cess, the advantage of 2 to 4 times the stereoscopic parallax will doubtless lead to the construction of these additional devices.

It is not easy to visualize the effect of this camera on surveying and mapping as we now know it. Imagine an entire quadrangle within the scope of one photograph on a scale of 1:27,000. Allowing 60 % overlap, both along and between the strips, only six or seven photographs will be required per quadrangle at 1:24,000 scale. The need for adjusting radial line plots should largely be eliminated. On account of a stereoscopic parallax of two to four times that of present cameras, it should be practicable to extend the advantages of stereoscopic mapping to more level terrain as well as reducing the cost of topographic mapping considerably below that possible with present methods of equipment.

NOTES ON SURVEY APPARATUS AND INVENTION.

(Extract from *Empire Survey Review*, London, July 1935, page 172).

THE FIRST THEODOLITE. — The name first given was *theodelite*, for which Leonard DIGGES was responsible. According to GUNTHER the word is a corruption of *athelida* (found in W. BOURNE's "Treasure for Travailers", 1578), itself a corruption of the Arabic *al'idhāda* (whence "alidade") ; but it is noteworthy that the Oxford English Dictionary is non-committal on the etymology and definitely rejects the Arab origin. Thomas DIGGES described his father's instrument in 1571 ; his description shows that it was not a theodolite in the modern sense. The mediæval instrument of this nature was the *plane astrolabe*, or circumferentor as perhaps we should now name it. One of these made in Valencia in 1086 is in the museum of Cassel ; another of 1240 is in the British Museum. (H.D. HOSKOLD, "Notes upon Ancient and Modern Surveying and Surveying Instruments, Trans. Inst. Min. Eng., 1900). The plane astrolabe made by RIBERA (1529) was apparently the best known of these instruments. According to E.A. REEVES (Fothergill Lectures, Society of Arts, 1916) the vertical circle was suggested by the astrolabe and the astrolabe and the horizontal circle by the circumferentor. The general principle of the design was this : from the centre of the graduated horizontal circle there rose a column to which was attached a graduated vertical semicircle ; the readings were referred to the horizontal and vertical direction of a rocking bar swinging on a horizontal spindle also attached to the vertical column, the bar carrying a pair of plain sights at its extremities. All the angle-measuring field instruments of the period conformed to this general type ; *e.g.* WALDSEEMÜLLER's *Polimetrum* (1512), the *Cadrant Differential* of ROTZ (1542), the DIGGES *Theodelitus* and the so-called "theodolite" of Humphrey COLE (1586). It seems that the vertical semicircle was a separate component, mounted only when required ; but there were doubtless minor variations from the type indicated above, which appears to have marked the maximum of development. Indeed, until the telescope was invented by LIPPERHEY in 1608 and GASCOIGNE in 1641 had devised the filar reticule for a telescope of the KEPLER type, there was not much hope of these crude instruments leading to accuracy much greater than that of the plane-table order. The true theodolite did not appear until a later century, though (following GASCOIGNE) HUYGENS (1659), MALVASIA (1662), HOOKE (1665), AUZOUT (1666), and PICARD (1669) had all applied the KEPLER type of telescope *and* the micrometer to astronomical instruments.

The theodolite as we now know it was the invention of Jonathan SISSON, who invented also the Y-level. This maker has not received that meed of praise which is his due, but it is unquestionable that SISSON was a manufacturer superior even to Jesse RAMSDEN in some ways ; for example, he was able to construct *small* instruments. ("Surveying and Navigational Instruments from the Historical Standpoint", by Dr. L.C. MARTIN) (Trans. Opt. Soc. xxiv, N° 5, 1922-3). The late W.F. STANLEY had previously published the same finding (op. cit., p. 214, 4th ed. by H.T. TALLACK). SISSON's theodolite of 1725 had a circle of no more than 4 ½ inches ; its three verniers read to 6' ; the vertical circle gave altitudes up to 70°, read by a single vernier ; the level was set above and attached to the telescope ; the instrument was levelled by four foot-screws. But perhaps the most surprising feature of this small theodolite is that according to Dr. MARTIN it was furnished with *spirit* levels. Apart from this, however, Jonathan SISSON in 1725 constructed the first theodolite. He was also the inventor of the Y-level.

THE RETICULE. — The reticule dates back to GASCOIGNE's "perspicills with threads" (1641). The spider-web reticule was fitted to the theodolite by TROUGHTON in 1775, but there is no proof that this was the earliest fitting. According to BION, it was DE LA HIRE who first suggested the ruling of lines with a diamond on glass. In 1748 Tobias MEYER ruled the lines on glass with ink; but it was G.F. BRANDER, between 1764 and 1773, who first succeeded in making diamond rulings. Ruling on glass was introduced into England by General SABINE in 1822, a glass diaphragm of this nature being fitted in a transit instrument.

A PROJECTOR FOR TRANSFERRING DETAIL FROM ODD-SCALE PHOTOGRAPHIC COMPILATIONS TO HYDROGRAPHIC SHEETS.

by

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The air-photo project, sheets for which were compiled at Savannah, Georgia, by a field party of the U. S. Coast and Geodetic Survey, covered a strip of coastline approximately fifteen miles wide extending from the vicinity of Beaufort, South Carolina to the St. Johns Rivers, Florida. The entire project covered an area of 3051 square statute miles embracing 5414 statute miles of shoreline. At approximately the same time that photo compilation was begun, five separate combined operations parties took the field within the project area. These field parties had immediate need for the shoreline for hydrographic sheets, so the photo compilations were rushed through with shoreline only; the other detail being left to be added at a later date.