A HAND HELIOSTAT, FOR THE PURPOSE OF FLASHING SUN SIGNALS FROM ON BOARD SHIP, OR ON LAND, IN SUNNY CLIMATES.*

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A flash of sunlight from a looking-glass, of a few inches in the side, can be seen further than any terrestrial object whatever; and the instrument about to be described shows how this remarkable power may be utilised for the purposes of telegraphy. Heliostats are used in all Government surveys; their visibility is well known, both in clear weather and also in hazy atmosphere, and their utility is recognised in requiring no "sky line;" they were habitually employed by the Russians, for telegraphic purposes, during the late Crimean war, but all heliostats that have been hitherto used have been fixtures of large dimensions. Commonly a shaded screen is erected with an aperture in it, at many yards' distance from the signaller, who stationed himself in such a position that when he could see the play of his flash about the hole in the screen, he might be sure that some of the rays which passed through it would be visible at the distant station. At other times a polished ring was used for the same purpose as the screen, but the principle was the same. The present instrument dispenses with all fixtures; it is more portable than a ship's telescope, and as manageable as a ship's quadrant, and it can be made by any carpenter who possesses a convex spectacle lens of short focus, and a piece of the best kind of looking glass. The glass attached to the heliostat is about 3 in. by 4½ in., and therefore calculated to be seen at distances, which may be gathered from the fact that a mirror, one inch square, is perfectly visible to the naked eye, in somewhat hazy but sunny weather, at the distance of seven miles and a half, and that it shows as a brilliant and glistering star at two miles.

Before describing the principle and action of the hand heliostat it will be necessary to explain, in a few words, the peculiar characteristic of the reflection of the sun's rays from a plane mirror. If we take a small square looking-glass, and throw its flash upon a wall two or three feet off, the shape of the flash will be little different from that of the mirror itself, seen in perspective; but if we direct it on an object three or four yards off, the angles of the flash will appear decidedly rounded; at fifteen or twenty yards it will appear fairly circular; and if we manage to see it at fifty or 100 yards (which can only be effected by selecting some object to throw it on that is naturally of a light colour, but lying under a dark shade), it will appear like a mock fan, of almost identically the same shape and size as the fan itself; and for all greater distances the appearance remains the same. In fact, whatever may be the shape or size of the mirror, and whatever the irregularity of the distant objects on which its flash may be thrown, the shape and size of that flash, if it could be seen by the signaller, would always appear to him as exactly equal to that of the sun. The flash forms a cone, having the mirror and the signaller's eye at its blunted apex, and having its vertical angle equal to that subtended by the sun's diameter. Now if the eye could trace the appearance of the mock sun on distant objects, it would be perfectly easy for a person holding a looking-glass to direct its flash upon them when and where he desired; but the hand heliostat requires no mock sun to aid the direction of its flashes, itself supplies the appearance of a sun, which exactly overlies the very spot where the mock sun would be seen, supposing it became visible; and by bringing this image over the distant station in the fashion of a sextant observation, the flash is directed thither, just as certainly as if it had been the mock sun itself which had guided the signaller's aim.

The principle of the instrument is exceedingly simple; Fig. 1 is intended to explain it, and Fig. 2 shows the instrument opened so as to exhibit its construction.

L, N, is a convex lens, or rather a piece cut out of one, as shown in Fig. 3, having a screen S attached to it, and adjusted to its exact focal distance. M is the mirror, seen in section in Fig. 1 (such as it would be, if a section were made of the instrument, when in position). E is the position of the signaller's eye.

It will be observed that the mirror flashes a few of its rays on the lens and the rest of them out into space, the eye looks partly through the lens and partly free of it, the size of the pupil of the eye admitting readily of this. Now, consider the rays represented in Fig. 1, which are supposed to be those proceeding from some one single point of the sun's disc; those that go into space proceed in parallel lines towards some "vanishing point," V. Those that impinge on the lens are converged, by its means, to some point, K, on its surface. Now, of the rays that are radiated in all directions from the bright speck at K, those which impinge on the lower part of the lens will be reduced, by means of it, back again to an exact parallelism with the rays that first left the mirror. Consequently, E will see them as proceeding from the vanishing point, V; and, by looking partly free of the lens, will be able to refer V to that one of the distant objects of the landscape with which it may happen to coincide. Now what is true for any one point on the sun's surface is true for every point, and, consequently, instead of a speck of light being seen at K, a disc is seen there; and a disc it is of exactly the same shape and size as the sun itself; and this is the image which we have spoken of as overlaying the area of the mirror's flash with the utmost precision. All the signaller has to do is to bring this image down upon the distant ship or station; he must turn the mirror on its axis, and rotate the instrument until he catches the sun's disc on the lens, and, when he has done so, an inclination

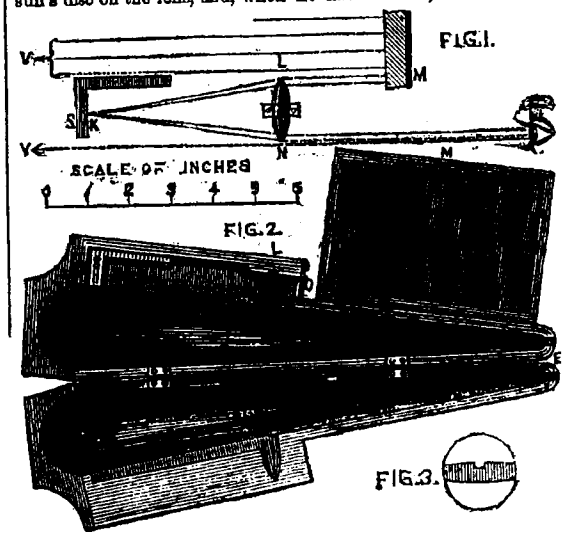

FIG. 1.

FIG. 2.

FIG. 3.

of the hand will supply the necessary contact. Each contact makes a flash, and by using three groups of flashes, consisting of one, two, or three flashes in each group, any letter can be made; by using two groups, any numeral. The mirror should be of the best plate-glass, or there will be an irregularity in the flash; a common looking-glass is worthless for intelligible signalling. It is very important that the two sides of the glass should be ground parallel to one another, with reasonable accuracy, else each surface will reflect its mock sun in a different direction, and they will form two separate and overlapping discs, of which only the overlapped part is fully illuminated. When signals are made the flash should be allowed to dwell a quarter of a second on the distant station, a rapid flash is scarcely visible. The brilliancy of the image should be toned down to a moderate degree, by pushing up the slide D; it diminishes the pencil of rays that reach the lens. Care must be taken that neither the hand nor the head interfere with the light that falls on or off the mirror. It is perfectly easy to flash to within 12° of a point exactly opposite to the sun, by holding the tube a short distance from the eye. The utmost care should be taken in the adjustment of the screen S; it is the only adjustment in the instrument, and should be made with the greatest precision, by comparing the precision of the image of the sun with that of the mock sun as watched upon a well selected and distinct white screen, properly shaded. S must be pushed backwards or forwards till the images coincide exactly, and then fixed firmly and permanently.

* British Association, Section G., Leeds Meeting, September, 1858.

The East India Company's Fleet.—The East India Company's steamer Queen has just been broken up. The Cleopatra was lost in