HORIZONTAL PROJECTOR FOR OPAQUE TRANSMISSION

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THIS bureau, charged with the production of City and County Tax Maps, is jointly sponsored by Mr. Roy L. Williamson, Commissioner of Public Works for the City of Raleigh, and Mr. John P. Swain, Chairman of the Wake County Board of Commissioners, with Mr. Vincent J. Hanrahan as Director.

The schedule called for the preparation of Planimetric Maps based on aerial photographs, secured from the AAA, covering an area of 850 square miles. These planimetric maps were to be on a scale of $1'' = 1600'$, as recommended by the Federal Board of Surveys and Maps. They were to show all the roads, railroads and the drainage of the County. From these basic maps, a set of tax maps, on a scale of $1'' = 800'$, was to be made. These tax maps were then to be completed by plotting all the farms in the County whose acreage had previously been laid out on "picture overlays" on a scale of $1'' = 660'$.

For the efficient conduct of this phase it was desirable to secure the use of a projector sufficiently large to permit the utilization of our $9'' \times 9''$ aerial photos. It would have been possible to avail ourselves of the use of an Overhead Projector which the U. S. Coast and Geodetic Survey in Washington owned. In view of the travel and the considerable losses in time involved, we shopped around closer by. Due to the emergency, however, all avenues for rental or purchase of a projector seemed to be closed.

It appeared as if we would have to compile and complete the mapping work without a projector, with resultant higher costs and losses in time. It was then that the idea of constructing a projector of our own design slowly took shape. Of course, we had never built a projector nor was any expert advise available, but we were determined to try, basing our confidence on our knowledge of a few optical principles.

Upon reflection as to the specific uses to which our homemade projector would be subjected, we knew that we had to meet the following minimum conditions:

1) Opaque projection of $9'' \times 9''$ paper positives of varying density onto planimetric smooth sheets (scale $1'' = 1600'$)
2) Two-diameter enlargements of the smooth plots into Tax Maps (Scale $1'' = 800'$)
3) Reduction from 660 feet to the inch down to 800 feet to the inch of the overlays for the final plotting of acreage on the tax maps.
4) Other incidental pantographic work involving reduction down to $\frac{1}{4}$ diameter and enlargements up to 3 diameter.

If at all possible, we wished to avoid the disadvantages inherent in the usual Overhead Design and we decided to employ "horizontal erecting" projection. Lantern Slide projection was out since we had to work with paper positives. We, therefore, had to devise some way of "opaque" projection which would, nevertheless, give us erect images of overall brilliancy and detail.

The schematic sketch (Fig. 1 and Fig. 2) encompasses the major design as it finally evolved. The centre ray from the paper positive strikes a 45° mirror, passes through the lens and, via a gimbal mirror, is projected to the drafting window.

As can be seen from the photographs, the apparatus was completed. It was put to immediate use and has proved eminently satisfactory. The features which we particularly appreciate in this design are:

a convenient drafting height (36″);
easy correction of radial distortion and tilt by means of handy wheels;
immediate adjustment for altitude differences;
a cool and unimpeded drafting table, and
the workability of the apparatus in broad daylight and without a dark room. It is only when our opaque drafting material (acetate or linen) is placed on top of the drafting glass that the final image forms; until then the reflection rays travel "in camera."

In view of the limited funds available for the purpose, the actual construction presented mechanical problems which, perforce, had to be met by improvisations of all kinds.

For the optical system we employed a secondhand Zeiss "Tessar" (f 7/7) with a focal length of 14 inches. This focal length (being longer than the diagonal of our 9″×9″ photos) was ample to cover the entire picture and the wellknown

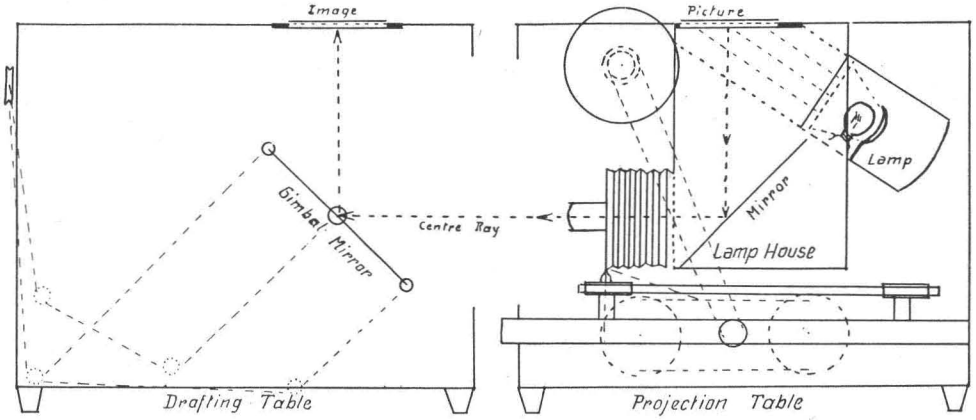


FIG. 1

HORIZONTAL ERECTING PROJECTOR FOR OPAQUE PROJECTION
(Capacity 9″×9″)

Designed and built by Wm. Rickenback, Raleigh. N. C.

qualities of the "Tessar" as to chromatic and spherical corrections assured clear, allover definition.

We would have preferred using a Goerz "Dagor," 16″ focal length. This unit, a symmetrical anastigmat, would have permitted 2 diameter enlargements by simply removing the front element and, generally, would have given a wider scope. We found, however, on inquiry that it had been sold.

For the mirror material we chose "First Surface Chromallumin" in order to eliminate the refraction factor which the glassbase of ordinary amalgam mirrors would have introduced. One 45° mirror (14″×17″) was placed under the picture-carrier plate so that sufficient clearance remained for the positioning of the illumination unit. The second mirror (17″×17″) was mounted in a gimbal—the movements of which were controlled by a wire-and-pulley system; this latter to allow correctional distortion of the image.

The danger of parallax presented by the picture-carrier plate ($\frac{1}{4}$″ plate glass) was neutralized by the employment of a $\frac{1}{4}$″ plate glass for the drafting window, of equal refraction factor.

The major problem offered itself in the illumination. Opaque projection, so we had been told, would prove the "enfant Terrible" of the entire apparatus.

All types of illumination were considered, from Cooper-Hewitt to Fluorescent to Water-cooled Mercury Vapor. Some were unsatisfactory, others too costly. We also experimented with Spotlights and finally chose a 2000 Watt Spotlight with concentrated filament bulb, equipped with silvered reflector and an 8″ Fresnel Lens—the infra-red and the visible radiation being carried away by a small blower system. This illumination unit is eminently satisfactory and any excess of light (in case of occasional non-dense positives) can be diminished by stopping down the lens with the diaphragm.

The rest of the construction was comparatively simple although some of the mechanical movements and adjustment-features caused perplexing moments,

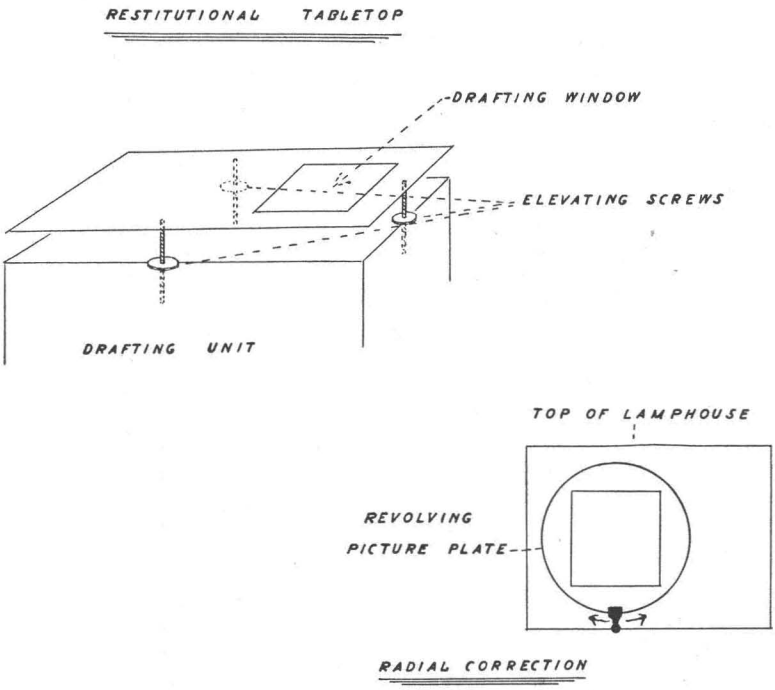
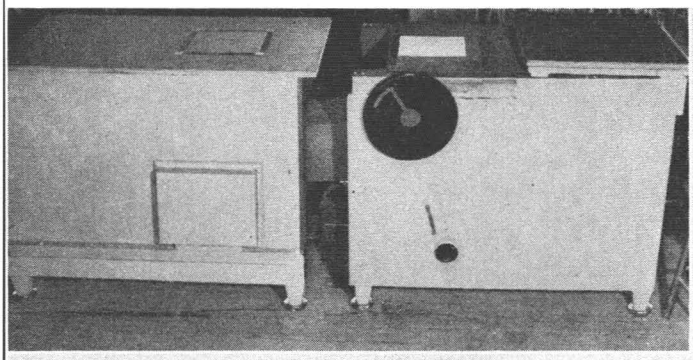


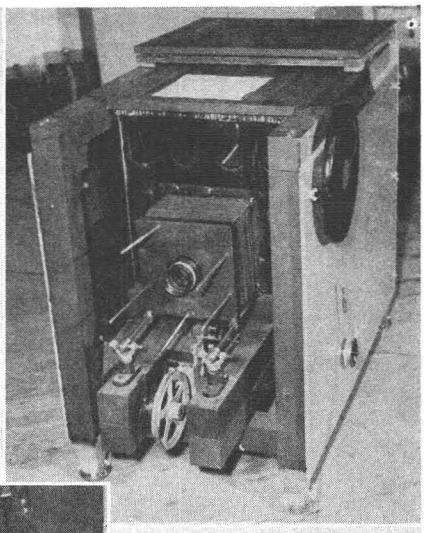
FIG. 2

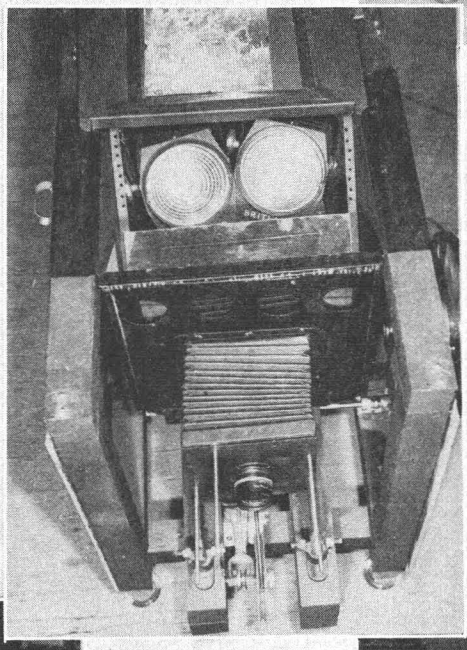
due to the necessity of substitution and improvisation. It would have been far less exasperating to simply order special "gears" for the lens and gimbal movements. Instead, we were compelled to employ hangers and shafting of available dimensions and to use piano wire for the transmission and conversion of movements.

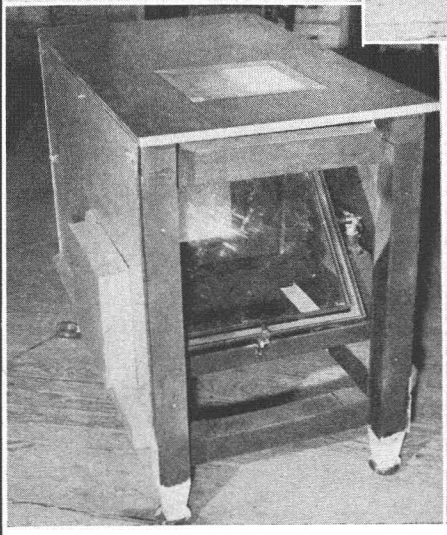
When the finished projector was finally put to actual work, we were very pleased with its performance. (And, we may as well confess here, immensely "relieved" too, since the planning and construction had to proceed under the skeptical eyes of the goodnatured panning of wellmeaning colleagues.)

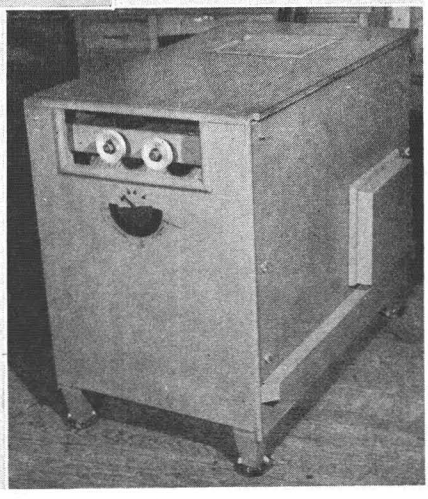
Through the effected speeding up of the mapping work, the projector has paid for itself within the first month. The total cost amounted to approximately $300.00 (of which $110.00 went for the lens) including carpentry and equipment, not counting, naturally, the manual and mental effort which the originator had to contribute.











HORIZONTAL ERECTING PROJECTOR
(Capacity 9″×9″)
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This projector may be the only one of its kind, yet in principle its design offers very few theoretical obstacles since it is based on wellknown optical laws. It might be injected here that the conjugate foci have to be measured from the lens nodes, via the mirrors, to the projection or the drafting plates, following the path of the centre ray as shown in the sketch.

As for the mechanics any kind of devise will do which will permit of the movements desired, as long as a certain stability is maintained.

In conclusion, we should like to again emphasize the versatility of the design for photogrammetric and pantographic work, its sturdy compactness, its ease of operation and, a very desirable feature in the South, its useability in broad daylight without the inconveniences of a dark-room.