Mountain Equipment for the U. S. Army

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FEW mountain climbers there are who have not spent untold hours arguing over the merits of this or that ice axe, or whether Tricouni or Swiss edge nails are better, or any one of the innumerable controversial subjects involved in mountaineering equipment. Mountain climbers are at least on a par in this respect with fishermen, yachtsmen, hunters, golfers and others who are attracted by specialized sports in which equipment figures prominently. When you add to personal prejudices and idiosyncrasies the added problem of military requirements, you create a field for discussion even more than usually conducive to difference of opinion. Members of the 10th Mt. Division and other army personnel who had occasion to use specialized Quartermaster clothing and equipment are well aware of this, as are those of us who worked on the design end.

Because research and development in Quartermaster equipment brought to light and use many new materials and designs in large measure free from personal prejudices, a discussion of some of the major developments in army mountain equipment should be of interest to most mountaineers. Of at least equal interest are the various factors peculiar to military requirements which necessitated divergence from many accepted civilian concepts of "the right piece of equipment."

As is well known, the U. S. Army up to the beginning of World War II had no substantial experience in mountain or cold weather problems. Unfortunately lessons on cold weather problems learned in the first World War were forgotten and were not available when the need for them arose. As far as mountain problems were concerned, considerable experience had been available from mountain fighting in the Philippines. None was available on temperate or cold weather mountains, however, since the possibility of the need for this type of fighting had not been foreseen. Therefore neither equipment nor tactical understanding existed.

Fortunately during the winter of 1940 and 1941 a start was made on the cold weather equipment problem, notably by Maj. General Simon Buckner, then in command of the Alaska Defense Command. He immediately called on the Quartermaster to in-

itiate action to make available suitable cold weather clothing and equipment to enable his troops to operate effectively outside their barracks. Likewise in the War Department there were a few officers who believed so strongly in the need for troops able to operate in any kind of weather and over any terrain, that they were able to initiate maneuvers for testing tactics, logistics and equipment in Wisconsin in the winter of 1940-41, and on the Wood Yukon Expedition the following summer. On the latter, rations and personal equipment were supplied and an official observer, Captain Albert H. Jackman, was detailed to accompany the expedition to report on the military problems connected with travel in glacier and high mountain country.

As the result of all these reasons, the fall of 1941 found the War Department very much concerned with the problem of equipment and desirous of making use of the best available civilian experience. Following a series of conferences attended by many of the leading mountaineers and skiers of the country, it was decided that experienced personnel were needed to design, correct and test equipment, rather than to rely merely on advice to procurement officers on what was believed to be the most suitable equipment.

Great credit is due Colonel L. O. Grice who as chief of the Standardization Branch of the Office of the Quartermaster General started to build an organization of qualified personnel with experience in the fields of cold weather and mountain problems. With them he planned to design completely new functional equipment for the Army's prospective mountain divisions, for troops in Iceland and Greenland, and for such requirements in Arctic and cold weather warfare as might develop. Robert Bates was called from Phillips Exeter Academy to be the first member of the new unit. Others followed in close succession: myself, Bestor Robinson, Adams Carter, Richard Leonard, Terris Moore, Bradford Washburn, as well as men with true arctic experience such as Sir Hubert Wilkins and James Ford.

In the beginning, this group exhibited the same highly individualized opinions that characterize mountain climbers anywhere. There were those who favored Swiss edge nails over Tricounis because they had used them in certain mountains. There were those who thought the Horoschowski design was the only right one for ice axes, and so on with all the many items of equip-

ment that were needed. It soon became apparent that few actual scientific data were available from past experience, and that if we were to get anywhere we would have to study military requirements, combine that knowledge with our own individual backgrounds, and come out with something that was practical for an army, not just the product of our own likes and dislikes.

As might be expected, the influence that purely military requirements had on the choice of equipment was tremendous, though in all the work was the need of understanding the basic problems of rough country travel, and protection from the elements, knowledge we had gained in earlier years.

One of the first considerations was where the equipment was to be used. Mountain ranges differ greatly all over the world. We found ourselves in the amazing position of having to determine where combat was going to take place. Would American troops be involved in the mountains of Greenland or Iceland, Alaska, the Pyrenees, Norway, the Alps, the Caucasus, even the Himalayas? If so, what were the most likely possibilities? Even the General Staff, who were approached for help, could give no advice except that a mountain division was to be formed for mountain fighting, and that in addition suitable equipment would have to be available for a possible arctic campaign. Where? It was not known where, but equipment would have to be supplied troops at the earliest opportunity. Can anyone conceive of a single mountaineering kit which would be usable in any mountain range of the world?

This brought us face to face with the second, and probably the most important, factor in equipment design, one which more than anything has influenced all types of military equipment whether it be boots or field artillery. That was the overwhelming need for a minimum number of types of equipment. Even well before the war it was recognized that the form that the inevitable world-wide war would take would make supply a complex and difficult problem. Lines of supply were sure to be long, relatively inflexible, and subject to interruption, while over and above everything the actual theatres of combat were not known. The result was that in design as well as in choice of materials every single item had to be capable of serving adequately as wide as possible a field of use. Some extremes, of course, were incapable of being reconciled, such as tropic and arctic clothing and foot gear, but every decision on

equipment had to be made in the light of how well each item would work under many different conditions.

As can well be imagined, the compromises that had to be made were substantial and frequently resulted in bitter but understandable complaints on the part of the using troops, who felt that the equipment they were issued was not right for the conditions they were encountering. Despite this and in view of the known problems of supply and the unfamiliarity of the new army with new types of equipment, we felt justified in making every item do as many jobs as reasonably could be expected without seriously impairing its functional utility.

A third maxim that constantly faced us was that soldiers were traditionally hard on equipment. Whereas they might treat their own civilian clothing with reasonable care, the fact that military clothing was issued by the government removed the necessity for caring for it. This attitude was shared by nearly all troops, even a majority of the especially trained mountain troops, and was often not changed until shortage of supply on a combat front made it essential to make their equipment last. An additional factor too was that the job of the soldier was tough and he frequently was not able to protect his clothing and equipment in the same manner as a civilian. Between the two, though, some real design headaches were produced. We knew that lightness was essential to civilians in any kind of movement in the mountains, and was infinitely more important to the soldier, who was already burdened with many pounds of essential fighting equipment not carried by the civilian mountaineer. Boots, windproof clothing, sleeping bags, tents—all had to be made more rugged than for civilian requirements, and until the priceless lightweight nylon fabrics became available, clothing had to be considerably heavier than what we had previously been accustomed to.

A fourth factor, and one of the most frustrating, was material shortages. Quartermaster requirements were low on the list of priorities, especially in the fields of lightweight fabrics and metals. No less important were shortages of productive capacity or of available machines. In many cases compromises in usefulness and durability had to be made because of higher priorities awarded other Army materiel.

Hardly less important than these reasons was the fact that few manufacturers were familiar with the production in volume of

many of the specialized items of equipment needed by the mountain soldier. Often the numerical requirements were too small to interest those equipped for large scale production of mechanical items, while still being too large to permit the individual craftsmanship that had been adequate for civilian demand. Also, most of the equipment was new to procuring officers and inspectors and satisfactory control of quality was difficult.

Over and above everything was the terrible urgency to have the proper equipment in the hands of troops early enough in 1942 and 1943 to enable them to train properly, and if necessary to fight before their training period was up. Little time could be spared for testing, and many pieces of equipment went directly from a few crude prototypes into specifications, and thence up for bid.

Later as the Research and Development Branch of the Quartermaster General's Office expanded under Brigadier General Georges F. Doriot, many of the inadequacies of the earlier emergency methods were corrected. Equipment was more thoroughly tested and the needs of troops more accurately analyzed. Most of the basic designs of the early few months, however, were with improvements still standard at the time of the end of the war.

It is good to know that this same work is continuing in the post war period, and that by expert and complete analysis of military requirements, plus development of new and better materials and their application to the soldiers' needs, better equipment will be available in future years.

For those who either have used specialized mountain equipment in the services or have bought some as war surplus, a brief sketch of the reasons behind specific designs of a few interesting articles is here given.

Ice Axe

Probably no piece of equipment except possibly skis is more subject to individual convictions than the ice axe. Added to this problem was the fact, noted above, that it was not known where mountain troops would fight. If it were to be in the high mountains or in Greenland or parts of Alaska where glacier travel is an important problem, a typical guide's ice axe, capable of heavy ice work, would be needed. If it were to be in lower mountains where the axe would be used only occasionally, a lighter axe with

greater ease of carrying was the logical solution. We decided in favor of the former and chose an axe modeled on the Horoschowski pattern as combining the advantages of sound balance for heavy ice work, yet reasonable portability. As the mountain troops developed their tactics and training, we came to recognize that this decision had not been correct and that the best over-all interests of the mountain soldier would probably have been better met by a lighter axe, even at the expense of heavy step cutting. By that time, however, the requirements for ice axes had ended and time and effort were directed towards more immediately important ends.

Choice of a design was only the beginning. All of us, amateurs in the field of industrial design and manufacture, soon learned that there is a wide gap between a good idea, even one well outlined in a specification, and an acceptable finished project. We found among other things that high grade properly dried ash was not available for the ice axe shaft and had to turn to the heavier hickory. An unauthorized change from specifications in welding of the tangs to the head placed a weld line directly across a rivet hole, a feature invisible in the finished product. For this we got many breakages and heartfelt curses from the soldiers. Also, since neither the manufacturer nor the inspectors recognized the extreme importance of proper balance and alignment of the pick and cutting blade, sloppy workmanship was permitted, which resulted in the pick being considerably less than at right angles to the shaft. This angle resulted in a tendency of the axe to bounce when step cutting, especially when cutting down hill. Eventually, however, these "bugs" were removed, inspection and compliance were made more rigid, and the later axes were good axes, if on the heavy side. It is interesting to note that even with the restrictions of very tight specifications and inspection, the cost to the government was between three and four dollars apiece. In fact one misinformed but enthusiastic manufacturer offered to make 300,000 for one dollar apiece. Doubtless he could have, but the source of his information that the Army intended to buy that many axes still remains a mystery to us all.

Mountain Boots

The first idea that any of us had about boots for mountain troops was that the "Bramani" boot sole of rubber should be investigated. Several had seen it in use in Italy, and the few re-

ports on its performance were very encouraging. It seemed to combine in a very convenient package all the main requirements of a mountain boot sole. It was adaptable to a wide range of mountain surface conditions, such as wet and dry rock, snow, ice, moraines, and rough terrain in general. It was relatively light and flexible, and caused neither noise nor sparks.

Alas, hardly had we begun to think about these soles before an order prohibiting the use of rubber in any new equipment was issued and we had to turn to the more conventional nailed boot. After a lot of discussion the Tricouni type was decided on as the most practical nail, not only on a performance basis but on a production basis as well. Machines to make the Swiss edge nail type were lacking and hand manufacture was out of the question.

A good start in the design of the boot itself had been gained in a model made for the 1941 Wood Yukon Expedition by Bass. This had a sole shaped to fit in a ski binding, but was not so stiff as the usual "down hill" ski boot. The toe was made unusually high to permit the use of a felt insole and to make room for the toes at low temperatures. Although the design was not envisaged as anything like an arctic boot, it was felt that troops in the mountains would have to endure low temperatures and inactivity and therefore needed the maximum of protection. This model with some changes eventually became the Army Ski-Mountain Boot. In large measure due to the early overemphasis on skiing, objection was made to the Tricouni type nails by members of the early mountain units on the ground that they made skiing difficult. This they did, as snow tended to ball up between the sole and the ski, and the Tricouni nails plus the insole tended to place the foot too far above the ski for good stability. A boot with good gripping power was still needed, however, for the period off skis, time which we felt in practice would occupy the greatest part of the mountain troopers' day. Fortunately by early 1943 it was possible to secure compounds of both natural and synthetic rubber and we were able to go ahead on the "Bramani" design. After much experimentation with both compounds and cleat designs, a sole was adopted which we believed better than the original "Bramani" sole. It consisted of a $\frac{3}{16}$-inch rubber sole with $\frac{3}{16}$-inch moulded cleats, "V"-shaped on the middle of the sole and square "U" shaped on the edges, a boot which gave good grip on almost any surface except smooth ice.

This remained the standard mountain boot for winter or cold weather mountaineering and amply justified our efforts to make it a good cold weather boot. No really good summer mountaineering boot was ever adopted, in part because as the war progressed new and special equipment was discouraged for supply reasons and because the generally issued composition sole service boot was found to have surprisingly adequate qualities for everything short of snow and ice climbing.

Mountain Rope

By far the greatest single contribution to mountaineering made in wartime mountain equipment was the nylon rope. Because of the need for quick supply of safe ropes for training purposes we turned at once to the standard high grade Manila ropes used by most civilian mountaineers. However, acute shortage of all grades of Manila hemp, especially the high grades, necessitated an early attempt to find a good substitute. Sisal was a possible choice, although the increase in diameter necessary to provide adequate strength and its low resistance to abrasion made it only a stop-gap solution.

The almost incredible performance of some of the synthetic fibers suggested an investigation there. Under the able direction of Richard Leonard work was undertaken in cooperation with the Plymouth Cordage Company, and tests were made of many different types, consistencies and lays of nylon rope. With no exceptions the final choice of medium lay bright nylon was found to be superior to the highest grades of Manila. Chief and foremost was its great resistance to shock. It was found to absorb over three times the shock loading as the same weight of Manila. As an example, the best grades of Manila could be stretched only to approximately 13% of their length before breakage, whereas the nylon rope would stretch over 39%. In addition to this most important safeguard for the mountaineer, resistance to abrasion was found far greater than in Manila, although the first few hours' use resulted in a frayed appearance which some early testers thought was premature wear. Holding capacity of knots in relation to strength of rope was found better than Manila and moisture absorption was far less.

All in all the advantages were so great that it was expected that they might be put to further use by making the rope thinner

and therefore lighter, while still having a much stronger rope than the conventional 7/16-inch Manila. The Army Mountain and Winter Warfare (Testing) Board decided against this reduction, however, because of possible difficulty in handling. Therefore 7/16-inch diameter nylon with a specification strength of 3400 lbs. and a weight of 6½ lbs. (120 feet) was adopted.

Use of this rope in army rock climbing schools, where it received very heavy use, justified the confidence placed in it, and at the present time only high price should keep all mountaineers from using it.

Crampons

As with most of the early equipment, the urgency of the need for equipment was so great that standard, well proved designs were relied upon to a great extent. This was especially true of crampons, where very little discussion was needed to decide on the relatively light 10-point ones. Manufacturing them in quantity proved another matter. In order to reduce sizes to a minimum, a high degree of ductility was required in the uprights, while the teeth had to be tempered to be tough but not brittle. We were assured that this combination could be accomplished by proper annealing and heat treatment, but the degree of reliability required was never reached in quantity production. At this point the American Fork and Hoe Company suggested a novel design utilizing bent steel straps ½ inch wide and ⅛ inch thick, secured by rivets set in square holes. The result was a pattern functionally the same as the traditional 10-point crampons, but made from sections which could be given different heat treatments: the uprights were of low carbon steel merely annealed, while the teeth segments were of slightly higher carbon steel, heat treated and drawn to give them necessary toughness and hardness.

Attempts were made later in the war to utilize aluminum, but none of the alloys then available gave a sufficient strength-weight advantage to justify their use. It is possible that some of the new magnesium and other light alloys may prove more satisfactory.

Tents

This proved to be a tough problem all along. Again we did not know where troops would fight, but felt that they should have a tent that would protect them from wind, rain and cold, and still be

light enough to carry. None of the ultra-light cotton fabrics were available in sufficient quantity and the heavier ones were not only too heavy for back packing troops, but did not have the necessary waterproofness. The only means of securing waterproofness and light weight was to use a cotton material lightly coated with synthetic resins. Because of the coating, fabric too porous in itself could be made absolutely wind tight. The resulting tent was modeled after the Meade-type Everest tents, only made a little smaller. Poles were simple A frame poles, which permitted erection easily in high winds, a real advantage.

Had this tent been put up for civilian consumption, the complaints about it would have put the manufacturer out of business. As can be imagined, the waterproof fabric held in and condensed moisture, either as droplets at temperatures above freezing or as frost when below freezing. The resulting annoyance to military occupants was terrific though overemphasized. However it was still a tent giving protection from the elements, light enough to be back packed and easily handled. Experiments with permeable tents showed that they picked up to as much as 100 percent of their dry weight in ice held by the fabric whereas the coated fabric tents added only a fraction of their original weight.

Toward the end of the war real advances were being made in light weight, partially coated fabrics, which may realize the dream of all mountaineers as well as outdoorsmen of a fabric which will let sweat and body moisture out, but keep rain from coming in from the other side. Application of this material to future army light weight tents and clothing should solve one of the greatest single problems of protecting the soldier.