Other tests were instituted with the object of ascertaining whether the illumination of the spark-gap of the transmitter had any effect upon the impulses transmitted, and accordingly the ball dischargers were inclosed in a box opaque to light. No perceptible difference, however, was noticed in the strength of the signals received, whether the spark-balls were or were not exposed to daylight.

It would be interesting to ascertain whether the same effects are to be observed when using transmitting elevated conductors covered with insulating material opaque to ordinary light.

I have never noticed any appreciable difference in the distances over which signals are obtainable during the day and the night respectively in the course of all the other numerous experiments which I have carried out with installations not designed for very long distances, and in which the electrical power used at the sending station has been small compared with that used at the Poldhu installation.

Probably the much higher potential to which the elevated conductor at Poldhu was charged may have greatly increased the facility with which losses might occur, due to diselectrification through the influence of daylight.

I hope to be able to make a complete study of the effects described in this note, in the course of further long-distance tests which are likely to be undertaken shortly.

"A Portable Telemeter, or Range-finder." By George Forbes, F.R.S.

Received February 22,—Read March 20, 1902.

CONTENTS.

(1.) *General Description.*—The instrument consists of a folding steel base, 6 feet in length, and a field glass. The base is a square tube hinged at its middle, and folds up to 3 feet 3 inches. Each half has at each end a doubly reflecting prism. The rays of light from a distant object strike the outer pair of these four prisms, are reflected at right

angles along each tube, and are then reflected at the two middle prisms into the two telescopes of the binocular fixed to the base, in directions parallel to the original rays, intercepted by the outer prisms. It is the measurement of the angle between these rays that tells the distance of the object looked at. This angle is measured by two vertical lines, one in each telescope, seen by the two eyes. One of the lines is fixed, the other moved by a micrometer screw until the two lines appear as one, while the object is seen distinctly. This gives the distance accurately to 2 per cent. even at 3000 yards. But now stereoscopic vision comes in and gives far greater accuracy. The line seems to stand out solid in space, and the slightest turn to a micrometer screw may cause the line to appear nearer or farther than the object looked at, and when the line appears to be at exactly the same distance, the micrometer reading gives the distance with an accuracy far greater than that attainable by observing the duplication of images on the retina.*

(2.) *The Adie Telemeter.*—This was the first short-base telemeter or range-finder ever supplied, but its inaccuracies were great. These inaccuracies were in part avoided in the designs of Barr and Stroud, and of Zeiss. These three are the only instruments of the kind which have ever been obtainable. In all of them a double base is used, placed at right angles to the direction of the object, having two plane reflectors at its two outer ends, and two plane reflectors at its middle point parallel to the others—all of these plane reflecting surfaces being inclined at 45° to the base. In all three instruments the two object glasses are close to the outer reflectors, the eye-piece or eye-pieces of the telescopes being at the middle of the base. The three instruments differ in the means of measuring the angle of parallax. The angle to be measured is very small, and if any one of the reflectors be twisted in the plane of vision through a small angle, the error produced is double this angle. This necessitates exact parallelism between the two reflecting surfaces in each half of the base. Such rigidity cannot be attained in a portable instrument. Nor can the warping action of the sun's rays be prevented from affecting the parallelism without diminished portability.

(3.) *Double Reflection at each end of the Base.*—I have succeeded in overcoming the necessity for extreme accuracy in the rigidity of the base by replacing the single reflectors by a double reflection at each end of each half of the base. The angle between the two surfaces producing the double reflection is maintained unalterable by grinding and polishing these surfaces on a special glass prism. I have experimented on many forms of prism, but fig. 1 is ex-extremely convenient. Light enters the first prism at the surface AB. It is reflected at the two surfaces BC, DE, which are silvered, and are

* [It has been found convenient in practice to replace the lines by balloons photographed on glass.]

inclined at about 45° to each other. It emerges at the surface AE, and suffers similar deflection by the second prism, and, if the angle between the silvered surfaces BC, DE be the same in both prisms, and if the axes of the prisms (*i.e.*, the line of contact of reflecting surfaces) be parallel, then the emerging ray must be parallel to the incident ray. If the axes of the two prisms be not exactly parallel, a rotation of one prism relatively to the other in the plane of vision, *i.e.*, in a plane approximately perpendicular to their axes, produces no error; and a rotation about any other axis, through any angle, produces an error which is only a small fraction of that angle. Consequently no absolute rigidity in the base connecting the first and second prisms is required, as is the case when there is only a single reflection at each end of the base.

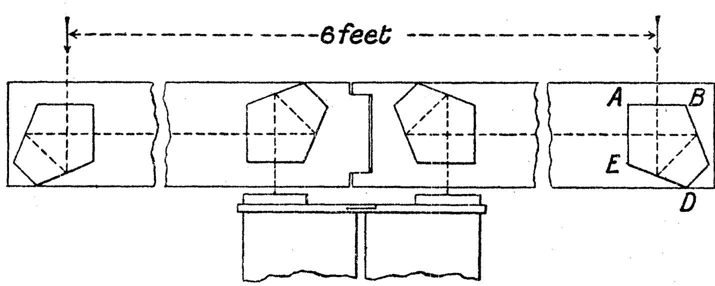

FIG. 1. Path of rays of light through base prism to binocular of range-finder.

(4.) *Advantage of placing the Object Glass outside of and behind the Base.*—In all three instruments previously perfected the object glasses are close to the outer prism. This necessitates the rigidity of the connection between the two halves of the base as well as between the reflectors constituting each half. If one-half of the base were not exactly in line with the other half, the image formed by it would be displaced relatively to the other image.

But when the base has no lens in it to form an image, if the reflecting surfaces be parallel then the emergent rays which enter the telescope must remain parallel to the incident ray, however much the base as a whole be inclined in any direction.

(5.) *The Double Base and Hinge.*—Even when the axes of the prisms are not exactly parallel the two halves do not require to be absolutely rigidly connected, and thus it has been possible to introduce a hinge which doubles the portability of the base. One-half of the base may be rotated with respect to the other about any axis.

Rotation of one-half of the base, either about the line of vision or about an axis perpendicular to the plane of vision, produces no effect except that due to shortening the base by an amount that is immaterial

in practice. Rotation of one-half of the base about the line of the base produces no error if the axes of the two prisms in each half-base be parallel, and if not parallel the hinge can easily be made sufficiently true to prevent an appreciable error arising.

(6.) *Accuracy Required.*—The angle which has to be measured is the angle between two rays from the distant object to the two ends of the base, and the distance of the object is $d = b/\alpha$ if b is length of base; and the angle corresponding to any distance is $\alpha = b/d$.

The smallest angle perceptible to the naked eye has been supposed to be $30''$. A magnifying power of 12 is the highest which can be used in practice without a tripod or other stand. Hence $30''/12 = 2''{\cdot}5$ is the smallest angle which can be observed, or an angle $= 0{\cdot}0000125$. Now an infantry range-finder must be capable of distinguishing between 2940 and 3000 yards (2 per cent.). Hence the angle $b/2940$—$b/3000$ must be at least equal to ·0000125, which gives b not less than 1·838 yards. Following this argument, I have employed a base of 2 yards' length in the form of a steel tube of square section, 0·5 mm. thick, with a hinge in the middle, so that in travelling the 6-feet base folds up to 3 feet 3 inches.

As a matter of fact I find that, owing to the adoption of stereoscopic vision, with which the limit of visibility is far less than the $30''$ assumed above, the accuracy of the instrument in the hands of a practised observer on a well-defined object is far greater than 2 per cent. at 3000 yards—the limit of accuracy which I had laid down.

(7.) *The Binocular.*—When the base is stretched out and the binocular attached, the distant object can be viewed by stereoscopic vision. The eyes have little or no power of estimating absolute distance by this means, but have the greatest accuracy in the comparison of the muscular effort required to converge the eyes on objects at different distances. Two marks are fixed in the focal planes of the binocular, and it has been found best to make this mark in the form of a balloon photographed with a tail-rope hanging down to the centre of the field of view. The two balloons are almost identical, but on the left side of the left balloon the letter L is marked, and on the right side of the right balloon the letter R is marked. This assists in the focussing of each eye-piece separately, and indicates when both eyes are operative. If the distance between oculars is wrong, or if the line of the oculars be not horizontal, one of the letters, R or L, disappears.

One of the balloons is movable by a micrometer screw towards or from the other, so that they can be seen stereoscopically with any convergence of the optic axes of the eyes, and therefore at any apparent distance by turning the micrometer. The observation consists in turning the micrometer until the balloon appears to be at the same distance as the object. The micrometer head is divided and marked with distances inversely as the angular movement from infinity.

The binocular is of the prismatic type and is constructed very solidly, and the inter-objective distance must not vary much when the distance between the oculars is changed to suit different pairs of eyes. A hinged axis gives the most solid design, and the hinge is so placed as to lie on the plane containing the axes of the objectives. The distance between the objectives is then fairly constant.

The balloons would become inclined on working the binocular hinge if no special means were used to prevent this. With this object the glass photographs in the focal planes can rotate, and their mountings are provided with slides which keep them parallel. The focal length of the object-glasses is 243 mm. The pitch of the micrometer screw is 0·3 mm. The micrometer screw has a drumhead attached, 8 cm. diameter, with the periphery divided into 100 equal parts for purposes of adjustment. On the outer face a spiral groove is cut, making three and a-half turns, and a radially sliding pointer, with a pin running in the spiral groove, enables any range to be read off over three and a-half turns. The scale marked on the groove reads off distances directly, from infinity down to 500 yards.

(8.) *Advantages of Stereoscopic Vision.*—A single telescope might have been used, but the difficulty of being sure that the images are single or double is very great and leads to error. With the binocular the two images of the balloon leap together so soon as attention is concentrated on them, and the balloon seems to be at some distance; so with the distant object, however faint, the two images leap together when the attention is concentrated on them, and the object's distance can be compared with the apparent distance of the balloon. I find that I can thus appreciate an angle of 6″ with the naked eye, or 0″·5 with a power of 12.

(9.) *Construction and Mounting of the Prisms.*—The prisms are mounted by being sunk and cemented in a steel plate. The clear aperture of the transmitting surfaces is $\frac{3}{4}$-inch square. They are mounted in a tube of rectangular section which forms the base. At first I preferred aluminium, but since I was able to obtain steel tubes of the requisite quality and 0·02 inch thick I have used them. They are 1 inch high and 1·25 inch broad. The two prisms are ground and polished as one, and afterwards cut; and I find that with the special glass used the cutting does not distort the surfaces. The whole prism is included in the tube, and this can be done only by making the angle between reflecting surfaces a little less than 45°, this angle being absolutely the same in the two prisms of a pair. Each prism is held to the bottom of the square tube by three screws, which engage in the base plate of the prism, the screw heads abutting on the square tube, and the prism bed-plate being pressed from it by three pieces of clock spring with a hole through which the screw passes. Two of the screws are in line with the base tube, the third is at a right angle. Thus, if

either of the two screws first referred to be turned, the plane of the prism will be turned about a horizontal axis inclined at 45° to the base. A tilt of one prism about its axis of symmetry gives rotation to the picture about the optical axis. A tilt about an axis at right angles to the axis of symmetry raises or lowers the picture seen by the half-base under consideration.

(10.) *Errors of the Base and Hinge.*—The errors of the hinge and base may best be considered with reference to the half-base. The error is the angular deviation, measured in the plane of the binocular, of the ray entering the binocular from the direction in which it entered the outer end of the base. This error depends upon three things—(1) the inclination of the axis of the two prisms to each other, (2) the position of the plane which is parallel to these two axes relatively to the line of vision, and (3) the part of the field of view in which the observation of the distant object is made.

Let OZ be parallel to the axis of the first prism and OP parallel to the axis of the second prism. Let OPZ be the plane of XZ. Let OS be parallel to the direction of the object viewed. Let xyz, $x'y'z'$ be the co-ordinates of the point S according as OZ or OP is taken as axis of Z.

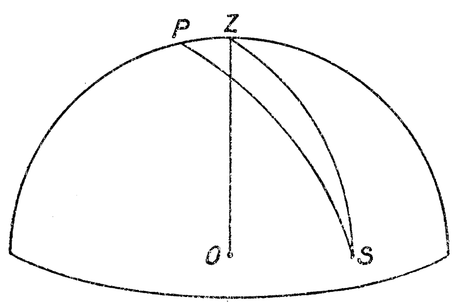

FIG. 2.

Let ZS $= \theta$, and PS $= \theta'$.
$\pi -$ PZS $= \phi$, and ZPS $= \phi'$.
PZ $= i$, which is a very small quantity.
$\theta' = \theta + \delta\theta$, $\phi' = \phi + \delta\phi$; then $\delta\theta$ and $\delta\phi$ are very small.
$\frac{1}{2}\pi - \theta = \alpha$, then in practice α is small.
OZ = unity. Then we have

$$x = \sin\theta \, . \cos\phi \qquad x' = \sin\theta' \, . \cos\phi'$$
$$y = \sin\theta \, . \sin\phi \qquad y' = \sin\theta' \, . \sin\phi'$$
$$z = \cos\theta \qquad z' = \cos\theta'$$

$$\sin\theta' \cos\phi' = x' = x\cos i + z\sin i = \sin\theta\cos\phi\cos i + \cos\theta\sin i \ldots (1)$$
$$\sin\theta' \, . \sin\phi' = y' = y = \sin\theta\sin\phi \quad \ldots \ldots\ldots\ldots (2)$$
$$\cos\theta' = z' = z\cos i - x\sin i = \cos\theta\cos i - \sin\theta\cos\phi\sin i \ldots (3).$$

From (3) we have

$$\cos(\theta+\delta\theta)-\cos\theta = -\sin\theta\cos\phi\,.\,i$$

so that $$\delta\theta = i\,.\cos\phi \quad \text{.............................(4).}$$

Now the first prism deflects the line (θ_1, ϕ_1) or (θ_1', ϕ_1') the direction of the object, to (θ_2, ϕ_2) or (θ_2', ϕ_2') the direction of the image, where $\theta_2 = \theta_1$, and the second prism deflects this line back to (θ_3', ϕ_3'), where $\theta_3' = \theta_2'$. Also, since the angle between reflecting surfaces is equal in the pair of prisms, and generally taken equal to $\frac{1}{4}\pi$, we have

$$\phi_2' - \phi_3' = \phi_2 - \phi_1 = \tfrac{1}{2}\pi \quad \text{.......................(5).}$$

Now the deflection of the image vertically, in the plane through the axis of the second prism, after reflection in the two prisms, is

$$\theta_3' - \theta_1' = \theta_2' - \theta' = (\theta_2' - \theta_1) - (\theta_1' - \theta_1)$$
$$= (\theta_2' - \theta_2) - (\theta_1' - \theta_1) = \delta\theta_2 - \delta\theta_1.$$

Therefore vertical displacement $= i(\cos\phi_2 - \cos\phi_1)$ ....(6).

Also from (2)

$$\sin(\phi+\delta\phi) = \sin\phi' = \frac{\sin\theta}{\sin\theta'}\,.\sin\phi = \frac{\sin\theta}{\sin\theta+\delta\theta\cos\theta}\,.\sin\phi$$
$$= (1-\delta\theta\cos\theta)\sin\phi,$$

and therefore by (4) $\delta\phi = -\delta\theta\cos\theta\tan\phi = -i\cos\theta\sin\phi$.

The error of observation is the angular deflection of the image horizontally, supposed to be in a plane perpendicular to the axis of the second prism, after reflection in the two prisms, and is

$$\phi_3' - \phi_1' = [\text{by (5)}]\ (\phi_2' - \phi_2 + \phi_1) - \phi_1'$$
$$= \delta\phi_2 - \delta\phi_1 = -i\cos\theta\,(\sin\phi_2 - \sin\phi_1)$$

or error $$= -i\,.\,\alpha\,(\sin\phi_2 - \sin\phi_1) \quad \text{....................(7).}$$

Now, translating there, we see from (6) that the vertical displacement of the image by one-half of the base is

$$i(\cos\phi_2 - \cos\phi_1),$$

which is clearly a maximum for a fixed value of i, if $\phi_2 - \phi_1 = \frac{1}{2}\pi$, when

$$\phi_2 = \tfrac{3}{4}\pi, \quad \text{and} \quad \phi_1 = \tfrac{1}{4}\pi.$$

This occurs when the plane cutting one prism symmetrically through its axis is parallel also to the axis of the other prism; and, if I be the greatest possible inclination of the axes of the two prisms to each other, through bad adjustment, then the vertical displacement cannot exceed

$$\sqrt{2}\,.\,\text{I for one half-base} \quad \text{and} \quad 2\sqrt{2}\,.\,\text{I for the whole base.}$$

Again, we see from (7) that the error arising from want of adjustment of the prisms

$$= -i\,\alpha\,(\sin\phi_2 - \sin\phi_1),$$

which is clearly a maximum for a fixed value of i, if $\phi_2 - \phi_1 = \frac{1}{2}\pi$, when

$$\phi_2 = +\tfrac{1}{4}\pi, \quad \text{and} \quad \phi_2 = -\tfrac{1}{4}\pi.$$

This occurs when the plane parallel to the axes of the two prisms is at right angles to a plane cutting the prisms symmetrically.

And, if I be the greatest possible inclination of the axes of the two prisms to each other, through bad adjustment, then the error in the angle used for finding the range cannot exceed

$$\sqrt{2}\,.\,\mathrm{I}\alpha \text{ for the half-base} \quad \text{and} \quad 2\sqrt{2}\,.\,\mathrm{I}\alpha \text{ for the whole base.}$$

Also it appears that there is no error in this angle when the axes of both prisms are in one plane cutting the prisms symmetrically. Similarly, if the plane of the axes is at right angles to this plane there is no vertical displacement of the image.

It is found that with ordinary care in use the maximum value of I need never exceed one or two minutes of arc for a long period after the adjustments have been made. Now, in order to attain an accuracy of 2 per cent. (60 yards) in 3000 yards, we may not have an error greater than 2·8 seconds of arc. Hence, if I amount to 1′, we must have

$$\alpha \text{ less than } \frac{2''\cdot 8}{1' \times 2\sqrt{2}} = 0\cdot 0165 = \text{nearly } 1^\circ,$$

but the diameter of field of view of the instrument is 2°. Hence it is possible to observe the object in any part of the field of view, without error amounting to the prescribed limit, if the inclination of the axes of the prisms to each other does not exceed 1′. And by bringing the object viewed to the centre of the fields limited by the outer prisms the accuracy of the base is practically perfect.

The only defect of the hinge which can lead to error is due, as stated above, to a rotation of one-half of the base with respect to the other half of the base, about the line of the base. When this occurs, the two fields of view seen by the two eyes are not the same, although the object whose distance is required may be in both fields. The conclusions arrived at in this section prove that, if the prisms in each half base were parallel to within 1′, then, if one image can be seen in any part of its field when the other is in the centre of its field, the error is under the limits assigned, and this would involve an error of 1° in the allignment of the two halves of the base. It would be very inconvenient to have the two fields of view differing so much in appearance; and this error never amounts in practice to the prescribed limit.

(11.) *Errors of the Binoculars.*—If the binoculars be not held level, the plane in which the measurement of angles is made may be inclined to the plane of vision. The error amounts only to the versed sine of the angle of inclination, and to produce an error of only 1 per cent. in the distance, this angle would have to be at least 8°. The binocular is liable to an index error, which can be corrected by setting the index of the scale if its amount be known. This error would be a constant source of trouble if the instrument were not strongly made. Even so, however, the index must be set whenever the distance between oculars has been changed for a new observer. To test the index of the binocular, choose any object of unknown distance. First use the instrument without the base, and move the index to read infinity. Then use the base. Suppose the distance recorded to be 3000 yards. Deduct 1/30th, because the distance between the objectives is 1/30 of the whole base. Set the index so as to read 2900 yards; the index error is then corrected for all distances. Temperature may have an influence on the binocular by expanding to different extents the metal connecting the object glasses and the metal connecting the balloons in the focal planes. Most of these metal connections are a solid brass hinge which cannot be subject to variations of temperature in its parts. But the other parts of the connections, in the bodies of the telescopes, might vary one or two degrees in temperature. The distance between the centres of the objectives or balloons, independent of the hinge, is about 25 mm., but cannot be measured accurately. With brass 25 mm., each degree Centigrade expands it 0·0005 mm. Now the focal length of the objective is 143 mm., and the angular permissible error being 0·000014, the difference between the distances by which the two objectives and the two balloons are separated must not vary to the extent of 143 mm. × 0·000014 = 0·00200 mm. due to 4° C. This difference of temperature is not to be expected in practice. In cases where great distances may have to be measured with the utmost exactness the index error should be corrected, in the manner described above, at the time of observation, and this will correct for temperature. To do this easily the binocular is mounted to the base by a hinge, which enables the base to be removed during the preliminary observation with a minimum of time and trouble.

(12.) *Practical Adjustments.*—The fields of view of the binocular are limited by two round diaphragms. The outer prisms show a square field with ragged edges in the round field. The hinge of the base and the binocular mounting are so set by the maker that each square field is in the middle of its round field horizontally. They may be above or below, and they may be twisted about the visual line, and these corrections are separately made by the two adjusting screws on each of the two middle prisms. It is best to make all adjustments first on the half-base to which the binocular is attached; and afterwards on

the other half-base, using the whole base with the binocular. Having now got the square fields in the middles of the round fields, and square with each other, these adjustments seldom if ever require attention. All subsequent adjustments are made by the screws on the outer prisms; the object of these adjustments is to make the prism axes parallel. If the eyes seeing the balloons as one balloon see distant objects double, one image over the other, then the screw which tilts the prism about an axis perpendicular to its axis of symmetry will accurately remove this defect, and here also one prism is adjusted with the half-base first, and then the other prism, with the whole base. The tilting of the prism about the axis of symmetry would be cured by the other screw, but the defect is not easily seen by the binocular. It can however be detected by the collimator and removed by using the adjusting screw, which operation will not affect the previous adjustments.

The collimator is a telescope with a spectroscope-slit, near the eye end, mounted at the end of a tube projecting at right angles to the telescope tube and attached to it near the focal plane, and having a right angled total reflection prism in the axis of the telescope and a mirror with a universal joint for illuminating the slit. The binocular being removed, the collimator is pointed to one of the middle prisms. Four images of the slit are then seen, reflected from the two unsilvered surfaces of each of the two prisms in the half-base under examination. They are easily identified by their different brightnesses. The 2nd and 3rd in brightness are chosen, and the screw worked until these appear in the same line. Then the faces of the two prisms which are opposed to each other must be parallel so far as a tilt about the direction of vision is concerned. Adjustment about a vertical axis is not necessary. The two adjustments now made render the axis of the two prisms perfectly parallel, and the base is adjusted. The slit of the collimator can be varied in width by a divided screw head. One turn of the screw opens the jaws of the slit fully, when the width is three minutes of arc. This gives a ready means of measuring the error. There are other methods of proceeding to the corrections of the outer prisms. We may begin by using the collimator and adjusting either or both of the screws previously used; and afterwards, with the binocular, and using the third screw, we make the ends of the balloon ropes rest on the same distant horizontal line. In actual warfare this method has certain advantages.

Addendum, received March 1, 1902.

Beaufort West, Cape Colony.

I have made a large number of tests of the instrument, some days giving better results than others. Instead of choosing the days that

gave the most favourable results, I prefer to append to my paper the results of two days upon which I had with me experienced independent authorities, who were good enough to draw out and sign certificates of all the tests made.

Copy of certificate of an ordinary day's work on a cloudy day, drawn out and signed by Sir David Gill, K.C.B., H.M. Astronomer, Sir John Ardagh, K.C.I.E., C.B., R.E., Lieut.-Colonel J. E. Edmonds, R.E.

February 5, 1902, *Royal Observatory, Cape of Good Hope.*

The following measures of distance were made from the roof of the Royal Observatory, Cape Town, on February 5, at 4 P.M., on a dull day, clear atmosphere, light S. breeze, without tripod stand, by Professor G. Forbes. The distances recorded were in each case read independently off the screw head by Mr. V. Löwinger, of the Observatory. The actual distances of these points are based on actual survey.

	Distance in yards.	Observed.	Computed—observed.*
		yards.	yards.
Mowbray Church	1859	1868	−9
House of Refuge	3036	3127	−91
North-east corner cottages between Observatory and Salt River	852	857	−5
Chimney of Cement Works, Salt River ..	1432	1440	−8
Chimney in Salt River Railway Works ..	1711	1748	−37
Dutch Reformed Church steeple, Woodstock†	2740	2920	−180

* [The errors being all negative and increasing with the distance is due to the binocular having had its scale index set inaccurately.]

† The steeple was at the time enveloped in a dust storm.

Copy of certificate of an ordinary day's work on a very windy and dusty day, drawn out and signed by Sir David Gill, K.C.B., H.M. Astronomer.

The following measures of distance were made from the roof of the Royal Observatory, Cape Town, on February 6, at 11 A.M., bright clear day, strong S. wind, by Professor G. Forbes. The distances recorded were in each case read independently off the screw head by Mr. V. Löwinger, of the Observatory. The distances of the points are based on actual survey.

	Separate results.	Mean observed.	Actual distance.	Computed—observed.
		yards	yards.	
Mowbray Church	1860 1885 1825	1857	1859	+2
Cement Works Chimney, Salt River..............	1430 1410 1405	1415	1432	+17
Salt River Works Chimney..	1715 1735 1705	1718	1711	−7
N.E. corner of cottages between Observatory and Salt River..............	861 858 850	856	852	−4
Chimney of Oude Mollen...	701 702 711	705	686	−19
Spire at Altentby Asylum ..	751 744 733	743	749	+6
Spire at Clarendon Mowbray	1910 1950 2050	1970	1994	+24
Chimney at Nieuve Moelem	1350 1395 1380	1375	1388	+13

[Since the above was written, the instrument has been carried on horseback between 300 and 400 miles in less than three weeks with Colonel Crabbe's column in the South African War. The author frequently tested with the collimator the parallelism of the prisms in each half of the base. The error never amounted to 1 minute of arc. Applying this in the formulæ of the paper, it follows that the angle α may amount to 1° without introducing an error of $2\frac{1}{2}''$, the limit of accuracy aimed at. In other words, while it is shown in the paper that the error increases with the vertical angular distance of the object aimed at from the centre of the field, the tests during a rough experience show that the limit of accuracy aimed at is not exceeded, though the object be in any part of the field of view, and that no adjustment is required after leaving the maker's hands.]