PHOTOGRAMMETRY FOR TAKING TOPOGRAPHY OF WATERSHED.

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[NOTE.—Readers of *The Canadian Engineer* will remember Mr. Nelles as the author of the valuable article on "Mapping of Canadian Cities," which he wrote for our issues of January 6th and 13th, 1916. The following article was prepared by Mr. Nelles for "Engineering News" of New York.—Editor.]

PHOTOGRAMMETRY, on this continent at least, has been made use of principally by governments where large areas were to be mapped in rough, rugged, mountainous regions. In Canada 22,750 square miles has been mapped by this method; and if to this is added the 31,000 square miles mapped by the Canadian International Boundary Commission in Alaska, it makes the total of approximately 53,750 square miles to date.

The recent use of photogrammetry for mapping 163 square miles of the Thirty-one Mile Lake watershed, Quebec, was, however, of an entirely different nature. This presented a mass of irregular, bush-covered hills from 500 to 1,000 ft. high. Running through the centre of the watershed are two main lakes, Thirty-one Mile and Pemichangan, and in between the hills on either side are 101 small lakes.

The Geodetic Survey of Canada had two primary triangulation stations established in this vicinity, one in the centre of the watershed and one on the outside of the southern edge, from which a secondary triangulation was thrown over the watershed, comprising 24 stations. Ten of these stations were in the southern portion of the watershed, containing 93 square miles.

To these 10 stations were tied 83 photo-topographic stations, and from each station was taken a set of photographs forming a panorama of the country that could be seen from each station. Plotting from photographs taken during the summer was not a success, as enough points could not be identified to control the topography. Another set of photographs was therefore taken during February, from which very successful results were obtained.

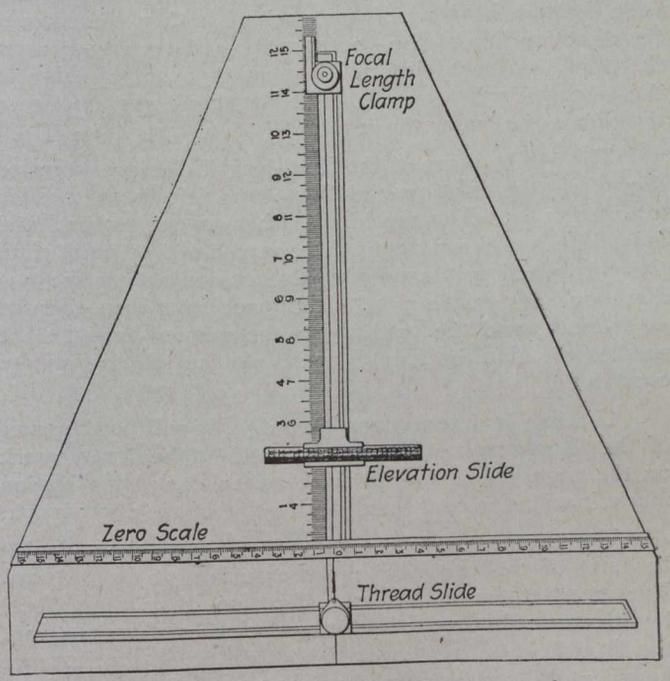
All the lake outlines, creeks, farms and clearings were surveyed by plane table, and the roads by transit and stadia. All these detail surveys were tied to the triangulation and camera stations. The rest of the topography was filled in from the photographs.

Office Work and Methods.—The office routine consisted of computing the positions of stations; drawing a polyconic projection on the scale chosen; plotting triangulation and camera stations; transferring and adjusting the plane-table topography to the map; drawing the horizon and direction lines upon the photographs; identifying and marking direction points; choosing and marking topographic control points on photographs; plotting the photograph traces on the map, as explained later; plotting control points; determining their elevations and finally sketching in contours and other detail.

The ordinary methods of plotting from photographs are generally known and will not be described. In this work a special machine, shown in the accompanying illustration, was used entirely for taking out elevations. The credit for the original idea of determining elevations by the method to be described is due to W. H. Boyd, chief topographer of the Canadian Geological Survey. The machine designed by the writer and made in the Dominion Observatory machine shop, besides giving elevations, measures the focal length of a photograph and plots the photograph trace on the map.

The focal-length clamp has a double action. The larger screw clamps the scale in position. Inside of this screw is a smaller one with a fine steel point on its lower end. The smaller screw serves the purpose of lifting the needle point so that it will not touch the paper when the machine is being used for determining elevations. This point is inserted at the station point when the machine is being used to plot photograph traces or to determine focal lengths.

The focal-length clamp has a vernier with two zeros, one at the forward edge, from which the thread swings, and one opposite the centre of the needle point. The vernier reads to 0.01 in. In the centre of the forward edge of the focal-length clamp is a small hole in which a



Simple Device for Plotting Topography from Photographs.

fine silk thread is fastened by a wooden plug. The other end of this thread is attached to a spring that serves the purpose of keeping it taut. The spring is attached to a ring placed around the screw of the thread slide. The thread-slide clamp is kept tight enough so that the slide will stay at any position.

Use of Plotting Machine.—To determine an elevation: Set the focal-length clamp at the focal length of the photograph, using the line of the zero scale as zero (see illustration). Set the altitude scale of the elevation slide so that the part of it opposite the centre mark of the slide will read the altitude of the station plus the height of the camera. Now measure the distance between the control point and the photograph trace and make the distance between the elevation slide (on the focal-length scale) and the zero scale equal to it. Measure the distance of the control point above or below the horizon line and set this distance off on the zero scale above or below the zero. Move the thread to cut the point so obtained, and the thread will also cut the altitude scale of the elevation slide at the elevation of the station.

When working on small scales and in a region of high altitudes such as the Rocky Mountains, points are