EQUIPMENT • TECHNIQUES OF ALPINE ICE CLIMBING • ROPED CLIMBING TECHNIQUES • PRACTICING FOR THE FREEDOM OF THE HILLS

CHAPTER 19

ALPINE ICE CLIMBING

Ice is found on or around the summits of many alpine peaks, and developing ice climbing skills increases climbers' opportunities for safe exploration of those summits. With proper skills, they will be able to use ice as yet another avenue to the alpine realm.

To climb ice, mountaineers use much of what they have learned about rock and snow climbing, adding the special tools and techniques needed for climbing ice. Ice climbers experience the same joys as snow climbers do and face the same perils: avalanches, hazardous couloirs and unstable cornices, ice blocks, and icefalls. Ice climbing opportunities can be found year-round, from climbing waterfall ice on the short, dark days of winter to ascending alpine ice on long, warm summer days.

Ice can appear in a variety of forms. Under the combined effects of pressure, heat, and time, snow and other forms of frozen precipitation metamorphose into the alpine ice of glaciers, icefields, and couloirs. There is no clear distinction between alpine ice and hard snow. Alpine ice sometimes appears as blue ice; this hue means that the ice is relatively pure. Black alpine ice—old, hard ice mixed with dirt, pebbles, or other debris—is another common variation. Liquid water freezes to form water ice. Water-ice formations can be as dramatic as a frozen waterfall or as common as *verglas*, the thin, clear coating of ice that forms when rainfall or melting snow freezes on a surface, such as rock. Verglas is difficult to climb because the thin, weak layer provides scant purchase for crampons and ice tools. Old alpine hard water ice is usually the most compact and difficult-to-penetrate form of ice when compared with alpine névé or more recently frozen alpine ice.

The next chapter, Chapter 20, Waterfall Ice and Mixed Climbing, hones in on very steep ice and mixed ice and rock. This chapter covers the rest.

Ice is as changeable and ephemeral as snow. A rock route is likely to be there unchanged for years or decades, but what was a water-ice route in the morning may be, by afternoon, nothing but a jumbled pile of ice blocks or a wet spot on the rock. Similarly, with glacial alpine ice a single route may morph throughout the year: in early season the climb may be a straightforward jaunt up perfect névé, but by August or September (in the northern hemisphere) it becomes a jumble of crevasses and seracs requiring as much routefinding ability as it does technical climbing skills.

Climbers must learn to anticipate the changeability of ice. Ice can exhibit a wide range of characteristics. At one extreme, it can seem as hard as steel; ice tools bounce off it, barely scratching the surface. Hard ice can also be as brittle as glass, requiring climbers to expend time and energy chopping away at the surface until they can plant an ice tool without the placement shattering. At other times, ice can be soft and plastic, allowing climbers to make secure placements effortlessly with a single swing—an ice climber's dream. Ice can also be too soft and weak to provide good protection placements or to support a climber's weight. It takes experience to assess the relative condition of ice.

TABLE 19-1. STEEPNESS OF SLOPES

DESCRIPTION	APPROXIMATE ANGLE OF STEEPNESS
Gentle	0° to 30°
Moderate	30° to 45°
Steep	45° to 60°

Extremely steep	60° to 80°
Vertical	80° to 90°
Overhanging	Greater than 90°

As is true of all types of climbing, the steepness of the slope greatly affects which ice climbing technique is appropriate. On flat névé—or on relatively level areas of rock-impregnated ice such as a glacier below the firn line—it is usually possible to walk without crampons. But on flat ice that is hard and smooth, crampons might be needed to avoid falling. Modern crampons are relatively quick and easy to put on and take off, but this can use up precious time. Occasionally, for one or two moves on a short slope where there is limited exposure, an ice axe can be used to chop steps. However, in almost every instance where the snow or ice is too firm to kick a trustworthy step, especially if it is exposed, crampons should be used.

As the slope angle increases, climbers can use French technique, also called *flat-footing*, but only up to a point. The steepest routes require front-pointing, also called *German technique*. Chapter 20, Waterfall Ice and Mixed Climbing, covers steep ice techniques in more depth.

This chapter uses the descriptive terms in Table 19-1 in referring to the approximate steepness of slopes.

EQUIPMENT

Continuing refinements in equipment have helped ice climbers improve and expand their techniques and use them to undertake greater climbing challenges. Manufacturers are producing a steady stream of specialized and innovative clothing, boots, crampons, ice tools, and ice protection. (See Chapter 16, Snow Travel and Climbing, for a general description of gear such as crampons and ice axes.) This section describes the equipment that is specific to alpine ice climbing.

CLOTHING

Clothes for ice climbing should offer a combination of comfort and function. Employ a layered system, with layers appropriate to the conditions. Whatever system you choose, ensure the components work together and use either specialized fabrics or openings to regulate your body temperature. Clothing manufacturers are constantly bringing forward new fabrics that dissipate excess heat while still providing warmth, water repellency, and wind protection. Pants with side zippers ventilate the lower body without exposing your boot tops. Jackets with armpit zippers also allow you to regulate your temperature. It is important to choose unrestrictive clothing that stretches as you move and is designed to stay put when you lift up your arms. See Chapter 2, Clothing and Equipment, to learn more about technical climbing clothes for various conditions.

Handwear

Ice climbers' hands need protection from dampness, cold, and abrasion. The type of handwear you choose and use depends on the difficulty, steepness, and conditions of the ice or snow. Your choices always strike a balance between dexterity, strength, and warmth. Walking or climbing low-angle alpine snow or ice on a summer day with an ice axe in hand may require nothing more than a pair of lightweight gloves. Climbing steep, deep snow on a cold day and plunging your ice tools and hands well under the surface calls for a well-insulated pair of bulky gloves or mitts with waterproof taped shells. When ascending steep to overhanging snow and ice, the best choice is gloves with a snug fit and enough friction on the palms to allow a good grip on your tools. Thin gloves provide dexterity to place screws or manipulate gear.

Some climbs may demand several different pairs of gloves or mitts. For example, on long, cold technical routes you may want to use a lightweight pair of gloves or liners for the nontechnical approach, a pair of thin, snug gloves for climbing—plus a spare in case they get wet or lost—along with a thick, warm pair of gloves or mittens to keep your hands warm at belays or rests.

BOOTS

When you select boots, it is essential to get a precise fit: room for the toes to wiggle a little but snug in the instep and heel. There should be minimal lift at the heel to prevent stress on the calves when front-pointing or walking, yet not so snug over the top of the foot that circulation to the toes is impeded. Be sure to fit boots to accommodate the sock system you will wear. Most modern mountaineering boots have molded toe and heel grooves to accommodate clip-on crampons.

Leather and synthetic. For alpine ice climbing in moderate to cold conditions, modern leather or high-performance synthetic mountaineering boots are the best choice. Boots used for extensive front-pointing must have very stiff soles to prevent overstressing the crampon frame or letting the foot twist out of a clip-on crampon binding. In French technique (flat-footing), ankle rotation is critical; boots must permit good range of motion, and leather boots are better in this regard. For extreme cold, or at high altitude, double boots, with a removable insulated liner, provide extra warmth. The outer and inner boot materials on modern double boots are an ever-changing combination of fabrics and foam materials and even carbon fiber insoles. Boots keep getting lighter and better.

GAITERS

Today, few alpine and waterfall ice climbers use full-length gaiters. Some alpine ice climbing boots now come with built-in gaiters to repel snow, ice, and moisture. Modern climbing pants feature either an integrated gaiter, hooks or straps that go under the boot (so the pant leg acts as a gaiter), or pant cuffs fit close enough to the boot that gaiters are not needed. Hardshell pants are another common alternative. Sometimes a climber opts for short gaiters that cover only the boot top and are worn underneath pants. However, there are conditions in which full-length gaiters may be useful, such as deep snow or very cold temperatures. When using full-length gaiters, make sure they fit your boots securely, can accommodate any additional layers of insulation you wear on your legs, and can accommodate your specific crampon attachment method. Gaiters or pants with reinforced leg bottoms can help prevent abrasions and snags from crampon points.

CRAMPONS

A variety of modern crampons are available for different types of snow and ice climbing, including technical crampons designed for better performance on steep ice and for mixed climbing. (See “Crampons” in Chapter 16, Snow Travel and Climbing.) Regardless of the type of crampons selected, points must be sharp; the harder the ice, the sharper the points need to be. Check the points before each climb and sharpen them if necessary before setting out.

Front and Secondary Points

The front points on nearly all crampons, whether intended for use on alpine climbing or waterfall ice, are angled downward. The front points on crampons designed for snow and alpine ice are often oriented horizontally to give them more purchase in snow. Waterfall ice crampons, on the other hand, often have front points oriented vertically to give better penetration in hard ice (fig. 19-1). The secondary points immediately behind the front points are angled forward on most modern crampons to provide added stability.

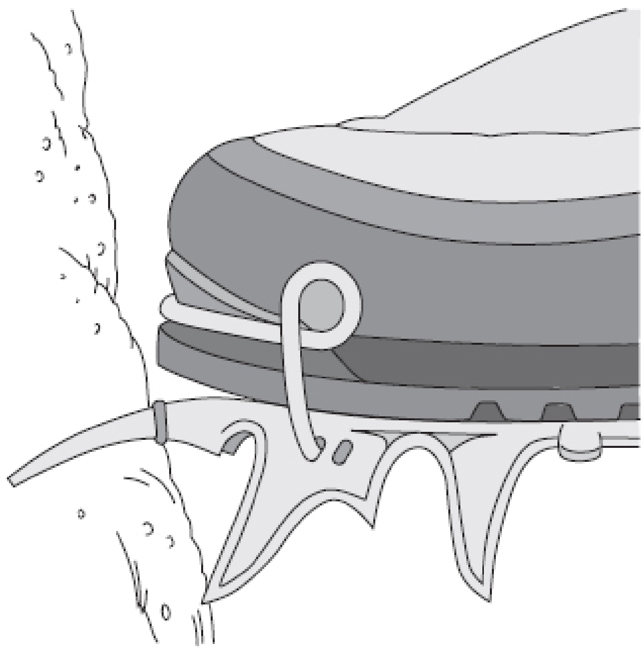

Fig. 19-1. Side view showing how front points and secondary points on crampons engage in near vertical ice.

ICE TOOLS

Ice tools come in three basic styles. For steep ice (greater than 45 degrees), it is advantageous to have a hybrid ice axe similar to a general mountaineering axe but with a slightly bent shaft. Hybrid ice axes come in various lengths. They generally have an integrated pick and adze or hammer, but they are also available with a modular head to accommodate replacement picks.

For extremely steep terrain (greater than 60 degrees) it is better to have a bent-grip shaft ice tool with teeth with a grip rest at the base of the shaft. For extremely steep and vertical ice and mixed climbing, many climbers prefer an ice tool with an ergonomic handle and bent shaft. These tools come in fixed lengths (commonly 50 centimeters) and have a modular head to accommodate different types of picks, with a choice of hammerhead or adze (see Chapter

16, Snow Travel and Climbing, for a description of ice axes versus ice tools). Some ice tools have removable head weights that allow climbers to fine-tune the tool's "swing weight."

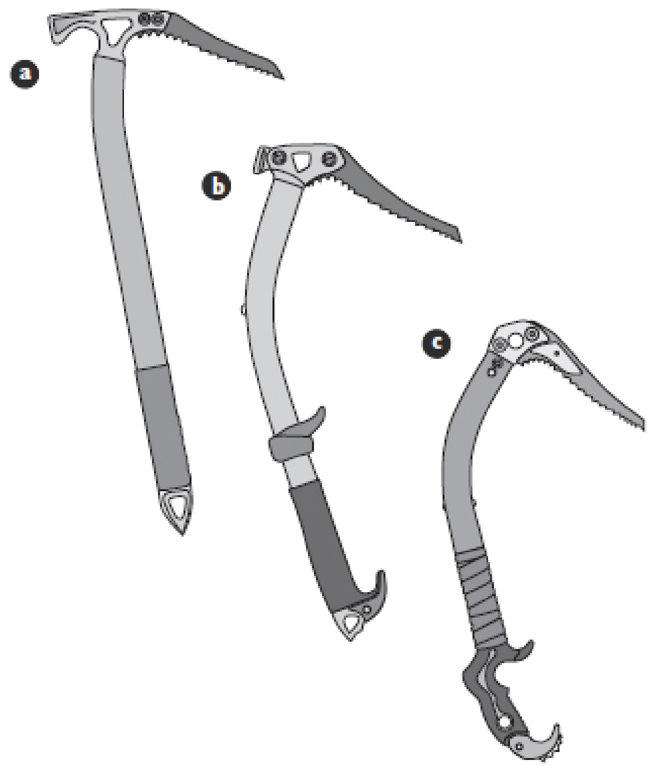

Fig. 19-2. Typical ice tools: a, technical ice axe, with hammer; b, semimodular tool; c, modular tool.

Ice tools are usually equipped with a hammer opposite the pick rather than an adze (fig. 19-2a). However, for alpine routes where excavating snow or digging a tent platform in dirt or gravel might be required, some climbers prefer to equip one ice tool with an adze. Having a sharp adze when ice climbing deserves caution. If a tool with an adze suddenly pops out of the ice or slips off a hold, it can cause a nasty gash on a climber's face.

Modern ice tools feature modular and semimodular designs. With semimodular tools, only the pick is interchangeable (fig. 19-2b). Fully modular tools provide the option of interchangeable picks and adzes or hammers (fig. 19-2c). Being able to replace picks, adzes, and hammers as the need arises provides added flexibility because the tool can be assembled to accommodate prevailing conditions, or a broken pick can be replaced in the field.

There is no standard fastening system for interchangeable parts on modular ice tools. Components of one manufacturer's system are not compatible with those from another company, and some systems are easier to use than others. The trend has been to design fastening systems that require a minimum of tools. The components of some ice tools are designed to be changed by using a simple wrench, or the pick or spike of another ice tool made by the same manufacturer.

QUESTIONS TO CONSIDER WHEN SELECTING ICE TOOLS

When selecting ice tools, ask the following questions:

- Are the tools designed for the kind of climbing I intend to do?
- Do the tools swing and penetrate the ice well?
- If I'm going to use them for mixed climbing or dry tooling, do the tools work well on both ice and rock?
- Can I comfortably grip the tools with the type of gloves I will be using?

What is the "perfect" ice tool? It is whatever works best for you. Try to demo a variety of tools on ice to determine which work best for you in terms of weight, technical features, and how they handle. See the "Questions to Consider When Selecting Ice Tools" sidebar.

The styles of ice tools vary greatly. The following sections describe the principal design variations of the parts of the ice tool: shaft, pick, adze or hammer, spike/teeth, and tether.

Shafts

Ice-tool shafts are mostly manufactured from aluminum alloy, carbon fiber composites, and steel. Only general mountaineering ice axes now come with straight shafts. Ice tools intended for steep terrain (greater than 45 degrees) all come with bent shafts that enable the tool to reach around bulges in the ice and keep the climber's fingers from hitting the ice when swinging. The angles of bent shafts can vary (figs. 19-3a, b, and c) depending on the purpose of the tool. The sharper the bend, the steeper the terrain it is intended for. Check to see that the curve of the bend and the swing weight complement your natural swing.

Shafts on modern ice tools to facilitate grip are usually covered partially in rubber. Although modern bent-grip tools make it easier to climb steep ice and mixed terrain, the ergonomic handle and the grip rest may impede plunging the shaft into snow. Some technical ice tools come without a grip rest, which might be a better choice for situations where there will be a lot of steep snow. The bent shaft also makes hammering pitons awkward; if a lot of piton work is anticipated, some climbers carry a light piton hammer to make that job easier.

The circumference and cross-sectional shape of the shaft affect your grip. A particular shaft might be too large or too small for your hand. A shaft that is too large in circumference is fatiguing to grip. A shaft that is too small in circumference is hard to control. A climber's choice of handwear also affects the grip (see "Handwear" above).

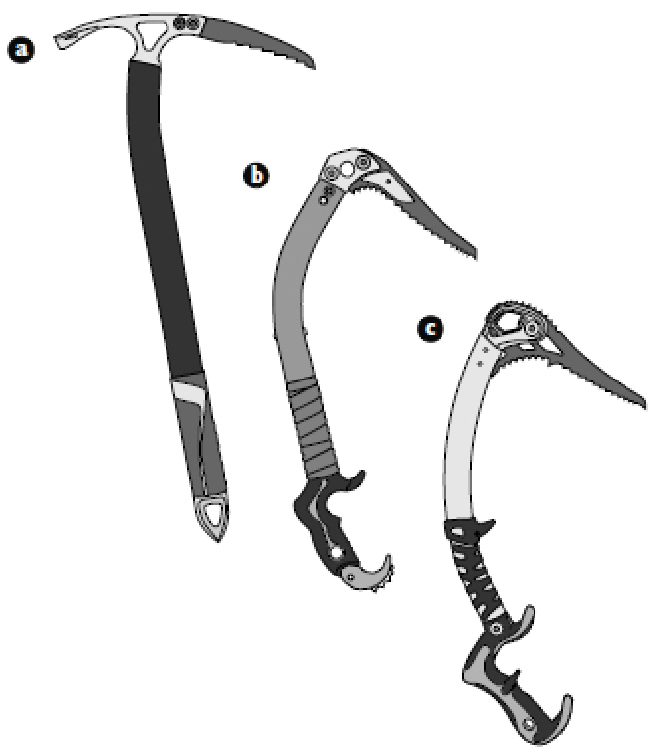

Fig. 19-3. Ice tools with various shaft designs: a, slight high-bend shaft; b, bent-grip shaft; c, compound-curve shaft.

Picks

The ice tool's pick must penetrate the ice, hold against a downward pull, and release easily when its grip is no longer needed. The holding and releasing characteristics of a pick are determined by its geometry, thickness, and tooth configuration. The teeth should be shaped to bite into the ice when pulling down on the shaft of the ice tool. In most cases, only the first few teeth provide any useful bite into the ice.

Ice-tool picks are made for the type of tool that you purchase and often come in multiple thicknesses. The thinner pick is meant primarily for pure ice with penetration. The thicker pick is a bit more likely to shatter the ice, but it is stronger and meant to be used for mixed climbing and dry tooling where torquing it in cracks and other abuse might break a thinner pick.

Technically curved. The pick of a general mountaineering ice axe curves slightly downward, whereas the technically curved pick of an ice tool (fig. 19-4a) curves down more sharply and thus holds better in ice. It is most often used on alpine ice and glacial ice climbs. It is the most effective technical pick for self-arrest.

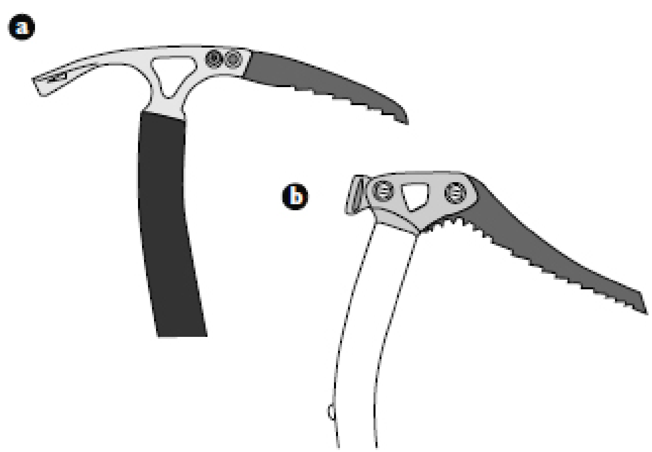

Fig. 19-4. Picks: a, technically curved; b, reverse curved.

Reverse curved. The reverse-curved pick (fig. 19-4b) is both secure and easy to remove from the ice, making it the most popular choice for extremely steep ice routes. During self-arrest, this pick grabs so well that climbers may not be able to hold on to the tool.

Picks are easily dulled when swinging into thin ice and hitting the rock underneath. Picks also get worn from climbing on rock while used when mixed climbing and dry tooling. A dull pick can be sharpened with a good file; but after being filed multiple times, the pick can get filed back to the first tooth. Once this has happened, it is time to replace the pick. A pick will last longer if it is sharpened only enough to reestablish its original shape and edge (fig. 19-5). Using a grinder may remove more metal than is necessary; take care not to weaken the pick by overheating it.

Adzes and Hammers

As with picks, ice-tool adzes come in an array of shapes and sizes. The most common adze is straight, extending more or less perpendicular to the shaft or drooping slightly downward (see Figure 19-4a). Modular ice tools provide the option of installing either an adze or a hammer.

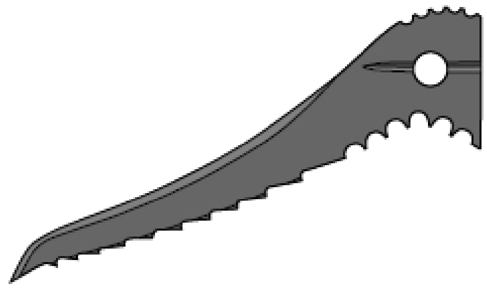

Fig. 19-5. Detail of a reverse-curved pick: note that the tip and top edge are sharp, and the sides of the teeth are beveled.

Spikes or Teeth

To penetrate ice, the spike or teeth on the bottom of an ice tool's shaft must be reasonably sharp. Most spikes have carabiner holes (see Figures 19-2 and 19-3), to which a climber can clip a tether to keep from losing the tool if dropped.

Tethers

For the most part, leashes attaching the wrist to the ice tool are no longer used when alpine ice climbing, waterfall ice climbing, and mixed climbing. To prevent the loss of a dropped tool, tethers (also called *umbilicals*) are often used. A tether is usually made of an elastic cord with a clip on one end (for attaching to the spike of the ice tool) and a loop on the other (for girth-hitching to the harness; fig. 19-6). Tethers made for two tools feature two cords and clips coming together in a single loop. Some manufacturers still provide a removable wrist leash for climbers who prefer them, but the flexibility of climbing leashless has made the use of wrist leashes almost obsolete.

Fig. 19-6. Tethers, or umbilical leashes, attached to harness.

Maintenance

Inspect ice tools before each outing, checking for rust, cracks, and other signs of wear or damage. Be sure that adzes, picks, and spikes are sharp. If the tools are a modular design, also check to see that all fastening systems are secure.

ICE SCREWS

Modern ice screws are made from steel, aluminum, or titanium alloy. Ice screws come in a variety of lengths ranging from 10 to 22 centimeters (ice screws are commonly measured in metric units). The length of an ice screw has a great bearing on its strength. A longer screw is stronger but only when the ice is thicker than the length of the screw. Modern screws include hangers with knobs (fig. 19-7), which make placement, clipping, and removal almost effortless compared with older screws (see the “History of Ice Screws” sidebar).

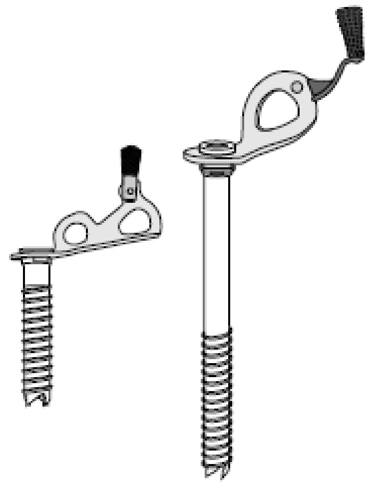

Fig. 19-7. Contemporary ice screws with various knobs and hangers.

OTHER GEAR

Ice climbers use other gear adapted specifically for ice, including racking devices, eye protection, and V-thread tools.

Racking Devices

Personal preference and compatibility with a particular harness influence how a climber chooses to rack ice screws. Most commonly, climbers use a specialized plastic carabiner that attaches directly to the harness waist belt (fig. 19-8). These devices allow ice screws to be racked conveniently and provide easy, one-handed unclipping when the gear is needed. These clips can also be used for temporarily securing ice tools. The downside of a plastic device is that it can break if pressed against a hard surface: for example, in a rock chimney on a mixed climb.

HISTORY OF ICE SCREWS

Until the mid-twentieth century, ice pitons were extra long, blade-type rock pitons with holes, notches, or bulges to increase their grip in ice. After World War II, climbers experimented with new designs that featured a greater surface area (to decrease the load per square inch on the ice) and more holes (to help the shaft freeze into the slope). In the early 1960s, when ice pitons evolved into ice screws, enthusiasts claimed that they would revolutionize ice climbing, bringing security to the slopes. Critics countered that the screws were not much better than the older ice pitons. This was true of the lightweight, relatively weak "coat hanger" ice screws, which are no longer in use. Ice screws have continued to improve and now provide reliable protection when placed in good ice.

Ropes

Standard 60- or 70-meter double ropes (see "Double- and Twin-Rope Techinques" in Chapter 14, Leading on Rock) are most commonly used for alpine ice climbing, though this depends on the type of climb and the climbers' preferences (see also Table 9-1 in Chapter 9, Basic Safety System). Double ropes are each individually lighter than a single rope. Double ropes are safe to use on ice (on rock a larger-diameter rope may provide greater resistance to abrasion and cuts from sharp edges), and they allow for full-length rappels on the descent.

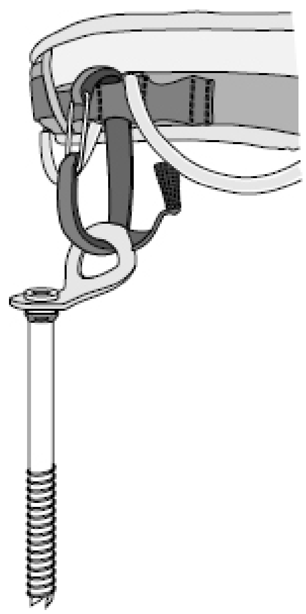

Fig. 19-8. Ice screw on a specialized racking device.

Manufacturers of all ropes, both single and double, are continuing to develop ropes of increasingly smaller diameter that satisfy international testing standards. These smaller-diameter ropes are an advantage to alpinists because they are much lighter. The trade-off is the smallest-diameter ropes may not be as durable as a larger-diameter rope.

Because ice climbing can be wet, water-repellent (“dry”) ropes are worth the extra cost. In comparison with untreated ropes, dry ropes retain more strength and are less likely to freeze—though a dry rope can still become coated in ice, and the water repellency may not last the lifetime of the rope.

Head and Eye Protection

All ice climbers should wear helmets. Most helmets have an adjustable band around the head that accommodates a lightweight hat or balaclava. Safety glasses or sunglasses are recommended to keep eyes safe from flying debris.

V-Thread Tools

The V-thread tool is a hooking or snaring device used to pull cord or webbing through the drilled tunnel of V-thread anchors (see “Setting Up Ice Anchors” later in this chapter). Several styles of V-thread tools are available commercially. They can consist of a piece of wire cable with a hook swaged to one end (fig. 19-9a), a piece of stamped metal or plastic with a hook on one end (fig. 19-9b), or a simple snare to capture the end of a rope without damaging it (fig. 19-9c). Some budget-conscious climbers make V-thread tools from a piece of wire hanger. For tools with hooks, remember to keep the hook sharp, and protect it from catching on clothing or gear.

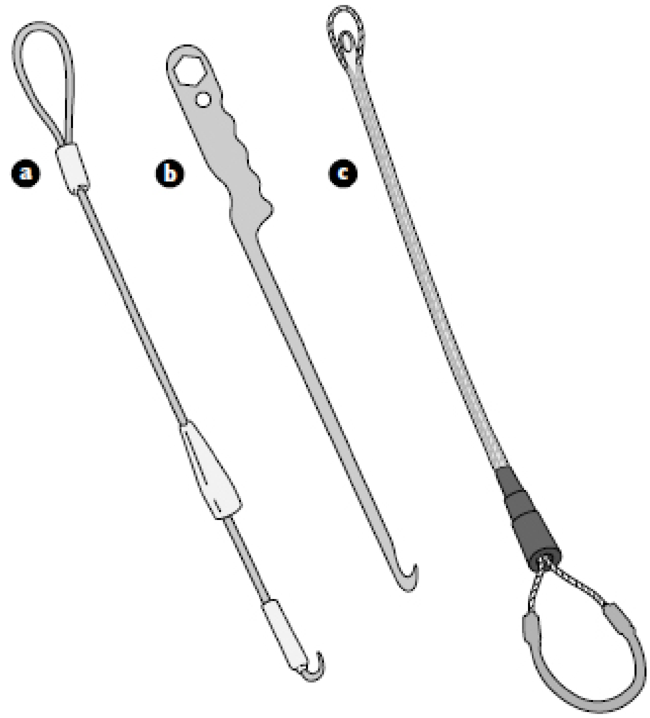

Fig. 19-9. V-thread tools. a, fish-hook cable with hook guard; b, pick-type multipurpose tool; c, snare, no hook.

TECHNIQUES OF ALPINE ICE CLIMBING

Climbing the perennially shaded side of a mountain can be an exhilarating passage over an ever-changing medium in a steep and cold environment, all of which challenges both mind and body. An alpine ice climber must move quickly and efficiently up long and sometimes sparsely protected faces to reach the summit, then safely descend within the allotted time.

On alpine ice, climbers use surface features, seeking out depressions, pockets, and ledges for tool placements, crampon purchase, and belay points. Unlike rock climbers, and unless they are climbing mixed rock and ice (see Chapter 20, Waterfall Ice and Mixed Climbing), ice climbers are not in direct contact with the surface of the mountain. The ice climber must rely on ice tools, axes, and crampons. They make do with anchors and protection placements that can be uncertain. Note that many of the techniques described here are also used to climb waterfall ice.

CLIMBING WITHOUT CRAMPONS

Alpine climbers often encounter short sections of ice or frozen snow. Sometimes they are not carrying crampons, or they may face short ice problems that do not merit taking the time to put on crampons. Negotiating these sections without crampons requires climbing in balance with caution and skill, moving up from one position of balance to the next. At each position of balance, the inside (uphill) foot is in front of and above the trailing outside (downhill) foot. The axe, in the uphill hand, moves only after body and feet are in balance, and the feet move only after the axe has been moved forward. Shift weight from one foot to the other smoothly as though friction climbing on rock. While climbing, look for irregularities in the surface of the ice such as *suncups* (small hollows that have been melted by the sun) or embedded rocks to use as footholds.

If the slope is too steep for secure balance, consider taking another route, or returning with crampons.

Step-Cutting

For the earliest alpinists, chopping or cutting steps was the only technique available for climbing steep ice and hard snow. While the invention of crampons reduced the need for step-cutting, there are some good reasons for understanding the technique of cutting steps with the ice axe. A lost or broken crampon, or an injured or inexperienced climber, may be reason enough to cut steps. Climbers should also be able to chop out a comfortable belay platform.

The adze of the ice axe can be used for cutting steps in two ways. It can be used to slash the ice by swinging the tool in a motion nearly parallel to the surface of the ice to create a slash step (fig. 19-10), or it can be swung perpendicular to the ice to chop out a pigeonhole step (see below).

Slash steps. The most frequently used step-cutting technique is cutting slash steps, for traversing up or down gentle to moderate slopes. To cut ascending slash steps, stand in a position of balance, holding the axe in the inside (uphill) hand (fig. 19-11a). To cut two steps in sequence, swing the adze parallel to the uphill foot and away from the body. Swing the axe from the shoulder, cutting with the adze and letting the weight of the axe do most of the work. With successive swings, slice ice out of the step, starting at the heel end of the new step and working toward the toe. Scoop out chunks of ice with the adze, and use the adze and pick to finish the step. The climber proceeds up the slope, moving in and out of a position of balance on the steps (fig. 19-11b).

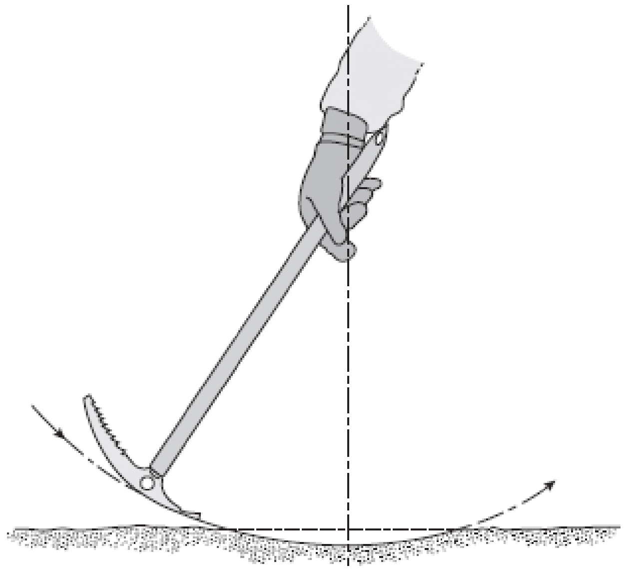

Fig. 19-10. The motion of the ice axe in cutting a slash step.

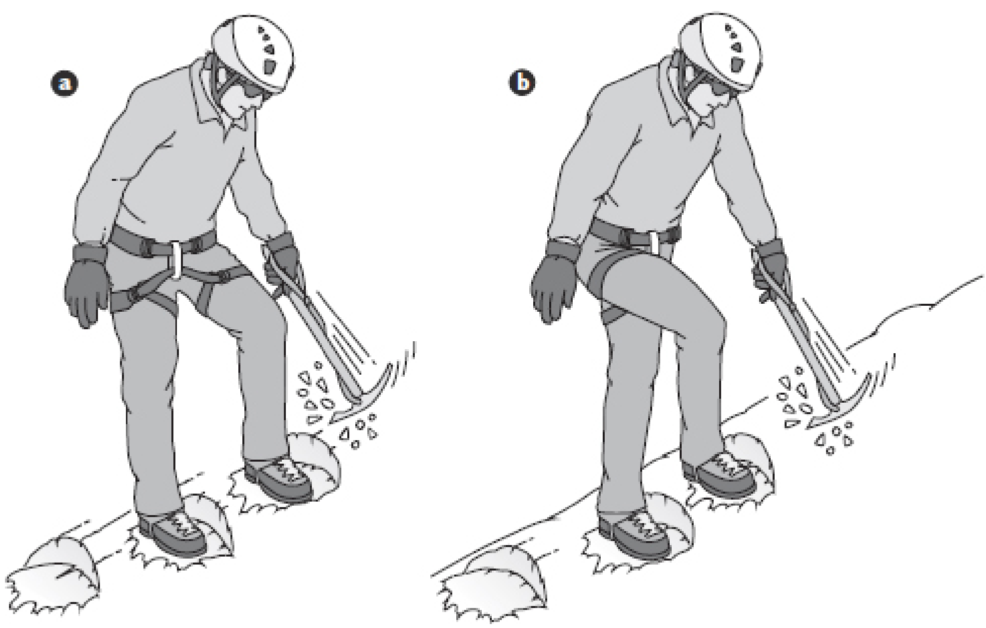

Fig. 19-11. Cutting slash steps on a diagonal ascent: a, working from a position of balance, with the axe in the inside (uphill) hand; b, working from an out-of-balance position.

Pigeonhole steps. For negotiating steeper slopes, cut pigeonhole steps. This is done by swinging the axe perpendicular to the ice and chopping out a hole with the adze. Each step should slope slightly inward to help keep boots from slipping out of the step. On gentler slopes, it is acceptable if the step holds only a small part of a boot, but the steps on steeper slopes should be large enough for the front half of a boot. Space the steps so they are convenient for all members of the party to use. Pigeonhole steps for the direct ascent of steep ice are placed about shoulder width apart and within easy stepping distance of each other. Each step functions as both a handhold and foothold, so each should have a small lip to serve as a handhold.

Ladder steps. To chop steps down an ice slope, the easiest method is to cut a "ladder" of pigeonhole steps that descend almost straight down the hill. To cut two steps in sequence, start in a position of balance, facing down the slope. Chop two pigeonhole steps directly below. When the new steps are ready, step down with the outside (downhill) foot and then the inside (uphill) foot. To cut just one step at a time, again start in a position of balance. Cut the step for the outside (downhill) foot and move that foot down into the step. Then cut the step for the inside (uphill) foot and move that foot down into it. Some climbers may opt to rappel rather than cut steps down an icy incline. Note that climbers usually rope up on ice; see "Roped Ice Climbing Techniques" later in this chapter.

CLIMBING WITH CRAMPONS

Ice climbers usually employ two basic techniques, depending on steepness of the slope, conditions of the ice, and their ability and confidence level: French technique and German technique. Although each technique has its own distinct benefits, modern ice climbing melds the two. Mastery of both French and German techniques is essential for climbing in the changeable alpine environment. Below are brief descriptions of these methods, followed by sections that apply them to specific types of terrain.

French Technique (Flat-Footing)

French technique, also called flat-footing, is the easiest and most efficient method of climbing on gentle to steep ice and hard snow (see Figure 19-13). Good French technique demands balance, rhythm, joint flexibility, and the confident use of crampons and ice axe. Specifics of this technique are described in the sections that follow.

Front-Pointing (German Technique)

Developed by Germans and Austrians for climbing the harder snow and ice of the eastern Alps, German technique, better known as front-pointing, allows an experienced ice climber to go up the steepest and most difficult ice slopes. With this technique, even average climbers can quickly overcome sections that would be difficult or impossible with French technique. The German technique is much like kicking steps straight up a snow slope, but instead of kicking a boot into the snow, kick that boot's front crampon points into the ice; then step up with the other foot, directly supported by the placed boot's front points. Just as in French technique, good front-pointing is efficient, rhythmic, and balanced, with the weight of the body balanced over the crampons.

TABLE 19-2. TECHNIQUES FOR CRAMPONS, ICE AXES, AND ICE TOOLS

TECHNIQUE	APPROXIMATE STEEPNESS OF SLOPE
CRAMPONS	
Walking (French technique; *pied marche*)	Gentle, 0° to 15°
Duckwalk (French technique; *pied en canard*)	Gentle, 15° to 30°
Flat-footing (French technique; *pied à plat*)	Moderate to steep, 30° to 60°
Rest position (French technique; *pied assis*)	Extremely steep, 60° and higher
Three o'clock position (American technique; *pied troisième*)	Extremely steep, 60° and higher
Front-pointing (German technique)	Steep through vertical and overhanging, 45° and higher
ICE AXES AND ICE TOOLS (FRENCH AND GERMAN TECHNIQUE)	

Cane position (*piolet canne*)	Gentle to moderate, 0° to 45°
Cross-body position (*piolet ramasse*)	Moderate, 30° to 45°
Anchor position (*piolet ancre*)	Steep to extremely steep, 45° and higher
Low-dagger position (*piolet panne*)	Steep, 45° to 55°
High-dagger position (*piolet poignard*)	Steep, 50° to 60°
Traction position (*piolet traction*)	Extremely steep through vertical and overhanging, 60° and higher

Combination Technique (American Technique)

Modern crampon technique evolved from the French and German styles. As on rock, climbing on ice involves the efficient and confident use of footwork to maintain balance and minimize fatigue. Flat-footing is generally used on lower-angle slopes and where crampon point penetration is easy. Front-pointing is most commonly used on slopes steeper than 45 degrees and on very hard ice. In practice, most climbers blend these two techniques into a combination approach, sometimes called American technique.

In any technique, the most important element is confident use of the crampons. Practice on gentle and moderate slopes (see Chapter 16, Snow Travel and Climbing) to develop the skill, confidence, and the aggressive approach needed at steeper angles. On alpine ice, a skilled ice climber, whether flat-footing or front-pointing, displays the same deliberate movement as a skilled rock climber. The crampon points must be carefully and deliberately placed into the ice and the climber's weight smoothly and decisively transferred from one foot to the other. Boldness is essential to skillful crampon technique. Exposure must be disregarded and concentration focused solely on the climbing. But boldness is not blind bravado. It is confidence and skill born of experience and enthusiasm, nurtured in many practice sessions on glacial seracs and on ice bulges in frozen gullies, then matured through ascents of increasing length and difficulty.

ICE CLIMBING TERMS

Table 19-2 lists ice climbing techniques for crampons, ice axe, and ice tools, along with the approximate steepness of the slope on which each technique is used. (A clinometer helps determine slope angle if you are unsure; see “Slope Angle” in Chapter 17, Avalanche Safety.) French terms are sometimes used, given in parentheses. The French word *pied* (pronounced “pee-EY”) means “foot”; the French word *piolet* (pronounced “pee-oh-LAY”) means “ice axe.” Terms including the word *pied* refer to footwork; terms including the word *piolet* refer to ice-axe positions.

None of these techniques are restricted to any particular set of conditions, and all can be useful in a wide range of snow and ice situations. When practicing these techniques, keep in mind that a “sharp crampon is a happy crampon,” requiring only body weight to set it securely in place.

CLIMBING ON GENTLE TO MODERATE SLOPES

On gently to moderately sloped ice, French technique (flat-footing) dominates. An essential alpine ice climbing technique, flat-footing means firmly setting all bottom points of the crampon into the ice. Keep boot soles parallel to the ice surface and feet slightly farther apart than normal to avoid snagging a crampon point on clothing or on a crampon strap on the other foot. Use the ice axe in the cane position (see Figures 19-12 and 19-13), holding the axe in the self-belay grasp (for ice axe positions and grasps, see Chapter 16, Snow Travel and Climbing).

On gentle slopes, begin by simply walking. Flexible ankles are sometimes necessary in order to keep boot soles parallel to the surface. Boots that are flexible at the ankle facilitate flat-footing. Climbers with rigid boots can loosen their bootlaces at the cuff for more comfortable flat-footing. As the gentle slope steepens slightly, splay feet outward in duckwalk fashion (fig. 19-12), easing ankle strain. Keep knees bent and weight balanced over the feet. Continue to use the axe as a cane.

As the slope gets steeper still, no longer gentle but moderate, duckwalking straight upward causes severe ankle strain. Instead, turn sideways to the slope and ascend diagonally for a more relaxed, comfortable step. Be sure to use flat-footing, with all crampon points weighted into the ice (fig. 19-13). When using this technique for the first time, people have a tendency to edge with their crampons. The crampon points can skate off the ice, throwing the climber off balance. Fight this tendency, and keep the crampon points flat against the ice at all times. Start with feet pointed in the direction of travel. As the slope steepens, rotate both feet more and more downward in order to keep them flat. As the slope angle increases, ease ankle strain by pointing both boots downhill more and more, so that the flex needed to keep both feet flat comes from the more normal forward flex of the ankle and from the knees, which are bent away from the slope and spread well apart (see Figure 19-14). On the steepest slopes, both knees may be pointing straight downhill.

Fig. 19-12. French technique on an ascent of a gentle slope: duckwalk combined with ice axe in cane position.

Fig. 19-13. French technique on a diagonal ascent of a moderate slope: flat-footing combined with ice axe in cane position.

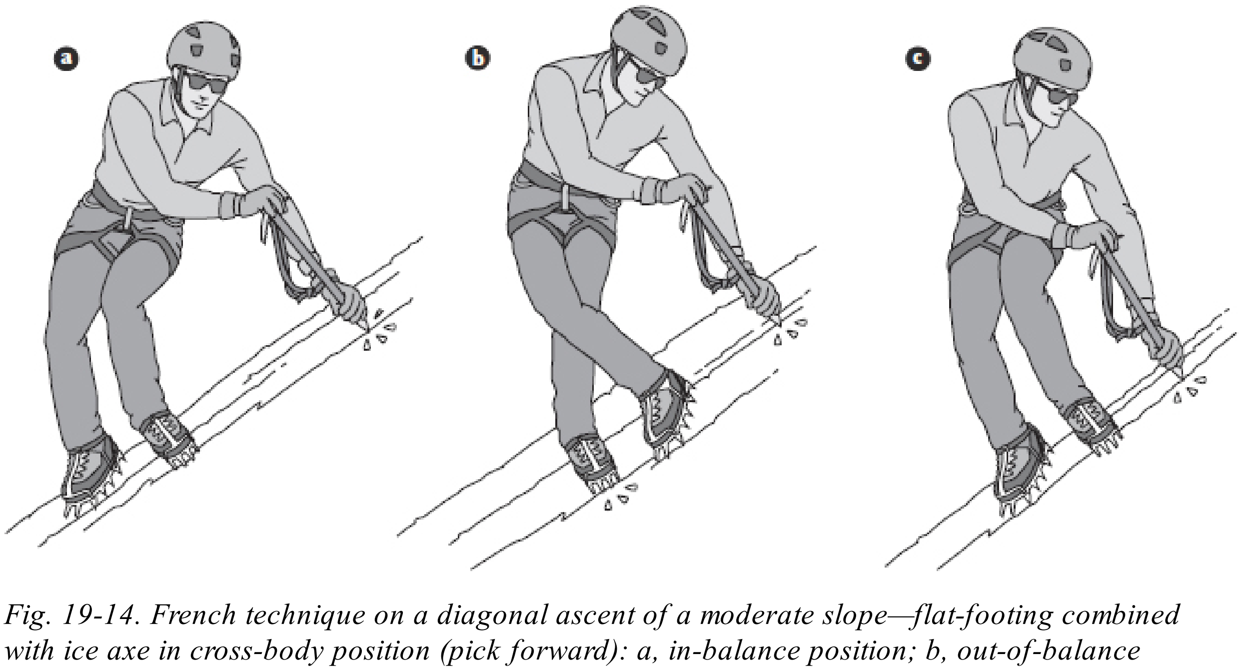

Fig. 19-14. French technique on a diagonal ascent of a moderate slope—flat-footing combined with ice axe in cross-body position (pick forward): a, in-balance position; b, out-of-balance position; c, back to in-balance position.

As the slope angle changes from gentle to moderate, using the axe in the cane position becomes awkward. Greater security can now be achieved by holding the axe in the cross-body position. Grip the shaft just above the spike with the inside (uphill) hand and hold the head of the axe in the self-belay grasp, pick pointing forward, with the outside (downhill) hand. Drive the spike into the ice, the shaft perpendicular to the slope. In the cross-body position, most of the force on the axe should be from the hand on the shaft. The hand on the head stabilizes the axe and is a reminder not to lean into the slope. To keep from leaning into the ice, a full-length ice axe is needed, rather than a shorter ice tool. Even experienced ice climbers have difficulty maintaining proper French technique with a short axe.

Move diagonally upward in a two-step sequence, much the same as ascending a snow slope without crampons. Remember to keep feet flat at all times. Start from a position of balance, with the inside (uphill) foot in front of and above the trailing outside (downhill) leg (fig. 19-14a). From this in-balance position, bring the outside foot in front of and above the inside foot, into the out-of-balance position (fig. 19-14b). Cross the outside leg over the knee of the inside leg; crossing at the ankle compromises stability and makes the next step difficult to accomplish. To return to a position of balance, bring the inside foot up from behind and place it again in front of the outside foot (fig. 19-14c). Keep the body centered over the crampons. Avoid leaning into the slope and creating the danger of crampon points twisting out of the ice. Step on lower-angle spots and natural irregularities in the ice to ease ankle strain and conserve energy.

During this diagonal ascent, plant the axe about an arm's length ahead (as shown in Figure 19-14a) each time before moving another two steps. Whether using the axe in the cane or the cross-body position, plant it far enough forward so that it will be near the hip after you move up to the next in-balance position (as shown in Figure 19-14c).

To change direction (switchback) on a diagonal ascent of a moderate ice slope, use the same technique as on a snow slope where crampons would not be used, but keep both feet flat. From a position of balance, place the axe directly above this location. Move the outside (downhill) foot forward, into the out-of-balance position, to about the same elevation as the other foot and pointing slightly uphill (fig. 19-15a). Grasping the axe with both hands, turn into the slope, moving the inside (uphill) foot to point in the new direction and slightly uphill. You are now facing into the slope, standing with feet splayed outward in opposite directions (fig. 19-15b). If the splayed-foot position feels unstable, front-point. Return to the in-balance position by moving the foot that is still pointing in the original direction to above and in front of the other foot. Reposition your grasp on the ice axe, for either the cane or cross-body position. You are now back in balance and facing the new direction of travel (fig. 19-15c).

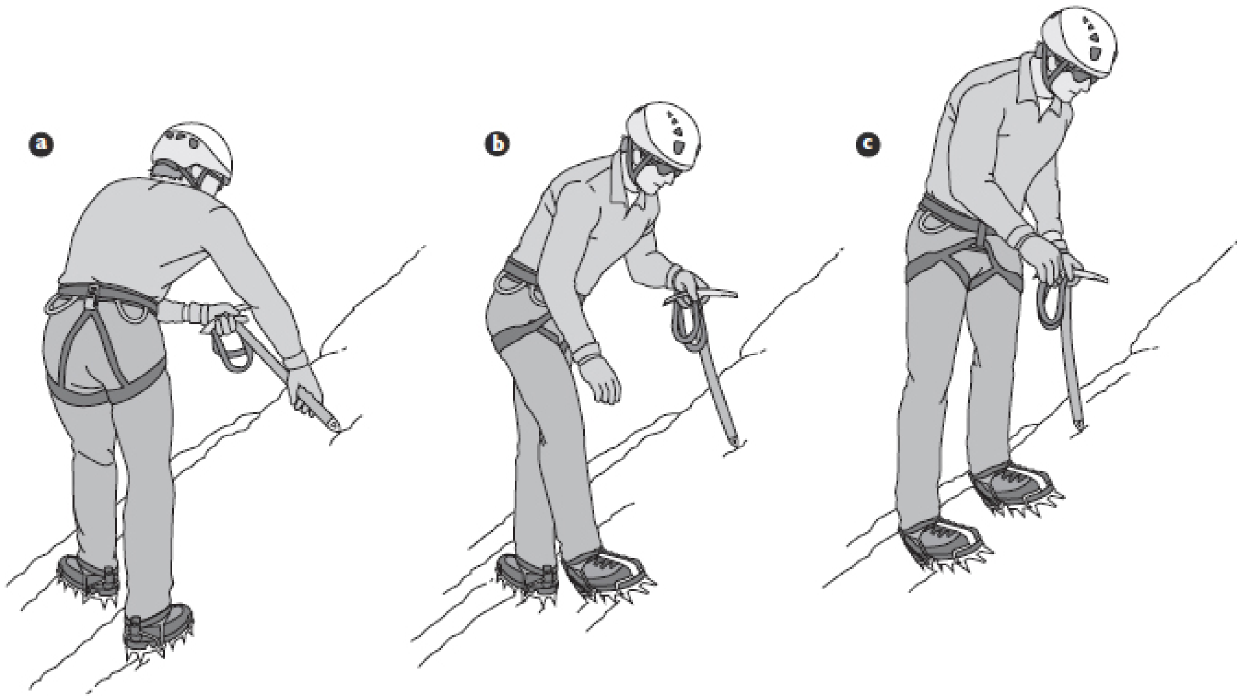

Fig. 19-15. French technique while changing direction on a diagonal ascent of a moderate slope —flat-footing combined with ice axe in cross-body position: a, out-of-balance position; b, turning; c, in-balance position in new direction.

CLIMBING ON MODERATE TO STEEP SLOPES

Steeper ice calls for other variations of flat-footing. At some point, the German technique of front-pointing comes into play.

Using French Technique

For more security on moderate to steep slopes, switch the ice axe from the cross-body position to what is known as the anchor position. Your feet remain flat, with all bottom crampon points weighted into the ice at each step.

To place the axe in the anchor position, begin in a position of balance. Grip the ice axe shaft just above the spike with the outside (downhill) hand (fig. 19-16a). Swing the axe so that the pick sticks into the ice in front of and above your head, with the shaft parallel to the slope; with the other hand, take hold of the axe head in the self-arrest grasp (fig. 19-16b). Now pull out on the spike end of the axe with the outside (downhill) hand while moving two steps forward, as described for Figure 19-14 to a new position of balance (fig. 19-16c). Use a gentle and constant outward pull on the ice axe to set its teeth and keep it locked into the ice. When it is time to release it, push the bottom of the shaft toward the ice and lift the pick up and out.

To keep feet flat at these angles, you must lean your body farther away from the slope, with knees and ankles flexed and the toes of your boots increasingly pointing downhill. Try to continue advancing upward in the standard sequence, moving two steps at a time. At the steepest angles, however, your feet point downhill and you must take increasingly smaller steps, essentially moving backward up the slope. But continue to plant and remove the pick from a position of balance. The foot that is on the same side as the direction of travel should be at least slightly higher than the other foot, allowing your upper body to rotate for a smooth, strong swing of the axe.

To change diagonal direction when the ice axe is in the anchor position, use the same sequence as with the cane or cross-body position, as in Figure 19-15. However, on the steepest slopes, where you are stepping backward, change direction simply by switching hands on the axe and planting it on the other side. There is not much diagonal movement at this point, because you are mainly moving backward straight up the slope.

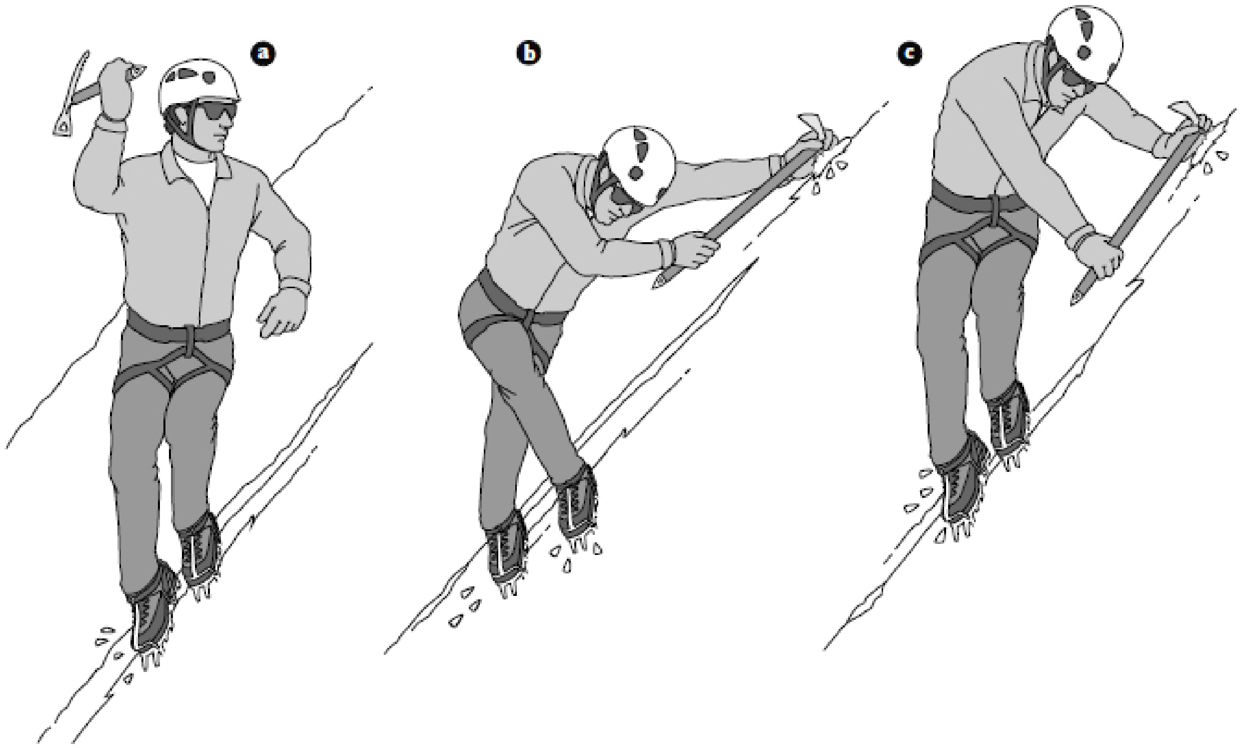

Fig. 19-16. French technique on a diagonal ascent of a steep slope—flat-footing combined with ice axe in anchor position: a, in-balance position; b, out-of-balance position; c, in-balance position.

Fig. 19-17. French technique of pied assis *for a balanced rest while climbing a steep slope.*

The French also devised a rest position—called *pied assis*—that gives leg muscles a rest and provides more security for replanting the axe. From a position of balance, bring the outside (downhill) foot up and beneath your buttocks, with the boot—flat, as always—pointing straight downhill. Then sit down on the heel of that foot (fig. 19-17). This is a balanced position, and a relatively comfortable one.

The invaluable technique of flat-footing, used with the ice axe in the cane or cross-body position, will serve an experienced climber for many alpine routes. For short stretches of steeper ice, flat-footing combined with the ice axe in anchor position will often work, but this marks the upper limit of French technique.

Using German Technique (Front-Pointing)

On steep ice slopes, use of French technique and front-pointing begins to overlap. They both have a place on these slopes. Most people pick up front-pointing quickly because it feels natural and secure. Unfortunately, this encourages its use on moderate slopes where flat-footing would be just as secure and more efficient. In flat-footing, most of the strain is on the large, powerful thigh muscles. Front-pointing, however, depends almost solely on the smaller calf muscles, which burn out much faster. Even climbers who strongly prefer front-pointing would benefit from alternating the techniques to give their calf muscles a rest.

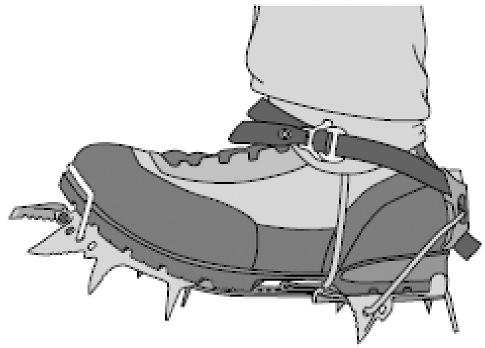

Fig. 19-18. Soft-soled boots flex too much for front-pointing with crampons.

Fig. 19-19. To front-point effectively, toes should be straight in with heels slightly down.

Well-fitting, very stiff-soled boots provide a firm base for crampons and make front-pointing easiest. Less-stiff-soled boots can be used in some cases but require more muscular effort. However, flexible-soled boots just do not provide the necessary support for front-pointing (fig. 19-18). Pioneer ice climber Yvon Chouinard said it well in *Climbing Ice*: "You can't dance on hard ice with soft-soled shoes" (see Resources).

Front-pointing uses not only the primary points of the crampons but also the secondary points immediately behind them. These points, attached to a rigid boot and properly placed in the ice, provide a stable platform that can be stood upon. The most stable placement of the boot is straight into the ice, perpendicular to the surface. Avoid splayed feet, which tend to rotate the outside front points out of the ice; the boot soles should be perpendicular to the ice surface, with heels slightly down in order to engage the secondary points in the ice and complete the four-point platform for standing (fig. 19-19). Slightly bend at the knee to reduce the strain on calf muscles.

Resist the temptation to raise your heels. This pulls the secondary points from the ice, endangering placement of the front points, and accelerates calf muscle fatigue. Your heels will normally feel lower than they really are, so if it feels as though your heels are too low, the odds are that they are in the correct position: slightly lower than horizontal. This is especially important when a climber is coming over the top of steep ice onto a gentler slope, where the natural tendency is to raise the heels, relax the level of concentration, and hurry. This is a formula for trouble because it could cause the crampon points to shear from the ice. A good way to become comfortable with the essential skills of crampon placement and foot positioning is to practice on a top rope with an experienced ice climber who can critique your style.

In the initial crampon placements on a route, concentrate on determining the amount of force required to secure a foothold. After that, a single confident leg swing should be all you need. Watch out for two common mistakes: kicking too hard (which is fatiguing) and kicking too often in one place (which fractures the ice and makes it harder to get a good foothold). As with climbing rock, make your foot placement and keep to it. After making a crampon placement, avoid foot movement because it can make the points rotate out of the ice.

Front-pointing uses a variety of ice-axe positions. Dagger positions (see below) are useful in hard snow and relatively soft ice. They do not work well in hard ice. The jabbing and stabbing motions of placing the pick are not very powerful, and poor pick penetration into the hard ice could mean an insecure placement. Attempts to force a deeper placement may result in nothing more than a bruised hand. For harder ice or a steeper slope, abandon the dagger positions for the anchor and traction positions.

Low-dagger position. Hold the axe by the adze in the self-belay grasp and push the pick into the ice near waist level, to aid balance (fig. 19-20). This position is helpful in tackling a short, relatively steep section that requires only a few quick front-pointing moves. It tends to hold you away from the slope and out over your feet, the correct stance for front-pointing.

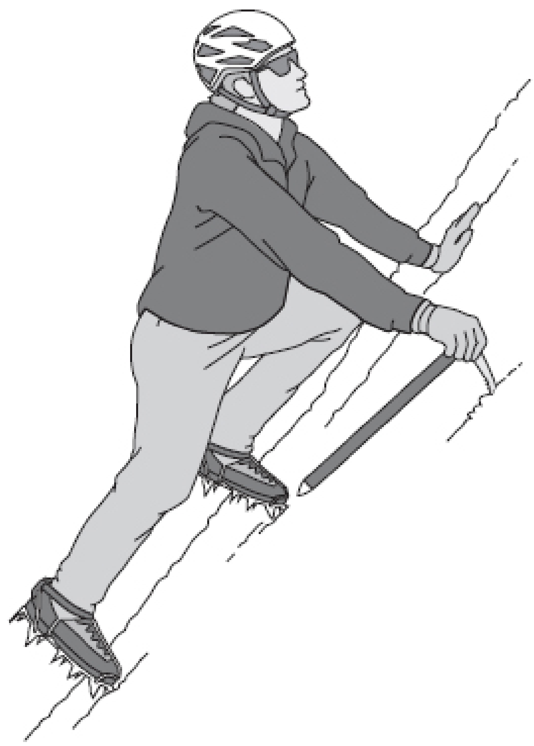

Fig. 19-20. Front-pointing with axe in low-dagger position.

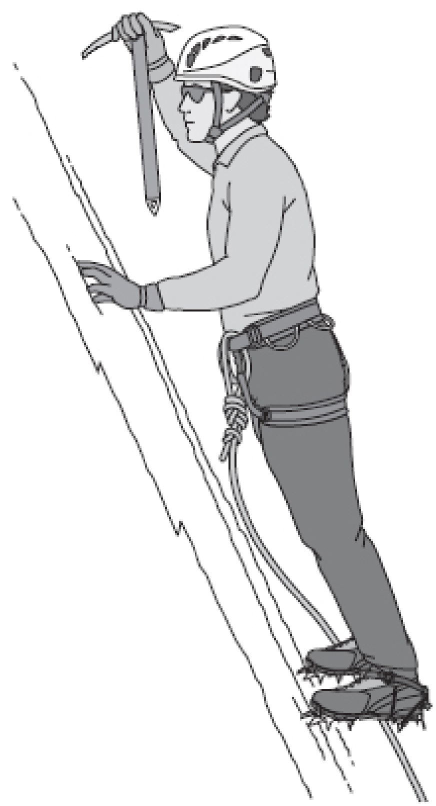

Fig. 19-21. Front-pointing with axe in high-dagger position, above shoulder height.

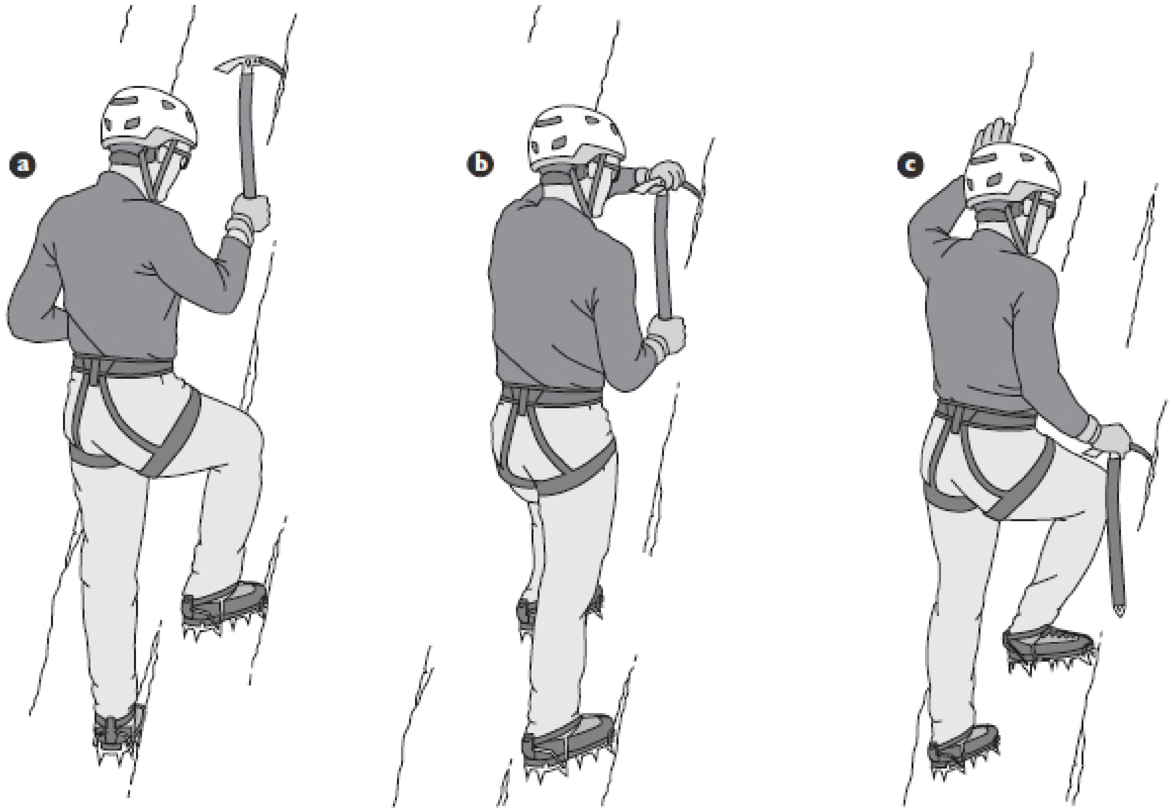

Fig. 19-22. Front-pointing using axe in anchor position: a, placing the axe high without overreaching; b, adding a self-arrest grasp on the axe while moving up; c, holding the axe in the low-dagger position before moving it up again.

Fig. 19-23. Front-pointing with axe overhead in piolet traction*, pulling straight down on axe without moving the hand on the shaft.*

Fig. 19-24. Front-pointing using two tools, both in low-dagger position.

High-dagger position. Hold the axe head in the self-arrest grasp and jab the pick into the ice above shoulder height (fig. 19-21). Use this position if the slope is a bit too steep to insert the pick effectively into the ice at waist level in the low-dagger position.

Anchor position. While standing on front points, hold the axe shaft near the spike and swing the pick in as high as possible without overreaching (fig. 19-22a). Front-point upward, moving your hand higher and higher on the shaft while you progress, adding a self-arrest grasp on the adze with your other hand when you are high enough (fig. 19-22b). Finally, switch hands on the adze, converting the anchor position to the low-dagger position (fig. 19-22c); when the adze is at waist level, remove it from the ice and replant it higher, again in the anchor position. Use the anchor position on harder ice or a steeper slope.

Piolet traction. Hold the axe near the spike and plant it high; then climb the ice by pulling straight down on the axe while front-pointing up (fig. 19-23). Do not move your hand on the shaft. Use *piolet traction* on the steepest and hardest ice.

On very hard or extremely steep ice, when it becomes too difficult to balance on front points while replanting the axe, it is necessary to use a second ice tool. You can use two tools at the same time because, except for the anchor position, all ice-axe techniques used with front-pointing require only one hand.

Using two tools provides three points of support—for example, two crampons and one ice tool while you replant the second tool. The placements must be secure enough so that if one point of support fails, the other two will hold you until you replace the third point. Your legs carry most of the weight, but your arms help with both weight bearing and balance.

In double-tool technique, you can use the same ice-axe method for both hands or a different method for each. For instance, climb with both tools in low-dagger position (fig. 19-24), or place one tool in high-dagger position and the other in *piolet traction* (fig. 19-25). (See “Climbing on Vertical Ice” later in this chapter for details of double-tool technique using *piolet traction* with both tools.)

Using Combination Technique

One fast and powerful technique combines flat-footing and front-pointing. This is called the three o’clock position, *pied troisième* (fig. 19-26), because as one foot is front-pointing, the other is flat and points to the side (to three o'clock if it is the right foot or to nine o'clock if it is the left). This combination is an example of American technique.

The three o'clock position is a potent resource for a direct line of ascent, much less tiring than front-pointing alone. The position lets climbers distribute the work over more muscle groups by alternating techniques with each leg. When climbing, seek out irregular flatter spots and any pockets or ledges for flat-footing, allowing calf muscles to rest. Use whatever ice-tool positions are appropriate for the situation.

Fig. 19-25. Front-pointing using two tools, with the tool in the left hand in piolet traction *and the tool in the right hand in high-dagger position.*

Fig. 19-26. Three o'clock position for the feet, combining flat-footing (right foot) and front-pointing (left foot).

Climbers alternate crampon techniques depending on ice conditions. Flat-footing is usually more secure on frozen snow, ice crust over snow, and soft or rotten ice, because more crampon points dig into the surface than the four points of front-pointing. When soft snow covers ice or hard snow, using front-pointing technique (or the three o'clock position) lets the four front points blast through the surface to get into the firmer layer beneath. Front-pointing is often the most secure technique for the average climber to use on very hard ice on all but gentle slopes. If you are having serious problems on a climb with flat-footing—perhaps due to fatigue, winds, high altitude, or fear—switch to front-pointing or the three o'clock position.

ICE-TOOL PLACEMENTS

The objective of placing any ice tool is to establish a solid placement with one swing. Each swing saved during a pitch means that much less fatigue at the top. It takes a lot of practice to learn pinpoint placement, especially when swinging the tool with the nondominant arm. But with a combination of proper technique and equipment, it should be possible to place a tool swiftly and precisely so that it is both secure and easy to remove.

At the base of the route, try a few tool placements to get a feel for the plasticity of the ice. Plasticity—which determines the ability of the ice to hold and release a tool—varies tremendously with temperature and age of the ice. Study the ice for good placements. Ice holds the pick better in depressions than in bulges, which shatter or break off under the impact of an ice tool due to radiating fracture lines. Try to make placements in opaque ice, which is less brittle than clear ice because it has more air trapped inside. Minimize the number of placements needed by planting the pick as high as possible and by moving upward as far as possible with each placement. Placement techniques vary, depending on the type of pick.

Technically curved. Also known as alpine picks, technically curved picks are most like the pick of a standard ice axe (see Figure 19-4a). However, the picks are more acutely curved than that of a regular axe, so they hold better in ice. A tool with a technically curved pick is placed with a natural swing from the shoulder. This pick is used in conditions ranging from soft serac ice to hard water ice, though a harder swing is needed for good penetration in hard ice.

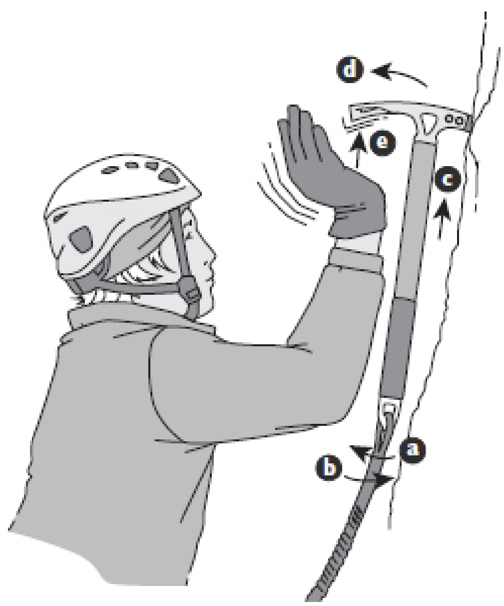

Fig. 19-27. How to remove an ice tool: a and b, rock the shaft back and forth in the same plane as the pick; c and d, push up with the shaft and then pull the shaft out; e, strike up on the adze (or hammerhead).

Reverse curved. The more acute angles of reverse-curved picks (see Figure 19-4b) require a somewhat different swing, with a definite wrist snap just prior to connecting. To plant the pick, bring your arm back, with your elbow bent about 90 degrees, then swing at the desired spot. At the end of the swing, snap your wrist toward the ice. The steeper the droop of the pick, the more wrist action is needed to set the pick. The reverse-curved pick also works well for hooking holes in the ice. Large icicles often form in clusters on vertical sections, creating slots or gaps that are ideal for secure hooking placements.

Removing the Tool

In addition to learning the proper force to use in placing a tool, climbers must also learn the best way to remove it. Unless it is done correctly, removing a tool can be more tiring than placing it. Try to remove the tool in reverse of the motion used to set it. First, loosen the placement by rocking the spike end of the shaft of the tool up and down in the same plane as the pick (fig. 19-27a and b): away from and back toward the ice. Then try to remove the tool by pushing the shaft up toward the pick and then pulling the shaft out from up near the pick (fig. 19-27c and d). If this fails, release your grip on the tool and try to knock it loose by hitting up against the adze with the palm of your hand (fig. 19-27e). Then grab the head and pull up and out. Never remove a tool by torquing it from side to side because the pick may break.

CLIMBING ON VERTICAL ICE

The most efficient and secure method of climbing vertical ice is front-pointing combined with use of two ice tools, vertically staggered, in *piolet traction*. This method of climbing ice is called *tracking*. The standard position for the feet is about shoulder width apart and level with each other, a stable and relatively comfortable stance. One tool is planted above your head so that your arm is straight. The other tool is planted and weighted, at shoulder height. At this point your feet and upper tool form a triangle against the ice. Pull down and slightly outward on the spike ends of the tools' shafts to keep the picks' teeth set in the ice, and apply inward pressure on the crampon points.

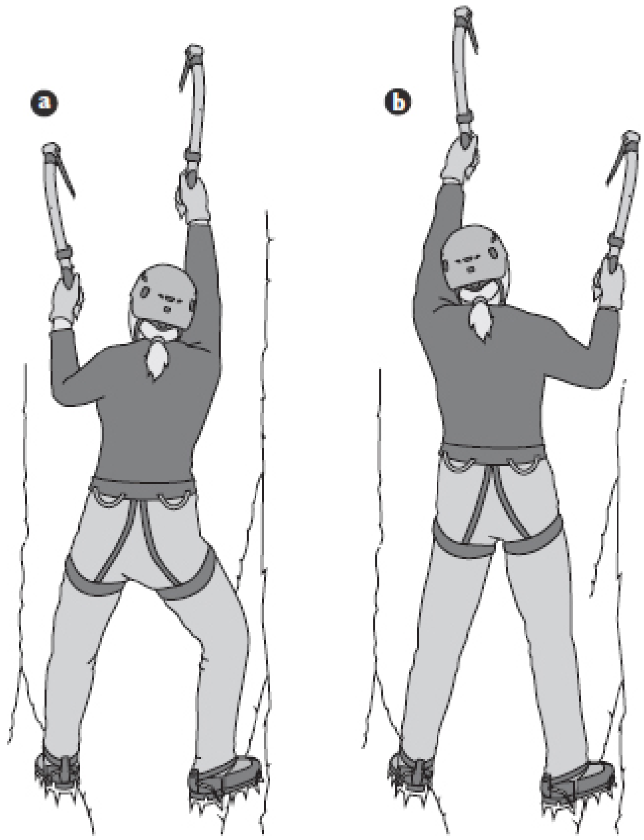

Fig. 19-28. Staying in balance on vertical ice: a, center body weight on the right-hand tool and remove the left-hand tool for higher placement; b, after moving the feet up, center body weight on the replanted left-hand tool and remove the right-hand tool for the higher placement.

To ascend, grasp the tools, walk both feet up taking small steps, then remove the lower tool (fig. 19-28a) and replant it above your head. Maintain three points of contact at all times. Let your legs do most of the work; do not burn out your arms by doing pull-ups while climbing. Now repeat the sequence: place one tool, move both feet, place the other tool (fig. 19-28b), move both feet, and so on. Be careful not to overreach for a tool placement because that motion may cause your front points to dislodge from the ice. Concentrate on efficient, methodical placement of crampon points and ice tools. Rhythm is as important as balance.

Climbers sometimes find themselves “barn-dooring”—their body swinging sideways away from ice, out of balance—as they remove one tool in order to place it higher. Avoid this by shifting your center of balance toward the tool that will remain in the ice, as shown in Figure 19-28a. Once that new, higher placement is made, shift your center of balance to the higher tool (as shown in Figure 19-28b) and then remove the lower tool.

Tracking, also referred to as the “tripod” or the “A-frame,” is a good technique to use for ascending ice bulges, small overhangs, and longer vertical sections (see Chapter 20, Waterfall Ice and Mixed Climbing).

From Vertical to a Horizontal Stretch

Oddly enough, one of the most challenging sequences involves climbing from a vertical face up onto a horizontal step or ledge. With a secure horizontal section of ice ahead, climbers may relax concentration and forget about good foot placement. At the same time, they face the problem that it is virtually impossible to obtain a confident tool placement by blindly swinging over a ledge. They must move high enough to see onto the ledge.

To do this, make shorter tool and foot placements when approaching the lip of the ledge, then step up to a high-dagger position so you can see onto the ledge and look for a good spot to place an ice tool. You may need to remove snow or rotten ice, which often accumulates on ledges and moderate ice slopes. Place an ice tool securely into the ledge, well back from the lip, and then place the second ice tool (fig. 19-29a); move your feet up until they are safely over the lip (fig. 19-29b). Remember that it is especially important to keep the heels low.

TRAVERSING STEEP TO VERTICAL ICE

The principles for traversing are much the same as for front-pointing up steep ice. However, because the climber is moving to the side instead of straight up, it is more difficult to keep one foot perpendicular to the ice while replacing the front points of the other foot. If your heel rotates, the front points will also rotate and come out of the ice. Ice tools also tend to rotate out during sideways travel.

Fig. 19-29. Pulling onto a ledge: a, plant tools on ledge; b, move feet up and over the lip.

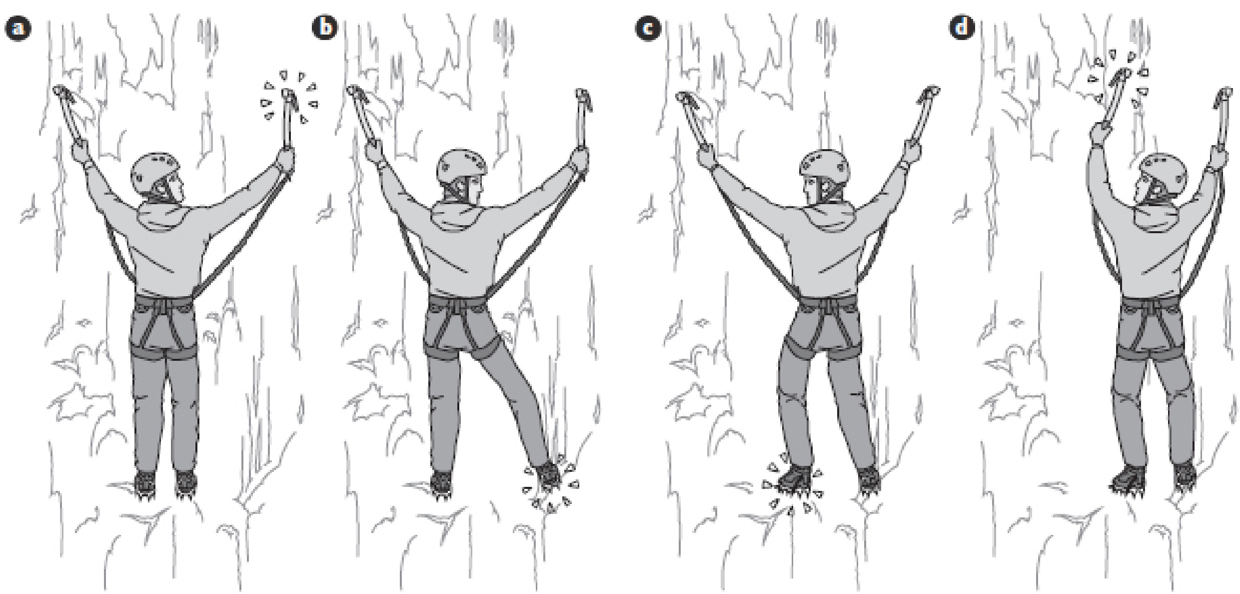

Fig. 19-30. Traversing to the right on vertical ice: a, planting the leading tool to the side to begin the traverse; b, shifting the right foot under it; c, shifting the left foot closer to the right; d, shifting trailing tool closer to leading tool.

Start from a secure position with both feet at the same level. Lean in the direction of travel and plant the leading tool in the ice (fig. 19-30a). This places the leading tool lower than it would be if you were ascending, but not so far to the side that it causes your body to rotate out from the wall (barndoor) when the trailing tool is removed. This also puts the trailing tool in a position so that it can be pulled on in a modified lieback while you are traversing, without twisting the tool out of the ice.

Now shuffle sideways on front points (fig. 19-30b and c). Move the trailing tool closer to the lead tool (fig. 19-30d). It is also possible to make a two-step move, crossing the trailing foot over the leading foot and then bringing the other foot back into the lead. Most climbers prefer the shuffle, which is less awkward and feels more secure. After moving your feet, replant the trailing tool closer to your body at a 45-degree angle (as in Figure 19-30a), lean in the direction of travel and replant the leading tool, and repeat the process.

DESCENDING ON ICE

Depending on the angle of the ice, a climber may use French, German, or American technique while descending.

Using French Technique

Once mastered, French technique is the most efficient means of descending gentle to moderate icy terrain.

Cane position. To descend gently sloping ice, simply face directly downhill, bend your knees slightly, and walk firmly downward. Plant all bottom crampon points into the ice with each step. Hold the axe in the cane position. As the descent angle steepens, bend your knees more and spread them apart, with your body weight over your feet so that all crampon points bite securely (fig. 19-31). Thigh muscles do the bulk of the work.

Cross-body position. For greater security, plant the axe perpendicular to the slope in the cross-body position (fig. 19-32).

Support position. For the next level of security, use the axe in the support position (fig. 19-33). Grasp the axe near the middle of the shaft and hold it beside you while descending, with the axe head pointing uphill, pick down, and the spike pointing downhill. This position is more secure because the pick and axe are in contact with the surface and the axe is set up for self-arresting.

Banister position. As the slope steepens, use the axe in the banister position. Grasp the axe near the spike and plant the pick as far below you as possible (fig. 19-34a). Walk downward, sliding your hand along the shaft toward the head of the axe (fig. 19-34b). Maintain a slight outward pull (away from the ice) on the end of the shaft to keep the pick locked in the ice (fig. 19-34c). With a reverse-curved pick, this is less secure; you must pull parallel to the ice. Keep moving down until you are below the axe head (fig. 19-34d), then release the pick (fig. 19-34e) and replant the axe farther down.

Fig. 19-31. Flat-footing on descent with ice axe in cane position.

Fig. 19-32. Flat-footing on descent with ice axe in cross-body position.

Fig. 19-33. Flat-footing on descent with ice axe in support position.

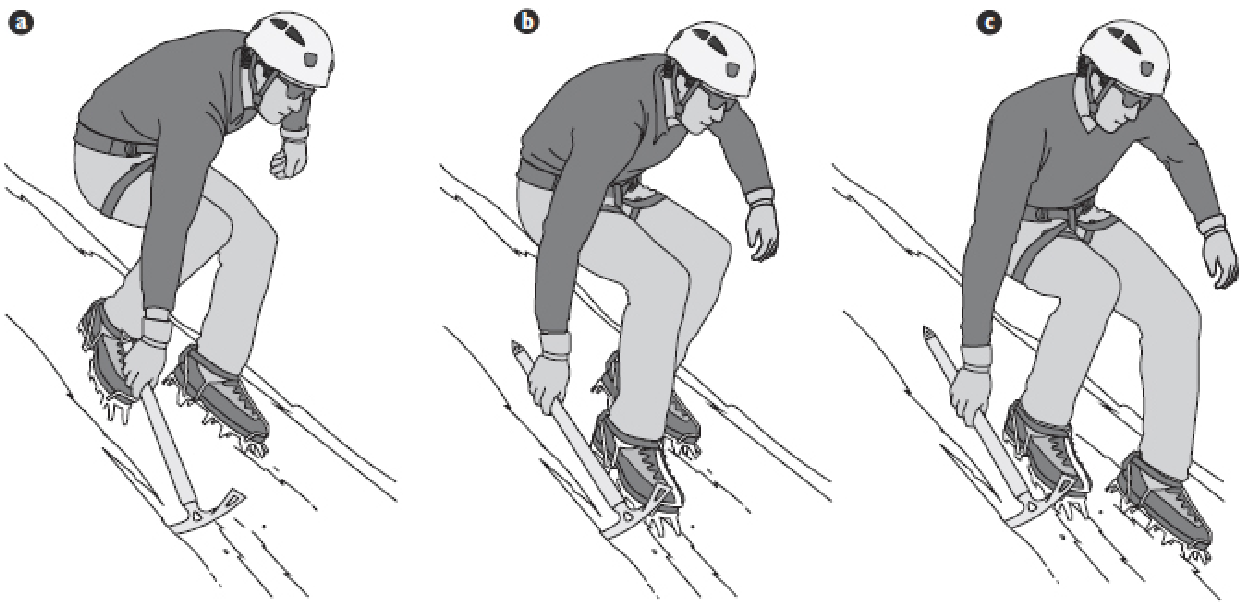

Fig. 19-34. Flat-footing on descent with ice axe in banister position: a, plant the axe; b, slide hand along the shaft like you would a banister; c, pull outward slightly to keep axe locked in ice; *(continued on facing page)*

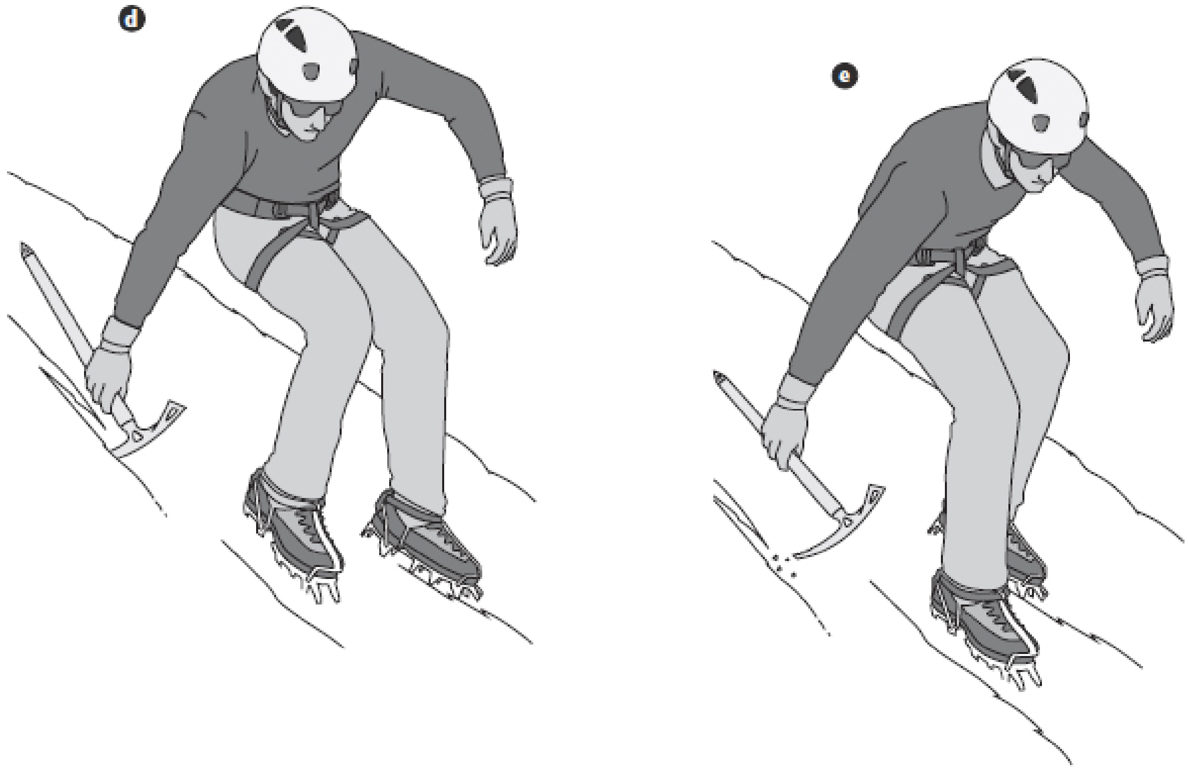

Fig. 19-34. (continued from facing page) d, ready to replant the axe; e, remove to replant it.

Fig. 19-35. Flat-footing on descent with ice axe in the anchor position.

Anchor position. On a slope too steep to safely descend facing outward, turn sideways and descend diagonally. Your footwork changes to the same flat-footing technique used to ascend diagonally. Use the axe in the anchor position (fig. 19-35). With your outside arm, swing the axe out in front and plant the pick in the ice; take hold of the head with the other hand in the self-arrest grasp; and then flatfoot diagonally down below the axe. The shaft rotates as you pass below it.

Using Front-Point Technique

On steeper slopes, front-point and ice-tool techniques are generally the same for going down as they are for going up. But, just as on rock, down-climbing is more difficult. The tendency is to step too low, which keeps your heels too high, so front points may fail to penetrate in the first place or may shear out. A good view of the route is not possible on a descent (although descending on a slight diagonal helps). It is awkward to plant the ice tools because they must be placed closer to your body, so the power of a good full swing is lost. On a descent, the only feasible way to get secure placements may be to plant the tools back in the holes that were made on the ascent.

Climbers do not often front-point to descend, but it is still a valuable skill for some occasions, such as retreating from a route. Down-climbing ability also builds confidence in ascending. Ice climbers usually rappel down steeper routes (see “Rappelling on Ice” later in this chapter).

ROPED ICE CLIMBING TECHNIQUES

Climbers usually rope up on ice. Ice pitches can be climbed using a standard single rope or by using two ropes (see “Double- and Twin-Rope Techniques” in Chapter 14, Leading on Rock). The principal exception comes when overall team safety is served best by climbing unroped. Late on a stormy day or while ascending a couloir threatened by rockfall, a climbing party might find that unroped travel offers relatively more safety with its greater speed than would continuing on the rope. It may be sensible to travel unroped through a section so difficult to protect that a fall by one roped climber would sweep away the whole team. However, make no mistake: unroped ice climbing is serious business.

PLACING PROTECTION ON ICE

Modern ice screws offer reliable protection in good ice. However, some safety is sacrificed because of the time and energy it takes to place them. Therefore leaders commonly place fewer points of protection on an ice pitch than they typically would on a rock pitch of the same length. Ice climbers also make some use of natural protection. Practice so that you are able to use either hand to place protection.

Natural Protection

Natural protection is often hard to come by on an alpine ice route. Good natural protection may be available not on the ice itself but in rock bordering the route or protruding through the ice. Shrubs and trees may provide protection opportunities as well.

Protection with Ice Screws

For any given ice-screw placement, there are dozens of variations. And climbers must ask some very serious questions: What is the quality of the ice? What is the depth of the ice? What is the projected amount of force on the piece? What is the projected direction of force? Which screws are still left on the rack? Which will be needed later? Observations, calculations, estimates, and experience will help climbers answer these questions and place gear accordingly.

Each screw placement is different, which is one of the great things about climbing ice. It is an ever-changing medium. In solid ice and under ideal conditions, ice screw placements are actually stronger if the screw is placed in the projected direction of force. In other cases, placements are stronger if the screws are oriented away from the direction of force. But the decision must be made at the time the placement is made.

A favorable location for an ice-screw placement is the same as that for an ice tool. A good choice is a natural depression, where fracture lines caused by the screw are not as likely to reach the surface. A screw placed in a bulge in the ice, on the other hand, can cause serious fracturing that weakens the placement or makes it useless. In general, keep screw placements at least 2 feet (60 centimeters) apart to reduce danger that fracture lines from one placement will reach the other, weakening both. Avoid the temptation to reuse a previous screw placement, unless it has refrozen.

The procedures for placing a screw vary somewhat with ice conditions, but the basic routine is much the same in any case:

1. For maximum leverage during placement, keep the screw placement at about waist level. If the ice screw doesn't "bite" into the ice right away, the climber can punch out a small starting hole with the pick or spike of the ice tool, to give the starting threads or teeth of the screw a good grip. Make the hole gently, with light taps, to avoid fracturing the ice. The starting hole can also be an old pick hole.
2. Start the screw in the hole by setting it at the selected angle; in solid ice, for example, place the screw at a right angle to the ice surface, with the screw head angled downward about 5 to 15 degrees off perpendicular. This takes advantage of the holding power of the screw threads in the ice in the event of a downward load (see Figure 20-6 in Chapter 20, Waterfall Ice and Mixed Climbing). Press the screw firmly with one hand and twist it into the ice at the same time. Drive the screw in until the hanger is flush with the ice surface and pointed in the direction of load. In poor-quality or rapidly deteriorating ice (rotten, slushy, sun-exposed, et cetera) where there is no better protection option, place the screw at a right angle to the ice surface with the screw head angled uphill 15 degrees to take advantage of the levering action of the screw.
3. Clip a quickdraw or runner in to the eye of the screw hanger, with the carabiner gate down and out. Clip the rope.

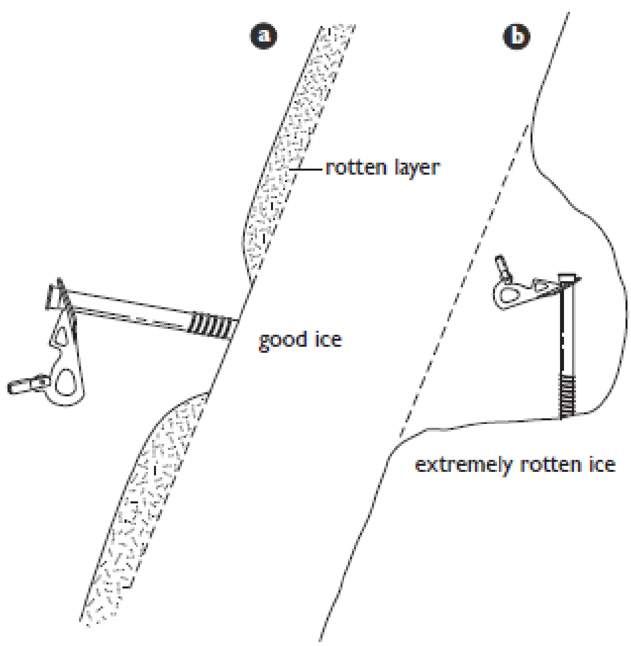

Fig. 19-36. Ice-screw placements: a, with soft or rotten surface layer; b, in extremely rotten ice.

On ice topped with a layer of soft snow or rotten ice, use the adze or pick to scrape down to a hard, trustworthy surface before you make the starting hole (fig. 19-36a). In extremely rotten ice, make a large horizontal step with an ice tool and place the screw vertically at the back of the step (fig. 19-36b). If the ice fractures and shatters at the surface, you may still get a secure placement by continuing to drive the screw and gently chopping out the shattered ice with sideways strokes of the pick.

Climbing extremely steep ice is fatiguing, both physically and mentally, so minimize the number of screw placements when it is safe to do so. Unless the ice is rotten, only one screw is placed at each protection point. Relying mainly on your tool and crampon placements and skills for safety (a concept known as "self-belayed" climbing) also affects the number of ice screws that need to be placed.

With practice, it should be possible to place an ice screw with either hand. On a moderate to steep slope, it may help to chop a step to stand in while placing the screw. On extremely steep ice, however, chopping steps is too difficult, so save your energy. Try to place screws from natural resting spots on the route. Maintain your body weight on your feet, using a tool placement for balance only. Do not wear yourself out by overgripping the tool while placing screws. On extremely steep ice, placing ice screws is exacting business. When it is time to place an ice screw, do it efficiently and confidently from your front points, and then continue climbing.

After you remove a screw, ice inside its core must be cleaned out immediately or it may freeze in place, rendering the screw useless until it is cleared. The interiors of some screws are slightly tapered, facilitating ice removal. Shake the screw to remove the ice core; if this does not work, then tap the hanger end of the screw against the ice or the shaft of an ice tool. Do not bang the teeth or threads of the screw against anything hard. This will only pit the teeth and screw threads and make the screw harder to place, especially in cold conditions. If ice does freeze to the inside of the screw, try to melt it with your breath, with the warmth of your hand, or inside a jacket pocket. Be careful about cleaning out a screw with your pick or a metal V-thread tool; this can damage the inner surface of the screw, making ice more likely to stick in the future. If this continues to be a problem, try squirting a lubricating and penetrating oil inside the screw before climbs.

SETTING UP ICE ANCHORS

For belaying or rappelling, ice climbers have several options for anchors, including the V-thread, an ice bollard, and ice screws. This section discusses the V-thread and ice bollard, which are used mainly in rappelling. The next section, "Belaying on Ice," explains the standard anchor setup using two ice screws.

The V-Thread

The V-thread anchor (see Figure 19-37) is popular because it is simple and easy to construct. Devised by Vitaly Abalakov, a premier Soviet alpinist in the 1930s, the V-thread anchor (also known as the Abalakov) is nothing more than a V-shaped tunnel bored into the ice, with accessory cord or webbing threaded through the tunnel and tied to form a sling. The V-thread anchor has held up well in testing and in use, but remember that it is only as strong as the ice in which it is constructed. Multiple V-thread placements can be constructed and rigged together to create an equalized anchor point. Here are the steps to construct a V-thread anchor:

1. Screw a 22-centimeter ice screw into the slope. Angle the screw uphill 10 degrees against the anticipated direction of pull; also tilt it about 60 degrees to one side of perpendicular to the slope (fig. 19-37a).
2. Back this screw out about halfway, but keep it there as a guide. Insert a second screw into the slope 6 to 8 inches (about 20 centimeters) from the first, angling it about 60 degrees to the other side of perpendicular so it will intersect the first hole at its bottom (fig. 19-37b). In other words, the angle between the two screws is about 120 degrees, with an imaginary line perpendicular to the slope being at the midpoint (60 degrees from either screw). Remove both screws.
3. Thread a length of 6- to 8-millimeter accessory cord into one side of the V-shaped tunnel. Use a V-thread tool to fish the end of the cord out through the other side of the tunnel (fig. 19-37c).
4. Holding both ends of the cord, saw it back and forth in the tunnel in order to smooth the sharp edge of the ice where the two screw holes intersect. Otherwise, the edge might cut the cord in a fall. Tie the cord so that it forms a sling (fig. 19-37d).
5. Place an ice screw 2 to 3 feet (0.6 to 1 meter) above the V-thread anchor. Clip this screw to the V-thread sling as a backup. The anchor is now complete.

For a rappel, the rope is threaded directly through the loop of cord or webbing and then pulled free when the rappel is completed. Alternatively, if no accessory cord is available, the rappel rope itself can be threaded through the tunnel (sometimes referred to as a “zero-thread”). But be aware that ropes have been known to freeze in the V-thread tunnel.

Many abandoned V-threads are found on popular ice climbs at rappel and/or belay stations. As with any other fixed anchor, check it carefully before committing your life to it. Inspect the sling material for burn marks, wear, or other damage, and check that the knot is secure. Sometimes the free tails of the knot may be frozen in place, resembling a secure portion of the sling. Take care! Be sure that the rope is rigged through the sling and not through these frozen tails. Do not make that fatal error. Inspect the integrity of the V-shaped tunnel. See if it has melted out to an extent that it is too shallow for safety. If you have any doubt about the anchor, back it up or replace it.

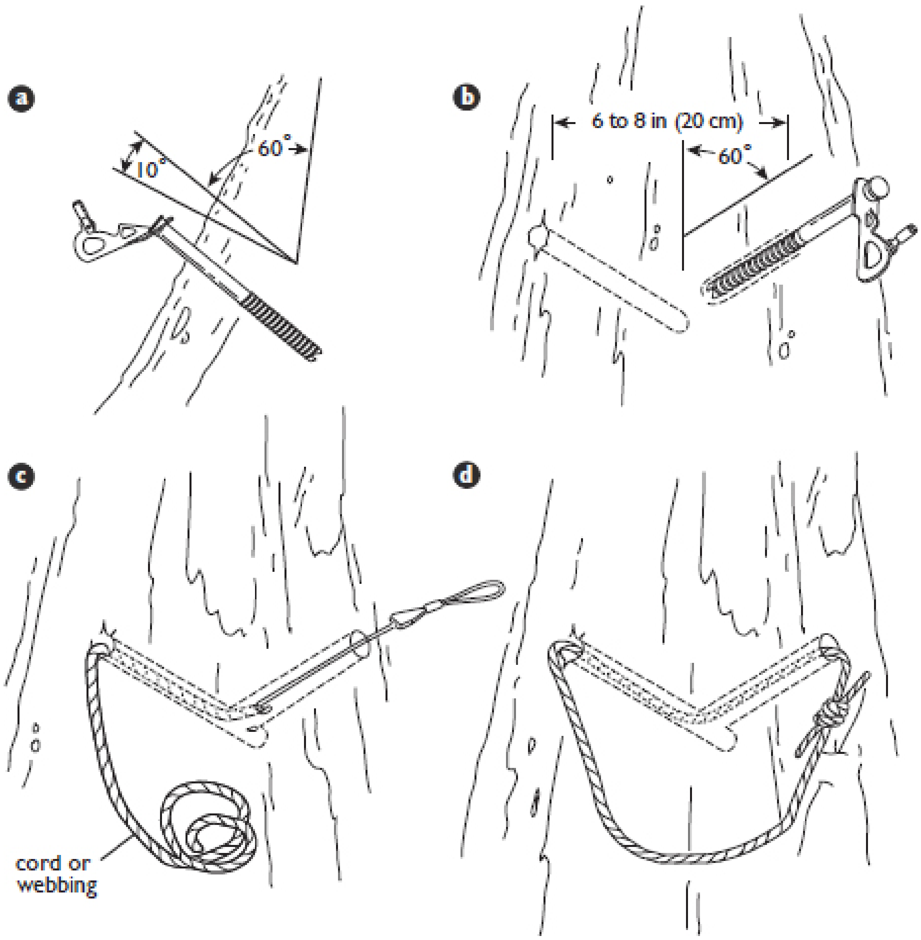

Fig. 19-37. The Abalakov, or V-thread anchor: a, bore first hole with ice screw tilted up 10 degrees and tilted out to the side 60 degrees; b, bore an intersecting hole with another ice screw; c, thread a piece of accessory cord through the V-shaped tunnel, using a V-thread tool; d, tie cord to form a sling and complete the anchor.

Ice Bollard

A bollard can be among an ice climber's most useful natural anchors. While they take time to create, it is a technique worth knowing. The strength of a bollard is proportional to its size and the quality of the ice. Made in hard, solid ice, a bollard can be stronger than the rope. The single largest disadvantage to a bollard is the long time it takes to construct one. A completed ice bollard is teardrop-shaped when viewed from above (as in Figure 19-38a and c) and mushroom-shaped when viewed from the side (as in Figure 19-38b). All that is needed for an ice bollard is an ice axe and good ice, uniform and without cracks or holes.

Cut the outline of the bollard with the axe pick. In hard ice, give it a diameter of 12 to 18 inches (30 to 45 centimeters) across the wide end of the teardrop, and make it 24 inches (61 centimeters) long (fig. 19-38a). Cut a trench around the bollard at least 6 inches (15 centimeters) deep (fig. 19-38b), working outward from the outline with both the pick and the adze. Undercut the sides and top half of the bollard to form a horn that prevents the rope from popping off over the top (fig. 19-38c). This is the most sensitive part of the construction because the bollard is easily fractured or broken if you do not take care. Bollards are also used as anchors in snow (see Chapter 16, Snow Travel and Climbing).

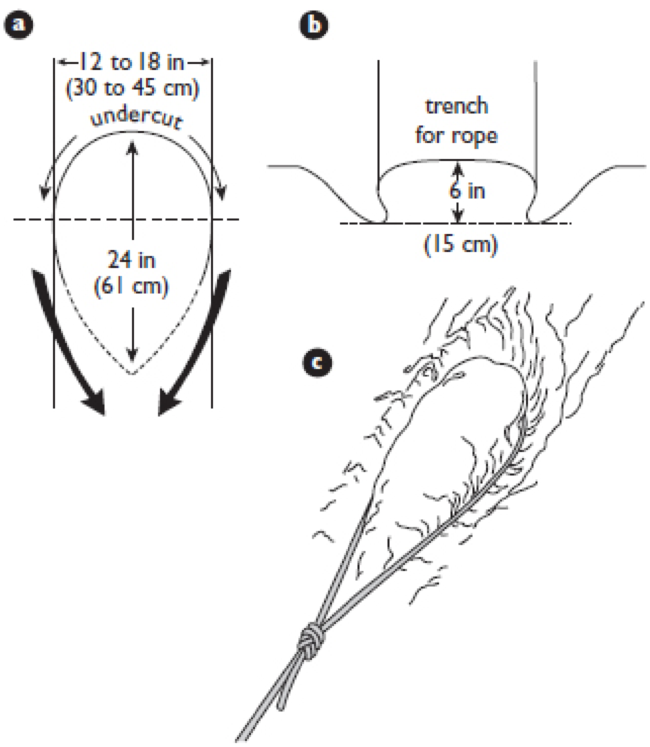

Fig. 19-38. Ice bollard: a, top view, showing width and length; b, side view, showing depth; c, top view, with rope in place.

BELAYING ON ICE

Ice climbers have the options of using running belays or fixed belays, as in other types of roped climbing.

Running Belays

By setting up a running belay, ice climbers can get a measure of protection that is somewhere between climbing on belay and climbing unroped. A running belay is another way for a team to move faster when storms or avalanches threaten—circumstances under which, more than ever, speed means safety. It can also be useful on gentle to moderate terrain where danger of falling is minimal and fixed belays would be too time-consuming.

A running belay on ice is created in very much the same way as a running belay on rock (see Chapter 14, Leading on Rock) or snow (see Chapter 16, Snow Travel and Climbing). The team members, usually just two climbers, move simultaneously. The leader places protection as they climb and clips the rope through it; the follower removes the protection. The idea is to keep at least two points of protection between them at all times to hold the rope in case of a fall. The protection is usually spaced so that as the leader makes each new placement, the follower is removing the bottom one.

Because the technique of running belays sacrifices much of the safety of true belaying, the decision to use it takes fine judgment, based on extensive experience. As the difficulty of the route changes, the team can easily shift between running belays and pitched climbing.

Fixed Belays

Fixed belays (pitches) on ice require a belayer, a belay anchor, and intermediate points of protection, just as they do on rock or snow. A belay anchor is set up; the leader climbs the pitch on belay, sets up another anchor, and then belays the follower (also called the second) up the route. The climbers can either swing leads, or one climber can continue as the leader.

The leader should, when near the end of a pitch, keep an eye out for a good belay spot, perhaps at a slight depression, at a place where the ice is not so steep, or in an area where a platform can be chopped out quickly. If you choose to chop out a stance, place an ice tool off to one side for balance while chopping a step large enough for you to stand facing the ice with both feet flat and splayed. On steep ice, it may be possible to chop only a simple ledge the width of your foot.

Belay Anchor

A standard anchor setup for an ice belay must meet the same SERENE (Solid, Efficient, Redundant, Equalized, and No Extension; see Chapter 10, Belaying) standards as a rock anchor; it takes two ice screws (a third can be added if conditions are less than optimal), preferably screws with either two clipping eyes or a single oversized eye that will accommodate two carabiners. (Ice bollards and V-threads also can serve as belay anchors, but they are more time-consuming to set up and are used primarily for rappelling.)

Place the first screw in the ice directly in front of you at about waist to chest level. Clip in a locking carabiner, then clip yourself in independently using a personal anchor or the rope. Now place the second ice screw, 18 to 24 inches (46 to 61 centimeters) to the side of and slightly above the first screw, so the small fractures created by any screw placement don't intersect, which would weaken the entire section of ice. Clip a runner or cordelette to each screw and create an equalized anchor (see "Equalizing the Anchor" in Chapter 10, Belaying). This completes the anchor setup (shaded rope and the runner in fig. 19-39).

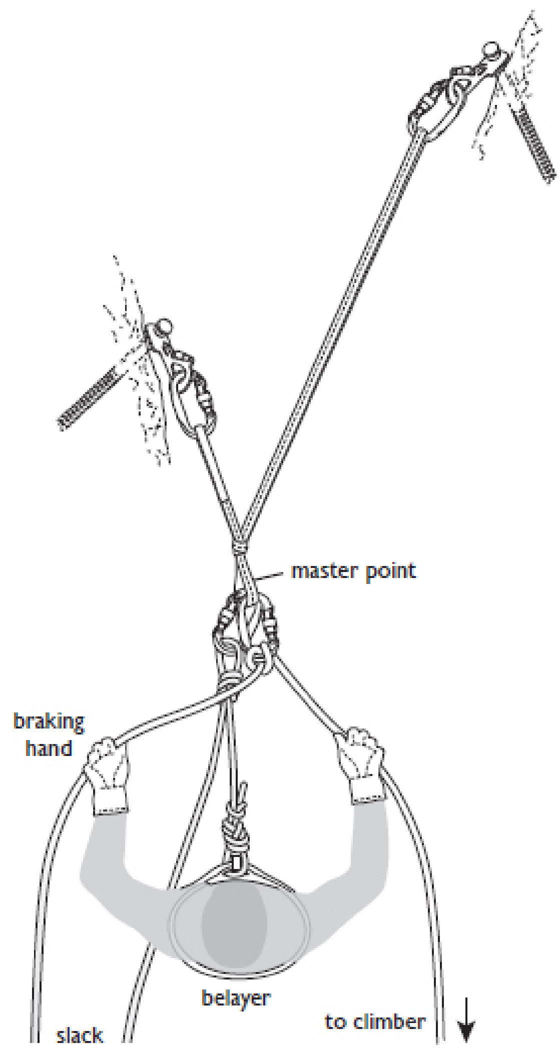

Fig. 19-39. Anchor setup for belaying the second directly off the ice anchor, using two ice screws 18 to 24 inches apart. Second climber is on belay using a munter hitch.

Belay Methods

Choose between belaying off the anchor using a belay device or a munter hitch, or belaying using a hip belay. The anchor setup is the same in any case. The choice probably depends on what the climbers are accustomed to and on the degree of their confidence in the anchor. The hip belay (see below) tends to be somewhat dynamic, with a bit of movement at the belay—resulting in a slower stop to a fall but less force on the anchor and intermediate protection points—yet may be the only option if the rope is iced up and will not work in a belay device. Belay devices and the munter hitch, on the other hand, tend to be less dynamic, stopping a fall faster but putting more force on the anchor and intermediate protection points. For a detailed description of belaying indirectly off the harness, see Chapter 10, Belaying; the mechanics for belaying on ice are essentially the same. For more, see "Choosing a Belay Method" in Chapter 10, Belaying.

Regardless of the belay method employed, rope management remains the same. As the belayer brings rope in while the second ascends, "butterfly" it in coils draped across the rope tethering the belayer to the master point of the anchor. Do not let it fall loosely below, as the dangling loops of rope can impede the second's ascent and subsequently get hooked on small ice features as the next climber leads out above.

Belaying directly off the anchor. Belaying with an auto-locking belay device or a munter hitch directly off the anchor is easy and efficient (as shown in Figure 19-39), and many ice climbers use this method as standard procedure. Attach the belay device or a munter-capable (pear-shaped) locking carabiner to the shelf of the equalized anchor just above the figure-eight knot of the master point (see Figure 10-20 and "Static Equalization" in Chapter 10, Belaying) or to a second locking carabiner attached to the master point, then rig the device (per manufacturer's instructions) or munter hitch properly (see "Belaying a Follower" in Chapter 10, Belaying) and announce to the second that he or she is on belay.

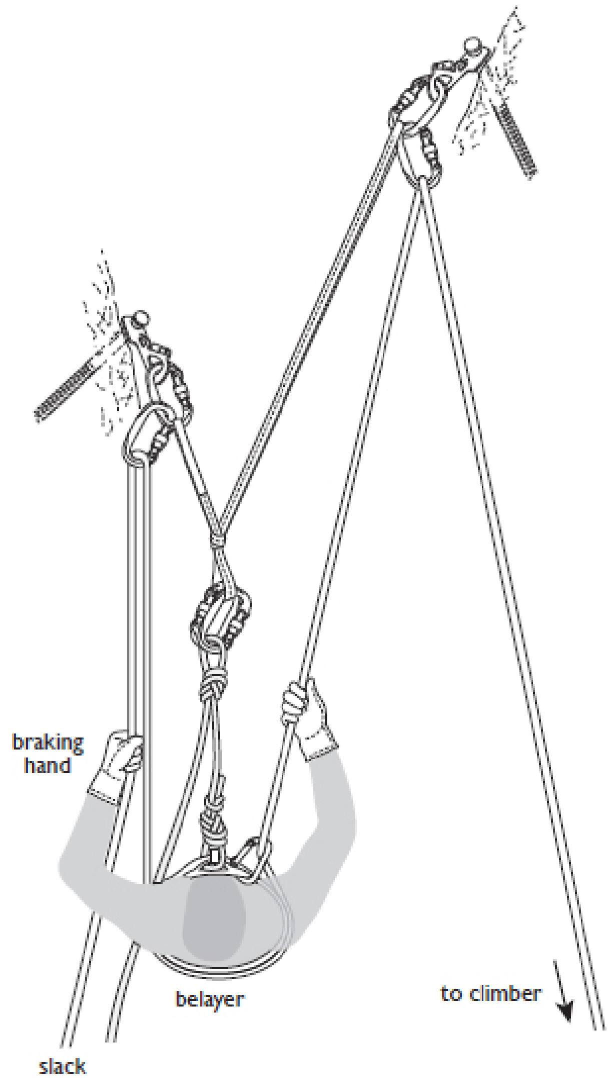

Fig. 19-40. Ice belay setup for a hip belay.

Hip belay. The hip belay is favored when the rope is stiff and frozen and could jam in belay devices. To establish a hip belay, stand facing the ice belay anchor, run the belay rope through an extra carabiner or quickdraw on the second screw, then through a control carabiner at your waist, around your back, through an extra carabiner on the first screw, and into your braking hand (fig. 19-40).

Swapping Leads on Ice

Once the following climber has reached the anchor, both climbers should secure themselves to the anchor using a personal anchor or the rope attached to either screw or to the shelf of the equalized runner, then exchange gear as needed. If the belayer has been belaying directly off the anchor, move the device and its carabiner from the anchor to the belay loop on the belayer's harness and clip the rope leading from the device to the second climber through the quickdraw attached to the upper screw.

The leader now becomes the second, placing the second climber—the new leader—on belay; the new leader detaches his or her personal anchor and begins climbing. The quickdraw attached to the upper anchor screw temporarily becomes the new leader's first piece of protection. Once the new leader has placed the first piece of protection above the anchor, the belayer detaches the quickdraw on the upper anchor screw from the lead rope. Repeat this changeover sequence at the top of each pitch to the end of the climb.

RAPPELLING ON ICE

For descending steep ice, rappelling is usually the method of choice. The principal considerations for rappelling on ice are the same as for rappelling on rock (see Chapter 11, Rappelling), but there is a big difference in anchor options. On rock, a natural anchor such as a rock horn or a tree can often be used. On ice, climbers frequently have to make their own anchors. The most popular rappel anchor for ice is the V-thread, with the ice bollard as an alternative if conditions and available equipment dictate (see "Setting Up Ice Anchors" above). An ice screw is commonly used to back up an ice anchor until the last member of the party descends. The last person removes the screw and rappels on the anchor with no backup.

PRACTICING FOR THE FREEDOM OF THE HILLS

Skill and confidence in alpine ice climbing come with long practice. The ability to assess or read the ice comes with years of experience. Link up with a steady ice climbing partner if possible. Practice together often. Work on pinpoint ice-tool and crampon placement, which conserves energy. Also work to increase the speed and efficiency of your climbing, gearing it to the conditions of the ice and your body's strength. It is up to each climber to decide when to rope up for protection—and when it is safer not to. Experienced ice climbers learn these skills, continue to hone them, and apply them with confidence and good judgment so they can meet the rigors of their chosen routes.