ellers. The juice of lemons and limes is both a preventive and a remedy, and should always be in store for issue to troops likely to be long on transports, as it is to ship's companies, as well as to those exceptional stations where soldiers are completely cut off from the supplies of fresh vegetables. Unadulterated vinegar has much virtue, and it has been suggested that the tradition that Hannibal made a way for his troops through the Alps with vinegar refers to preserving their health in those frozen wastes by its use. Generally speaking, fresh succulent vegetables and fruits fill the need; but of these the seeds are the least useful parts, and the Leguminosæ have no virtue. The tomato, the raw potato, and the onion are practically the most valuable of the common vegetables. Fresh cabbage is better than sauerkraut. Raw potatoes peeled and sliced and covered in alternate strata with molasses keep well and are antiscorbutic. The yellow mustard and the cresses eaten raw; the young shoots of the pokeberry (phytolacca decandra) as a vegetable; the lamb's quarter (chenopodium album), and the dandelion (taraxacum) as a salad or boiled as greens, should never be neglected. Of these the lamb's quarter is peculiarly grateful and is reasonably common. All the varieties of cactus, a very widely distributed genus, are efficacious and do not seem to be properly appreciated by our troops. The spiny tough skin torn off after action by fire yields a succulent interior, not very palatable but always useful. The tall varieties of cactus contain valuable juice to be obtained by tapping. The best antiscorbutic is the agave (American aloe). The leaves should be cut off close to the root and be cooked well in hot ashes, after which the juice should be expressed. This may be taken raw or sweetened, two to eight ounces, three times a day. The white interior of the leaves may be eaten. The agave is both preventive and curative, and no pains are too great to procure it when needed. In Mexico pulque from the agave Mexicana is similarly used.

Beverages.—Water, discussed in another volume, is the base of the ordinary drink of soldiers. It is enough to say here that water contaminated with appropriate poisons will certainly convey typhoid fever, dysentery, cholera, and kindred diseases, will probably communicate diphtheria, and it is not yet disproved that the malarial plasmodium may be thus introduced. The source of the water supply must therefore be carefully investigated and where possible protected. Besides the active physiological poisons just indicated, there are mechanical and chemical vitiations to be avoided. As the exigencies of the service often compel the use of impure water, there are two points especially to be impressed upon all officers and men. The first is that much water which is acceptable both to the sight and to the taste is unhealthful, and secondly that the boiling of such water will reduce that risk to the minimum. The bacterial causes of disease as found in water may be quite destroyed by brisk boiling, continued for a short time. Distilled water is necessarily free from them, unless introduced after condensation. But boiled or distilled water is flat to the taste, and it may be made more acceptable by the simpler methods of aeration, such as pouring it repeatedly from one vessel to another, or by the use of a churn. On a large scale air may be forced through under pressure, and it may be charged with carbon dioxide by special appliances. Too much stress cannot be laid upon the importance of boiling the water in the presence of water-borne diseases. Under proper discipline this can always be effected in garrison, and there have been remarkable instances where under very difficult conditions marching troops have succeeded in boiling all their drinking-water and have remained free from disease that attacked a companion column.

The inorganic substances held in solution that are the most common are the alkalies soda, potash, and magnesia, as found on the great plains and elsewhere. They seriously disorder the digestive apparatus or are so intense as to render the water undrinkable, and as far as known can be removed only by distillation. And that cannot be carried out on a large scale, because of the lime and other salts clogging the boilers. The ordinary "hardness" of water depends on the bicarbonates of lime and magnesia in solution and on free carbon dioxide. When such water is boiled half an hour the carbon is dissipated and the bicarbonates are transferred into simple carbonates, which being insoluble are precipitated. The temporary hardness is thus removed and the permanent hardness, due to soluble lime and magnesia compounds, usually sulphates which cannot be extracted, remains. On a large scale the addition of lime subtracts a certain amount of CO_2 from the soluble bicarbonate of lime and precipitates it into one insoluble carbonate (Clark's process). Besides the dissolved foreign matter, water often contains both organic and mineral substances in suspension, toward which the most of the processes of clarification and filtration are directed. The most of the insoluble particles of slightly greater specific gravity than the water itself, which make water muddy, usually fall to the bottom when the water is at rest, and this sedimentation on a small scale is often sufficient for domestic use. On a large scale settling basins are important adjuncts to reservoirs. A more rapid process to make water potable by removing diarrhœa-causing turbidity is the use of alum, especially if the water is hard. About six grains of crystallized alum to the gallon slowly dissolved forms calcium sulphate, which with the bulky aluminum hydrate entangles and carries down the suspended particles. Very soft water requires first a little calcium chloride and sodium carbonate. Chopped cactus leaves clarify muddy water, and citric acid, half a drachm to the gallon, acts upon algæ in water. The disagreeable odor of impure water in casks may be removed by the gradual addition of Condy's fluid (solution of permanganate of potassium), until the slightest permanent pink is obtained, and of six grains of crystallized alum to the gallon. Suspended matters, dissolved organic matter, and bacterial organisms may be removed by filters. Sand filters, costly in their construction and care, are the best for large communities but are not adapted to military establishments. Ordinary filters for the house supply of cistern water should be arranged for percolation upward through gravel and then sand, after the water has passed through a settling basin for the deposit of coarse sediment. Portable filters equipped to restrain the impurities mechanically are generally not efficacious. Animal charcoal, formerly much used, is objectionable in yielding phosphates and nitrogen, which favor the growth of bacteria in water. Putrefactive organic matter is oxidized, but that which is active passes through unchanged; so that the filtrate soon contains more germs than the unfiltered water. Vegetable charcoal filters against micro-organisms when fresh. Sponge, cotton, and wool acting mechanically soon become foul. The best filter for domestic use is unglazed porcelain through which the water passes at moderate pressure, but as the bacteria will ultimately grow through the kaolin the bougie must be carefully brushed and boiled at least once a week. In the form of the Chamberland-Pasteur this is supplied in the military service to sterilize water whose gross impurities have been removed by the Berkefeld filter. But a cardinal principle which can never be overlooked is that no filter is automatic in its renovating power and all gradually deteriorate. Therefore every part of the apparatus must not only be accessible but be systematically and frequently cleansed, or the water may become fouled by the very effort to purify it. For the field one barrel pierced near the top may be enclosed within another pierced at the bottom and sunk in the water-supply, with the intervening space filled with sand or gravel. Whatever action is taken with water after it is drawn, one of the first duties in establishing even the most temporary camp or halting place is to establish a guard over the water-supply, to see that the animals drink farther down stream if there is running water, or at another pool, and that all bathing or washing be conducted below the drinking places. If the supply is small, great pains

must be taken to husband it and to see that it is not made turbid. It may be increased by digging out a small spring and sinking a barrel, and in a shallow stream a small reservoir for drinking should be made by a temporary dam, with one below for horses, and still another for washing. One or more reservoirs should be made to retain for cooking and drinking the water that flows by night, and there should be rows of sunken half barrels connected with little gutters for the horses, with a still lower reservoir to collect the waste. Horses drink best and most rapidly when the water is at least five or six inches deep. Nothing is better established than that no refuse, and especially no fecal matter, should be discharged so as to follow a stream either directly or indirectly, unless it be a great river; and then only when it is certain that no one within a reasonable distance will use from it. It is suicidal to pollute small streams that may possibly supply our own forces then or later, and it is criminal to spread disease in that way among others. When the supply is from springs or wells the latrines should be carefully placed so that no drainage, either by proximity or through the dip of the strata, could enter them. Sodium bisulphate, fifteen grains to the pint, will sterilize water as against the typhoid-fever cause, so prevalent in the field (L. Parkes and Rideal). The rule is general that in ordinary soil the bottom of a well may be considered the apex of an inverted cone whose radius is equal to its depth, all of whose contents drain inward. In sand the area drained is very much greater, and in some rocks faults, the direction of the strata, and, notably in limestone formations, crevices will conduct fluids very long distances. Contaminated water is not necessarily disagreeable, and that containing animal waste is apt to be more sparkling and may be very acceptable. Wells sunk in a river bank draw the most of their supply from the subsoil water going toward the stream, hence great care should be taken not to intercept that soaking down from a contaminated site. Where rain water is depended upon, it may be important to determine the quantity available from a non-absorbent surface. This is found by multiplying the inches of rainfall by the square inches of area, and the cubic inches of rain thus obtained may be divided by 1,728 for cubic feet or by 277.274 for gallons. The amount of water required on the march for a man for drinking and cooking is six pints, increased in hot climates to eight pints, with an equal amount for ablution. In stationary camps five gallons are required for all purposes. In barracks ten gallons will be used where there are no sewers, and twenty-five where there are water-closets and baths. For permanent hospitals fifty gallons per head should be allowed daily; and all these may be regarded as minima figures. Horses will drink from six to ten gallons a day and require about three gallons for police purposes.

Ice.—The sources of domestic ice-supply should be as carefully protected as those of water, for freezing is but an imperfect means of purification and bacteria are especially apt to be entangled in snow-ice and in that holding air bubbles. Artificial ice not made from distilled water may be very impure. Those in control should be carefully taught that polluted water is practically without remedy, so that the only safety consists in keeping the water-supply inviolate.

Coffee.—Soldiers in garrison appear to like coffee best when it is not very strong and the volume is great. Such use of hot drink should be encouraged, for it insures the water being boiled. In winter the heat is a stimulant without reaction, and in summer it supplies without risk fluid lost by perspiration. The men often like it adulterated with chicory and with so-called coffee extract. This is well enough in garrison where there is no special strain, for the chicory is harmless and the ordinary coffee "extracts" appear to be innocent compounds of liquorice, sugar, and possibly small amounts of some artificial flavoring. The advantage is that the ration thus supplies much more warm fluid. In the field reliance should rest only upon the coffee itself. Its physiological effect is that of a nervous stimulant, with probably a tendency moderately to delay tissue change. The so-called concentrated coffees are not looked upon with favor, probably containing little real coffee. The disadvantages of coffee in campaign are its bulk and the liability of the roasted and ground berry to accidental loss and damage.

Tea has much the same physiological action as coffee, but its flavor is not so acceptable to most American soldiers. It lends itself very admirably to campaign purposes, being easily carried in small bulk—a stout flat glass vial is an admirable vessel—but it is not a popular drink. The behavior of the contained tannin with iron utensils makes it very distasteful.

Chocolate, not a part of the ordinary ration, is nutritious and palatable when properly prepared. But this can rarely be done in the field, and it is too costly for the ordinary garrison diet. It is a part of the emergency ration.

Alcohol, in all its forms, is only mischievous to the soldier. Formerly a daily dram of ardent spirits was regarded as essential for soldiers and sailors, and as late as 1865 whiskey was kept by the Subsistence Department for special issue as preservative of health after great exposure and fatigue. These regular and special allowances were made because of the general belief, and the almost universal earlier practice among civilians, that under ordinary exposure, to say nothing of extraordinary fatigue, "strong drink" so-called was required to support those doing hard work. Strong drink seems to have been regarded as the complement of strong meat, and the few who did not use it were thought to deny themselves proper care. In fact in the first half of the nineteenth century British life companies discriminated against total abstainers as undesirable risks. But all insurance statistics now show that abstinence from alcohol increases the expectation of life. Alcohol comes fairly within Headland's definition of a narcotic, as a "medicine which acts first to exalt the nervous force and then to depress it, and to have also a special action on the intellectual part of the brain." Intoxication is a semi-narcotic condition with physical and mental want of coordination, and the "exhilaration and stimulation are stepping-off stones in the order of progress to narcotism." But alcoholic drinks have further effects. Pure alcohol constricts the blood-vessels, restricts and arrests the movements of the blood globules, destroys the circulation, and causes sloughs. Diluted alcohol as spirits is quickly absorbed after food, enlarges the blood globules, increases the volume of the blood through its affinity for water, dilates the capillaries, quickens the heart's action, accelerates the respiration, and drives the blood more quickly through the lungs. Considered by itself, and particularly when administered under conditions of depression where natural reaction is not to be expected, a small quantity of diluted alcohol may be taken occasionally without harm. But drank ordinarily or without physiological necessity, from artificial desire or the mere habit of drinking, it works mischief. The quickened circulation already described is accompanied by the subjective feeling of greater warmth, which is real in a very moderate degree and for a very short time, depending upon the primary dilatation of the capillaries. But that very condition speedily cools the blood by exposing it to the atmosphere through the lungs and skin, and by increasing the evaporation through stimulation of the sweat glands. Hence one under the influence of alcohol loses the power of resistance to cold, and not only the drunkard but any one drinking perishes from such exposure more quickly than the sober or the abstinent. But for a person greatly reduced and without oleaginous food in an excessively low temperature spoonfuls of spirits carefully served are invaluable. Nevertheless the subsequent depression leads to harm, and such treatment cannot be permanently depended upon. Under the habitual use of alcohol the soft and vascular tissues suffer first. There are congestions of the digestive tube tending to hemorrhage, the liver is soon disturbed, and the repeated distentions lead to congestions, to inflammation, and by

the increase of connective tissue often to cirrhosis, notwithstanding that the experiments of Dujardin-Beaumetz upon pigs seem to show that cirrhosis is not thus produced in them readily. In the military service, however, whiskey drinkers generally break down from other causes before the cirrhotic condition is reached. Gastric catarrh is set up and imperfect digestion follows the excessive use of whiskey; the nerve cells are distinctly changed and atrophied and the neuroglia is increased; the heart's action is habitually hurried, a sign of weakness; the heart muscle becomes fatty, and the arteries become atheromatous. The more intoxicating drinks do the most mischief, but they are not harmful in proportion to their strength but to their free acids and volatile oils, which depend upon the substances from which they are derived. In the modern destructive distillation at high temperatures these oils are thrown off in excess. Fusel oil is one of the most hurtful of these, but it partly evaporates with age if the spirit is not held sealed in glass. It is probable that it is an excess of fusel oil that makes the "vino" of the Philippines such a peculiarly pernicious beverage.

The physiological and pathological statements just made as to the action of alcohol as found and used in daily life may be accepted as actual and controlling facts, notwithstanding that laboratory experiments with the living man warrant the assertion that within narrow limits alcohol is academically a food. It is partly oxidized in the blood, is transformed into acetic acid and alkaline acetates and then into carbonates, and it retards tissue change (Yeo). These features give it the character of food. But a part is always eliminated unchanged through the kidneys and the lungs, and in excess of very small amounts it is invariably hurtful. One ounce of brandy or whiskey freely diluted is the extreme quantity that may be taken at one time without risk of depression, and twice that amount within twenty-four hours is the maximum for a healthy man. A very wide difference exists between the results of undisturbed experiments under artificial conditions and the experience of daily life. The habitual use of alcohol, in any form or to any degree, is no more necessary for the ordinary man of twenty-five than it is for the lad of fifteen, for whom no one would think of advising it. Like any other medicine, its employment in health only results in disturbing health.

Malt liquors are frequently regarded as innocent, if not directly strengthening. They do contain nutritive material useful for a certain class of invalids, but not for persons in such health as soldiers are supposed to possess. "They produce plethora, and habitual excess of this overtaxes the organic, and weakens the conservative powers; so that the florid countenance and fatness of persons addicted to fermented liquors are suspicious evidence of a constitution taxed to the highest, and constitutional predispositions that might not have been aroused are frequently excited into activity." But beer contains only about three per cent. of alcohol, as compared with forty-two per cent. of brandy and whiskey.

But there is always a practical as well as a theoretical side to this subject. Without hesitation ardent spirits are to be condemned as a beverage and their use as such discouraged in every possible way. But beer presents a different problem. For several years the post exchange, a happy substitute for the old trader and the older sutler, has sold under supervision beer in moderate quantities to enlisted men. The unanimous testimony of competent observers has been that the garrisons have become more temperate, that the troops have been more contented, and that both minor and major offences against discipline have been fewer when the sale of beer has been authorized as an incident of the soldiers' refreshment rooms established under the above name. The reason is that the recruits and older soldiers, although required to be of good character when enlisted, are not as a rule from a totally abstemious class. The most of them have been accustomed to drink beer, many of them to occasional indulgence in spirits. When no drink of either kind is to be found on the government limits they are easily enticed, especially after periodic pay-days, to the low-class saloons that spring up just off the reservation. In them it is no exaggeration to say every unfair as well as legitimate inducement is offered to acquire their money in exchange for bad liquor and the concomitant opportunities for vice that flourish in such resorts. As a consequence unauthorized absence, defiance of orders, disorderly conduct away from and upon the reservation, arrest and punishment frequently by both civil and military authorities, physical injury, sometimes serious, sometimes fatal, and disease, often long continued and deplorable in its consequences, followed. The saloons just beyond military control were a constant annoyance and a menace to the good order of the garrison, and ruined men who otherwise would maintain a reputable character. The sale of beer in the posts, the profits from which in common with the other profits of the establishment went to increase the variety and improve the quality of the soldiers' mess, satisfied the desire of most men who cared to drink (for, contrary to the opinion of some, the average regular is not a drunkard, because drunkards cannot remain in the military service), the practice of treating was not allowed, the quantity sold to any man at any one time was carefully regulated, there was small temptation to stray away in search of alcoholic excitement, the bar was distinct from other parts of the exchange, and the liability for a non-drinking man to learn to drink was less than one of a similar class would have at his home. Unfortunately legislation has recently (1901) abolished this feature of the exchange, and in an effort to improve the habits of the enlisted men it has gravely damaged the prospect of true temperance among them. The writer believes in the theory and the practice of total abstention from alcohol for all men, civil as well as military, as leading to their greater efficiency and assisting in the elevation of character; but he recognizes that such a change in the mode of life in those accustomed to occasional drinking cannot be effected at once nor by the exercise of authority, where opportunities which cannot be suppressed abound for greater indulgence. This expression of opinion is made in the hope that it will assist in forming an intelligent judgment in aid of the true elevation of the enlisted man. With the reservation just expressed in favor of allowing the moderate sale of malt liquor to those accustomed to it, as an evil much less than that of leading them into the temptation of stronger drink with its associated perils, it is not necessary to insist from theoretical or medical grounds alone upon the mischief that alcohol causes soldiers. The observation of any officer of experience is enough. Liquor, besides weakening men physically, tampers with their will power, disturbs their temper, makes them less trustworthy even when sober, is at the bottom of almost every violation of discipline, and is the one agent that converts a regular force into a mob. The absence of liquor usually means a clear guardhouse. Abundant liquor means a heavy sick-list, a large guard report, and a general feeling of doubt as to the command. As the popular prejudice that a soldier is of necessity a drinking man, if not a drunkard, is one of our direct inheritances of English vice and stupidity, although I am free to affirm that our regular troops of late years have been far and away more temperate than the majority in the class of life in which they were recruited, it is proper to lay emphasis upon these convictions of Parkes, the great military sanitarian, who reached them after long years of observation of the most drunken army of the world and a careful review of the whole subject: "When debarred from spirits and fermented liquids men are not only better behaved, but are far more cheerful, are less irritable, and endure better the hardships and perils of war. The courage and endurance of a drunkard are always lessened; but in a degree far short of drunkenness, spirits lower, while temperance raises, the boldness and cheerfulness of spirit a true soldier should possess." He asks: "Are there any circumstances in a soldier's life in which the issue of spirits is advisable, and if the question

at any time lies between the issue of spirits and total abstinence, which is the best?" He answers: "If spirits neither give strength to the body nor sustain it against disease—are not protective against cold and wet, and aggravate rather than mitigate the effects of heat—if their use, even in moderation, increases crime, injures discipline, and impairs hope and cheerfulness—if the severest trials of war have been not merely borne, but most easily borne without them—if there is no evidence that they are protective against malaria or other diseases—then the medical officer will not be justified in sanctioning their issue under any circumstances." I cannot refrain from a final quotation from the same great authority, a quotation perfectly apposite, because civilians, with their inbred personal habits, are the stock upon which military methods and military virtues must be grafted and cultivated in the army, and are the reliance of the nation in a great war. He says: "It is the same thing in civil life: there is no question that more disease is, directly and indirectly, produced by drunkenness than by any other cause, and that the moral as well as the physical evils proceeding from it are beyond all reckoning; and yet the attempts of the legislature to set some bounds to intemperance have been, and are, opposed with a bitterness which could only be justified if the degradation, and not the improvement, of mankind was desired." I can add nothing to the solemn weight of Dr. Parkes' opinion, which cannot be too frequently repeated nor too well learned and practised by every man who wears a uniform. It follows that if the use of alcohol is hurtful in a personal and in a martial sense to the private soldier, who is the first unit in the military scale, it is very much more mischievous in its ultimate consequences when an officer, who is so potent with those beneath him, is its victim.

Habitations.—*Sites.*—As a rule soldiers live in barracks or tents supplied by the Quartermaster's Department. It is seldom necessary that a permanent post should be established on a directly unhealthy site, and a proposed locality should be carefully examined, especially as to the air and water in the soil as well as in relation to the condition of the adjacent country. The ground air is air that is always found in the soil above the level of the ground water. It is constantly in motion vertically and laterally, and is forced upward by a rise in the ground water or is drawn by aspiration into heated dwellings. It follows that sites charged with organic matter and especially those upon impure "made soils" are to be avoided, and it is better to exclude all subsoil air from dwellings. This factor, which is not readily recognizable by the senses, deserves more consideration than it generally receives. The soil is moist when it contains water as well as air. Ground water is defined by Pettenkofer as that condition in which water fills all the interstices of the soil, forming, except as separated by the solid soil particles, a continuous sheet of water. As Parkes points out, the soil becomes moist by absorption of rain water, by the rise and fall of the subterranean water-sheet, and by evaporation and capillary attraction from that surface. Soil moisture and ground water are distinct conditions, the latter being relatively low and the other in the levels reached by the air. Practically every soil contains at some depth a constantly moving body of ground water, which, like the ground air above it, varies in the rate and the direction of its progress. Soil moisture depends upon the relative proportion of air and water. Moist soils are associated with catarrhs, neuralgia, rheumatism, the paroxysmal fevers, and notably with consumption, and should be avoided if possible. If compelled to build upon them, they should first be dried by deep drainage and by attention to the surface drainage. The removal of a few inches of the surface soil, and the substitution for it of a mixture of quicklime and dry ashes, is an advantage. Military necessity sometimes compels camps to be pitched in unsanitary positions, and proximity to water-supply often controls the choice. Very little camp labor is more profitable than that of ditching, which should never be neglected; for the place selected for the camp of a night may be occupied for weeks.

Topographical Sites to be avoided are enclosed valleys, ravines, or the mouths of ravines, any ill-drained grounds, the neighborhood and especially the lee of marshes, the northern side of mountains or high hills, and in warm latitudes, in the northern hemisphere the northern banks of rivers. *Soils* to be avoided are those that hold moisture. Granite and metamorphic rooks are usually healthy and so are clay slates, but with the latter drinking-water will be scarce. Unless dominated by adjacent heights, deep gravels are always healthy, and gravel hillocks are the best of all sites. Sand when pure and deep is healthy; but such a site soon becomes charged with refuse whose air and water pass through it laterally as well as vertically. When clay underlies dry sand, water is apt to be held and to be harmful. Clay and alluvium are generally suspicious from the contained moisture, but well-cultivated soils in the vicinity, rice-fields excepted, are acceptable.

Vegetation upon Sites.—For camps as well as for more permanent posts, brush and undergrowth may be cleared for convenience as well as because they favor dampness; but speaking generally trees should not be disturbed except when, by cutting off light and air from a domicile, they are hurtful in that they make it dark and damp. Rank vegetation should be cut in the heat of the day and be burned before decaying, but neither the heavy brush near a marsh nor the soil itself should be disturbed. Belts of trees and tall shrubs at some distance are acceptable as barriers against malaria whether mosquito-borne or conveyed otherwise, and trees in plantations break cold winds in cold climates and cool the ground in hot climates. The eucalyptus, which grows only in a frostless climate, rapidly drains the ground by absorbing the water through its roots and dissipating it by evaporation. Its aromatic odor is particularly distasteful to the mosquito, and malarial disease rapidly lessens where this tree grows. In colder climates the growth of masses of sunflower, by absorbing the moisture and perhaps by interfering with the flight of the mosquito, has been followed by diminished malarial disease.

Barracks.—The essential conditions of barracks, besides healthful sites, are a reasonable temperature in relation to the seasons, light, dryness, and an adequate air-supply within the buildings. Casemates, sometimes used for the artillery, are dark, damp, ill-ventilated, and unsuited for residence except under the stress of war. When permanently occupied their sick-list shows a contrast with that of better structures. Many of the other troops have lived in buildings lacking one or another sanitary essential, but as the newer barracks are generally receiving intelligent supervision it is unnecessary to rehearse examples of the vicious construction formerly so prevalent. But however well planned no apartment should receive more inmates than its sanitary number, which should be conspicuously painted upon the doors. There is a constant temptation to overcrowd, because the evils of sanitary overcrowding do not appeal to the eye; and when the command is increased the medical officer should be alert to invite attention to the proper complement of the room and to the unwisdom of attempting to require two bodies (or major fractions thereof) to occupy the space of one. The building should be suited to the climate. In the United States the adobe (sun-dried brick) makes for the relatively rainless regions houses warm in winter and cool in summer. Where the country is heavily wooded, the primitive log-house is better than one of sawn timber, which is almost sure to be unseasoned and consequently too open. Brick, which generally costs most at first, is in the end the cheapest, always on the condition that more quarters are built as the garrison increases, not that more men shall be crowded into the existing brick house. Barracks should take advantage of the full flood of the sunlight and of the southerly winds, by facing north and south; they should not throw one another in shadow, or intercept the natural movement of the air; and while they should be placed with due regard to military convenience

in relation to ground for assembly and drill, there is no reason to maintain in the modern cantonments and posts the traditional hollow square, which is a quasi-defensive arrangement the relic of the blockhouse and the primitive fort. Parkes advises the long axis of barracks to run north and south, so that the sun's rays may fall on both sides of the ridge. But this does not seem necessary in the simple quarters now under discussion, where the sunlight should pour through the windows as here suggested. In hot climates, at home or abroad, the buildings should be raised a few feet on piers to allow the air to circulate freely under the floors, and they should have broad verandas. Where there are cellars, especially when higher ground is near, the foundation walls must be protected by blind drains lower than the bottom of those walls, through which the intercepted water may be drawn off. Cellar walls laid dry or only slightly pointed on the inside are liable to dislocation by water entering and freezing. Underground foundation walls should be laid in mortar of cement and sand and, unless drained on the exterior, the outer space should be filled with gravel to conduct surface water down into the soil, if that is porous. If the soil is not porous, the bottom of the wall on all sides should be drained. The outside of every foundation wall made of sandstone, soft limestone, or brick should be coated with melted tar for water-proofing, and, besides, a damp-proof course should be introduced to check the upward capillary movement of moisture. In other words, no pains is too great in the estimate of health to secure dry dwellings. In our insular possessions troops will be quartered for a long time to come in permanent public buildings erected for other purposes but appropriated for the time by the military arm, in a few wooden Spanish barracks, or in temporary newly constructed one-story barracks of bamboo and nipa. It is particularly desirable that in all of these the men should sleep well above the ground. Where tropical barracks are constructed the roof should not be flat, unless it is double with ample air space, and there should be wide verandas. The most important room in the barracks is the dormitory, which is usually called the squad-room, and in it the men pass the most of their time while indoors. Unlike some foreign armies, our men have separate dining-rooms well equipped with attractive table ware. The newer quarters also provide a reading-room as a place for quiet assembly free from lockers, beds, and gun-racks. The minimum allowance of space per man in the squad-room is fifty square feet floor area and six hundred cubic feet of air. South of 36° North in the United States these figures should be seventy and eight hundred, and in the tropics men require from seventy-five to one hundred and fifty square feet and from fifteen hundred to three thousand cubic feet. In calculating the air space, allowance may be made for a certain percentage of inmates constantly absent in the hospital, on guard, in confinement, detached, and the like; but the floor space should be estimated in relation to the actual number of bunks (cots) allowed, regardless of their average occupation. Where the squad rooms are heated by coils containing steam or hot water, as is the case in some of the newer barracks, these should not be placed aloug the wall, because the radiation would be intenser near the heads of the sleepers instead of nearer their feet. It is a common error to make the squad-room too wide. More than twenty-four feet in width renders it more difficult for the sun to penetrate everywhere and for the air to be completely changed. The walls should not be less than twelve nor more than fourteen feet high. Where ordinary dwelling-houses are taken for temporary quarters, their capacity may be estimated as follows: In rooms fifteen feet wide one man to the yard in length; in those between fifteen and twenty-five feet wide, two men; in those more than twenty-five feet wide, three men to the linear yard.

Good ventilation consists in not permitting the air to exceed the standard of allowable carbonic impurity (6–7 parts CO_2 in air 10,000). Perfect ventilation consists in supplying every man at all times not only with air which has not been recently breathed but which is not contaminated with the products of combustion nor with the emanations of human bodies, which is not of uncomfortable temperature, and which is free from currents or draughts. The renewal of air so as to attain even good ventilation is one of the most difficult problems to solve, both theoretically and practically. It requires three thousand cubic feet of fresh air per man per hour; that is, if six hundred feet of air space is the allowance. It should be filled five times an hour, which would compel a change of the entire volume every twelve minutes. With a smaller allowance of space, the change must proportionably be more rapid. This change is necessary because, through the diffusion of gases, the air contaminated by the lungs, the skin, the generation of artificial illumination, and the decomposition of fuel mixes freely with the whole volume of air and defiles it. If it were possible for a man to inspire from a reservoir of fresh air and to expire into an independent receptacle, the allowance of six hundred cubic feet would not require prompt renewal. It is, however, useless with the means at our disposal to attempt perfect ventilation for soldiers' barracks; all that we can hope to attain is the technically "good." This is accomplished by means of the diffusion of gases and by the passage of air from and into the outer atmosphere. By the property of diffusion, by which every gas will enter the space occupied by another gas and the mixture will not separate, the gaseous products of respiration and combustion pollute the natural air but at the same time are themselves diluted, so that they do not present a concentration of harmful gases, but rather tend to their natural dissipation. To conduct the contaminated air out of the building and fresh air into it is the mechanical side of the problem. The gaseous diffusion goes on naturally, except as far as restrained by material obstacles. The systematic renewal of the domestic atmosphere is the real difficulty. The ventilation of elaborate permanent barracks is the work of specialists, and it is useless to occupy space here in the discussion of such problems. But in the temporary and the simpler permanent structures that shelter the troops provision to this end is necessary, is frequently overlooked, and should be carefully insisted upon. In one-story buildings the usual method is to carry air shafts from the ceiling several feet beyond the roof ridges, terminating them in cupolas with louvred sides. These should not be greater in cross-section than one square foot and they should be provided at the rate of one for every twelve occupants. If larger shafts, which are objectionable, are used, they should be divided by one or more longitudinal diaphragms. The outgoing current, usually sufficient in intensity, is created by the difference in temperature between the inside and the outside air in cold weather, or by aspiration due to the force of the wind then and at other seasons. This is practically natural ventilation, the supply being provided by the numerous doors and windows with attendant accidental crevices. Should the indraft be insufficient it may be increased by openings in the floor, which connect directly with the outer air and are controlled by registers. When the air supply is drawn from near the ground, care must be taken to keep that surface free from decomposing material or other filth; otherwise it is possible that active disease-causes may be introduced, and at the best the air-supply would be fouled. The outlet shafts should have valves to control the currents. In winter the fresh air is best warmed by introducing it through pipes at the base of the heating apparatus, which should be in great part enclosed by a jacket breast high. The outer ends of the pipes should curve down, to prevent the wind blowing in violently. The exit shafts should be placed in the corners of the room near the eaves and be tall enough to use the aspirating force of the wind without interference from the ridge. Valves may be arranged when, as sometimes happens, the cold air is liable to descend through these tubes. An excellent method to take advantage of those differences of temperature in the air upon which all natural ventilation depends, is to surround one

tube by another a little larger and pass both from the ceiling through the ridge. The inner shaft should extend farther than the other, both above and below, and at the lower end should have a shelf extending nearly

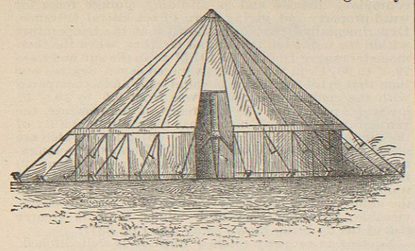

Fig. 3344.—Improved Conical Tent.

parallel with the ceiling for a short distance, to direct the in-coming air. (This shelf must be carefully wiped for dust at frequent intervals.) Ordinarily the warm air will escape by the inner tube and the fresh air will descend through the outer tube. Much air passes directly through ordinary walls, including those of brick and plaster. Walls that are painted or papered are much more nearly impermeable. The advantage of a hard finished or painted wall is that it may be washed down with a disinfectant solution when required. The disadvantage is that if there are many occupants the room must have ample openings for the admission of air.

The particular reason why the air should be constantly changed is because air just expired "is loaded with moisture, and is contaminated with organic matter which has a strong tendency to putrescence," and acts as a direct poison when taken into the system, as it must be if men are compelled to breathe it. And it is true also that numbers seem to intensify the ill effects, so "that the more men are placed together, the greater should be the air supply per head." It is difficult to impress upon line officers the evil, apart from the merely unpleasant, effects of overcrowding; for these manifest themselves slowly. But comparison between commands otherwise similar will always show the men least supplied with air to be the least effective and the most sickly. The results are the same as those in civil life in crowded domiciles. The walls and ceilings of plastered rooms should be lime-washed at least twice a year and the plaster should be renewed not less frequently than once in ten years, and oftener should there have been an epidemic, for the organic matter already referred to is liable to become entangled therein. Painted or hard-finished walls should be washed down with a bichloride-of-mercury solution semi-annually and the paint be renewed once in two years. The squad-room windows should be freely opened for at least an hour at reveille and again toward evening, regardless of any but the most stormy weather. In a suitable climate some windows should be constantly open. This seems to be too obviously necessary to require formal instruction, but experience shows that without constant oversight even the simplest sanitary rules will be disregarded. The floors should be dry scrubbed or mopped carefully with a damp cloth, but unless restrained soldiers will invariably dash upon it bucketfuls of water requiring hours to dry. Wainscoted walls are frequent harbors of vermin and should be discouraged. Under the ground floors of temporary buildings there is a constant liability to the collection of slops, dust, and general débris, leading to the formation of what is practically a shallow cesspool. The care of his arms and accoutrements can be taught the average soldier much more readily than the intelligent care of his quarters. Soldiers in permanent barracks are supplied with single bedsteads and wire mattresses, and have cotton mattresses with sheets, pillows, and pillow cases. It is

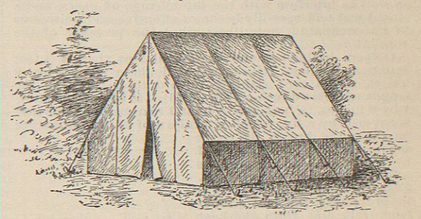

Fig. 3345.—Common Tent.

my impression that a good bedsack, with a reasonably frequent change of hay or straw, is more comfortable and more healthful than the cotton mattress after it has been used a few months. All bedding of whatever kind should be freely exposed to the sun half a day at least once a week, and the more frequently the better. Blankets should be aired and sunned every fine day, and neither dampness nor overheating should be tolerated within the quarters.

Tents and Camps.—In the field the improved conical (or modified Sibley), the common (or wall-**A**), or the shelter tent (*tente d'abri*) are used for soldiers and the wall tent for officers. In very active operations officers may use tents like those of their men. Hereafter, according to recent instructions, all tents will be tan color instead of white. The conical and wall tents are used for camps of some permanence, or for slow movements in heavy marching order; the shelter tent is used on campaign. As now issued, the conical tent (Fig. 3344) is 16 feet 5 inches in diameter at the base; it has a wall of 3 feet, from which it slopes inward to a circle 18 inches in diameter 10 feet from the ground. Its top is crowned and protected by a conical hood open at the side and the apex. It may contain a central stove; it is fairly ventilated; and it is the most economical and comfortable tent for a fixed, or fairly permanent, camp, or for a slow march. Its floor space is about 212 feet, and its cubic capacity is about 1,450 feet. Its official complement of men, which at the least is double the proper number, is 20 infantry, or 17 cavalry with their saddles. The com-

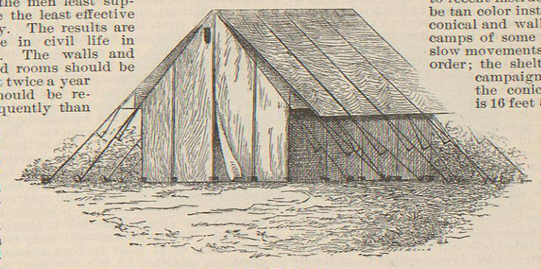

Fig. 3346.—Wall Tent.