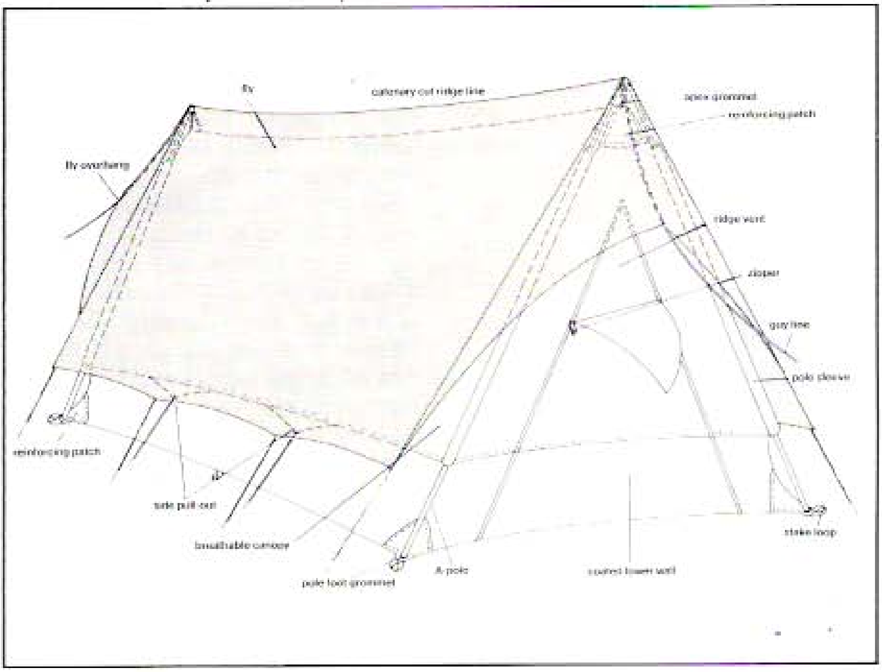
TENT CONTRUCTION II: Design

How a tent is built—and why.

by Seth Masia

To keep you dry, a tent has to do more than just keep out the rain.



The first backpacking tent was built by Edward Whymper for summer climbing during 1862 when he made his solo attempt on the Matterhorn. It weighed 23 pounds, was 6½ feet long rolled, and it took one Swiss guide to carry it. It cost Whymper about $25.

The English mountaineer wrote that his tent was "sufficiently portable to be taken over the most difficult ground, whilst combining lightness with stability. Its base was just under six feet square, and a cross-section perpendicular to its length was an equilateral triangle, the sides of which were six feet long. It was intended to accommodate four persons. It was supported by four ash poles, six feet and a half long, and one inch and a quarter thick . . . these were shod with iron points."

In other words, what Whymper had was an early A-frame. He found the lightest and strongest material around for the canopy, an unbleached calico called forfar. For the floor he used the most waterproof material available: mackintosh. The floor was sewn in and came three feet up the sides; the forfar was laid out so that no seams appeared in the canopy. One end of the tent was permanently closed, the other covered by two overlapping triangles of forfar. The ash poles were fastened together at the top with stove bolts, and the forfar was nailed to the poles. It could be set up by two people in three minutes and would stand up to any gale.

Until quite recently, most tents relied on cotton and wood. GI pup tents, beloved of boy scout and YMCA camps, were heavy, creosote-smelling, droopy, ovenlike caverns erected on spiked wooden poles which looked like window shade rollers.

The significant advance came with nylon and aluminum. Still, the most widely accepted modern alpine and backpacking tents are simply lightweight versions of Whymper's A-frame tent, with fly. Having solved the weight problem, the industry has reached a point of diminishing returns in tent design. Spending an extra fifty bucks now buys less than a pound shaved, and designers put incredible amounts of time and energy into devising ventilation and rigging systems which yield marginal performance improvements.

Water Vapor.

Quite simply, staying out of the rain won't necessarily keep you dry. During a normal night's sleep you produce a pint of water vapor—some perspired, some exhaled. On a hot night two of you will produce rather more than a quart, to which you must add the evaporating water from your wet socks, boots and clothing, the steam from the stewpot and the humidity of a rainy night. It adds up to a murky, swampy little atmosphere, restricted in volume to less than 70 cubic feet. If your tent is waterproof—and a lot of inexpensive tents are surprisingly so—it's going to feel like sleeping inside a plastic bag. All that water vapor tends to condense on the inside of the rain-cooled urethane coated canopy, to drip back down on you and your high lofting down bag. Result: a soaked bag, a sleepless night and five pounds of moisture to pack out in your stuff sack come morning.

Unless, of course, your tent is properly ventilated. The most widely accepted method of preventing condensation is to make the tent out of a light and porous fabric. Water vapor goes through the stuff instead of condensing on it. If the tent canopy isn't waterproof, though, you have to carry a tent fly to hold off the rain.

In severe weather, the best bet undoubtedly is one form or another of the tent and fly combination. The fly has the additional virtue of shielding the tent from high winds. Several manufacturers now make tents from mosquito netting, with waterproof flies riding high enough to allow plenty of air to get in and out. In high winds you can pull the fly down tight against the ground. But remember to leave a vent somewhere, and preferably a vent at each end.

Ventilation.

Some manufacturers now produce waterproof tents with elaborately designed ventilation systems to keep the water vapor circulating out. Some of these systems work better than others. If well designed, such a tent is lighter than and nearly as efficient as a tent-fly combination. One manufacturer locates vents both high and low, and claims the arrangement encourages convection, making for more efficient circulation than is possible even with a tent and fly. But he also admits that in humid climates —New England, the Midwest, and the Pacific Northwest—there was no way even his tent could avoid condensation. So he redesigned it with an inner wall.

Waterproof tents are a problem in very still or very stormy weather. There's little so frustrating as a wringing, dreadfully hot night with no breath of wind to clear the steam out of your tent. And if heavy winds force you to close the ventilation ports against the rain, you're sealed in your own juices.

CO, CO_2, and Gasoline.

It's also well to remember that you have to breathe all night. Anytime you feel like zipping up against the weather, think about ventilation. If your tent is of the plastic-coated variety, leave something open. People have suffocated in sealed tents.

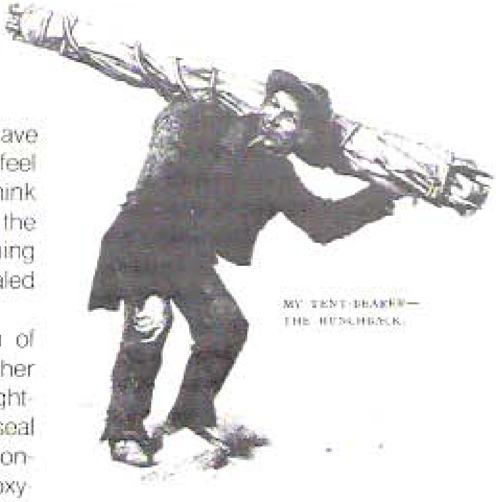
Which brings us to the problem of carbon monoxide. Heavy weather makes you want to cook inside. Lighting your stove makes you want to seal the wind out. That little gas stove consumes gallons of oxygen. When the oxygen inside the tent falls below a critical point (a point far above that at which you'd find any difficulty breathing), it begins to produce carbon monoxide at a constantly increasing rate. Carbon monoxide poisoning is one of the primary causes of death in the wilderness. It will kill you with no warning: you experience no respiratory distress. You simply feel a bit drowsy (natural after a long hike), fall asleep and die. Moral: Never cook in a tent that's sealed.

Don't fill the stove in any tent. A tent full of gasoline vapor is highly explosive, as I discovered when I lit my stove and a brief blue flame filled my tent—fortunately to no ill effect beyond singed eyebrows. Gasoline will also damage the urethane coating on the tent floor. If you plan to do a lot of indoor cooking, it pays to invest in a cookhole or vestibule, so that spilled food and gas will land on bare ground.

Cross Ventilation: Ridge Vents.

I like a system with a high vent at each end for cross ventilation, as close to the ridgeline as possible. In that position, they exhaust the warm air and are close enough under the tent fly to receive protection; it's usually unnecessary to zip the vent closed in heavy weather.

Many tents are built with a ridge vent at the back end and no vent over the door, on the theory that the door itself is a vent. But if the door zips down the center and across the bottom, leaving the zipper undone at the bottom for the sake of ventilation invites the storm in. A better arrangement is to have the door zip *up* its sides, with the two zippers meeting at the apex. Then, when you leave the zippers open a few inches, the door forms a neat ridgeline vent right under the fly—high, dry and handsome.



MY TENT-BEARER—
THE HUNCHBACK.

Exhaust Vents.

It's especially important to have a ridge vent in any tent you intend to cook in: this exhaust vent should be located near the highest point in the tent in order to expel exhaust gases. Some exhaust vents look like miniature tunnel entrances: they can be poked around and tied in various directions to avoid the wind and weather. Since the purpose of the exhaust vent is to draw air *out*, a second vent should be open near the other end of the tent, preferably the windward end, to let fresh air in. If your tent is of the plastic-coated variety, this requirement is vital.

Mosquito Netting and Zippers.

Naturally, all vents and entrances should be fully mosquito netted. Getting in and out is easier if the netting zippers follow the same pattern as the door zippers. When the door zips down two sides and the netting likewise, you can zip each down about two-thirds and enter and leave with no trouble. If the netting, instead, zips down only one side and across the bottom, you'll have to open the door all the way in order to reach the netting zipper so you can get in. The same is true in reverse: It's a bother to have to hunt for zippers in the dark when the rain starts. But it's worse if you have to open the netting all the way and then fumble through folds of fabric to find the door zipper. Everything is easier if you can just unzip the netting and have the door zipper right there, adjoining the net zipper.

Tunnel Entrances.

Zippers, like tent designers, have human failings. They can be recalcitrant in times of stress. The jammed zipper is one reason for the existence of the tunnel entrance, a sleeve closed by a drawstring, through which you can crawl when the zippered door won't work or is blocked. Because of its function as an escape route, the tunnel should be located at the opposite end of the tent from the door. In heavy weather it allows you to squirm out through a hole just big enough for you, minimizing heat loss and admission of weather. It may also be rolled up with another tunnel entrance to provide a weather-tight seal between two tents, rather like the accordion passage between two railroad cars.

The ultimate in summer ventilation is achieved by the tent with fully netted entrances at each end. The wind just blows right through. Delightful.

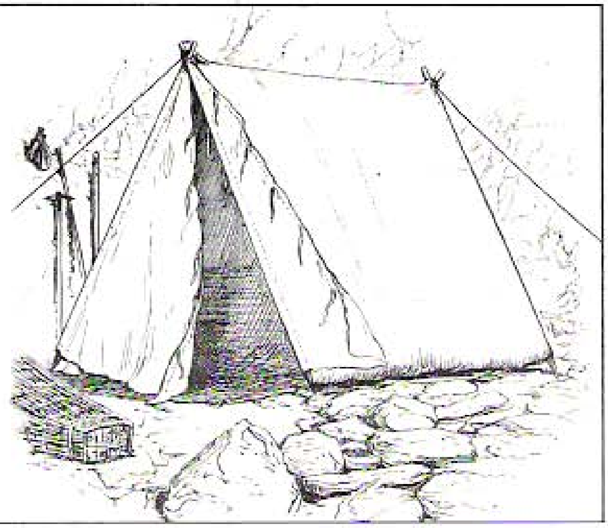
Vestibules.

Another form of entrance is the vestibule, an extension of the fly or canopy beyond the tent door. Some tents have built-in vestibules, and some are available with add-on vestibules. If large enough, the vestibule is useful for storing packs out of the wet. If too small for that, it's still a good place to leave wet boots and a way to keep the rain away from an open-for-ventilation door. Finally, if properly vented, the vestibule makes a good kitchen.

Sometimes a vestibule isn't separated from the rest of the tent and shares the tent floor. In that case it should have a cookhole: a zippered flap cut in the floor of the tent so that wet boots, spilled soup and hot pots can rest on bare ground instead of on nylon. Cookholes now are commonly semicircular and should close with one very tight, almost waterproof zipper. You may still see some cookholes with two zippers which form two sides of an equilateral triangle.

Floors.

The ideal floor would have no seams.



Whymper's 1862 alpine tent was just under six feet square, weighed 23 pounds, and rolled into a package 6½ feet long. It could sleep four, and is considered the first back-packing tent.

The coated floor material would wrap several inches up the sides to form the lower part of the tent canopy. But in order to form box corners at the corners of the tent, all floor fabrics have to be folded, cut and stitched, which creates seams. Still, the fewer seams near the ground, the better. A tent with waterproof material running partway up the walls is said to have a bathtub floor, although one hardly expects it to hold water.

The coated side of the floor fabric should face up, toward the inside of the tent, to protect it from ground abrasion. Additionally, its rubbery surface will help keep your slick nylon sleeping bag from sliding toward the lowest corner.

Catenary Cut.
If you expect your tent to stand up against the wind, you'll be concerned with catenary cut. A catenary is the curve made by a cable or cord when hanging between two points. Catenary cut is the practice of designing tent walls to conform to the natural catenary, or sag, of the ridgeline, thereby sharply reducing the sag, slack and wrinkles in the walls themselves.

Winds can flap a tent's walls in a drumroll all night. Wild flapping will keep you awake only so long, but it imposes severe point loads on the tent's fabric and seams. A well-designed tent has smooth, tight walls when pitched, which flap less than sagging, wrinkled walls. You can tell how carefully a tent was designed and built by looking for slack in the canopy. You should find sag only in the ridgeline, not in the sides. Catenary cut not only reduces wind flap but also spreads the strain out evenly along the seams. A well-cut tent imposes fewer point loads; the stitching is exposed to less strain and should last longer.

Domes and Semi-Domes.
Another solution to wind problems is the semicylindrical design. With no flat surfaces, no sharp edges or corners, a Quonset-shaped tent presents a smooth airfoil shape to the wind. Because the surface is curved, it may even develop a certain degree of lift in a steady wind, increasing the room inside the tent.

Another advantage to the Quonset or dome tent (but one that would be more important to the winter camper) is its smaller surface-to-volume ratio. The less surface area the tent presents, the less heat it radiates away and the less fabric required. Less fabric means less weight, though whatever weight is saved in nylon is often more than offset by the elaborate system of aluminum poles or fiberglass wands necessary to maintain the dome or Quonset shape.

I-Poles.
The lightest and simplest pole system is the ordinary old-fashioned straight tent pole. It must be guyed in at least three directions, usually by the tent itself and one additional guy line. It may hold up one end of a tent or the center. Some backpacking tents have an A-frame at the front and a short I-pole holding up the lower rear. The disadvantage of the I-pole is that it obstructs the entrance or interior, making space less usable.

A-frames.
The next step up in complexity is the A-frame, as used by Whymper and the majority of alpine tents. A-frame poles really describe an inverted V. The poles run down the corners of the tent, pulling the walls tight and clearing the entrance for easier access. Most good mountain tents use the A-frame because of its stability and strength in the face of a stiff wind, which results from the property of a triangle being self-supporting in its own plane.

Exoskeletons.
Several tent models use Blanchard-type frames. These exterior skeletons consist of three or more long legs and a central framework from which the canopy is hung with shock cords to keep it tight. Such a tent is completely self-supporting. Once pitched, it can even be picked up and carried to a new location. Nevertheless, it still must be firmly guyed down against the wind.

Dome tents and semicylindrical tents with exoskeletons usually rely on the springiness of the bent poles to provide tension, rather than on shock cords. The poles fit into sleeves sewn to the outside of the canopy. In general, the more complex a canopy's curves, the more complex the framework required to hold it, and the heavier and bulkier the poles. Another drawback is that a hoop-shaped frame isn't as rigid as a triangular rig and will flex somewhat in the wind. Finally, curved, springy poles put a lot of strain on their joints, so joint failure is fairly common.

Flies.
A well-designed tent should have a tight, generous fly, with enough overhang at the ends and sides to protect the vents and, perhaps, any gear left outside. The primary purpose of the fly, of course, is to protect the canopy from wind and rain, and it therefore should be tailored on a catenary so it won't flap and tear loose. The easiest flies to rig are those that are guyed to the stakes you've already put in to hold the tent.

One of the most frustrating camping problems is trying to put up a complicated tent fly, with its tangle of guy lines, in the rain. Only one or two manufacturers, in my experience, have devised really workable quick-rig systems for flies. You may be able to work out your own by judicious use of spring clips and short sections of shock cord. Despite the general lack of sophistication in fly rigging, the fly itself is usually the best tailored part of a tent, probably because it's the first thing you see of the erected tent in the equipment shop.

In mild climates, some hikers will carry the fly alone for shelter. It provides no pest protection, but it keeps rain and wind off better than a poncho.