

## TARGETS AND STATION MARKS FOR MOUNTAIN TRIANGULATION

(Extract from an article by W.M. SCAIFE, U.S. Coast and Geodetic Survey, in *Geodetic Letter* N° 2, Vol. 3, Washington, June 1936, page 47).

When weight and bulk have been factors to consider, I have found 2" × 2" dressed, kiln dried lumber very satisfactory for center poles, and 1/2" × 6" lumber, or even thinner, about right for target boards.

My favorite target is built by staggering boards around all four faces of the center pole. To build, start by nailing a board to a face of the pole at its top. Turn pole 90° for second board, 180° for third, and 270° for fourth. Repeat the cycle if more boards are required.

It is obvious that if boards are nailed to only one or two faces of the pole a certain amount of eccentricity in the pointings will result unless the target is so faced that the line of sight passes through both the center of the target and the center of the pole. With the boards distributed around all four faces of the pole alternate boards as seen by the observer will appear to be off center to right and left, respectively, unless one face of the target is normal to the line of sight.

The amount of eccentricity which would result from pointing on a single face of the target is equal to one-half of the apparent eccentricity of a board on the type of target described above. Eccentricity is entirely eliminated by use of this type of target, no matter how it faces.

It is convenient to keep on hand a supply of painted boards, cut in standard lengths, for different lengths of lines. For lines of five to ten miles or a little longer, I have found 30" boards quite satisfactory, the top four black and the others white, unless the background from all directions is sky, in which case four or six black boards only make a fine target. It is well to have some black on a target, even if the background is dark. Sometimes black shows more clear-cut than white even against a fairly dark background.

In general, I avoid cloth banners for triangulation, partly because they are not as well adapted as boards for making a target which has no eccentricity, such as the type already described. If used, cloth banners should be framed at the sides as well as at the top and bottom. Otherwise there is danger of eccentricity caused by tearing or distortion of the cloth.

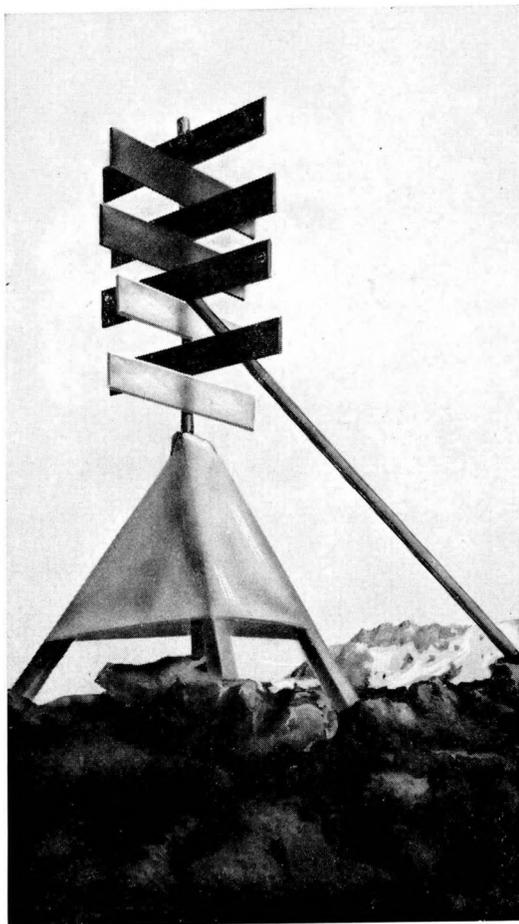
I am one of those who prefer a rather large target. Large targets promote ease of observing and can sometimes be seen when unfavorable conditions make it impossible to see smaller objects. It is not necessary to have a fine object such as a diamond or other odd shape to point on. I have even obtained good closures on a 36" target at less than two miles, with the edges of the target coming outside of the vertical hairs of the theodolite. Such an extreme, however, is not recommended. Accurate centering of the target on the pole and careful plumbing are far more important than size.

At times a small or supplementary target, placed below the main one is helpful. A convenient type can be made by nailing to each of the four sides of the 2" × 2" center pole a piece of 2" × 2" lumber 12" to 18" long. The enlarged section of pole should be dressed in black or black and white to suit the back-ground. When pointing on a white target of barrel shape it is of course necessary to consider the possibility of phase if one side is in shadow.

It is a good policy to sight as low on a signal as a definite object on which to point can be seen. If the top of an eight foot pole is an inch out of plumb, the one foot mark is of course, only 1/8 inch out. With this in view, it is well, with short lines, to paint or dress the lower part of the pole, usually in alternance black and white sections about a foot long. Also, an entire target built low makes for a minimum of eccentricity.

The lower the target, the easier it is to secure it well. I generally use an 8 foot pole, sometimes a shorter one, and seldom one longer than 10 feet.

A single brace of 2" × 2" lumber, with one end nailed to at least two of the boards, and a cross piece nailed to the ground end and heavily weighted with rocks adds greatly



Type of signal recommended for mountain triangulation; 2" X 2" X 8' pole, 1/2" X 6" X 30" boards for lines of about 5 to 10 miles. The signal cloth around the three lower braces is not for pointing on, but merely to aid in picking up the signal easily. A round guy slightly above the middle of pole could be substituted for lower braces. The long brace prevents twisting of target in wind.

Note that the boards appear to be off center due to location on opposite sides of pole.

*Type de signal recommandé pour la triangulation en montagne; cabrion de 5 cm. X 5 cm. X 240 cm., planches de 1 cm. 25 X 15 cm. X 75 cm. pour les lignes de visée de 5 à 10 milles (8 à 16 km.) environ. La toile entourant les trois arcs-boutants inférieurs ne doit pas servir pour la visée, mais elle sert uniquement à aider à relever aisément le signal. Un entourage de haubans légèrement au-dessus du milieu de la perche centrale pourrait être substitué aux arcs-boutants inférieurs. Le long arc-boutant empêche la torsion de la mire par le vent.*

*A remarquer que les planches semblent être décentrées du fait de leur mise en place sur des côtés opposés du cabrion.*

to the stability. If a piece of lumber laid along the ground is nailed to the bottom of both center pole and brace and is heavily weighted with rocks, a further improvement is effected. If this is not done, the bottom of the center pole as well as the bottom of the brace, should have a cross piece weighted with rocks. An unbraced target tends to twist in the wind, thereby stretching the guys and throwing the pole out of plumb and possibly causing it to fall.

A 2"  $\times$  2" pole of eight feet or greater length is somewhat flexible and will generally require support between bottom and top. Satisfactory support is provided by a round of four guys fastened slightly above the center of the pole. In erecting the signal, always plumb the center pole to the point of the lower guys first and secure them permanently. Then plumb upper section of pole. Finally, put on brace, etc. Whenever possible, it is best to have eight guys in the top round. If there are only four, failure of one will leave the target unsupported from one direction. For guys I prefer 14 gauge galvanized wire. It is better to use many guys of light wire than a few of heavier material.

To prevent slipping of the bottom of the center pole, a hole about 1/8 inch in diameter and at least an inch long should be drilled in the center of the station mark to receive the headless nail projecting from the bottom of the pole.

A target of the type described in spite of the comparative weakness of 2"  $\times$  2" lumber, will stand through many storms if well secured. I have even found some still standing on mountains after having gone through a winter of Alaskan storms.

All guys should be made fiddlestring tight. In securing a guy to a large boulder it is poor technic to bring the end close around the boulder and fasten in such a manner that the main part of the guy pulls on a large loop spreading at a big angle. The wire in the big loop tends to stretch during high winds, resulting in a slack guy. Many signals have failed because the wire slipped off of a rock, when chipping of grooves in the corners of the rock would have prevented slipping.

There are times when, because of lack of room on a sharp mountain top or lack of suitable objects to which guys may be secured, ingenuity must be exercised to build a signal which will stand. In such cases the height of the target should be cut down to a minimum. On some occasions I have built targets so low that from a distance they resembled rock cairns.

If there is no room for guys in all directions, braces, or a combination of braces and guys, must be used. Sometimes it is necessary to hang a heavy rock on a guy and suspend over a cliff. In this case, dependence should not be placed upon a single wire and rock. Where there are no rocks or suitable natural objects to which guys may be secured, 3/16" or 1/4" screw eyes with expansion shields, cemented into drill holes or crevices in the rock, are excellent. Spikes, such as damaged drills, or lumber driven into crevices are often handy.

