IMPROVEMENTS.

It is a gratification to us to be enabled to say to our friends, that not only is the invention and introduction of **ENGINEER'S TRANSIT** *due to our house, but likewise, in our belief, we are justly entitled to claim that every actual improvement, in either Transit or Level, as well as other instruments, have originated with us.*

GRADIENTER.

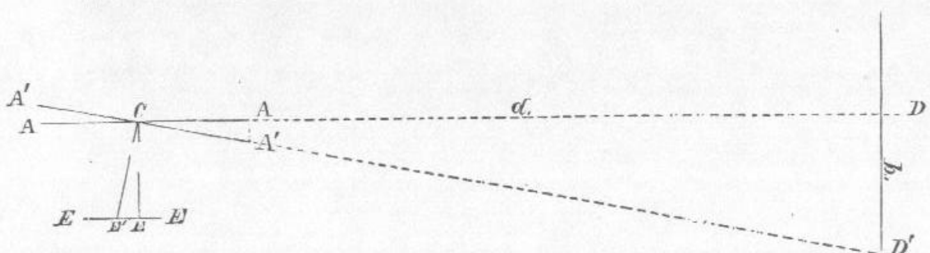
This important addition to our Transit instrument measures, with accuracy, and economy of labor and time,

1st, Gradients,
2d, Distances,
3d, Actual differences of Level.

The ordinary Transit simply measures the angular position, as referred to a certain line; the Gradienter addition determines every other condition necessary to establishing the actual position of any point.

The addition adds very little to weight of plain instrument—nothing whatever where level is already placed on, and its peculiar advantage consists in no manner interfering with the use of instrument as a Transit.

In its construction, a clamping arm extends downwards from axle upon which telescope revolves, and is forked at lower extremity to embrace a micrometer headed nut. This nut moves along a screw, accurately cut upon our straight line engine, making a certain number of revolutions to the hundredth of a foot. The head of screw is graduated into one hundred parts, and attached is a zero edge for reading graduations.



If the line A A represents the centre line or optical axis of telescope, when level, and which produced strikes a rod at D; C E, the perpendicular or clamp piece of Gradienter; and E E the micrometer screw parallel to telescope or A D:—then, when we clamp Gradienter, and move the micrometer screw along E E, the telescope and its produced line will also move the same angular distance, the produced line striking at D′.

It is evident that C E E′ and C D D′ are similar triangles, and if we know positive values on one, and relative values of both, we can determine other values.

Thus, if one revolution of micrometer screw moves Gradienter with a proportion of one foot perpendicular to one hundred feet horizontal, then the telescope would be elevated (or depressed) as to indicate a difference of one foot on D D′ placed one hundred feet off; and two revolutions indicate an elevation or depression of two feet in the hundred feet. Hence, the number of revolutions, and parts of a revolution, as indicated by graduations on the screw head, measures the grade from the level,—not in *terms of arc*, but in measures of base.

As the proportion of screw is such that a full revolution gives one foot vertical in a distance of 100 feet horizontal, when the motion of telescope measures this foot, it necessarily follows the rod must be 100 feet distant; or if telescope measures 1.50 feet, the rod must be 150 feet distant.

Or if points D D′ are at a fixed distance from each other, so as to form a base, and the Gradienter is moved that the micrometer head travels as to bring line of sight from D to D′, then is given the similar sides D D′ and E E′, and their proportional value to other sides, from which C D or distance is known.

It will thus be seen how simple are the principles upon which Gradienter depends. For its use, we give following simple

DIRECTIONS

where the screw and micrometer head are so arranged as one full revolution, or 100 graduations gives proportion of one foot vertical to 100 feet horizontal.

TO RUN A CERTAIN GRADIENT.

Bring Telescope level by means of milled head; then noting reading, continue motion of milled head one revolution and part thereof for each foot and part thereof, of foot per hundred of your desired gradient.

Thus to set off gradient of 0.5 foot per 100 feet, move micrometer milled head 50 graduations from the level.

To set off 2.25 foot per 100 feet, move 2 revolutions and 25 graduations.

TO MEASURE A GRADIENT.

Bring Telescope level, and note reading as before; then turn micrometer head until telescope line strikes the target or other object; the number of revolutions, and parts of a revolution, indicate the feet and parts of feet per hundred of gradient.

Thus 1.40, or 1 revolution and 40 graduations, indicate 1.40 foot per 100 feet; 2.50, or 2 revolutions and 50 graduations, indicate 2.50 foot per 100 feet.

TO MEASURE DISTANCES.

Performed by two methods.

1st, By use of usual graduated rod. *By noting distances on rod graduated in usual style, passed over by one revolution of micrometer head.*

Thus, if one revolution of micrometer head passes the reading by the cross web of telescope from 5.00 ft. to 6.27—difference 1.27, the distance is 127 feet; if from 4.50 to 6.78—difference 2.28, distance 228 feet.

It is not necessary the operation should be confined to a single revolution of head, but there may be made as many as desirable. Thus, as above, the first reading 5.00, 3 revolutions gives 8.81—difference 3.81; divided by 3, number of revolutions, 127. Again, first reading 4.50, 2 revolutions give 9.06—difference 5.56; divided by 2, number of revolutions, 228 feet.

2d, By having an ascertained base, as two targets or other marks placed upon a rod, at any desired distance apart. *Bring telescope on one target or mark, note reading, and turn micrometer head until it strikes other; the difference in readings or number of graduations passed over by micrometer head, divided into base and multiplied by* 100, *gives distance.*

If in previous figures we denote D D′, on this case, our base by b; C D the distance by d; number of graduations passed over by n; then we obtain as formula, $d = \frac{b}{n}$;

or, DISTANCE EQUALS BASE, DIVIDED BY NUMBER OF GRADUATIONS.

As the graduations are hundredths of a whole revolution, it is necessary to multiply result by 100 to bring it to feet.

Thus, targets are placed 6 feet apart, number of graduations passed over are 250, or 2 revolutions, 50 graduations; then

$$\frac{600}{250} = 2.40 \times 100 = 240 \text{ feet.}$$

Targets 8 feet apart, graduations 315,

$$\frac{800}{315} = 2.539 \times 100 = 253.9 \text{ feet.}$$

The advantages of this last method consists,

1st, In the sights being taken on targets or other prominent marks, more plainly visible than figures or graduations on a rod, by which means a distance of at least three times as great can be taken as where it is necessary to read the figures; or same distance can be taken (except short distances, where figures are *very* distinct) with three times the comparative accuracy.

2d, The base can be changed as desired, and made to suit the nature of work and character of ground.

It is not necessary in this method to use a graduated rod; any two marks at ascertained distance apart answer equally as well.

In previous description we have supposed the fineness of screw to be such as to give a ratio of one foot vertical to 100 feet horizontal. We have deemed it preferable, in our larger instruments, to make screw finer, as giving more sensitive motion, and have made it to have ratio of 0.5 foot vertical to 100 feet horizontal. The former rules should then be modified as follows:

TO RUN CERTAIN GRADIENT.

Turn micrometer head, double the number of graduations of micrometer head that is wanted in feet, per hundred.

Thus, wanted 1.7 ft. per 100, turn 1.7 × 2 = 3.40.

TO MEASURE A GRADIENT.

Divide the number of graduations of micrometer head by 2, *to obtain ratio per hundred.*

Thus, 280 graduations, $\frac{280}{2} = 1.40$ foot per 100.

TO MEASURE DISTANCES.

1st, By use o usual graduations on rod. *Move double number of revolutions.*

Thus, two revolutions give 2.60 on rod; distance equals 260 feet.

2d, By ascertained base.

Change formula into $d = \frac{2b}{n}$;

OF DISTANCE EQUALS TWICE THE BASE, DIVIDED BY THE NUMBER OF GRADUATIONS

Thus, base 6 feet, graduations 500; distance 240 feet.

In use of Gradienter, as in use of every instrument to which a screw movement is attached, it is preferable to set micrometer head somewhat back, and bring it up to readings in direction in which movement is to be made. Though, perhaps unnecessary, it is a precaution that is always advisable.

The utility of Gradienter in running of grades on rail-road or other work, or in measuring gradients on preliminary or location, are evident to any engineer.

To illustrate its benefits in a general way, suppose the Engineer to desire a position of point, not only as regards alignment, but also as to distance, grade and difference of level.

He sends rodman to point, with target (fixed, if desired, at height of instrument), and with another target, or other plain mark, placed at, say 6 feet apart from first. He brings telescope level by micrometer head, and from this raises or depresses telescope, by micrometer, until it strikes first target. His readings then give him his gradient. He then makes a full revolution (or two or more if desired), and reads distance on his rods; or, he uses base on rod, and reads the number of graduations passed over, and thus obtains distance; or again, uses both methods, one to check other. Having distance and gradient, he multiplies them together, and obtains difference of level.

Example.—Suppose, with screw giving ratio of 1 vertical to 100 horizontal, the observations are:

From level he depresses . .	283 graduations.
1 turn of screw gives . .	310 feet on rod.
Motion over base of 6 feet gives .	193 graduations.
Then, 1.92, divided into 6, gives .	310.1.
Results, therefore, gradient, . . .	2.83 ft. per 100 ft.
Distance, ...	310 ft. by reading.
Or more accurate by base, . .	310.1.
Difference of level, 2.83 × 310 .	8.773.

With screw giving ratio of 0.5 ft. per 100 feet, the observations would have been—

From level, grade . . .	5.66 graduations.
2 turns of screw give . .	310 ft. on rod.
And base 6 feet, ...	286 graduations.

No other instrument in practical use accomplishes the same results, viz., measurement of distances, grade and differences of level. For the measurement of distances we believe it preferable to the stadia wires. As a measure of comparison we generally place fixed stadia wires in telescope. As compared with stadia it has several advantages; the line of sight is in all cases directly in optical axis of telescope, being unaffected by want of flatness in the field, a source of inaccuracy and great objection to the stadia; the measurements are made from centre of instrument direct, while in stadia measurements it is claimed allowance must be made for focal distances.

A great advantage in favor of Gradienter lies in the inability to use ordinary stadia wires at a distance beyond where the figures on rod are plainly visible,—the setting of targets in use of stadia is so slow, and so difficult an operation, as to forbid its general use, while the reading of hundredths of a rod, at any great distance, is an impossibility. The Gradienter, on contrary, in use of base system, makes the sights to targets or other marks which can be made, as distinct as needed. Not only this, but the base on Gradienter can be altered—made large or small—to suit character of work desired.

That property of the Gradienter, by which all that is positively required for its use, is to know the simple distance of marks or targets apart, is a remarkable illustration of merits of Gradienter. Using this distance as a base and measuring distance by micrometer screw,—WITHOUT USE OF GRADUATED ROD, with nothing but the knowledge of this distance of targets—then follows:

The measurement of Grade.
" " of Distance,
" " of difference of Level.

It is not even necessary to *know this distance at the time.* In case of emergency two marks may be placed upon a temporary rod, the observation made and distance of targets obtained afterwards.

The form of Gradienter, of German origin, where the micrometer screw is placed under the end of telescope, entirely prevents the use of instrument as a Transit, producing an instrument which the Engineers of this country look upon with especial disfavor.

With advantages enumerated, taken in connection with its adding nothing to weight or complexity of Transit with level to telescope, we feel confidence in recommending to favor of profession Young's Gradienter.

EYE PIECE.*

The Improved Eye Piece adjusts the focus to web with great precision and smoothness. It is so made that the eye piece does not turn as it moves out and back, but moves in same straight line, preventing rotation of eye piece upon image.

An incorrect focusing of eye piece produces parallax in sighting, throwing object to one side or other of web. An accurating focusing of eye piece is of as much importance as power of telescope; and as power increases it is the more difficult to focus with the usual slide—with extreme high power almost impossible—hence, importance of this improvement.

* The original adjustable eye piece we believe to have been made by Messrs. Kübler & Seelhorst. We believe our method to be an improvement.

IMPROVED TELESCOPE OR WEB FASTENER.

In the usual construction of the Level instrument, even when in perfect adjustment, an observation taken other than at immediate intersection of cross web, tends to produce error, from the rotation of telescope in Y bearings throwing all other parts of horizontal web above or below the true level line. The bringing to exact intersection on rod is tedious,—the examination and correction of horizontal web each time still more so; while, unless one of these are resorted to, error is almost certain, and this error is the great source of inaccuracies in operation of levelling.

To obviate these errors, we fasten the telescope on the Y's so as to prevent any rotation. Observations can be made at any portion of the field of view, equally as well as the centre. Another advantage consists in the certainty with which the Engineer can regulate the perpendicularity of his rod.

The attachment interferes in no manner with adjustment of instrument. It has met with universal approbation wherever used.

SLIDE PROTECTOR.

The motion of tube or slide of object glass upon main telescope tube is apt in time to wear, one or both sufficient to produce a shake, the result of which is to throw line of sight to one side or other in focusing the telescope. Inability to wear a long time without shake is a sign of a poorly constructed instrument; but even in best constructed the dirt, grit, &c., which adheres to slide and is carried into tube by it, is a cause of more rapid wearing, or a greater inconvenience at the time, be a fretting of the slides. Rain and moisture is also carried in, making air inside of tube damp and affecting the performance of telescope.

As a preventive we have added our SLIDE PROTECTOR,—a thin tube or sleeve covering the slide and moving with it, so that neither dust nor dirt can reach it.

The attachment preserves the slide, upon which perfection of collimation depends, in good condition for a much longer time.

TANGENT.

The Tangent with double nut, or a follower, and spring between the two in such manner as to keep them apart, is an English invention.

It forms a desirable method, whereby the wear of a screw is constantly taken up and dead motion prevented.

We have improved upon this by an addition, so covering the tangent as to prevent dust, dirt, &c., from reaching it.

There are other points of improvement in our tangent screw, such as length of attachment, by which the screw is kept acting more nearly at a tangent.