

near the spark gap. The results on this small scale seemed to agree fairly well with the theory on which it was based and it was decided by the investigator to try out the system under conditions that prevail in practice, i. e., using loftier air wires and grounding the complementary terminal of the spark gap.

The place selected for making the out-of-door tests was the polygon military drill grounds at Strasburg. Three different stations were set up within this limited space, one for sending and the other two for receiving. At the transmitting station, instead of the usual aerial wire there were three radiating wires arranged at equidistant points from each other around the building and several meters from it. The aeriels were suspended from the tops of their respective masts in the usual manner. The lower ends of these wires led into the building which housed the transmitting apparatus. The lower terminals of all the aeriels were connected to one side of the spark gap, the opposite side of the latter being connected to the earth in the ordinary way. Now, when the disruptive discharge took place, the aeriels *a b c* were energized by the oscillations thus set up, but while the oscillations in the aeriels *b c* were exactly in step, those in *a* lagged slightly, due to the added inductance near the spark gap; yet the values of inductance and capacity remained identical, so that the length of the waves emanating from each remained constant. When all the aeriels were emitting waves, those radiated by *a* would, in virtue of the fact that it was out of phase with *b* and *c*, set up an interference, with the result that an electrical shadow was cast in a direction at right angles to the plane of the aerial wires *b* and *c*, and hence the radiation of waves in that direction was a minimum. Oppositely, if the oscillations in the aerial *a* were made to take place in advance of those occurring in *b* and *c*, provided the difference in time was rightly proportioned, then a wave more or less amplified would result and its propagation would be in the direction previously stated, while the shadow due to the interference of the waves on *b* and *c* was projected from the rear of *a*.

In this system of amplifying the waves in one direction and diminishing them in another, the greatest difficulty seems to grow out of the fact that it is of the utmost importance to time the period of oscillation with absolute precision; and when it is stated that this difference of phase amounts to approximately only one ten-millionth of a second, it will be seen that the adjustments of the co-efficients are of an extremely delicate nature. From Prof. Braun's experience with high-frequency oscillations he concludes that the difference in time between the phases of the aeriels can be adjusted to within one two-hundred-millionth part of a second, or more popularly expressed it would amount to a difference of only one second in six years.

Two or three years ago the scheme was tried to form a parabolic reflector of gigantic proportions by arranging a number of aerial wires around a radiating aerial wire so that the latter would be in the focal line. This arrangement failed to produce the desired results, since the wires thus placed permitted much of the energy to be lost through dispersion. Prof. Braun investigated the reflection of waves on a scale sufficiently large to show its utter impracticability. He employed waves having a length of 120 meters and placed the radiating aerial wire a distance of 30 meters or a quarter of a wave-length from the reflecting wires, which had an opening equivalent to the length of the waves to be emitted.

By utilizing the three-wire system the large and complicated reflecting-wire scheme is eliminated, the distance of transmission is increased and, what is equally advantageous, it is possible to direct the messages in any one of six directions. Without removing a single connection the waves can be sent in either one of two directions by merely increasing or decreasing the frequency of the oscillations in *a* so that these will be a ten-millionth of a second faster or slower than the currents that surge through *b* and *c*. By changing the relative phase values of *a b c*, it is obvious that any of six different predetermined directions can be obtained at pleasure.

In the recent experiments made by Prof. Braun and his co-workers, while messages were being transmitted in one direction and received by a station in line with it, a second receiving station at right angles to the line of propagation, though much nearer the transmitter than the first, was not affected.

Should it prove of advantage to transmit in more than six directions, five wires would be used, with the result that any one of ten stations, assuming they were located at equidistant points about the transmitting station, could then be communicated with to the exclusion of all the others. The maximum distance covered in these preliminary trials was 1.3 kilometers; it is stated, however, that a commercial test is to be made at an early date.

On her return trip the Cunard turbine steamer "Carmania" steamed on an average 17½ knots. During the whole voyage she met with persistent head winds. Her best day's steaming was 420 knots.

THE SOLDIER-MOUNTAINEERS OF ITALY.

BY WILLIAM G. FITZ-GERALD.

It is difficult for us who have practically no frontiers at all to realize the conditions that obtain in the Old World, where comparatively small nations adjoin one another like the squares on a chessboard; the boundary line in many cases being purely imaginary, and beyond it commencing a new language and a new country, with totally different manners and customs. In many places, however—as, for example, at the Franco-Spanish frontier, and also between Italy and Switzerland, and Switzerland and Austria—the boundary between the nations consists of a stupendous wall of snow-clad mountains; and as invasion is to be feared even across the lofty passes (did not the mighty Napoleon himself cross the great Alps with an army, carrying dismay and terror into Austria?) there are in European armies whole regiments that are carefully trained to fight literally "above the clouds." In other words, they combine the strength, endurance, and skill of the most intrepid Swiss Alpine guide with the ordinary profession of soldier. And there is nothing more interesting than to watch the maneuvers of these soldier-mountaineers—say, at Andermatt in Switzerland, or Aosta on the Italian side of the Great St. Bernard.

Andermatt is a village lying over 4,000 feet above the lower end of Lake Lucerne, and here will be found the headquarters of the Swiss Alpine troops, whose maneuvers should be seen to be believed, so daring are they, and so astonishing the spectacles presented by long files of panting men, small as flies on the wall of some terrible precipice, yet dragging literally inch by inch some big field gun up a tremendous slope by means of pulleys and hemp cables. One notices that these infantrymen are provided with alpenstocks and coils of silk rope, as well as snowshoes, ski, and other paraphernalia which we usually associate with the pleasure tourist in the high Alps—say at Chamounix, Zermatt, Grindenwald, or some other popular climbing center of the "Playground of Europe."

Their signaling is done from rock to rock by means of huge painted linen disks, held upon the outstretched arms of the signaler. The wounded are carried strapped "pick-a-back" fashion on a curious kind of easel-backed chair, fastened on the stalwart backs of their comrades. It is a fact that these troops maneuver literally "above the clouds"; and there is no more impressive spectacle than a Sunday morning service in some little icy recess at nine or ten thousand feet, when the chaplain of the regiment mounts into a rude portable pulpit, and discourses upon the wonders of the Almighty to the assembled soldiers who are shivering in their furs, even though it be July or August. At one side of the pulpit are the members of the band, and these play the hymns which reverberate through the awful desolations of glacier and snow-peak, gloomy gorge, and sky-piercing pyramid.

The Italian Alpine troops are in some ways still more remarkable. Indeed, I doubt whether as a whole any army in the world goes through such curious maneuvers as that of Italy. I have seen a prince of the House of Savoy—H. R. H. the Count of Turin—plunging into the River Arno at Florence at the head of his hussars, and the entire regiment swam across, each trooper with his arm about his trained charger's neck. I have also seen the same high commanding officer ride his regiment straight into the sea at Viareggio; for it is necessary to accustom both cavalrymen and the mounts to the negotiation of deep water, against the time they may find themselves in an enemy's country with all the bridges destroyed.

As one leaves the Swiss town of Martigny, and begins the long, toilsome ascent of the Great St. Bernard Mountain, one looks forward to reaching the Italian frontier at Aosta, by way of the far-famed hospice of St. Bernard, whose dogs and monks are a household word the world over. At the side of the lake near the hospice, a few stones mark the Italian frontier. As we descend, the scenery assumes a soft Italian character, and the awful desolation of Mount St. Bernard gives place to walnut groves, chestnuts, vines, and fig trees. Soon the southern spurs of Monte Rosa appear; and just before we enter Aosta, the pass is alive with soldiers. Some of them are marching on ski over the frozen snow; others again are glissading down steep slopes.

The little town lies about 2,000 feet above sea level, and is surrounded by ancient walls flanked with towers. On every side rise great mountains, like the 10,000-foot Becca di Nona, and the Mont Emilius, 11,670 feet. Aosta is an admirable climbing center, not only because the Italian Alpine troops have their headquarters here, but also because various Alpine clubs have built refuges and cut paths up colossal mountains, which would otherwise be inaccessible to any living creature save the Alpine bear and the chamois.

Aosta is filled with military barracks, and in these as well as in the open squares one sees embryo soldier-mountaineers in the making. Here is a party of recruits, half extended on the ground leaning on their left arms, while their right are high in the air, raising

and lowering big weights. This exercise is to develop the muscles of arm and back for the long, tedious climb over high, snowy mountains, and across slippery glaciers abounding in treacherous crevasses, which may be covered by an insidious layer of snow, liable to give way at any moment after a burst of sunshine.

One great idea is to accustom these men to hauling and pulling; for while Alpine troops are on the march it is obvious they cannot take any pack animals with them, much less commissariat wagons. Each man is heavily burdened with rifle, bayonet, two or three hundred rounds of ball cartridge; several days' rations, a steel-pointed alpenstock, some silken or hemp ropes, snowshoes or ski, blankets, and other items, which in themselves make up a serious load, to be carried up great mountains by paths which to the uninitiated look only fit for goats.

And yet, on top of all this equipment the Italian soldier-mountaineer is required, on occasion, to take over parts of machine-guns, portable telephones, camp utensils, and other articles. Down below, in Aosta, pack-mules were loaded up in trains with the barrels of mountain howitzers; also with their wheels, separately, and certain shelter-tents, picks and shovels, and other implements. These hardy beasts are led as high as it is possible to take them, but the troops themselves venture up wild icy precipices of the Alps where not even a mule could find foothold. At a certain point, therefore, the pack-mules are unloaded and led down again to Aosta, after their loads have been distributed among the hardy troops, who shoulder their added burdens with a smile, grip the ashen shaft of their alpenstocks, and scramble up the precipices and almost perpendicular crags the best way they can. Sometimes the most daring among them will reach a point of vantage, and then lower a rope up which his fellows are to climb one by one. These soldier-mountaineers are the most wonderful rope-climbers I have ever seen in action. It is no small matter for a man to climb up a rope at all in the ordinary way; then what must it be when he is loaded with nearly sixty pounds' weight of equipment? Down at the barracks in the town, all recruits go through regular exercises in rope climbing, bearing the whole of their equipage.

The idea of the whole training is that one day it may be necessary to meet an enemy equally daring and skillful among these wild Alpine solitudes. For the French also have Alpine troops, and one may see these indulging in similar strange tactics on the colossal Mont Blanc itself. It is a fact that lightly-equipped French infantrymen, led by young officers, have gained the very summit of the giant of the Alps, which, as everyone knows, is nearly 16,000 feet high and is clothed in eternal snow!

All these soldier-mountaineers are crack shots; and it is difficult to see how one of the forts held by them amid the great granite bowlders and terrible pinnacles and spires of the Great St. Bernard could ever be forced by an enemy in the face of these troops, who would act as scouts, crawling up precipices, and planting themselves on wild and seemingly inaccessible spots, whence they would pour an invisible fire which nothing could withstand. These Alpine troops, when scouting or reconnoitering in the mountains, use a curious kind of rifle-rest, formed by three alpenstocks and one of the pillows they use at night when they sleep in the snow. For, strange as it may seem, these men when bivouacking at great altitudes do not trouble to put up tents, but merely dig out caverns in the vast snow-drifts, and line these with waterproof sheets and blankets, and there sleep amid dreary Alpine desolations as comfortably as though they were down on earth in a comfortable city bed.

The life of the men is magnificently healthy and exhilarating, as may be seen by the bright eyes, rosy cheeks, and clear complexions of a party of scouts that come glissading like lightning down the slopes of frozen snow on their long curving ski, guided and supported by the alpenstock. The troops also carry Arctic sledges for the transport of their "wounded"; and sometimes realistic demonstrations are given, when one or several men will lie at full length on these sledges and be dragged or glissaded over glacier and snowfield.

Much has been said and written about aerial warfare—I mean between airships provided with explosives. This may be a dream of the distant future, but nothing is more practicable than a clash between the Alpine troops of say France and Italy in the tremendous mountains of the Haute Savoie, many thousands of feet above the level of the sea. And just consider what that warfare would be! No cavalry, of course, no wheeled artillery; but only busy soldier-mountaineers clambering by ropes up dizzy precipices, hoping to pour their fire from a height.

Officers, too, shouting commands through megaphones, or using the field telephones from rock to rock, and encouraging their men to carry up the mountain guns and open fire with these until the vast silent domes and sky-splintering peaks echo and re-echo with a thunderous roar that sounds sharp and clear, even above the rolling reverberations of the avalanche!



Sighting for a Long Shot.



A Squad of Italian Soldiers About to Cross the Pass of the Great St. Bernard on Skis.



Gymnastic Exercises of the Alpine Troops.



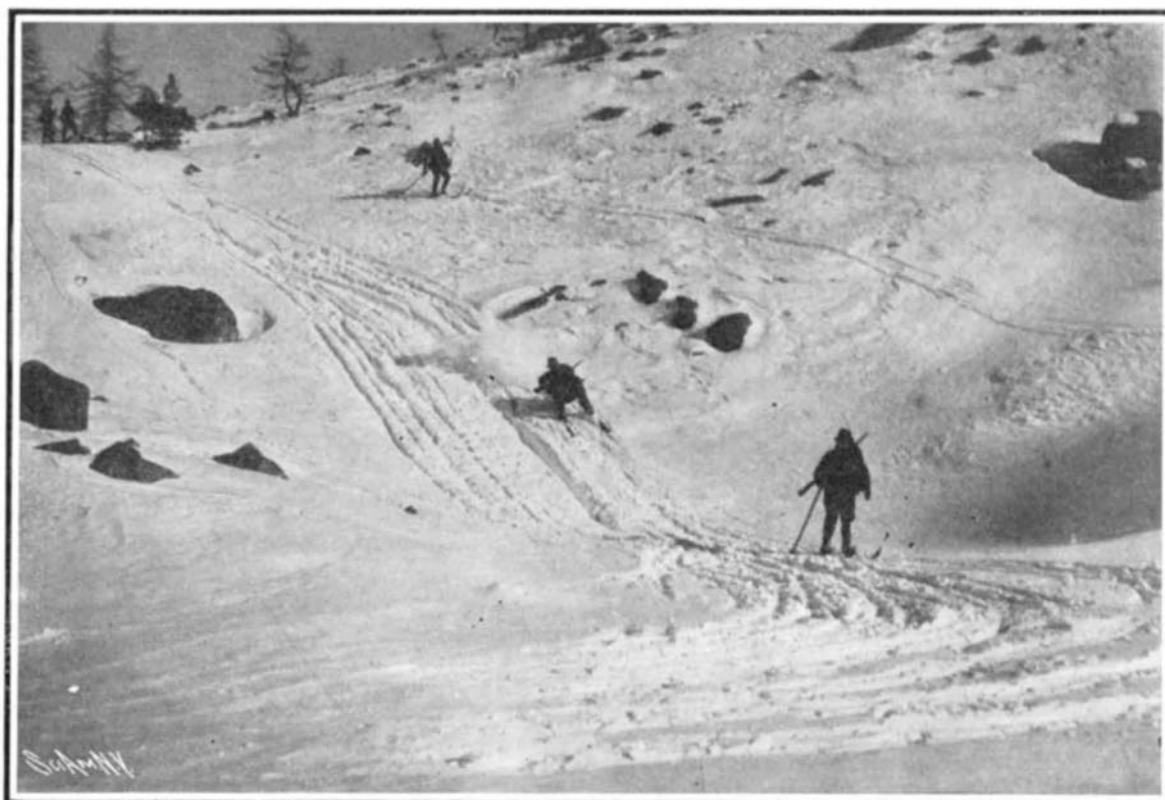
The Squad in the Picture Above This Crossing the Pass.



At Night Time Holes Are Dug in the Snow. In These the Men Sleep, Wrapped in Blankets.



How the "Wounded" Are Transported on Sledges by the Italian Alpine Troops.



Stray Scouts of the Italian Alpine Troops Glissading Down the Mountain Side on Skis Controlled by Their Alpenstocks.



Climbing a Rope with All Accouterments is One of the Gymnastic Exercises of the Italian Alpine Troops. The soldiers may fall into deep crevasses in active service, and only a rope can help them out.