The HELIOGRAPH

by LOUIS MEULSTEE, PAØPCR.

Heliography, or signalling with the sun's light by means of mirrors has been well known for centuries. Herodotes tells of a signal flashed from Athens to Marathon by means of a burnished shield at the time (480 B.C.) when the Greeks were about to come to grips with Darius' army. Xenophon mentions similar signals sent by Lysander before the battle of Aegospotamos.

The Moors in Algeria were using sun flashing as far back as the 11th century A.D. An extensive system of signalling by means of mirrors placed on high towers provided communication, under favourable conditions, between major cities in Algeria.

The forerunner of the heliograph is the HELIOTROPE, a device by which a flash may be sent in any desired direction regardless of the sun's motion. This was invented by Willem Jacob van 's Gravesande (1688-1742), a Dutch physicist. A similar instrument was devised by Gauss, the German mathematician, in 1821, and used operationally during surveying in Germany.

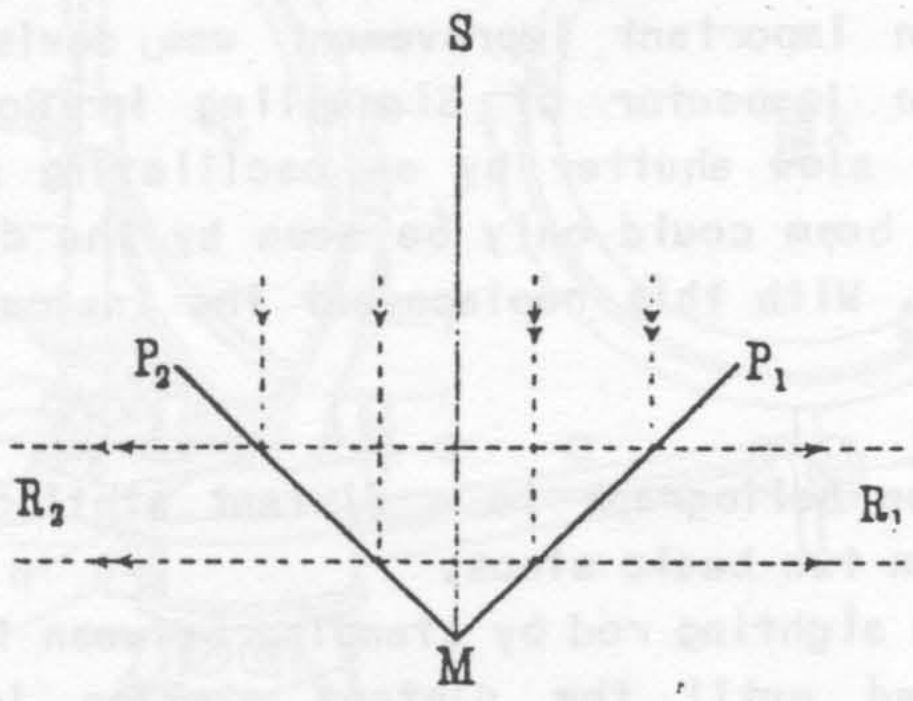
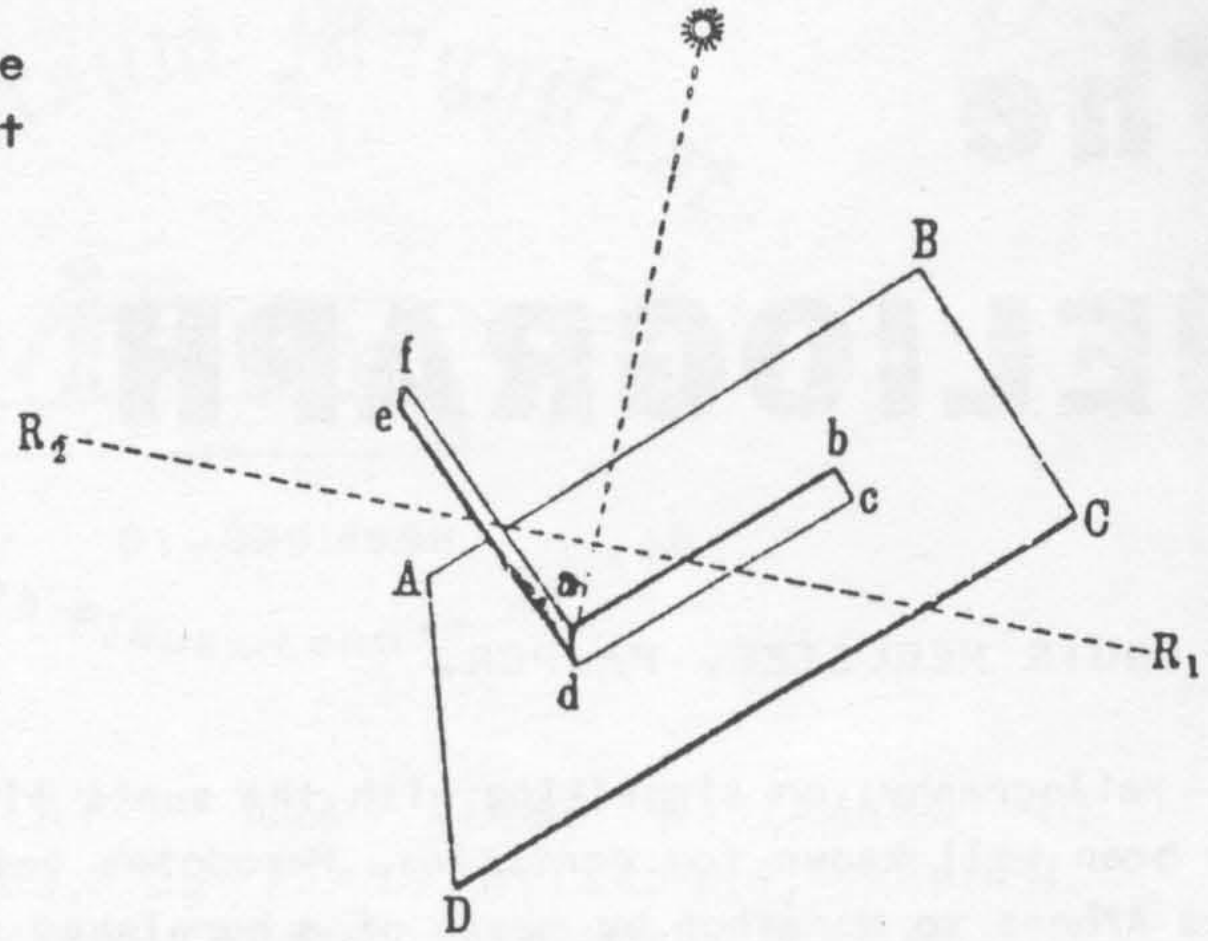


Fig. 1a. Principle of the heliotrope. P1 and P2 = glass plates fixed at right angles at M. The beam of the sun S is reflected to the observer at R1 and the distant station at R2.

Fig. 1b. The heliotrope as a practical instrument



Pre-coded messages were signalled by interruption of the beam of sunlight. The invention of the Morse code opened up a new field. In 1860 the heliotrope was modified by insertion of a shutter between the mirror and the distant station. This increased the speed of Morse signalling considerably.

The Heliostat

The heliotrope however was fragile and inaccurate. These disadvantages were overcome by the HELIOSTAT, prototype of the heliograph, invented in 1869 by Mance (later Sir Henry) and introduced into the British Army in 1875.

This instrument consisted of a mirror with unsilvered spot and a sighting arm or duplex mirror. Signalling was still by means of a shutter. In 1877 an important improvement was devised by Lieutenant G.R.R. Savage, then Inspector of Signalling in Roorkee, India. He replaced the rather slow shutter by an oscillating mirror. Correctly adjusted, the light beam could only be seen by the distant station if the key was pressed. With this replacement the instrument evolved into the HELIOGRAPH.

Using the heliograph

Alignment of the heliograph to a distant station is quite simple and is carried out in two basic steps.

1) Adjustment of the sighting rod by standing between the sun and mirror and moving the head until the distant station is hidden by the unsilvered spot in the centre of the mirror. Keeping the head still and moving the sighting rod until the cross wires exactly coincide with the reflection of the distant station and the unsilvered spot.

2) Adjustment of the reflected sunlight to the distant station by moving the mirror until a dark spot (unsilvered spot) coincides with the sighting mark on the rod.

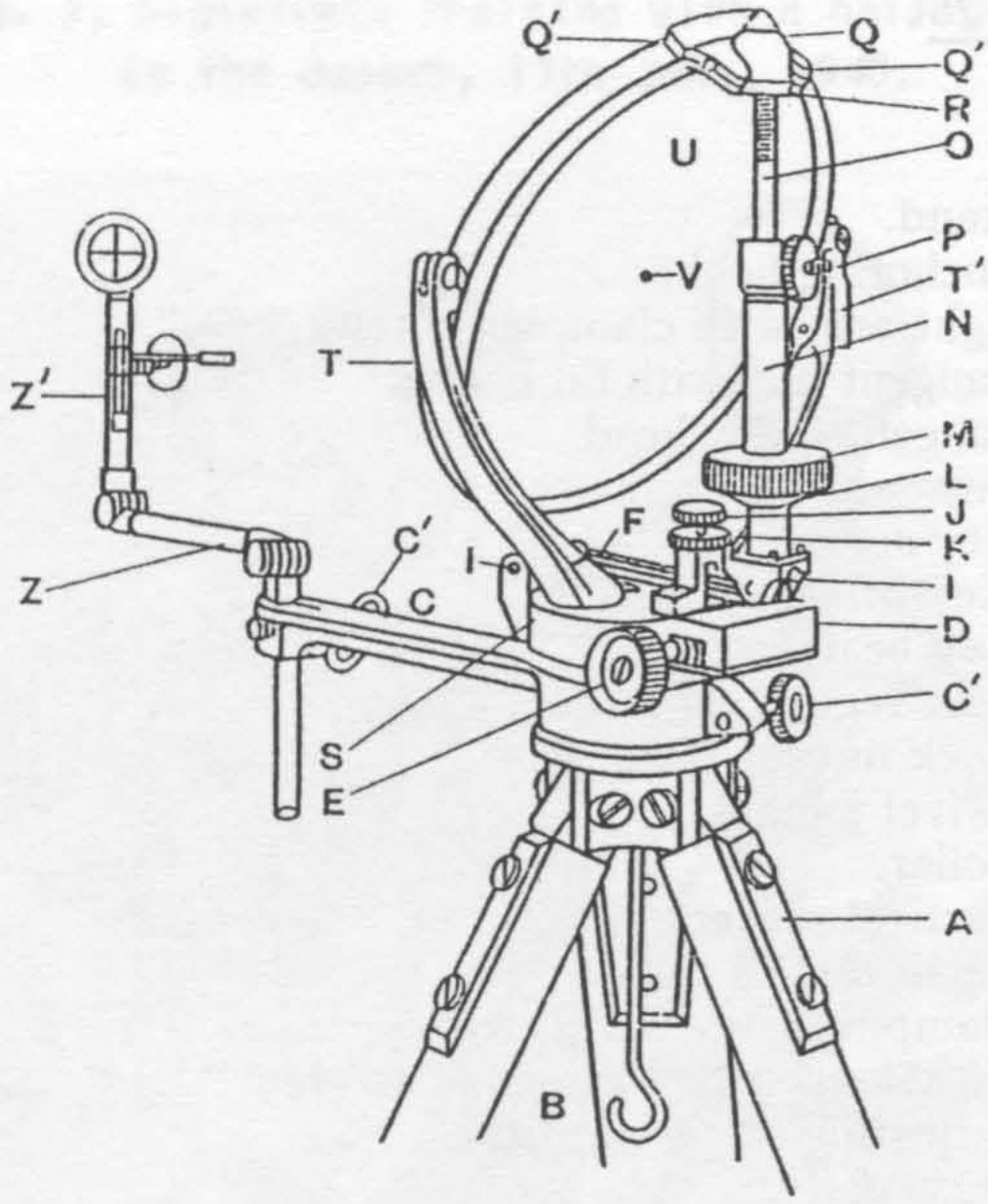


Fig. 2a. Heliograph without duplex mirror. F = Morse key. When this is pressed the mirror turns upward in the direction of the distant station.

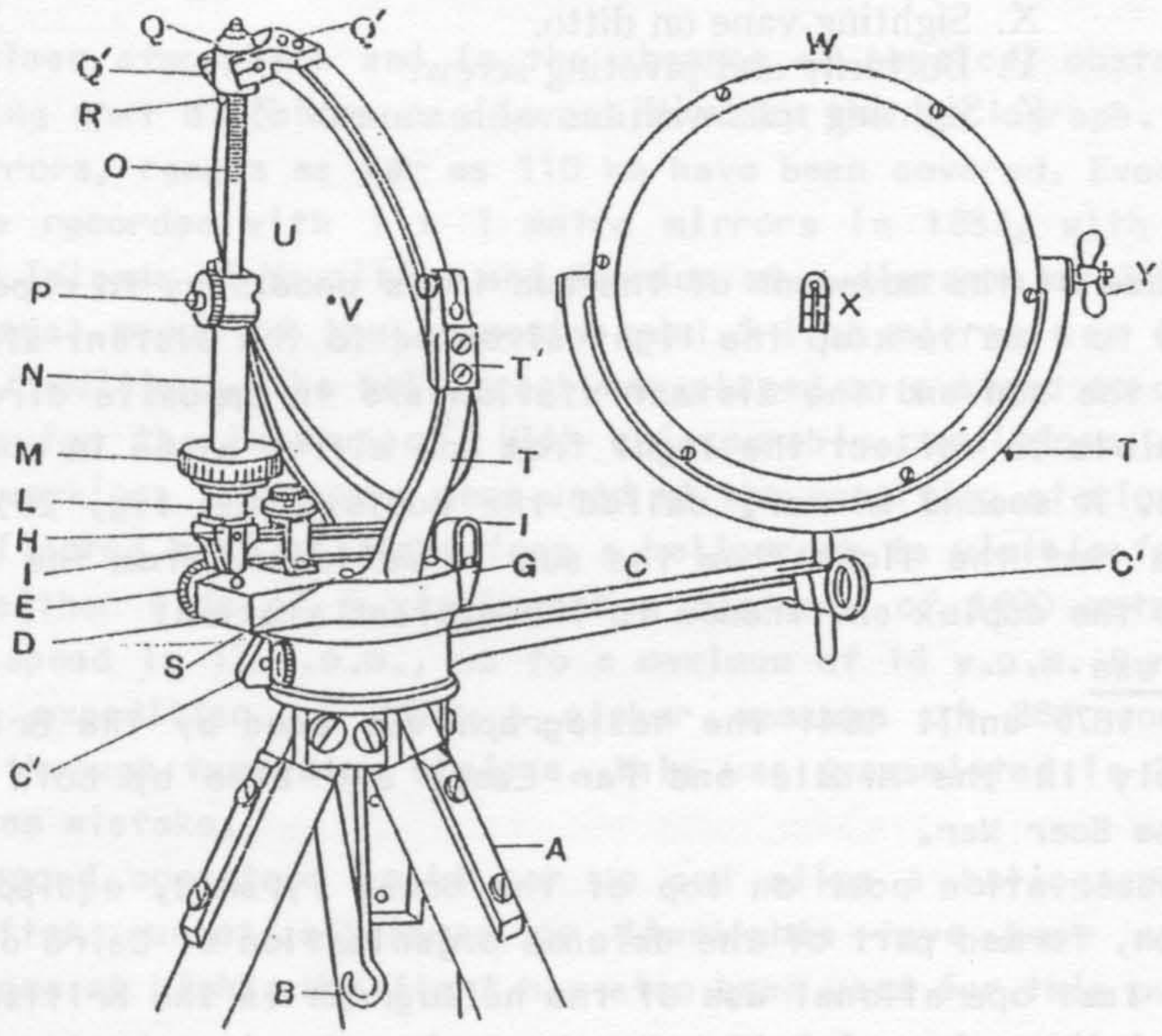


Fig. 2b. Heliograph with duplex mirror.

Key to figs 2a and 2b.

A. Stand.
B. Anchoring hook.
C. Sight arm with clamping screws " C^1."
D. Tangent box with lid below.
E. Tangent screw head.
F. Key.
G. Key spring.
H. Key bridge.
I. Key bearings.
J. Beat regulating screw.
K. Lock nut for ditto.
L. Swivel joint.
M. Collar.
N. Vertical socket.
O. Vertical steel rod.
P. Clamping screw for ditto.
Q. Nickel silver ball attached to claw " Q^1."
R. Adjusting screw for ditto.
S. Brass plate.
T. U-arms, with detachable portion " T^1 " and screws adjusting.
U. Signalling mirror in frame.
V. Unsilvered spot at centre of signalling mirror.
W. Duplex mirror with frame in U-arms " T."
X. Sighting vane on ditto.
Y. Butterfly and pivoting screw.
Z. Sighting rods with movable vanes " Z^1."

Because of the movement of the sun it is necessary to repeat step 2 from time to time to keep the light directed to the distant station.

When the sun and the distant station are in opposite directions it is impossible to reflect the light from one mirror alone in the required direction. A second mirror, called the duplex (see fig, 2b), must be placed so that the light from the sun is reflected from the signalling mirror to the duplex and thence to the distant station.

Military use

From 1875 until 1941 the heliograph was used by the British Army extensively in the Middle and Far East, and also by both opponents during the Boer War.

An observation post on top of the Great Pyramid, equipped with a heliograph, formed part of the defence organisation of Cairo during WW1.

The last operational use of the heliograph in the British Army was in 1941 at the seige of Sollum Hayata during the desert campaign of the 8th Army.

Fig. 3. Signallers training with a heliograph in the desert, 17th June, 1940.

Performance

In a clear atmosphere and in the absence of physical obstacles it is surprising what distances can be achieved by the heliograph. With 15 x 20 cm mirrors, ranges as far as 110 km have been covered. Even larger ranges were recorded with 1 x 1 metre mirrors in 1883, with signals between the islands of Mauritius and Reunion at a distance of 240 km.

The normal range of the commonly used 5-inch mirror was 40–80 km under good conditions. The heliograph was placed on a stand to obtain a stable base for the instrument. With unfavourable conditions, or with long range working, telescopes were used at the receiving stations.

The reflected beam of light from a heliograph is visible for eight metres on either side of a station at a distance of 1600 metres. The signalling speed is 12 w.p.m., up to a maximum of 16 w.p.m. During the Zakka Khal expedition of 1908 a cipher message of 884 words was despatched through two relay stations. This was transmitted in $2\frac{1}{2}$ hours with only one mistake.

Experienced operators could set up and align a heliograph in 60 seconds. After sunset oil-lamps or limelights have been used for communications at night. Moonlight has also been used for this purpose.

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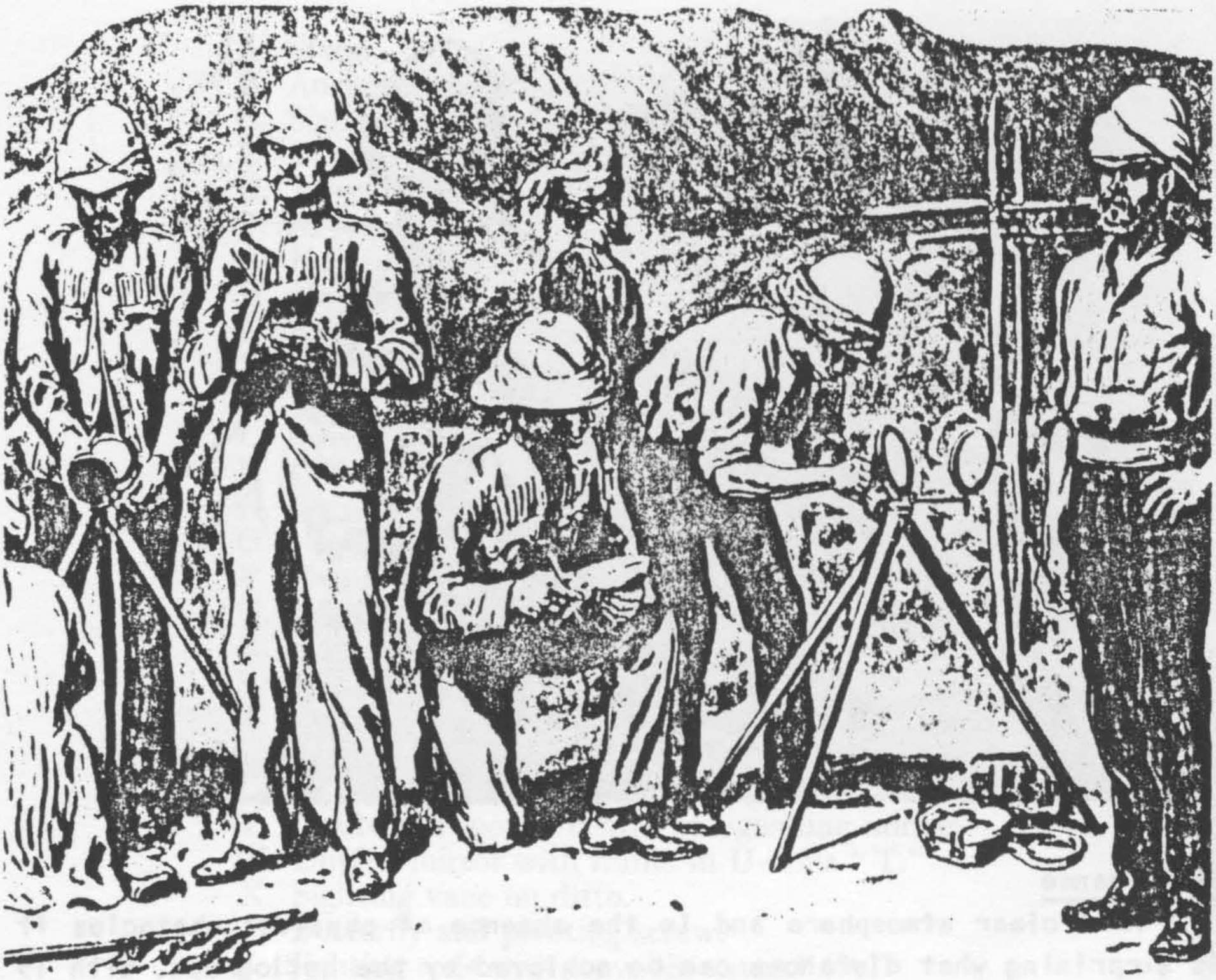
Fig. 3. The heliograph in use with the Tochi Field Force, North West India. (From "The Graphic", 9th October, 1897)



From A CODE OF MORALS by Rudyard Kipling.

Now Jones had left his new-wed bride to keep his house in order
And hied away to the Hurram Hills above the Afghan Border,
To sit on a rock with a heliograph; but e're he left he taught
His wife the working of the Code that sets the miles at naught.

At dawn, across the Hurram Hills, he flashed her counsel wise-
At e'en, the dying sunset bore her husband's homilies.

But he kept his gravest warning for (hereby the ditty hangs)
That snowy-haired Lothario, Lieutenant-General Bangs.
T'was General Bangs, with Aide and Staff, who tittupped on the way.
When they beheld a heliograph tempestuously at play.
They thought of Border risings and of stations sacked and burnt-
So stopped to take the message down - and this is what they learnt:-
'Dash dot dot, dot, dot dash, dot dash dot' twice. The General swore,

'Was ever General Officer addressed as "dear" before?'
The artless Aide-de-Camp was mute, the gilded Staff were still,
As, dumb with pent-up mirth, they booked that message from the hill;
For clear as summer's lightning flare, the husband's warning ran:-
'Don't dance or ride with General Bangs - a most immoral man!'

With damnatory dot and dash he heliographed his wife.
Some interesting details of the General's private life.
The artless Aide-de-Camp was mute, the shining Staff were still,
And red and ever redder grew the General's shaven gill.
And this is what he said at last (his feelings matter not):-
'I think we've tapped a private line. Hi! Threes about there! Trot!'
All honour unto Bangs, for ne'er did Jones thereafter know
By word or act official who read off that hello.
But the tale is on the Frontier, and from Michni to Mooltan
They know the worthy General as 'that most immoral man.'

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WRONG DIRECTION!

Does anyone remember the Mad Mullah perched up on his little tower at Abadan, in 1944-45, with a heliograph that was always pointed in some other direction than that of the ship calling him? Reading a heliograph off the side is not to be recommended for good copy!

Gus Taylor, G8PG.