W. F. Stanley & Co. Ltd.

instructions for the use of the

ZERO-SETTING

compensating polar

PLANIMETERS

Sliding Bar and Fixed Index models

The STANLEY "ALLBRIT"
Zero-Setting COMPENSATING

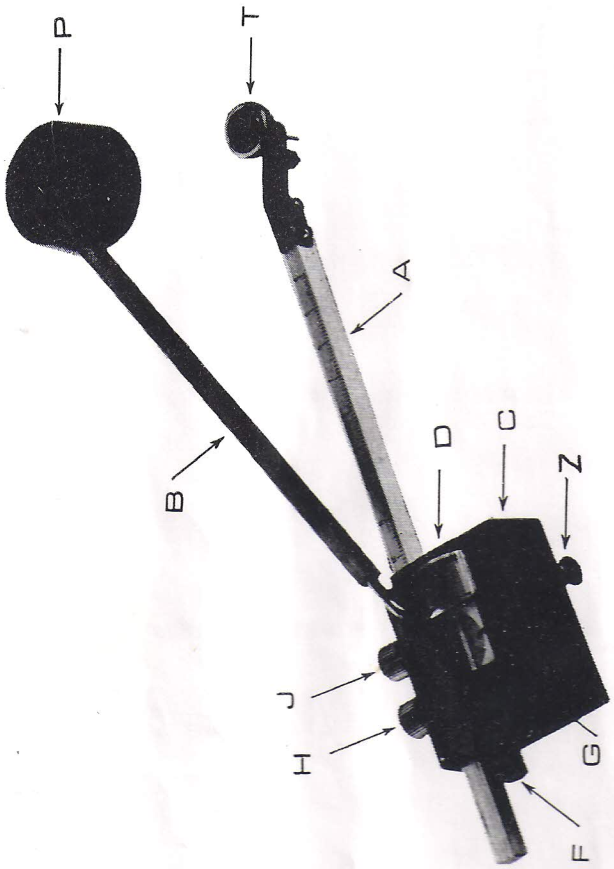


Fig. 1

Many other types of ALLBRIT Planimeter are available, both for measurement of area and for the evaluation of a large variety of recording instrument charts, having either uniform or non-uniform scale characteristics. Where possible, enquiry should be accompanied by specimen charts and examples of the work for which the instrument is required.

POLAR PLANIMETER

This Planimeter is a Stanley product, and is an extremely accurate, and yet robust, instrument which, with ordinary careful treatment, will yield consistently good results.

The zero-setting arrangement is a new and time saving feature of this series of planimeters which are now adjusted so that individual calibration is not required : the same settings and constants are applicable to all instruments of the same size. This uniformity is achieved by a careful combination of manufacturing interchangeability.

1. DESCRIPTION

Fig. 1 is a general view of the instrument, showing the following essential features :

THE TRACER ARM, A.

THE CARRIAGE, C which is adjustable to various positions on the tracer arm.

THE MEASURING WHEEL, W to which is attached the divided drum D and to which is geared a COUNTING DIAL G for recording the number of revolutions. See Fig. 1 A.

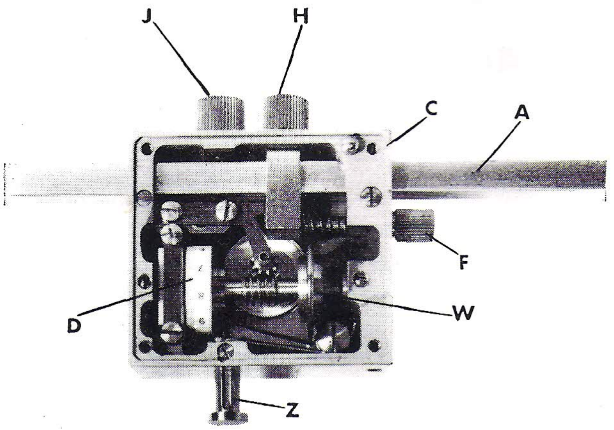
THE TRACER POINT T with ADJUSTABLE SUPPORT to maintain the point just clear of the surface or alternatively a Magnifier Tracer.

THE POLE ARM, B which carries at each end a small sphere, one end resting in a socket on the carriage C, and the other in the POLE WEIGHT P.

THE CLAMPING SCREWS H and J and the

FINE ADJUSTMENT SCREW F.

THE ZERO-SETTING PLUNGER Z.



Underside of carriage with cover plate removed.
Fig. 1A

2. SETTING TO SCALE

On the underside of the planimeter carriage is a printed table of "settings". In column 1 is a number of scales in common use, in column 2 the *scale area* for 1 revolution of the measuring wheel and in column 3, the corresponding "setting' for each scale. Extended versions of this table are given in paragraph 10 later in this booklet (Tables 2 and 3).

It should be noted the setting (*S*) *is the actual area in sq. inches for 1 revolution:* this is a new feature in Allbrit planimeters.

To set the carriage, slacken the clamping screws H and J and slide along the tracer arm to the approximate setting: then tighten screw H and make fine adjustment by turning screw F: finally, tighten screw J. In Fig. 2 the setting shown is 15.50.

3. SETTING TO ZERO

While holding the tracer with one hand to keep it on the chosen *starting point, use the other hand to press and release the zero-setting plunger Z: (Note: raise carriage off paper during operation of pressing plunger) this action will set to zero both the counting dial G and the drum D: if the latter does not remain exactly at zero, fine adjustment can be made by a very slight movement of the pole weight P.

*See Para. 5.

4. READING THE MEASURING WHEEL

The reading for measuring the area consists of two parts:

(a) The complete revolutions shown by the counting dial (G, Fig. 1);

(b) The partial revolution shown by the drum of the measuring wheel itself: the figures and sub-divisions giving tenths and hundredths of a revolution respectively, finally reading to thousandths by estimation to one tenth of a sub-division.

The complete reading, therefore, consists of four figures (if less than ten revolutions have been made), i.e., whole number and three decimal places: thus, in Fig. 2 the reading is 2·125.

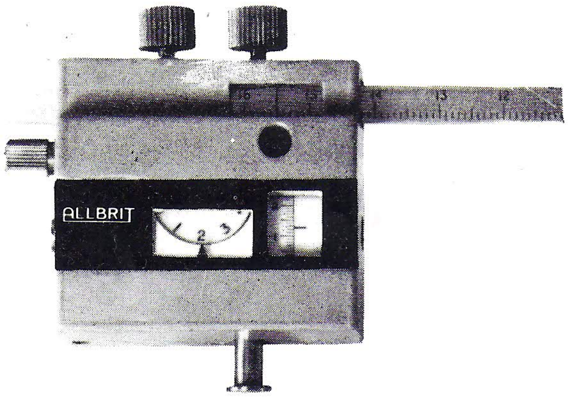


Fig. 2

(Showing reading 2·125, setting 15·50).

5. MEASURING AN AREA

The Planimeter can be used with the pole weight either outside or inside the area to be measured, as shown in diagrams Fig. 3 and Fig. 4, but wherever possible it should be used with the pole outside, as this is the more accurate and less complicated method.

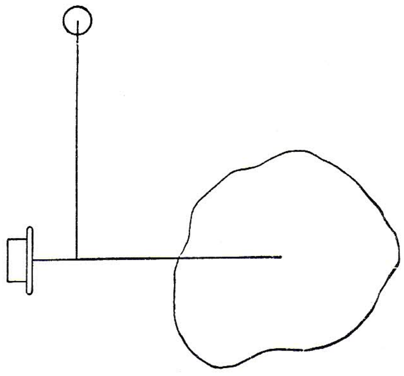


Fig. 3

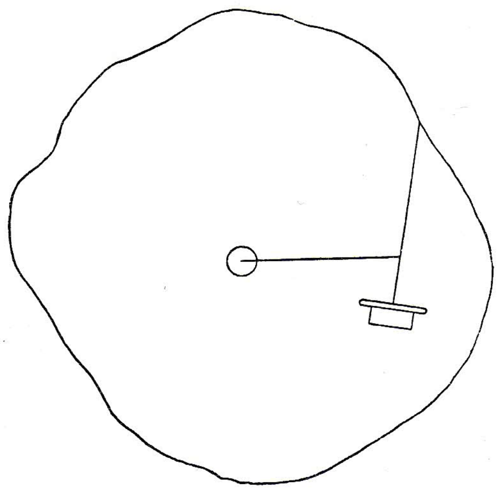


Fig. 4

OUTSIDE POLE METHOD

Assemble the instrument as in Fig. 1 and place on the area to be measured in such a way that with the tracer in the middle of the area, the pole arm is approximately at right angles to the tracer arm (see Fig. 3).

Lightly circumscribe the area to see that it is within the capacity of the instrument, if not, the pole must be placed in another position. If the area is very large it can be divided into sections, and each section measured separately.

Having set up the instrument, find a point (on the outline) at which the measuring wheel does not revolve with a small movement of the tracer along the outline. This point forms a useful starting point for measuring the area, and should be marked; then, with the tracer on this mark, carefully set the measuring wheel to zero as described in Paragraph 3. Trace round the area carefully in a clockwise direction by means of the tracer, finishing at the starting point, and read the measuring wheel: the result will be a value from which can be calculated the area desired.

Example I—Suppose the scale of the plan is 1 : 200 and area is required in sq. metres. Set the carriage on the tracer arm to 15·50, the setting for this scale obtained from the tables (see para. 2). Dispose the instrument correctly about the area (see Fig. 3). Lightly trace round the area and find a good starting-point. Set to zero, trace round the area and note the reading (say 2·125).

Multiply this reading by the appropriate "area per revolution of the measuring wheel," taken from the tables, i.e., 400 sq. metre, 2·125×400= *850 sq. metre.* If it were desired to know the actual area of the plan, the multiplier would be 100 sq. cm. (=15·50 sq. in.).

2·125×100=212·5 sq. cm.

Thus, in the simplest case, these instructions can be summarized:

1. Set up Planimeter and set to zero.
2. Trace.
3. Read area.

INSIDE POLE — FIRST METHOD

The manipulation of the Planimeter with the pole inside the area to be measured is a little more complicated, but enables the instrument to cover a much larger area at one setting up. The CONSTANT (k) in the last column of the tables 2 and 3 on pages 14-17 enters into this, and we will first consider how this is arrived at.

Dispose the Planimeter as in Fig. 5.

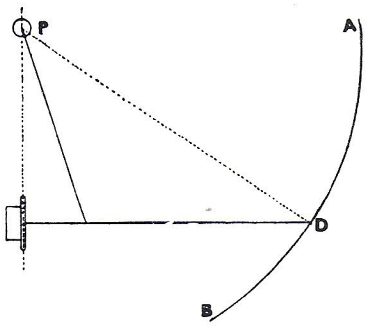


Fig. 5

Take a drawing compass and with centre P describe an arc A B. Now, if this arc be traced with the tracer it will be observed that the measuring wheel makes no movement whatever, and a whole circle could be described in this manner without the measuring wheel making any movement. This circle is known as the Zero Circle and the CONSTANT (k) is the area of this circle *expressed in revolutions of the measuring wheel.* If the area to be measured is greater than the zero circle, then the drum will move forward and measure the amount by which the area exceeds that of the zero circle; therefore, the reading must be added to the CONSTANT to give the true area. If the area is less than that of the zero circle the instrument will measure the difference between the two areas, and this value must be subtracted from the CONSTANT.

The first step with the inside pole method is to find out whether the area is greater or less than

that of the zero circle. This is done by tracing round the area roughly, in a clockwise direction, and noting the total movement of the measuring wheel. This operation is simplified if the dial, and measuring wheel are first set to zero. Frequent readings of the counting dial will reveal whether the instrument is making a forward or backward movement.

If, while the figure is being traced, the counting dial makes one or two complete revolutions, then the values of these revolutions must be accounted for and added to the reading. Note that each complete revolution of the counting dial represents ten revolutions of the measuring wheel.

Having ascertained whether the measuring wheel makes a forward or a backward movement, set to zero and proceed to trace the area as accurately as possible. If the instrument records a forward movement the reading should be added to the CONSTANT; if it records a backward movement the reading should be subtracted from 10·000 and the resulting value then subtracted from the CONSTANT.

Example II. Set up the instrument as in Example I, except that the pole is inside the area to be measured. Roughly trace the area, noting carefully whether the total movement of the counting dial is forward or backward. Suppose the movement is backward: place the tracer on a convenient starting point and set the measuring wheel to zero. Trace the area, returning exactly to the starting point and note the reading, say 3·488. Subtract this from 10·000 and then subtract this difference from the constant, thus:

10·000	Constant (k)	=25·640
— 3·488		— 6·512
6·512		19·128

Had the reading been forward it would have been added to the constant. In either case the result must be multiplied by the appropriate area per revolution taken from the tables as before.

INSIDE POLE — SECOND METHOD

There is another method of inside pole measurement which combines the advantages of both inside and outside pole methods. The area to be measured is either inscribed with, or circumscribed by, a figure of known area (see Figs. 6 and7).

The surrounding strip is then measured as if it were cut at X Y, and added to, or subtracted from, the known area.

This method is somewhat longer than the ordinary method, but it is considered to be more accurate, and it is certainly speedier than dividing up the area to be measured into a number of small areas to be measured separately.

The procedure is to trace the outer contour in a clockwise direction from X to X, then move the tracer along the line XY and trace the interior contour in the reverse direction from Y to Y; finally retrace the line YX. The result is the required reading.

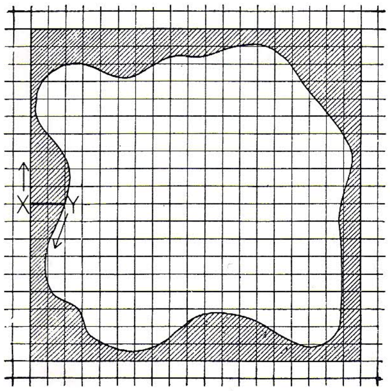


Fig. 6

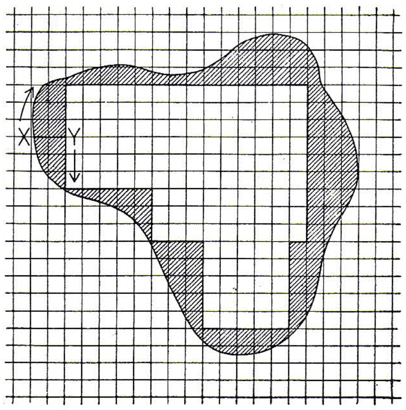


Fig. 7

6. TO FIND THE MEAN HEIGHT OF INDICATOR DIAGRAMS

Adjust the carriage on the tracer arm to the setting 10·00 where the area for one revolution=10 sq. in. Then measure the area of the diagram in the usual way. Find the greatest length of the diagram, and the mean height can then be obtained by dividing the area by this length. For example if x is the area and y is the length of the base, the mean height of the diagram is $\frac{x}{y}$.

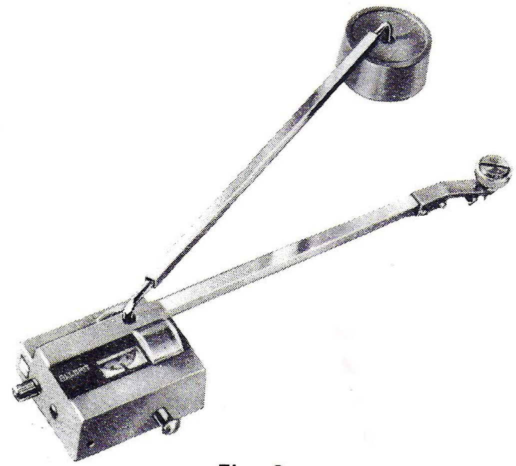


Fig. 8
(Fixed Index Zero-setting Planimeter)

7. THE STANLEY ALLBRIT FIXED INDEX PLANIMETER

This Planimeter (Fig.8) is similar in construction to the Allbrit Sliding Bar Planimeter, but the carriage is fixed and the instrument measures in square inches only or in square centimetres only.

For scales other than full size, conversion tables can be used to find the scale area.

The directions for using the Sliding Bar Planimeter apply, except those for setting the carriage.

8. POLE WAGON

When readings have to be taken from continuous diagrams for the purpose of ascertaining the mean height, a Pole Wagon can be employed. This accessory is illustrated in Fig. 9, and consists of a pair of heavy knurled rollers connected by an axle, with a central pivot. The pole-arm is removed from the Planimeter and the pivot of the pole wagon is inserted in the socket hitherto occupied by the pivot of the pole-arm.

The Planimeter can now be towed in a straight line along the diagram. The use of the pole wagon eliminates much tedious work and calculation, as without it the diagram would have to be divided up into a number of sections and the areas added together.

The procedure is: Adjust the carriage on the tracer arm so that the area for one revolution= 10 sq. in., or other convenient value, dispose the Planimeter and pole wagon so that the latter can be towed as nearly as possible parallel to the base line of the diagram; measure the area of the diagram in the usual way. To obtain the mean height, divide the area thus ascertained by the length of the base line.

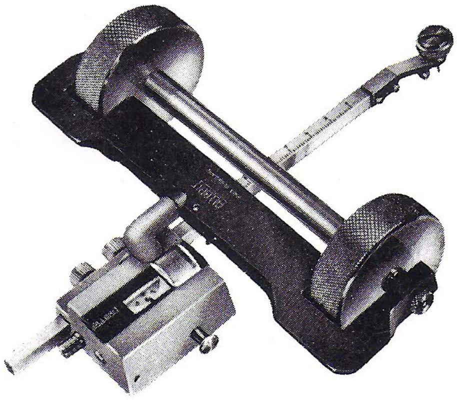


Fig. 9
(Pole Wagon)

9. THE CHECKING RULE

This contains a pentagonal recess to accept the planimeter magnifying tracer also a centre mark between which and the centre needle are known lengths, which form radii of a circle, the area of which is engraved on the rule, and its use is to test the accuracy of the instrument should this be questioned at any time.

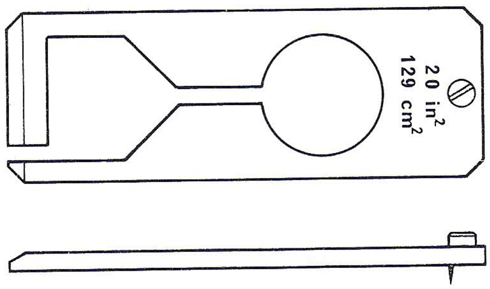


Fig. 10

To use the checking-rule press the needle point into the paper, regard this needle point as the centre of an area to be measured and dispose the Planimeter accordingly, having first adjusted the carriage to the desired area for one revolution. Place the tracer in the pentagonal opening of the rule. (In the case of a planimeter fitted with a TRACER POINT, this point must be placed in the centre mark on the left of the pentagonal opening, the tracer support having first been removed.) Next describe a complete circle and from the resulting reading calculate the area of the circle in the usual way. This should correspond with the area marked on the checking-rule within 1%. If not, the carriage may be incorrectly set on the tracer arm or the axis of the measuring wheel may not be parallel to a line drawn between the tracer point and the pole-arm socket.

On the subject of accuracy it may be noted that for the best results the working surface should be slightly rough: cartridge paper is near the ideal.

10. SETTINGS AND CONSTANTS FOR OTHER SCALES AND UNITS

While the tables (2 and 3) give settings and constants for a large number of scales in common use, it should be emphasised that settings can readily be calculated for *any scale ratio* and *any unit of area* whatsoever.

Let a=number of units of scale area per revolution of measuring wheel.

c=a coefficient depending on the unit chosen (values of c are given in Table 1 on page 13).

r=scale reduction ratio : (e.g. for $\frac{3}{4}''=1'$ r=16).

s=setting=*actual* area in sq. inches per revolution.

then, maximum value of a=

$$\frac{16\ r^2}{c} \quad \text{for standard size planimeter}$$

$$\text{or} \quad \frac{32\ r^2}{c} \quad \text{for large size planimeter.}$$

A convenient 'round' number (such as ·1, ·2, ·5, 1, 2, 3, 4, 5, 10, 20, 30 etc.) is chosen for a, not exceeding this maximum value, then, $s=\frac{ac}{r^2}$.

The CONSTANT k for inside pole method is calculated as follows:

$$k=\frac{179{\cdot}59}{S}+{\cdot}5541\ S+2{\cdot}132$$

(for standard size planimeter)

$$k=\frac{346{\cdot}28}{S}+{\cdot}5541\ S+2{\cdot}132$$

(for large size planimeter)

(These formulae are derived geometrically, using the mean value of certain fixed dimensions of the instruments.)

Example III

Setting and Constant required for scale 1″=1′ (1 : 12) reading in sq. feet, for standard size planimeter.

$$a\ (\text{max.})=\frac{16r^2}{c}=\frac{16\times12\times12}{144}=16$$

choose a=10

$$\text{then } s=\frac{ac}{r^2}=\frac{10\times144}{12\times12}=\underline{\underline{10}}=\underline{\underline{\text{required setting}}}$$

$$k=\frac{179{\cdot}59}{10}+10\times{\cdot}5541+2{\cdot}132$$

$$=17{\cdot}959+5{\cdot}541+2.132=25.632$$

for all practical purposes this value may be rounded off to $\underline{\underline{25{\cdot}630.}}$

11. THE CARE OF THE INSTRUMENT

It is hardly necessary to point out that continued accuracy of the Planimeter depends on its being treated with reasonable care, although the instrument is robust enough to stand ordinary intelligent use.

The tread of the measuring wheel is a very important part of the instrument, and must be guarded against damage by careless handling, or by contact with hard substances. It is best never to touch this tread with the bare fingers.

When the counting dial is at zero, fine adjustment to the zero on the drum can be made by a slight and gentle movement of the pole weight. (See para. 3.)

The measuring wheel should always revolve very freely, and the spindle should have, therefore, a *very slight* end shake. The graduated edge of the drum and its index must not touch.

It is of the utmost importance that the tracer-arm should not be bent, and this should be guarded against, care being exercised in placing the instrument in its case and removing it therefrom.

TABLE 1

Unit of area	C
Sq. millimetre	·001550
Sq. centimetre	·1550
Sq. decimetre	15·50
Sq. metre Centiare	1550
Sq. dekametre Are	$1{\cdot}550\times10^5$
Sq. hectometre Hectare	$1{\cdot}550\times10^7$
Sq. Kilometre	$1{\cdot}550\times10^9$
Sq. inch	1·000
Sq. foot	144·0
Sq. yard	1296
Sq. fathom	5184
Acre	$6{\cdot}273\times10^6$
Sq. mile	$4{\cdot}014\times10^9$

It may be noted that the value of C is the number of sq. inches in the unit concerned.

100 are

TABLE 2. FOR STANDARD SIZE PLANIMETER

1	2	3	4	5
		Area for 1 revolution		
Scale	Reduction ratio	Scale	Actual sq. in.	Constant
1 : r	r	a	= Setting S	k
Full size	1	50 sq. cm.	7·75	——
Full size	1	100 sq. cm.	15·50	22·300
1 : 100	100	1 are	15·50	22·300
1 : 200	200	4 are	15·50	22·300
1 : 250	250	4 are	9·92	25·730
1 : 400	400	10 are	9·69	——
1 : 500	500	25 are	15·50	22·300
1 : 1000	1000	1 hectare	15·50	22·300
1 : 1250	1250	1 hectare	9·92	25·730
1 : 2000	2000	4 hectare	15·50	22·300
1 : 2500	2500	4 hectare	9·92	25·730
1 : 4000	4000	10 hectare	9·69	——
6″=1 mile	10560	100 hectare	13·90	22·750
Full size	1	5 sq. in.	5·00	——
Full size	1	10 sq. in.	10·00	25·630
Full size	1	15 sq. in.	15·00	22·420
½ size	2	50 sq. in.	12·50	23·430
3″=1′	4	1 sq. ft.	9·00	——
1½″=1′	8	5 sq. ft.	11·25	24·340
1 : 10	10	10 sq. ft.	14·40	22·580
1″=1′	12	10 sq. ft.	10·00	25·630
¾″=1′	16	20 sq. ft.	11·25	24·340
½″=1′	24	50 sq. ft.	12·50	23·430
⅜″=1′	32	100 sq. ft.	14·06	22·700
¼″=1′	48	200 sq. ft.	12·50	23·430
1 : 50	50	250 sq. ft.	14·40	22·580
3/16″=1′	64	400 sq. ft.	14·06	22·700
⅛″=1′	96	1000 sq. ft.	15·63	22·280
1 : 100	100	1000 sq. ft.	14·40	22·580
10′=1″	120	1000 sq. ft.	10·00	25·630
1 : 200	200	2500 sq. ft.	9·00	——
20′=1″	240	5000 sq. ft.	12·50	23·430
22′=1″	264	0·1 acre	9·00	——
33′=1″	396	0·25 acre	10·00	25·630
1 : 400	400	10000 sq. ft.	9·00	——
40′=1″	480	0·5 acre	13·61	23·820
1 : 500	500	2000 sq. yd.	10·37	25·200
1 : 500	500	0·5 acre	12·55	23·400
44′=1″	528	0·5 acre	11·25	24·340
66′=1″	792	1 acre	10·00	25·630
1 : 1000	1000	2 acre	12·55	23·400
88′=1″	1056	2 acre	11·25	24·340
100′=1″	1200	3 acre	13·06	23·120
1 : 1250	1250	3 acre	12·04	23·720
2 ch=1″	1584	5 acre	12·50	23·430
1 : 2000	2000	8 acre	12·55	23·400
1 : 2500	2500	10 acre	10·04	25·580
4 ch=1″	3168	20 acre	12·50	23·430
5 ch=1″	3960	30 acre	12·00	23·750
6 ch=1″	4752	50 acre	13·89	22·760
1 : 5000	5000	50 acre	12·55	23·400
12″=1 mile	5280	50 acre	11·25	24·340
8 ch=1″	6336	100 acre	15·63	22·280
10 ch=1″	7920	100 acre	10·00	25·630
1 : 10000	10000	200 acre	12·55	23·400
6″=1 mile	10560	200 acre	11·25	24·340
3″=1 mile	21120	1000 acre	14·06	22·700
1 : 25000	25000	1000 acre	10·04	25·580
1″=1 mile	63360	10000 acre	15·63	22·280
¼″=1 mile	253440	100000 acre	9·77	——
2 × full size	0·5	2·5 sq. in.	10·00	25·630
5 × full size	0·2	0·5 sq. in.	12·50	23·430
10 × full size	0·1	0·1 sq. in.	10·00	25·630
100 × full size	0·01	0·001 sq. in.	10·00	25·630
2 × full size	0·5	25 sq. cm.	15·50	22·300
5 × full size	0·2	4 sq. cm.	15·50	22·300
10 × full size	0·1	1 sq. cm.	15·50	22·300
100 × full size	0·01	1 sq. mm.	15·50	22·300

(1 hectare = 100 are)

TABLE 3. FOR LARGE SIZE PLANIMETER

1 Scale 1 : r	2 Reduction ratio r	3 Area for 1 revolution Scale a	4 Actual sq. in. =Setting S	5 Constant k
Full size	1	100 sq. cm.	15·50	33·060
Full size	1	200 sq. cm.	31·00	30·480
1:100	100	2 are	31·00	30·480
1:200	200	8 are	31·00	30·480
1:250	250	8 are	19·84	30·580
1:400	400	20 are	19·38	30·750
1:500	500	50 are	31·00	30·480
1:1000	1000	2 hectare	31·00	30·480
1:1250	1250	2 hectare	19·84	30·580
1:2000	2000	8 hectare	31·00	30·480
1:2500	2500	8 hectare	19·84 2.45	30·580
1:4000	4000	20 hectare	19·38	30·750
6″=1 mile	10560	200 hectare	27·80	29·990
Full size	1	20 sq. in.	20·00	30·530
Full size	1	30 sq. in.	30·00	30·300
½ size	2	100 sq. ft.	25·00	29·840
3″=1′	4	2 sq. ft.	18·00	31·340
1½″=1′	8	10 sq. ft.	22·50	29·990
1:10	10	20 sq. ft.	28·80 — 15.5	30·110
1″=1′	12	20 sq. ft.	20·00	30·530
¾″=1′	16	50 sq. ft.	28·13	30·030
½″=1′	24	100 sq. ft.	25·00	29·840
⅜″=1′	32	200 sq. ft.	28·13	30·030
¼″=1′	48	500 sq. ft.	31·26	30·530
1:50	50	500 sq. ft.	28·80	30·110
3/16″=1′	64	500 sq. ft.	17·58	31·570
⅛″=1′	96	1000 sq. ft.	15·63	32·950
1:100	100	2000 sq. ft.	28·80	30·110
10′=1″	120	2000 sq. ft.	20·00	30·530
1:200	200	5000 sq. ft.	18·00	31·340
20′=1″	240	10000 sq. ft.	25·00	29·840
22′=1″	264	0·2 acre	18·00	31·340
33′=1″	396	0·5 acre	20·00	30·530
1:400	400	20000 sq. ft.	18·00	31·340
40′=1″	480	1 acre	27·23	29·930
1:500	500	5000 sq. yd.	25·93	29·850
1:500	500	1 acre	25·10	29·840
44′=1″	528	1 acre	22·50	29·990
66′=1″	792	2 acre	20·00	30·530
1:1000	1000	200000 sq. ft.	28·80	30·110
88′=1″	1056	5 acre	28·13	30·030
100′=1″	1200	5 acre	21·77	30·100
1:1250	1250	5 acre	20·07	30·500
2 ch=1″	1584	10 acre	25·00	29·840
1:2000	2000	500000 sq. ft.	18·00	31·340
1:2500	2500	20 acre	20·07	30·500
4 ch=1″	3168	50 acre	31·26	30·530
5 ch=1″	3960	50 acre	20·00	30·530
6 ch=1″	4752	100 acre	27·78	29·990
1:5000	5000	100 acre	25·10	29·840
12″=1 mile	5280	100 acre	22·50	29·990
8 ch=1″	6336	200 acre	31·26	30·530
10 ch=1″	7920	200 acre	20·00	30·530
1:10000	10000	400 acre	25·10	29·840
6″=1 mile	10560	500 acre	28·13	30·030
3″=1 mile	21120	2000 acre	28·13	30·030
1:25000	25000	2000 acre	20·07	30·500
1″=1 mile	63360	10000 acre	15·63	32·950
¼″=1 mile	253440	200000 acre	19·54	30·680
2×full size	0·5	5 sq. in.	20·00	30·530
5×full size	0·2	1 sq. in.	25·00	29·840
10×full size	0·1	0·2 sq. in.	20·00	30·530
100×full size	0·01	0·002 sq. in.	20·00	30·530
2×full size	0·5	50 sq. cm.	31·00	30·480
5×full size	0·2	4 sq. cm.	15·50	33·060
10×full size	0·1	1 sq. cm.	15·50	33·060
100×full size	0·01	10 sq. mm.	15·50	33·060

Allbrit Planimeters are
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