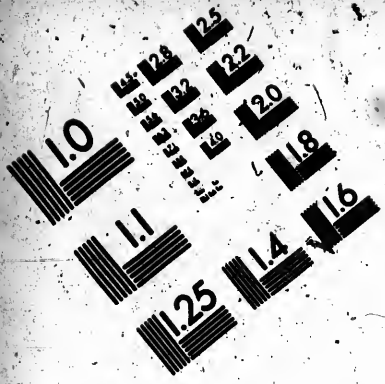

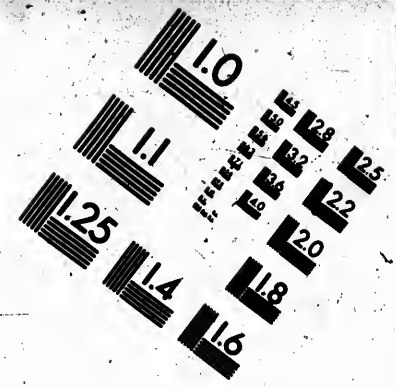

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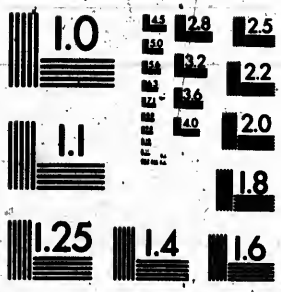

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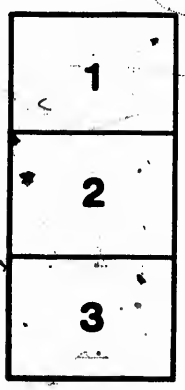

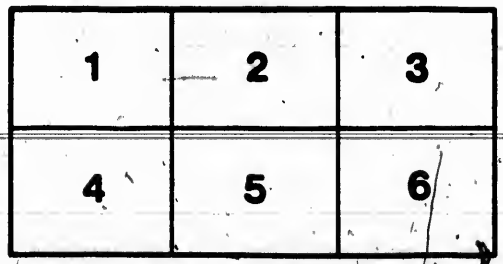

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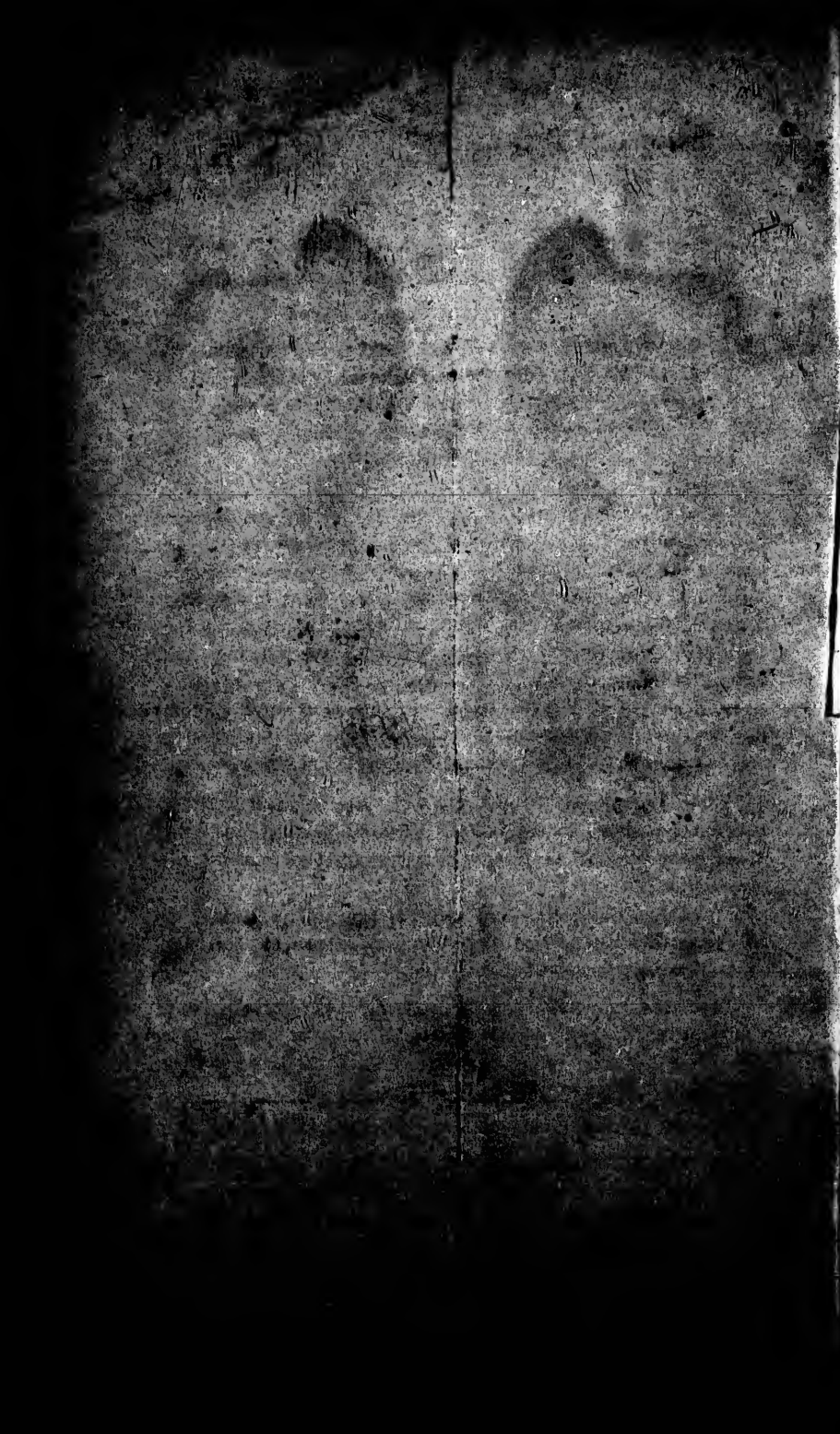


From G G.D. R. Shanly Quebec Sept 1880.

"THE CITOMETER,"

An Instrument for setting out Slope-Stakes and computing the cubic contents of Earthworks on Railroads, Canals, &c. by a newly invented system, patented, and lately brought to the notice of the Engineering profession, by W. E. Soare, Civil Engineer.

The Citometer has been subjected to the most severe tests in comparative trials against the methods hitherto in use for performing the work for which it is designed, and the result shows it capable of doing *three weeks' work in one day.* It is much more accurate, the removal of all need for calculation reducing the chance of error to a minimum. The time saved by the new system is enormous, and the Instrument itself is so handy to carry, so simple to operate, and so accurate in its working, that the certainty of its completely superceding the level and rod in cross-sectioning, &c. will be established directly it becomes known.

This Instrument, in the hands of one Engineer and an assistant, has shown its capability of accomplishing as much work in one hour as would be performed by the old system in twenty-three hours.

It enables the Engineer to arrive at the amount of work to be executed, while in the field—doing away with all need for caloulation, and for plotting, in the office. How?

The amount of chopping necessary for cross-sectioning with it in bush land is reduced so as to dispense with the services of at least 3 men per party, while this class of work can be done by it in less than one-fortieth the time now required.

It is much more reliable than the old, complicated style.

It can be used in all weathers, and in lights where the level would be useless, and the Engineer can wear his mitts in winter —no small boon, and its working is at all times under his immediate notice.

For measuring up *partly finished work* it will be found to save much time—using it as in obtaining data for ordinary plotting of cross-sections, as already described.

The annexed lithograph, fig. 1, will, with the following description, show the Citometer and its working.

A. is a staff or rod about 6 ft. high, graduated on one side; B. is a sliding frame with an arm which can be set at any angle to the rod, so as to correspond with that desired for the slope of the cutting or embankment. B. is so arranged that it can be raised or lowered to any position on the rod—and held there.

The rod can be held perfectly vertical, by means of a plumb-bob.

C. is a tape-line, the end of which is passed through an eye at one end of the arm and hung on a hook at the other, near the rod. It will be seen that in plotting a cross-section the length of this tape, in a direct line from the rod, through the eye, to its point of contact with the ground, will give the position of that point as the height of B. upon A. is already known. If any intermediate spot, such as D. has to be plotted, let the tape be held at that spot and the slide lowered till the tape is in line, and note the height of the slide and the length of the tape.

In this way levels can be taken at numerous points, as F., G., in an incredibly short time.

To show the accuracy with which the spot E. can be ascertained, it will be found that by holding the tape even *one quarter of an inch* too far from the rod the tape will catch the upper side of the eye, as it will the *lower* side if held too near. It must always pass clear of the eye in a perfectly straight line.

In ascertaining sectional areas and the cubic contents of cuttings and embankments, no calculation is necessary as under the old style with the level.—*Vide Fig. 2.*

In all cases the centre levels have to be run, and in the operation about to be described the grades must have been determined and the cuts and fills recorded, either in the notes, or on the profile or centre stakes.

Let A. B. be the cross-section at a spot where a cutting has to be made, whose sides shall be between C. D. E. F., and whose

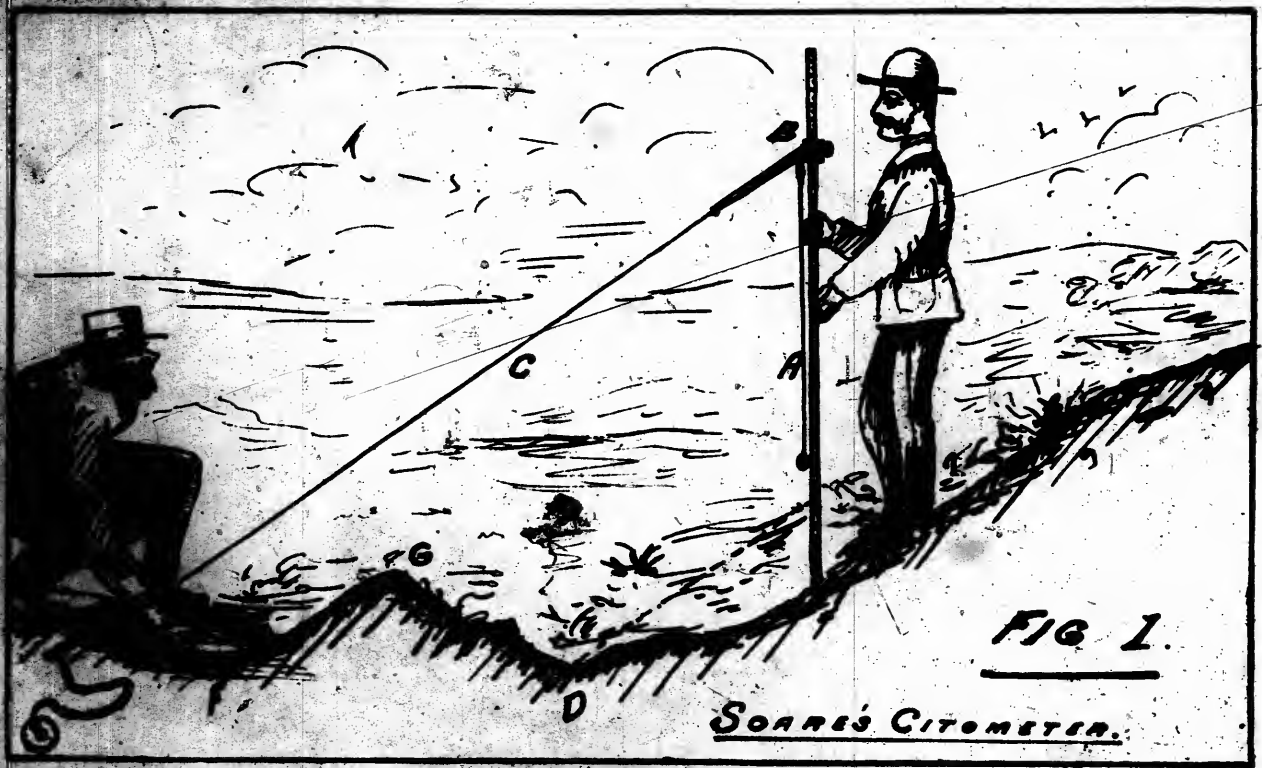


FIG 1.

SOANE'S CITOMETER.

MR. SOARES FORMULA.
(corrected)

R Total length of Rods.
T " " Taper.
S Sine of Angle DJE = .832 (constant for 1½ to 1 slope.)
B [illegible] DJE, (constant for each width of road bed)
X Required area GHEF.

Then

$$X = \left[\left(\frac{R \times T}{2}\right) \times S\right] - \tfrac{1}{2}B.$$

T	48.6
R	15
	2430
	486
2	729.0
	364.5
S	0.832
	7290
	10935
	29160
	303.2640
½B	27
X	276.26 area GHEF.

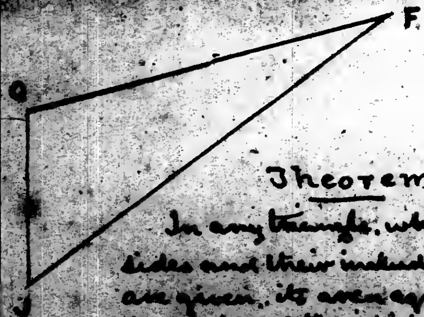
Correct area.
See two following pages.

17.4
15
870
174
2) 261.0
130.5
0.832
2610
3915
10440
108.5760
27
X [illegible] area GHEF. correct.

276.3
81.6
357.9
Total

277
82
359

True area of Cross Section, calculated in the usual way = 81.75.



Theorem.

In any triangle, when two sides and their included angle are given, its area equals half the product of those sides into the sine of the included angle;

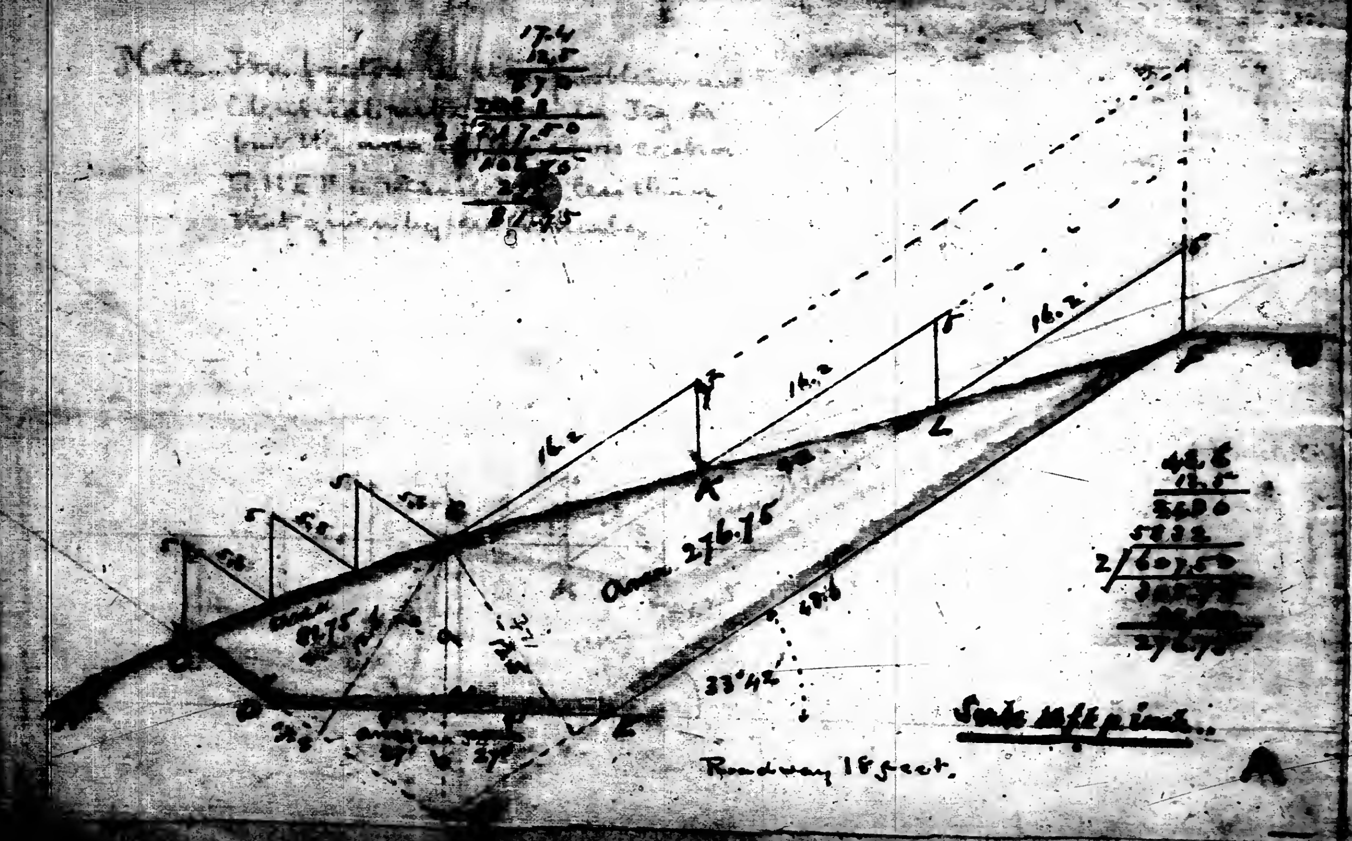
[illegible]) X [illegible] GJF]

17.4

... of the included angles; [illegible] x [illegible] OJF]

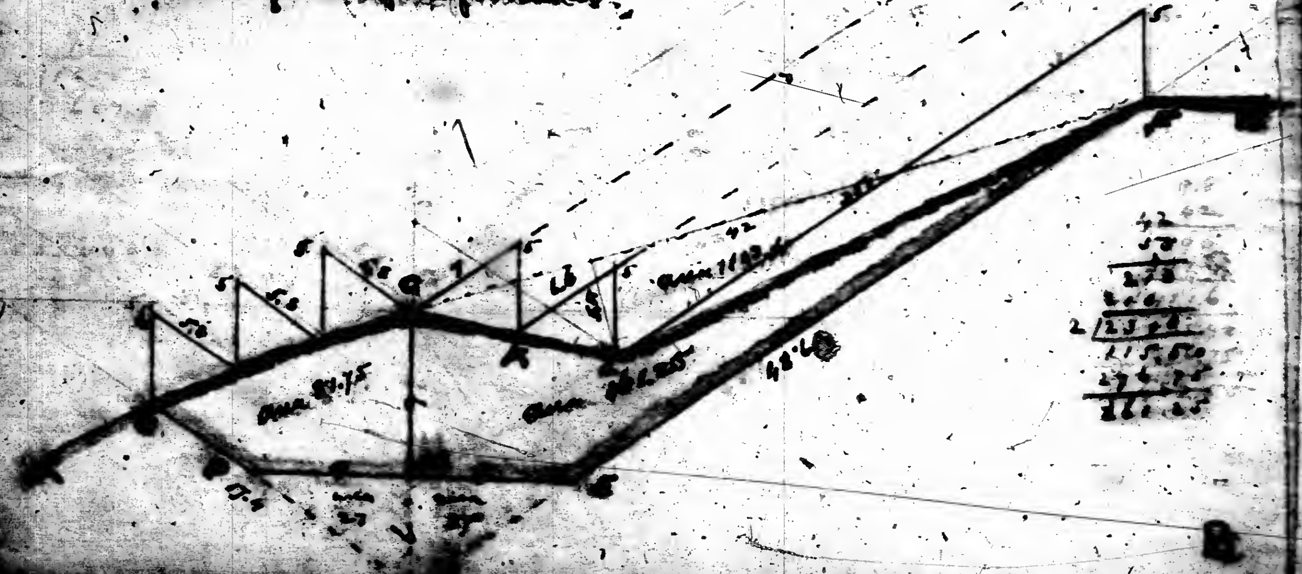
True area of Cross Section, calculated in the usual way, = 81.75.

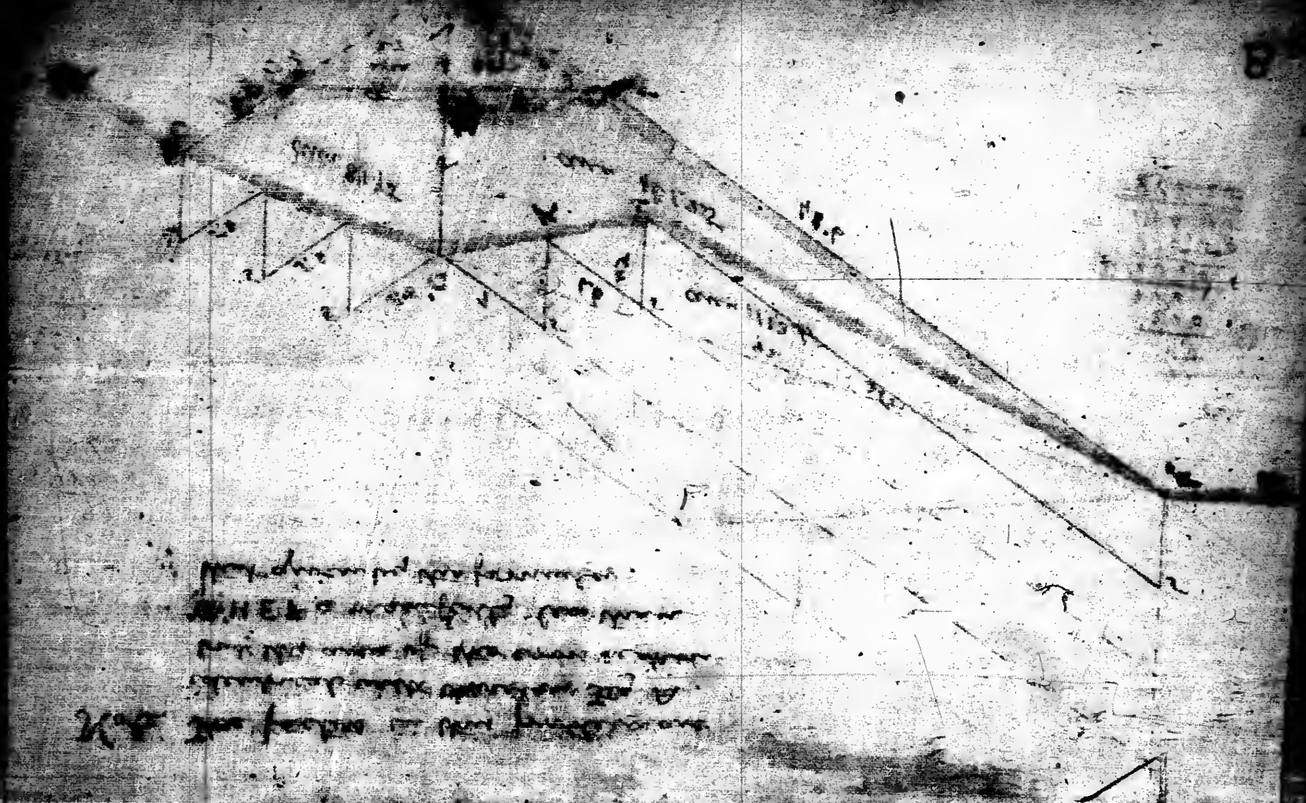
100.5 [illegible] / 27 x [illegible] cu. yds. [illegible] correct.



Note. The features in this portion are identical with those in Fig A'.

Note. The factors in this problem are identical with those in Fig A'. but the area of the cross section [illegible] H E P is manifestly less than that given by the formulae.





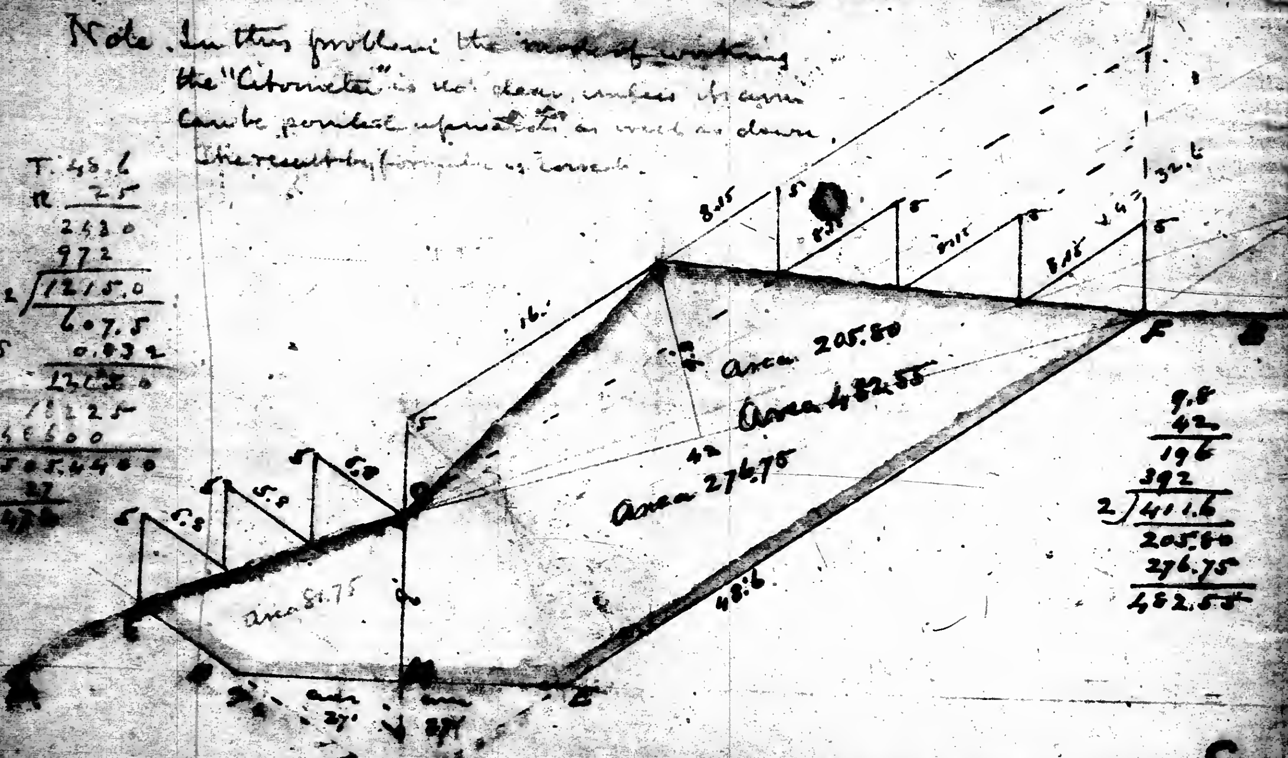
[illegible]

Note. In this problem the mode of working the "Clinometer" is not clear, unless it

No. 8 [illegible]

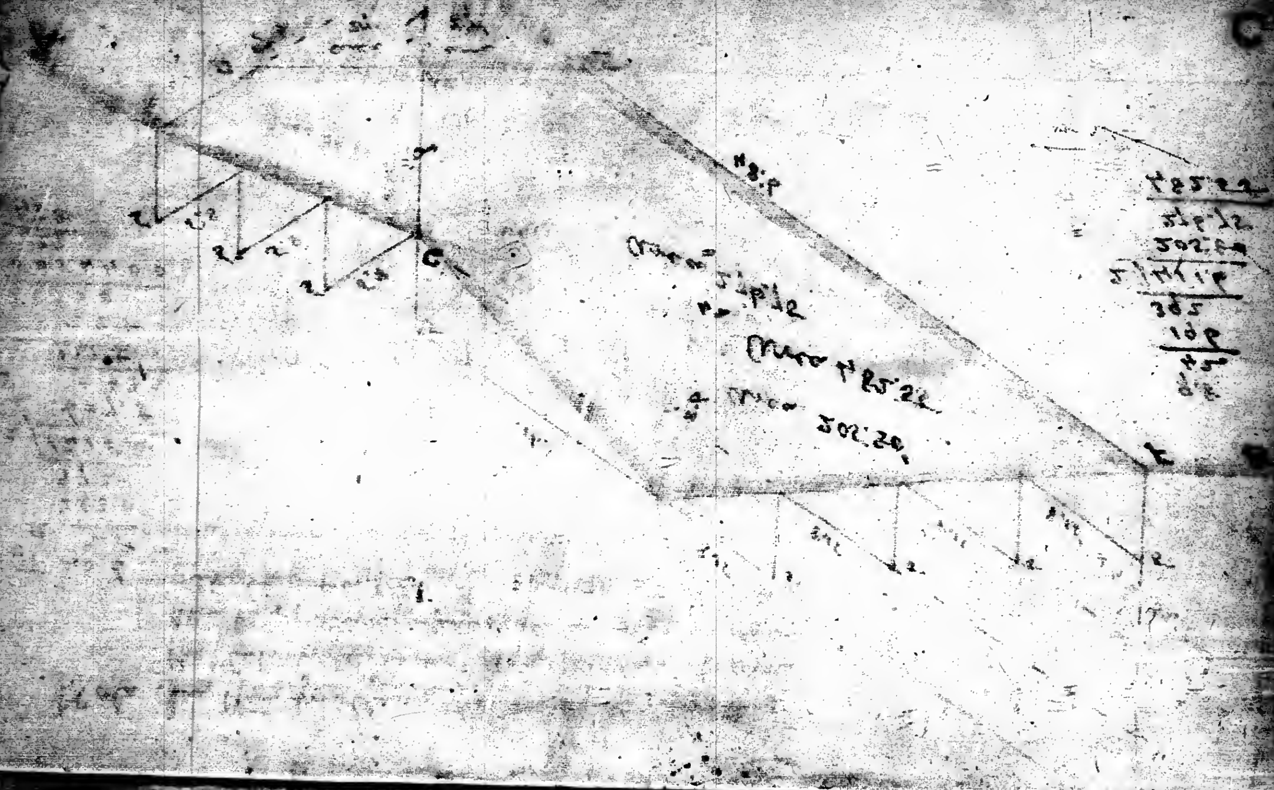
Note. In this problem the mode of working the "Citometer" is not clear, unless the figures can be pointed upon [illegible] as well as down. The result by formula is correct.

T. 48.6
R 25
243.0
972
2)1215.0
607.5
S 0.832
12150
18225
48600
505.4400
27
[illegible]



9.8
42
196
392
2)411.6
205.80
276.75
482.55

C



SORRE'S CITOMETER.

FIG. 2.

base (sub-grade or formation level) shall be, say 18 feet wide between D. and E. It is required to find the sectional area of C. D. E. F. and where the slope-stakes C. and F. will stand. The depth of cutting at G. (ground level) down to H. (sub-grade or formation level) is to be, say 9 feet. Now, whatever may be the width D. E. add one-third such width to G. H., (*This is for slopes 1½ horizontal to 1 perpendicular,*) which will reach J., and the sum will then represent "*height of rods.*" The sliding frame (B., fig. 1) can be set as high as 5 feet, therefore three such heights will equal G. J. *i.e.* 9 + ⅓ of 18.0 6 = 75 ft. of rod.

So, first set the rod to 5 feet and hold it in such a position that the tape stretched (as in fig. 1) will strike the ground at G. (fig. 2); now the arm is set at the angle desired for the slopes C. D. and E. F., viz: 1½ = 1, therefore the slope of the tape is parallel to E. F. Now, hold the tape at K. and move the rod—with slide still 5 feet high thereon—towards B. till the tape is again in line; move the rod towards B. till the tape is in line and strikes at L. The foot of the rod will then be on F.—*the position for the slope-stake.* And because the sum of the rods has been shown to equal G. J., and the tapes have been shown to be parallel to E. F., all the rods vertical, and the angle of the tapes and rods equal to the angle desired for the slopes, therefore the sum of the tapes must be equal to J. F. As the tapes are stretched their lengths must be noted in a field-book, and the sum of the rods will always = cut (or fill) + ⅓ road-bed. Now, as the area of triangles here shown as D. J. E. will vary according to the width D. E., a set of tables will accompany each Instrument, and these tables are so prepared as to suit road-beds of all widths by deducting from the product of the areas, as C. J. F., on a given segment of line, the areas, as D. J. E., multiplied by the number of places at which cross-sections have been made and areas found.

In setting out an embankment the rod, and not the tape, has to be held at the centre-stake—otherwise the operation is like that for a cutting.

(Fig. 3.—For *Rock Excavations* an arm is provided with the Citometer. This arm has a sliding scale by which it can be lengthened to the half-width of the road-bed. It has also a bubble

near its junction with the rod, and it can be raised or lowered so as to make it level between the foot of the centre-stake and the rod. The position of the end of this arm on the rod when so levelled will give the difference in ground-level between the centre and the half-width, and the mean of the cutting has then to be multiplied by the half-width of the road-bed. This gives the superficial area of E. F. G. H., and for that of G. H. B. proceed as in fig. 2, with the small arm of the rod set at an angle of, say 1 to 4—the usual slope of rock-cutting faces. G. H. B. will contain the product of H. B. ÷ 2 × G. B. The use of the arm will be seen to save much work which would otherwise result from the great depth of D. below F., caused by the acuteness of the angle F. D. G.

Formula for ascertaining sectional areas, and by which the tables above referred to are computed:

R. = Rods.

T. = Tapes.

S. = Sine of angle formed by face of slope and a vertical line from centre line of cut or fill to J.—(fig. 2).

B.—Base, or that portion of C. J. F. below D. E.

X.—Sectional area G. H. E. F.

Then

R. and T. ÷ 2 × S − ½ B. = X. = [½((R × T) × S)] − ½ B.

The patentees, Messrs. W. E. Soare and G. J. O'Doherty, will be happy to make arrangements with Engineers, Railroad Companies, &c. for the right of using the Instrument.

Apply to

G. J. O'DOHERTY,
Solicitor,
OTTAWA, ONTARIO,
CANADA.

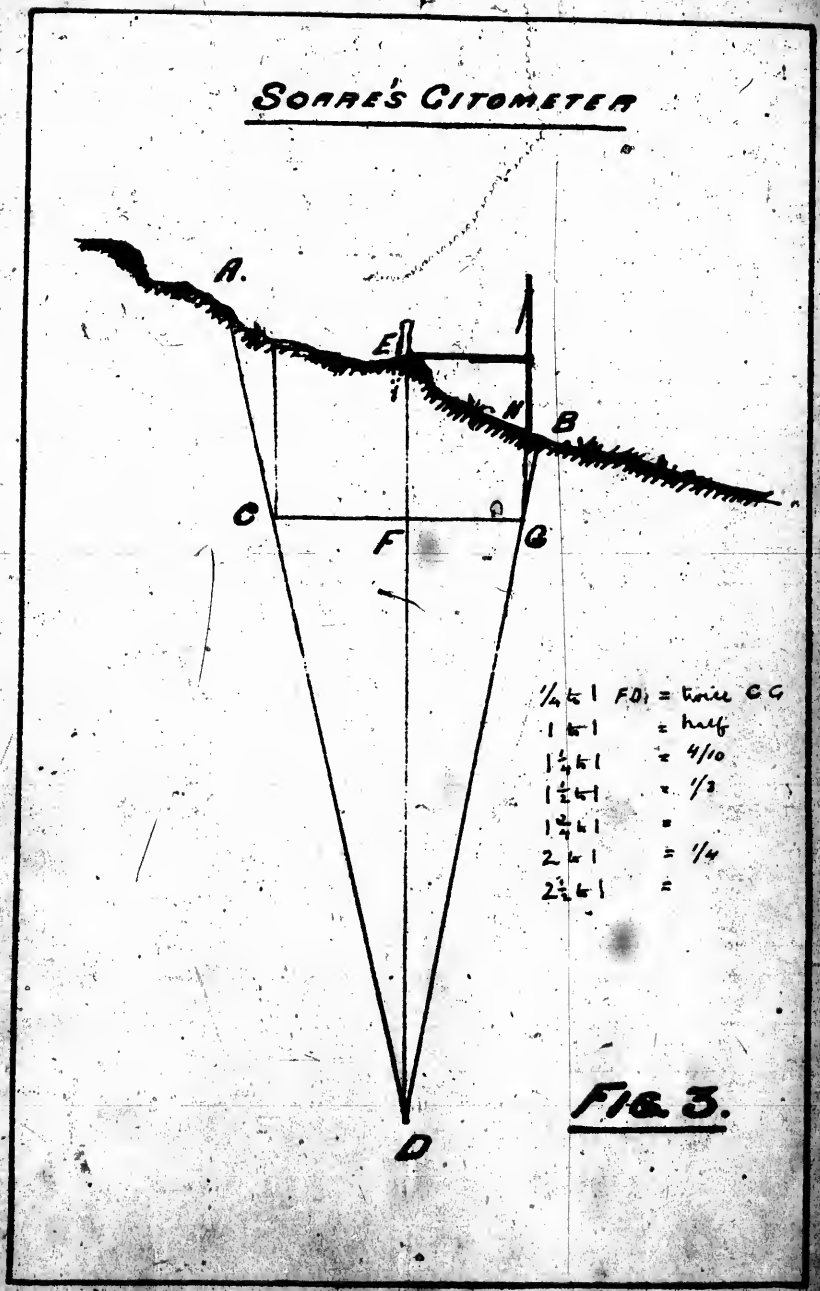

SOARE'S CITOMETER
A.
E
N
B
C
F
G
D
1/4 to 1 FD = twice CG
1 to 1 = half
1 1/4 to 1 = 4/10
1 1/2 to 1 = 1/3
1 3/4 to 1 =
2 to 1 = 1/4
2 1/2 to 1 =

FIG. 3.