A NEW CAMERA FOR RECONNAISSANCE SURVEYS

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GROUND photography has been employed for many years to support field surveys of both detailed and reconnaissance character. Somewhat greater reductions in mapping costs have been realized through the use of ground photos in those surveys of reconnaissance nature, which involve the coverage of relatively greater areas, than in surveys of more detailed character which require less movement of field parties.

The early experiments with ground photography in Europe and later applications in Canada, India and Alaska indicate that reconnaissance specialists were the earlier exponents of photogrammetry.[1] After the first World War however, aerial photography increasingly claimed the attention of map makers and ground photogrammetry was relegated to a poor second place, though its use was continued in some reconnaissance surveys and a few special large scale projects.

In Alaska reconnaissance mapping topographers had used panoramic photos as early as 1904 to "fill in" skeletonized field surveys during the office season.[2] In this way valuable field time was spread over extensive areas by carrying a main scheme of graphic triangulation and vertical angles, and deferring the greater amount of detail sketching for the winter months. This procedure, supplemented whenever possible with aerial photographs, was employed until World War II when field mapping was suspended in order to supply, by office compilation methods, basic terrain data for the world-wide requirements of the Army Air Forces. Meanwhile, the unmapped areas of Alaska (nearly 300,000 square miles) were covered by Trimetrogon photography and compilations for 1/1,000,000 scale aeronautical charts as part of this program. In resuming the 1/250,000 scale topographic mapping of Alaska the greatest possible use must be made of these new data, and procedures have been developed for that objective.

The most urgent need in this connection is vertical control, and considerable thought has been given to the means by which the required pattern can be produced with the greatest economy. Doubtless the future will bring practical applications of Radar to reconnaissance surveys in general and certain of the terrain clearance indicators[3] show great promise for determining approximate elevations at low cost. Recent experiments in developing vertical control by altimetry indicate that this approach is feasible for relatively large scale mapping.[4] However, the limiting factors of working radius and the relatively small number of days with stable air conditions are serious handicaps for the application of this procedure to reconnaissance surveys. When the Helicopter becomes practicable for everyday use and extensive areas can be "covered" during the brief periods of proper atmospheric conditions, this method should be given

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[1] "The Progress of the Photographic Surveying Method," J. A. Flemer, 1900 (Republished in Photogrammetric Engineering, Vol. X, No. 2).

[2] "The Use of the Panoramic Camera in Topographic Surveying," J. W. Bagley, U. S. G. S. Bulletin No. 657.

[3] "A Terrain Clearance Indicator" *Journal of Aeronautical Sciences*, Feb., 1939 and Photogrammetric Engineering, Vol. V, No. 2, "Absolute Altimeters" Proceedings, Institute of Radio Engineers, Vol. 32, No. 3.

[4] "Control by Precision Altimetry" U. S. Geological Survey, June 30, 1944. "Precise Barometric Altimetry" Bull. No. 9, Syracuse U. Jan. 1945.

consideration. For the present however, we must look to the long range vertical angle survey to supply data of reliable quality within feasible cost limitations.

This procedure will be somewhat similar to that previously employed on Alaskan surveys but will be limited to the development of a large-figured scheme of graphic triangulation and vertical angles supported by panoramic photographs of the entire horizon taken at each instrument station. From the photographs thus controlled in several sectors of the horizon, vertical and horizontal angles to numerous features can be determined with accuracy approximately equivalent to that of the main scheme. In a hundred mile trek it may therefore be possible to limit the number of stations to be occupied to ten or twelve by careful

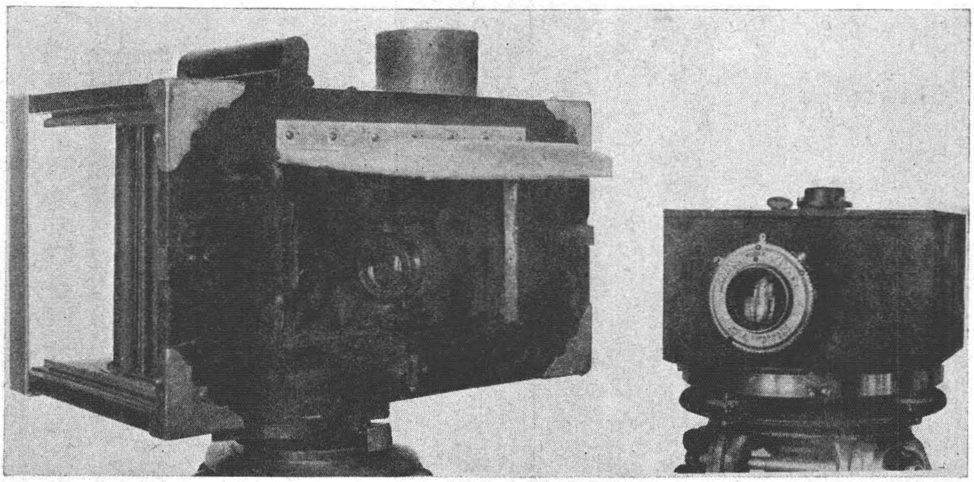

FIG. 1. Old type panoramic camera and experimental model of new type with lens of similar focal length.

planning and field procedure. This is decidedly advantageous since the areas previously unmapped—which must now be controlled—are generally the more remote and difficult to traverse. In such regions dominant points must be occupied for large figures and photo coverage radiating thirty or forty miles from the meander of the field party obtained. Although this presents an arduous physical task, the relative simplicity of the technical operations and few stations to be occupied alleviate the problem to some extent by allowing ample time for reconnoitering, relay packing and choosing favorable weather for station work. Under average conditions it is probable that an area of approximately 5,000 square miles can be controlled, in the manner described, by a three man party in one field season.

The panoramic cameras formerly used by the Geological Survey are now in such condition as to require rebuilding and would be somewhat large and heavy for the work presently to be undertaken. A new design has therefore been developed featuring mechanical simplicity, coverage of the whole horizon in one exposure and easier portability than the old types (Fig. 1). An experimental model has been built by the Survey's instrument shop and tested for performance in the field with very satisfactory results.

It will be noted in the schematic diagram (Fig. 3) that an arrangement of revolving lens and stationary film was employed in the old cameras whereas in

FIG. 2. Photos taken with old and new type cameras (about one-third contact print scale, covering 125° of horizon). Lower print is about one-third of entire exposure.

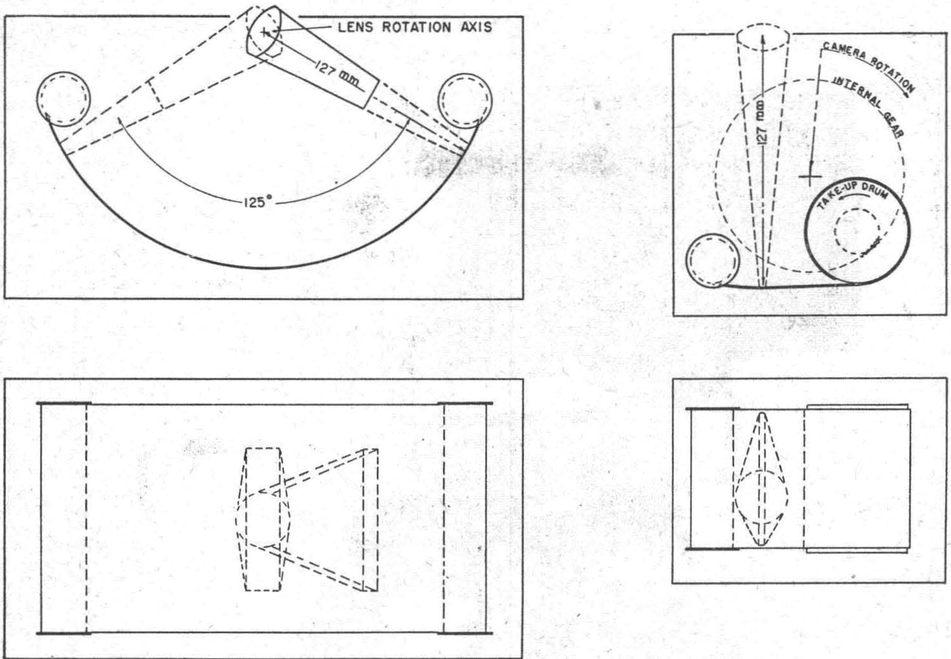

FIG. 3. Schematic diagram showing basic features of old and new camera designs.

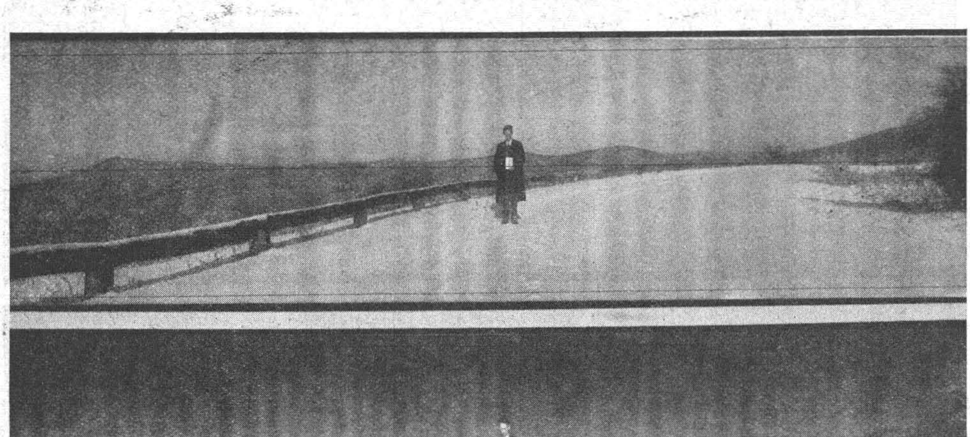

FIG. 4. Exposures by turning camera with rod (half scale). Upper-Pan chromatic $f/11$, 10 second trip (360°), no filter. Lower-infra-red, $f/8$, 15 second trip, *A* filter.

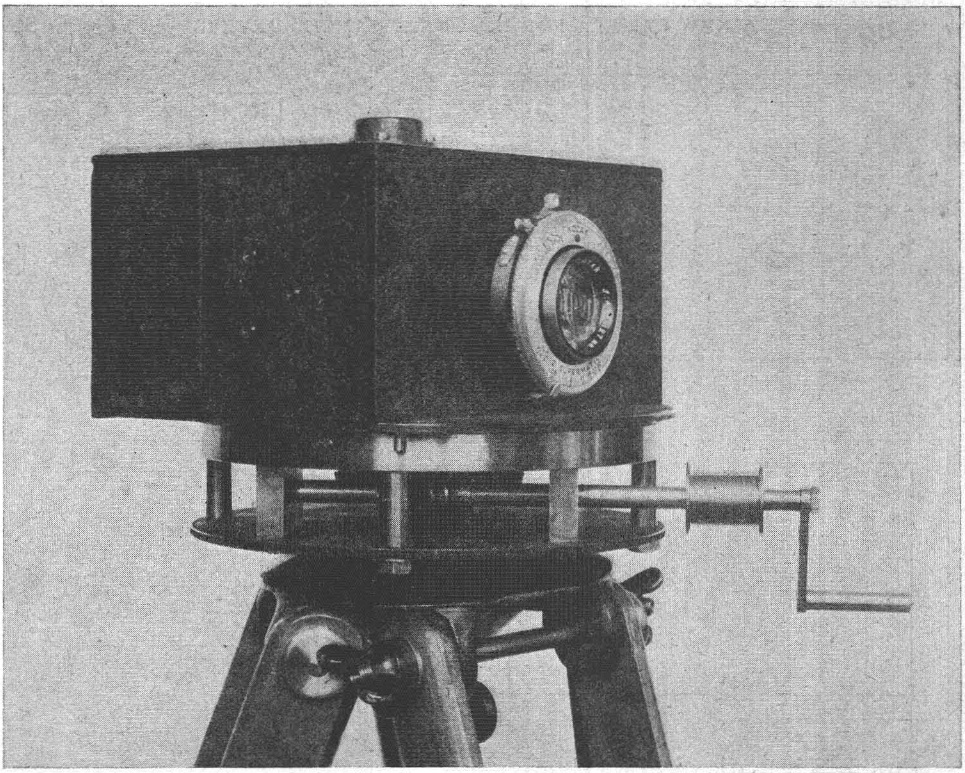

FIG. 5. Camera with worm gear for operation by draw cord or crank.

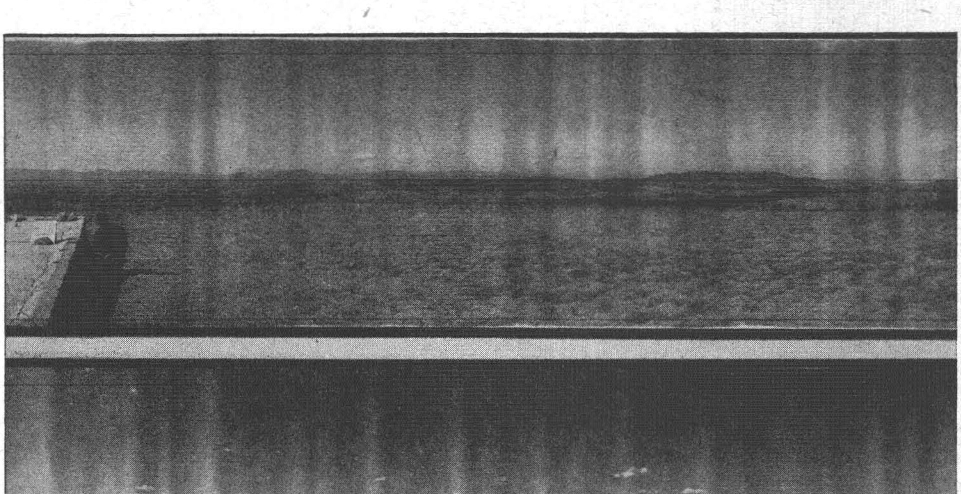

FIG. 6. Exposures made with draw cord and crank. (Skyline above barn foundation is approximately 30 miles distant.) Upper-Panchromatic, *f*/22, 18 second trip with draw cord, no filter. Lower-Infra-red, *f*/5.6, 12 second trip with crank, *A* filter.

the new design the film passes across the focal plane aperture as the camera revolves. This is accomplished by direct gearing to effect the passge of $2\pi f$ of film in one complete circuit. A lens of 127 mm. focal length was used in the new model which was designed to accommodate standard film (no. 116, 8 exposure rolls).

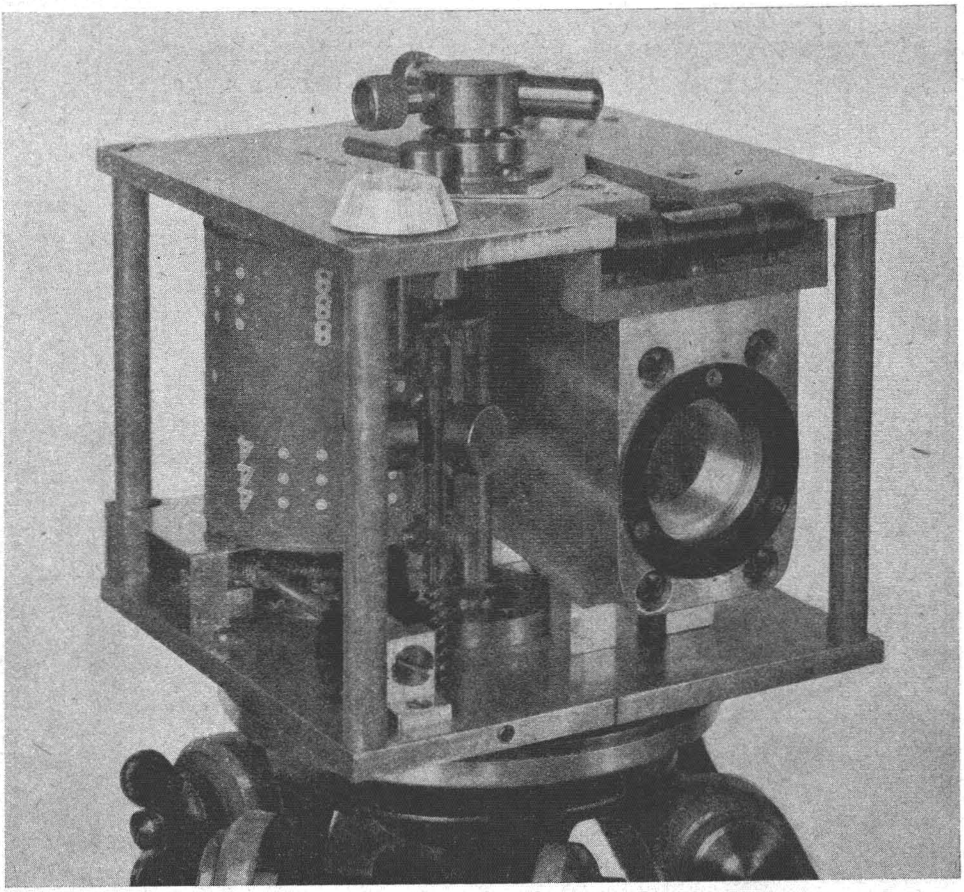

FIG. 7A. New Model with spring drive and governor. Front view.

In its simplest mechanical arrangement the camera is revolved manually with a rod. Figure 4 shows portions of two exposures made in this manner. A worm-and-gear was then installed to appraise the results when rotation is accomplished by draw cord or crank (Fig. 5). The resulting photos (Fig. 6) show slightly less "banding" from exposure variation than is evident in Figure 4. Because of the possible objection to "banding" for certain uses of the photographs, another camera has been designed, with spring drive and governor, to make either type available for the field engineer's preference. This model has just been completed, Figures 7A and 7B, and field tests will be made in the very near future.

The simpler mechanism appears desirable for operations in remote areas to reduce the chances of breakdown and increase the likelihood of adequate repair, in such event, with the limited facilities at hand. Manual operation also enables the operator to make appropriate changes in speed for variations of brightness in different sectors of the horizon. It is therefore possible that the manually operated type of camera may find greater favor with reconnaissance engineers than the mechanically driven type—especially since the scarcely objectionable banding may be considerably reduced with practice by the operator.

The present method of "reading" prints employs a 20× Brinnel type micro-

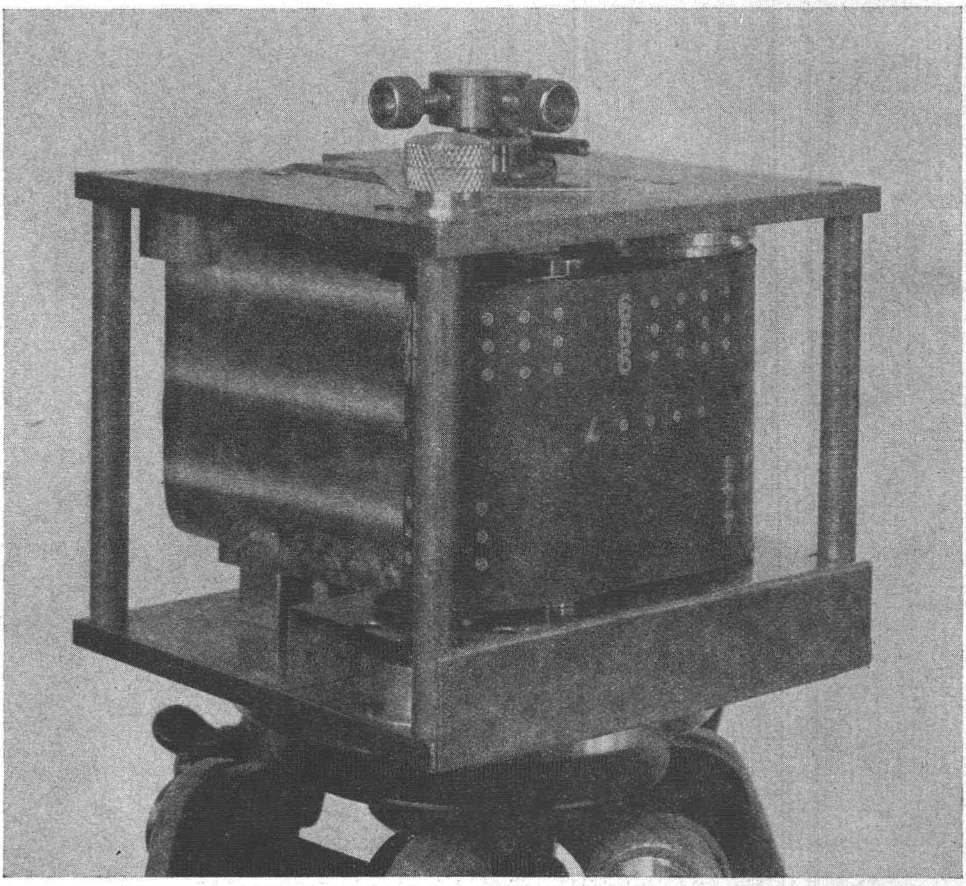

FIG. 7B. New model with spring drive and governor. Rear view.

scope to measure the equivalent vertical angles to selected features in the landscape from the center fiducial line which approximates the true horizon. The reference value of this line is determined at 20 or 30 degree sectors from the vertical angles observed in the main scheme. Employed in this manner, it is unnecessary that the camera construction conform to accepted standards for "precision" instruments. In fact, it will be used with the standard Johnson plane-table tripod, but has a separate leveling facility in order that the lens axis will approximately describe the true horizon in transit.

Figure 8 simulates the observer's view of a small portion of a print through the microscope. The reticule covers a 6 mm. field and is graduated to tenths of a millimeter, which have a value in the proximity of the reference wire of ap-

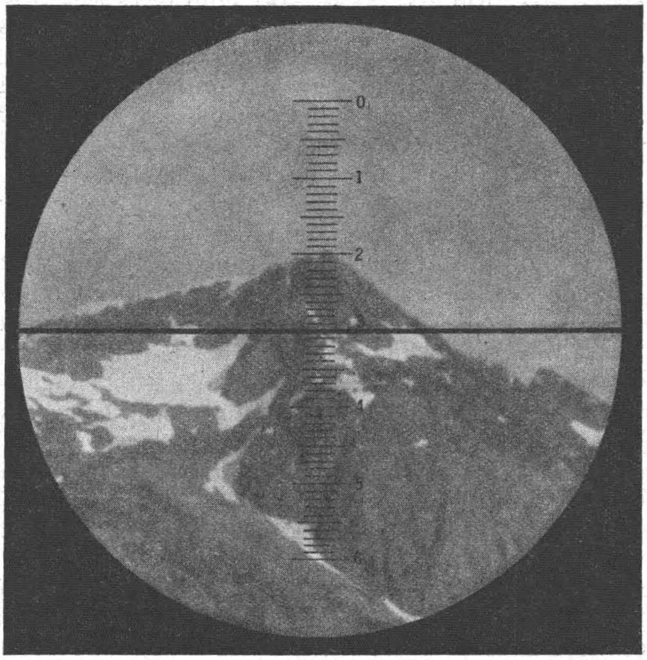

FIG. 8. Brinnel microscope view of print.

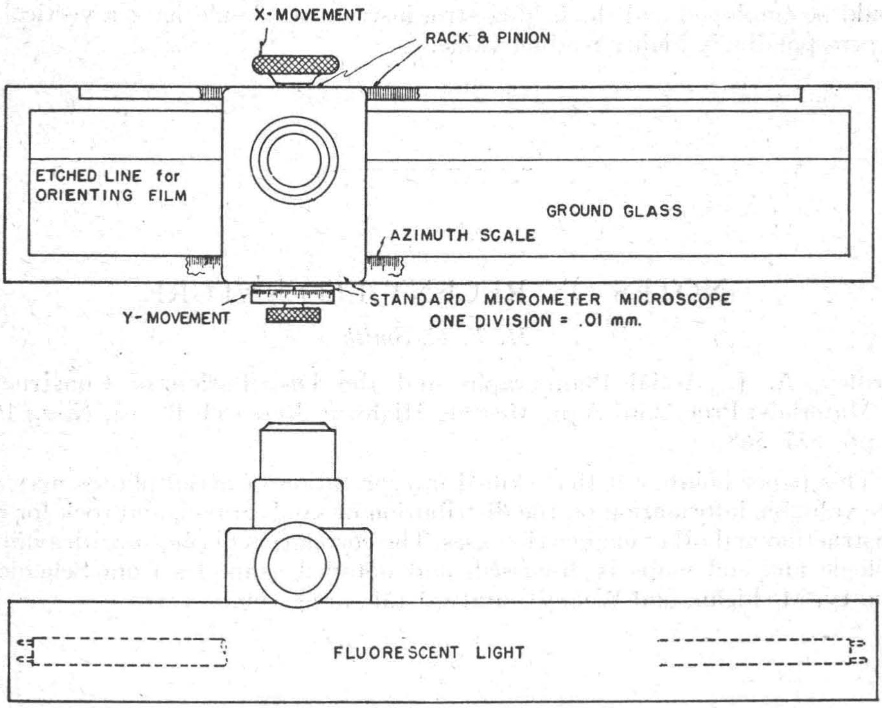

FIG. 9. Schematic diagram for Panoramic Photo Comparator.

proximately 2′40″ of vertical arc, for the 127 mm. focal length lens, providing the paper print is undistorted. The upper and lower fiducial lines seen in Figure 4 afford a check on the print scale. Readings to clearly defined features in the landscape can be interpolated to the nearest minute of vertical arc and are closely equivalent in value to field readings made with the standard telescopic alidades which have one minute verniers.

A simple comparator is now being designed to facilitate the reading of vertical and horizontal angles on the contact prints of the camera exposures. Film positive prints will probably be used on an illuminated ground glass surface about 2 inches wide and 33 inches long, which will cover the usable area of the exposures. Figure 9 shows the general arrangement contemplated for this comparator which will utilize a $20X$ microscope with micrometer control of movement in the Y direction, while movement of the microscope carriage in the X direction will be afforded by a rack and pinion. Vertical angles will be determined from the Y distances while horizontal angles will be converted from distances read on the X scale and vernier. The latter scale will be graduated in four sections since the take-up drum used in the camera will make four revolutions during the 360° circuit and will have a diameter increment of approximately .015″ with each revolution, with a proportionate effect upon horizontal angular values.

It is hoped that the instruments and procedures which have been described will expedite the use of high oblique aerial photographs for the preparation of reconnaissance maps in other parts of the world as well as Alaska. Many other uses may develop for this type of equipment—particularly where it is desirable to simplify field operations and relegate the ferreting of detail to office procedures. However, for requirements of higher order, a longer focal length lens should be employed and the field control instrument should have a vertical arc of correspondingly higher reading value.

NOTES ON RECENT LITERATURE

H. T. U. Smith

Eardley, A. J., Aerial Photographs and the Distribution of Construction Materials: Proc. 23rd Ann. Meeting Highway Research Board, Nov., 1943, pp. 557–568.

This paper points out that skilled interpretation of aerial photos may provide valuable information on the distribution of sand, gravel, and rock for road construction and other engineering uses. The correlation of photos with available geologic and soil maps is discussed, and detailed examples from Schoolcraft County, Michigan, and Weber County, Utah, are given.