with the long arms, thy brethren are mourning thy loss, deign to relieve their cruel anxiety, by returning to them!"

And then they raised Bhima swiftly through the waters, and placed him on the flowery bank upon which he had fallen asleep.

Then Bhima, resplendent with the strings of jewels the nagas had flung around his neck, and proud in the gift of new strength he had received, went home to his mother Kunti, who sat in her palace mourning for him as one dead. And Bhima saluted his mother reverently, and kissed his younger brothers. But to Yudisthira alone he told the story of Duryodhana's treachery. Then Yudisthira charged his brother to keep silent. "Henceforth," he said, "the sons of Kunti must be more united than ever, and always upon their guard."

SIGNALS ON SEA AND LAND.

By the Author of "The Telephone, and how to Make One," &c.

I THINK that we can say without fear of contradiction, that we can talk. The mere fact of asserting this information will at once prove to the most disbelieving mind that we are speaking the truth. Some there are, though, who have never had the power of speech, and who probably never will have it: I allude to those poor people who are deaf and dumb, and who are therefore shut out almost entirely from communion with us. I dare say that most of you will think that these afflicted ones cannot speak because their mouths are not properly made, or because there is some defect in their lips or tongues. But this is not the case. They are dumb simply because they are deaf, and therefore could not hear the sounds of the words and letters which you and I learnt long ago, and which go to make up what is called speech.

A great many plans have been tried to help these poor deaf and dumb folk to understand each other, and to make their wants known. The most common mode is, as you most probably know, a kind of alphabet of signs, made by various movements and different positions of the fingers and thumbs. Another more recent method, which has been brought to great perfection and practised with great success by Mr. Bell, the inventor of the telephone, is taught by watching the movements of the lips in ordinary speech. By this plan people who are dumb can understand language by their eye-sight. However, whatever plan be adopted, you will understand that they are dependent upon signs, not sounds.

Now, occasionally, people who have all their senses perfect are placed in such circumstances that intercourse by speech is impossible. For instance, they may be separated by such distances that sounds cannot be heard. "Oh," you will say, "in those cases they could have a telegraph, or that telephone that you have just been writing about." But both these instruments require wires to connect them, and people are now and then so placed that wires could not possibly be used. Thus two ships may be passing each other with half a dozen miles of ocean between them; or part of an army may be shut up in some fort, surrounded by an enemy, and yet within a few miles of their comrades. How are these to communicate. It is the object of this article to tell you how this can be easily done, and how it has recently been accomplished in Zululand.

First, I must explain to you that for many years a system of talking by signals has been in use on board ship. Certain combinations of differently coloured flags meaning certain sentences. A kind of dictionary of these words in colour is kept for reference, and this book is called a code. Thus an admiral on board his flag-ship can telegraph his directions to all the ships composing the squadron by running up different flags to the masthead. Thus a blue flag above a yellow one may appear. Then the captains of the other vessels refer to the code, and see immediately that this combination means "move forward," or perhaps "retire," and they act accordingly. You have all, no doubt, heard of that celebrated signal given by brave Nelson at the battle of Trafalgar, "England expects every man to do his duty," which was communicated to the fleet in the way that I have just explained. But since those days a far more expeditious and simple mode of communication has been adopted, which is applicable to both land and water—by night as by day—and even in weather when everything is hidden in fog. It was this system that was adopted, as I have already stated, in Zululand. First, we will consider the peculiar conditions under which its use became necessary, and indeed of vital importance to our brave troops.

In the invasion of an enemy's country it often becomes necessary to push forward small bodies of troops, in order that they may form entrenched camps at different distances. These camps form points of connection—like the links of a chain—so that supplies of ammunition and food can be easily carried from one to the other: just like the system which often prevails at fires in country places, where men form a chain and hand buckets of water from one to the other. Well, Colonel Pearson pushed forward in this manner thirty-five miles into the heart of Zululand to a place called Ekowe, where he formed an entrenched camp. But his object in journeying to this place was entirely frustrated, for the Zulus appeared in such numbers, that they were able to cut all his communications in the rear. So poor Colonel Pearson found himself and his brave little army shut up, as it were, in a trap, and there he remained—surrounded on all sides by Zulus—for two whole months. It is needless to say that his comrades did not let him remain to starve at Ekowe. An army of release under Lord Chelmsford came as soon as possible to his rescue. But an army, with its enormous number of waggons carrying supplies, moves but slowly in such a rough country as that. And so it came to pass that Lord Chelmsford was in sight of Ekowe a great many days before he actually reached it. Here, then, the great advantage of being able to communicate by signals became apparent, and I will now tell you how it was done.

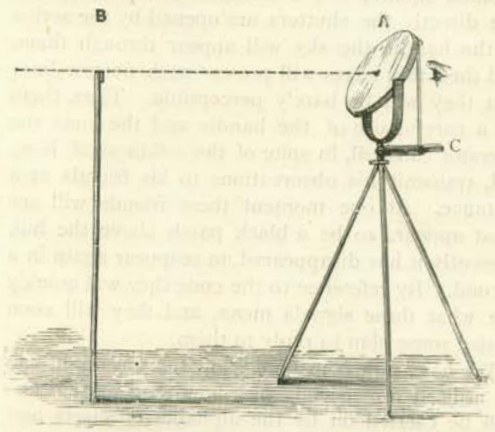

Fig. 1.

The next time the sun shines into your room—and during the autumn and winter months you may perhaps have to wait a considerable time for that event—take a small looking-glass, and hold it upturned towards the sky near the window-sill, so that the sunlight falls upon its surface. If you hold it at the proper angle, you will find that a bright spot of light is reflected from it on to the ceiling. By gently moving the mirror, this spot can be made to travel to nearly every part of the room.

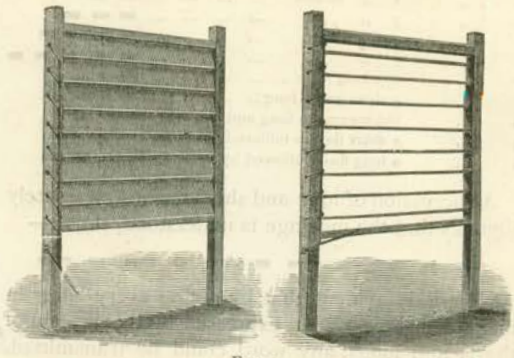

Fig. 2.

In that experiment lies the germ of an instrument called the Heliograph—that instrument which told Lord Chelmsford how the little garrison were getting on at Ekowe, and comforted the prisoners with the assurance that their period of captivity was nearly over.

Well, then, this heliograph, or sun-writer, as we may translate the word, consists of little more than a round mirror (A in Fig. 1.) so mounted that it can easily be turned in every direction. It has a small hole in the centre through which the operator can focus the sun's rays on any desired spot. This work is further helped by a stick (B) planted in the ground a few yards in front of the mirror. Upon this stick a little rod slides up and down, so that it can be adjusted to any required height. Suppose now that a signal is to be sent to a fort on a hill ten miles away: the mirror is first roughly adjusted to the position, so that flashes can be sent towards the fort; but in order to make all sure, the stick with the sliding-rod is placed in front, so that when the observer is looking through the hole at the back of the mirror, this sliding piece just comes in a line with his view of the fort. It therefore acts much in the same manner as that little notch of metal which projects above a gun-barrel, called the sight—it enables the operator to *sight* the object, and to fire his sun-flashes across the country with a true aim, and exactly in the direction of the observers.

But supposing that he has sighted the object, he can do nothing without some method of giving these flashes a meaning, although he might amuse himself at his friends' expense by flashing his signals into their faces, and making them wonder what it all meant. An alphabet composed of short and long flashes is contrived to meet all

requirements, and here it is in its simple form, an alphabet not of letters, but of numerals.

1 is signified by a short flash, thus : ... ... -
2 ,, 2 ,, flashes ... ... - -
3 ,, 3 ,, ,, ... - - -
4 ,, 4 ,, ,, ... - - - -
5 ,, 5 ,, ,, ... - - - - -
6 ,, one long flash... ... ... —
7 ,, a short and a long .. .. - —
8 ,, the reverse, a long and a short ... — -
9 ,, 2 short flashes followed by a long - - —
0 ,, a long flash followed by 2 short... — - -

A succession of long and short flashes alternately signifies that the message is understood, thus :—

— - — - — - — - — - —

Now it is evident that by giving every letter in the alphabet a number, expressed by this system of shorts and longs, any word could be transmitted. but this would be a most tedious business. A plan has therefore been adopted for reducing both the trouble and time occupied in flashing a message. This plan is founded on the knowledge that there must be certain sentences which in practice are constantly required. I will quote one or two of these sentences as they appear in the code, and then you will readily understand the simplicity of the system—

The enemy is advancing—1480.
The enemy is retreating—1481.
The enemy's cavalry is numerous—1477.

Suppose now we take the second sentence quoted, "The enemy is retreating;" instead of spelling through all the words we can transmit the message by the number placed against it in the code-book—1481, or to reduce it to flashes, as would have to be done in practice, it would appear thus—

— — — — — — — —
1 4 8 1

Having sighted our mirror, so that it appears like a brilliant star to those who hold the fort on the distant hill, we will now try and make this message plain to them. This can be done in two ways, either by obstructing the light by placing a card before the mirror, or by the much neater plan of moving the mirror itself between each flash.

If you refer once more to A, Fig. 1, you will see that a little rod is fastened to the top of the mirror at the back, and that this rod is connected with a little lever like a piano key (c). By a finger pressed upon this key the operator is able to instantly alter the angle of the mirror to a small extent, so that its beams will no longer be seen at the distant fort. A spring to bring back the mirror to its proper position, and a screw to prevent it going too far (both of which I have omitted from the drawing for the sake of simplicity) complete the arrangements of the instrument.

It is obvious that we can no more command the sun to shine just when we want it to do so, than could Canute keep back the advancing tide from his toes, as prophesied by his flattering courtiers. So in dull weather we must contrive some method not dependent upon such a fickle source for the exercise of our alphabet of longs and shorts. Fig. 2 will give you a rough idea of how this is brought about. The drawings represent one and the same instrument in two different positions. A framework of wood or iron is fitted with shutters very much resembling those employed for Venetian blinds. You well know that if you pull the cord on the left-hand side of such a blind you can cause the laths of which it is composed to assume almost any position. You can darken the room by making the edge of each lath approach its fellow, or you can let in a flood of light by placing each lath edgeways. Precisely the same action can be obtained with this frame of shutters, only instead of being moved by a cord, as in a Venetian blind, they are moved by a rod fastened to each, and communicating with a handle below.

Now suppose that such an apparatus, several feet square, be planted on a hill-top, so that its outline to an observer at some distance is seen plainly against the sky. It is obvious that when the shutters are closed its general effect will be that of a black square, like a diminutive church tower. But directly the shutters are opened by the action of the handle the sky will appear through them, and their thin edges will present such narrow lines that they will be barely perceptible. Thus, then, by a careful use of the handle and the code the operator can still, in spite of the sulkiness of King Sol, transmit his observations to his friends at a distance. At one moment these friends will see what appears to be a black patch above the hill, presently it has disappeared, to reappear again in a second. By reference to the code they will quickly see what these signals mean, and they will soon devise some plan to reply to them.

We have now considered how the sun's light can be utilised for speech, and how that speech can still be carried on by the alphabet of shorts and longs when the sun is obscured by clouds. We will now look to the means adopted for carrying on communication when the sun has sunk below the horizon, and when the country is wrapped in darkness.

You will readily guess that a bull's-eye lantern will furnish for short distances all that could be desired, and the naval pattern lamp consists of little more than an oil lamp furnished with a screen

by which its light can be shut off for long or short intervals, as may be necessary for the purposes of the alphabet. But it is obvious that there are many occasions when such a source of illumination would fall lamentably short of what was wanted. For instance, a blinking light placed near a town where many lamps were in use would never be noticed. It would be like one glowworm among a thousand; its absence or presence would not be remarked. For such situations, therefore, we want a light of such a brilliant character that there will be no mistake about it.

Fig. 3.

You will at once, perhaps, recommend the electric light. But the electric light cannot be had without a great deal of trouble and apparatus—such as would be quite out of the question in many situations where a signal is suddenly required. On our ships of war—where apparatus for its production is already in use, the electric light can of course be used with the greatest possible advantage, but for an army in the field, or on a hilly country, we can obtain flashes of great intensity by much more simple means.

Once more we will look at a little experiment. Make a paper tube by rolling a half-sheet of writing-paper round a pencil, and securing the free edge with gum or paste. Now introduce a little finely-powdered resin into this tube—about as much as will cover your thumb-nail—and urge it by your breath through the flame of a candle. A flash caused by the sudden explosion of the finely divided particles of resin will immediately take place, and will surprise you both by its suddenness and its intensity. (I may tell you that this simple plan has been resorted to for years past for the production of artificial lightning at dioramas, and exhibitions of a similar nature.) Now here we have a simple, cheap, and effective mode of producing flashes with apparatus that might be enclosed within a bandbox, and in it lies the germ of a newly-invented lamp for flashing signals, which I will now describe.

Most of you know that a spirit lamp gives hardly any light; a pale blue flame is all that you can see, and you cannot even see that in bright daylight. Now in the lamp which I am going to describe to you a spirit flame forms the nucleus of the light. There is no mechanical shutter, or contrivance of the kind, for the inventor knew well that there was no need to shut off so feeble a light. But how are the flashes produced? Well, pointing towards the spirit flame are three little bent tubes, which proceed from a reservoir in the body of the lamp. These tubes are devoted to exactly the same purpose as the paper tube in the experiment already described. The reservoir with which they are connected is filled with a highly inflammable powder, and an india-rubber tube passing to the mouth, or to a pair of bellows, does the rest. The powder is composed of resin, lycopodium, and the metal magnesium, and the flashes obtained from it seem almost to rival the electric light itself in their brilliancy. Here then is our alphabet of short and long flashes, interpreted by a series of short and long puffs from the observer's lungs.

"But," you will say, "these appliances, this mirror for sunlight and these lanterns for night time, are all very clever; but what is to be done when a heavy fog occurs?" The difficulty in this case is not half so great as you suppose. One night, a year or two back, I was on a steamer in the middle of the English Channel on a very foggy night, and there was one sound which appeared like a distant moan of distress, occurring at regular intervals, which particularly attracted my attention. I inquired what it was, and was informed that it was a fog-horn, blown by steam, at a distant headland, miles and miles away, and which in thick weather did duty for the light usually displayed there. If you look into a penny trumpet you will see a tiny slip of brass, the vibrations of which as you blow into the mouthpiece give that rasping sound so well-known to you. The fog-horn is but a greatly magnified penny trumpet, with a slip of brass, or *reed*, as it is called, about twelve inches long, and as thick as your little finger. Of course no human lungs would be capable of influencing such an instrument, so air pumped by steam power furnishes it with breath.

Fig. 4.

Such a horn, on a smaller scale, and blown by the lungs, or by a bellows (see Figs. 3, 4), according to the distance of the corresponding operators, furnishes their means of communication; and according to the impulse given to the supply of wind, are the sounds reduced to that system of shorts and longs, which enables speech to be carried on in a dense fog.

Here, then, we end our account of how signals may always be made, whether on sea or land, on dull or clear days, by night, or even in a fog T. C. H.