movements of troops and supplies in the valleys. Snow more than 1 foot deep, ice, and darkness may considerably limit or prevent the use of such vehicles; therefore, sidings, unloading points, and by-passes have to be reconnoitered when weather conditions are adverse.

Neither tracked vehicles nor cross-country wheeled motor vehicles can negotiate steep slopes, and no vehicle should cross difficult terrain alone; help from other vehicles with tow ropes and winches must be available. Damage and rapid wear of matériel, delays due to motor stalling, and high fuel consumption result from cross-country operations. In winter special measures must be taken against severe cold. Motor units should avoid relatively long stops. There is more wear and tear and a higher fuel

consumption in mountains than in the flat; consequently, ample supplies of fuel and spare parts are needed for all vehicles, and time must be allowed for overhauling.

6. AIR OPERATIONS [5]

The lack of suitable advanced and intermediate airfields may hinder the use of reconnaissance planes assigned to the Army for mountain operations; moreover, flying and observation of the enemy are difficult and special care is necessary in navigating over mountains. Observation often is made difficult by deep shadows in the valleys, low-hanging clouds, and, in the morning and evening hours, rising mist. Snow on the ground, however, facilitates reconnaissance.

Reconnaissance squadrons reconnoiter mainly rear communications. Major movements cannot escape detection from the air in fairly favorable weather. On clear nights reconnaissance over highways has a chance of success if flares are used, although balloon barrages in passes and valleys constitute a threat to such activity.

In addition to reconnoitering highways and valleys which are likely assembly areas for reserves, reconnaissance squadrons act as artillery observers for counterbattery missions, for which the organic artillery reconnaissance units are inadequate. Because of the difficulty of observation, squadrons for these missions require more airplanes than in the flat. The aerial observer must be able to determine the location of advanced friendly elements. Recognition, however, is particularly difficult in the mountains, and the ground troops must help by extensive use of air-ground liaison panels.

Attacks by air-combat units against the rear communications of the enemy can disorganize his supply system and thus destroy his

[5] The rapid development in air warfare since the publication of the German manual undoubtedly has resulted in changes in German doctrine.—EDITOR.

freedom of movement. Besides engaging enemy reconnaissance and bombing formations, air-combat planes make low-level attacks against troop columns more frequently than they do in the flat.

Antiaircraft artillery is most effective when used on heights. When bad weather forces planes to follow certain routes along passes and valleys, prospects for effective antiaircraft fire are particularly favorable, but it is always necessary to know whether planes can fly below the antiaircraft gun positions.

Heavy antiaircraft batteries and 150-cm antiaircraft-searchlight batteries seldom can find good positions in the mountains, because the road net and the carrying capacity of bridges are limited, and because observation points and gun positions are few. These batteries (fig. 6) can be used on heights only if suitable highways or mountain railways are available. It takes a long time, however, to place heavy equipment, hauled by railway, in position. Consequently, heavy antiaircraft batteries are employed mainly against enemy aerial reconnaissance, and protect important traffic centers, depots, and assembly areas for reserves in valleys and approaches to mountainous regions.

Light 20-mm and 37-mm antiaircraft batteries and the 60-cm antiaircraft-searchlight platoons can usually go into position on heights and side slopes and thus protect mountain troops in the front lines. In mountain warfare, command of antiaircraft artillery should be centralized, but because of the extensive dispersion of the combat elements of mountain troops, the direct subordination of some batteries to tactical units cannot always be avoided.

The same rules apply for Air Force signal units operating in high mountains as for Army signal units. Motorized air-raid warning companies and mountain air guards, trained in peacetime, comprise the air-raid warning service.

In mountains as elsewhere no plane may take off without a written forecast from the weather service. Motorized weather stations, which are subordinate to the Air Force commander with the Army command, provide weather reports, which are based

Figure 6.—88-mm heavy antiaircraft gun (*8.8 cm Flak*) in position to cover Italian mountain communications.

on data from the general meteorological service supplemented by local observation by the advanced weather sections of the Army and the Air Force. These stations are at the disposal of Army units in the mountains for information bearing on weather and road conditions.

7. MOUNTAIN INFANTRY

a. Mountain Rifle Company [6]

(1) *Squad.*—On narrow mountain paths the squad of the mountain rifle company (*Gebirgsjägerkompanie*) marches in double or single file. In pathless terrain, it marches in single file only. The intervals from man to man depend on the terrain, and because of the strong tendency toward accordion movements in the column, enough distance must be allowed for each man to climb without causing the man following him to change his pace. Orders to slacken pace should be issued before the men start climbing. The men carry their rifles slung, and pack animals carry the light machine gun and its ammunition as long as the terrain and the situation permit. The soldier puts on special mountaineering equipment on order of the squad leader.

In situations where light machine guns can be employed effectively, a rifle squad working forward can provide itself with support by overhead fire from a flank or from a height. In an attack up a slope, however, overhead fire generally cannot come from within the squad, and supporting fire is feasible only from the flanks or through gaps between the men. The distance between the men in an attack changes as the character of the terrain changes; but the men must be close enough together to be able to work as a unit, and the squad leader must maintain control at all times. Especially in uphill attacks he must keep his squad fresh by resting it from time to time under cover. Often difficult terrain offers a better opportunity for surprise than easy ground, but a squad cannot climb difficult places under effective enemy fire. The closer the squad gets to the enemy, the more it should guard against counterthrusts. In mountains, a failure of the attack just short of the objective always leads to heavy losses and frequently to complete annihilation. Every man of the squad must be aware of this and carry out the attack and penetration with the utmost determination.

[6] See par. 24, p. 97.—EDITOR.

In defense, a squad holding out to the last man and the last cartridge at times determines the fate of a whole sector. A favorable opportunity for a limited counterthrust presents itself when the attackers, exhausted by their advance and hampered in the use of their weapons, approach the defense positions. The leader uses as little of the strength of his squad as possible to cover approaches; he holds the main part of the squad together, ready for combat, in a favorable position which has flank protection.

(2) *Platoon.*—After making route and terrain reconnaissance with his platoon headquarters, the platoon commander brings up details from the platoon to make the necessary route repairs. Over difficult ground the platoon may have to increase the intervals between squads to counteract the effect of accordion movements. On good roads and over easy ground the pack animals follow the platoon in close order. When at times the men must remove and back-pack the loads of the animals and help them over difficult paths and difficult terrain, the pack animals march with the squads. If the platoon has to advance for any considerable time without its pack train, the commander of the platoon train receives orders for his subsequent movements from the platoon commander. Details from the squads reinforce the platoon train in order to provide the train with security against the enemy and to help bring up animals and supplies.

The fact that separate squads often have to attack over various kinds of terrain must be taken into account in planning the advance of the platoon. To hold the platoon together and assure control by the commander, it may be advisable to approach the enemy by stages, reorganizing several times. Reserves accompanying the attacking platoon follow closely over terrain offering the most cover, in order to exploit its success or to intercept enemy counterthrusts. If the heavy weapons can no longer support the attacking platoon and it needs fire at once, its own light machine guns must form a powerful fire echelon under a single leader. At an early stage the platoon commander should

designate his exact objective so that he will have the support of heavy weapons and artillery fire when he needs it. After a successful penetration, he decides on the next move of the elements which make the penetration. A bold advance by the platoon in a favorable direction can exploit the success of the unit to an extraordinary degree.

In defense, the platoon reserve waits in readiness just behind or on the flank of particularly threatened points of the defensive area. If the enemy penetrates the forward defense position, the reserve makes an independent surprise attack in accordance with the plans of the platoon commander. The reserve must maintain close signal communication with the engaged elements of the platoon and must have detailed knowledge of the terrain. For the execution of independent attack and defense missions in mountain terrain, machine guns, trench mortars, and artillery frequently are attached to the platoon. The platoon commander must know the use and effect of these weapons in combat and how to assign to them a definite mission.

(3) *Company.*—The rules for the platoon apply also to the company. Under ordinary circumstances the interval between platoons is 20 paces, but it may be changed when expedient. Under difficult conditions the company commander may order changes. If the combat train is with the company, he assigns men from the platoons to help it in difficult places.

From the beginning of the attack the company commander must know whether he can deploy his whole company effectively in the sector assigned him; crowding may well lead to heavy losses and reverses. Usually once his company has started to advance for an attack, the commander can change his plans only with a considerable loss of time, if at all. His influence is sharply limited because his men generally have to advance along a wide front over terrain which cannot be seen entirely from any one point. To coordinate the advance of units going forward separately requires careful planning and control; the battalion may

have to help out by assigning the company some of its communication personnel and equipment.

In attack, the company often moves forward by stages, reforming frequently and continuing reconnaissance as it advances. Surprise is the key to successful attack; the commander must make use of the terrain to deceive the enemy about his intentions and to direct his forces along lines and toward points where the enemy does not anticipate an assault. It is easier to make a surprise attack by night than by day, but such movements must be mastered by special training. Often the area suitable for combat widens considerably behind the point of a narrow penetration so that an increased number of the enemy can deploy effectively for defense. The attacker must take this possibility into account in his plan so that if his main effort is in the area of penetration, his reserves can follow through skillfully and promptly.

In defense, the breadth of the company sector and the varied nature of the terrain often necessitate the issuance of orders in advance and special arrangements for communication. If the company cannot organize its defense in depth, the commander must offset the danger of an enemy penetration by reinforcing the combat outposts, by increasing flanking fire, and by emplacing silent machine guns and artillery.[7] Often he can provide an effective defense by putting the main line of resistance on a reverse slope. He can also set up strong points on heights and at points which the enemy must cross.

Under certain conditions the company may have to use a mobile defense, wholly or in part. It may be advisable, for example, to have only outposts at an important part of the company sector particularly exposed to observed fire from the enemy, and

[7] A "silent" machine gun or "silent" artillery piece is a weapon placed in a well-concealed position close in to or on the flank of the main line of resistance. It holds its fire until the enemy is at point-blank range.—EDITOR.

to hold the main force under cover ready to attack the ascending enemy the moment that he penetrates the line. For this kind of defense the sector must not be too wide and the terrain must favor a counterthrust supported by heavy weapons, which nearly always will be attached to the company in defense as well as in attack. When the company commander has a broad front to defend, it will often be difficult for him to draw off a reserve and find a satisfactory position for it, but he should not be entirely without a final reserve.

b. Mountain Machine-gun Company [8]

(1) *General.*—The mountain machine-gun company (*Gebirgsmaschinengewehrkompanie*) is armed with heavy machine guns and mortars. The heavy machine gun, which can follow mountain infantry everywhere, is either transported on pack animals or carried by the crews (fig. 7). It often not merely complements, but replaces, the artillery. The terrain and the ballistic characteristics of the machine gun, which present more difficulties in mountains than in the flat, affect its employment in combat. The observation of the cone of fire in mountains is more important than in the flat because of the frequent contraction of the beaten zone. Firing in rocky and dry terrain makes observation easier, and making proper allowances for the effect

[8] See par. **24**, p. 97. The German manual antedates the inclusion of a heavy-weapons company (*schwere Kompanie*) in the mountain infantry battalion (see par. **25**, p. 98). At that time, 1935, German tables of organization called for a mortar company as well as a machine-gun company for the battalion. Tactical principles for the mortar company, however, apply equally well to the mortar platoon of the machine-gun company, and have been incorporated in the appropriate sections. The only exception follows: "On the march the commander of a mountain infantry mortar company is with the *force commander*, and in combat is with him or with one of the platoons. He supervises the firing of the mortars to see that they follow the tactical plan of the commander and controls supplies and replacements." To what extent this practice applies to the role of the present-day mortar-platoon commander is not known.—EDITOR.

Figure 7.—Machine gun (*M. G. 34*) on antiaircraft tripod. (Heavy machine-gun squads are equipped with this mount as well as with the standard tripod.)

of wind and cold on the ballistic properties of the machine gun will speed the adjustment and improve the prospect of effective firing.[9] Usually the heavy machine gun will use direct fire from

[9] German rules for the care and use of machine guns and other weapons in conditions of extreme cold will be found in "German Winter Warfare," *Special Series*, No. 18 (15 Dec 1943), sec. XIII, p. 154.—EDITOR.

a concealed position. Alternate firing positions must be prepared, but in selecting them it must be kept in mind that a major change of position takes a great deal of time.

The mortar can follow mountain infantrymen off the road over easy ground, and because of its range and its high trajectory it can put fire on targets that other weapons can reach only with great difficulty, if at all. It can also occupy positions, defiladed from the enemy, from which artillery and other weapons cannot fire. The rules for artillery with respect to reconnaissance, marching, combat methods, and security apply also to mortars.

In mountain warfare, heavy machine guns generally are used by platoons, and even when all the guns of the company are used as a unit, the platoons will be allowed more initiative than in the flat. For this reason the platoon commander must have a thorough knowledge of battalion combat methods in mountains and be able to lead his men in accordance with sound tactics and firing principles. The same is true to an even greater degree for the company commander; the latter strives, even when the platoons are separated, to control the fire of the whole company in order to get a concentrated effect. He can thus prevent the scattering of fire on targets of minor importance. To be capable of independent action, the mortar-platoon commander also must know the principles of mountain combat and be able to deliver accurate fire with his weapons.

(2) *Marches and reconnaissance.*—The rules for march intervals are the same as for the mountain rifle company. To avoid tiring the men, pack animals carry the heavy machine guns as far as possible. Over long and very muddy stretches loads must be taken off the animals and manhandled. If speed is required and bad conditions force frequent unloading, the commander will order the men to carry the equipment and fix a moderate rate of march, particularly at the beginning. He will also take steps to prevent the men from falling down slopes and will arrange reliefs for men carrying heavy loads. The pack train left behind should receive definite orders. Often the unloaded animals must go over

detours and meet the company later at a rendezvous where they may be loaded again. The heavy machine guns always must have security against surprise attacks, for an encounter with enemy patrols may take place at any time.

On the march, infantry mortars are generally attached to the advance guard. If at all possible, they should be carried into position on pack animals.

In mountains the reconnaissance of firing positions and observation posts takes a long time, if the combat zone is to be covered effectively. The platoons must have time to find positions from which they can carry out as many missions as possible. From well-located positions machine guns can deliver cross fires, while the forward and rear platoon positions provide mutual support. Lateral and forward posts must supplement the main observation post.

Hasty reconnaissance leads to an early change of position and to an unnecessary interruption of action—a serious matter, because the heavy machine gun is frequently the only heavy weapon available to support the rifle company. Men from the platoon headquarters and the company headquarters detachment with special training and much mountaineering experience should be used for route reconnaissance. Frequently they should be assigned an engineer section with pack animals to carry entrenching tools.

(3) *Employment in combat.*—If the heavy machine guns are in positions close to the forward elements of the rifle company, they will have close contact and good communications with them as well as a good field for effective flanking fire. If they are not disposed in depth, however, they may not be able to fire over the heads of the riflemen, to clear the masks close to their firing positions, or to repel an enemy penetration. Machine guns emplaced relatively far from the front line can deliver overhead fire and can operate from behind cover and at points beyond the effective range of rifles and light machine guns. Machine guns so emplaced can support riflemen attacking across a valley all the way

up to the enemy line, and can also provide covering fire if the riflemen are thrown back or enveloped. Crews of machine guns echeloned in depth, however, have a hard time observing targets and maintaining communications with the front line in an advance. They can rarely fire from defilade in high mountains, but will generally use direct fire from concealed positions, resorting to indirect laying only for distant targets.

In order to coordinate firing and change of firing positions so that the riflemen closing in on the enemy will get continuous support, machine guns must be displaced by echelon. In defense, silent machine guns [10] cover dead space and support defense at short range, from the flanks, if possible. The coordination of the heavy machine guns with the other heavy infantry weapons, particularly those with a high trajectory, and with artillery, is even more important in mountainous terrain than in the flat. To achieve the cooperation necessary for the utmost effectiveness of the few heavy weapons available for defense, fire plans must be prepared in advance. Heavy machine guns are well suited for delaying actions and withdrawals, but in mountainous terrain they often cannot be fired at their maximum range.

Because of limited visibility in mountainous terrain heavy machine guns are frequently attached to front-line companies, the smallest attached unit being generally half a platoon. Because the difficulty of supplying ammunition affects the operation of machine guns in mountains more than in the flat, commanders and gunners must be trained to economize on ammunition. They must also learn to recognize the most dangerous adversary quickly and must engage him at once.

Mortars may be used separately or as a unit, depending on the situation. In combat they supplement the artillery, and they are particularly suited for very close cooperation with units in the front line. Indirect firing is usually the rule, but frequently direct mortar fire will be very effective. After a rapid occupation

[10] See p. 29, note 7.—EDITOR.

of a concealed position, the mortars can quickly fire on point targets and moving targets. Their fire is likely to be especially effective on targets that are higher than the firing positions.

c. Mountain Infantry Battalion [11]

Usually the mountain infantry battalion (*Gebirgsjägerbataillon*) is the largest tactical unit which is employed for independent missions.[12] It may be reinforced with mountain artillery, heavy weapons, combat engineers, signal-communication troops, and supply columns.[13] The personality of the commander, the example that he sets for his men, and his mountain experience must develop troops with spirit and an ability equal to the requirements of mountain warfare. He must have a well-developed understanding of terrain difficulties and a sense of timing troop movements.

The battalion usually marches in one column with advance, flank, and rear security units whose strength depends on the situation. It rarely marches in several columns; but if the situation requires more than one column, the separated units must know how to fight and maintain themselves independently. To achieve surprise, battalions may march at night and in fog, but only with good leadership and thorough advance reconnaissance.

To recognize and reconnoiter the few routes of approach over which attack is possible in the mountains is the task of combat reconnaissance; to exploit such routes tactically constitutes an art of command. Often the initial disposition for the attack is decisively important. To deploy heavy weapons takes a long

[11] See par. **24**, p. 97.—EDITOR.

[12] The German mountain infantry regiment, for all practical purposes, is an administrative unit. The absence of a discussion on the tactical employment of the heavy-weapons company (*schwere Kompanie*) (see par. **25**, p. 98) in the German manual is due to the fact that this organization was not a part of the battalion when the manual was published.—EDITOR.

[13] The degree of reinforcement necessary may now be different because antitank and infantry guns, the 120-mm mortar, and an engineer platoon were made organic in the mountain infantry battalion after the German manual was published.—EDITOR.

time, and to change their position successfully without seriously interrupting protective fires calls for careful planning. The battalion commander detaches a reserve from the heavy-weapons company only to support a change in the battalion position. In attack, centralized fire control of the heavy machine guns and infantry mortars is a goal, although the terrain often demands the use of platoons, half platoons, and even single mortars. It is necessary to attach heavy infantry weapons to individual companies operating in mountains more frequently than in the flat.

The mountain artillery, which is nearly always under the control of the battalion commander, supports the attack as long as possible without displacing. Individual guns whose effectiveness can be increased by the allotment of additional ammunition may be brought well forward even at the beginning of the attack. By liaison with the artillery commander and by dependable signal communication with all of his heavy-weapons units, the battalion commander must try to have fire shifted where he needs it as the attack develops.

It is well to hold reserves near elevations and crests from which they can launch an attack downhill. Mobile mountain infantry is particularly well adapted to pursuit in mountainous terrain. By pressing on in a daring manner, often without artillery support and without stopping anxiously on lines where the enemy offers little or no resistance, the battalion renders its best service to the force of which it is a part.

Clear arrangements for the responsibility of command, for disposition of reserves, and for careful siting of the heavy weapons are of prime importance when the battalion is in a defensive position. The numerous dead spaces and angles nearly always found in front of mountain defense positions should receive special attention. Heavy machine guns, trench mortars, and, when necessary, individual cannon should protect its flanks. Alternate firing positions must be prepared in advance so that heavy weapons discovered by the enemy can be quickly shifted. A fast and dependable observation and liaison service must keep

a sharp lookout for the approach of the enemy. If it is not necessary to employ the whole force close to the main line of resistance, and if an easily accessible position is available, the commander creates a reserve. Sometimes a defensive disposition in small groups may be advantageous.

d. Mountain Antitank Company [14]

The limited cross-country mobility of its prime mover limits the antitank gun to the immediate vicinity of roads and highways of valleys and passes.[15] Although it can reach the zone in which medium and heavy tanks can operate, it will often have trouble negotiating mountain slopes and high valleys where small tanks may appear. Off the road the piece nearly always has to be manhandled. The split trail of the gun requires a firing position as nearly level as possible. A slight difference of level between the wheels and the trails makes it hard to elevate and depress the tube.

The commander of the mountain antitank company (*Gebirgspanzerjägerkompanie*) is the adviser of the regimental commander on all questions of defense against tanks. He, his headquarters detachment, and his communication section must master the technique of mountain climbing, but his command post must be accessible to motor vehicles.

The platoon commander must use his platoon to create unfavorable conditions for enemy movement and to develop favorable opportunities of action for himself. He must know the combat technique of tanks and be trained to build obstacles in a skillful manner. If his platoon is employed independently, he is responsible for the supply of ammunition, equipment, and food. The platoon commander and his headquarters detachment must

[14] This antitank company of the mountain infantry regiment is not to be confused with the component companies of the mountain antitank battalion (see pars. **23**, p. 96, and **27**, p. 101).—EDITOR.

[15] This would not be entirely true of an antitank gun on a self-propelled mount.—EDITOR.

be qualified as Army mountain guides [16] so that they will be able to reach observation posts by climbing difficult slopes.

When advancing through narrow valleys, the guns should be distributed in the march column early, because, once the march has started, it may be impossible for them to pass other units. If enemy armored vehicles are reported when the march column is approaching a pass, it is advisable to manhandle the leading piece, tube forward, over short stretches. The platoon commander sees that the men moving the forward guns are properly relieved. Snow limits the movement of the platoons to cleared and packed roads, and ice on the roads frequently slows up the march.

The antitank company rarely fights as a unit; the platoon is the unit normally employed. In its area, which usually is very small, the platoon organizes gun positions that command the enemy's line of approach. Under the leadership of the chief of section the gun crews should be able to manhandle the gun up steep slopes for short distances and even in difficult terrain should be ready to fire quickly. They will do most of their firing by direct laying on fast-moving targets which are visible only momentarily. They also erect most of the antitank obstacles, but engineers are often attached to set up extensive obstacles at key points.

The mission of the light machine-gun party of the antitank platoon is mainly to protect the antitank gun, but it can also help defend the antitank obstacles. The platoon commander cannot always count on the assignment of mountain infantry for security of the gun position. Going into position requires so much time in mountainous terrain, and observation of the enemy line of approach is so difficult, that it is necessary to prepare to fire early. The antitank guns, therefore, cannot be kept coupled to their prime movers behind the obstacle. In broad valleys and on extensive plateaus the platoon operates as in the flat.

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[16] See sec. III, p. 79.—EDITOR.

Because the company commander can seldom set up a centralized warning service the platoons themselves must operate the warning service in their sectors. They are usually aided by personnel of the company headquarters detachment and of the communication section.

For attack in a valley the guns, after a reconnaissance, should be brought up to the rendezvous or firing position in echelons. Defense requires careful reconnaissance of the possible line of approach for enemy tanks and a sharp lookout for them in valleys on the flank and the rear. The difficulties of the terrain usually prevent a shift of the platoon during combat.

8. MOUNTAIN ARTILLERY [17]

a. General

The basic tactical principles for artillery in the flat remain valid in mountains. In the approach march and in combat, horse-drawn and motorized artillery is limited to the roads and their immediate vicinity. The problem of clearing masks from mountain roads usually limits flat-trajectory guns to long-range missions, but there are many opportunities to use high-angle guns.

Mountain artillery (*Gebirgsartillerie*) can follow mountain infantry off the mountain trails over easy ground, but snow, bogs, or muddy roads, especially in the spring thaws, may seriously hinder its employment. Mountain artillery can rarely fire in groups of batteries, or even as single batteries, because of the limited space for gun positions and the difficulty of fire control; usually it is employed by platoons or individual guns. Occupation of positions and replacement of ammunition are much harder and more time-consuming than in level country. Firing in mountains differs from firing in the flat; the guns will usually make precision adjustments and fire planned concentrations.

[17] See par. **29**, p. 104.—EDITOR.

b. Reconnaissance and Observation

Successful and rapid employment of artillery in mountains requires careful and early reconnaissance of routes, gun positions, and observation posts. With the help of a map the artillery commander gets a general idea of where the guns may find good firing positions. Artillery reconnaissance units, sent out with those of the mountain infantry and assigned to definite artillery sectors, must determine the opportunities for firing which are open to the different types of artillery. The use of motor vehicles on roads and mountain horses on paths will speed up artillery reconnaissance considerably. In addition to the reconnaissance of the artillery commander, every subordinate commander must make his own route reconnaissance and see that his approach route is passable and is marked.

The reconnaissance of heights for possible observation points must go on regardless of the difficulties of terrain. Because bad weather can prevent observation for long periods, and visibility and conditions of observation often change very quickly and unexpectedly, it is often necessary to install several auxiliary observation posts at different altitudes. They should be distributed as widely and as irregularly as possible over the terrain to decrease the effects of enemy fire and to provide several complementary fields of vision, especially for lateral observation. These posts should always be organized as small centers of defense, and, if possible, should not be placed on conspicuous points. They should have prompt and dependable communication with the firing positions by several independent means; lateral communication should be arranged between observation posts, and from observation posts to adjacent units. Artillery observers with signal communication accompany the assault troops and direct fire to keep pace with the infantry advance.

c. Marches

Mountain artillery marches in mountain order, closing up to regular march formation only on roads. To save the pack ani-

mals, the pieces, or at least the carriage alone, can be drawn along good roads. For local security, the light machine-gun section marches at the head of the battery in advance and at the rear in retreat.

The artillery commander and his staff march in the advance guard with the force commander. The attachment of individual guns or platoons well forward in the advance guard is often advantageous; but because mountain artillery moves slowly by comparison with the other weapons and requires numerous road improvements, most of the pieces have to march at the tail of the column.

The gun and its crew march in close formation. Between the men and animals the distance should be only great enough to allow for the accordion action of the marching column (fig. 8). The distance between the sections changes according to the character of the terrain. The order is given for slackening the pace before the beginning of the ascent. The gun crew takes measures to prevent noises when near the enemy.

Inept saddling and loading may chafe and gall pack animals and greatly decrease the mobility of the battery. Commanders of all grades in mountain artillery must carefully supervise the animal drivers and inspect saddling and loading, for if one gun load drops out, a whole piece is put out of action.

At the beginning of a march it is better to move too slowly than too quickly. Later the rate of march will depend on the steepness of the slope; the pace should be steady and regular, both uphill and downhill. A quiet, willing pack animal should head each unit.

There should be a short rest for examining saddles and loads not later than an hour after the beginning of an ascent. Pauses for breathing spells for the animals should not be made on very steep places. The first rest lasting at least 1 hour, during which the men unload the animals, should come no later than 3 to 4 hours after the start. A level spot where men and mules will not block the route makes the best resting place. All the animals

Figure 8.—Mountain artillery on the march.

should be made as comfortable as possible. On comparatively wide level places they should be placed crosswise to the route with their heads toward the valley.[18]

[18] If the animals are faced toward the valley, they are not likely to back over the edge of a cliff; this may happen if they are faced up the mountain.—EDITOR.

In a steep descent check cords are used because they relieve the pressure caused by the load slipping forward. They are also useful at danger points. Animals should be marched over unavoidable boggy places with great caution; at the narrowest point a crossing should be strengthened by stones, earth, or branches. If the ground is too soft, the men may have to unload the animals. If the commander so orders, the packs of the men may be placed on the backs of the pack animals when the animals are hauling the assembled guns on good roads.

d. Employment in Combat

The bulk of the field artillery can find its best positions in broad valley bottoms and on the gradual slopes of the foothills (fig. 9). Often field pieces can be brought into position only by manhandling and roping, and the crews must be trained for this expedient. Deployment on a broad front is best for field artillery, but conditions will frequently force it to echelon in depth.

Figure 9.—Medium artillery (Skoda 150-mm howitzer) firing in the valley below Mount Olympus during the Greek Campaign (1941).

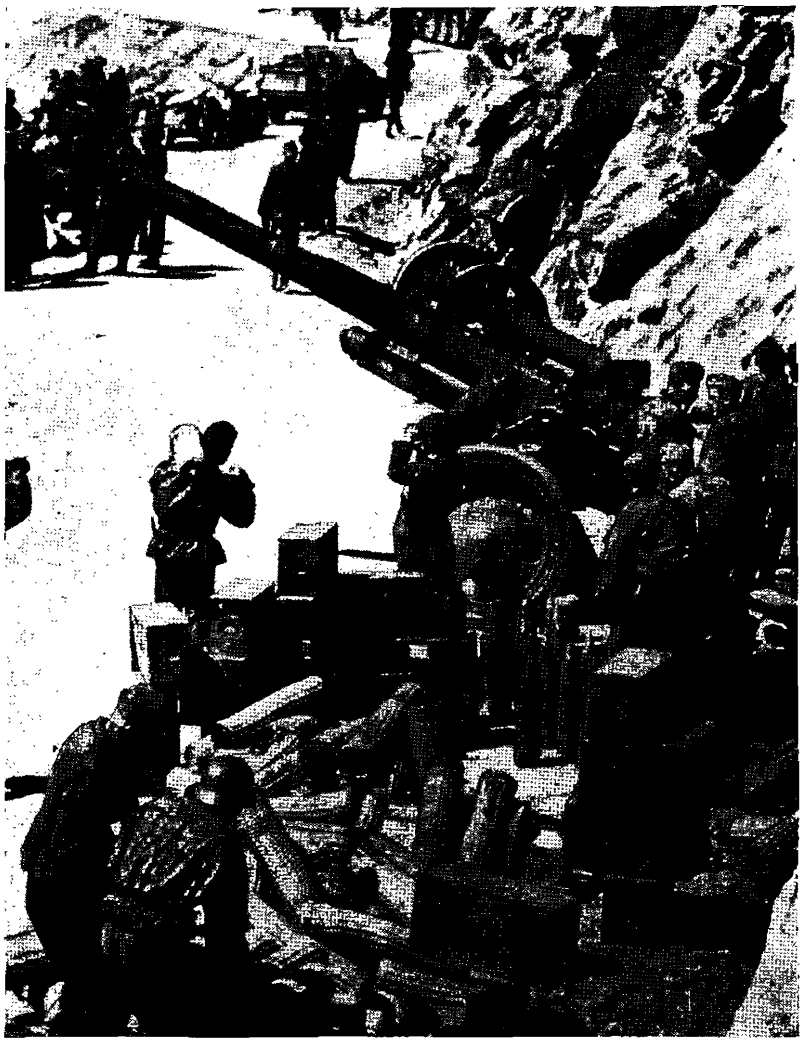

Figure 10.—150-mm howitzer (s.*F.H. 18*) on a mountain road. (This gun was employed by the *Leibstandarte-SS "Adolf Hitler"* motorized division during the Greek Campaign, 1941.)

As a rule, flat-trajectory batteries will be in the rear and high-trajectory batteries in front. Officers, observation sections, and communication sections of field artillery employed in mountains must have mountaineering equipment and training.

Mountain artillery provides the only reliable artillery weapons in mountains, except in large valleys. Emplacing mountain guns and replacing ammunition are generally difficult and require considerable time. Pieces must have positions that enable the commander to adapt the plan of fire to the conduct of the battle and to concentrate fires in decisive places. The force commander needs information on the availability of the artillery for certain missions; he must know in particular how long the main elements of the artillery will take before they are ready to fire. With situations hard to evaluate, liaison with the force commander cannot be too close.

Field artillery, especially high-trajectory batteries, initially protect an advance into large valleys or mountainous terrain on either side of valleys (fig. 10). When a column expects to encounter the enemy at the very beginning of an ascent or descent, some artillery should protect the movement. The remainder of the artillery remains in the march column, sending out advance patrols to reconnoiter possible gun and observation posts.

Mountainous terrain often makes it difficult for the artillery to provide continuously the protection needed for an assault on an organized position; more frequently than in the flat it displaces forward by echelon. Under the protection of the artillery units in position, the other batteries follow the assault troops, and, by leapfrogging, keep up with the advancing infantry. In case of an encounter, the displaced echelon gives direct support to the forward units. Because of the time necessary in getting mountain artillery ready to fire (fig. 11, p. 46), the artillery commander should save time by advance planning.

Mountain artillery can rarely support an attack from all the positions from which it has covered the deployment and assembly; most of the observers and the pieces will have to have new and

Figure 11.—Roping an artillery piece down a cliff.

carefully reconnoitered positions. Because the field of vision from the observation post will often extend up to the point of penetration but not deep into enemy terrain, artillery observers must accompany the assault troops and further observation must be furnished by air units.

The communications of artillery with the assault troops and the coordination of its fire with those of other heavy weapons require special care. The assault troops need highly effective support up to the very point of penetration. Without such support they are likely to draw fire just before they reach their objective. An infantry attack over rising terrain is easier to support up to the moment of penetration than one over descending terrain, but in the former case artillery fire may dislodge rocks which will endanger the advancing troops. Often in the last stage machine guns and mortars must take the place of artillery.

In a pursuit through mountains, artillery fire is needed to help overcome quickly the resistance of enemy rear guards taking advantage of cover, but getting enough ammunition forward in time becomes the critical problem. In such a situation it is hard to establish a balance between ammunition supply and food supply, even in broad valleys.

In mountain terrain, artillery defensive fires are hard to lay down, because the areas that the enemy uses for carrying out his attack are often masked, full of dead spaces, and widely separated. By means of well-placed observation posts, good communications with batteries, platoons, and individual guns, and an abundant ammunition supply, the commander must make up for limited fire power by greatly enhancing the flexibility of his defense. In many places the other heavy weapons supplement or replace artillery, and in others the pieces can be used only as silent guns [19] far forward and on the flank. In sectors where only a mobile defense of counterthrusts is feasible, the artillery must adapt itself to the situation by echeloning in depth. The fewer the possibilities of frontal action, the more the batteries must be alert for surprises and be

[19] See p. 29, note 7.—EDITOR.

ready to fire on an enemy that has penetrated the defense position. In case of a breakthrough, the batteries join with the centers of resistance in the front line and organize strongpoints which must fight, if necessary, until the guns are lost.

9. MOUNTAIN ENGINEERS [20]

a. Missions

Mountain engineers (*Gebirgspioniere*) should not be assigned tasks of minor importance. If the roads are good, motorized engineers may well be assigned special missions on and near them.

The most important missions of the engineers in mountain combat are—

(1) Construction and removal of major obstacles. The destruction of bridges, tunnels, and embankments along major roads and railways in defense and retreat and the replacement of mountain bridges in an advance may be of utmost importance in combat.

(2) Bridging mountain streams. The bridging of torrential streams with steep banks and highly variable water levels, and the construction of light, emergency bridges require special skill (fig. 12).

(3) Improvement of supply routes in sectors of special importance by blasting routes and paths in rock and ice, building bridges, cable railways, and supply slides.

The commander of the mountain engineer battalion (*Gebirgspionierbataillon*) is the adviser of the force commander in all engineering matters. On extensive projects the battalion operates as a unit, but usually it is divided into smaller groups. Projects in the rear areas must be turned over as soon as possible to work battalions in order to release mountain engineers for combat missions.

b. Employment in Combat

Mountain engineers should be incorporated in the advance guard, far forward, if necessary, and the mountain reconnaissance detachments must often be reinforced with an engineer de-

[20] See par. 30, p. 108.—EDITOR.

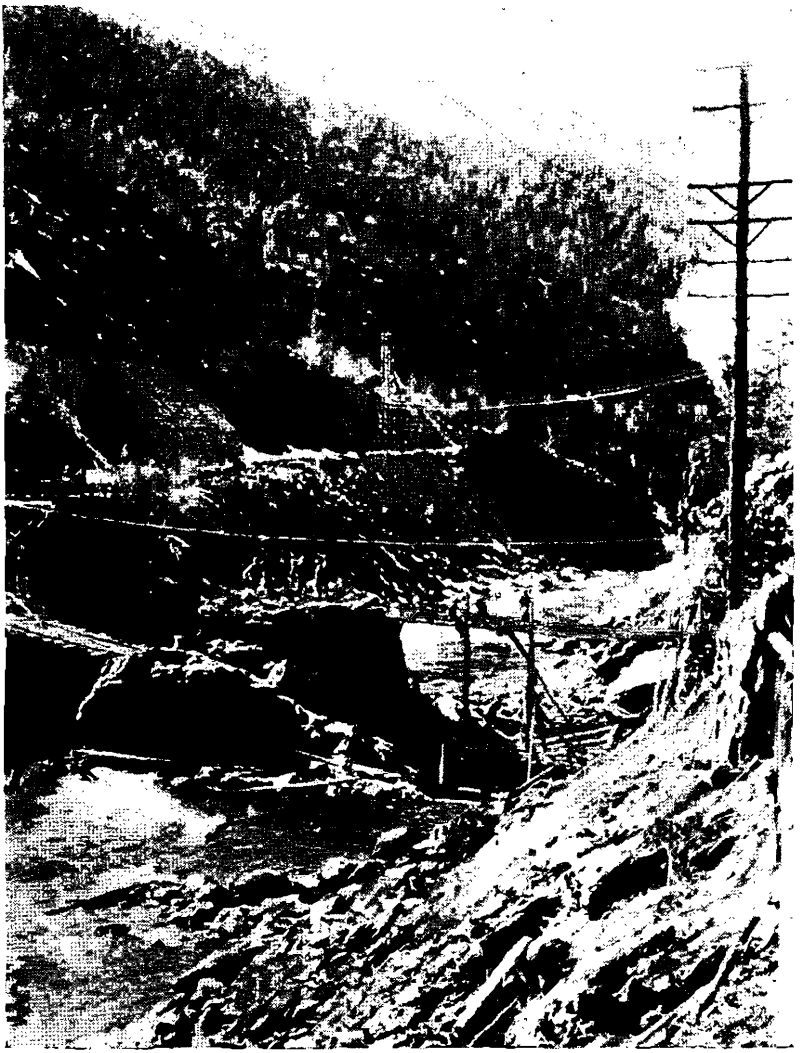

Figure 12.—Bridging a mountain stream during the Norwegian Campaign (1940).

tachment. With equipment loaded on pack animals, the engineers have the same mobility in mountains as the mountain artillery. The engineers provide security for shelters by constructing obstacles at particularly important and difficult points. On approaching a river the engineer commander makes plans to bring forward engineers and bridging equipment quickly.

In attack, the mountain engineers support the advancing troops by removing obstacles and attacking strongpoints. They also serve units fighting away from valley roads by preparing a route for transporting supplies.

In pursuit, motorized engineers can clear away obstacles, reconstruct destroyed bridges in collaboration with pursuit columns, and block enemy routes of retreat.

In defense, the mountain engineers first set up obstacles in important areas in front of the main line of resistance to delay the approach of the enemy. Then they help the infantry organize the main defense zone, placing entanglements at probable focal points of attack, camouflaging positions, building bridges and foot paths, and improving the supply system by erecting small aerial railways. The engineers by themselves prepare major technical defense measures such as rock and snow avalanches, which will not be used until the battle starts, when they are put under the control of the local tactical commander. The engineers can thus greatly assist weak units which are defending a wide front. When a front becomes stabilized, they construct caves, tunnels, and galleries of all kinds and conduct mining operations.

In delaying action, engineers should be used to place whatever large obstacles are needed in front of the lines of resistance and at intermediate delaying positions linked with the road net. One major demolition of strategic significance often furthers the general plan of operation more than a number of small demolitions. Engineers must be ready to reconstruct bridges destroyed by enemy flyers in rear areas.

When retreating, obstacles created in valleys delay the pursuit

by the enemy. Close communication between the infantry and engineers is important, because combat troops must be informed in ample time of the location and the nature of the obstacles and the distance between them.

10. MOUNTAIN SIGNAL AND COMMUNICATION TROOPS [21]

a. Missions

Because the strain on the physical powers and morale of mountain signal and communication troops (*Gebirgsnachrichtentruppen und Gebirgstruppennachrichtenpersonal*) is very great, they must be excellent mountain climbers with great endurance. The commander of the smallest unit must have a thorough technical knowledge of signal equipment.

The mountain signal unit sets up signal communication between the command posts of divisions or brigades and the subordinate troop units. To install the network promptly, platoons or sections must be assigned in advance to the subordinate command posts. When the signal unit commander cannot intervene locally himself, he must consider assigning some of his troops to certain march and combat groups. In the main, the communication platoons and sections of the units themselves install communications within regiments and battalions; but when a major engagement develops, regular signal troops must reinforce and relieve this network. All signal and communication officers must work together for smooth cooperation between the signal unit and the communication detachments. The commander of the mountain signal unit proposes the communication plan for the march and for combat.

b. Marches

Mountain signal units not otherwise disposed march with the commander of the column in the advance guard or wherever in

[21] See par. **22**, p. 91, and par. **31**, p. 108.—EDITOR.

the column it seems probable that they will be used later. The communication platoons of regiments and battalions always march as far forward as possible. The column commander distributes the various units after consulting the signal unit commander. The communication sections of the artillery and of the mortar company [22] and the antitank company are divided between their own units and the commander's group. Other communication sections march with their units. Only pack communication troops can move over narrow, steep mountain trails.

c. Employment in Combat

The mountain signal unit should be reserved for use in real mountain terrain, where ordinary communication units cannot go. In an advance through mountains, the mountain telephone platoons will usually lay a trunk line, using heavy cable. Their line should connect with the lines of telephone platoons in the valley that follow the mountain detachments as far as they are able. Radio and blinker stations, established on the main line, relay messages from patrols or advance guards over that line to the command posts. Whether the point of the advance guard, important patrols, and flank guards are accompanied by radio and blinker detachments or use organic communication units depends on the equipment available.

The communication detachments of all mountain units are to be spared during the advance and held ready for immediate use when contact with the enemy is imminent. Mountain reconnaissance units and important patrols should get communications first from the communication platoon of the regiment rather than from the communication platoon of the battalion. For

[22] The German mountain division no longer has an independent mortar company. Instead, it now usually has an 81-mm mortar platoon in the machine-gun company of each battalion, a 120-mm mortar platoon in the heavy-weapons company of each battalion, and a 50-mm mortar squad in each platoon of the mountain rifle company. Also, the latest organization of the heavy-weapons company includes a communication platoon (see fig. 30, p. 94).—EDITOR.

communications with its patrols, the artillery depends on its own equipment, but it may use available mountain infantry installations. Blinker and radio sections in the advance guard maintain communication with the reconnaissance units and make the results of reconnaissance quickly available. A telephone section can sometimes maintain wire communications for reconnaissance units and advance guards. Such lines are called reconnaissance lines.

Only radios are used for communication among the several columns of battalions or regiments. They also supplement wire nets over rear lines. Radio traffic should be carefully scheduled. With the development of combat, the wire net should constitute the framework for signal communication and should be extended wherever possible with radio as a supplementary means.

Because the consumption of wire in mountains is very high, units must carry a good supply of it. Locating and clearing trouble on wire nets, which require much time and personnel, can be facilitated by establishing testing points at proper intervals. Men setting up stations must take into account rockfalls and avalanches, wind, cold, dampness, and lightning, and they must camouflage all the tents they set up. Since recovery of cable takes much time, in a short engagement the commander must decide whether to do without wire communications or to take the loss of matériel.

In addition to telephone and long-wave radio, the following means of communication are used in high mountains:

(1) Portable radio sets. These can be put into action quickly if their location and the weather are favorable. They are good for communication with the artillery.

(2) Heliograph apparatus. When usable, it is preferable to radio, because it cannot be intercepted.

(3) Blinker apparatus. Its utility is limited because it transmits slowly and depends on satisfactory terrain and weather. It can, however, transmit prearranged messages quickly.

(4) Signal flags. They are a good auxiliary means when other methods are not feasible. To economize on equipment, they are used to supplement communication lines wherever possible.

Figure 13.—Mountain troops with a messenger dog.

(5) Messengers. Because of the time element they are not very useful but they cannot be dispensed with entirely.

(6) Carrier pigeons. They can be successfully used if there are no birds of prey in the vicinity.

(7) Messenger dogs (fig. 13). They can carry messages rapidly, but they cannot go over even easy climbing terrain.[23]

d. Technical Considerations

(1) *Wire communication.*—On permanent lines the cables should not be bent at a sharp angle horizontally or upward. The lines must sag to withstand great changes in temperature, the

[23] See par. **14b**, p. 66.—EDITOR.

weight of ice, and high winds, and all lines should be strung high enough to prevent them from being buried under snow. In order to prevent breaks, frost and snow must be knocked off wire often with long sticks. In valleys and other places protected from the wind, poles may be 80 to 160 yards apart, but on windy heights they must be much closer together. On very windy crests and mountain peaks, lines must he anchored to the ground or strung through insulated pitons. On cliffs, small wooden stakes driven into cracks in the rock hold the cable. To avoid interruptions to communications caused by avalanches and rockfalls, Army mountain guides [24] must carefully reconnoiter the threatened places, and use should be made of the knowledge of the local inhabitants. A specially armored cable offers some protection against rockfall.

Cables laid loose on snow and ice soon break and must be replaced after every snowfall. When there are no natural high supports, the cables may be strung on tripods about 1 yard high, made of wooden slats, that can be pulled up after a snowfall and placed on the surface. The line may have to run through a conduit, which must always be marked with small flags on both ends. If there is no danger of interception, steel or strong iron wire, with the outgoing and return lines spaced fairly far apart, may be laid on top of the snow and allowed to freeze in.

To prevent damage and injury from lightning when wire is strung on poles, every second or third pole should have a grounded lightning arrester—a strong 0.2-inch steel wire or a bundle of several thinner steel wires nailed along the pole. The wire should be extended about 8 to 10 inches above the pole and wrapped once or twice around the embedded part of the pole. Cables attached to trees or laid on the ground do not need lightning arresters, but all switchboards do. Summits, rocky spurs, and high ice and snow peaks offer no good ground; therefore, telephone equipment in such terrain must be provided with a special lightning arrester, consisting of poles with zinc-covered

[24] See sec. III, p. 79.—EDITOR.

iron points on top. On these are soldered 6 to 12 iron wires one-sixth of an inch in diameter, laid out like a screen so that they hang down free 10 to 20 yards. The arrester works still better if each hanging wire is split into 3 to 6 smaller wires. Negligence can destroy communications and personnel; continual supervision is necessary because most people incline to underestimate an invisible danger.

(2) *Radio communication.*—On peaks or crests, radios have a long range, but static interferes with reception. The position of the transmitter with respect to the mountains between it and the receiver affects the strength of the signal. If the angle from the transmitter to the highest point on the line between the transmitter and receiver is less than 45 degrees, the loss of energy is of no practical significance. The greater the angle, the more energy is absorbed by rock, and the range is reduced. The ultra-short-wave transmitter requires an area without defilade for 100 to 200 yards, but its signal is less subject than that of long-wave sets to atmospheric disturbance.

Strong sunshine, especially on snow- and ice-covered slopes facing the sun, dissipates energy and temporarily lessens range. Deep ravines and gulleys and humid, leafy woods likewise reduce the strength of signals, and radios in rock caves and rock tunnels can neither send nor receive. When the signal is strong and distances are short, indoor antennae may be used in caves and tunnels constructed of ice or snow. Shifting a set a few feet often improves short-wave transmission and reception. It is necessary to ground antennae promptly and thoroughly because of the danger from lightning.

Snow and frost should be removed from antennae and grounds, and the whole radio set with its accessories and portable generators must be protected against dampness and cold.

(3) *Visual signal communication.*—Opportunities for visual signaling increase with altitude, but systematic employment of such means requires reconnaissance and thorough study of large-scale maps. Mists and clouds may limit to certain hours visual

communication between two points of a valley or between a mountain and a valley or between two peaks.

The use of smoke signals facilitates mutual identification for visual signalers. Where there is no direct visibility, a message can be sent a short distance at night by lighting up an intervening lake surface, glacier, snow field, or cloud layers. This is a useful expedient when the rear blinker position has to blink toward the enemy.

For alarms and similar short-range communications the commander may order special signals, such as smoke signals in the daylight and beacons at night, which can be recognized at great distances from many sides.

11. MOUNTAIN SERVICES [25]

a. Mountain Medical Service

The combat units themselves must cooperate more than in the flat in providing medical service, especially in forward areas, in difficult terrain, and among cliffs. They must be able to give first aid to the wounded and sick and to rescue the wounded from particularly difficult areas.

By repeated and regular examination and instruction, medical personnel must prevent diseases and injuries which develop from strain and exposure. Medical officers must continuously supervise the young soldier to determine the effects of physical exertion. Snow blindness, sunburn, frostbite, and diseases caused by carelessness must be kept at a minimum. In addition to dressings, the soldiers even in the very smallest units must carry snow goggles and antisunburn and antifrostbite creams.

Treatment of the wounded in forward areas is most difficult because a single company often is spread over a wide front in terrain which is difficult of access. Without the help of the combat troops the wounded can rarely be brought from scattered front-

[25] See par. 32, p. 108.—EDITOR.

Figure 14.—Roping down a casualty. (The casualty is secured to a standard sled stretcher.)

line aid stations to the advanced emergency dressing stations or to the regular battalion aid stations. As a rule, the wounded remain at the battalion aid station until the litter bearers of the medical company carry them to the clearing station.

The battalion surgeon directs evacuation and disposes his medical platoon properly along the lines of evacuation. The most difficult evacuations are those from steep cliffs where the wounded have to be roped down (fig. 14). On terrain off paths and on narrow paths the wounded are back-packed in shelter halves or carried in one-pole litters; on cart roads, regulation litters, ordinary local mountain vehicles, or motor vehicles may be used. If slightly wounded men ride down mountains on mountain saddle horses, detailed safety measures should be issued. The practice of riding, however, should be avoided as much as possible. The wounded should not be carried by pack animals.

If the snow is right, medical personnel can use regular or ski sleds for evacuating the wounded.[26] Sometimes they may even use skis off the road, and make use of any available aerial tramways. Unless there are mountain roads, the wounded can be loaded on ambulances only in valleys. From here on they are evacuated as in the flat.

The difficulties of evacuating the wounded call for a larger body of medical personnel and litter bearers than are needed in the flat. The men evacuating the wounded carry up fresh medical supplies on their return trip.

The medical officers and noncommissioned officers of mountain medical units must qualify as Army mountain guides and must be able to train their own personnel scientifically in mountain operations, to direct the roping down of the wounded from difficult cliffs, and to render first aid themselves in places difficult of access. The medical troops must have the same training in mountain climbing as other mountain soldiers.

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[26] See "German Ski Training and Tactics," *Special Series*, No. 20 (31 Jan 1944), appendix D, p. 96.—EDITOR.

b. Mountain Veterinary Service

A veterinary officer should always accompany the larger mountain detachments. For this service he must be perfectly healthy, strong, and hardened. Since the mountain veterinary service calls for special knowledge and great experience, the standards of selection should be high. The blacksmith section must be trained for mountain service. The noncommissioned blacksmith and his men should not have to lead pack animals.

Sick and wounded animals still able to march are led to an assembly place for sick animals; they are allowed plenty of rest in protected places on the way. Animals that cannot be moved from heights are left in alpine pastures and cared for there. They need little care, and if necessary may be left at haystacks with feed. If they cannot be transported at once, they need not be shot. On suitable trails the men can lead the animals with minor wounds to the dressing station or to the animal ambulance, and in winter may try to evacuate on sleds those that cannot walk.

The veterinary equipment, including oxygen apparatus, stays with the combat train of the mountain echelon. The veterinary officer and the blacksmiths carry veterinary pouches on their saddles or belts for first aid.

Every pack animal should have two horseshoe pouches on its saddle, each with a front shoe, a hind shoe, 32 nails, 8 blunt calks, and 8 sharp calks. In one of the horseshoe pouches there is also a screw calk wrench. The most appropriate kind of horseshoeing includes screw calks and sharp toes and shanks. Every pack animal leader must know that the calks should be tightened and renewed from time to time. The screw calk shoe can be adapted to roads of all kinds, and hence always assures the animal a good footing and the least possible fatigue. If the animal marches without calks, the screw holes should be filled with plugs of oiled tow. The commanders and men must clearly understand that they are responsible if the animals cannot march, become tired too soon, or stumble because of improper use of the calks. The ani-

mal leader must put on the calks properly under the supervision of the blacksmith.

c. Mountain Supply

As there is no food in high mountains, the men depend entirely on transported supplies, which are difficult to bring up. Supplies usually go through valleys in motor vehicles, and by animal or porter columns in pathless terrain; but when snow, ice, and bad weather seriously hamper regular movement, caterpillar tractors and snow plows may be put to use.

For supply purposes, mountain troops require a valley echelon as well as a mountain echelon. The valley echelon is responsible for all horse-drawn and motorized vehicles including the second rations train. Besides ammunition the valley echelon carries food for 2 days, forage for 2 days, reserve clothing and mountaineering equipment, and baggage.

The mountain echelon consists of pack-animal columns which may be supplemented by porter columns. It should be able to carry ammunition for 1 to 2 days, food for 2 days, oats for 3 days, and a part of the baggage. It includes the pack animals carrying medical and veterinary equipment, the mountain kitchen, and pioneer and mountaineering equipment.

Extra mules may be needed to carry water. The number of pack animals necessary will depend on the weight of the food, ammunition, equipment, and baggage, and the carrying capacity of the animals.

Ordinarily the mountain units will have food for 4 to 5 days. If the distance from the troops to the valley echelon is greater than a day's march, the mountain echelon must be reinforced in order to set up new distributing points closer to the troops and to keep them constantly supplied. When position warfare starts, some of the pack animals of the combat units should be used for supply purposes.

The use of aerial railways takes a great burden from the pack

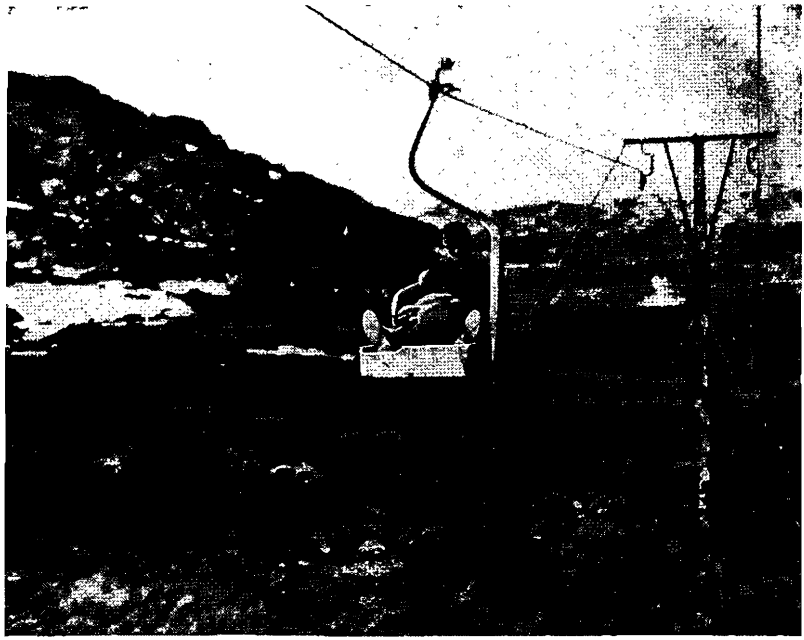


Figure 15.—Use of an aerial railway to move supplies.

animals and porter columns (fig. 15). In difficult rocky terrain and in snow-covered, high mountains improvised rope elevators or airplanes are often the only means for supplying large units regularly.

When non-mountain troops fight in high mountains, they should be equipped if possible with pack animals and light trucks or with the usual local vehicles. Since these troops will generally be used near roads, they may be allowed to keep their regular baggage vehicles.

Section II. TRAINING

This section is based on translations of several German documents and on other sources. Figures 17, 18, 19, 20, and 21 have been redrawn from sketches in ***Ausbildungsvorschrift für die Gebirgstruppen (A.V.G.), Heft 1, Alpine Technik, H.Dv. Nr. 374/1 (Training Manual for Mountain Troops, Volume 1, Alpine Technique, Army Manual, No. 374/1,*** *no date.)*

12. GENERAL

Experience on the Austro-Italian front in the First World War convinced German military experts that all soldiers fighting in mountains needed some special training, and particularly that soldiers fighting in high mountains should have an intensive course of considerable duration. In the period between the wars the German Army continued to train mountain troops. The mountain soldiers in the days before Hitler seem to have received the high degree of training which has since been reserved for Army mountain guides (see sec. III, p. 79). When the German Army was expanded, mountain units grew with the rest of the Armed Forces. The *Anschluss* brought a further accession of strength, because Austria had specialized in training mountain soldiers for over half a century.

As the training program expanded, the standard of achievement in mountaineering was somewhat lowered. It was felt that not all mountain soldiers need to be expert mountaineers. Consequently German mountain training is now carried out on two levels; a course for Army mountain guides, including skiing, for officers and a number of selected enlisted personnel, and a less thorough course for the remaining enlisted personnel of the mountain divisions.

The training of the mountain soldier begins in the flat, and for 6 months he learns the fundamentals of soldiering. He usually arrives in the mountains in early summer, and remains for a full year.

During the first phase of the course he is introduced to mountaineering and is led gradually on climbs of increasing difficulty. Men who are to be trained as Army mountain guides are selected on the basis of military performance and tests of mountaineering ability and receive separate training. They alone receive instruction in military mountain skiing. The other soldiers learn to move over the snow with or without snowshoes, and later their marches are combined with training in military operations in snow. In the middle of January the soldiers go by groups for 20 days of training in high mountain stations where they are sure to find snow the whole time. Here they fire rifles and machine guns under simulated combat conditions (fig. 16).

Figure 16.—Mountain riflemen firing under simulated combat conditions.

13. INDIVIDUAL AND UNIT TRAINING

Although there are different degrees of specialization among them, all German mountain soldiers may be considered specialists. They go through a long, arduous mountain-training program. During their training they are treated less like regular infantry than like students at a military school, and they are exempted from parades, inspection, drill, and manual of arms. This treatment and this training are given not only to mountain combat soldiers but to mule drivers, cooks, and other service troops as well.

However, reports concerning German mountain units engaged in the present Italian campaign indicate a curtailment of the training program since the outbreak of the present war. Some of the personnel, after they had received basic infantry training, were merely taken on a few walks and climbs in the mountains; others were sent to the Tyrolean Alps in Austria for advanced training, including roping and handling of pack animals. Then, during the summer, the latter received a three-week course in skiing in regions of perpetual snow. Their training was completed with participation in maneuvers in the mountains.

When he has finished his course, the mountain soldier is one of the best trained soldiers in the German Army, and from that time on he is likely to be one of the best equipped. Because each mountain unit is largely recruited from one mountain district, mountain soldiers are likely to add local pride to their pride as select troops. The final result is high morale and *esprit de corps*, although these attributes are likely to find expression in an individualism that conceals the high degree of self-discipline imposed by each man upon himself. This attitude is probably the natural outcome of training designed to prepare the mountain soldier for a virtually self-sustaining role in combat.

14. MOUNTAINEERING

a. General

Despite the dangers and hardships of mountain training, the Germans believe that they can instill in soldiers a love of the mountains that will make them regard any other service as tame and uninteresting. The joy that the individual soldier derives from mountains and mountain climbing is a basis of training. The hard but rewarding task of officers in charge of training is to develop this love for the mountains and foster it. They are helped in this by the fact that most of the recruits come from Alpine country. To give the soldier self-confidence, officers set a patient, systematic pace in training. They raise the physical and technical requirements gradually so that the beginner unconsciously attains the calm self-confidence that he needs. As the fondness for mountains increases, officers will encourage the troops to climb mountains and to ski as a recreation, always, however, under the supervision of an Army mountain guide. The alert commander, staying close to his men on and off duty, quickly gets to know their worth, because service in mountains quickly tests their character. Thus he can have clearly in mind which men are best qualified as noncommissioned-officer replacements.

b. Scale of Requirements

To systematize training in mountaineering, the Germans have worked out a graded series of requirements based on the degree of difficulty of the terrain and the duration of the march. Achievement in mountaineering is marked by a steady increase in physical endurance, as demonstrated in mountain marches, and by a corresponding improvement in mountain-climbing technique. While improving his performance the mountain soldier also gets the experience that he needs for the service.

For purposes of training, the Germans classify mountain terrain as follows:

(1) Easy walking terrain—pathless terrain, including ridges and slopes, over which men can walk without danger of falling.

(2) Difficult walking terrain—steep rock ridges and ragged slopes over which the men can move without using their hands if they choose the right route, but where they run the risk of slipping.

(3) Easy climbing terrain—exposed grass or rock ridges where even the trained mountain climber must at times use his hands to keep his balance and sense of security but has no trouble in choosing a route.

(4) Moderately difficult climbing terrain—ridges and faces of grass or rock with small but good handholds and footholds. This terrain requires no very special technique, but calls for acumen and experience in selecting a route that will avoid major difficulties.

(5) Difficult, very difficult, and extremely difficult climbing terrain—very steep, exposed ridges some parts of which can be climbed only with special equipment and technique.

Bad weather or a coat of ice increases the degree of difficulty of moving over roads, paths, and otherwise easy walking terrain. The Germans consider that moving under full pack and arms instead of merely with mountaineering equipment demands an increase in efficiency corresponding to one degree of increase in terrain difficulty, as classified above.

The Germans set out minimum standards of proficiency which all mountain soldiers must attain. They must practice until they can make any kind of ascent (*Steigen*)[1] on a road or path free of snow. They must also learn to walk on easy wooded, grass, and scree slopes, until they can master fairly difficult terrain which requires easy to moderately hard climbs. In the snow they are required to walk with snowshoes on roads, over easy and difficult terrain, and through woods and low, protected draws. They must also be able to get over icy stretches and make moderately hard climbs. The Germans teach that individual training in mountaineering attains its goal only when the regular mountain soldier under normal conditions of marching and combat

[1] *Steigen* is used as the generic word for any kind of ascent. The Germans use *Kletterei* to denote moving up or down slopes on which the climber must use his hands.

can move about in all kinds of terrain in a quiet, orderly, confident way, without wasting time or unconsciously taking unnecessary risks.

c. Technique

(1) *Marching.*—The first thing that a recruit in a German mountain unit is required to learn is mountain marching. Mountain marching means not only the ability to make ascents and descents on and off roads, but also the development of self-assurance and rooted habits of march discipline.

The German mountain soldier is taught to make ascents at a slow and rhythmic pace, and to develop an even stride which is not too long. He walks not on his toes and the ball of his foot but on his entire foot from toe to heel. When his forward foot is set, he puts his full weight on it so that he will not slip. He walks erect, not leaning into the slope; and he keeps his knees loose. He breathes deeply. The fundamental principle in marching as elsewhere in German mountain training is conservation of energy. So that they will be as fit as possible for combat, the German mountain soldiers are taught to avoid hasty ascents, long strides, stiff-kneed walking, straight uphill climbs, and steep paths, and to zigzag gradually up steep slopes wherever they can. Their training emphasizes march discipline; all marches are closely supervised. They are taught not to bunch up but to maintain their prescribed distances, and not to take short cuts or stop unless ordered. They learn to cut down on talking to save wind, and straggling is absolutely forbidden.

(2) *Climbing.*—The inexperienced German mountain recruit learns to climb by starting on easy rock so that he gradually acquires confidence and gets a feel for the work. He is taught to use his legs slowly and rhythmically, to use his arms to provide support and balance, and to pull his body up with them only when absolutely necessary. The Germans teach their mountain soldiers to pick handholds and footholds not too far apart, to grasp them slowly, test them, and always keep weight on three

points in going up. When the German mountain soldier climbs, all his muscles work together, and he breathes quietly and easily and tries to achieve perfect balance. In descents he avoids sitting down, lest he slide too fast for control, and if the rock is not very steep and the footholds are good, he goes down with his back to the rock. He learns to be especially cautious on steep grass slopes, because they are treacherous. In traversing them he gets footholds on tufts, keeping the inner edge of his foot close to the slope. On straight descents he kicks his toe well into the grass. He never uses tufts as handholds for pulling himself up.

On steep snow and ice the German mountain soldier is instructed that he has to kick or cut steps for himself for safe climbing, unless he is using crampons. As on rock he takes short steps and usually zigzags to save his strength. When he can see the bottom of a snow slope from the top, it is permissible for him to glissade, or slide down on his feet. In glissading he learns to change his course, slow down, and stop with the aid of his ice-ax (see (3), below). He is warned against attempting to glissade with crampons on, or on a solid-frozen ice slope, or when he cannot see the full length of the slope.

(3) *Special climbing equipment.*—The special climbing equipment used by the German mountain soldier depends on the kind of surface he is going over. A basic principle is that the weight of it must be kept to the absolute minimum. On rocks he learns to use rock pitons, snaplinks, and rope- or felt-soled rock-climbing shoes (*Kletterschuhe*) (see fig. 24, p. 85); on grass, crampons; on snow, snowshoes (*Schneereifen*); on ice and snow, snaplinks and ice pitons. On all three types of surfaces he uses his rope and his ice-ax.

The German mountain soldier regards his rope as his most important piece of climbing equipment, and he is taught to take good care of it. The rope consists of about 100 feet of twisted hemp of the highest quality, seven-sixteenths of an inch in diameter. He dries it in the open air, hangs it from a peg in loose loops

when not using it, and repairs it promptly. Before he makes use of the rope, he learns three simple knots: the overhand noose, the square knot, and the double overhand noose (figs. 17 and 18). The double overhand noose is made by dropping part of the loop of an overhand noose back through the knot and then passing the original loop through the small loop thus formed (fig. 18).

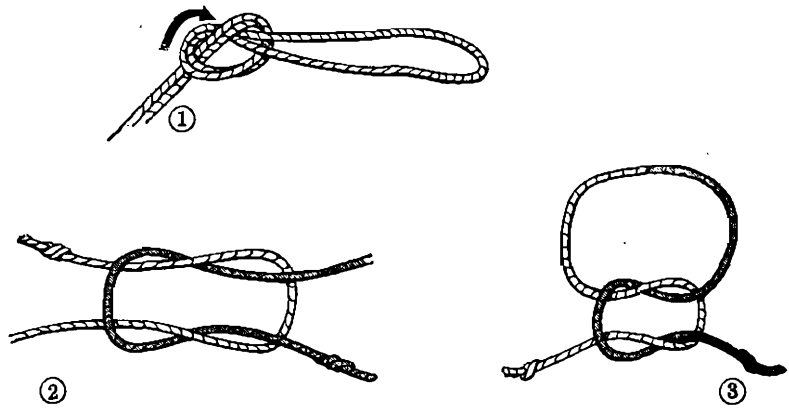


Figure 17.—Basic knots used by German mountain troops. (① Overhand noose, for securing a man to the rope; ② square knot, for joining ropes together; ③ sling, for securing the rope to a projection for the purpose of belaying.)

German mountain soldiers are likely to climb three men to a rope with an Army mountain guide for rope leader. The men are secured in the rope with a noose around the body. They use the rope for all difficult climbing or whenever any of the men decide that it is necessary.

For difficult climbs the German mountain soldier learns how to rope down and belay. A belay is a turn on the rope around some secure point, usually a rock projection. A sling (fig. 17 ③) is often used with the belaying rope. The belay serves to pre-

vent a climber who slips from falling far. A climber can be belayed from above or below, on climbs up or down slopes. In his training in climbing the German mountain soldier learns how to pay out rope if the man he is belaying is climbing away from him, and to take up slack if the climber is moving toward him, always keeping the rope taut, but never pulling the climber off his holds. When he can find no suitable projection, he learns to use his ice-ax or a piton and a snaplink (see fig. 20, p. 74), or to get himself well set and use his own body as the belaying point, with or without the help of a piton and a snaplink.

The German mountain soldier is taught to use his rope to get down an otherwise impassable cliff, and even to negotiate an overhang where he cannot bring his body into contact with the face

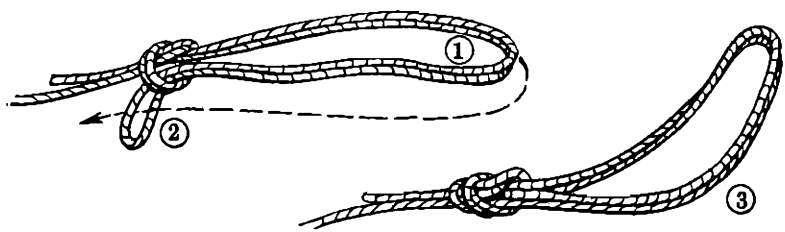


Figure 18.—Double overhand noose. (This is the preferred knot for roping up. The end of the simple overhand noose ① is inserted in the loop ②, and pulled through. The result is the noose ③.)

of the cliff. In carrying out the most common German technique, he passes the rope between his legs, up across his chest, and over one shoulder. He holds the dangling part of the rope with one hand, the suspending part with the other. By raising the dangling part of the rope he can slide; by pulling it down over his shoulder he can stop. This is known as roping down (fig. 19, p. 72).[2] By means of the more complicated one-thigh and two-

[2] There are many other variations of technique in roping down. One of these is illustrated in fig. 24, p. 85.

Figure 19.—Roping down a rock face.

thigh rope seats he can take more weight off his arms and free one hand. His instructions do not allow him to shinny down a rope or go down hand over hand.

The German ice-ax is a 2½-pound 10-inch crosshead ax with a 3-foot wooden shaft. The crosshead has an adze end and a pick end and the base of the shaft is shod with a long iron point. The German mountain soldier uses the ice-ax as an extra support for ease and firmness in walking. He handles it with care to avoid injuring himself or his companions. In special emergencies on rock, where he has no other holds and where he can drive the ax

in securely, he is taught to use it as a handhold or foothold and to make a satisfactory belay with it on grass slopes where it can be thrust in deep. On ice and snow it offers him support during traverses, helps keep his body erect in descending steps kicked into the ice, and gives him handholds and footholds, and again in deep, firm snow it is used by him to make a good belay. When he glissades down a slope, the German mountain soldier uses his ice-ax to brake his slide and to stop himself. He tests the strength of snow crossings with it, and if a slope is too steep for crampons, he cuts steps with the pick end of his ax and clears them with the adze end when the ice is hard or cuts them with the adze end on softer ice or snow.

Whenever possible, the German mountain soldier uses crampons rather than the ice-ax as a climbing aid on icy slopes. German crampons are steel frames with twelve 2-inch iron spikes attached. They fit the bottom of the soldier's ski-mountain boot and strap on over the top. When the soldier climbs flat-foot over ice slopes, the spikes bite into the ice, giving him a secure foothold. They save him the labor and avoid the noise involved in cutting steps. He is taught that he may also use crampons on a difficult grass slope, but that he must remove them when he comes to rock.

Pitons and snaplinks help the climber when no natural belaying point is available and a body belay is unsafe. Rock pitons (fig. 20) are iron wedges, 5 or 6 inches long and of varying width and thickness. The German ice piton before the outbreak of the present war was a 10-inch barbed iron spike. All pitons have an eyelet near the top for inserting a snaplink. The snaplink is a smooth oval metal ring with a spring-closed hinged section (fig. 20, p. 74). To use the piton as a belaying point, the climber hammers it into the rock or ice with a piton hammer, snaps the snaplink into the piton eyelet, and the rope into the snaplink. Pitons are left behind as the men climb past them. Snaplinks are collected and used again in later belays. The mountain soldier may also use the piton hammer as a makeshift to cut a few steps in ice, or to knock out holds or crack off sharp edges on a rock face.

With special rope- or felt-soled rock-climbing shoes (see fig. 24, p. 85) the mountain soldier learns to move securely and silently over rock faces (fig. 21). He cannot, however, use this footgear on grass slopes, for there they do not grip.

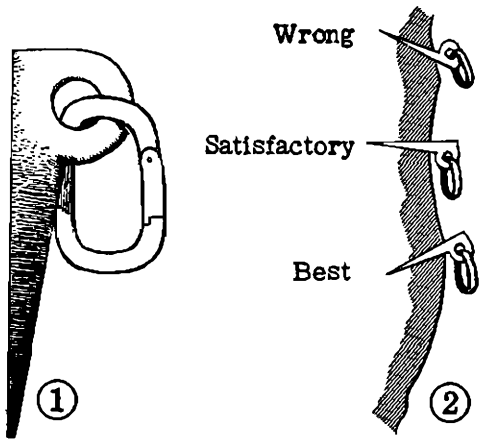


Figure 20.—German piton and snaplink ①, and ways of inserting pitons ②.

d. Bivouacs

The Germans emphasize the importance of training in bivouacking, because they feel that the combat efficiency of a mountain soldier, and sometimes his life, depend on his ability to get all the rest possible under difficult conditions. The German mountain soldier is taught to take care of himself at night in the mountains in all seasons and all weather. He learns how to set up a lean-to, using a rock ledge for the roof and one wall, and to dig snow holes and erect snow huts. He also learns that beds in shelters should be raised above the ground whenever possible in order to avoid dampness; that air holes must be punched into the walls of a snow hut with ski poles to prevent the air from fouling; and that care must be taken to set up bivouacs on slopes which are safe from avalanches and rockslides.

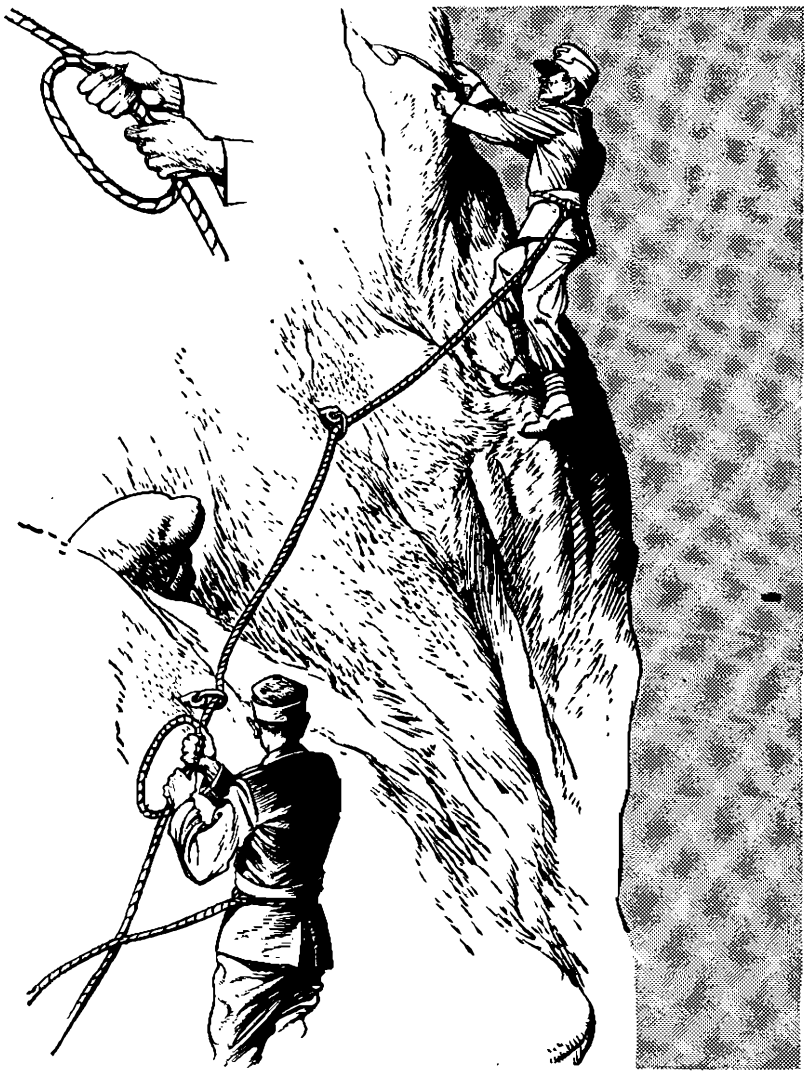


Figure 21.—Rock climbing.

German rules for mountain bivouacking are, to a considerable extent, the same as those for winter bivouacking, with added precautions against hazards like avalanches and landslides.[3]

e. Self-preservation; Orientation

The Germans are convinced that the cost in casualties which results from sending unguided soldiers without mountain training into high mountains is exorbitant, and that such soldiers suffer less from the enemy than from the difficult environment in which they find themselves. Consequently, the German mountain soldier is trained to take care of himself in the midst of natural perils.

Both the form and the height of mountains menace the mountain soldier. The special dangers in mountains are rockfalls, landslides, cornice fractures, snowdrifts, avalanches, glacial crevasses, icefalls, and ice slides. Avalanches are the most serious mountain danger; the Germans believe they are likely to cause more casualties than enemy fire among troops not trained for mountain service. To detect mountain dangers unerringly and to cope with them require technical knowledge, considerable training, and long experience. The rescue of the casualties that they cause is highly specialized work. The Germans place the main responsibility with respect to these dangers on the Army mountain guides (see sec. III, p. 79) rather than on the ordinary mountain soldier.

Every German mountain soldier is required to know something about self-protection against dangers presented by weather. Lightning is a particular danger on ridges and peaks. Rain, snowstorms, clouds, and cold are especially dangerous in mountains, because they occur suddenly. The mountain soldier is also subject to snow blindness, glacial sunburn, exhaustion, and exposure. Because the weather changes sharply, the Germans train mountain troops in the fundamentals of forecasting. They are

[3] For the results of the German examination of the problem of survival in cold weather based on the Russian campaign, see "German Winter Warfare," *Special Series*, No. 18 (15 Dec 1943).

taught the following simple weather omens. A ring around the moon, unusual twinkling of the stars toward morning, rising clouds, bright red sunrise, early morning warmth, and the sun shining through mist presage bad weather. A red sunset, evening clouds in the valleys, lack of wind in clearing weather, heavy morning dew, and cold nights promise fair dry weather. If the mountains look clear and especially close and the woods blue, rain is usually in the offing, while a down-valley wind at night and an up-valley wind during the day are also signs of good weather. In warm months, early morning cloud layers between 6,500 and 10,000 feet that soon disappear are a 12-hour advance notice of lightning. Towering thunderheads precede lightning by 2 hours; a crackling hum in metal objects and a glow in the dark immediately precede lightning. Low, dark, rapidly moving clouds mark the approach of a snowstorm in cold weather.

As safeguards against lightning, the German mountain soldier is instructed to clear out of high places and off ridges, to avoid wire cable and metal, and to refrain from huddling with his companions. He learns that snowstorms and clouds make it hard to judge whether nearby terrain slopes up or down, and that light reflected from the snow produces glacial sunburn and snow blindness. The German mountain soldier uses lanolin or a special salve to prevent glacial sunburn, and goggles to prevent snow blindness. Mountain sickness is a physical reaction to heights, and dizziness is a psychological reaction. The Germans believe that men easily prone to either of these ailments are ill-suited for mountain service.

As the soldier moves about in the mountains, he always risks suffering from the cold. Insufficient protection from cold results in frostbite, exhaustion, and sometimes death from exposure. The Germans say that while clothing must be warm, it must not make the soldier sweat, since moisture on the body can be disastrous in severe cold. The German mountain soldier wears rather light clothing while moving and puts on heavier apparel during rests and bivouacs. He learns to use paper as body insula-

tion. Because the extremities suffer most in cold weather, he is taught to take every precaution to keep his feet and hands dry. In a very cold bivouac, where there is danger of freezing to death, he should not sleep, and he is taught to use every available means to overcome sleepiness. If as a result of lack of sleep and strenuous climbing a German soldier suffers exhaustion, he and his comrades are expected to recognize the symptoms and apply proper first-aid measures.

German mountain soldiers ordinarily will not separate from their unit unless they are accompanied by an Army mountain guide to maintain direction in the mountains. Getting lost in the mountains, however, presents such perils that all German mountain soldiers receive training and field experience in the use of the compass, maps, and the clinometer. In addition, they must be able to describe exactly and clearly, both orally and in writing, any mountainous terrain or any path that they have gone over. Their memory, which the complicated mountain terrain will tax severely, is thoroughly trained and developed.

Section III. ARMY MOUNTAIN GUIDES

15. GENERAL

The German High Command is convinced that for success in mountain operations it needs a certain number of specialists who are more skilled in mountaineering than are regular mountain troops. These experts are called Army mountain guides (*Heeresbergführer*), and they include all officers of mountain divisions and a portion of their enlisted personnel, the staffs of the mountain training centers, and training groups used to encourage interest in mountaineering among German youth. The entire personnel of the so-called high-mountain battalions are also trained to qualify as Army mountain guides. Certification as a guide carries no increase in pay and no special rating. But high proficiency in mountaineering is prerequisite for many of the noncommissioned grades, and, therefore, certification as a guide opens the way to promotion.

16. GUIDE TRAINING

Men who show promise of making good mountain guides during ordinary mountain training are segregated after tests on snow in the autumn. Then they are put through a tougher training schedule as a preparation for taking the special Army mountain guide course.

After selecting prospective Army mountain guides, the officers in charge organize them into special squads and platoons for rigorous training. They make climbs of the utmost difficulty and act as rope leaders. The rope leader is the front man on the rope in ascents and the last in descents. For this work the guides are required to become very proficient climbers; they also receive intensive training in selecting the route for a climb, a responsibility

which may fall on any rope leader. German doctrine emphasizes the importance of accurate judgment in choosing a route, since a single mistake may jeopardize the success of a military mission. The guides undergo long systematic training in orienting themselves in a strange area of which they have only a partial view, relying only on memory, a description, or a sketch. They go out on such difficult orientation problems in bad weather and at night.

Guide candidates must have had some previous skiing experience; in training they learn special military skiing technique similar to the best civilian technique but with modifications made necessary by the soldier's heavy pack. When the men have learned to execute an exercise without pack, they start practice on the same exercise with full field pack. The instructor tries to select a different kind of terrain and a different snow cover each day so that the candidate gets experience under all conditions. Since each group is limited to 15 men, the instructor can give individual attention to each candidate. A former instructor in one of the German Mountain Training Schools attributes its success to this individual instruction. The training program is divided into six grades. The more intricate ski turns are not emphasized, the Germans having found that the simpler turns usually have a greater practical value. The Germans insist that the instructors always keep in mind that they are training mountain soldiers, not racing skiers. The mountain soldier is taught to avoid speed that involves any unnecessary risk. At the end of ski training most of the guides take up their regular assignment in the various units of the mountain division. They are assembled again only for special Army mountain-guide training.

The guide candidates and all mountain-unit officers undergo two periods of this special training during the year. The Germans believe that longer periods are not necessary. The first period comes in winter; the second, as a rule, between the company-training phase and maneuvers of larger forces. The aim of this training, as stated in German doctrine, is "to make use of the outstanding mountaincering aptitude of individual mountain soldiers of

all grades for special missions in mountain warfare." In the special course, candidates and officers train in battalion units, while special troops such as signal personnel are trained in small units which are attached to larger organizations.

Training takes place on snow-covered as well as bare mountain terrain. German mountain-unit officers and guide candidates get identical training in the difficult and technical work of leading troops through mountains without getting lost and with a minimum of casualties from mountain dangers. This part of the course deals primarily with map reading, terrain sketching, orientation and the use of instruments for orientation, and the selection of routes. The guide candidates learn to read maps and to judge terrain on the basis of their reading. In a typical exercise, an area including difficult terrain with rocks is selected from a map for a reconnaissance mission. On the basis of a study of the map the men reconnoiter the terrain for suitable combat positions. They learn to march and take bearings from a compass as they go, and to use the altimeter for orientation by checking their altitude against a contoured map. Besides learning to select the easiest—and sometimes the only—route over difficult climbing terrain, the German Army mountain guide must acquire sound technical knowledge of mountain dangers so that he will not take troops within reach of rockfalls, landslides, breaking cornices, and avalanches, or over soft bridges across crevasses. In case of accidents he is required to know certain fixed rules for rescue; otherwise the rescue effort is likely to cause more casualties than the initial accident or to impede or delay rescue until too late.

Army mountain-guide candidates who fail to attain the required standard in military aptitude, mountaineering, or character are dropped from the course, but may be readmitted. On the recommendation of the director of guide training, based on the reports of the instructors, certificates and special insignia (fig. 22, p. 82) are awarded to the men who finish the guide course. A guide may be deprived of his certificate for a serious military or civil offense or for misconduct. Certifications of the guides are recorded on their service records and on the cadre roll.

17. MISSIONS OF GUIDES

The Germans use their Army mountain guides for several different purposes. Some are formed into high-mountain battalions (*Hochgebirgsbataillone*), which are rifle battalions whose entire personnel are required to have guide certificates. These units are employed to fight in sectors which present particular mountaineering difficulties, or to carry out a mission which calls for rapidity of movement beyond the capabilities of an ordinary mountain unit. It is not known whether the high-mountain battalions are different in organization or armament from the regular mountain infantry battalions.

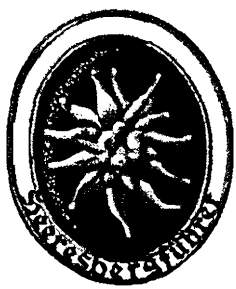


Figure 22.—Badge of Army mountain guides. (This badge may be worn on the left breast pocket of the coat.)

In peacetime all officers of mountain divisions were required not only to qualify as Army mountain guides, but also to return annually for additional guide training. Besides the officers, almost all enlisted personnel in certain units, such as the signal battalion and unit communication detachments, must qualify in the guide course. Finally all other units need a proportionate number of mountaineering experts to serve as squad or rope leaders, to carry out reconnaissance missions, and to lead patrols. The Germans estimate that in every mountain unit at least one man in three should be an Army mountain guide.

In mountain divisions the German Army mountain guides, both commissioned and noncommissioned officers, perform special missions in their particular branch of the service. Guides who are engineers join in the reconnaissance of routes and plan

the repairs and improvements necessary for the movement of the march column, and they estimate the time, personnel, and equipment needed for this work. In the mountain infantry units Army mountain guides are the assault troops. They are chosen for the harder patrol missions, for surprise movements, and for attacks over terrain of great or extreme difficulty. Whether the ordinary mountain rifle company has a separate platoon or squad of Army mountain guides for carrying out difficult missions, or whether the guides are grouped for such missions as the situation demands, is not known. In machine-gun, mortar, infantry-howitzer, and artillery units, certain noncommissioned officers who are qualified as mountain guides, as well as officers, observe and adjust fire from observation posts which can be reached only by difficult climbing.

Sometimes it may be necessary for units without much training in mountain warfare to pass through high mountain terrain to reach their battle sector in medium mountains or valleys. Also, no matter how undesirable it may be from the German point of view, such units may have to fight in high mountains. In either case they must have expert help. The Germans believe that officers trained only for warfare in the flat will not be able to cope efficiently with logistic and tactical problems which arise in mountain operations. To meet this situation, Army mountain guides are attached as advisers to unit commanders when the solution of technical problems of mountaineering has a direct bearing on plans and decisions. The Germans direct that officers without mountain training should accept the advice of their attached guides, whatever their rank, on technical mountaineering questions, and that they must accept full responsibility if they disregard such advice. Another function of Army mountain guides attached to units deficient in mountain training is to improve the routes for units advancing through mountains. The guides cut steps, lay planks, drive spikes into rock faces for climbing, and perform other duties that will facilitate movement.

Section IV. CLOTHING; IDENTIFICATION; INDIVIDUAL EQUIPMENT

18. CLOTHING

The mountain soldier travels as light as he can, especially when combat seems imminent, and carries the minimum of equipment which is absolutely indispensable under almost any condition. This minimum load consists of sun glasses, antisunburn preparation, compass, matches, combination knife, three signal rockets, maps in a water-proof container, shelter half with pole, stakes and rope, first-aid kit, flashlight, and waterproof foodbag with emergency ration, and, in winter, a light aluminum shovel, an avalanche cord, and, if he is a skier, an extra ski tip. He will also have with him extra underwear, extra mittens, and several extra pairs of socks.

The mountain soldier receives a standard mountain clothing issue which differs from the issue in normal infantry divisions. Among his clothes are two knitted shirts that are lighter but no less warm than the regular-issue woven shirt. His sweater, too,

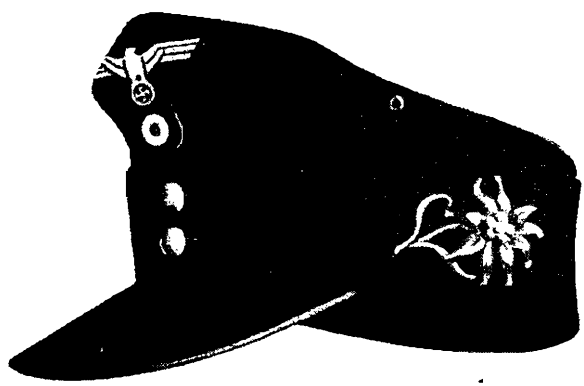


Figure 23.—Mountain cap with edelweiss badge.

is superior to the regular-issue sweater. The high-crowned wool mountain cap (fig. 23), formerly a distinguishing feature of the mountain uniform, has become a standard item throughout the German Army. The tight-woven, unlined wind jacket worn over the coat in cold windy weather is still issued only in mountain units.

Figure 24.—Mountain soldier. (This master sergeant wears rock-climbing shoes and the badge of a mountain guide.)

Over his mittens the German mountain soldier wears canvas, leather-palmed mitten shells which provide insulation against the cold and help keep his mittens dry. The trousers of the mountain soldier are voluminous and baggy (fig. 24, p. 85) and will not bind the soldier engaged in the most arduous kind of climbing. They lace around the ankle. The junction of the trousers (*Berghose*) with the ski-mountain boots (*Bergschuhe*) is covered by small ankle-wrap puttees (*Gelenkbinden*) (fig. 25) which are closed with a buckle. These puttees tightly seal the top of the mountain soldier's boots, keeping out mud, snow, and ice, and help to keep his feet dry. Except for motor-vehicle drivers and some engineer-battalion personnel, mountain soldiers do not wear half-length boots. In addition to ski-mountain boots they are issued regular laced walking shoes (*Schnürschuhe*).

For operations in snow, mountain units have three different types of camouflage dress: a white surcoat, white two-piece overalls

Figure 25.—German ski-mountain boot and ankle-wrap puttees.

(fig. 1, p. 5), and a camouflage parka (fig. 2, p. 11). The parka (a hooded pull-over) is reversible, one side being white, the other side field gray. The first two garments are light, and they are designed primarily for camouflage rather than for warmth. Further camouflage protection is provided by the issue of white boots, caps, and rifle covers.[1]

19. IDENTIFICATION

The certain means of identifying the German Army mountain soldier is by his edelweiss badges. He wears a metal badge on the left side of his mountain cap (fig. 23, p. 84) and a cloth badge (fig. 26) on the upper right sleeves of his coat and overcoat. Two other fairly certain means of identification are ankle-wrap puttees (fig. 25) and the baggy mountain trousers (fig. 24, p. 85). High heavily hobnailed ski-mountain boots (fig. 25) indicate that their wearer probably is a mountain soldier. While other units in mountain divisions wear the regulation color of their arm or service, the mountain infantry organizations wear light-green braid on their shoulder straps rather than infantry white or the darker green of armored infantry. This light-green braid also

Figure 26.—Edelweiss badge worn on the right sleeves of mountain troops' coats and overcoats. (This badge was introduced late in 1939.)

appears on the uniform of the light (*Jäger*) infantry divisions; however, these troops wear oak-leaf clusters instead of edelweiss badges.

[1] For special climbing equipment issued to the individual German mountain soldier as the need arises, see par. 14c (3), p. 69.

Ordinarily Army mountain guides will not be identifiable by any peculiarity of their uniforms. They are entitled to wear on the left breast pocket of the coat an enameled metal badge displaying an edelweiss and the inscription *Heeresbergführer* along its lower edge (fig. 22, p. 82). The badge alone is not a satisfactory method of identification, however, because it is evidently not worn in the field.

SS mountain troops, whose uniforms and personal equipment are usually similar to (and frequently identical with) Army uniforms and equipment, can most readily be distinguished from Army troops by difference in insignia. On the right-hand collar patches of SS coats and overcoats is worn a runic device (fig.

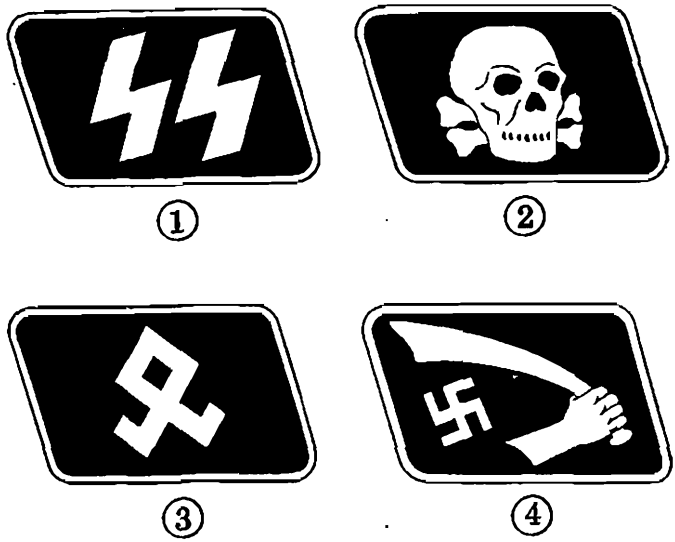


Figure 27.—Right-hand collar patches of SS units. (Special insignia of ① the majority of SS units; ② Death's Head units; ③ the Prinz Eugen Mountain Division; ④ the Bosnian-Herzegovinian Mountain Division.)

27 ①), standing for the initials *SS*. Death's Head (*Totenkopf*) units, which may be attached to mountain units, wear a white

skull (fig. 27 ②); the Prinz Eugen Mountain Division is identified by a rhombic device (fig. 27 ③); and Moslems of the Bosnian-Herzegovinian Mountain Division wear a device of a hand grasping a scimitar (fig. 27 ④). Insignia of rank, indicated by a system of bars and pips, are worn on the left-hand collar patch. Collar patches are rectangular in shape, and are of black cloth. Final identification is furnished by arm bands, usually sewn on the lower left sleeves of coats and overcoats. On these bands is inscribed the name of the division or regiment to which the individual belongs. Known inscriptions of mountain units are as follows: *Nord* (for the SS Mountain Division Nord), *Reinhard Heydrich* (for the SS Mountain Infantry Regiment Reinhard Heydrich of the Division Nord), and *Prinz Eugen* (for the mountain division of that name).

In the absence of such detailed insignia, the design and placement of the national emblem differentiates SS from Army troops. The SS emblem is an eagle, the spread wings of which, though similar to those of the Army emblem, are pointed at the center of their ends instead of at the top. Instead of being worn on the right breast of the coat, this emblem is worn on the upper left sleeve of the coat and overcoat. SS troops often wear over their coats a light camouflage jacket with elastic around the waist. Mountain SS troops add a mountain cap of the same mottled camouflage material.

20. INDIVIDUAL EQUIPMENT

Instead of an infantry pack, the mountain soldier carries a rucksack, a big canvas bag with compartments. Since he is likely at any time to be separated from the water supply of his unit longer than the soldier in the flat, he is equipped with a canteen that is larger than the regular-issue canteen.

In the extreme cold of a mountain winter, soldiers separated from specially prepared shelters must stay awake or risk freezing to death unless they have special sleeping equipment. Usually during the winter the mountain soldier is issued a sleeping

bag of quilted wool, varying in weight from 7 to 12 pounds, and a 4-pound air mattress. The mattress is essential as an insulation against dampness and cold. For extraordinary missions in which a small group is expected to face much difficult climbing and a considerable period of separation from its unit, the large sleeping bag is regarded as cumbersome and it is replaced by a very light, down sleeping bag. A former German mountain soldier, who had used this light bag, reported that it weighs only a few pounds and is good even in zero weather (presumably with the air mattress).

The tent issued to the mountain soldier is a combination poncho and shelter half. A one-piece tent weighing 6 or 7 pounds is used in high mountain operations in the winter.

21. FOOD

The Germans have worked out a special emergency ration for mountain troops. Its precise content is unknown, but it is probably high in fats. It was reported shortly before the outbreak of the present war that the ration was palatable, light, and nourishing. Among the items were pemmican, dried eggs, powdered milk, frozen green vegetables, dried and smoked meats, biscuits, and coffee concentrate. Extensive use was made of pills, probably vitamin concentrates.

The German mountain soldier uses the regular Army meat can, which has less surface area and is much deeper than the U. S. meat can. Moreover, the inverted top of the can will nest in the bottom section, in which hot liquids can be placed to keep the food in the top warm.

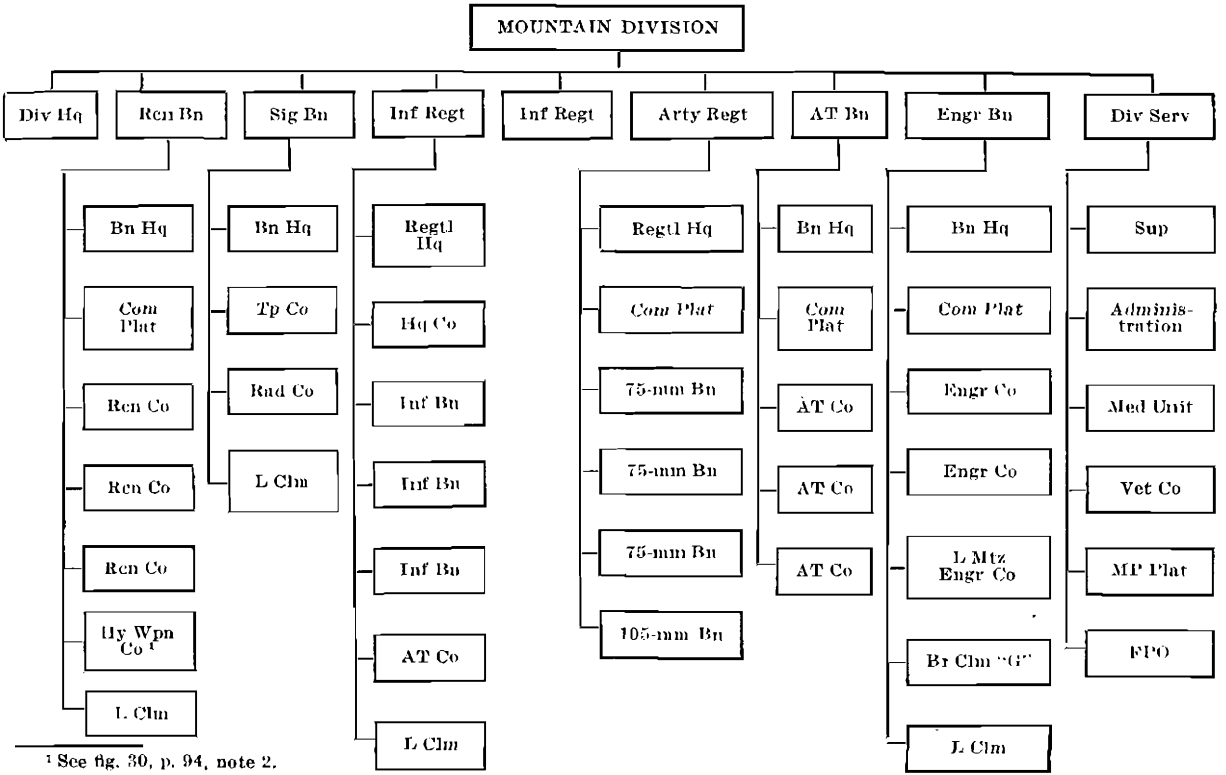
Section V. ORGANIZATION; ARMAMENT; EQUIPMENT

22. GENERAL

At the beginning of the present war Germany had three mountain divisions. Since that time four (probably five) more mountain divisions, three SS mountain divisions (see par. **19**, p. 87) and several independent mountain infantry and artillery regiments have been formed. The German mountain divisions have fought in the mountains of Norway, Yugoslavia, Tunisia, and Italy, and in several sectors of the Russian front. On Crete they were employed as airborne troops. Thus they have fought in and out of the mountains in some of the most difficult operations undertaken by any units of the German Army.

The organization of the regular mountain division (*Gebirgsdivision*)[1] is basically similar to that of the regular infantry division. It has a reconnaissance battalion, a four-battalion artillery regiment, and an engineer, a signal, and an antitank battalion, in addition to services (fig. 28, p. 92). But instead of three infantry regiments, the mountain division has only two. Its total armament is somewhat lighter than that of the regular infantry division, and although its manpower is almost equal to that of the regular infantry division, the distribution of personnel among units is different (fig. 29, p. 93).

[1] The organization of the SS mountain division, which is usually stronger than the regular mountain division, is reported to consist of four infantry battalions, instead of three, for each infantry regiment. Also, it is reported to contain organically one antiaircraft battalion, and it usually has a tank or assault-gun unit attached.



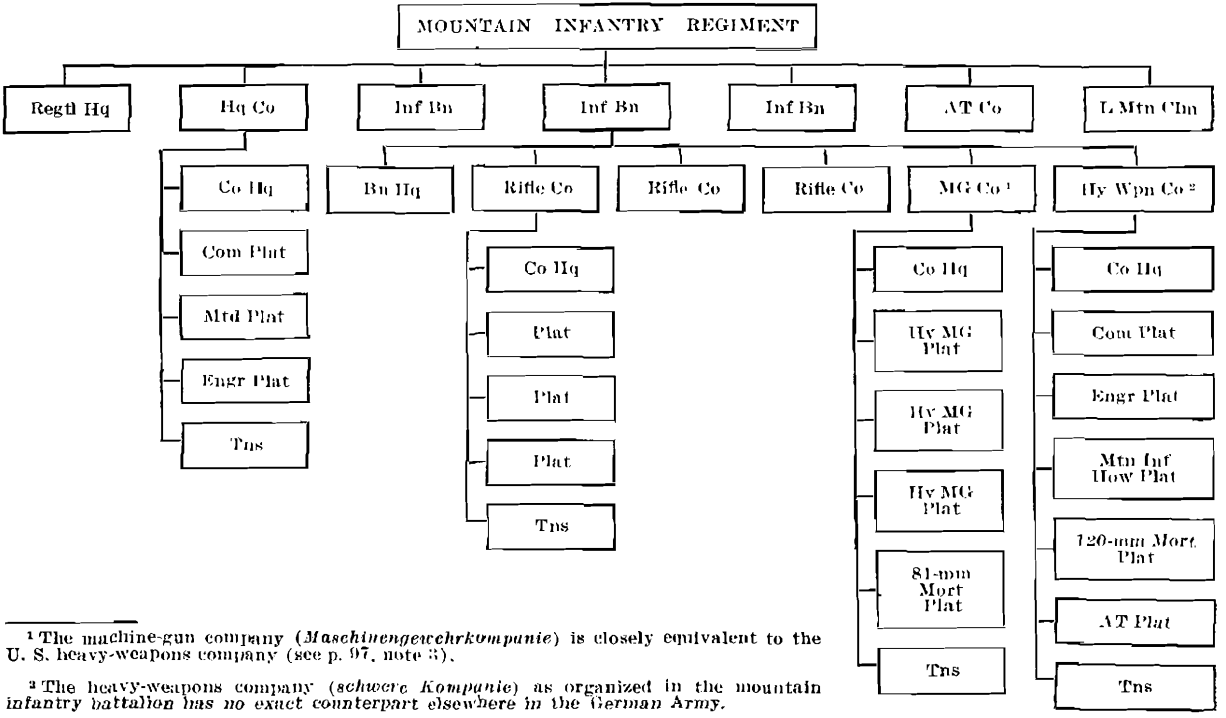
[1] See fig. 30, p. 94, note 2.

Figure 28.—Organization of the regular mountain division.

Unit	Personnel	MGs		AT rifle 7.92 mm	AT guns		Mtn AA/AT gun 20 mm	Morts			Mtn Inf How 75 mm	Mtn Arty		Transport			
		L	Hv		28/20 mm	50 mm		50 mm	81 mm	120 mm		75 mm	105 mm	Mtrcl	Mtr	H-Dr	Horses and mules
Div Hq	175	2												?	?	?	?
Mtn Inf Regt (2)	3,650	138	36	27	12	12		27	18	12	6				?	?	1,255
Mtn Arty Regt	2,750	24										36	12		?	?	?
Mtn Ron Bn	825	31	10		4			9	6	4	2			97	?		
AT Bn	550	18				36								44	93	?	?
Mtn Engr Bn	1,050	34			9									43	96	64	256
Mtn Sig Bn	400	17													?	?	?
Div Serv	2,750	30					8							91	201	487	1,354
DIV [1]	15,800	432	82	54	37	60	8	63	42	28	14	36	12	?	?	?	?

[1] A replacement battalion may be added to any mountain division, thereby increasing its strength and fire power (see par. 33, p. 110).

Figure 29.—Strength of units in the regular mountain division.



[1] The machine-gun company (*Maschinengewehrkompanie*) is closely equivalent to the U. S. heavy-weapons company (see p. 97, note 3).

[2] The heavy-weapons company (*schwere Kompanie*) as organized in the mountain infantry battalion has no exact counterpart elsewhere in the German Army.

Figure 30.—Organization of the regular mountain infantry regiment.

Unit	Personnel	MGs		AT rifle 7.92 mm	AT guns		Morts			Mtn Inf How 75 mm	Transport			
		L	Hv		28/20 mm	50 mm	50 mm	81 mm	120 mm		Mtrcl	Mtr	H-Dr	Horses and mules
Bn Hq	50												?	3 to 4
Mtn Rifle Co (3)	200	12		3			3						?	70
MG Co	200		12					6					?	90
Hv Wpn Co	230	5			4				4	2	?	?	?	100
Mtn Inf Bn (3)	1,080	41	12	9	4		9	6	4	2	?	?	?	400
Regtl Hq	35										?	?		
Hq Co	170	7									?	?	?	30
AT Co	170	6				12					20	30		
L Mtn Clm	35	2									1		10	25
REGT	3,650	138	36	27	12	12	27	18	12	6	?	?	?	1,255

Figure 31.—Strength of units in the regular mountain infantry regiment.

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23. MOUNTAIN INFANTRY REGIMENT

Each infantry regiment (*Gebirgsjägerregiment*) (figs. 30, p. 94, and 31, p. 95) in the regular German mountain division has about 300 more men than its counterpart in the standard infantry division.

The infantry comprises only 45 percent of the total strength of the mountain division (fig. 29, p. 93); in the standard infantry division 60 percent of the strength is in the infantry regiments. Although German doctrine stresses assault and shock action as being more important in the mountains than in any other kind of terrain, the exigencies of supply and replacement reduce the proportion of combat personnel in mountain units. In addition to its three infantry battalions, the regular mountain infantry regiment[2] includes a headquarters company and an antitank company, reportedly armed with twelve 50-mm antitank guns. In contrast with the regular infantry regiment, the regular mountain infantry regiment has no organic howitzer company; instead, the mountain infantry howitzers form part of the armament of the mountain infantry battalions (par. **24**). In mountain combat, the regiment is primarily an administrative, not a tactical unit.

Reports of mountain fighting in the present Italian Campaign indicate that one German mountain infantry regiment occupied a frontage of about 650 yards; its antitank defenses were approximately 875 yards behind the front line. Alternate weapon emplacements were dug about 30 yards to the flanks of the firing emplacements. The headquarters of companies were usually established approximately 200 to 300 yards from the front line, and the headquarters of battalions were located five-eighths to nine-tenths of a mile to the rear. The regimental headquarters was a little more than a mile from the front, while division headquarters was 6 miles to the rear. The combat train (*Gefechtstross*), including field kitchens, was pushed forward as near as possible to the combat troops, and rations were taken from the train to the troops by mules. The second supply echelon (*Mitteltross*) con-

[2] See p. 91, note 1.

tained a reserve pool of mules and the bulk of the unit's mule transport. At one stage of the operations the third echelon (*Fern-troß*) was reported to be between 25 and 30 miles behind the front line.

24. MOUNTAIN INFANTRY BATTALION

The Germans have emphasized the role of the reinforced infantry battalion (*Gebirgsjägerbataillon*) as the basic tactical unit in mountain warfare. The compartmented terrain as well as the acute problem of maintaining communications makes maneuver unwieldly and raises almost insuperable problems of effective command for any large unit, and by the same token dictates unique organization and armament for the mountain infantry battalion. The mountain infantry battalion is more heavily manned and more heavily armed than the battalion in the regular German infantry division. It consists of five companies: three rifle companies, a machine-gun company (*Maschinengewehrkompanie*),[3] and a heavy-weapons company (*schwere Kompanie*)[4]—which give it about 150 men more than the regular infantry battalion. It is armed with the same number of heavy machine guns, antitank rifles, 50-mm mortars, and 81-mm mortars as the standard infantry battalion, but it has five more light machine guns, and its fire power is augmented by four 28/20-mm antitank guns, four 120-mm mortars, and two 75-mm mountain infantry howitzers. The riflemen may be armed with carbines rather than with the standard German infantry rifle.

[3] The German machine-gun company includes, among other weapons, 12 heavy machine guns, whereas the U. S. heavy-weapons company includes 8 heavy machine guns. The basic weapons in both organizations are heavy machine guns and 81-mm mortars.

[4] For the organization and armament of the German heavy-weapons company, see par. 25, p. 98.

25. HEAVY-WEAPONS COMPANY

The increased strength and fire power of the mountain infantry battalion is based on its heavy-weapons company (*schwere Kompanie*).[5] This company, besides headquarters, a communication section, and a train, includes a howitzer, a mortar, an engineer, and an antitank platoon. The five power concentrated in the heavy-weapons company makes the mountain infantry bat-

[5] Since this company is usually under the direct command of the battalion commander, it is sometimes referred to as *Stabskompanie eines Gebirgsjägerbataillons.*

Figure 32.—75-mm mountain infantry howitzer (7.5 cm *l.Geb.l.G. 18*).

talion quite independent of its regiment in all categories of infantry weapons.

The howitzer platoon is armed with two 75-mm infantry howitzers (*7.5 cm l.Geb.I.G. 18*). This weapon is a version of the 75-mm infantry howitzer (*7.5 cm l.I.G. 18*) with steel-rimmed artillery wheels (fig. 32).[6] The howitzer in its mountain version fires a high-explosive shell (*7.5 cm Igr. 18 Al*) with a super-quick and delay fuze (*Az.23.n/A*) or a time and super-quick fuze (*Dopp.Z.S/60s*). The Germans commonly use the mark "Al" to indicate that the detonating charge contains aluminum. This accords with German practice for mountain artillery ammunition. Ten percent of the charge is an aluminum flash composition which facilitates sensing in the irregularities of mountain terrain or in snow and mud. For this weapon there is also an indicator shell (*7.5 cm Igr.Deut.*), which is used for marking targets for air and ground units. The detonation of the projectile throws out a canister which emits blue smoke. The shell is stenciled *Deut.* and *Blau.* The 75-mm mountain infantry howitzer weighs only 880 pounds and breaks into six loads (with a maximum load of 165 pounds) for pack transport.

Reports indicate that a platoon of 120-mm mortars has been added to the heavy-weapons company, although the presence of these weapons has not yet been reported from any mountain front. It may be that the 120-mm mortar was not designed for use in the mountains but was added to the armament of mountain divisions fighting on the plains of the Eastern Front.

The Germans have used captured Russian 120-mm mortars (*12 cm Gr.W. 378*) (fig. 33, p. 100), and they are believed to be manufacturing a weapon (*12 cm Gr.W. 42*) closely copied from the Russian piece. Its estimated weight is about 600 pounds, with an over-all barrel length of 6 feet and a bore length of 5 feet; it has the conventional bipod and base-plate mount. It fires a shell

[6] For a description of this howitzer, see "German Infantry Weapons," *Special Series*, No. 14 (25 May 1943), par. 18, p. 136.

Figure 33.—Group of captured Russian 120-mm mortars awaiting modification for German use.

weighing about 35 pounds, and its maximum range is 3½ miles. Available sources do not indicate whether the 120-mm mortar can be transported on pack animals. Even if it could be transported only over roads and the better mountain trails, a high-trajectory weapon capable of throwing a 35-pound missile 3 miles would add greatly to the fire power of the mountain infantry battalion.

The armament of the antitank platoon of the heavy-weapons company of the German mountain infantry battalion consists of four 28/20-mm antitank guns (*2.8/2 cm s.PzB. 41*). The 28/20-mm antitank gun is built on the so-called Guerlich principle with a bore that tapers from 28 mm at the breech to 20 mm at the muzzle. The projectile for Guerlich-type weapons has a soft metal skirt. When the projectile is forced through the bore, the skirt is squeezed down, reducing the projectile to a 20-mm shell with a desirable ballistic shape. The muzzle velocity of the 28/20-

mm antitank gun is 4,580 feet per second. The 4.6-ounce shell will penetrate 2.7 inches of armor with a 30° angle at 100 yards, and 2.1 inches of armor with the same angle at 400 yards. The gun is very light, weighing only 501 pounds.

To give the battalion additional strength for independent tactical operations in mountains, the Germans have provided the heavy-weapons company with an engineer platoon. Its estimated strength is 1 commissioned officer, 16 noncommissioned officers, 65 enlisted men, and 23 pack animals; its estimated equipment includes pneumatic rafts, pioneer tools for route improvement, demolition material including 500 pounds of explosives, and hand grenades.

26. REINFORCED RIFLE COMPANY

Although the battalion is the smallest self-supporting German mountain tactical unit, there is evidence that the reinforced rifle company (*verstärkte Gebirgsjägerkompanie*) is frequently employed on independent missions. Such a company might be employed out of necessity in long narrow compartments of terrain with extremely difficult lateral communications in which a larger force could not operate. The commander of the German mountain infantry battalion can reinforce a rifle company for an independent mission without recourse to higher echelons, because he has at his disposal heavy machine guns, 81-mm and 120-mm mortars, 28/20-mm antitank guns, infantry howitzers, and engineers.

27. MOUNTAIN ANTITANK BATTALION

German tables of organization for the mountain division include an antitank battalion (*Gebirgspanzerjägerabteilung*) of three companies. One of these companies may be an antiaircraft company, as may be the case in the antitank battalion of any German division. Each of the battalion antitank companies is armed with twelve 50-mm antitank guns[7] and six machine guns.

[7] For a description of the 50-mm antitank gun, see "German Infantry Weapons," *Special Series*, No. 14 (25 May 1943), par. 17, p. 123.

The inclusion of this battalion adapts the mountain division for fighting in any terrain where increased antitank protection is necessary. Whether a full antitank battalion would follow a German mountain division into high mountains is unknown.

The 50-mm antitank gun (*5 cm Pak*) replaces the now obsolescent 37-mm antitank gun (*3.7 cm Pak*). However, it is to be expected that this older weapon, large quantities of which are still in existence, may still be encountered. When terrain permits, 75-mm antitank guns (*7.5 cm Pak*) may be incorporated in mountain antitank units in order to supplement existing antitank weapons. With the conquest of Austria, the Netherlands, and Italy, the German Army has acquired large quantities of the 47-mm antitank gun of Böhler design. This gun was introduced in the Italian Army in 1935, and was designated by them as the 47/32. Those guns were pack weapons and were issued to Italian infantry divisions and mountain infantry regiments; they served both as support and as antitank guns. They fired both high-explosive and armor-piercing projectiles. Austrian Böhlers also were pack weapons and were used for a time in the German Army after the annexation of Austria. Since the Böhler design is very satisfactory mechanically and is well adapted to pack transport, Böhler 47-mm guns may be employed by German mountain troops.

In the antiaircraft company, which may be organic or attached to the antitank battalion, the usual weapon encountered is the 20-mm mountain antiaircraft gun (*2 cm Geb.Flak 38*) (fig. 34). This weapon, weighing about 700 pounds, is a somewhat lighter version of the standard 20-mm antiaircraft gun.[8] The lighter weight of the mountain gun is the result of lightening the carriage rather than of altering the gun itself.

[8] For a description of the basic model of this weapon (*2 cm Flak 38*), see "German Antiaircraft Artillery," *Special Series*, No. 10 (8 Feb 1943), par. 7b, p. 20).

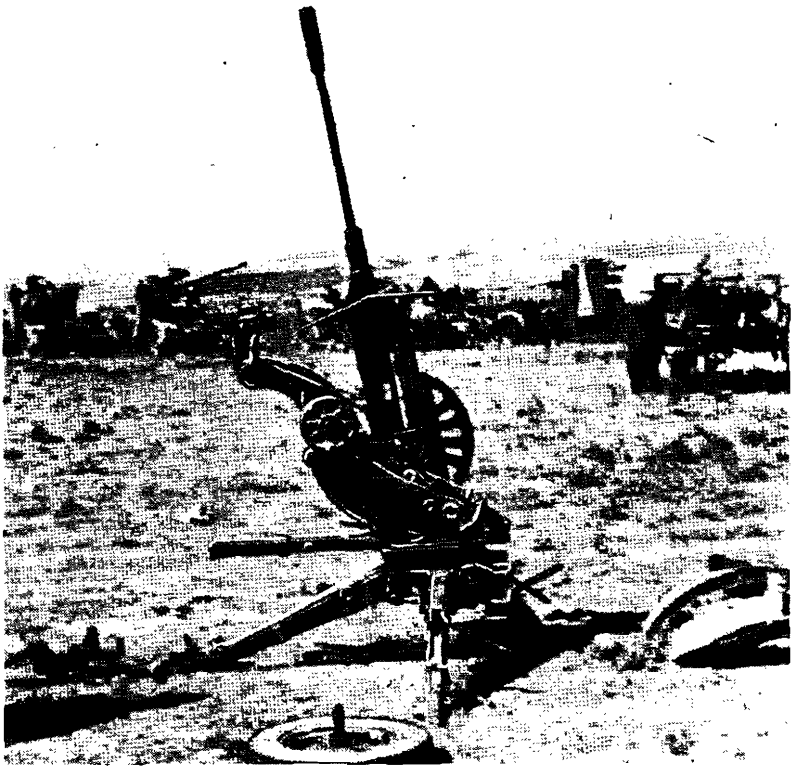

Figure 34.—20-mm mountain antiaircraft gun (2 cm *Geb.Flak* 38).

28. RECONNAISSANCE BATTALION

The reconnaissance battalion (*Aufklärungsabteilung*) of the German mountain division is a flexible organization, but it always has one bicycle company and a heavy-weapons company. It may have two or three bicycle companies, or one or two bicycle companies and one motorcycle company or one *Volkswagen* com-

pany.[9] When two bicycle, one motorcycle, and a heavy-weapons company are included in the reconnaissance battalion, its strength and fire power considerably surpass that of the reconnaissance battalion in the regular infantry division. The heavy armament of the mountain reconnaissance battalion may be significant when it is considered in relation to the limited reconnaissance missions assigned it by German doctrine. Its weight of armament suggests that the battalion is not employed entirely for reconnaissance. No German document so far examined indicates that the reconnaissance battalion fights as an infantry battalion when not employed on its special mountain mission. Nevertheless it is well equipped to do so.

29. MOUNTAIN ARTILLERY REGIMENT

The German mountain artillery regiment (*Gebirgsartillerieregiment*) with four light battalions, each with three four-gun firing batteries, has approximately the same structure as the artillery regiment of the regular infantry division. It breaks down into eight loads and can be towed by two special half-track vehicles (*Raupenschlepper-Ost*). The standard weapon of one of the battalions is the 105-mm mountain howitzer (*10.5 cm Geb.H. 40*). The standard weapon of the three other battalions is the 75-mm mountain howitzer (*7.5 cm Geb.G. 36*) (fig. 35). All firing batteries have two machine guns for close-in protection.

[9] The *Volkswagen* is the equivalent of the U. S. "jeep." Any motorcycle company or *Volkswagen* company may be replaced by a reconnaissance company riding on armored troop carriers (*Schützenpanzerwagen*), in which case the strength of the company will be reduced by approximately 15 men and the fire power will be increased by 16 light machine guns and three 37-mm antitank guns, each mounted on an armored personnel carrier of platoon headquarters.

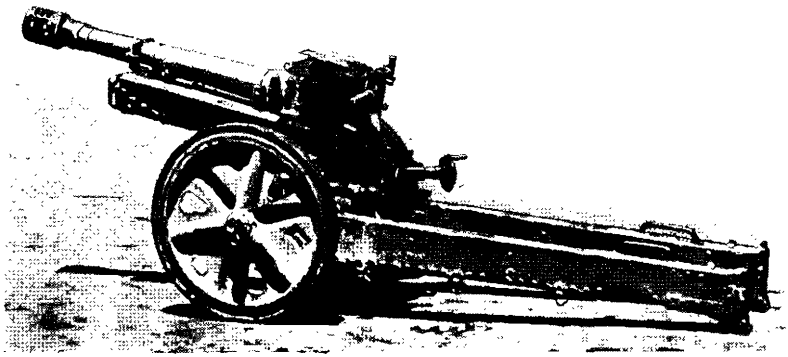

Figure 35.—75-mm mountain howitzer (7.5 cm Geb.G. 36) without trail spades.

The following are approximately the characteristics of the 75-mm howitzer:

Weight	1,600 pounds.
Length of barrel without muzzle brake	5 feet 6 inches.
Elevation	−10 to +70 degrees.
Traverse	40 degrees.
Muzzle brake	Perforated Soluthurn type.
Transport	Pack, animal-, or motor-drawn, sled-loaded (3 loads).
Maximum range:	
Charge 1	3,600 yards.
Charge 5	10,000 yards.

The 75-mm mountain howitzer fires several different kinds of ammunition. The *7.5 cm Gr. 34 Al* weighs 12 pounds 10 ounces; it has a percussion fuze and a filler containing 10 percent alumi-

num, which produces a flash to facilitate sensing. The *7.5 cm K.Gr. rot Al*, a red-band shell with aluminum flash filler, weighing 12 pounds 13 ounces, uses a time and percussion fuze (*Dopp.Z.S/60s.*) The *7.5 cm K.Gr. rot Bu.* is similar to the last-mentioned shell, but on detonation produces a multicolored smoke. The *7.5 cm Gr. 38* is a hollow-charge projectile. The *7.5 cm K.Gr. rot Deut.* with the *Dopp.Z.S/60s.* fuze is similar to the infantry howitzer indicator shell. To indicate targets for air-support units, the fuze is set to detonate 80 to 250 meters above the ground; for other ground units, 200 to 400 meters above the target. The shell is stenciled *Deut.*

The 75-mm mountain howitzer has a horizontal sliding breech-block. The hydropneumatic recoil cylinder and recuperator are both fixed in the cradle under the tube. The steel carriage is mounted on solid disk wheels with solid rubber tires. An equilibrator spring compensates muzzle heaviness of the weapon. The mountain howitzer has a split trail with detachable spades. It can be broken down quickly into 15 parts by releasing the lever latches that hold it together; it can be packed for transport on 6 animals, or towed by a special half-track vehicle (*Raupenschlepper-Ost*).

The Germans have considered the feasibility of increasing the fire power of their mountain artillery by increasing the weight of the mountain howitzers, but they seem to have concluded that to do so would excessively lengthen the pack column and the ammunition train. For long-range heavy shelling they rely on attached field artillery firing from valleys or easy slopes.

Though ordinary field artillery is usually attached to mountain units only for specific missions, batteries of 105-mm field howitzers (*10.5 cm l.F.H. 18*) have been manned by mountain artillerymen and become integral parts of mountain divisions. It is believed that field artillery is incorporated in a mountain division only when the division is expected to operate for prolonged periods in areas where a large proportion of the land is flat.

Mountain troops, particularly in the Caucasus, have been supported along mountain roads by self-propelled guns, particularly the 75-mm assault gun (*7.5 cm Stu.G.*). These self-propelled weapons are apparently not organic weapons of mountain divisions, but are attached as required.

Mountain units at present operating in the Balkans are armed principally with the former standard German 75-mm mountain howitzer (*7.5 cm Geb.K. 15*). This piece is of Skoda design. Similar mountain howitzers of the same model and basic design were in use in the Italian, Polish, and Yugoslav armies. That these weapons have probably been introduced into German SS mountain divisions is indicated by the capture of Polish-made Skoda M15 howitzers in North Africa. Also included in the armament of German mountain units in the Balkans is the Skoda M16 100-mm mountain howitzer. Introduced by the Austro-Hungarian Army during the last war, this weapon proved very valuable. After the occupation of Austria, German mountain troops were furnished with the M16. It is to be presumed that Skoda M16's used in the Italian and Yugoslav armies are also employed in the Balkans. The Polish Skoda version of the M16 is believed to be slightly different from Austrian, Italian, and Yugoslav howitzers with the same designation, but may nevertheless be encountered in German mountain units.

Reports of the present campaign in the Italian mountains indicate that German artillery battalions have generally been disposed as follows: The batteries occupied positions approximately 1 to 2 miles from the main line of resistance, and battalion headquarters was established usually between the main line of resistance and the batteries (five-eighths of a mile to 1 mile behind the main line of resistance). The main observation post was about five-eighths of a mile from the main line, and the forward observation post was either in or in front of the main position. The combat train (*Gefechtstross*) was taken up, like the batteries, to a point 1 to 2 miles to the rear of the main line of resistance, while the second echelon (*Mitteltross*) of the supply

train was generally established about 6 miles from the main position. The rear echelon (*Ferntross*) was about 12 miles to the rear.

30. MOUNTAIN ENGINEER BATTALION

In addition to the engineer platoon of the mountain infantry regiments and battalions, the German mountain division has an engineer battalion (*Gebirgspionierbataillon*) of about 1,000 men. The proportion of engineers to infantry is considerably greater in the mountain division than in the regular infantry division.

The battalion includes a light motorized engineer company, a light motorized engineer column, 2 companies of mountain engineers (pack), and a bridge column. The battalion has 34 machine guns, 9 antitank guns or antitank rifles, and grenades, flame throwers, barbed wire, mines, demolition equipment, and engineer tools in approximately the same quantity as carried by the infantry-division engineers. The special bridge column, designated as Bridge Column "G," carries 2 aerial tramways and other bridging equipment. The only other important distinctive feature of the battalion is the transport of the mountain engineer companies. Pack animals carry much of their equipment; such vehicles as they have are animal-drawn.

31. MOUNTAIN SIGNAL BATTALION

In organization and armament the German mountain signal battalion (*Gebirgsnachrichtenbataillon*) is not much different from the signal battalion of the regular infantry division. It is armed with 17 machine guns. It is reported to have some special equipment adapted to mountain conditions, but the nature of that equipment is not definitely known.

32. MOUNTAIN SERVICES

The most notable characteristic of the German mountain services as a whole is the greater manpower that they require. There is roughly one supply soldier to every four infantrymen in a regular

infantry division, and one for every two in the mountain division. The necessity of maintaining a valley echelon with motor transport, a mountain echelon with pack transport, a carrying unit for back-packing, and a very large veterinary unit for the pack animals accounts for the high proportion of supply personnel.

Little is known concerning special equipment carried by the mountain services except the medical service. The medical equipment of mountain troops, from the simplest first-aid kits to the equipment of the division medical unit, is specially designed.

Because a very small unit is likely to be separated from all medical personnel for several days, a small German command, before undertaking its mission, receives a pouch which the unit medical officer fills from unit stores with essential supplies, such as quick adhesive dressings and dressing packets, elastic bandages like the U. S. "Ace" bandage, metrazol (a heart stimulant), aspirin, and salves for sunburn, frostbite, and sweaty feet. All doctors in German mountain units carry with them a medical pouch similar to that issued to doctors in infantry-division units, except that it fits conveniently in a rucksack and contains a few special items such as snake-bite and tetanus serums and elastic bandages.

The use of mules and men for mountain transport necessitates special packing for mountain medical equipment. The maximum German medical pack load is about 220 pounds, and the maximum man load about 90 pounds. Pack loads are balanced, putting equal weight on both sides of the animal. The medical chest for mountain troops is packed in four containers of approximately equal weight and of special construction. On mules two containers are packed on either side of the animal, while a single container can be carried like a knapsack on a man's back. The battalion surgeon's full set weighs over 1,000 pounds; it can be divided into loads for five pack animals. The first animal carries the surgeon's combat chest, and the second a reserve chest of identical content. This accords with the German practice of carrying duplicate allotments

of all essential medical supplies. Specially constructed wood carriers (*Kraxen*) are provided as reserve carriers; they may be strapped to the back like a knapsack.

The mountain division medical unit has 25 mules and 3 trucks. It is divided into 3 groups: the division aid group with 16 mules, carrying a 1-ton load; the reserve group with 9 mules and 1 truck, carrying a 3-ton load; and the valley group with 2 trucks. The aid station unit carries the mountain division combat set, while the valley group carries as a supplement to this set a regular division combat set as well.

Mountain-division medical troops receive several special items of equipment for the care and evacuation of the wounded. The mountain oxygen unit in battalion and division aid stations contains about 40 cubic feet of oxygen and weighs 48 pounds. Equipment for evacuation of casualties includes a simple rucksack seat, a litter attachable to an improvised ski sled, a regular sled litter, and the army mountain stretcher, which permits moving a serious casualty over the most difficult terrain with minimum discomfort.

33. REPLACEMENT BATTALION

The German mountain division has attached to it a replacement battalion (*Feldersatzbataillon*) of approximately 800 men of various arms and services who are trained mountain troops. From this battalion the division draws its normal replacements, but in a serious emergency it may employ whole units of the battalion in combat.

Appendix. FIRING IN MOUNTAINS

The material in this appendix is an edited translation of sections of two German artillery manuals: ***Ausbildungsvorschrift für die Artillerie (A.V.A.), Heft 6, Schiessvorschrift, 1937 (Training Manual for the Artillery, Volume 6, Firing Manual, 1937,*** *and* ***Erläuterungen und Anwendungsbeispiele für den Gebrauch der Schiessbehilfe für die leichte Feldhaubitze 18 . . ., 1940 (Explanations and Examples of the Use of Firing Aids for the Field Howitzer 18 . . ., 1940).*** *Figures 36, 37, 38, and 39 have been redrawn from sketches in the first of the above-mentioned manuals. The illustration of a German graphic firing table in figure 40 is not a drawing in exact scale. It is a revised reproduction of a diagram in the second of the above-mentioned manuals. All numbers are illegible in the original; those appearing in the illustration have been added by the editor.*

34. PECULIARITIES OF FIRING

Firing at targets on gentle, easily observed slopes that run across the line of fire is not different from firing in the flat. In irregular, extremely rugged terrain, however, it is likely to be difficult to place an initial round where it can be sensed. Even after an adjustment has begun, successive rounds are likely to disappear after small shifts in range and deflection. Factors which will help in sensing on the first round are as follows:

(a) Accurate determination of deflection, range, and site (for this purpose, a map with a scale of 1:50,000 or larger must be used).

(b) Firing the initial round into terrain in the target area where observation is easy, and then moving the succeeding rounds on to the target by short bounds.

(c) Adjustment with a time fuze.

To avoid losing or getting doubtful sensings on succeeding rounds, it must be realized that the actual effect on the ground of a change in elevation depends on the point on the trajectory at which impact takes place (fig. 36) and on the slope of the terrain with respect to the trajectory at the point of impact (figs. 37 and 38). Moreover, when the direction of slope in the target area runs

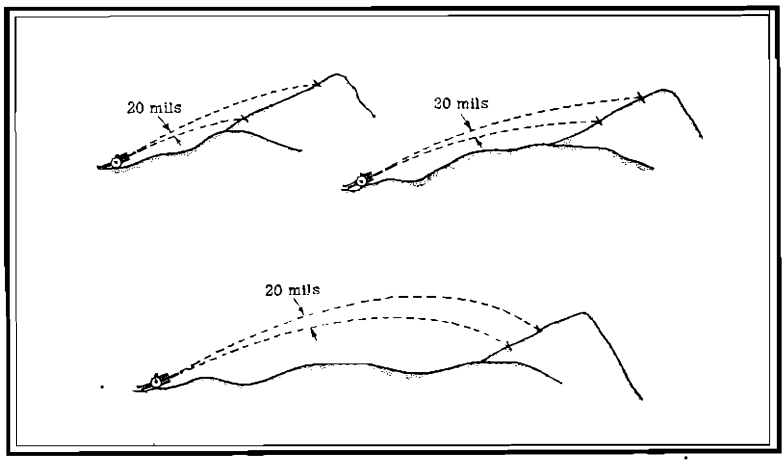

Figure 36.—Effect of equal increases of elevation on range at various points on the trajectory.

transverse to the direction of fire, a shift in deflection can affect the range considerably. A shift in deflection in the uphill direction will decrease the actual range (fig. 39 Ⓐ, p. 114), and a shift in the downhill direction will increase it (fig. 39 Ⓑ, p. 114).

Against targets near which both longs and shorts are lost, the first round is called long or short even though it is lost. Then range shifts are ordered, and in unfavorable impact areas shifts in deflection as well, until a positive sensing is obtained. Then the rounds are brought to the target by small shifts in elevation, the extent of which are determined by the configuration of the terrain,

until a bracket is attained. From then on, normal firing procedure is followed.

If the target area is extremely small, the mission can be accomplished best by using time fire both in adjustment and for effect. For this purpose, two possibilities must be distinguished. In the

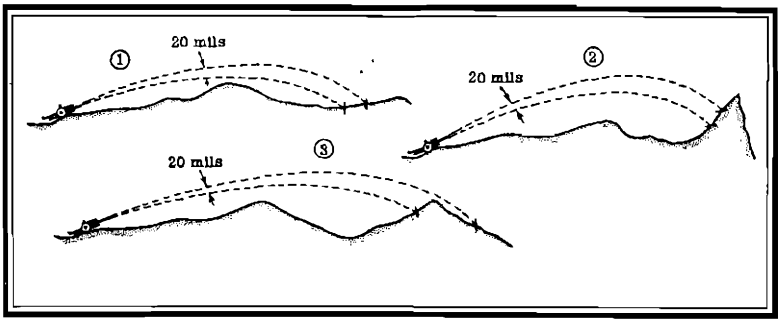

Figure 37.—Effect of terrain on range for equal changes in elevation—descending branch of the trajectory.

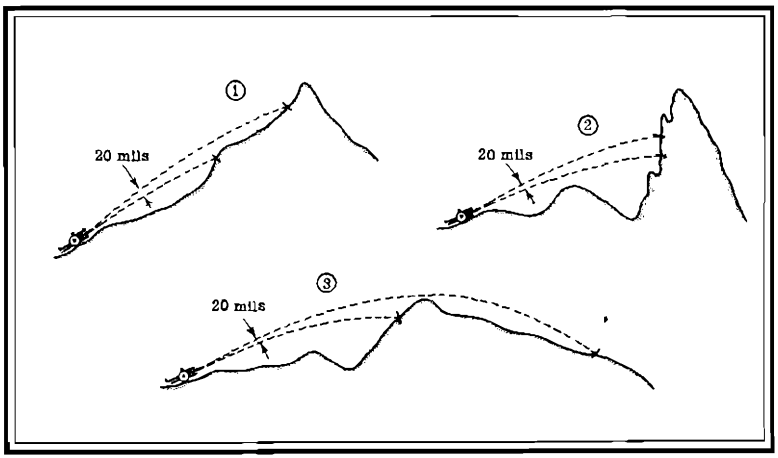

Figure 38.—Effect of terrain on range for equal changes in elevation—ascending branch of the trajectory.

axial conduct of fire the point of burst should first be adjusted by simultaneous changes in range- and fuze-setting until a satisfactory height of burst (about 50 percent graze bursts and 50 percent air bursts) is attained over the target; fire for effect is then begun. If the extent of the target requires it, further range shifts and corresponding changes in fuze-setting are made. In the lateral conduct of fire the point of burst must be shifted along a high trajectory until a sensing on the observer-target (OT) line above the target is obtained. Then with cautious changes of the angle of site, the point of burst is brought on to the target by the ordinary methods for adjustment and fire for effect prescribed for the lateral conduct of fire.

In firing at crests and ridges the target is approached by about 25-yard (¼ of c) bounds until a target hit or an over occurs. After a target hit, three rounds are fired at the same elevation; after an over, three rounds at 25 yards (¼ of c) shorter range. If these rounds are all short, 25 yards (¼ of c) are added; if

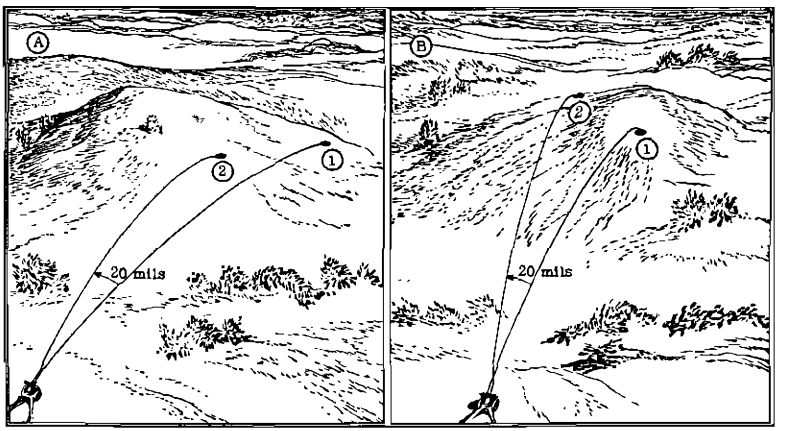

Figure 39.—Effect of change of deflection on range in terrain sloping across the line of fire. (The encircled figures indicate the order of firing the rounds without a change of elevation.)

over, subtracted. This procedure continues until shorts and overs are obtained at the same range-setting.

In firing at targets on steep slopes the center of impact should not be placed on the target, but in an area above the target, in order to profit by the effect of rockfall and avalanches.

Mountain targets are generally as follows:

(a) Strongpoints.
(b) Machine guns, mortars, and guns emplaced in the open, dug in, or in caves.
(c) Observers.
(d) Riflemen in motion.
(e) Marching columns.
(f) Shelters.
(g) Traffic centers.

For adjustment on (a) and (b), percussion fuzes are used; on (c) through (g), time fuzes. In fire for effect, the choice of time or percussion fuzes depends on the cover protecting the target.

35. GRAPHIC FIRING TABLES

Since mountain firing is usually done at targets which are either over or under the horizontal, the firing data must be taken from graphic firing tables. Graphic firing tables are necessary for—

(a) Determining whether effective fire is possible.
(b) Choosing the most suitable charge.
(c) Determining the elevation under standard conditions for a target that is over or under the horizontal.
(d) Determining the time of flight.
(e) Determining the change in the amount of drift that results from firing on targets above or below the horizontal.
(f) Determining the angle of impact.
(g) Determining dispersion.[1]
(h) Determining the setting for a time fuze.
(i) Applying the calibration correction.
(j) Adjusting by air-bursts.
(k) Clearing hills and masks.
(l) Measuring dead space.

[1] Or probable error.—EDITOR.

An example of a graphic firing table is shown in figure 40 (following p. 124). This specific example cannot be used to determine firing data, because certain essential data are illegible in the original German diagram and because the diagram itself is somewhat distorted. However, constant reference to figure 40 while reading the description and explanation of the graphic firing tables will help to make clear the German method of employing the device.

Graphic firing tables are used to determine firing data for all targets, especially for those not on the same level as the piece, for which the tables of angle of site no longer give values.[2] Graphic firing tables are handy and weatherproof, and therefore especially suitable for use in the field. They give the exact course of all standard trajectories, but values between 20-mil bounds in elevation must be interpolated by inspection. Values which can be determined only approximately on the standard firing table can be determined exactly with the graphic firing tables. They give firing data for all factors determined by the trajectory for targets not on the same level as the piece, and facilitate firing over masks. When graphic firing tables are used, differences in elevation must not be set on the angle-of-site scale of the piece; to do so would result in a double correction for site.

If a piece is fired in a certain direction at 0-elevation and fire is continued with 2-mil increases in elevation and 2-mil shifts to the right in deflection until maximum elevation is reached, the resulting trajectories taken together are called the trajectory mass. If no account is taken of the curve in direction resulting from drift, and it is assumed that the trajectories lie in the plane of departure, that is, in the perpendicular plane through the axis of the bore, then in such a trajectory mass each of the planes of departure from the firing position forms a trajectory at its intersection with the surface of the trajectory mass. Now if the trajectory mass is cut by a number of horizontal planes 25 meters apart, thus producing

[2] The site table for the German 105-mm howitzer (*H.H. 18*) does not give values for sites more than 80 mils plus or minus.—EDITOR.

a number of contour lines where they intersect the surface of the trajectory mass, a projection of these contour lines as a plane sketch on the metal surface of the graphic firing table will give the ground plan of the trajectory mass. This projection is similar to a scale reproduction of the terrain on a map by means of contours.

Graphic firing tables are usually scaled 1:25,000. For each charge a special trajectory map is necessary. To facilitate measurement, the contours are marked with lines of varying thickness. At intervals of 500 meters they are marked very heavily and their altitude is indicated. The 100-meter lines are lighter, and the 25-meter lines very light.[3] The 0-contour, that is to say, the horizontal, is a red line. The portion of the trajectory mass below the horizontal is bordered in red, and the altitudes are underlined. From the 0-point, that is, from the gun position out, map distances are indicated by arcs at 1,000-meter intervals. Intermediate distances from the 0-point are indicated at 25-meter intervals along a straightedge that accompanies the tables.

The lighter curves that cut the contour lines show equal time of flight; they indicate the points on the surface of the trajectory mass which will be reached in equal times of flight on all trajectories. These time-of-flight curves represent 2-second intervals, and are marked accordingly on the edges of the trajectory map. The curves of drift, fuze-setting, and lateral and diagonal dispersion are similar to the time-of-flight curves. These curves are not indicated on the trajectory map, but the appropriate data are recorded in a data chart accompanying the trajectory map for each charge.[4]

The maximum ordinates of all trajectories for a single charge are connected by a black line (labeled "Maximum ordinate line"

[3] The 25-meter contour lines are not shown in figure 40.—EDITOR.

[4] In the original diagram none of the headings of the data charts is legible. The description in the text of a typical chart, however, indicates that the first column gives times of flight and that other columns provide the corresponding data on drift, fuze-settings, lateral dispersion, and diagonal dispersion.

in the border of fig. 40). The projections of all trajectories would appear on the graphic firing table only as rays; they are not drawn in but are represented by the reading edge of a movable straightedge. Every point on the reading edge corresponds to a point on the trajectory looked at from above. Hence the reading edge can represent the configuration of any trajectory projected as a line.

The appropriate elevation is taken from a scale arc laid out above the trajectory map for each charge. This arc has two parts. The lower part gives the elevation in mils for the trajectory represented by the straightedge. This is the elevation for all points on the trajectory regardless of their distance from the 0-point, or gun position. The upper part of the scale arc gives the corresponding range to the horizontal in meters as it appears in the standard firing table. It thus represents only the distance to the point of intersection of the trajectory with the 0-contour, that is to say, with the horizontal.

36. USE OF THE GRAPHIC FIRING TABLE

a. Determining Trajectory Values

(1) *Charge and elevation.*—First the range and the altitude of the target must be determined, from a contoured map if possible. Then if the angle-of-site table no longer gives values, the graphic firing table must be employed. The charge is determined by using the straightedge to find out on which of the trajectory maps the map distance in question intersects the contour line of the target.

Example 1

Matériel	105-mm howitzer (*I.F.H. 18*) with HE shell (*F.H.Gr.*).
Map distance to target	4,175 meters.
Height of target	300 meters above the gun position.

On the chart for Charge 1 the 4,175-meter point on the straightedge does not intersect the target at the 300-meter contour line; therefore, the target cannot be reached with Charge 1, and a greater charge must be used.

Standard German artillery procedure is then followed to de-

termine which charge to use to take the target under fire. It is necessary, however, to determine whether all intervening masks can be cleared.

Continuation of Example 1

On the map for Charge 2, the 4,175-meter point on the straightedge intersects the 300-meter contour line at an elevation of 670 mils. Since this is above the maximum elevation prescribed for firing on a target, Charge 3 must be used. The straightedge is then laid on the trajectory map for Charge 3 with its 0-point at the gun position, and it is traversed along the map until its 4,175-meter point coincides with the 300-meter contour line. Then the elevation is read where the straightedge intersects the elevation scale of the scale arc. The reading is 462 mils. A range to the horizontal, or range-setting, of 4,800 meters is found at the intersection of the straightedge with the upper, or range, scale of the scale arc. Note that the elevation of 462 mils read off the scale arc is quadrant elevation; it includes the correction for site. Therefore, when the graphic firing table is used, the fire command for site is always "Si 300."

(2) *Masks.*—The height of this trajectory above the horizontal at each successive map distance can be determined by sighting backward along the straightedge. Thus, for example, the maximum ordinate lies 2,450 meters from the piece and is 625 meters high. In this manner it is possible to find out by inspection whether heights and masks along the entire course of the trajectory can be cleared. The procedure does not take dispersion into consideration, but by adding a sufficiently large safety factor for unknown influences on the trajectory, it can be determined accurately enough whether the target can be taken under fire.

b. Angle of Fall and Angle of Impact

The procedure to be followed in determining the angle of fall at the point of impact is the same as that used in determining slope of terrain on an ordinary contour map. This angle of fall can be determined without computation by using an angle-of-fall scale which is marked on the straightedge opposite the meter scale.[5]

[5] The angle-of-fall scale is not legible in the original.—EDITOR.

Continuation of Example 1

With the straightedge in position on the trajectory map as above, the distance between the two 100-meter contour lines enclosing the target is laid off on a strip of paper. This distance when compared with the angle-of-fall scale gives an angle of fall of about 350 mils.

If the target is in a flat area, then the angle of fall gives an approximate value for the angle of impact. If the terrain rises or falls, the angle of impact must be determined by more precise methods.[6]

c. Time of Flight; Drift; Fuze-Setting

The time of flight is read directly at the intersection of the straightedge with the time-of-flight curve at the target, or it is estimated by interpolation between the two adjacent time-of-flight curves.

Continuation of Example 1

The time of flight in this example is determined by interpolation to be 19.5 seconds. According to the data chart, standard drift for this time of flight on this trajectory is R 12 for Charge 3.

After determining the time of flight, the setting for a time fuze in degrees[7] to the desired point of burst is taken from the data chart for the appropriate charge.

Continuation of Example 1

In the present example, this procedure gives a fuze-setting of 124 degrees.

d. Dispersion

After determining the angle of fall at the point of impact, and

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[6] If the terrain slopes up or down in the direction of fire, the angle of impact (*Aufschlagwinkel*—the smallest angle between the long axis of the projectile and the ground at the point of impact) approximately equals the algebraic sum of the angle of fall at the point of impact and the angle of slope of the terrain.—EDITOR.

[7] The German time fuze is graduated in degrees up to 360.—EDITOR.

ascertaining the diagonal dispersion[8] from the accompanying data chart, axial and vertical dispersion can be found graphically or by computation.

e. Metro Data and Masks

Only uncorrected data for computing a metro message can be taken from the graphic firing table. The time-of-flight curve at the target is followed to the point where it intersects the 0-contour line, and the metro message is computed for the map distance to this point. The correction is then applied to the uncorrected elevation for the target, taken from the graphic firing table.

The chance of clearing heights up to 1,000 meters from the gun position may be determined from the table of elevations for piece masks in the standard firing table. If the masks and heights to be cleared are farther from the piece and if the angle-of-site table does not cover the differences in altitude, the graphic firing table must be used. If standard conditions hold, that is, if the metro corrections are no more than 2 percent of the range, one can decide whether it is possible to clear the mask by rapid inspection of the graphic firing table. First determine the elevation for the target on the graphic firing table. Then, by the same method, determine the elevation necessary to reach the crest of the mask. To the elevation of the mask add one-half of the vertical dispersion required for combat conditions, computed for the crest. If the sum is less than the elevation for firing on the target, the mask can be cleared. Ordinarily a rough estimate of vertical dispersion will do, but if friendly troops are close to the mask or if there is a large deviation from standard conditions, then the vertical dispersion must be determined accurately by a computation based on diagonal dispersion. In these circumstances the graphic firing table can be used only to determine the uncorrected data.

[8] Diagonal dispersion (*Querstreuung*) is the perpendicular distance between the tangents to the trajectories for the ends of the 50 percent zone at the point of impact.—EDITOR.

f. Location of a Gun Position

The following example demonstrates the method of locating points from which a height in the target area can be cleared.

Example 2

At a point 1,000 meters in front of the target rises a hill 250 meters higher than the target. In order to take the target under fire, how far from it must the gun position be when the target lies—

(1) On a level with the piece?
(2) 500 meters higher?
(3) 300 meters lower?
(This example is based on Charge 5.)

One thousand meters are scaled off on a strip of paper, and the strip is laid on the straightedge, which is placed on the trajectory map. The straightedge is then traversed to the right, and if the target is at the same altitude as the piece, the strip is simultaneously pushed upward to keep it in coincidence with the 0-contour line, until the strip fits between that contour and the +250-contour line. In the chosen example the suitable trajectory is at an elevation of 250 mils and the corresponding map distance, *as read from the straightedge*, is 5,150 meters. Assuming standard conditions and without considering dispersion, the battery or gun must go into position at least 5,150 meters from this target in order to take it under fire.

If the target area is 500 meters above the gun position, then one end of the 1,000-meter strip is kept in contact with the +500-meter contour line until the strip fits between the +500-meter and the +750-meter contour line (+500+250=+750). Here the elevation is 403, and the map distance from the gun position to the target is 6,000 meters.

If the target area is 300 feet below, then the strip is moved with one end on the —300-meter contour line until the other end touches the —50-meter contour line (—300+250=—50). The result is an elevation of 132 and a distance of 4,425 meters.

Where it is safe to fire into the mask in front of the target, dispersion does not present a serious problem. Otherwise, the dispersion must be allowed for in a computation based on the diagonal dispersion, and thus the distance of the gun position from the target will be considerably increased. Since nonstandard conditions must be taken into account, it is important to allow a considerable safety factor in the selection of a firing position. If the

influences affecting the trajectory are far from standard or if short rounds which would burst in the mask must be avoided, the elevation for clearing the masks must be determined precisely on the basis of a metro message.

g. Special Firing Precautions

If the terrain near the target falls away sharply, even slight shifts in elevation may cause considerable variations in the range (see figs. 37 ③ and 38 ③, p. 113). On the other hand, in the case of steeply ascending target areas bold range bounds may be necessary, although the first rounds do not fall very far from the target (see figs. 37 ② and 38 ②, p. 113).

The thin air and the low air pressure in the higher atmospheric layers often cause the burning time of the powder train to increase considerably, so that in the mountains the fuzes, unless they are mechanical time fuzes, produce a delayed detonation. Consequently, the fuze-setting must be somewhat less than for standard conditions. After firing with a time fuze at a target accurately located on a map, the difference between standard and adjusted data for the fuze-setting may be taken into consideration in later firing in the same area under similar weather conditions.

For indirect laying, the chief of section corrects for the calibration of his piece according to the directions on the shield. The directions contain accurate values only for targets which are nearly on a level with the piece. When differences in elevation between the gun position and the target are great, the correction, strictly speaking, is a function of the time of flight, but correction based on the map distance gives sufficient accuracy. In this case the map distance as well as the elevation for the target must be made part of the fire command.

Example 3

A 75-mm mountain howitzer (*7.5 cm Geb. K. 15*) that fires eight calibration units over is firing with Charge 3 at a target at a map distance of 4,000 meters which is 750 meters above the gun position. The command is "Si 300, map distance 4,000, F ①, 5,300." The calibration correction correspond-

ing to the elevation for a range of 5,300 meters in the horizontal calls for a shortening of the range by 200 meters; the correction corresponding to the elevation for a map distance of 4,000 meters calls for a shortening by 160 meters. Therefore, there is a difference of 40 meters.

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(For explanation of symbols, see FM 21–6.)

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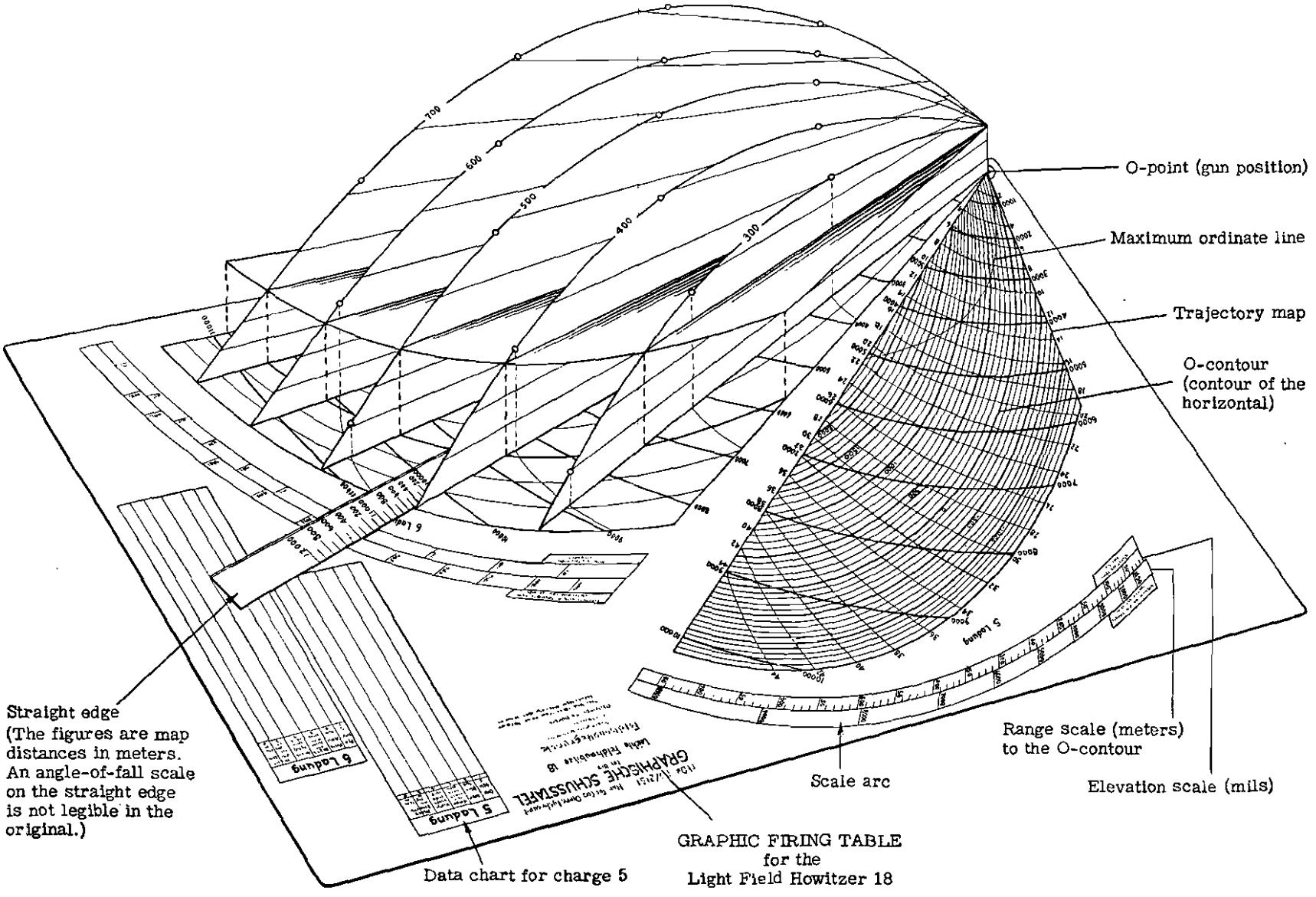

Figure 40.—Example of a German graphic firing table. (A spatial diagram of trajectories is superimposed on the trajectory map for Charge 6 in order to illustrate the construction of the graphic firing table.)