COMMISSION VI WORKING GROUP 2

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F.V.THOMPSON (1880 - 1917): A PIONEER OF PHOTOGRAMMETRY

Frederick Vivian Thompson was born on 26th April, 1880. He received a commission in the Royal Engineers in 1898 and his subsequent army career included appointments as Instructor in Photography at the School of Military Engineering, Chatham and as Officer for Technical Duties at the School of Musketry, Hythe. Between 1904 and the outbreak of the First World War, he was responsible for a number of inventions including the designs of two photogrammetric plotting instruments associated with the needs of topographic mapping. His Stereo-plotter of 1907 predated von Orel's solution. His Stereo-planigraph of 1908 was the first design for a fully automatic and rigorous instrument. Other inventions are chiefly concerned with simple surveying instruments, range finding and rifle target practice.

Thompson died of wounds received in action in October 1917. Little is known of his technical achievements and even less, beyond his family circle, of his other interests and accomplishments. Access to unpublished papers held by the Royal Engineers Museum and discussions with Lt.-Col.J.R.V.Thompson, the son of Vivian Thompson, have enabled this author to assemble a fitting tribute to a pioneer of photogrammetry. The centenary of Thompson's birth is seen as an appropriate opportunity to bring his contributions to the notice of a wider audience.

(The text of this paper should be read in conjunction with the British National Exhibit at the 14th International Congress of Photogrammetry which fully illustrates Thompson's work. A much longer biography will be found in The Photogrammetric Record (Atkinson, 1980).)

SOME BIOGRAPHICAL DETAILS

Many photogrammetrists are unaware of Vivian Thompson and his contribution to the design of photogrammetric plotting instruments. Text books ignore him or, perhaps, make only a passing and uninformative mention of his name. The purpose of this centenary tribute is to recognise, for the first time in any substantial measure, the scientific merit of Thompson's work.

Frederick Vivian Thompson was born on 26th April, 1880 at Haresfield near Andover, Hampshire. Following education at Bedford Grammar School and the Royal Military Academy, Woolwich, he received a commission in the Royal Engineers in March 1898. During the South African War (1901-02) he was employed as Intelligence Officer in operations in the Transvaal, Orange River Colony, the Zululand frontier of Natal and Cape Colony. Thompson was promoted Lieutenant in October 1901 and awarded the Queen's Medal. In April 1904, he joined the staff of the School of Military Engineering at Chatham, Kent, where he became Instructor in Photography until April 1908. It was during this period that he evolved his suggestions for mapping through the medium of photography. While at Chatham, Thompson married (on 17th February, 1905) and his wife, Evelyn Rachel, gave birth to their only child, James Ramsay Vivian.

Following promotion to the rank of Captain in March 1908, Thompson (Fig.1) was appointed Adjutant, Territorial Forces and Officer for Technical Duties at the School of Musketry, Hythe, Kent. During the years before the First World War, he turned his inventive attention to a number of military topics, completely dissociated from photogrammetry. His artistic ability was also put to official use to sketch landscape targets of terrain where the expected World War would most likely be fought.

Thompson was appointed Adjutant R.E. in November 1914 and, before going to France in May 1915, he was given command of a Divisional Signal Company which became an extremely efficient unit under his direction. He fought at the Battle of Loos and in March 1916 was appointed Brigade Major prior to the Battles of the Somme and Arras. When he was offered promotion as Chief Intelligence Officer, his desire for involvement in battle led instead to his command of the 9th Battalion of the Essex Regiment in May 1917. This appointment was a rare occurrence for an R.E. officer. As acting Lieutenant-Colonel, he was severely wounded in action whilst leading his men on 7th October, 1917, but refused to be moved until all the other wounded had been evacuated and he died later (on 14th October, 1917) in hospital from blood poisoning. Vivian Thompson received the Distinguished Service Order for reconnaissance work at the Battle of Loos (London Gazette for 3rd June, 1916) and was three times mentioned in Dispatches. He was buried in the British cemetery at Agnez-les-Duisans near Arras.

THE CONTEMPORARY WORLD OF PHOTOGRAMMETRY

Vivian Thompson began to work out methods of topographic survey using stereoscopic photography in 1905. It is worth reminding ourselves of the state of contemporary photogrammetry. In the first place, the term photogrammetry was not in universal use, even though it had been devised in 1893 by Meydenbauer during his pioneering work in architectural photogrammetry. There is no evidence that Vivian Thompson ever used the term himself. Photographic Surveying appears to have been the more usual expression, at least in the English language. In fact, this was the short title of a book on the subject, first published in a limited edition in 1889 (and more widely in 1895), by Deville who, though born in France, was Surveyor General of the Dominion of Canada from 1885 until his death. Deville's interest in and development of photographic surveying was partly the result of the formative influence of Laussedat, himself acknowledged as the founder of the subject. It should also be recollected that topographic mapping using terrestrial photography was frequently not based on stereoscopic photography. Certainly Laussedat and Deville were proponents of the graphical plotting of single photographs with random orientation but chosen to cover the ground in the best way, a method which is sometimes called plane table photogrammetry. Fourcade, a French-born South African, was the first to employ stereoscopic photography for topographic survey when he mapped Devil's Peak and part of Table Mountain in 1904. Both Fourcade and Pulfrich announced independent designs for the first stereocomparators within nine days of each other in 1901, thus allowing precise determination of three dimensional co-ordinates from stereoscopic pairs of pictures. In addition to his contribution to photographic surveying techniques, Deville began to develop a stereoscopic plotting instrument in 1896. However, Deville's instrument was not optically rigorous in that it relied on the depth of focus induced by restricting the pupil of the observer's eye. In general, there was visual parallax between the measuring mark and the virtual images of the photographs. Subsequently, Laussedat drew Pulfrich's attention to Deville's design and, in 1903, the Zeiss-Pulfrich Stereo-planigraph was completed according to the Deville principle.

This summary of the world situation in 1905 may help us in visualising Vivian Thompson's position but it does not paint the complete picture. Thompson was certainly aware of Pulfrich's stereocomparator and Deville's Canadian method of mapping. He appears to have been partially ignorant of Fourcade's work and this is a little difficult to understand in view of the existence of Fourcade's published work in _Nature_ (London, 1902).

It is against this background that Thompson developed his ideas for _stereo-photo surveying_ and his design for the _Stereo-plotter_, an instrument which represents the first attempt to remove calculation from the stereocomparator procedure. Field trials of the method and mapping with the Stereo-plotter took place in August 1907 and it seems likely that Thompson only became aware of Fourcade's work during the months immediately prior to delivery of his paper on the subject at the Royal Geographical Society in February 1908 (Thompson, 1908a). By the kind of remarkable coincidence with which scientific and technological achievements are often blessed, 1907 also saw the development of the first provisional model of von Orel's Autostereograph. Von Orel, a young Austrian officer, was assistant to von Hübl at the _Militärgeographisches Institut_ in Vienna and his ideas for a plotting instrument resulted in the firm of Rudolph and August Rost being responsible for the first production model of the Autostereograph in 1908. The first mapping, at the scale of 1:25 000, was produced by this instrument during the winter of 1908-09. Thompson was made aware of this development in a letter which he received from Pulfrich in August 1908. In May of the same year, Zeiss had taken over development of the re-named Stereoautograph, although two or three years elapsed before Pulfrich was able to bring a successful design to fruition. There is no evidence that Pulfrich's information had any effect on Thompson, nor does there appear to be any doubt about priority in this near parallel development. Allmer, von Orel's biographer at his centenary, gives precedence to Thompson as did Sander in his chapter on the development of photogrammetry in von Gruber's _Photogrammetry. Collected lectures and essays_ (1932).

STEREO-PHOTOGRAPHIC SURVEYING AND THE CUMBERLAND TRIAL

As one of the earliest practitioners of terrestrial stereophotogrammetry, it is evident that Thompson was well aware of the advantages of the technique. The opening sentences of his paper to the Royal Geographical Society (Thompson, 1908a) immediately clarify the issue. "The object of photographic surveying is to map the detail of a triangulated area at a minimum of expenditure of time and labour in the field, and at a total cost so far below that involved in plane-tabling as to warrant the sacrifice of that high degree of accuracy attained in good plane-tabling." "The economical advantages of the photographic method over plane-tabling increase as the scale of the map decreases, and as the ruggedness and general steepness of the country increases."

Thompson achieved stereoscopic photography by taking coplanar pictures from the two ends of a measured base which, typically, was 200 feet (60 m) to 300 feet (90 m) long. The base length was determined by a subtense method or by invar wire. At first sight, this arrangement for determining the position of points at, say, 1 mile from the camera stations was not geometrically sound. However, it can be shown that the theoretical positional accuracy was well within the requirements of 1:31 680 scale mapping (2 inches to 1 mile). An existing survey camera was chosen by Thompson as the basis of his field equipment. It was made by Sanger-Shepherd and Co. Ltd., London for use in Canada. As we have already noted, Deville's Canadian method did not involve the use of stereoscopic pairs of photographs. Vivian Thompson modified the equipment for his purposes by the addition of a theodolite telescope, mounted on the camera, an extra tripod to occupy the distant camera station, an extra tribrach with target and levels and a tangent screw on each tribrach. The camera was fitted with a Dallmeyer Rectilinear 6 inch (150 mm) lens, but later a Zeiss Tessar 155 mm lens, made by Ross, was used. The format was half plate or $6\frac{1}{2}$ x $4\frac{3}{4}$ inches (165 x 121 mm). Maximum aperture was f/6.3 and a typical exposure with Kodak Orthochromatic or Edwards Isochromatic plates was 5 s at f/32.

A test of the method and equipment took place during August 1907 when an area of about 50 square miles (130 km^2) of the Cumbrian fell country around Derwentwater in the English Lake District was mapped at a scale of 1:31 680. This survey was reduced to a publication scale of 1:63 360 (Thompson, 1908a). Triangulation for control purposes was supplied by a party of Royal Engineer officers. Photographic plates were processed in the field each evening and the rate of progress was about 10 square miles (26 km^2) each day. One of Thompson's assistants on this trial was Kenneth Mason, later to emerge as the most successful user of Thompson's method and instruments.

In October 1908, an article by Thompson (1908b) was published in The Royal Engineers Journal which emphasised the military advantages of his technique in reconnaissance and rapid surveys. This article contains a number of practical photographic details, as well as a description of a stereoscope which Thompson developed for field use, based on a French patent by Pigeon. This stereoscope was also manufactured by Sanger-Shepherd. A direct view of one photograph of the stereopair was combined with a mirror reflected view of the second photograph. During production of 10 x 7 inch (250 x 180 mm) enlargements, one photograph (evidently the right hand picture) was printed in reverse.

Since Thompson adopted a field method which was based on the acquisition of coplanar stereopairs of photographs, the design of the Stereo-plotter could make use of the Pulfrich stereocomparator principle. The stereocomparator unit in the Stereo-plotter (Fig.2) is shaded in Fig.3. The azimuth control wheel (1) moved the pictures horizontally beneath the stereoscope (2) which, in turn, scanned the pictures in a vertical direction by means of the height control wheel (3). Stereoscopic observation and fusion of objects at varying distances from the camera base was achieved by appropriate setting of the distance drum (4) which allowed the removal of parallax by moving the right hand photograph (5) with respect to the left hand photograph (6). A lead screw (7) transmitted any movement of (1) directly to the plan position lineal (8). The corresponding object distance was read from drum (4) and set, by hand, on the distance scale (9) so that the plan position (10) resulted. Movement or setting of the height control (3) was transmitted through a radius arm (11) to the height computer lineal (12). The radius arm (11) appears to have replaced a wire and pulley arrangement on the Stereo-plotter which was used for the Cumberland trial survey and, in turn, this was replaced on subsequent models by a lever. The lineal (12) intersected the height scale (13) to give the height value of the observed point. This could be written against the corresponding plan position and, subsequently, contours could be drawn by hand. It will be understood that the left hand photograph (6) was the reference for measurement and so lineal (8) gave the direction towards the observed point from the left hand perspective centre (14) and the lineal (12) gave the vertical angle towards the same point, again measured from the left hand perspective centre (14). Earlier models of the Stereo-plotter (Fig.2) appear to take no very precise account of the height difference between camera stations of a stereopair. Later models reversed the arrangement so that all directions related to the right hand photograph (perspective centre). The appearance of the instrument changed so that the parallax or height drum was placed to the extreme left of the instrument and both horizontal and vertical movements were controlled from immediately in front of the observer. In addition, the inclination of the base could be taken into account by adjustments to the position of the left hand photograph. The two lineals rotated about fixed points whose positions were equivalent to the perspective centre (14). These two points were offset from the lines of horizontal and vertical movement by amounts equal to the principal distance of the survey camera. At least four examples of the Vivian Thompson Stereo-plotter are known to have been constructed, in addition to the model which was used in the Cumberland trial survey of 1907. All models of the Stereo-plotter were made by W.Watson and Sons of High Holborn, London. Conrady was Watson's scientific adviser and lens designer during the whole period of construction of the Stereoplotters. Thompson also sought Conrady's advice on other optical matters, including the design of range finders. In 1917, Conrady was appointed Professor of Optical Design at Imperial College of Science and Technology, London.

Reports of the Cumberland trial (Thompson, 1908a) indicate that it was possible to map between 2 square miles (5.2 km^2) and 5 square miles (13 km^2) per hour with the Stereo-plotter. Kenneth Mason (1914) reported an average rate of 10 square miles (26 km^2) mapped in three to four hours from his photography of the Taghdumbash Pamir, taken during his expedition to connect the triangulations of India and Russia in 1913.

USE OF THE STEREO-PLOTTER IN INDIA

Kenneth Mason joined the Survey of India in 1909. He had assisted Vivian Thompson with his experimental survey of the area around Derwentwater in 1907 and, when he was put in charge of the 1913 expedition to connect the Indian and Russian triangulations, he was able to take survey photography in the Taghdumbash Pamir and to carry out mapping from this photography using a Vivian Thompson Stereo-plotter at Dehra Dun. The area of the Taghdumbash Pamir which was surveyed by terrestrial photogrammetry lies approximately 37° 10'N, 75° 00'E and the triangulation stations are more than 17 000 feet (5200 m) above sea level. Sinkiang lies to the north east, the Karakoram Mountains to the south east, the Russian Pamir to the north and Gilgit to the south. Mason's map was plotted at a scale of 1:63 360 with contours at 200 feet vertical intervals. The work was subsequently reduced and incorporated in the Survey of India 1:253 440 scale series with a 250 feet contour interval. Mason (1975) wrote that "the subsequent map has been sufficiently accurate not to be criticised adversely by British, Indian, Chinese or Russian travellers." In his book Abode of snow, Mason (1955) stated that "it was the first time stereoscopic photography had been used in exploration and proved itself to be most useful." Apart from Mason's well documented work with the Stereo-plotter, the only other known use of the equipment (Fig.2) occurred during the Survey of Fiji which took place between 1908 and 1910.

THE VIVIAN THOMPSON STEREO-PLANIGRAPH

In his paper on the Stereo-plotter, Thompson (1908a) states that, encouraged by the success of the Stereo-plotter, he is considering the "design of an improved plotting machine, or 'Stereo-planigraph', which will be entirely automatic, and in which contours can be traced direct on the plotting sheet without any reference to scales and settings, and without moving the eyes from the eye-pieces of the stereoscope." Conrady was of the opinion that the construction of the instrument offered "no insurmountable difficulties." Later that year, Thompson wrote that a Stereo-planigraph "has been designed (but not yet constructed) which should still further increase the rate of plotting and enable a single operator to keep pace with several camera parties. With this instrument it should be possible to draw a contour line as quickly as one could be traced from a map."

Vivian Thompson was not allowed to patent his Stereo-plotter by the War Office and its manufacture was financed by the Royal Engineers Committee. Unfortunately, financial support was not available to develop this second instrument, the Stereo-planigraph. All that now survives is a pencil sketch headed "Stereo-planigraph" and dated 29th January, 1908 (Fig.4). E.H.Thompson had long been aware of the existence of the design as the result of his perusal of relevant War Office files while Research Officer to the War Office Air Survey Committee during the 1930s. He published a reconstruction of Vivian Thompson's design in The Photogrammetric Record (E.H.Thompson, 1974) in which he explained how Thompson had seen the solution to the problem of continuous plotting of contours, one which troubled Pulfrich until 1910. Vivian Thompson's design was "rigorous in every way: geometrically, mechanically and optically" and, as such, the Vivian Thompson Stereo-planigraph may justly be claimed to be the first design for a completely automatic and thoroughly rigorous photogrammetric plotting instrument.

INVENTOR, ARTIST AND SPORTSMAN

Vivian Thompson's army responsibilities did not prevent him from developing original ideas on a variety of topics, completely dissociated from photogrammetry. These included three inventions which were marketed commercially. The Scout Range Finder was made by Foster Groom and Co. Ltd., London. The Thompson Pocket Range Estimator (Patent No.26584) and the Field Practice Sub-target (Patent No.25289)(Thompson, 1910) were both manufactured by Ralston and Co. of Glasgow. Both of these inventions date from 1910-11 when Thompson was at the Hythe School of Musketry. Thompson's interest in range finding is also borne out by his description of a colour fringe range finder for use by the Admiralty (1907), by sketches for a stereoscopic range finder in 1909 and a provisional specification (No.10614) for a pocket combination surveying instrument incorporating a range finder and dated 1911. Drawings which survive illustrate his ideas for a Submarine Telacoust or underwater acoustic telescope and, in the same year of 1908, he prepared suggestions for a boom or harbour defence system employing underwater telephone receivers and for a flash light aiming attachment for instruction in firing anti-torpedo boat guns in coastal defences. A specification of 1910 relates to a Pocket Perspectograph for use in instruction of perspective drawing.

Thompson showed considerable artistic flair. A number of cartoons and landscapes, mainly done at his wife's home at Petham, Kent, testify to his talent and show a personal and humorous side of his character. His sporting interests were expert enough to cause him to write an article entitled "Some notes on wild fowling on the Medway" (Thompson, 1911). He built a gunning punt which had a four bore gun, he was a good bird shot and he was an energetic rider to hounds. His artistic ability led to an official commission, in 1912, when he was sent to France and Belgium to sketch some of Marlborough's battlefields for landscape targets and in anticipation of the forthcoming 1914-18 war. These landscapes were published in a series of Hill-Siffken landscape targets. Each section measured 5 x 2 feet (1.5 x 0.6 m) and ranges were marked from 400 yards to 3000 yards. These targets remained in use for many years for teaching fire orders and recognition of targets. The pictures were done in a rather flat style for ease of reproduction and printing.

Vivian Thompson was 37 at the time of his death. Most of his inventive contributions were made when he was in his late twenties. More than four years of his short life were spent at war. We can only wonder at what could have been his achievement had he survived.

This paper could not have been written without the immense encouragement and kindness of Lt.-Col. and Mrs.J.R.V.Thompson and the assistance of the Curator of the Royal Engineers Museum, Lt.-Col.C.T.P.Holland.

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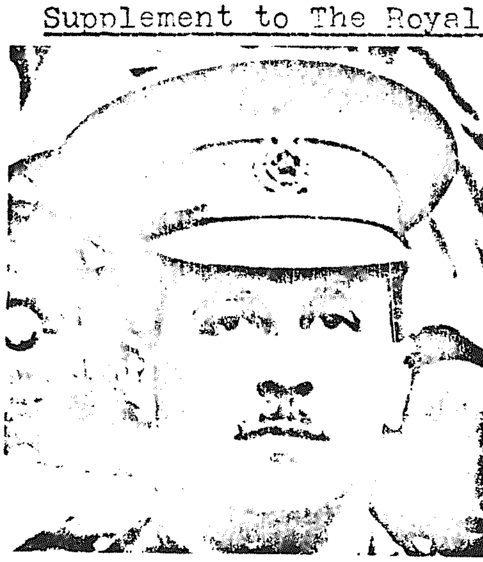
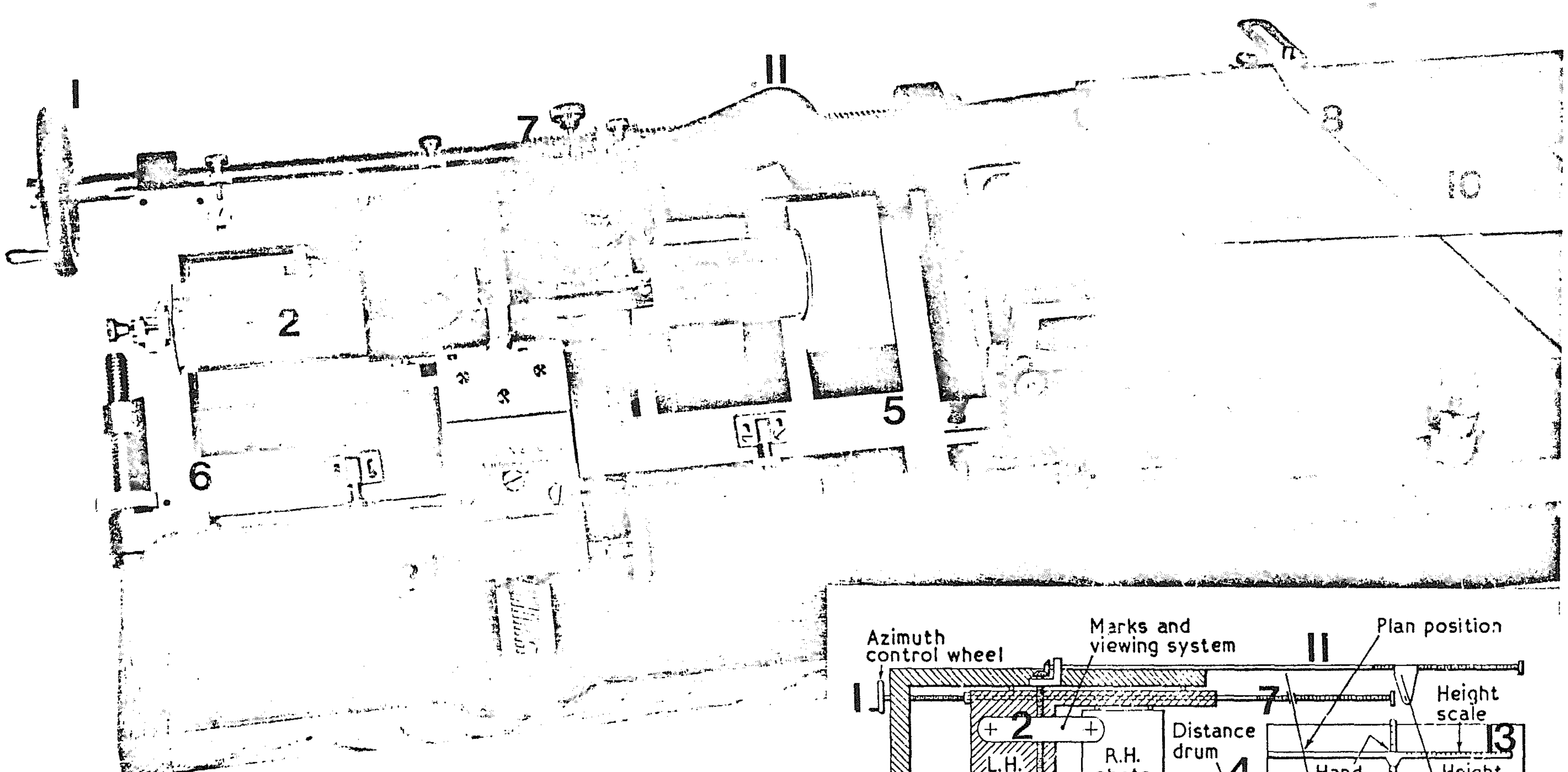


Fig.1. A photograph of Captain F.V.Thompson,R.E taken when he was an instructor at the School o Musketry, Hythe, Kent in 1909. (Royal Engineers Museum.)

Figs.2 and 3. The Vivian Thompson Stereo-plotte of 1908 which derived its final form as the result of modifications to the instrument used during the Cumberland trial. This instrument, which is in the possession of the London Scienc Museum, was donated in 1932 by the Government o Fiji. Fig.3 is a diagrammatic representation of the 1908 model of the Vivian Thompson Stereo-plotter which is to be found in D.R.Crone's Elementary photogrammetry (Arnold, London.1963)



I
II
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8
10
2
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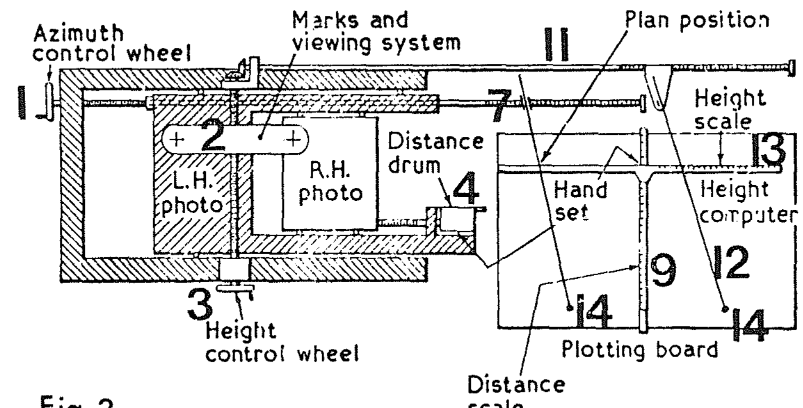
6

Fig. 2



Azimuth
control wheel
I
Marks and
viewing system
II
Plan position
7
Height
scale
2
L.H.
photo
R.H.
photo
Distance
drum
4
13
Hand
set
Height
computer
9
12
14
14
3
Height
control wheel
Plotting board
Distance
scale

Fig. 3

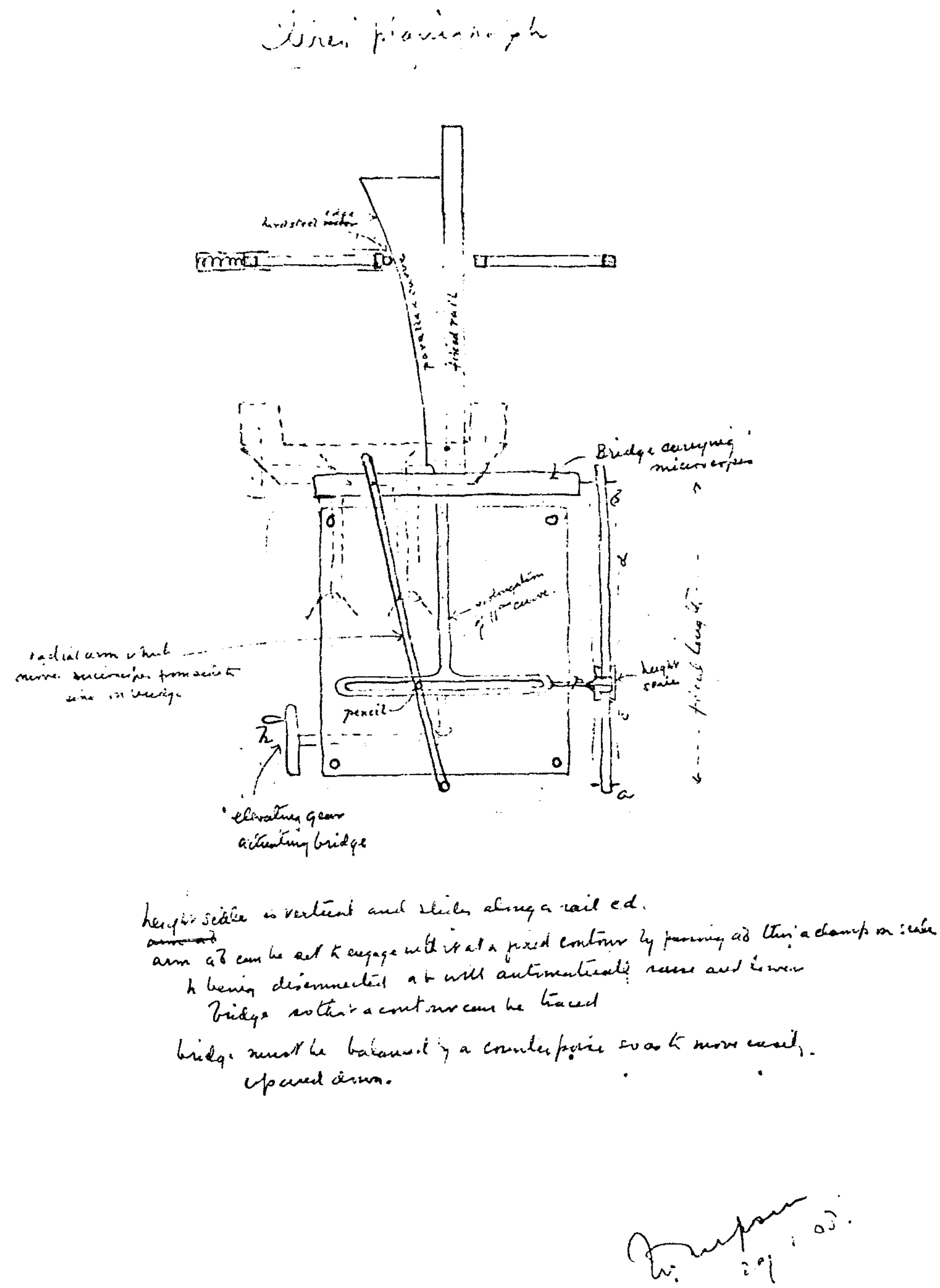


Fig.4. Vivian Thompson's sketch of his design, dated 29th January, 1908, for a fully automatic plotting instrument, the Stereo-planigraph. (Royal Engineers Museum.)