Signaling with a Heliograph

U.S. Army Signal Corps, 1910

Selected pages from Visual Signaling.

Historical diagrams show the tripod, mirrors and screen used to aim sunlight and pass messages between stations.

Compiled for The Survival University PDF collection

Historical.—Experiments with the heliograph with a view to its adoption as a part of the visual signaling equipment of the United States Army were commenced as early as 1878. The reported successful use of the instrument by the British in India about this time led to the importation of two heliographs of the Mance pattern. A series of experiments with these machines conducted for the purpose of eliminating certain objectionable features finally resulted in the evolution of the present type of service heliograph.

The early English heliograph was not provided with a shutter, the flash being directed on the distant station by means of a movable mirror controlled by a key. The great objection to this type of instrument was the impossibility of maintaining accurate adjustment during the transmission of signals due to the fact that the manipulation of the mirror tended to throw the flash constantly out of alignment. To overcome this, the American heliograph has been provided with a screen designed to operate as a shutter and control the flash reflected from an immobile mirror.

Description.—The service heliograph equipment of the Signal Corps consists of:

A sole-leather pouch with shoulder strap containing—
1 sun mirror.
1 station mirror. } Inclosed in a wooden box.
1 screen, 1 sighting rod, 1 screw-driver.
A small pouch, sliding by 2 loops upon the strap of the larger pouch, containing 1 mirror bar.
A skeleton leather case containing 2 tripods.

The mirrors are each 4½-inch squares of plate glass supported by sheet brass and cardboard backings, and mounted in brass retaining frames. At the center of

each mirror there is an unsilvered spot three thirty-seconds of an inch in diameter and holes corresponding

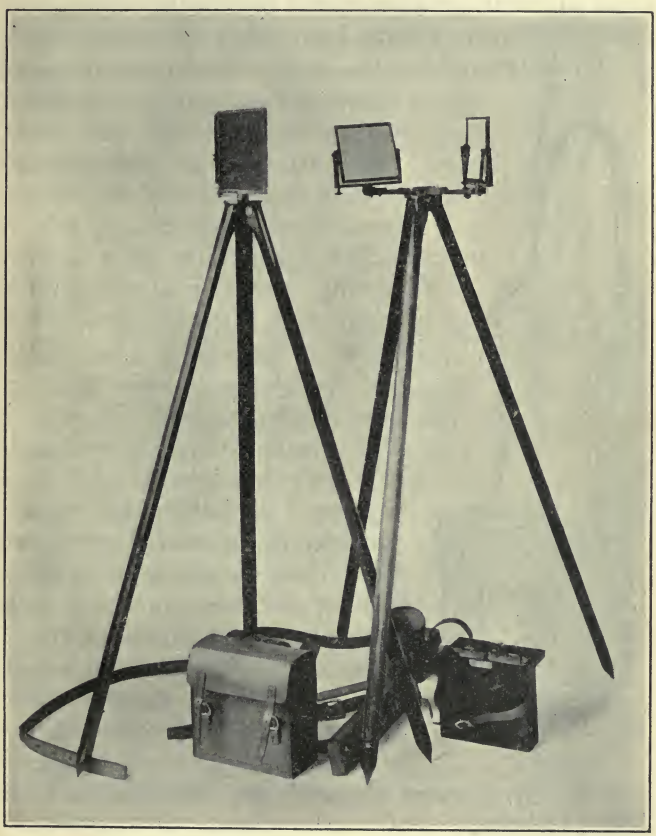

FIG. 1.—Heliograph assembled.

to these spots are drilled in the backing. The sun mirror differs from the station mirror only in that it

has a paper disk pasted upon its face covering the unsilvered spot. The mirror frames are carried by brass supports provided at the bases with conical projections accurately turned to fit the sockets of the mirror bar and grooved at the ends to receive the clamping spring. Each support is fitted with a tangent screw and worm wheel attachment functioned to control the motion of the mirror frame about its horizontal axis.

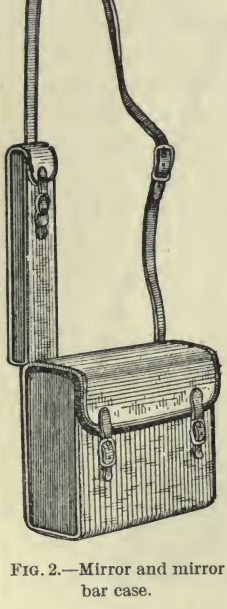

FIG. 2.—Mirror and mirror bar case.

The mirror bar is a bronze casting provided at the center with a clamp threaded to fit the screw of the tripod. By releasing the clamp the bar may be moved independently of the screw and adjusted to any desired position. Conical sockets for the reception of the mirror supports are provided at the ends of the mirror bar. These sockets work freely in the bar and, being actuated by a tangent screw and worm wheel, serve to regulate the motion of the mirror frame about its vertical axis. Clamp springs, for engaging and securing the ends of the mirror frame supports, are attached at each end of the bar.

The screen is a brass frame $6\frac{1}{2}$ inches square, in which six segments or leaves are mounted in such a way as to form a shutter. The leaves are designed to

turn through arcs of 90° on horizontal axes, unanimity of movement being secured by connections made with a common crank bar. The crank bar is operated by a key and retractile spring which serve to reveal and cut off the flash. A set screw and check nut at the lower edge of the screen frame limits the motion of the crank bar and the opening of the leaves. A threaded base support furnishes the means of attaching the screen frame to the tripod.

The sighting rod is a brass rod 6½ inches long, carrying at the upper end a front sight and a movable disk. About the rod is fitted a movable bronze collar, coned and grooved to take the socket and clamping spring of the mirror bar. A milled edged bronze washer serves to clamp the collar to the rod at any desired point.

The tripods are similar in all respects, the screw of either threading into the mirror bar or screen frame. Each tripod is provided with a hook at the base of the head, allowing the suspension of a weight when great stability is required.

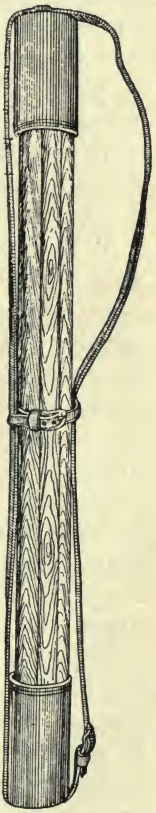

FIG. 3.—Heliograph tripods.

Assembling.—There are two ways of assembling the heliograph and the position of the sun is the guide in determining which of the two

should, in any given case, be employed. When the sun is in front of the operator (that is, in front of a plane through his position at right angles to the line joining the stations) the sun mirror only is required; with the sun in rear of this plane both mirrors should be used. With one mirror the rays of the sun are reflected directly from the sun mirror to the distant station; with two mirrors, the rays are reflected from the sun mirror to the station mirror, and thence to the distant station.

With one mirror: Firmly set one of the tripods upon the ground; attach the mirror bar to the tripod; insert and clamp in the sockets the sun mirror and sighting rod, the latter having the disk turned down. At a distance of about 6 inches, sight through the center of the unsilvered spot in the mirror and turn the mirror bar, raising or lowering the sighting rod until the center of the mirror, the extreme point of the sighting rod, and the distant station are accurately in line. Firmly clamp the mirror bar to the tripod, taking care not to disturb the alignment, and turn up the disk of the sighting rod. The mirror is then moved by means of the tangent screws until the "shadow spot" falls upon the paper disk in the sighting rod, after which the flash will be visible at the distant station. The "shadow spot" is readily found by holding a sheet of paper or the hand about 6 inches in front of the mirror, and should be constantly kept in view until located upon the disk. The screen is attached to a tripod and established close to, and in front of, the sighting disk, in such a way as to intercept the flash.

With two mirrors: Firmly set one of the tripods on the ground; clamp the mirror bar diagonally across the line of vision to the distant station; clamp the sun mirror facing the sun to one end of the mirror bar and the station mirror facing the distant station. Stooping down, the head near and in rear of the station mirror, turn the sun mirror by means of its tangent screws until the whole of the station mirror is seen reflected in the sun mirror and the unsilvered spot and the reflection of the paper disk accurately cover each other. Still looking into the sun mirror, adjust the station mirror by means of the tangent screws until the reflection of the distant station is brought exactly in line with the top of the reflection of the disk and the top of the unsilvered spot of the sun mirror; after this the station mirror must not be touched. Now step behind the sun mirror and adjust it by means of the tangent screws so that the "shadow spot" falls upon the center of the paper disk on the station mirror. The flash will then be visible at the distant station. The screen and its tripod are established as described in the single mirror assembling.

Alternate method with two mirrors: Clamp the mirror bar diagonally across the line of vision to the distant station, with the sun mirror and the station mirror approximately facing the sun and distant station, respectively.

Look through small hole in sun mirror and turn the station mirror on its vertical and horizontal axes until the paper disk on the station mirror accurately covers the distant station.

Standing behind sun mirror, turn it on its horizontal and vertical axes by means of the tangent screw attachments until the shadow spot falls upon the paper disk on station mirror.

Adjustment.—Perfect adjustment is maintained only by keeping the "shadow spot" uninterruptedly in the center of the paper disk, and as this "spot" continually changes its position with the apparent movement of the sun, one signalman should be in constant attendance on the tangent screws of the sun mirror. Movement imparted by these screws to the mirror does not disturb the alignment, as its center (the unsilvered spot) is at the intersection of the axes of revolution. Extra care bestowed upon preliminary adjustment is repaid by increased brilliancy of flash. With the alignment absolutely assured and the "shadow spot" at the center of the disk, the axis of the cone of reflected rays is coincident with the line of sight and the distant station receives the greatest intensity of light. Remember the distant observer is unquestionably the better judge as to the character of the flash received; and if therefore, adjustment is called for when the "shadow spot" is at the center of the disk, the alignment is probably at fault and should be looked after at once. In setting up the tripods always see that the legs have a sufficient spread to give a secure base and on yielding soil press firmly into the ground. Keep the head of the tripod as nearly level as possible and in high wind ballast by hanging a substantial weight to the hook. See that the screen completely obscures the flash; also that the flash passes entire when the screen is opened. This feature of the adjustment is partially regulated

by the set screw attached to the screen frame. The retractile spring should sharply return all the leaves of the screen to their normal positions when the key is released. Failure to respond promptly is obviated by strengthening or replacing the spring.

Operation.—It is of the utmost importance that uniformity in mechanical movement of the screen be cultivated, as lack of rhythm in the signals of the sender entails "breaks" and delay on the part of the receiver. Dark backgrounds should, when practicable, be selected for heliograph stations, as the signals can be most easily distinguished against them.

To find a distant station, its position being unknown, reverse the catch holding the station mirror and with the hand turn the mirror very slowly at the horizon over the full azimuth distance in which the distant station may possibly lie. This should be repeated not less than twice, after which, within a reasonable time, there being no response, the mirror will be directed upon a point nearer the home station and the same process repeated. With care and intelligence it is quite probable that, a station being within range and watching for signals from a distant station with which it may be desired to exchange messages, this method will rarely fail to find the sought-for station.

The exact direction of either station searching for the other being unknown, that station which first perceives that it is being called will adjust its flash upon the distant station to enable it when this light is observed to make proper adjustments. If the position of each station is known to the other, the station

first ready for signaling will direct a steady flash upon the distant station to enable the latter to see not only that the first station is ready for work, but to enable the distant station to adjust its flash upon the first station.

Smoked or colored glasses are issued for the purpose of relieving the strain on the eyes produced by reading heliograph signals.

Care of apparatus.—Minor parts of the instrument should be dismounted only to effect repairs, for which spare parts are furnished on requisition. Steel parts should be kept oiled and free from rust. Tangent screws and bearings should be frequently inspected for dust or grit. Mirrors should invariably be wiped clean before using. In case of accident to the sun mirror, the station mirror can be made available for substitution therefor by removing the paper disk. If the tripod legs become loose at the head joints, tighten the assembling screws with the screw-driver.

Powers and limitations of the heliograph.—Portability, great range, comparative rapidity of operation, and the invisibility of the signals except to observers located approximately on a right line joining the stations between which communication is had, are some of the advantages derived from using the heliograph in visual signaling.

The principal disadvantage results from the entire dependence of the instrument upon the presence of sunlight. The normal working range of the heliograph is about 30 miles, though instances of its having attained ranges many times greater than this are of record. The heliograph can be depended upon to transmit from five to twelve words per minute.