

*Proceedings of the Madras Government, Public Works Department,
14th April 1875.*

No. 303. Read the following Proceedings of the Government of India, Public Works Department, (Civil Works—Miscellaneous,) dated Fort William, 8th March 1875, Nos. 76—87 M. :—

Messrs. Cooke and Sons' Levelling Instruments.

Read again—

Public Works Department Despatch to Her Majesty's Secretary of State for India, No. 150, dated 1st October 1874, and enclosure.

Read also—

From the Secretary of State for India, to the Government of India, dated 28th January 1875, No. 8.

I HAVE received your letter in this Department, No. 150, dated 1st October 1874, forwarding a statement of certain defects observed in some of the levels furnished by Messrs. Cooke and Sons.

2. As the instruments were constructed under the instructions and superintendence of Colonel Strange, the Inspector of Scientific Instruments attached to this Office, I have thought it right, in the first instance, to cause the remarks in question to be referred to that Officer for report.

3. From a memorandum* drawn up by Colonel Strange, a copy of which is enclosed, it appears that the alleged defects are in most instances modifications which he has caused to be made in the construction of the levels, with a view to increasing their accuracy and efficiency.

4. Under these circumstances, it does not appear desirable to communicate the statement of defects to Messrs. Cooke and Sons, as suggested in your letter, the Firm having simply carried out, in these respects, Colonel Strange's instructions.

5. I have to request that Colonel Strange's memorandum may be communicated to the various Officers of the Public Works Department, by whom these alterations were noted as defects; and that I may receive from you any communications which they make in reference to Colonel Strange's observations.

Dated 18th November 1874.

Inspector of Scientific Instruments' reply to "reported defects in Cooke and Sons' levelling instruments" forwarded with letter from Government of India, Public Works Department, No. 150, dated Fort William, 1st October 1874.

Before replying *seriatim* to these remarks I would observe generally that defects in scientific instruments, as in most other human works, are relative. I know of no part of any instrument, even of my own design, in which I cannot point out defects. The question is one of comparison between the given form and some other known form. In deciding on the details of an instrument, one is limited to a choice of evils, perfection being unattainable. No criticism of such things is really valuable or conducive to improvement unless it discusses the *relative* merits of two or more arrangements, and points out in what respect; and for what reasons, the particular one under discussion is inferior to those with which it is compared. In none of the remarks under notice do I find any criticism of this kind :—

"I.—Want of arrangements for correcting any error in the direction of the telescope to its vertical axis, or adjusting the horizontal axis perpendicular to the vertical."

I would explain to the author of this objection that the optical axis is the "telescope," not its brass tube; the optical axis is also the "horizontal axis." This optical axis, telescope, or horizontal axis (as it may be indifferently called), is the mathematical line joining the optical centre of the object glass and the wire in its focus. In the instruments under notice there are arrangements for placing this line at right angles to the vertical axis, viz., by moving the wire by means of its "collimation screws." It is true that the same effect can be produced by moving the telescope bodily as a whole, and that arrangement used to exist; but I have deliberately, and after the fullest consideration, discarded it as unnecessary, clumsy, coarse, and insecure.

"II.—Power of glasses are found to be inferior to Troughton and Simms'. They are not sufficiently powerful, and in unfavorable weather found to be hazy in most cases."

The word "power" is often used very loosely with respect to telescopes. In science it is always held to denote "magnifying power." I believe that scarcely any difference exists between the magnifying power of levels of the same size made respectively by Messrs. Simms and Messrs. Cooke. And I therefore can only conjecture that the word "power" as above used refers in some way to quality. If so, I must again differ from the writer. I have compared great numbers of levels by both makers side by side on definite test objects. The telescopes supplied by both Firms are excellent; if there be any difference between them, I should say that those of Messrs. Cooke are the better. The latter part of the above remark is, I confess, quite unintelligible to me. It would imply that the disturbing effect of atmospheric irregularities can be counteracted by optical excellence in the telescope. I can only say that the production of a telescope that should not be "hazy in most cases in unfavorable weather" would be one of the most valuable advances ever made in optical science.

"III.—Adjustment of diaphragm by means of spiral spring and screw has not stood the test of wear and tear, while it is affected by temperature."

I do not understand what is meant by the first objection. When mechanism of any kind is said not to bear the test of "wear and tear," destructive action of some kind is attributed to it. But this can hardly be the case with the collimation adjustment of a level, which is altered very seldom, very gently, and by very small quantities. Something else must therefore be intended, and I should be glad of a fuller explanation of the writer's meaning. As to the second objection, that the part in question is affected by temperature, this applies to all collimation arrangements with which I am acquainted, and indeed, I may say, to every part of every instrument. What is required to be known is what is the effect on the adjustment of given changes of temperature, both as to direction and as to extent? By what means have these effects been determined or measured? and are they greater or less than those to which other modes of adjustment are subject?

I am anxious to receive accounts of really systematic experiments on this particular part of levels, as I have devoted a great deal of attention, aided by Messrs. Cooke, to improving it. Formerly, the adjustment was effected by four antagonizing screws. In this there was always a liability either to looseness or to undue strain, owing to the inconstancy and non-measurability of the force used. I have endeavored, by suppressing two screws and substituting a spring (in various forms) for one of them, to employ a constant force. My plan also facilitates the performance of an adjustment which used to be very troublesome—the motion of the diaphragm, under my system, instantaneously following that of the adjusting screw, as in micrometers. But as I have no opportunities for submitting this and other modifications introduced by me to the test of actual field work, I am dependent for the application of this final test to officers in India. But incomplete and vaguely worded remarks such as those under notice afford me no help or information whatever.

"IV.—Fixed lenses in object glasses found to be a great defect in India."

The writer does not specify the defect, which he should have done. This question of mounting object glasses is a good illustration of my opening remarks. It is a case in which a choice of evils must be made. When object glasses are mounted in "screwed cells" from which

they can readily be removed for cleaning by the observer, three evils are to be apprehended. First, the screwed ring may not be tightened sufficiently, in which case the object glass being loose, the observations are worthless. I once knew a whole season's survey operations lost from this cause. Second, the screwed ring may be tightened too much, in which case the lenses will be distorted and the definition of the telescope injured. Third, the lenses may inadvertently be reversed when restored to the cell, when the vision will, of course, be impaired. I have known instances of this.

To obviate these evils I therefore had the object glasses "burnished" into their cells, from which then no one but an experienced and skilful optical mechanic could remove them. But here I was met by a different evil. Object glasses are occasionally subject to the deposition on their interior and inaccessible surfaces, of a dim mist, which sometimes, if neglected, eats into the glass, which is then useless and needs re-polishing by an optician.

When Mr. Doderet was in England, I discussed these various evils with him, and I ultimately agreed with him in the opinion that the evil attending the "burnishing" system outweighed those connected with the "screwing" system. From that time I have had all object glasses mounted in cells from which the observer can readily remove them. So the remarks under notice refer to a form which is now no longer supplied. But I have given the above explanation in order to satisfy officers in India not only that such matters receive very careful consideration here, but also that supposel improvements are readily abandoned by me directly it is shown that the balance of evidence is against them.

I must conclude my remarks on this point, which is one of great importance in the construction of instruments, by observing that the adoption of "screwed" object glass cells imposes on superior officers the duty of carefully instructing their subordinates in the mode of dismounting and remounting them; and of keeping a watchful guard against loose, over-tightened, or wrongly inserted object glass lenses.

"V.—Bubble adjustment does not stand the test of wear and tear. Its tube is observed to be not truly constructed, and the bubble itself very fidgery."

I must candidly confess my inability to understand one word of this. What form of bubble adjustment is referred to of the numerous forms in use? What is "its tube?" The word "its" implies grammatically the tube of the "bubble adjustment" previously spoken of, which is quite unintelligible. In what of the many thousand possible respects is it "not truly constructed?" What is fidgery in a level? The word implies spontaneous agitation and almost vitality.

"VI.—Graduation of the compass circle contrary to the usual practice in consequence of which found inconvenient and troublesome."

The writer no doubt alludes to the numeration, not the graduation. Such an error as he mentions must have been accidental and have escaped my observation. The matter shall have my attention.

"VII.—The clamping screw needs a collar to secure it in its place."

The writer should have mentioned what "clamping screw". He should also have defined the word "collar," which is used in a great variety of senses. This is a case in which a diagram or drawing should have been supplied. At present I cannot even guess at the writer's meaning.

"VIII.—Collimation adjustment found to be insecure and easily thrown out."

The particular form of collimation adjustment referred to should have been specified, and the probable cause of insecurity indicated.

"IX.—Magnetic needle in some cases found unreliable to a degree."

The cause of this should have been ascertained and stated. Possibly, the steel point on which the needle revolves may have become blunted or bent or the magnetism of the needle may have been destroyed by lightning, an accident of which I have known several instances; in that case it would have to be re-magnetized. The information which it is important to communicate to me is whether there is any defect of original construction. I cannot gather any information on this point from the above remarks.

*Proceedings of the Madras Government, Public Works Department,
14th April 1875.*

It is satisfactory to me to learn from the concluding paragraph of the report under reply that the "defects noted above do not apply to all the levels made by Cooke and Sons, and not to theirs alone; and that officers in various parts of India have reported" "very favorably of Cooke and Sons' instruments," "notably the Officer in charge of the Mathematical Department in Madras."

Mr. Doderet, the Officer last referred to, is a most accomplished, scientific mechanic, whose opinion on such subjects as those under discussion would outweigh the opinions of any number of persons of less knowledge. I have personally conferred with him on the design and workmanship of these very levels by Messrs. Cooke, and believe he agrees with me in considering them the best instruments of their class ever sent to India.

I would also refer to a most elaborate report on these levels by Major Montgomerie, R.E., of the Great Trigonometrical Survey, one of the most scientific officers in the service. Nothing could be more decisive than his approval of Messrs. Cooke's levels.

I request that this reply may be circulated to all the Departments in India who use the instruments in question.

ORDER.—Ordered that a copy of the foregoing be forwarded to the Local Governments and Administrations marginally noted, in the Public Works Department, Irrigation Branch, for any remarks that may be considered necessary with reference to Colonel Strange's observations.

Madras.
Bombay.
Bengal.
North-Western Provinces.
Punjab.
Oudh.

Central Provinces
British Burmah.
Mysore.
Hyderabad.
Central India.
Rajpootana.

(Signed) G. T. SKIPWITH, Captain, R.E.,
Asst. Secy. to the Govt. of India.

No. 304. ORDER THEREON, 14th April 1875, No. 1,003.

CIVIL WORKS, No. 20.

COMMUNICATED to the District Engineer, Presidency, who will obtain and forward Mr. Doderet's remarks on the

several points noted in Colonel Strange's reply to the objections made to Messrs. Cooke's levels.

(True Extract.)

(Signed) G. W. WALKER, Colonel, R.E.,
Secretary to Government.

To the District Engineer, Presidency.

Exd. W. J. Lewis.

Spare Copies

P. W. 1875 Dept.
No: 1776

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.
Miscellaneous.

To

Nos. 76—87 M.

Dated March 8, 1875.

Dated March 8, 1875.
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G.O.Nv. 1003. 14-4-75

Messrs. Cooke and Sons' Levelling Instruments.

P. W.D. Press-9-3-75-60.

Thursday
Sept-15-4-75

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CHIEF OF THE PUBLIC WORKS

PUBLIC WORKS

Genl. Engineer
Residence.

Encl.

O. D. 14 April 1870, No. 107

No. 303. 304.

Mr. C. C. & Lons' Leveling
Instruments - Pro. of the
Govt of India forwarding
papers on the subject of -
for remarks with reference
to Mr. Strange's observation
Comm. to the Dist. Engr. Pro.
who is to obtain & forward all
Doder's remarks on the several
points noticed by Col. Strange