DESCRIPTION

OF

THE BRIDGES-LEE

NEW PATENT

PHOTO-THEODOLITE,

With full Instructions as to its manipulation

in the field.

L. CASELLA,

MAKER TO THE ADMIRALTY, ORDNANCE, &c.

147 HOLBORN BARS, LONDON, E.C.

[*Entered at Stationers' Hall.*]

No. 198.

DESCRIPTION

OF

THE BRIDGES-LEE

NEW PATENT

PHOTO-THEODOLITE.

DESCRIPTION

OF A

NEW PHOTO-THEODOLITE,

DESIGNED BY

J. BRIDGES-LEE, Esq., M.A., F.G.S., etc.

PATENTED IN ENGLAND AND ABROAD.

Made by LOUIS P. CASELLA, 147 Holborn Bars, London.

The Index Letters refer to the wood-cuts.

A. Rectangular box of aluminium (cast metal).

B. Rectilinear photographic lens with iris diaphragm. This lens is accurately set in correct position with reference to the other parts of the Instrument, and it has no focussing adjustment.

For the purpose of fitting the Instrument to be used for ordinary photographic work at short distances, a second photographic lens working in a focussing sleeve with rack and pinion adjustment is supplied.

C. Azimuthal circle divided to half degrees with vernier attached to back of the box to read to minutes.

D. Tribrach locking plates and levelling screws.

E. Telescope with cross webs in the body and usual adjustments. This telescope is free to rotate only in a vertical plane when the instrument is accurately levelled, and the line of collimation and the vertical web are in the median vertical plane of the instrument—the same plane which bisects the photographic lens and passes through the axis of revolution of the internal magnetic compass and the vertical hair in the camera.

F. Vertical limb divided to half degrees, moving with the telescope with fixed vernier to read to minutes.

G. Revolving tubular level let into a socket in the roof of the aluminium box. By the aid of this level the horizontality of the instrument can be adjusted in any position without disturbing the position of the camera.

H. Falling back to camera with hinged joints. The ground glass (*h*) has in it a window of polished glass (h^1) through which the vertical index hair and compass scale can be read, with or without the aid of a microscope.

I. Rectangular frame of metal with strong back stays not shewn in the drawing. This frame is rigidly attached to a bottom plate which supports the

compass box, and is free to move only in an antero-posterior direction, with rigid guides fixed to the base of the box to control its motion.

The back surfaces of the frame are all in a true vertical plane when the instrument is accurately levelled, and that vertical plane is accurately perpendicular to the principal axis of the photographic lens.

This frame can be racked backwards and forwards by aid of a transverse pinion traversing the bottom of

J J. the box and terminating in two milled heads (**J J.**)

Pointers (*jj*), which revolve with the pinion, serve to indicate whether the internal structures are forward or back when the falling back of the camera has been let down and replaced by a double dark slide containing a photographically sensitive plate. The dimensions of the rectangular frame (**I.**) are such that it can pass completely inside the double dark slides used (when the shutters are open), and carry back the **K. K.**^{1} hairs which it supports until they actually touch the plate.

There are also two small stops in the form of sliding bolts, which serve to prevent the frame from being carried back with too much force, or too far. These stops secure uniformity of focal distance. They do not appear in the drawings.

K. Vertical hair carried by the frame. This hair serves to mark on the photograph the median vertical plane of the instrument, and cuts the principal optic axis of the lens at right angles. This vertical hair serves also as an index by which to read the compass scale. It is in the same plane as the vertical web in the telescope, the optical axis of the telescope, the optical centre of the photographic lens, and the axis of revolution of the compass.

K.^{1} Horizontal hair carried by the frame. This hair crosses the vertical hair at right angles at the point where both hairs intersect the optical axis of the photographic lens. It serves to mark the horizon of the instrument on the picture when a photograph is taken, the instrument having been first accurately levelled. The intersection of these hairs marks the principal point of the perspective.

The hairs are fixed to the frame by the aid of small wood pegs. The proper positions are ascertained and fixed by the maker. If broken at any time they can be easily replaced in a few minutes by anybody.

L L. Small tablets of thin transparent celluloid on which Barometric pressure, station mark, or other particulars which it may be desirable to record photographically on the picture, can be noted by observer with quick drying ink. These are written upon in an ordinary way and then placed upside down in little pockets, in the frame specially designed to hold them and print out as shadowgraphs on the negatives and prints.

M. Magnetic compass with vertical cylindrical transparent scale divided to half degrees 0° to 360°. The cylindrical transparent scale passes quite close in its revolution to the vertical index hair, but never touches it. The pivot of the compass is rigidly fixed to the base plate before referred to, so that the compass scale is always at exactly the same distance from the vertical hair. When the base plate carrying the frame and compass is racked forward in the box, a copper disc automatically rises and lifts the agate off its pivot, and presses the top of the agate cup against the support (*m*) so that the compass is firmly clamped, and cansuffer no injury from friction at the pivot or otherwise. When the base plate is racked back so as to carry the frame and cross hairs, and part of the compass scale inside a double dark slide, and close to a photographically prepared plate, the agate cup is automatically lowered upon its pivot, and the magnetic compass adjusts itself to its natural position. This part of the internal mechanism is not visible in the woodcuts.

N. Catch to hold double dark slide in place. The back surface of the box is provided with a frame of aluminium to hold the double dark slides, and exclude light, and as a still further safeguard against the entry of extraneous light there are facings of velvet.

O. Microscope with universal joint movement to permit of its being used either for reading horizontal angles on the azimuthal circle, or for reading the compass bearings through the window in the ground-glass back.

P. Adjustable microscope for reading vertical angles.

Q. Clamp and tangent screw for azimuthal circle.

R. Clamp and tangent screw for camera.

S. Clamp and tangent screw for telescope.

T. Tripod with strong aluminium head and bronze clamping screws.

This tripod is fitted with transverse bars of bronze which serve as attachments for chains to safeguard the instrument. They also serve to give attachment to hooks attached to a net in which heavy stones can be placed, to give stability and steadiness to the instrument when in use.

These do not appear in the wood cuts. They are at a slightly lower level than the parts drawn.

U. The ++ marks on the top of the box indicate the focal distance. A straight line joining the centres of those crosses is the working focal distance for ordinary temperatures.

Below the centre of the instrument in the axial line is a small hook which serves as an attachment for a small plumb bob.

The telescope has an erecting as well as inverting eyepiece.

There is an optical colour screen of optically worked green glass to fit inside the sunshade of the photographic lens. Yellow or orange glasses can also be supplied when desired.

Also attached to the frame which carries the hairs is a horizontal transparent scale of angular distances, photographically prepared by aid of the identical lens and instrument as it is used for surveying purposes.

By the aid of this scale the exact angular distances of any points in the picture right or left of the median vertical plane, can be immediately read off with the aid of a parallel ruler.

This scale also facilitates the determination of compass errors, because if there are any points in a picture whose true bearings have been fixed with precision—trigonometrically or otherwise—it is only necessary to add or subtract the angular distances of those points (as read on the horizontal scale of angles) to or from the automatically recorded compass bearing of the median vertical plane, in order to ascertain the compass bearings of the points, and the difference between the compass bearings and the true bearings is the compass variation. This very simple operation can be performed in office at any time.

The instrument is supplied with six double dark slides of good construction to carry a dozen plates, size 5 × 4, either horizontally or vertically.

It fits easily and securely in a strong, well-made brass-bound mahogany case, with lock and key, and catches.

The double dark slides, extra eyepiece, plumb bob, and

optical screen, all fit in the same case, and for greater security and convenience of transport the mahogany case with its contents fits in an outer leather case with straps.

The tripod head is provided with a suitable protecting cover of its own and the legs are provided with a leather strap to hold them together when travelling.

In conclusion it may be noted that the instrument is a complete, symmetrical, well made theodolite, reading to minutes with sufficient vertical range for all ordinary terrestrial work, The camera is always in place, ready for immediate use whenever a photographic record is required, and the camera can, when desired, be made immediately available for taking ordinary photographs of persons or things at short distances by lowering the back stops and racking back the internal mechanism quite out of the camera. If a small piece of velvet be then laid over the guide table and pinion, the inside of the camera resembles the inside of any ordinary camera, and the focussing adjustment of the subsidiary lens affords ready means for focussing objects at short distances. The compass is large and good, and the vertical scale with parallel line divisions admits of very close readings being made through the back window or by looking through the lens from in front.

It will thus be seen that anyone possessing this instrument is provided with: (1) A good theodolite, complete for terrestrial observations; (2) A complete photographic equipment for all ordinary photographic purposes; (3) A very good azimuth compass; and (4) By far the most perfect photogrammetric apparatus ever made up to this time.

It is confidently submitted that this is the most generally useful instrument which any explorer can take with him, and its cost and bulk and weight considerably less than a theodolite, photographic outfit, and azimuth compass of equal quality carried separately.

The fact that the internal mechanism acts to a large extent automatically serves to minimise risks of error from inaccurate observations or false entries, and every picture taken with the instrument when used as a photo-theodolite will carry on its face the following information, which can be used at any subsequent time for interpreting the photographs and for making maps.

(1). The median vertical plane (*i.e.*, trace of principal plane).

(2). The horizon of the instrument (*i.e.*, trace of a horizontal plane bisecting the lens).

(3). The principal point of the picture (at the intersection of the last mentioned lines).

(4). The magnetic bearing of the principal plane (note this must be correctly recorded if it is recorded at all, because *(a)* If the observer were to omit accidentally to rack back the frame and compass before exposure, the lines and figures would not be printed on the photograph ; and *(b)* If he were to expose before the compass had come to rest, the compass scale and figures would not print out but would yield only an indistinct and almost invisible blur as the result of long exposure, such as is always given for photogrammetric purposes).

(5). A scale of horizontal angular distances right and left of the principal plane.

And the picture may be made to bear also on its face the following or other additional information which must be first written by the observer on strips of celluloid with Indian ink.

(6). Mark to denote the *station* where the instrument was placed when photograph taken.

(7). *Barometric pressure or computed altitude.*

(8). *Time, date, serial number* of photograph, or other information which it may be desirable to have recorded on the photograph. All the above information is printed in what will ordinarily be the sky region of the picture, except of course the fine straight lines which mark the vertical and horizontal planes, and the pictures taken will form most valuable records which can be interpreted at any time afterwards with a minimum of assistance from note books, and with great accuracy.

One great advantage arising from recording as much necessary or useful information as possible on the faces of the photographs themselves, is that there cannot be any mistakes made afterwards as regards the particular facts recorded, and another great advantage is that whenever a photograph is enlarged for map making purposes, the lines and scales are enlarged at the same time and in the same proportion, and are always present in evidence for mapping or measuring purposes.

For the rest, the instrument is compact, strong, light in weight, and beautifully finished in every way, and of reasonable cost, having regard to its great efficiency and practical utility.

The instrument can at any time be made available for astronomical photographic observations, or for cloud photography, by the aid of an adjustable mirror in front of the lens.

Specimen Photograph shewing scales, etc., taken with the "Bridges-Lee" Photo-theodolite

IT REPRESENTS THE OLD BUILDINGS OF STAPLE INN, HOLBORN

INSTRUCTIONS

Relating to the use of the BRIDGES-LEE New Patent

PHOTO-THEODOLITE

IN THE FIELD.

A.—*Choice of Camera Stations.*

1. As a general rule select points which overlook the area to be surveyed.

2. When the area to be surveyed contains points whose positions have been previously determined with precision (trigonometrically or otherwise), it is frequently advisable to select those points as camera stations.

3. It is frequently convenient to select new stations by aid of observations made from other stations.

4. Stations should be selected at such distances apart, and in such directions with reference to each other and to the areas to be surveyed, as to yield good intersections for plotting purposes.

5. Special stations may be selected for special individual views in definite predetermined directions.

6. Before proceeding to occupy any station, due regard must be had to the time when it will probably be reached by the observer with reference to what will be the position of the sun (*a*) as regards the camera, and (*b*) as regards the particular areas to be photographed from that station.

7. Camera stations should be numerous, and the views from those stations should cover as much as possible of the ground to be surveyed. All the more important individual landmarks must be visible from two stations at least, and most of them and many minor points should be visible in photographs from three or more stations.

8. For the purpose of obtaining pictures from which contour lines can be most easily plotted, it is a good plan when practicable to establish a number of secondary camera stations at different altitudes on a hillside below a principal station. The differences of altitude of these secondary

stations should be determined with care, as also their relative positions on a ground plan; and when selecting positions for these secondary stations, it is a good plan to select points of view as nearly as may be in the same vertical plane, which can be made a principal plane for one photograph at least taken at each point. Whenever an observer is ascending to or descending from a principal camera station on a hilltop, he should keep a sharp look out for suitable spots for secondary stations on the hillside.

B.—*Manipulation of the Photo-Theodolite at the Camera Stations.*

1. Set up the tripod with legs fairly wide apart and very firmly placed. The tripod head should be approximately level.

2. By aid of the plumb-bob determine the exact position of the instrument, and mark the correct spot on the ground by aid of a peg.

3. Attach a strong net by hooks or cords to the metal cross-bars on the legs, and load this net with heavy stones or turf to secure great stability.

4. Then unscrew the metal protecting cover from the axis of the tripod head and screw on the tribrach. Open the tribrach by pushing aside the locking plate to enable it to receive the terminal feet of the levelling screws.

5. Then take the instrument carefully out of its case and stand the feet in the recesses in the tribrach designed to receive them. Then close the locking plate and make certain that everything is secure.

6. Then take off the cap from the lens and open the iris diaphragm to full aperture, and rack back the internal structures as far as they will go (the stop bolts being pushed out).

7. Level the instrument. The best way to do this quickly is to turn the revolving level until the tube is approximately parallel to a line joining two of the levelling screws. Then manipulate those two screws until the air-bubble rests approximately at the middle of its run. Then rotate the spirit-level through an angle of ninety degrees, and manipulate the third screw until the air-bubble rests at the middle of its run. Again rotate the level through ninety degrees, and if necessary again manipulate the first pair of screws, and so on until the bubble remains approximately in the

middle of its run in all positions. After a little practice it will be found that the operation of levelling can be very rapidly effected in this way. At this stage of the operations approximate levelling is sufficient, and it is not necessary to lose time over efforts to secure an exactly level position until everything is ready for exposing a plate to take a picture.

8. Next adjust the microscope **O** in position to read the compass scale through the window. To do this correctly there are three main points to attend to: (*a*) the optic axis of the microscope should be approximately perpendicular to the window; (*b*) the index hair should bisect the field of view; (*c*) the focal distance should be conveniently adjusted so that the eye may be able at the same time to read the compass scale and to distinguish the vertical index hair.

9. While the above-mentioned operations have been in progress the compass will almost certainly have come approximately to rest, and the azimuthal circle may now be oriented if desired by aid of the compass. To do this it is only necessary after releasing the circle by turning the clamping screw **Q** to rotate the circle (which of course carries the camera round with it) upon its axis until the magnetic compass reading corresponds with the reading on the azimuthal circle. In practice it is convenient (before proceeding to orient the circle) to bring the *zero* of the vernier to correspond exactly with one of the divisions on the circle. This can be done by aid of the tangent screw **R** (the camera being clamped). The compass can also be read by looking through the photographic lens from the front of the camera. For this purpose the diaphragm aperture should be contracted (as small as possible), and a brightly illuminated sheet of white paper should be held at a short distance away from the glass back. When the orientation has been effected as above described, the azimuthal circle may be firmly clamped in position, and the accuracy of the orientation may be tested by releasing the camera clamp **R** and rotating the camera on its axis. The compass reading should in every position correspond with the reading on the azimuthal circle if the instrument is in accurate adjustment, and if the orientation has been correctly effected. If any important discrepancies appear, especially if these are found to be due to instrumental errors, it will be found best always to orient the azimuthal circle with the vernier *zero* opposite the same division of the scale.

It may be noted that the orientation of the azimuthal circle only becomes a matter of importance when it is intended to use the instrument as a Theodolite, and even then it is not always necessary, as for example when the observer

only wishes to read off angular distances without reference to bearings.

With Photo-grammetric instruments of any of the old fashioned types, correct artificial orientation of the apparatus and accurate notes concerning the bearings were always essential; *but with this new form of Photo-theodolite the orientation of the principal plane of every picture taken is automatically recorded in the face of the picture, and the picture record will be exactly the same whether the azimuthal circle has been oriented or not.* In practice, therefore, the operations detailed under the last two headings (8 and 9) may be often altogether omitted, and time saved and risk of personal errors of observation and entry avoided.

10. Next (having rendered the azimuthal circle quite rigid by aid of its clamp **Q**, and having set the camera and telescope free) remove the cap from the telescope, substitute the erecting for the inverting eyepiece (if the observer finds this most convenient for his personal use), focus the eyepiece upon the crossed spider-webs in the body, and focus the object lens upon some distant object. Then having decided upon the general direction of the view of which a picture is desired direct the telescope towards some distant landmark, so that its image in the telescope shall be bisected by the vertical web. The image of that point in the camera will then be on the vertical hair **K**, and the principal plane of the picture to be taken will pass through that point and the camera station.

When camera stations or trigonometrical stations are visible through the telescope, it is nearly always advisable and convenient to take photographs with their principal planes passing through those points. On the other hand, it is frequently advisable to take other photographs in directions which comprise convenient areas of the ground to be surveyed without special reference to any previously determined points.

11. Next clamp the camera firmly to the azimuthal circle by the clamp **R**.

12. Next take small slips of celluloid, and write on them distinctly with Indian Ink:

(*a*) The station number, *e.g.* (S. 3).

(*b*) The altitude of the station if accurately known, *e.g.* (A. 5325), or, if not, the barometric pressure, *e.g.* (B. 20·1).

(*c*) The mark on which the telescope was directed, *e.g.* (Ps. 2).

(*d*) The serial number of the photograph, *e.g.* (N. 18).

(*e*) Time, *e.g.* (T. 15·20) = 3.20 p.m.

(*f*) Date, *e.g.* (D. 7/6/98).

Release and let down the falling back **H**.

Place the slips when the ink is dry in the slits in the frame **I** provided for the purpose. They should be inserted in the slits upside down, and with the writing on face nearest to the operator.

13. Next rack forward the internal structures by turning the milled heads **J J**. Close up the iris diaphragm as far as it admits of being contracted. Insert in its proper place in front of the lens an optical colour screen of green or orange glass, unless the atmosphere is so clear or the chief objects to be photographed are so near and distinct as to admit of the coloured glass being dispensed with. Cover the photographic lens with its cap. Adjust in place a double dark slide charged with sensitive plates. Take care that this is securely held in place by the catch **N**. Then everything being secure, rigid, and light-tight, draw back the shutter of the dark slide as far as it will go. Then immediately rack back the internal structures by the milled heads **J J** until the frame has been carried against the surface of the sensitive plate as far as the stops will allow it to go.

NOTE.—While all these later operations are being performed it is well to shield the instrument, and more especially the double dark slide, from the sun and sky-light by a large thick umbrella; and so soon as the dark slide is in place, it is a good plan to throw a piece of black velvet over the back of the instrument. A square velvet falling curtain attached to the top of the back of the box is convenient and answers well.

14. Now pay careful attention to the levelling, by manipulating the levelling screws and the revolving level by light touches only with the finger and thumb.

At this stage in the proceedings extreme accuracy should be aimed at, and especially should the air bubble rest exactly in the middle of its run when the axis of the tube is perpendicular to the principal plane of the instrument (*i.e.*, parallel to the front and back faces of the camera).

It is above all things important that the horizontal line in the picture should be truly horizontal, and the vertical line vertical, which they must be if the bubble is in the centre of its run in that position of the level, but it is only a little less important that the horizontal line should mark accurately on the picture the horizontal plane of the instrument, and this it can only do if the bubble is in the centre of its run when the axis of the level tube is parallel to the

principal plane. Practically, therefore, the bubble should occupy the same position in the centre of its run for all positions of the level when at rest.

15. Next, look again through the telescope, and if the vertical web does not now bisect the mark on which it was originally directed, bring it to its proper position by aid of the slow-motion (tangent) screw which operates the camera. Then, again test the levelling, and if that is right, everything is now ready for an exposure to be made.

16. Next remove the cap from in front of the lens, and give a full, but not excessive, exposure.

NOTE.—The cap over the lens should be as loose fitting as possible without danger of letting in light, or of falling or being blown off. The removal of a tight-fitting cap for exposure of a plate might possibly disturb the level of the instrument.

Concerning the exposure: it is assumed that the operator is a competent or even a skilled photographer, and if he is not he should endeavour to become thoroughly proficient in all that appertains to the art of producing sharp, clear negatives before he starts to use an instrument of this class for practical work in the field.

Further on will be found some special notes relating to the preparation of photographs for surveying purposes.

17. When the exposure is thought to be sufficient the cap should be replaced, and immediately afterwards the internal structures should be racked forward, the shutter of the slide shut, and the slide removed; or, if another picture is to be taken from the same station, the slide may be replaced with opposite face inwards, after the celluloid strips which record serial number and time, and direction of principal plane have been changed. The shutter may then be opened and the internal structures racked back. Then the camera is released and rotated on its axis until it points approximately in the right direction. It is again clamped and levelled, and brought to exactly the right position by slow motion adjustment as before described, and so on for any more pictures after the first. It is necessary, of course, to take care in every case to allow sufficient time for the compass to come to rest before exposure, but if the precaution is taken to set free the compass by racking it back before commencing to turn the camera on its axis, the compass will be very little disturbed, and the time occupied in coming to rest will be very short.

18. After as many photographs have been taken as are thought necessary at any particular station, the observer should throw a light protecting cloth over his instrument

without disturbing it, and, note book in hand, he should observe and note all facts which he thinks may be of interest for future reference; and after noting everything which seems to him to be worthy of note, so far as he can observe with the naked eye, he may then return to his instrument, and after releasing the camera and telescope, he can scan the horizon and examine more closely the visible outlook by aid of the telescope, and make supplementary notes in his note book. At this time, also, he should search for other suitable camera stations, and if he is able at this time to fix upon suitable, or probably suitable, new stations, he may direct his camera towards the points selected and take supplementary photographs with their principal planes passing through those points. If he has still remaining some unexposed plates which he can afford to use up without risk of running short for other stations, he may now take duplicate photographs of portions of the area to be surveyed. As a general rule he should not waste time and plates by making a complete photographic tour of the horizon unless the camera station is well within the boundaries of the area to be surveyed, and unless clear well-defined views can be obtained in every direction. It is generally better to use the time and plates for obtaining duplicate or overlapping views in directions specially selected.

19. When the observer feels that there is nothing more to be done or noted at the particular station, he should at once prepare to dismount and pack up his instrument. This he should do carefully, as he values his instrument. The best way to do this is as follows:

First take care that the internal structures are racked forward as far as they will go, so that the compass cap may be firmly clamped against the top plate.

Then rotate the camera on its axis until the lens is over one of the levelling screws. Then tighten the clamp ***R***.

Then slide the microscope ***O*** round the azimuthal circle ***C*** until it is opposite the front of the camera.

Then bring the telescope to an approximately horizontal position after first racking back the object glass, putting on its cap and substituting the short for the long eyepiece. Then clamp the telescope.

Then all important structures being rigidly fixed in position by their respective clamps, the left hand may be laid on the top of the instrument to steady it while the locking plate of the tribrach is opened by lateral pressure of the thumb and finger of the right hand.

Then the instrument is gently lifted up by both hands and carefully placed in its wooden case face upwards.

The locking plate of the tribrach is then again closed and the tribrach unscrewed from the tripod head and the protecting metal cover is screwed on in its place.

The tribrach is then packed in its allotted space in the case. The plumb bob, erecting eyepiece, double dark slides, and other accessories should also be in their several allotted positions in the case which may now be closed and locked and deposited in its outer leather case ready for transport to another station.

20. The tripod stand may then be unloaded, shut up, and the legs strapped together, and a protecting cover slipped over the head when everything is ready for a start—except that the observer should certainly not leave the spot before he has set up some kind of abiding mark at the place where the instrument has been standing, either in the shape of a staff or a pile of stones, or both, of sufficient dimensions to be visible afar off through a telescope like that by which the instrument is surmounted.

21. When several instruments and several observers are available it is convenient to occupy, and to take photographs from, several stations simultaneously over the same ground, and with the telescopes directed upon the same points at the same times.

In such cases the observers should endeavour to establish telephonic or heliographic communication, or they may maintain communication by means of a series of preconcerted flag signals.

22. When working with this instrument, the observer should of course take care that no iron or steel is anywhere near. Bunches of keys in the pockets might cause appreciable errors, and an observer moving about with iron in his pockets might unwittingly disturb the compass from its state of rest and fail to obtain an automatic record of the compass bearing; or if he stood still during exposure, the bearing recorded might be wrong. It is true, as pointed out elsewhere, that compass errors can be easily detected and allowed for afterwards, but obviously artificial and unnecessary errors should not be introduced by mere carelessness.

23. Whenever it so happens that there is no well-defined point in a view whose exact position has been determined trigonometrically, it is always prudent to measure and record the exact angular distance between some well-defined point in the picture (the principal plane for choice), and one or more well-determined trigonometrical points which may be visible in any other direction.

C.—*Special Notes Relating to the Preparation of Photographs for Surveying Purposes.*

1. A surveyor's photograph should be as sharp and clear and full of detail as it can possibly be made to be.

2. The working aperture of the diaphragm when exposure is given should always be exceedingly small.

3. It is not expedient to use a deep orange optical screen on all occasions. Sometimes it happens that the prevailing conditions of light and atmosphere are such that perfectly bright clear pictures can be obtained without the use of any screen. More often the employment of a colour screen to stop the most refrangible rays of the spectrum is necessary but in such cases a screen of bright clear optically worked green glass will often be more efficient than deep orange. The best plan is for the photographer to take with him several screens of different tints and to use the one which observation on the spot and his own past experience leads him to believe will work best at the particular time and place. A screen which necessitates an enormously increased exposure of half-an-hour or more is very inconvenient to use and frequently the disadvantages which attend the use of a deep orange screen more than outbalance the advantages.

4. All the photographic operations should be conducted with a view to obtaining pictures which can be enlarged about three diameters, or more, if necessary, and yet yield sharp outlines. In this connection it is well to bear in mind that enlargement may, and often does, have the effect of giving increased sharpness to images of the more distant objects, so that a background which appears indistinct and as though obscured by haze in a small picture, may shew up fairly clear in the enlargement.

5. Thick coated glass plates should alone be used. Rapidity is not wanted, and rapid plates do not give such good results as slow fine-grain silver emulsion.

6. Do not be tempted to use celluloid instead of glass plates. The only possible advantages of celluloid plates are lightness of weight and unbreakabilty. The disadvantages for surveying purposes are serious. The flexibility of celluloid, and a liability to changes of form and dimensions under photographic manipulation, and changes of temperature, etc., may cause serious errors in the original perspectives which will affect the subsequent enlargements still more seriously. In practice, small coated glass plates very rarely break, and the number required for use by any one observer for any

single day's work will never be so great that the difference of weight will be a matter of real importance.

7. Isochromatic plates should be used in preference to ordinary untinted plates. When deep orange screens are used, isochromatic plates are necessary. It is best and most convenient for the observer to keep to the same kind of plate for all his work. For most ordinary work isochromatic plates behind green colour screens will be found to answer well. The obscuring effects of atmospheric haze will be to a large extent overcome without introducing unnatural exaggerations of light and shade, or necessitating a very excessive exposure. The green glass should be homogeneous, clear, and highly transparent for all the middle regions of the spectrum from the yellow to the commencement of the blue, but quite opaque to the ends of the spectrum.

8. The photographer should aim at the production of negatives which will yield the best enlarged positives on porcelain or glass by direct projection without intermediate processes.

Do not think about bromide enlargements or any other kind of enlargement on a paper ground. Gelatino-chloride or bromide emulsion on opaque or translucent plates of flat glass will yield the best results with least error, and the original negative should be produced not so much with the idea of producing positives by contact printing as by projection.

9. It is expedient to use an antihalation backing for the sensitive photographic plates, and to coat the edges as well as the backs of the plates.

To be thoroughly efficient the antihalation varnish should be opaque and black, and the medium which holds the black powder in suspension should have the same coefficient of expansion as the glass to which it is applied. The varnish should be spread on the glass itself, and dry there in optical contact with it.

If the plates used are thickly coated with emulsion richly charged with silver bromide there should be little or no appreciable halation, even if no backing were used; but effects resembling ordinary halation may be developed after long exposure of isochromatic plates, because the dyes with which they are tinted are fluorescent, and the brightly illuminated spots will emit photographically active rays which can produce effects resembling halation in the immediately adjoining shadows. The reason for coating the edges of plates is, of course, to prevent the accidental entry of extraneous light by those edges.

10. When duplicate exposures are made equal care must be taken with the duplicates as with the originals, but it is generally prudent to vary the conditions as regards

(a) Exposure. For one plate the exposure should be what is estimated to be about right; for the other plate it should be considerably longer.

(b) Colour screen. This should be changed, or if the atmosphere appears to be very clear one plate may be exposed without a screen.

(*c*) Plates. It is a wise precaution to use plates from different boxes for duplicates.

Do not be tempted to change the working aperture of the diaphragm, and do not think of using a colour screen behind the lens.

It is a good plan to develop duplicates separately, and to different degrees of density.

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Miss E. A. Johnston
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Referring to our conversation
of Tuesday evening at the Exhi-
-bition of the Royal Photographic
Society if you can manage
conveniently to call here tomor-
row (Friday) afternoon between two and
three oclock I shall be glad
to speak with you further
about my new Patent Photo
-theodolite and to shew you

some specimen photographs
from which you can select
specimens which you think
most suitable for your purpose.
If between 2 & 3 p.m. tomorrow is not
convenient any other time in
the afternoon will suit me
only to save you a possible disap-
pointment it will be best either
to call at that time or to let me
know when to expect you.
Thanks here a Photo theodolite and
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Yrs faithfully
J. Bridgeland


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