WHITING'S PATENT

INTEGRATOR

A NEW, SIMPLE AND ACCURATE INSTRUMENT FOR OBTAINING AREAS.

Especially suited to the Requirements of Naval Architects, Ship Builders, and others. . . . .

J. HALDEN & CO., Ltd.,

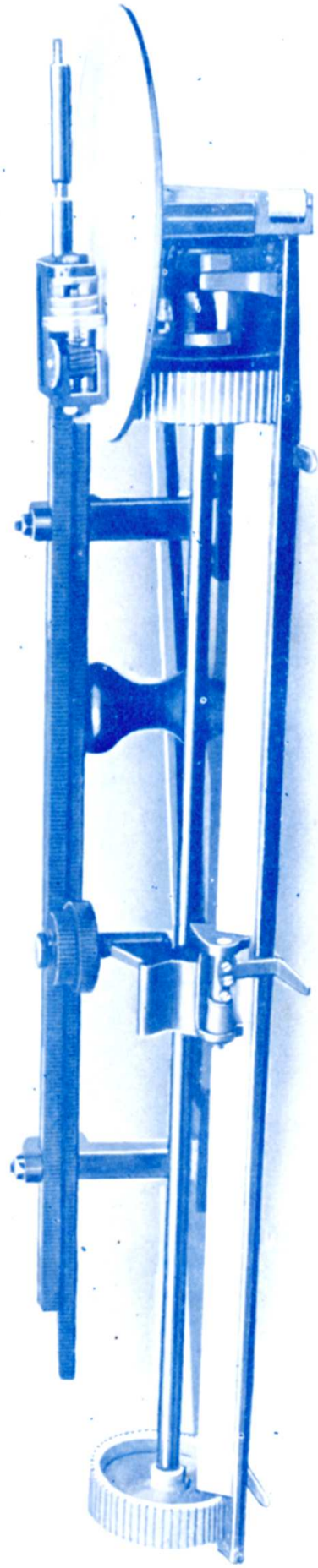
8, ALBERT SQUARE, MANCHESTER.

LONDON: 8 & 9, Great Chapel Street, Victoria Street, S.W.

NEWCASTLE-ON-TYNE: 8, Grainger Street.

BIRMINGHAM: 27, Upper Priory.

GLASGOW: 17, Cadogan Street. LEEDS: 14, Park Row.



DESCRIPTION

OF THE

NEW CONTINUOUS READING

INTEGRATOR.

Patent No. 21955/07.

SCOPE.

This instrument, the invention of Mr. W. R. G. Whiting, M.A. Cantab: Assoc. Memb. I.N.A., &c., has been designed to meet the special requirements of Naval Architects and Shipbuilders, but will be found of the greatest value to all who have to evaluate areas contained by a curved line and co-ordinate axes.

It is more expeditious than a planimeter and far less delicate than the usual form of integraph. Simple in principle

and use, it will be generally found preferable to either of these instruments. *It may be mentioned in passing that an attachment for automatically drawing the curve of areas can be supplied.*

Areas of unlimited length and of any width not exceeding 10½in. can be rapidly and accurately integrated. The average accuracy is approximately one third of one per cent.

Instead of tracing out the whole outline of the area to be dealt with, only the curved boundary is followed, and as each abscissa is reached the reading of the counter gear registers the actual area up to that point. It is therefore continuous in its action. Referring to Fig. II., which may be supposed to represent two stations from a body plan of a ship, the instrument is set to advance perpendicularly to x x. Placing the tracing pointer at o, the section is followed up to L2, and the reading then gives the area up to this water line. Continuing to L4, the reading now gives the total area up to this new water line, and so on.

The saving of time and labour over the old planimeter method when the areas of many sections up to numerous water lines are required is obvious.

The areas of half-breadth plans can be measured in a single operation, no matter how long the ship; and special

side rollers are provided for guiding the instrument by a straight edge should the parallel roller motion be liable to slight irregularities.

Electricians and meteorologists can readily obtain the mean heights of power graphs or barometrical charts similarly.

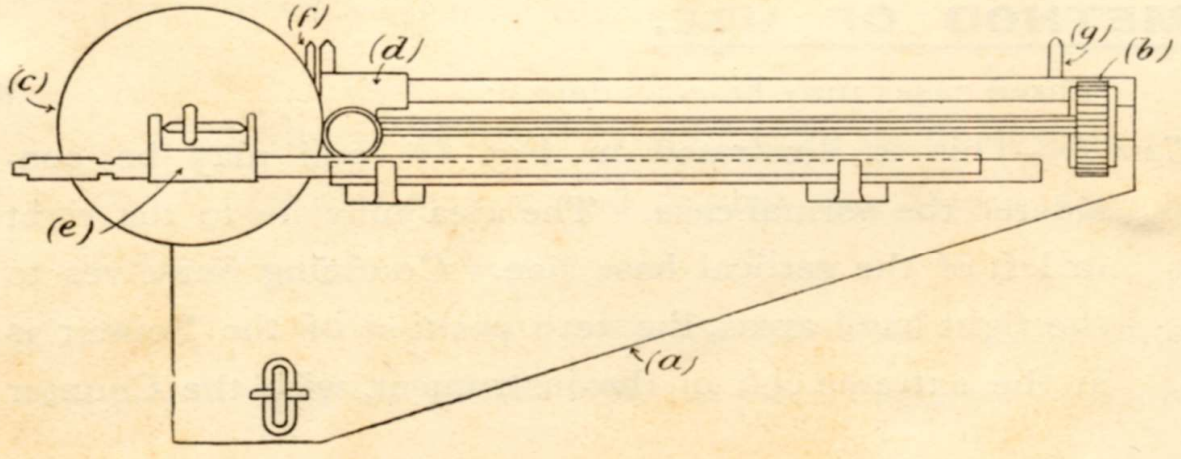
The instrument offers to teachers the simplest experimental illustration of the methods of the Integral Calculus.

PRINCIPLE.

Referring to the diagram in Fig. I., the instrument consists essentially of five parts, viz.: (*a*) the Frame; (*b*) the Parallel Roller motion, from which the rotation of (*c*) the Disc is derived; (*d*) the Tracing Pointer and Reduction Gear, which causes the (*e*) Counter Mechanism to slide outwards from the centre of the Disc.

FIG I

(a) Frame
(b) Parallel Roller
(c) Disc
(d) Tracer & Reduction Gear
(e) Counter Mechanism
(f) & (g) Pointers for Setting



The action is as follows: As the instrument is *advanced* the rotation of the Disc, driven directly from the Parallel Rollers, is proportional to the amount of this advance. As the Tracing Pointer is *traversed* from left to right, the Counter Mechanism moves a proportional distance from the centre of Disc. Hence the rotation of the Counter Wheel, which depends simultaneously on the angular motion of the Disc and on its own distance from the centre of the Disc becomes a measure of the advance of the whole instrument, and of the simultaneous transverse position of the Tracer. Since this is true continuously and for all relative positions of the Tracing Pointer and Instrument, it follows that the total rotation of the Counter Wheel is proportional to the area swept out.

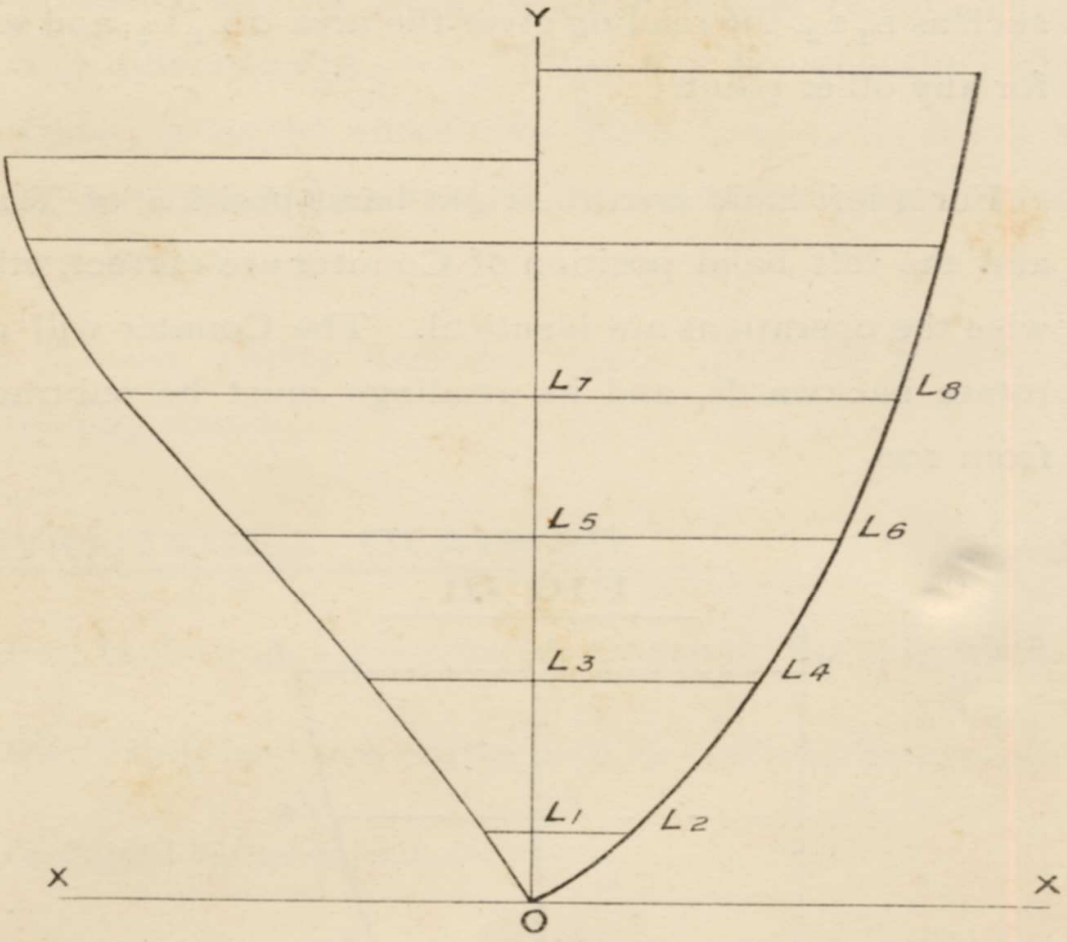
In the symbols of the calculus, where x measures the horizontal position of the Tracer from O Y and y the advance of the instrument, the increment recorded by the Counter Wheel in advancing the instrument through $d\,y$ is a measure of $x\,d\,y$ and the total reading is $f\,x\,d\,y$.

METHOD OF USE.

Three cases may be considered :—

Case I.—This is illustrated in Fig. II., and may be considered the normal case. The area may lie to the right or left of the vertical base line. Confining ourselves to the right hand areas, the zero position of the Pointer is at the extreme left of the instrument, with the Counter

FIG. II



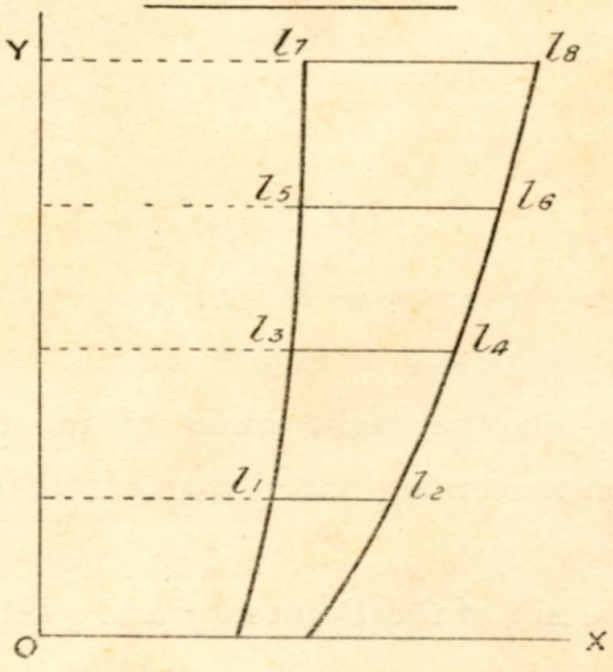
Mechanism on the right hand of its two alternative positions on traversing bar.

With the aid of the Pointers *f* and *g* set the instrument to roll parallel to x x, and so that the Tracer at zero position follows the line o x. Then, starting from o, advance the instrument with the left hand, at the same time moving the Tracer with the right finger and thumb,

so as to follow the curved outline. On reaching any line such as $L_1 L_2$, the reading gives the area o $L_1 L_2$, and so on for any other point.

For a left hand area the right hand position of Tracer and the left hand position of Counter are correct, otherwise the operations are identical. The Counter will now rotate backwards, and its readings must be subtracted from 100.

FIG III.



Case II.—Here the area lies between two curved lines (sections of a coal bunker for example). Trace the outer

curve, obtaining readings A_2, A_4, A_6, &c., and repeat the operation for the inner curve, obtaining A_1, A_3, A_5, &c. The differences $(A_2 - A_1)$ $(A_4 - A_3)$, &c., give the required areas up to the successive lines l_1 l_2, l_3 l_4, &c. Note that the precise position of the instrument, right or left of O Y, is immaterial.

Case III.—A wholly irregular figure must be traced completely round.

ADVANTAGES CLAIMED.

¶ More rapid than a planimeter, especially for ship work.

¶ More handy and less costly than an ordinary integraph.

¶ Unlimited range in one direction.

¶ Unlike a planimeter, its recording is continuous; hence, besides the great saving of time and labour, more accurate results may be expected, owing to a planimeter's readings being the difference of two large opposite rotations.

¶ The chances of error are lessened by the fact that the record *at each moment* is a *direct measure* of the area and not, as in a planimeter, a number bearing some unknown relation to the area.

WHITING'S PATENT INTEGRATOR.

The instrument will be found invaluable to Naval Architects, Engineers. and others, for the purpose of calculating—

Displacements. Stability. Cargo Spaces.

Launching Diagrams. Moments of Inertia.

Graphical Bending Moment Diagrams.

Mean Heights of Power Station Charts.

Barometric Records.

Sectional Excavation Diagrams.

WHITING'S PATENT INTEGRATOR.

The standard size instrument integrates (i. e. continuously measures the areas under) any figure of which the maximum breadth does not exceed 10 in. (or 25·4 cms.) The length dealt with is unlimited, but where the maximum height of the figure exceeds 15 in. it will be found advantageous to pen a batten or straight edge at the left hand side of the drawing, so that the rollers at that side of the instrument frame form a guide. The counting mechanism records up to 100 units. This is equivalent to about 125 square ins. (or 800 square cms.) If the area is greater than this it will be apparent that to the actual reading 100 units have to be added.

The units are divided decimally, and the one-hundredth parts may be estimated with the aid of the vernier. When areas of a less breadth than 2 ins. have to be dealt with, the locking pin on the top of the pinion gear wheels should be withdrawn and the locking nut at the side of the spindle screwed up. The readings will then be on five times the former scale, i. e.—

$$1 \text{ unit} = \frac{1{\cdot}25}{5} \text{ square in. approx.}$$

the exact multiplier being supplied with each instrument.

As areas to be integrated are usually drawn to varying scales according to the nature of the drawing, it will be found that a multiplier for square inches introduces no special difficulties on that account. For example, on a drawing $\frac{1}{8}$ in. to one foot, one square inch equals 64 square feet and hence 1 unit of the instrument readings equals $64 \times 1{\cdot}25$ or 800 square feet.

Enquiries are invited for sizes other than the standard.

Special patterns to integrate radially and to record moments of areas are under design and have patents pending.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