THESIS

DESIGN FOR A

SURVEYOR'S PLANE TABLE

WITH

SHIFTING CENTER

For Degree of C. E.

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A Design for A Surveyor's Plane Table With A Shifting Center

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A Design for A Surveyor's Plane Table
With a Shifting Center

The Plane Table cannot be said to be in very extensive use in America. The great majority of surveyors engaged in other than government work neither possess nor use a plane table, its use being practically confined to the United States Geological Survey, the Coast and Geodetic Survey, and a few state surveys. The reason is that the instrument is heavy, clumsy, and awkward to carry, and that it is very difficult to set it up so that a given point on the drawing paper is directly over a given point on the ground. Yet, when this instrument is properly set up and oriented, the facility with which it can be used for rapid mapping ought to count heavily in its favor. The motive for the accompanying design was found in a remark made by Professor Baker in his text book, "Engineer's Surveying Instruments", to the effect that plane tables are never made with shifting centers, owing to the difficulty of mechanical design, but that it would be a great convenience if they could be so made.

In plotting traverses with the plane table by the radiation method or any modification thereof, it is desirable to set the center of the instrument over a given point on the ground, and, rotating about that center, as with the transit, take sights at the various points to be plotted. In plotting

[illegible] and some given point of the paper [illegible] the point occupied on the ground. To quote from [illegible]: "To satisfy these conditions with any considerable degree of accuracy requires great patience and care. The difficulty is that having placed the point on the board over the point on the ground, it is necessary to destroy this condition in turning the board" to make the directions of the lines on the board and the ground coincide. In either method the use of a shifting center similar to that of a transit would be of great assistance.

The other disadvantages of the plane table, namely its heaviness and clumsiness, would have considerably less weight if the instrument could be set up more easily and quickly and with less lifting and manipulating of the tripod legs. Therefore it is believed that if a successful shifting center can be designed for a plane table the field of usefulness of that instrument will be very much widened. The accompanying design is offered as an attempt at a solution of the problem.

Any such proposed design must be practicable from the view point of the manufacturer and from that of the surveyor in the field. It must not add materially to the weight of the instrument as at present made; it should be as rigid as present constructions, and the shifting center should have a radius of movement somewhat greater than that of an ordinary transit.

A plane table with a shifting center could, of course, be designed with a levelling head similar to that of an ordinary transit; that is, with long centers and four levelling screws producing rotation about an axis through the center of a ball and socket joint. The great weight of such

a design really [illegible], [illegible] impractical. For the sake of lightness the plan of having three levelling screws is always adhered to in designing a plane-table levelling head.

As will be seen by referring to the accompanying drawings in the design herewith submitted the drawing board is fastened as usual with three brass screws to a revolving frame. This frame revolves about a conical center of bronze threaded into the levelling head. The exterior rim of the frame rests and revolves upon a circular path provided for it on the finished upper surface of the levelling head, which carries the usual clamp and slow motion tangent screw. The levelling head carries, on a six inch circle, three brass levelling screws of the type more common on other instruments, which are threaded into it and stand with their feet on the surface of the cover plate of the tripod head. A center screw whose head is a portion of a sphere depends from the under surface of the levelling head at its center, through a circular opening in the tripod head cover plate, and carries on its threads a center clamp and a check nut. The center clamp supports the shifting center which is a three bladed plate, the blades being equidistant. Each blade projects through an opening in the tripod head, one blade projecting through that portion of the tripod head which projects to receive each tripod leg. This shifting center is free to move horizontally in any direction when unclamped.

When the center clamp is screwed up tight the shifting center is held firmly against the under surface of the tripod head cover plate, bringing the feet of the levelling screws to bear on the upper surface of the said plate with sufficient

the usual [illegible] and fastened [illegible] by long brass bolts. Plate III shows the frame and other details. The frame is made as light as possible and provision is made for oiling the bearing surfaces if necessary. Plate IV shows the levelling head and other details. The continuity of the rim of the levelling head, on which the frame rotates, has to be interrupted to allow for the clamp yoke. If proper rules, as indicated on the drawing, be followed in manufacturing, no trouble need result. If made in quantities the clamp screw could more economically be made in two parts, the stem being threaded into the head. Plate V shows minor details. The center screw has its lower end fashioned to take a wire hook to support a plumb line under the center of the instrument. This wire hook could be made large enough to prevent the check nut getting lost, if there seemed to be danger of that in field operations. Of course the ordinary plumbing bar will support the plumb bob at points on the drawing other than at the center. The specification of the tangent spring is tentative. Experience might suggest a stronger or a weaker spring. Plate VI shows the shifting center. It is ribbed on the bottom for stiffness. Plate VII shows the tripod head and cover plate. They stiffen each other, and are fastened together with machine screws placed so as to prevent buckling of the cover plate. Ridges on the latter limit the travel of the levelling screws.

When working on the drawing board a slight movement of the draftsman will affect the levelling screws with considerable leverage. The upper surface of the cover plate should not be so [illegible] smooth that the center plug cannot

[illegible]
enough friction to prevent rotation when the draftsman exercises ordinary care.

In giving dimensions on these drawings no tolerances have been specified, for the reason that tolerances are best determined after considerable experience in manufacture. All parts are made of non-magnetic metals in deference to those who wish to use a compass with the plane table.

If made of the materials specified on the drawings, the design of plane table movement will weigh $14\frac{3}{4}$ pounds. The corresponding parts of the Heuffel and Esser standard design of plane table, supporting the same size drawing board, weigh $13\frac{1}{4}$ pounds. If, however, the tripod head and plate of the accompanying drawings be made of aluminum-zinc alloy two-thirds aluminum, one third zinc -- as it readily might be, the weight of the whole mechanism will be reduced to $10\frac{3}{4}$ pounds. The corresponding parts of the plane table used by the United States Coast and Geodetic Survey and described in the report of the Superintendent for 1905 weigh $10\frac{1}{2}$ pounds. It, however, supported a larger drawing board, namely 21 x 30 inches.

The alidade of any plane table may be used on the board of the one here described, the alidade forming no part of the present design.

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