CHAIN SURVEY LAND RECORDS MANUAL

PART I

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CHAIN SURVEY AND LAND RECORDS MANUAL

PART I.

Compiled under the Orders of Government of Tamil Nadu

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CHAIN SURVEY AND LAND RECORDS MANUAL

PART I

INSTRUCTIONS FOR CHAIN SURVEY

CHAIN SURVEY AND LAND RECORDS MANUAL, PART I.

INSTRUCTIONS FOR CHAIN SURVEY.

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Part I

CHAPTER I.

Elementary Arithmetic.

The instructions contained in this manual assume a knowledge of the four processes of elementary arithmetic, addition, subtraction, multiplication and division. A knowledge of the method of extracting a square root is also required, and this is explained below :—

2. When a number is multiplied by itself, the product is called the square of the number, and the number is called the square root of the product so arrived at.

E.G. $4 \times 4 = 16 = 4^2$: or in words four multiplied by four equals sixteen equals four squared.

$\sqrt{16} = 4$: The square root of sixteen equals four

3. Example of the way to extract the square root of a number are given below :—

Example 1:—To find the square root of the number 625.

Place lines between every pair of figures beginning from the right. Thus the number will appear as 6/25.

First step :—Take first the figure up to the first line from the left, i.e. 6. What is the number which multiplied by itself gives either 6 or the nearest number below it ? Answer 2 ; for 2 multiplied by 2 is 4, and 3 multiplied by 3 is 9. 2 will be the first figure of the root. Write it down as the divisor, effect the division and enter the remainder thus :—

```
2)6/25(2
  4
 ---
  2
 ---
```

Second step : To the remainder.

2, annex the two figures up to the next line.

We then have—

```
2)6/25(2
  4
 ---
 225
 ---
```

Then double the figure obtained for the root so far, 2, and enter it as the divisor of 225, thus —

```
2)6/25(2
  4
 ---
4)225
```

Consider next how many times 4 will go into 22. Answer, five times. Annex this figure 5 to the figure 4 already obtained, effect the division and add the figure 5 to the figure already obtained for the root, i.e., 2. We then have —

```
2) /6 5(25
     4
   ------
  45) 225
      225
   ------
```

Nothing remains. The square root of 625 is 25.

Example 2 :—Similarly to find the square root of 142,884 :—

```
3) 14/28/84 (378
   9
  ---------
 67) 528
     469
  ---------
748) 5,984
     5,984
  ---------
```

There is no remainder. The root of 142, 884 is 378. It will be noted that at each new step in the calculation the last figure of the root that has been obtained must be doubled, and that the number of lines by which the original figure is divided indicates the number of digits in the root.

Generally it facilitates work to refer to published tables of roots and squares instead of working out square roots by the above method.

5. *Arithmetical tables*:—

7.92 Inches	=	1 Link.
100 Links	=	1Gunter's chain.
12 Inches	=	1 Foot.
3 Feet	=	1 Yard.
22 Yards	=	1 Gunter's chain.
10 Chains	=	1 Furlong.
8 Furlongs	=	1 Mile.
144 Square inches	=	1 Square foot.
9 Square feet	=	1 Square yard.
484 Square yards	=	1 Square chain.
10 Square chains	=	1 Acre.
640 acres	=	1 Square mile.

One acre is aqual to 100 cents, 43,560 square feet or 1,00,000 square links.

Metric Measures.

1. One link (20 metres chain) : 2 metres.
   One link (30 metres chain) : 3 metres.

2. 10 Millimetres : 1 centimetre.
   10 Centimetres : 1 Decimetre
   10 Decimetres : 1 Metre.
   (1 M = 100 C.M. = 1,000m.m.
   10 Metres : 1 Decametre.
   10 Decametres : 1 Hectametre.
   10 Hectametres : 1 Kilometre
   (1 KM = 1,000 M).

3. 100 Square Millimetres : 1 Square Centimetre.
   100 Square Centimetres : 1 Square Decimetre.
   100 Square Decimetres : 1 Square Metre
   (1 Sq.m. = 10,000 Sq.cm.).
   100 Square Metres : 1 Are or 1 Square Decametre.
   100 Ares : 1 Hectare or 1 Sq. Hectametre
   (1 H.A. = 10,000 Sq. m.).
   1 Hectare : 10,000 Sq.Metres or 25 Square Chains (20 metres).
   100 Hectares : 1 Square kilometre.

Exercises.

Extract the square root of :—

(1) 1,42,884 378
(2) 2,94,849 543
(3) 10,81,600 1,040
(4) 9,78,121 989
(5) 12,56,641 1,121
(6) 13,34,025 1,155
(7) 22,92,196 1,514
(8) 28,22,400 1,680
(9) 58,51,561 2,419
(10) 60,76,225 2,465
(11) 62,40,004 2,498
(12) 61,70,256 2,484
(13) 45,92,449 2,143
(14) 43,97,409 2,097
(15) 39,92,004 1,998

CHAPTER II.

Definitions and some simple geometrical theorems.

A straight line is the shortest distance between two points, such as the corners of field.

2. An angle is a bend or corner formed by two straight lines meeting each other.

3. When one straight line meets another straight line so as to make the two angles so formed equal to one another, each of these angles is called a right angle and the straight line falling on the other is called a perpendicular or in Surveying an offset to it. If these two straight lines cross each other, they form four right angles

4. An obtuse angle is one which is greater than a right angle and an acute angle is one which is less than a right angle.

If two straight lines cut each other, the sum of any two adjacent angles is equal to two right angles; also the opposite angles are equal.

5. Two straight lines cannot enclose a space. A field, therefore, cannot have less than three sides. A figure of three sides and three angles is called a triangle. The sum of three angles of a triangle is equal to two right angles.

Any two sides of a triangle are together greater than the third side. Otherwise no triangle can be formed on the ground or plotted on paper.

A triangle is determinate when its three sides are given.

Two triangles are equal in all respects if (1) two angles of one triangle are equal to two angles of the other triangle each to each, and any side of the former triangle is equal to the corresponding side of the latter triangle ; or

2. If two sides of one triangle are equal to two sides of the other triangle, each to each and the included angles are equal.

(6) When one angle in a triangle is a right angle, the triangle is called a *right angled triangle*. In right-angled triangle the side opposite to the right angle is called the hypotenuse. The other two sides which enclose the right angle are called respectively the base and the perpendicular.

7. Triangles are said to be similar when the angles in the one are equal to the angles in the other each to each. Then the sides opposite to or containing equal angles are proportional. Thus in the figure the angles at A, B and C are equal to the angles D, E and F respectively. AB is to BC as DE is to EF, BC is to CA as EF is to FD ; CA is to AB as FD is to DE :—

If two sides of a triangle are proportional to two sides of another triangle and if the included angles are equal, the two triangles are similar.

8. A quadrilateral is four sided figure. The straight line joining the opposite angles of a quadrilateral, thus dividing it into two triangles is called a diagonal.

9. If all the angles of a quadrilateral are right angles, the figure is called a rectangle. The opposite sides of any rectangle are equal. If all the sides of a rectangle are equal, it is called a square.

10. A trapezoid : as far as this manual is concerned means a quadrilateral with two of its sides parallel and two of its angles right angles.

11. A Polygon is a figure contained by more than four sides. It may be divided into triangles by drawing straight lines from one corner to another.

12. Parallel straight lines are those between which the perpendicular distance is always the same. Such lines if produced to any length in either direction cannot meet. Straight lines which are parallel to the same line are parallel to one another. Straight lines whic are perpendicular to the same lines are parallel to one another.

13 Any line parallel to the base of a triangle cuts the sides of the triangle in the sameh ratio. Conversely, if points dividing the sides of a triangle in the same ratio are joined together the straight line so formed parallel to the base.

In the figure, DE is parallel to BC

$\therefore$ AD : AB : : AE : AC

AD : DB : : AE : EC

Also the triangles ADE and ABC are similar.

$$\frac{DE}{BC} = \frac{AD}{AB} = \frac{AE}{AC}$$

If D and E happen to be midpoints of AB and AC, then DE is half of BC.

14. Triangles on the same base (or on equal bases) and between the same parallels are equal to one another in area.

15. A Parallelogram is a quadrilateral figure which has its opposite sides parallel. The opposite sides are also equal. Any quadrilateral with one pair of its side parallel and equal must necessarily be a parallelogram. A Parallelogram with one of its angles a right angle is a rectangle. Parallelograms on the same base (or on equal bases) and between the same parallels are equal to one another in area.

CHAPTER III.

PROPERTIES OF RIGHT ANGLED TRIANGLES AND TRAPEZOIDS.

Calculation of the third side in a right angled triangle where two sides are known.

1. The Chief characteristics of a right angled triangle are—

(1) The hypotenuse is longer than either of the two sides containing the right angle.

(2) The square on the hypotenuse is equal to the sum of the squares on the sides containing the right angle.

(3) The square on one of the sides containing the right angle is equal to the differences of the squares on the hypotenuse and the other side containing the right angle.

Examples.

In figure I ABC is a right angled triangle with the right angle at B.

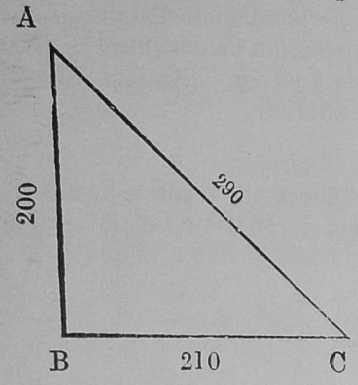


Fig. 1.

AB :—is 200 and BC :—210

$AC^2 = 200^2 + 210^2$

$AC = \sqrt{200^2 + 210^2} = 290$

$BC^2 = 290^2 - 200^2$

$BC = \sqrt{290^2 - 200^2} = 210$

$AB^2 = 290^2 - 210^2$

$\therefore\ AB = \sqrt{290^2 - 210^2} = 200$

Where perpendiculars fall on a straight line from any two points on opposite sides how to calculate the distance between the two points.

2. If on a given base line perpendiculars are drawn from any two points situated on either side of it, the distance between the points if found by adding the square of the sum of the two perpendiculars to the square of the distance between the two perpendiculars and extracting the square root of the result.

In figure 2, AC and BD are perpendiculars to the base CD. Construct the rectangle ACDE.

Then ED—AC and AE—CE.

$BE = BD + DE$

Then $AB^2 = AE^2 + BE^2$

$= CD^2 + (BD - DE)^2$

$AB = \sqrt{115^2 + (128 - 185)^2} = 333$

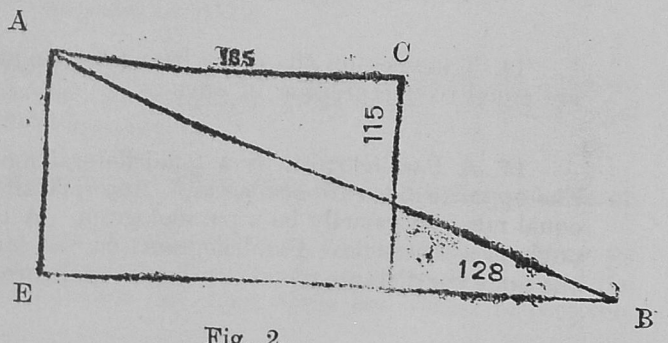


Fig. 2.

When perpendiculars fall on a straight line from any two points on the same side of it how to calculate the distance between the two points.

3. If on a given base line perpendiculars are drawn from any two points situated on the same side of it, the distance between the points is found by adding the square of the difference of the two perpendiculars to the square of the distance between them and extracting the square root of the result.

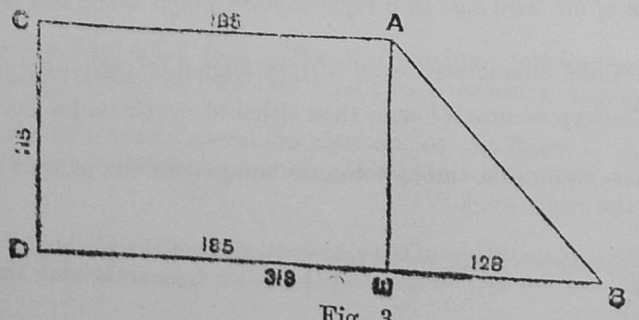


Fig. 3.

Thus in figure 3, AC and BD are perpendiculars to the base CD on the same side of it. Again construct the rectangle CAED then.

$$CA = DE \text{ and } CD = AE$$
$$BE = BD - DE$$
$$AB^2 = BE^2 + AE^2 = (BD - DE)^2 + AE^2$$
$$= (BD - AC) - CD^2$$

By this method the fourth side of a trapezoid can be calculated when the other three sides are known.

Relation between the sides of a right angled triangle when a perpendicular is drawn from the right angle to the hypotenuse.

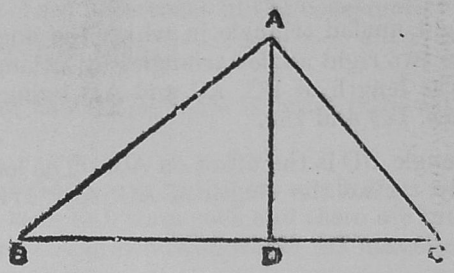


Fig. 4.

4. ABC is a right angled triangle and AD is the perpendicular from the right angle to the hypotenuse BD and DC are called the segments of the hypotenuse. The perpendicular divides the right angled triangle ABC into two triangles DAC and DBA which are similar to it and to each other.

From the similar triangles ABC and DAC we have

$$AB : BC :: AD : AC$$
and $$AC : BC :: DC : AC$$
i.e. $$AB \times AC = AD \times BC \qquad (1)$$
and $$AC^2 = DC \times BC \qquad (2)$$

From the similar triangles ABC and DBA we have

$$AB : BC :: BD : AB$$
i.e. $$AB^2 = BD \times BC \qquad (3)$$

From the similar triangles DBA and DAC we have

$$AD : BD :: DC : AD$$
i.e. $$AD^2 = BD \times DC \qquad (4)$$

Formulae, 1, 2, 3, and 4 are important :—

Exercises for calculation of sides of right angled triangles.

(1) The sides containing a right angle are 404 and 383. What is the side subtending that angle ? Ans. 557.

(2) The hypotenuse of a right angled triangle is 378 and the base 159. Find the perpendicular. Ans. 343.

(3) The perpendicular and the hypotenuse of a right angled triangle are 267 and 503 respectively. Find the base. Ans. 426.

(4) The length of each of the sides of a triangle is 484. Find the length of a perpendicular drawn from the vertex to the base of the triangle. Ans. 419.

(5) The length of a perpendicular drawn from the vertex of a triangle having equal sides is 249. Find the sides of the triangle. Ans. 288.

(6) One of the sides of a square is 252. Find the diagonal. Ans. 356.

(7) The diagonal of a square is 603. Find the sides. Ans. 426.

(8) The perpendicular and the base of a right angled triangle are 454 and 368 respectively Find the length of the line joining their middle points. Ans. 292.

(9) The perpendicular and the base of a right angled triangle are 276 and 372 respectively. Find the length of the line joining the vertex with the middle point of the base. Ans. 333.

(10) ABD is a right angled triangle in which the angle BAD is a right angle. The triangle is split up into two right angled triangles by letting a perpendicular AC fall on BD from the point A. The length of BC, AC and AD being 101, 123 and 194 respectively. Find AB and CD. Ans. 159 and 150.

(11) ABC is a triangle BD is the offset on AC. The lengths of AB, BD and BC are 89, 75 and 98 respectively. Find the length of AC. Ans. 111.

CHAPTER IV.

Instruments Required for Chain Survey.

1. The measurement of straight lines is made with a 20 metres chain. For the simple operation described in this manual, the only angle with which we are concerned is the right angle and that is measured or formed on the ground with the cross staff.

20. *Metre chain.—Vide* Figure 5-A.

This comprises of 100 links, each 20 centimetres in length. The brass handle at each end is included in the length of the last link at either end. In the middle of the chain, i.e. at the 10th metre from either end there is a brass index (tally) with two prongs and at the 5th metre from each end, there is tally with one prong. A tally with a single prong will thus read 5 or 15 metres according to the left or right end of the chain from which the measurement is taken. A distinguishing brass ring is suspended at every metre length, except where tallies are attached. Please see Figure 1 for a 20 metre chain.

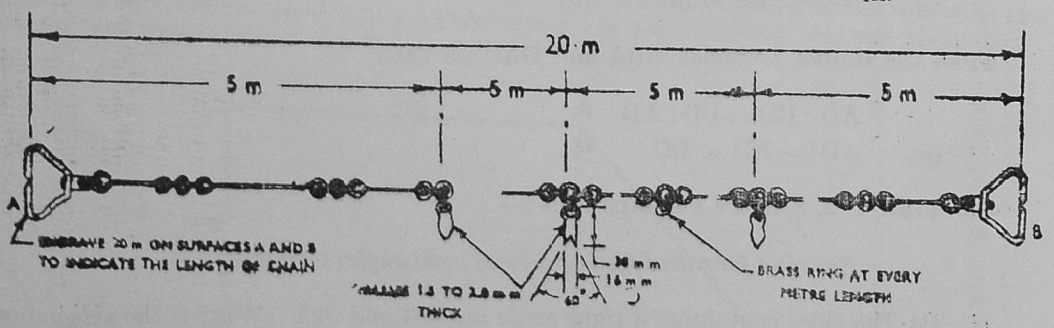


Fig. 5-A. 20 METRE CHAIN

30. *Metre chain.—Vide* Figure 5B.

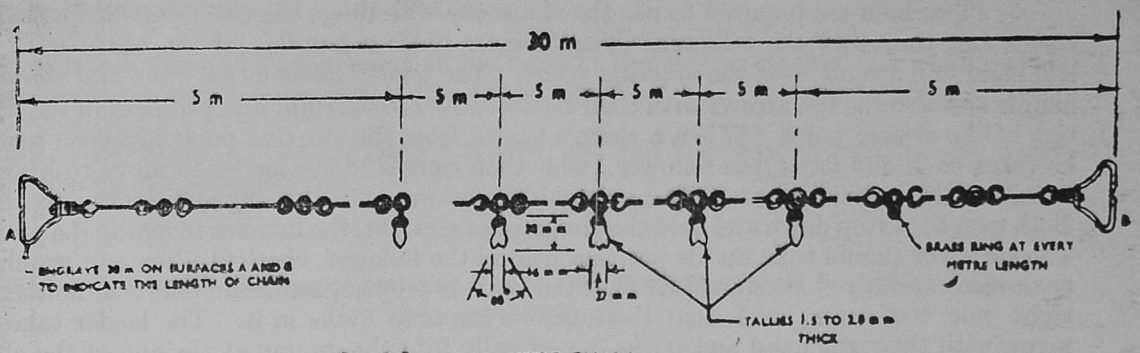


Fig. 5-B. 30 METRE CHAIN

The following are the three differences in the construction of this chain :—

(*a*) It comprises of 150 Links.

(*b*) In the middle of the chain, there is brass tally with three prongs denoting 15 metres.

(*c*) At the 25th Link from each end, there are indices with a single prong to denote 5 or 25 metres and at the 50th link from each end there are indices with 2 prongs to mark 10 and 20 metres, according to the end from which the measurement is taken.

To fold the chain, take the middle of it in the left hand and with the right hand take hold of the doubled chain just beyond the second link ; double up the two links between your hands and continue to fold up two double links at a time, laying each pair obliquely across the other so that when it is all folded up, the handles will be on the outside, easy to tie up and carry. To unfold the chain, place it at about half a chain's length from the point from which the measurement is to start and at an angle of 45°450 to the line to be measured; take the two handles in the hand and walk away from the chain as it lies on the ground. The two chainmen should then take one handle each and move to their positions.

Arrows.

3. Each chain is provided with ten (figure 6) arrows made of stout iron wire about (a foot long) thirty centimetres in length. They are pointed at one end so as to be easily thrust into the ground. The other end of the arrow is curled into a ring to serve for a handle. The arrows are used for counting the number of chain lengths in a line.

FIG. 6

Method of measurement.

4. To find the distance between two points such as the corners of a field measurement is made in a straight line from one to the other. When the ground is sloping the *horizontal* distance must be measured and not the distance along the ground (see paragraph 7 below). The point from which the measurement begins is called the starting point, and the other end of straight line to be measured is called the closing point. A flag should be placed upright at each of these points. If the distance to be measured is very long, intermediate flags should be placed so that the chain may not deviate from the line required.

Duty of the leader, the follower and the surveyor.

5. Two men are required to use the chain one who drags the chain forward called the leader and the other the follower. The follower holds a handle of the chain with his left hand and stands over the starting point. The leader takes in his left hand the other handle and also the ten arrows with their heads turned to his right and proceeds in the direction of the closing point. When a chain's length from the starting point has been reached he turns back and faces the follower, who then signals to the leader to move to his right or left until the chain is exactly in a straight line between the starting and the closing points Both men then stop down and hold the chain quite straight, the handles touching the ground. The surveyor should take up his position behind the follower, check the line and watch the chainmen carefully. He should see that the chain is properly stretched that it is neither too tight nor too loose, and that there are no knots or kinks in it. The leader takes an arrow with the right hand and sticks it vertically into the ground at the end of the chain, touching the outside of the handle. If the ground is too hard to admit of the arrow being thrust in, the leader makes a cross mark thus + on the ground with the sharp point of the arrow, and lays it on the ground so that its point touches the centre of the cross. Both men then stand up and shift chain to one side or the other to avoid disturbing the arrow and walk in the direction of the closing point. When another chain's length is measured, the follower reaches the first arrow, and holding the chain handle and the arrow together again directs the leader to the right or the left. The leader also checks the points of the follower by seeing that the latter is in a line with the flag at the starting station and puts down another arrow. Then the third chain is measured, the follower picks up the second arrow and so on until he reaches the tenth arrow. He then marks the position of the tenth arrow on the ground by planting the cross staff at that point and returns the ten arrows to the leader before the measurement of the eleventh chain begins. The surveyor should note in his field note book "200 metres" (1,000 links) when ten chains have been measured. On the leader arriving at the closing point he will pull the chain past that point till the follower calls "halt" and neither the leader nor the follower should leave his position to come to the closing point.

NOTE.—The surveyor should keep a continual watch over the chainmen while measuring lines. Although to do this his position must be in rear of the line he should occasionally, when chaining a long line, change his place to the front of the chain and see that the chain has not got out of the direct line. When the cross staff is planted at the end of the tenth chain he should invariably check his alignment between the starting and closing stations of the line by means of that instrument. As the follower is the more responsible person of the two men the more intelligent of them should be put on to this duty.

Reading of links.—The surveyor then reads off the number of links on the chain by looking at the brass indices and counting the links. The total distance measured will be made up of (1) as many thousands of links as there were changes of arrows, (2) as many hundreds of links as there are arrows in the hands of the follower; and (3) as many odd links as are read off on the chain between the last arrow and the closing station.

For example.—Suppose the follower has returned the arrows 5 times and has 7 arrows in his hand and the 47th link is on the closing station. The distance measured is 5,000 links–700 links 47 links 5,747 links.

To check the number of arrows with the follower, the surveyor should count the number in the hands of the leader. He should do this frequently in the course of measurement to satisfy himself that no arrow is dropped carelessly by the follower or the leader.

Exercises in reading links.

(1) The follower returned the arrows thrice and has 9 arrows in his hand and the distance between the last arrow and the closing station is 58 links. Find the entire length of the line. Answer (3,958 links) 791·6 metres.

(2) The leader had in his hand 7 arrows after they were changed six times and the last chain in the measurement was deficient by 39 links. What was the total distance measured? Ans. (6,361 links) 1,272·2 metres.

(3) The distance measured between two stations is 25,496 links. How many times were the arrows exchanged ? Ans. 25 times.

How many arrows had the leader in his hand at the closing station and what was the distance between the last arrow and the closing station ?

Ans. The leader had in his hand 6 arrows, and the distance between the last arrow and the closing station is 96 links.

Where the closing station for both the closing and starting stations become invisible after a certain length.

6. It sometimes happens that in the course of measurement the closing station becomes invisible after a certain length. The follower cannot therefore, direct the leader. The latter should then fix his position in the line with reference to the starting station. Where the starting station also becomes invisible, the surveyor should plant flags at either end of the chain where from it was last visible and the leader should find his position with reference to them.

Measurement of slopes.

7. It should be clearly borne in mind that the distance to be measured between two stations is the horizontal distance and not the actual distance along the surface. When therefore the ground is uneven, the process described hereunder should be followed vide Figure 7.

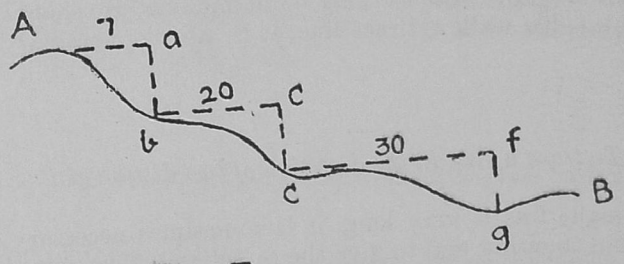


Fig. 7

Descent.

8. In descending a slope the follower should hold one end of the chain at the starting station. The leader should hold a convenient part of the chain raising it a few feet over the ground on which he stands so as to keep it as nearly as can be judged horizontal. Holding the point of an arrow in the other hand, he should drop it vertically making a mark on the ground where the arrow falls. He should wait till the follower reaches him, taking care not to let go the point in the chain at which he dropped the arrow. The follower then takes charge of the chain at the same point and the process is repeated as often as necessary till the bottom of the slope is reached.

The sum of all these horizontal distances will be the total horizontal distance of the slope. This process is called "Stepping" or "levelling" or "Breaking" the chain. In figure No. 7, the process described above was repeated three times and the total horizontal distance between A and B is 72 links (14·4 metres).

Ascent.

9. In ascending a slope a very similar process is performed. The follower holds one end of the chain vertically over the starting station at a convenient height and directs the leader who goes some distance up the slope until the chain or a portion of it is stretched horizontally. He then drops a pebble vertically over the starting station. If the pebble falls exactly in the middle point of the station, he instructs the leader to make a mark on the ground. If not he signals to him to draw up or give in the chain until the pebble falls on the correct point. The process is repeated until the whole slope is measured. It is much easier to measure down than to measure up a slope.

Running chain over prickly pear and such other obstructions.

10. Sometimes an obstruction less than a chain in width is met within the line of measurement such as a well or a bed of prickly pear. When he arrives at the edge of it, it may happen that the leader cannot reach the spot where an arrow is to be placed. In such cases he should fix it in the ground as near the obstacle as is convenient, the surveyor noting at what point in the length of the chain it falls, so that he may afterwards subtract the deficiency from the total distance. From this point the chain can generally be easily stretched over across the obstruction thus avoiding the necessity to employ one of the more or less troublesome methods of measuring round obstacles explained in Chapter VII.

To walk in a straight line between two points.

11. Sometimes it is necessary for the surveyor to walk in a straight line between two points. He should fix upon some object such as a tree or a stone in front of or behind the closing station, so that it and the object may be in one line, He should go forward keeping the two objects in line. To walk a direct line, it is always necessary to in be guided by two objects.

To trace a line in the direction of two distant points.

12. When a straight line is very long, it is sometimes necessary to get into the line without sending a man to either end to give the direction. Two men should stand in about the line at a distance of two or three chains from, and facing each other. Then by alternately motioning each other to move right or left, they soon get exactly into the line.

Testing Chain.

13. The length of the chain should be tested daily before measurement begins. For this purpose, select a level piece of ground and stretch the chain moderately tightly over it. Straighten the links that are bent and fix two stout wooden pegs at each end in the handle of the chain. Take two standard poles and measure the chain carefully by laying one standard pole beside the chain and the second touching it in continuation. The first pole can then be lifted and placed in continuation of the second, and so on until the chain has been completely measured care being taken that the second pole is not disturbed while the first is being moved. If the chain is less than ten links between any two indices add one or more rings as requisite a few of which made by the Village blacksmith, should be kept in stock, if it is longer than ten links between any two indices remove one or more rings from it. The ends of the chain and each index point as thus corrected should be marked on the ground by pegs or other suitable marks. If the pegs

are allowed to remain permanently in the ground the chain need only be put upon them in order at any time to test its correctness. Karnams, who are not equipped with two standard poles for this purpose must use the offset pole with which they are equipped in the following ways :—The chain Stretched on the ground between pegs, as described above, must be carefully measured with the offset pole. Each time the pole is laid against the chain a scratch must be made in the ground carefully at the far end of it, and the pole replaced with its near end touching the scratch. The distance between any two of the brass indices on the Chain must be exactly the same as the length of the offset pole, and rings must be added or removed as described above, until the two measurements correspond exactly. The testing of a chain is facilitated and much time Saved by making permanent.

Cross Staff Construction.

14. The cross staff (Fig. 8) consists of a Piece of wood called the head (10 centimetres) (4″) square and about (6½ centimetres) (2½″) thick and the staff an iron about (16 m.m) (5/8 ″) in diameter and (1·5 metres) (4½ feet) long, which screws into the underside of the head and is sharply pointed at the other end so that it can be struck into the ground. On the upper surface of the head two grooves are cut with a saw half an inch deep and at right angles to each other crossing in the Centre.

FIG. 8

Offset meaning.

15. A straight line drawn from a given object to a chain line so as to make right angle with it is called an offset, It is the shortest distance between the object and the chain line.

The use of the cross-staff-first use-laying the offset from a given object to the chain-line.

16. The cross staff is used for three purposes (a) for laying the offset from a given object to the chain line, (b) for laying an offset from a given point on the chain line and (c) for aligning points or ranging flags in a chain-line by observation of the terminal stations. For the first purpose, it is inserted in the ground at that point in the chain line where, when one groove is directed to the forward (or back) Station the other points to the object to the right or left or of the line. The chain-line is read off and the distance from the object to the cross staff measured. The relative Position of the object to the chain lines can then be exactly reproduced upon paper.

Second use for laying the offset from a given point on the chain line.

To find a spot at a given distance from a point in the chain-line and at right angles to it, plant the cross staff at the given point in the chain line, and align one groove between the forward and back stations. Looking through the other groove send a man towards, and by a rough guess beyond the spot you are endeavouring to find and signal to him to move to the right or left until you see him exactly in the centre of the groove. The given distance is now measured from the cross staff towards the man and thus the proposed situation of the object is correctly determined. This is the converse of the first method since we reproduced on the ground what has already been measured and plotted upon paper.

Hints to be observed in the use of the cross staff.

17. The following instructions should be carefully followed :—Plant the cross staff upright in the ground, so that it does not incline in any direction. When the forward or back station has been sighted through one groove, the staff must not be held or touched while observing the right angle. If the ground is very hard, observations may be made by two men, who must look through the grooves simultaneously, and the cross staff may be held by one of them. Always check the correctness of the chain line by sighting both forward and back stations.

Restriction of length of offsets.

18. Offsets of three chains (60 metres) and upwards in length require to be observed and measured with exceptional care by reason of the possibility that error in the instrument or in observation may seriously affect the accuracy of the result at such distance Offsets exceeding five chains (100 metres) should not be taken.

Why a right angle is formed on the ground.

19. It is hardly necessary to explain that the grooves on the cross staff might be cut to form any angle with each other. A right angle is however chosen because it can be accurately laid out on paper with such simple instruments as the scale and bit. Other angles require special instruments and even then cannot be so correctly plotted. A right angle also assists in the calculation of areas by a simple process of arithmetic which will be explained in chapter IX.

Testing the cross-staff.

20. To test the accuracy of the cross staff sight a distant object through one groove and plant a flag at a distance of 2–3 chains (40–60 metres) from the instrument so that it is intersected along the second groove. Then turn the cross-staff a quarter round until the distant object is along the groove through which the flag was sighted. If the flag is now correctly intersected along the other groove the instrument is correct. The use of an incorrect cross staff is forbidden.

Standard pole Construction and use of.

21. A standard pole is a straight piece of teak wood (2 metres)10 links in length with marks out representing the links in the chain. The accuracy of each part can be checked with any plotting scale.

An offset pole is similar to a standard pole but less accurately constructed of bamboo and shod with iron. Its use by karnams for testing has been described in paragraph 13 supra. It may also be used for measurements not exceeding 50 links (10 metres) being turned over and over in a straight line between the two points from and to which measurements is to be made.

Caution in the use of instruments.

22. A surveyor is not allowed to do field work of any kind until he has made sure that his instruments are quite accurate. He must test his chain every day before starting on his field work.

CHAPTER V

Demarcation.

Revenue Survey —Its Meaning—Necessity and use.

A Revenue Survey (or a cadastral Survey) is a survey in which the boundaries area, reputed ownership and position of holdings are determined. Under the ryotwari system the assessment on a piece of land is directly proportional to its area other things being equal and is collected direct from the person in whose name the land is registered in the revenue accounts. Hence arises the necessity for a detailed survey of holdings. Actually a survey does much more than the more determination of area and ownership of holdings. Boundaries are laid down and records including plotted maps are prepared which are of help in settling disputes between one holder and another and also in protecting lands, whether public or private against encroachments. A detailed survey is thus necessary in the interests of both Government and ryots.

A revenue survey includes the demarcation of fields, their measurement and plotting and also their area computation.

Necessity for demarcation.—Before beginning measurement it is necessary that the surveyor should have a clear notion of what it is that he had to measure. With this object in view he has to fix the limits of extremities of the lines to be measured. Survey being only a practical application of geometry, demarcation is but the determination of the geometrical points which the surveyor wants to connect by straight lines for his measurement and for subsequent plotting into rectilineal figures. Should the field boundary happen to be a curved line he had to split it up into as many straight lines as no measurement will be possible in such cases. Thus arises the general necessity for demarcation to proceed measurement.

Demarcation in Revenue Survey.

As all survey proceeds from whole to part in a revenue survey the village boundary is first demarcated. The village is then divided in to Khandams of 100 to 200 acres (40 to 80 Hectares) in extent, the boundaries of which should generally follow natural boundaries. After the completion of khandam demarcation the village and khandam boundaries are traversed with the theodolite. Then field demarcation is taken up. Generally if holdings happen to be small they are clubbed together to form survey fields of convenient shape not exceeding 5 acres (2 Hectares) in wet and 10 acres (4 Hectares) in dry lands the holdings being treated as subdivisions of the survey field. No survey field thus formed should contain more than 20 subdivisions unless its area is below 2 acres (80 ares) in wet and 4 acres (One Hectare and 60 ares) in dry lands when no limit is placed on the number of subdivisions. In the case of narrow fields like roads and channels more than 50 links (10 metres) in width they are split up into survey fields of 10 chains (200 metres) in length. Individual holdings of more than the extent prescribed above are not split up but are retained as separate survey fields. In demarcating fields it is obviously impossible to follow the exact contour of the ground and to note all the slightest defections from straight lines. In practice, therefore subject to certain exceptions the surveyor ignores small bends and lays down the survey boundary in such a way that the natural boundary at no place deviates from the survey boundary by more than 10 links (2 metres) in wet and twenty links (4 metres) in dry and also the portions included in the field are as far as possible, equal to the portions excluded from it . The two principles involved are the ignoring and equalization of bends.

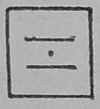
Description of demarcation stones.

In this state, demarcation is effected by planting at maintainable points stones of durable quality roughly squared and of the following descriptions.

1. Ist Class (theodolite) stones measuring roughly 3′ ×.″ ×9″ (90 c.m. ×25 c.m. ×25 c.m.)

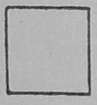
2. IInd class (field stones) measuring roughly 2′ ×6″ ×6″(60 c.m. ×15c.m. × 15c.m.). At demarcation points which are not maintainable as per rules, only pegs of small rough stones are planted (usually three in number of ∴ this shape) to facilitate measurement.

Side view of a demarcation stone



Top view of a theodolite bijunction stone

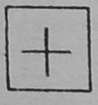
Top view of a theodolite trijunction stone



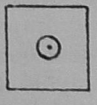
Top view of a field stone

Top view of a field Stone used for demarcating sub-divisons

Top view of a khandam theodolite stone



Top view of a field stone on the village boundary



Top view of a minor circuit station

Fig. 9

First class stone are the marks set up at village trijunctions and their pointers on the boundaries between villages. They have a plummet hole cut at the top and a broad arrow on one side. In districts that have been resurveyed all the theodolite stations fixed at the original survey were not marked on the resurvey map. In some cases theodolite stones have been built into masonry bases of stone and morter.

Field stones are the marks placed at the following points.

Areas surveyed on the system of simple triangulation—At the bends and trijunctions on the boundaries of all survey fields, poramboke sub-divisions and sub- divisions belonging to or vested in local bodies and of lands alienated to private individuals or private institutions free of assessment.

All other cases (*i*) (*a*) at the places marked on the village map or other record prepared at the time of survey as stations at which a theodolite has been set up with the exception of the points specified against I class stones above.

(*b*) At trijunctions on the boundaries between villages and at the bends and trijunctions of poramboke survey fields and sub-divisions belonging to or vested in local bodies and of lands alienated to private individuals or private institutions free of assessment as also of minor circuits, i.e. survey fields which have been surveyed with an angular instruments.

NOTE. (1) When two porambokes whether whole fields or sub-divisions belonging to Government adjoin each other the bends on the common boundary need not be demarcated with stones except where the bends or in the boundary of a field surveyed on the system of simple triangulation.

NOTE. (2) Bends on the boundaries of roads, cart tracks and channels shown as porambokes in the Revenue accounts which are 4 metres (20 links) and below in width and which are measured as sub-divisions need not be durably demarcated.

(ii) at the trijunctions of other survey fields.

(iii) At the end of G. lines which do not coincide with field trijunctions or theodolite stations.

Field stones are of the dimensions 2'x6"x6" (60 c.m. x 15 c.m.x 15 c.m.) and have a broad arrow cut on one side. Such of the stones as mark minor circuit stations and theodolite stations other than a village trijunction and its pointers and khandam stations will have a plummet hole cut on the top. Field stones demarcating sub-divisions will have the letter 'S' cut on the top, while those on village boundaries will have a St. George's cross on the top.

In certain special tracts, variations from the prescribed dimensions of survey stones have been permitted.

The broad arrow cut on all stones should be at least $2\frac{1}{2}$"(6 c.m.) long and $\frac{1}{4}$" (half centimetre) deep.

In estate surveys, the letter E or Z is usually cut on the stones in place of an arrow mark on the side.

CHAPTER VI.

Field Measurement.

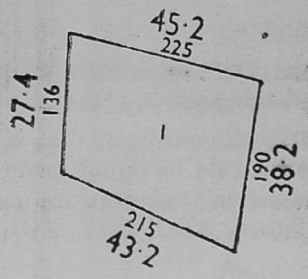
Preparation of a rough hand sketch.

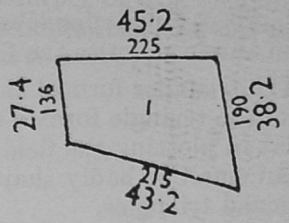
1. After the completion of demarcation, the surveyor should walk over the ground to be measured for the purpose of obtaining a general knowledge of the surface. A rough sketch of the field should be prepared showing all bends and in it should be marked the positions of the trijunctions of adjoining fields and the most conspicuous objects, such as wells, houses, temples, roads and streams. The following instructions should be borne in mind in the preparation of the rough sketch. The north point should always be indicated first. It is sufficient to make the top of the paper the north whenever possible. The surveyor should start from a corner of the field, say the north-west or north-east proceed round the field keeping always to the same direction, either right or left. As he goes he should send a man in advance to the next bend. He should then walk towards the man counting his paces as he goes. This will give him the approximate distance between the two bends, 25 paces being ordinarily equal to a chain. He should next determine roughly the length of the line to be drawn by him on paper for the distance paced by him and should accordingly draw the line between the first and the second bends. This process should be repeated at each bend until the starting point is reached. Before proceeding to measure the lines with the chain, the surveyor should draw on the sketch all such lines as it will be necessary to measure to enable the field to be plotted upon the principles explained hereunder.

Note.—The above procedure applies to the survey of isolated fields in surveyed tracts. In initial survey, the demarcation sketches should be drawn as the demarcation progresses.

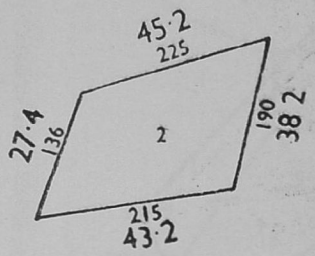
Triangulation.

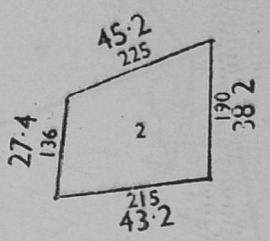
2. A triangle is a simple geometrical figure that has always a definite shape and size if the length of its sides are known. Its shape can always therefore be correctly drawn on paper. An irregular four-sides field on the other hand is not determinate in shape and size if only the length of its sides are known. The following diagram (figure 10) shows how such a field may be made to assume different shapes and gives different areas. Figure 10 shows the diagrams under the Foot Pound and Metric systems. To define the shape of the field therefore and to plot it correctly, we should divide it into triangles. This is done by measuring a diagonal from one corner to another opposite to it. In this way, a field of any number of sides can be divided into triangles. Thus (Figure 11) two triangles are formed in a field of four sides. three triangles in a field of five, four in a field of six and so on .The number of triangles accordingly into which a field can be divided is equal to the number of the sides of the field minus two.



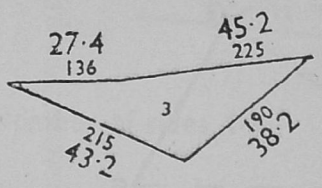


Area	Cents
1. 0 -	34
2. 0 -	28
3. 0 -	17

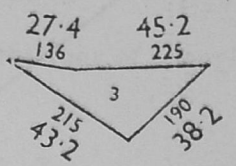




Area	Sq. Metres
1.	1376
2.	1133
3.	688

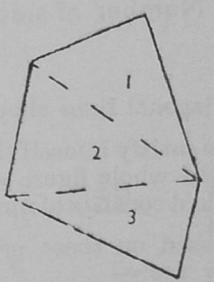


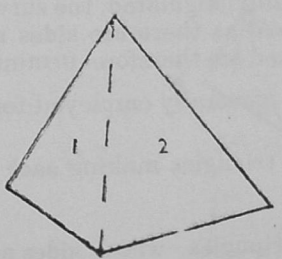
SCALE 1 INCH = 2 CHAINS



SCALE 1 = 2000 m m

Fig. 10





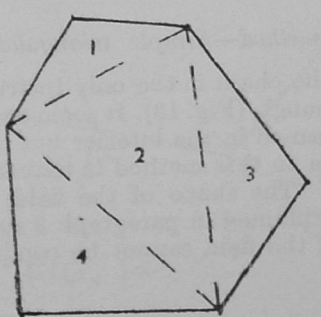


Fig. 11

Principles of Triangulation.

3. The process just described of dividing a piece of land into triangles, is called triangulation and in practice the following rules should be borne in mind :—

(1) The triangles formed should be as large and well conditioned as possible i.e., the three sides of the triangle formed should as far as practicable be equal (vide Fig. 12). The reason is that in plotting the field, large and well formed triangles ensure greater accuracy of shape than small or badly shaped ones. In the figure, ABC, CDE, ACK and CKF are well conditioned triangles.

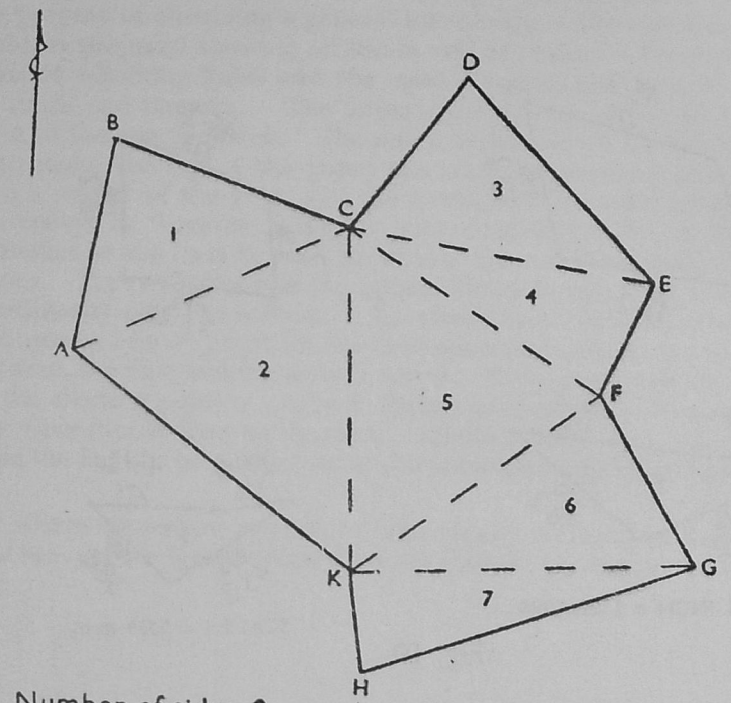


Fig. 12

(2) Diagonal lines should not cross each other.

(3) To satisfy himself that no quadrilateral is left untriangulated, the surveyor should see that in the whole figure as many triangles are formed as there are sides minus 2. In Fig. 12, the field consists of nine sides; the triangles obtained are therefore 9 minus 2, i.e., 7.

(4) Based on these principles, two methods are generally employed for measuring fields. They are:—

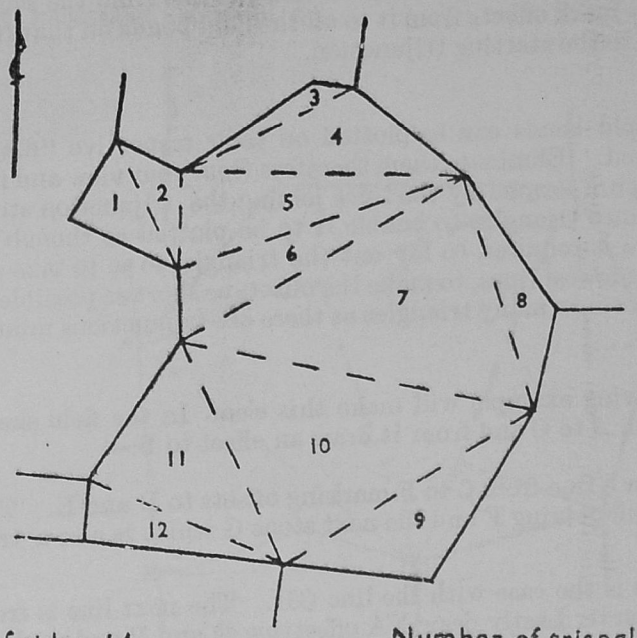
(1) To divide the field into a number of small triangles making each side of the field generally the base of a triangle.

(2) To divide the field into fewer but larger triangles whose sides are the lines joining trijunction points only ; minor bends are offsetted from these lines.

First method—Simple triangulation.

5. For the first method the chain is the only instrument required. Each side of the field should form the base of triangle (Fig. 13). It some times happens however that a quadrilateral or a polygon is thus formed in the interior but it again should be subdivided into triangles. The chief objection to this method is that in many cases it is not possible to secure well-formed triangles. The shape of the field, therefore, when plotted, will not be true to fact, as has been explained in paragraph 3 supra. Another, though minor, disadvantage is that the area of the field cannot be computed mathematically except by a

laborious process. Moreover it often involves the measuring of a large number of lines. The process to be described next is therefore generally preferable, and has superseded the method of simple triangulation for all future surveys and re-surveys.

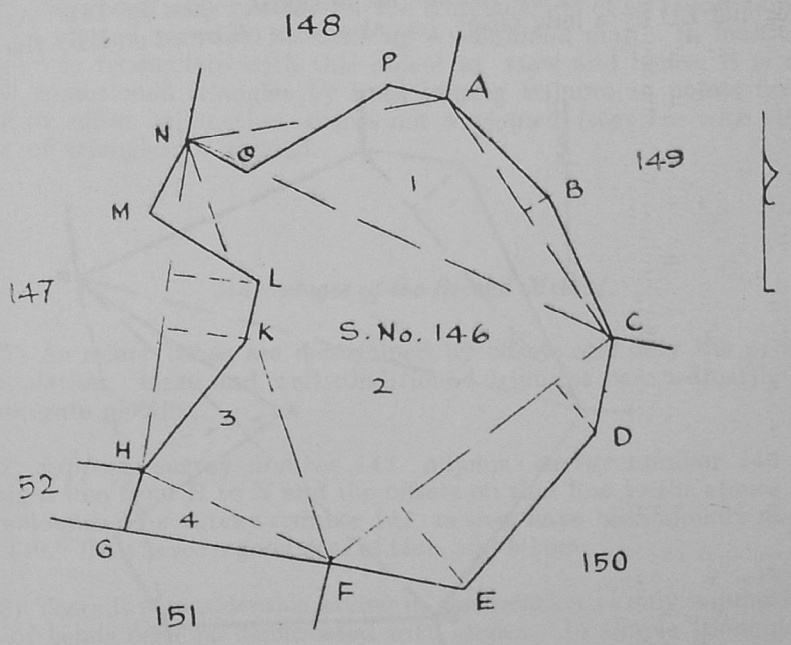


Number of sides 14 Number of triangles 12

Fig. 13

Second Method—Triangulation and offset.

6. To carry out this method, both chain and cross staff are used The process is as follows (See Fig. 14).



No. of Trijunctions 6 No. of Triangles 4.

FIG. 14

(i) Start from a trijunction generally in the north-east corner of the field and proceed round the field keeping always to the same direction, either right or left. Draw a straight line from the first trijunction to the next, and mark offsets on it to all the field bends situated on either side of it. Then draw a straight line from the second to the next trijunction and similarly mark offsets from it to all the field bends on that line. Repeat the process until you return to the starting trijunction.

(2) The field bends can be plotted on their respective "diagonal" lines when they have been offsetted. Eliminate them therefore from your view and fix your attention for the present on the figure formed by the lines joining the trijunction stones. This figure must now be divided into triangles to enable it to be plotted as though it were a separate field. Considerable care is required to lay out the triangles so as to take in the greatest number of offsets with the fewest lines, to make the offsets as short as possible, and to avoid obstacles. You will thus obtain as many triangles as there are trijunctions minus 2.

The following example will make this clear. In the field sketched in Fig. 14 draw a straight line from A to C and from it draw an offset to B:—

Next draw a line from C to F marking offsets to D and E. There are no offsets to be marked on the line joining F and the next stone G which is also a trijunction.

The same is the case with the line GH. The next line is from H to N, K, L and M being offsetted on it. Lastly draw NA offsetting O and P and we have now returned to the starting station A.

Triangles are formed by joining CN, NF, FH, thus making four triangles as there are six trijunction stones.

(3) If a field bend is fixed from a diagonal line by a long offset, an additional offset should be measured from it, etc. the nearest diagonal. (See fig. 15). A, having been fixed on the diagonal BC by a long offset, has also been offsetted on BD, the nearest diagonal

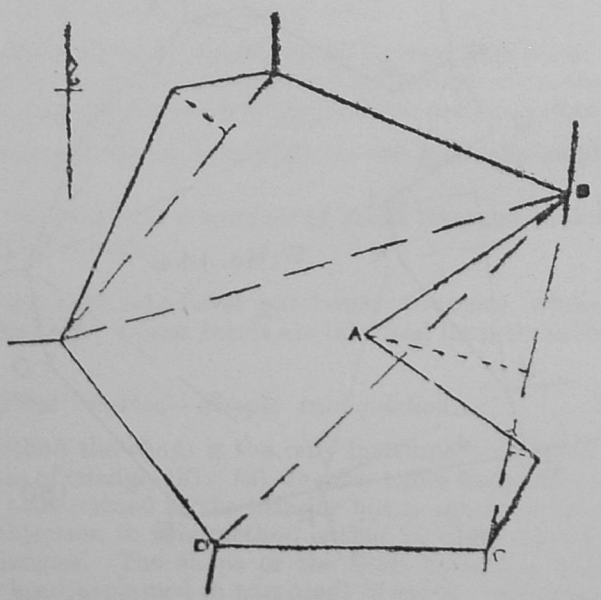


Fig. 15.

(4) If it is required to calculate the area of the field by the offset and base process (vide paragraph 6 of Chapter IX), an offset should be measured in each triangle for this purpose. (See Fig. 16.) Thus in the triangles BCD, ABD and AED, offsets have been taken to the points C, D and E from the bases BD, AB and AD, respectively. This is however rarely necessary in practice.

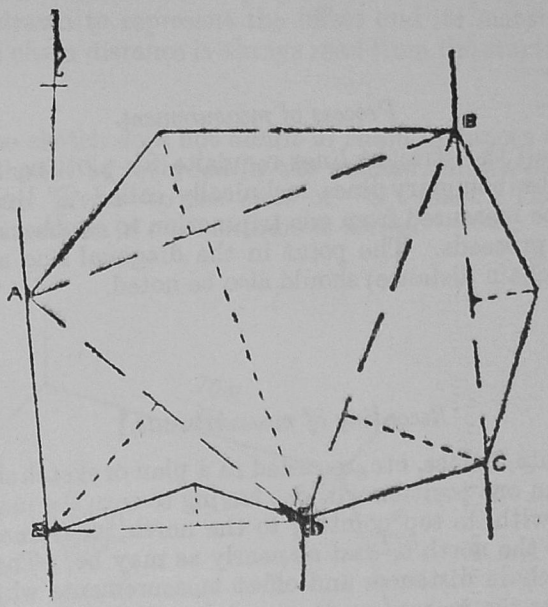


Fig. 16.

(5) If any of the triangles formed is ill-conditioned (i.e., the shortest side is less than half the longest side of the triangle), the vertex should be offsetted from the base so that the offset can be used for plotting the triangle.

(6) The above rules provide for the triangulation of all trijunctions to enable survey fields to be plotted together to make up a combined map. In maintenance, it is often unnecessary to triangulate with this object in view and hence, it is often sufficient to form well conditioned triangles by lines joining trijunction points not necessarily adjacent and to offset trijunction points not so joined (together with other field bends) on the sides of triangles so formed.

Advantages of the Second Method.

7. (1) As minor bends are determined by offsets and only the principal points fixed by triangulation, large and well conditioned triangles can ordinarily be formed which ensure accurate plotting.

(2) Suppose, survey number 147 adjoins survey number 146 as in Fig. 14. The straight line from H to N and the offsets on that line to the stones K, L, and M need not be remeasured for survey number 147, as they have been already measured for survey number 146. This saves a good deal of time and labour.

(3) There is a considerable saving in demarcation as only trijunctions and a limited number of bends need be demarcated with stones. In simple triangulation every bends has to be demarcated with a stone and consequently the work of the maintenance staff becomes much heavier.

(4) Some check in office is possible with reference to the chain and offset distances and the corresponding 'F' measurements. In simple triangulation, practically no check is possible and consequently errors cannot be detected in the Office.

(5) The calculation of area is a simple matter whereas in pure triangulation it is a laborious process.

Process of measurement.

8. After drawing all the straight lines requisite for plotting the figure, the surveyor should first measure the boundary lines technically called 'F' lines. Diagonal lines (or 'G' lines) should then be measured from one trijunction to another and offsets if any, taken to bends as the work proceeds. The point in the diagonal line at which the offset falls (technically called the chain distance) should also be noted.

Recording of measurements.

9. All measurements, names, etc. recorded in a plan or sketch should be written so that they may be read from one position without having to turn the map round. As the plan or sketch is always read with its top pointing to the north, measurement should be recorded in it so as to point to the north or east as nearly as may be. The only exception admissible is in the case of chain distances and offset measurements which should be entered in the same direction as the measurement were taken (See Figure 17.)

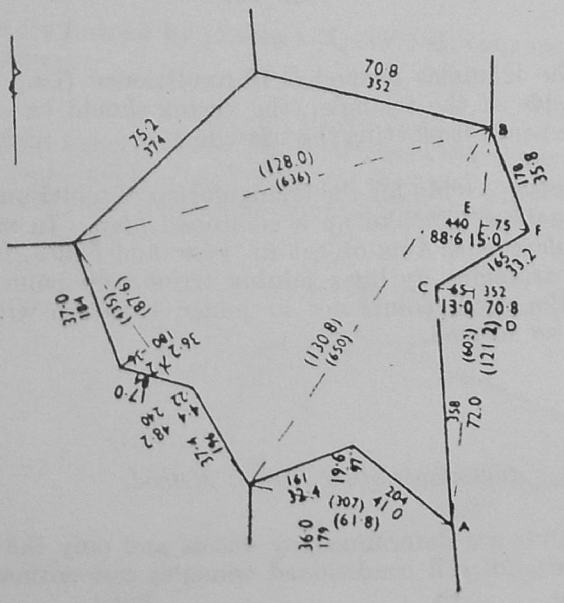


Fig. 17

The surveyor should therefore remember the following points :—

(1) 'F' measurements in the top and bottom of the sketch should be entered immediately over and under the lines respectively outside the field so that they may be read from left to right. 'F' measurements in the left and right of the sketch should also be entered immediately over or under the lines respectively outside the fields so that they may be read from bottom to top.

(2) Measurements of 'G' lines should be entered in the same manner.

(3) Measurements of offset and the *chain distances* should be entered as follows :—

The chain distance is written at that point in the 'G' line from which the offset is taken ; a dotted line is drawn to represent the offset and its measurement is entered immediately above it. The chain distance is always read from the starting station.

(4) If the space in the sketch does not admit of chain distances and offset measurements being entered they should be recorded in the manner, indicated in diagram No. 18. Alphabetical letters are given to the ends of 'G' lines. The bends which are offsetted on them are given numbers in one continuous series.

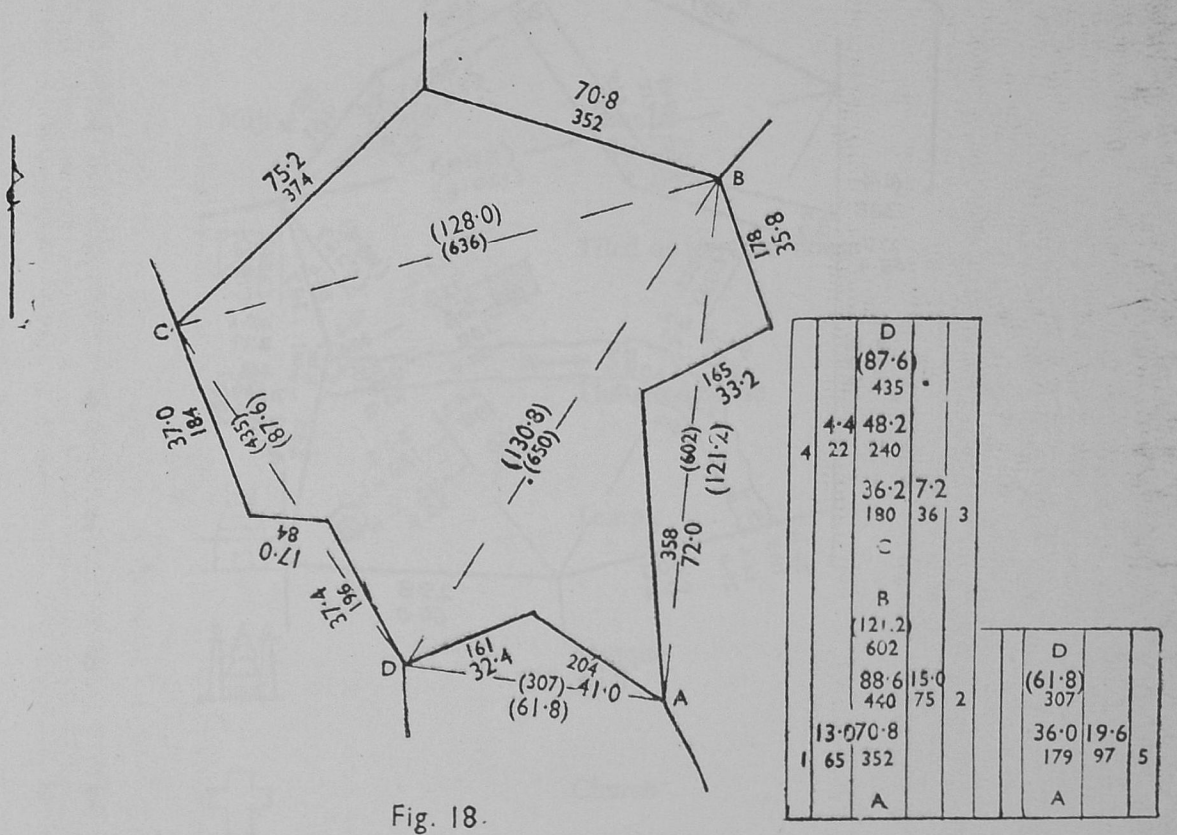


Fig. 18.

Draw outside the sketch in a convenient corner four parallel lines running from top to bottom. Write the letter given to the starting station at the bottom of the space between the two inner parallel lines. Over it enter the chain distance at which the first offset is measured. Enter the offset distance to the right or left of the chain distance outside the inner parallel lines but inside the outer lines according as the bend offsetted is to the right or left of the line along which you are proceeding ; also enter the number of the bend to the right or left of the offset distance outside the outer line. The second chain distance should then be entered above the first chain distance between the two inner parallel lines and the offset distance and the number of the bend should be entered as already explained. Proceed in this way and when all the bends are offsetted enter total distance of the diagonal over the last chain distance and over that enter the letter indicating the closing station. As many sets of parallel lines are drawn as are necessary.

Recording of details.

10. A "detail" is a conspicuous object of a permanent character in a field such as a house, well, temple, channel, burial ground or road. It is necessary to mark it in the map for the following reasons. Its exhibition is an indication of its existance at the time of survey. This may be of help in deciding future disputes. If a part of a channel runs along any field its existence at the time of survey, if marked in the plan, is an extra check against any arbitrary encroachment on it. Lastly the existence of details is of great help to the azmoishing officer in the identification of fields.

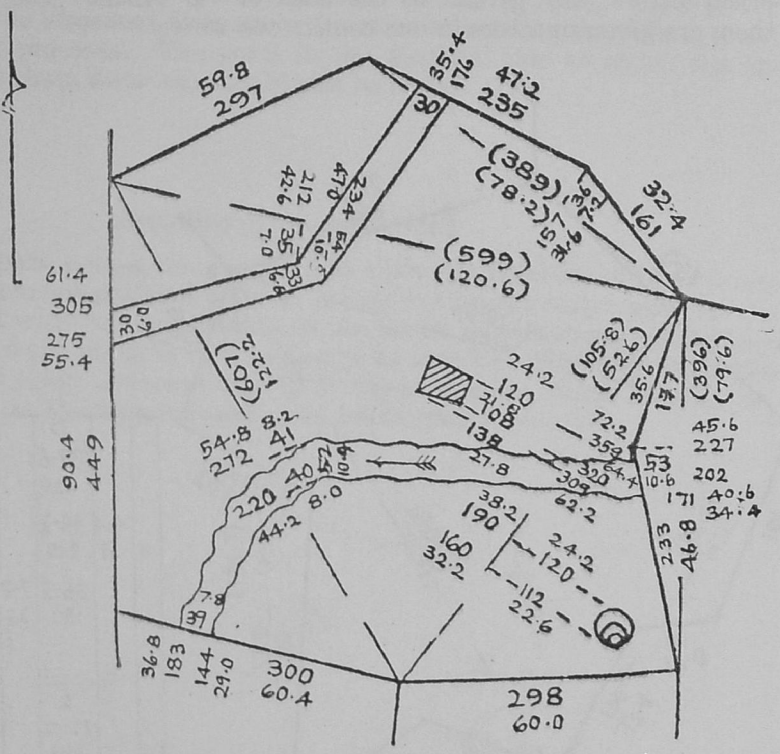
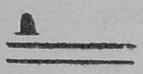
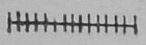
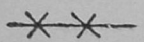
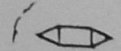


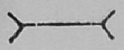
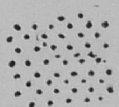
Fig. 19

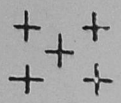
Details should be recorded by taking offsets from the nearest 'G' lines to a few prominent points in them such as corners in the case of a house, bends in the case of road or channels (Fig. 19). In the case of roads, cart-tracks, foot paths, channels, etc., the distance in the 'F' lines at which they enter and leave the field and their width at important bends should be recorded. In the case of channels the direction of the current should be indicated by an arrow. The conventional signs which are generally used for denoting details are given in the following pages :—

Reference Sheet.

1	Palli	Parent Village
2	Nuji	Hamlet
3		Tiled or terraced house
4		Thatched house
5		Temple
6		Mosque
7		Church
8		Fort
9		Lamp post

10		**Light house**
11	.....	**Foot path**
12	– – –	Cart track
13	:::::::	Earthen road
14		Gravelled road and mile stone
15		Metalled, Concrete and Black top road and mile stone
16		Railway line
17		Telegraph line
18		Telephone line
19		River, Canal and aqueduct.
20		River and stream with anicut
21		Culvert and bridge
22		Ferry

23		Tank
24		Callingula
25		Sluice
26		Square well
27		Round Well
28		Indigo Vat
29		Fountain
30		Hydrant
31		Swamp
32		Salt Pan
33		Sand

34  Burial ground

35  Scrub and jungle

36  Limit of rocky ground

37 

Lambton's G. T. Survey Station and Height in metres above sea level

38 

Modern Series

39 

Madras Survey

40  Village boundary station

41  Village Trijunction Station

42  Khandam Station

43  Minor Circuit Station

44  Theodolite Station-Town Survey

45  Chain Survey Station

46		Field Stone
47		Rock mark
48		Forest cairn or pillar
49		Village boundary
50		Survey field boundary
51		Electric Transmission Line
52		Electric Power House
53		Electric Sub-station
54		Telephone Station
55		Telephone Exchange
56		Boundary of the Units in the grouped villa g

Measurement of sub-divisions in the course of Survey.

11. Suppose the field to be measured contains two or more sub-divisions. These have also to be measured. The sides forming the boundaries of the sub-division should be measured first. The sub-division bends should then be offsetted on the nearest diagonal lines of the field. (vide diagram No. 20). Should these lines be obstructed the sub-division bends may be offsetted on the nearest convenient diagonal lines of the field.

The sub-divisions in a field should be numbered consecutively commencing from the north-west corner of the field. The numbering should be from north to south, west to east and generally from north-west to south-east.

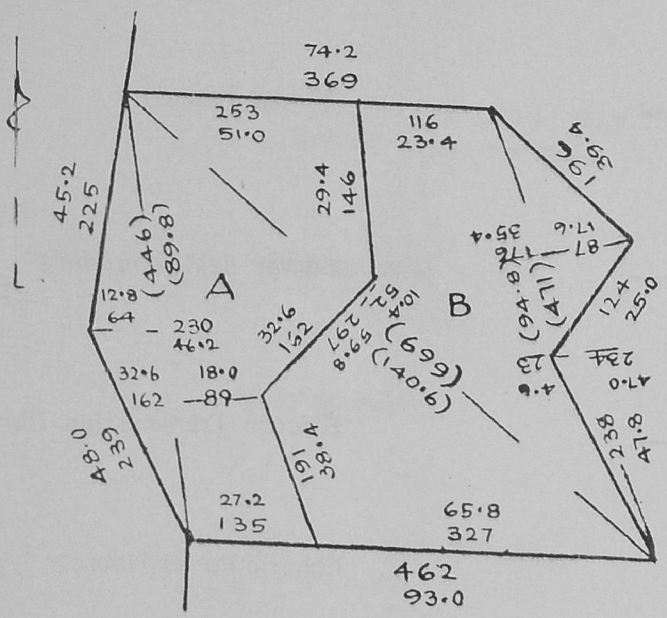


Fig. 20

Exception to the rule of triangulation in the case of long narrow fields.

12. The system of triangulation described in paragraph 5 supra should be followed as a rule, but in the measurement of long narrow channels, roads and similar fields, triangulation will give ill-conditioned triangles formed on very small basis. The figure when plotted cannot therefore be depended upon to give the true shape of the field on the ground (See Fig. 21).

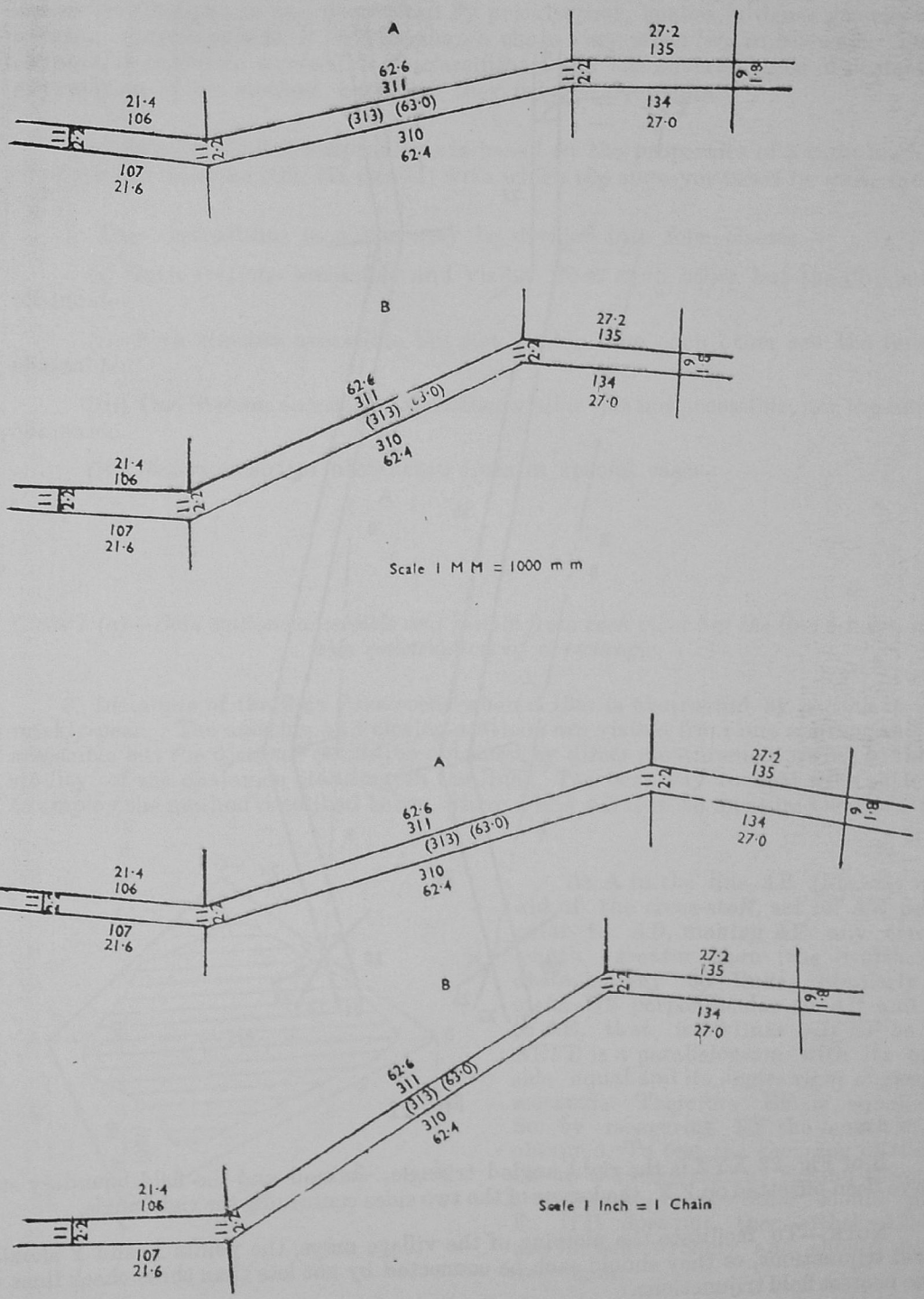


Fig. 21

In such cases, the stones on the field boundary should be offsetted from a line drawn between two trijunctions at opposite ends of the field. See Fig. 22, Section A, in which X and Y are the opposite ends. If the line from X to Y is not visible nor easy to chain, a right angled triangle should be formed so that the line between the two trijunctions may subtend the right angle and the stones on the field boundary offsetted from the longer of the two sides which contain the right angles. In section.

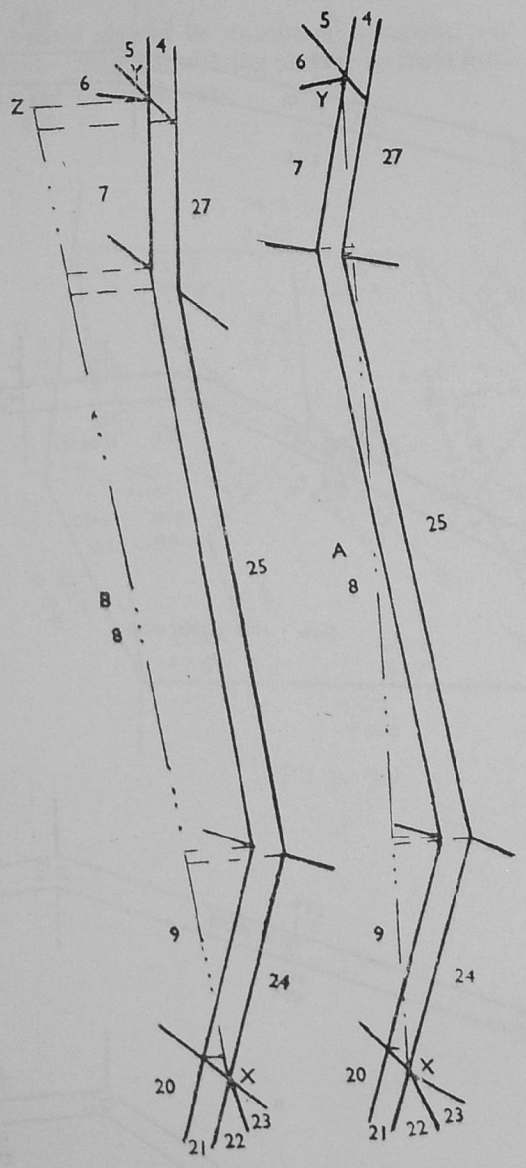


Fig. 22

B of Fig. 22 XYZ is the right angled triangle, formed and the field boundary stones have been offsetted on Z X, the longer of the two sides containing the right angle.

NOTE.—To facilitate the plotting of the village maps, the points X and Y should be field trijunctions, or they should each be connected by not less than three check lines with the nearest field trijunctions.

CHAPTER *VII.*

Measurements of obstructed lines.

In the course of his field work, the Surveyor may be impeded by various obstacles. A line may happen to be obstructed by prickly-pear, bushes, a dense growth of trees or houses. A river or a tank broader than a chain very often lies in his way. The present chapter is therefore devoted to a classification of the several kinds of obstacles and an explanation of the methods by which they may be overcome.

The solution of all these problems is based on the properties of a right angled triangle or of similar triangles (Ch. III and II) with which the surveyor must be quite familiar.

2. The obstructions in a line may be divided into four classes.—

(i) Both stations accessible and visible from each other but the line between not chainable.

(ii) Both stations accessible but not visible from each other nor the line between chainable.

(iii) One Station accessible ; the other visible but not accessible, nor the line between chainable.

(iv) Measurement of obstructed lines in special cases.

Class I (a)—Both stations accessible and visible from each other but the line between not chainable construction of a rectangle.

3. Instances of the first class occur when a line is obstructed by a tank or a bed of prickly-pear. The starting and closing stations are visible from one another and are also accessible but the distance cannot be obtained by direct measurement owing to the impossibility of the chainmen standing on the line. The best way to deal with such cases is to employ the method described below, where a line AB is to be measured across a tank.

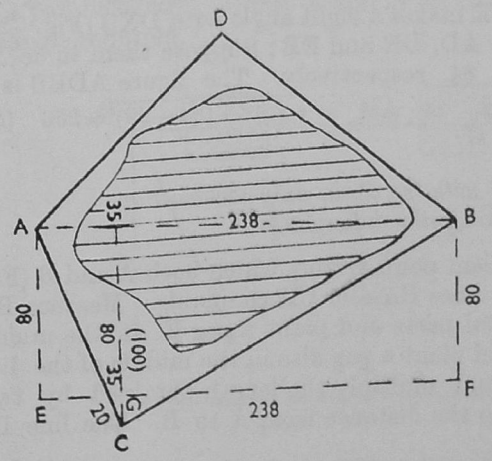


Fig. 23

At A in the line AB (Fig. 23) with the aid of the cross-staff, set off AE perpendicular to AB, making AE any convenient length, greater than the width of the obstacle say 80 links. Similarly at B make BF perpendicular to AB and equal to AE, that is 80 links. If EF be joined, AEFB is a parallelogram with its opposite side equal and its angles right angles, i.e., a rectangle. Therefore EF is equal to AB. So by measuring EF the length of AB is obtained. To test the accuracy of the work, set up the cross-staff at E and through one groove sight A ; the other should point to F. If it does not, then either AE or EF was laid out wrongly and should be done over again.

Class I (b)—Measuring an offset on a line obstructed as above.

4. Suppose it is required to take an offset to a stone 'C' on the obstructed line AB (Fig. 23). Find the length of AB by forming a parallel and equal line EF in the manner explained above. On the straight line EF, take an offset to C from the point 'G' 35 links from E which we will suppose to be 20 links. The distance therefore, of C from AB, which we want to find, 20 links—the distance of EF from AB, that is, 80 links, making a total of 100 links.

If C had been 20 links to the left of EF, its distance from AB would have been 80 links—20 links that is, 60 links.

Class II (A)—Both stations accessible but not visible from each other nor the line between them chainable.

5. We may next consider the obstructions included in Class II when a chain line is obstructed by houses, trees or other growth, so that the starting and the closing stations are not visible from each other. Both stations are accessible but the line between them cannot be measured directly on account of the obstacle which also intercepts the line of vision from one to other.

(1) *Method with the cross staff and the chain construction of a right angled triangle.*

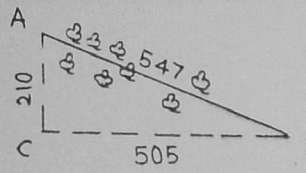


FIG. 24

6 (1) suppose (Fig. 24) the line AB is obstructed by trees, so that A is not visible from B. Move the cross staff to any convenient point C, until the grooves are directed to A and B, respectively. AC and CB are measured and are, say 210 and 505 links, respectively. The angle ACB is a right angle and AB $= \sqrt{210^2+505^2} =$ 547 (*See* Chapter III).

(2) *A second method with the cross-Staff and the Chain by Constructing a trapezoid on any arbitrary line.*

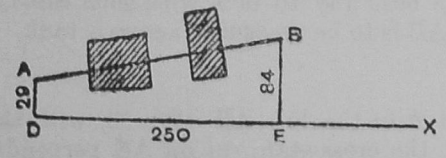


FIG. 25

7. At a convenient point D, say 30 links from A, set up the cross staff and sighting A through one groove, through the other select some convenient spot X in the neighbourhood of B. Now with the cross staff find a point E in the line D X (at which BE makes a right angle with DX.) (Fig. 25). Measure AD, DE and EB ; Suppose them to be 29, 250 and 84, respectively. The figure ADEB is a trapezoid. So AB $= \sqrt{250^2+(84-29)^2} = 256$ (*See* Chapter III).

(3) *A third method with the chain only-construction of two similar triangles.*

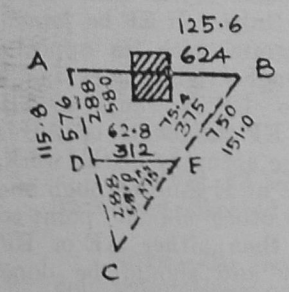


Fig. 26

8. Select a convenient point C from which both A and B (Fig. 26) are visible and the lines CA and CB chainable. Measure BC. Divide it into two equal parts and plant a peg E at the middle point. Measure AC and plant a peg also in the middle of the line at D. Measure DE and multiply the length obtained by two. The product is equal to the distance from A to B. The line DE is also parallel to AB.

Class II (B)—Measuring an offset on a line obstructed as above :—

(i) First method-constructing a rectangle by producing both ways the base of a similar triangle formed in any triangle :—

9. The manner of measuring offsets on an obstructed line such as those of class II differs from that described in paragraph 4 above only in the method of which we measure a line parallel and equal to the obstructed line. There are several ways of doing this but one of the most accurate is that which has been just described in the previous paragraph. Having thus obtained ED parallel to and half of AB (Fig. 27) the cross staff is planted at a point F in the line ED produced so that when one groove is directed to E or D the other points to B, G is found in the same way. The line GF is now equal and parallel to AB. Offsets to any points may be measured from GF, and their positions in relation to the line AB discovered by subtracting from or adding to 55 (The length of AG or BF), the distances to the objects measured from GF, according as they lie to the left or right of this line, starting from G.

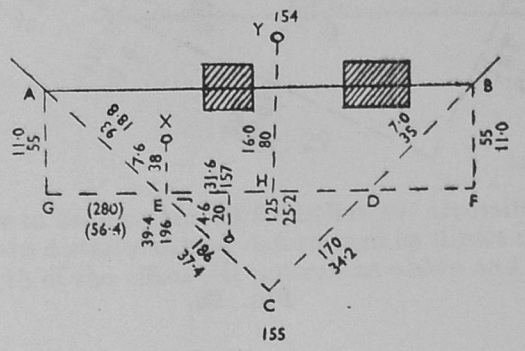


Fig. 27

Class II (b) Measuring an offset on an obstructed line.

(2) *A second method of constructing a rectangle from a parallelogram.*

10. The method given above requires a lot of space in front. If the ground does not permit the use of this problem the following method of constructing a rectangle from a parallelogram may be adopted. With the cross-staff make a right angle ACB at any point C. Fix the Cross staff at B and make a right angle CBD. Make BD equal to AC. AB, DC is then a parallelogram. Offset A and B on CD at M and N respectively. A M N B is the rectangle required.

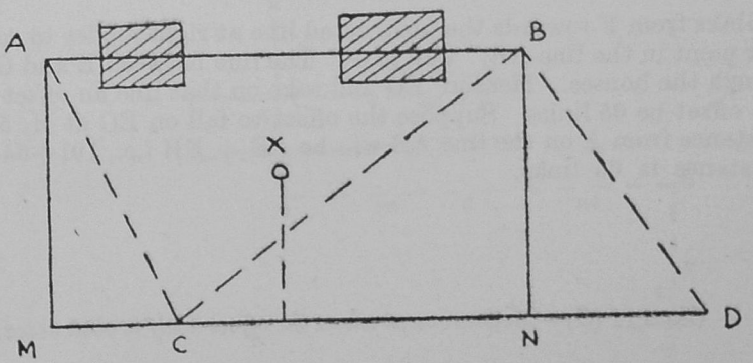


FIG. 27-A

(3) *A third method of measuring an offset on a line obstructed as above-Forming similar triangle in a right angled triangle and calculating the perpendicular.*

11. Another method is also adopted for measuring an offset from a diagonal line obstructed by houses, etc. Suppose it is required to measure an offset to X from the line A B obstructed by houses (Fig. 28). Find the measurement of AB by the process explained in paragraph 6 (1) supra. Let the right angle be at C. Measure B C and C A the perpendicular and base of the right angled triangle. The length of 256 and 540, respectively. AB is therefore 596. Proceeding along AC from A suppose at D you find yourself clear of the

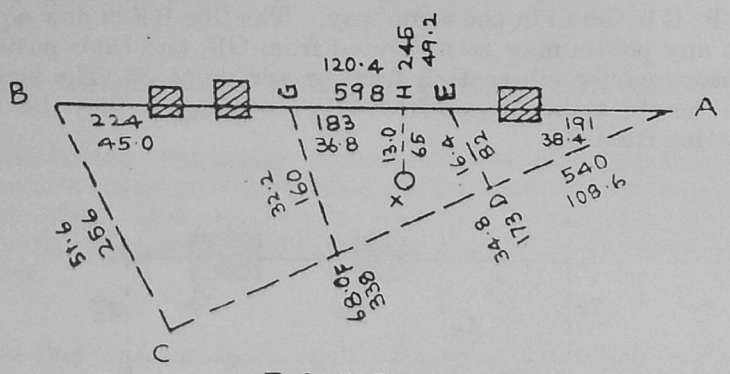


FIG. 28

FIG. 28.

obstruction. Fix your cross staff at this point view A and C through one groove and through the other send a man in the direction of the obstructed line. We should now calculate the distance to be measured in this direction in order to get into the obstructed line AB. This is obtained by multiplying the perpendicular of the right angled triangle first formed with the chain distance now measured on the base and dividing the product by the length of the base. The offset to be laid out at D is therefore $= \frac{BC \times AD}{AC} = \frac{256 \times 173}{540} = 82$

Measure 82 links from D in the direction you sent the man and let him stand at E, which is in the line AB. The distance from A to E can also be calculated and is equal to $\sqrt{173^2 + 82} = 191$

Proceed on the base AC and at another convenient point say F fix the cross staff and repeat the process. The offset to be laid out from F to reach AB $= \frac{256 \times 338}{540} = 160.$

Measure 160 links from F towards the obstructed line at right angles to AC and thus you reach another point in the line AB. Call it G. The line between E and G is the line AB running through the houses. Measure EG and take on that line an offset to X. Let the length of the offset be 65 links. Suppose the offset to fall on EG at H, 54 links from E. The chain distance from A on the line AB will be AE + EH i.e., 191 + 54 = 245 links and the offset distance is 65 links.

Class II (C)—Measurement where the offset itself is obstructed.

12. When measuring an offset on an obstructed line, it sometimes happens that either the stone to be offsetted is not visible from the line drawn parallel to the obstructed line

or the offset from the stone where visible falls in an inconvenient point on the chain line. The offset to the stone and the chain distance should in such cases be measured as follows :—

See Fig. 29. Set up the cross staff at any convenient point, say, M on the line XY, view XY through one groove and direct a man through the other to a certain point say P. On the line MP take an offset to C at N. The chain distance on the line XY at which an offset to C falls is equal to XM—NC and the offset distance is equal to MN.

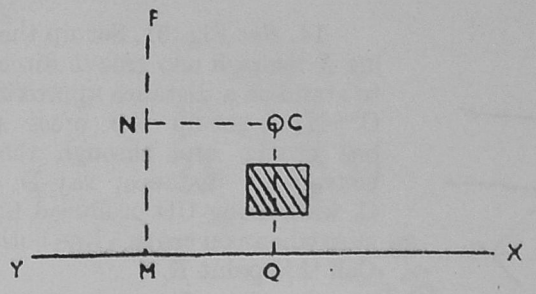


Fig. 29

Where the stone to be offsetted is visible but not accessible being surrounded by thick prickly pear, the chain distance can be determined by direct measurement on the line XY. For getting the length of the offset CQ proceed as above and measure NM.

Class III—One of the two stations alone accessible and the other visible but the distance between them not chainable.

(1) One method—construction of two equal right angled triangle.

13. We shall next consider how to overcome obstacles included in class III. A river in flood affords the best illustration of obstruction of this kind. Suppose the surveyor is at B in Fig. 30 and it is required to measure AB when A is visible from B but cannot be reached. Set up the cross-staff at B and viewing A through one groove direct a man through the other to stand at a distance approximately equal to AB, say at C from which point A must be visible. Fix a flag at C.

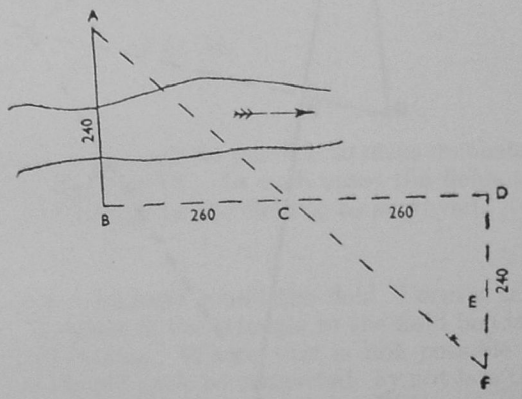


Fig. 30

Produce BC to D and make CD equal to BC. Take the cross staff to D and sighting B or C send a man forward in the direction of the other groove to a convenient distance say E. Leaving the cross staff at D walk along DE produced having E and DF in sight and stop when you are in a line both with AC and DE. Call this point F and the distance DF will be equal to the distance AB.

(2) *Another method—Construction of similar right angled triangle.*

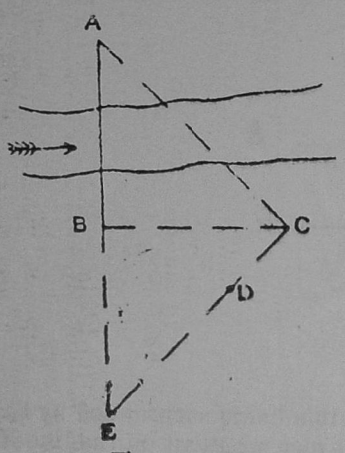


FIG. 31

14. *See* Fig. 31. Set up the cross staff at B and viewing A through one groove direct a man through the other to stand at a distance approximately equal to AB, say at C. Next set up the cross staff at C view A through one groove and through the other direct a man to a convenient distance, say D. Leaving the cross staff at C, walk along CD produced having D and C in view and stop when you are in a line both with C D and AB. Call this point E.

$$\text{Now } AB \times BE = BC^2$$
$$\therefore AB = \frac{BC^2}{BE}$$

See Chapter III.

Note (3).—Even if A and B are invisible from each other the distance between them can be found out by a slight modification of the above method. All that is necessary is to find out with the help of the cross staff a point X from which A and B are visible and also at which A and B substand a right angle. AXB is a right angled triangle of which BX can be measured. AX can be found out by either of the above methods AB which is only the hypotenuse of the triangle can thus be easily calculated. *See* Fig 31–A.

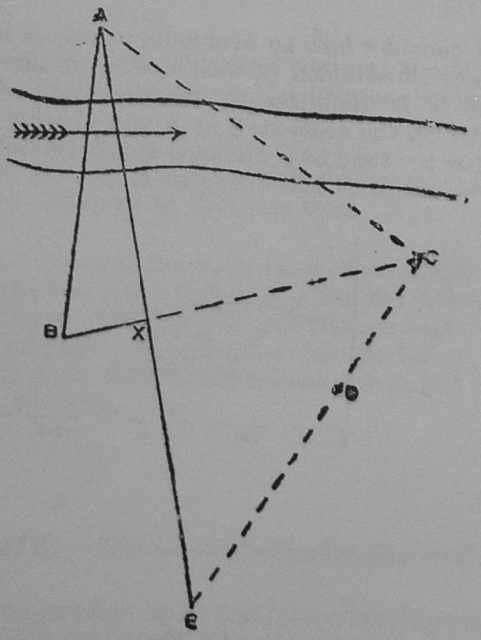


Fig. 31-A.

AXB is a right angle
$AX \times XE = XC^2$
Paragraph 14.
$AX = \frac{XC^2}{XE}$

Class IV.—Measurement of obstructed lines in special cases.

(a) Betel gardens, village-sites and similar fields.

15. When fields are impenetrable owing to thick growth of vegetation such as

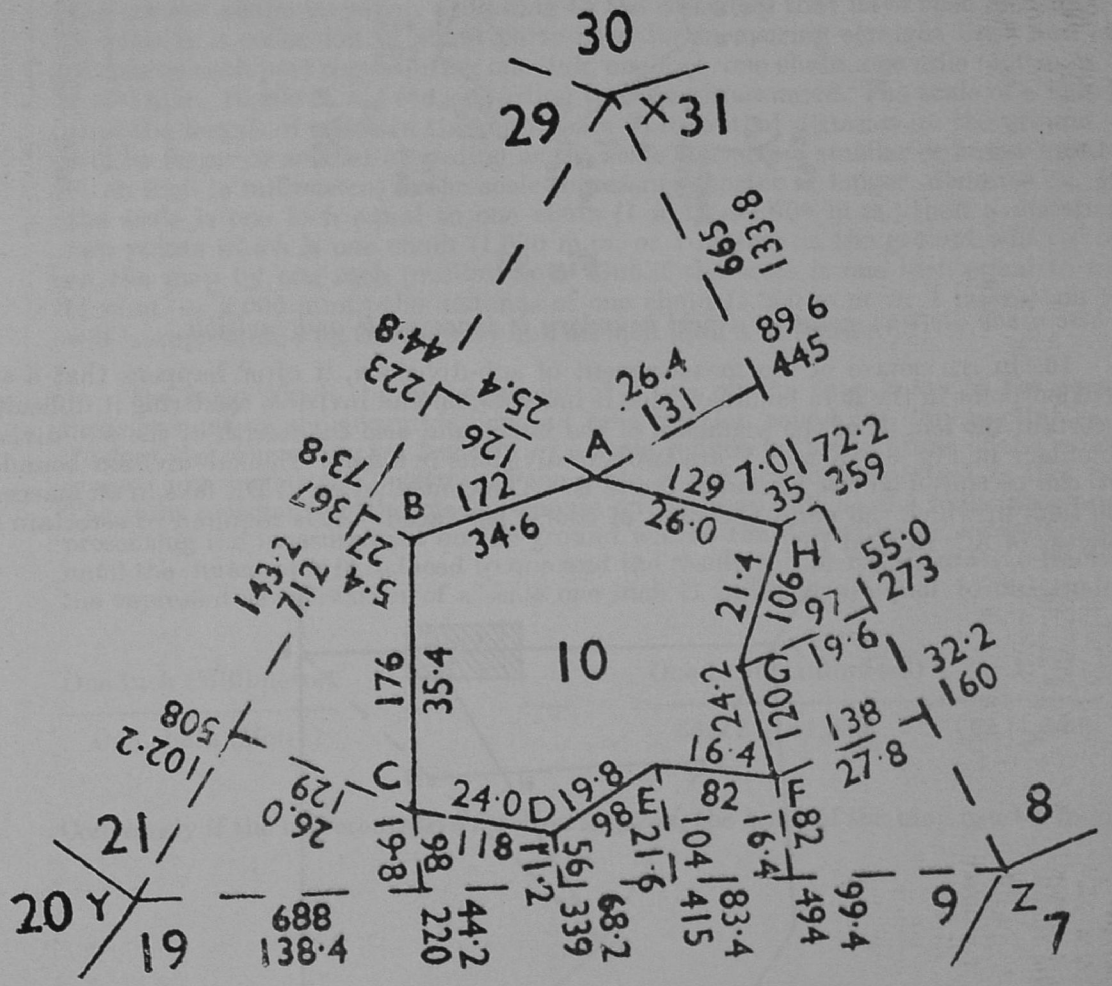


Fig. 32.

betel or prickly-pear or houses, it may not be possible to measure them under the diagonal and offset system described in Chapter VI. In such cases the fields should be measured in the following way. Let ABCDEFGH be the field to be surveyed.

First Method—By Forming a triangle round the field. Form a triangle XYZ outside the field. Take offsets from the sides of the triangle to the field bends. The Points XYZ should if possible be field trijunctions. Where this is not possible the points selected should be field bends and they should each be connected by not less than three tie lines with the nearest field trijunctions. The lengths of the 'F' lines in the obstructed field may be calculated from the offset and chain measurements as explained in Chapter III.

Second method-Run a line between two field trijunctions and offset the bends of the field in question.

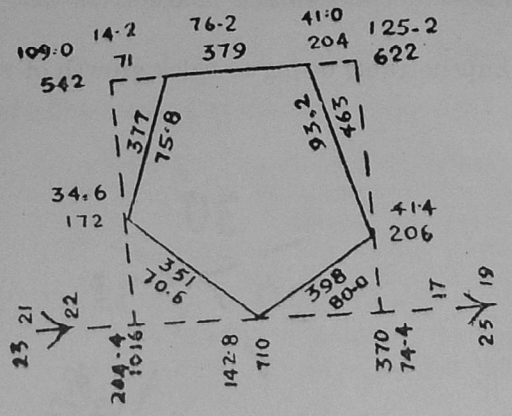


Fig 33

Where a sub-division point in a field boundary is inaccessible and invisible.

16. In the course of the measurement of sub-divisions, it often happens that a sub-division point in the field boundary line is inaccessible and invisible rendering it difficult to ascertain the length of the segments of the latter and also the length of the sub-division boundary in Fig. 34. X and Y are two sub-divisions in a field. The sub-division boundary DC can be traced on the ground as far as E. The continuation of DE falls in an inaccessible tank in which the point C cannot of course be traced. It is required to ascertain the lengths of AC, BC and DC.

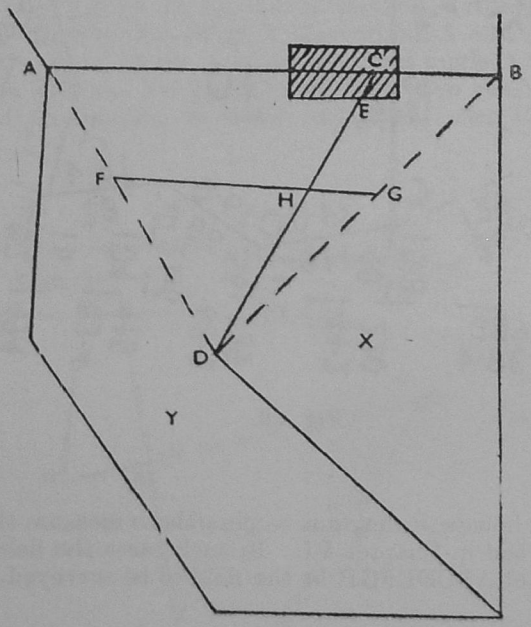


Fig. 34

Measure D A and bisect it at F. Measure DB and bisect it at G

$AC = 2 \times FH$; $BC = 2 \times HG$.

$DC = 2 \times DH$.

Measure FG. Let H be the point, where it meets DE. Measure FH, GH and DH.

CHAPTER VIII.

Plotting.

1. Plotting is the process of preparing to scale a map or plan of a piece of land showing the correct shape on paper, according to the distances that have been measured on ground. A scale is a collection of equal parts used for measuring straight lines and laying down distances each part representing one link, one foot, one chain, one mile (500 m.m. 1,000 m.m. 2,000 m.m. 10,000 m.m.) etc. according to the unit assumed. The scale of a map is the ratio that the length of a line in the map bears to its actual distance on the ground. The map will be larger or smaller according as the scale contains a smaller or larger number of parts in an inch (a millimetre) in the scale represents shorter or longer distance on ground. If the scale is one inch equal to one chain (1 m.m.=1,000 m.m.) then a distance between two points which is one chain (1,000 m.m. or 1 metre) on the ground will be represented on the map by one inch (millimetre). But if the scale is one inch equal to two chains (1 m.m. = 2,000 m.m.) the distance of one chain (1,000 m.m. or 1 metre) on the ground will be represented on the map by half an inch (half a millimetre).

The ratio which the measurement of a line on the map bears to the corresponding measurement on the ground is denoted by a fraction called the "representative fraction". To find the representative fraction of a scale reduce both the terms of the ratio to a like quantity as inches (millimetres, if the scale is not already expressed in like quantities). The term representing the measurements on the map will be the numerator and that representing the measurement on the ground will be the denominator, simplify the fraction until the numerator is reduced to one and the result will be representative fraction—Thus the representative fraction of a scale one inch (1 millimetre) equal to one chain (Metre).

$$\frac{\text{One inch (Millimetre)}}{\text{One chain (Metre)}} \quad \text{—} \quad \text{—} \quad \frac{\text{One inch (millimetre)}}{66\text{x}12\ (1\text{x}1{,}000)} = \frac{1}{792\ (1{,}000)}$$

Conversely if the representative fraction is given, the scale of the map can be found.

Instruments required for plotting a chain survey.

2. A scale, an offset scale and a pair of compasses are essential for plotting a chain survey.

Scale and offset scale.

3. The Plotting scale is a flat piece of wood (box wood) with a straight edge on which are marked divisions representing chains and tenths of a chain or ten-links. The scales most commonly used for drawing field maps are one inch equal to 2 chains or 40 inches

equal to one mile (1 m.m. = 2,000 m.m.) and one inch equal to 5 chains or 16 inches equal to one mile (1 m.m. = 5,000 m.m.) On the same piece of wood it is convenient to draw the two different scales one on each bevelled edge vide Fig. 35 (36).

Fig. 35

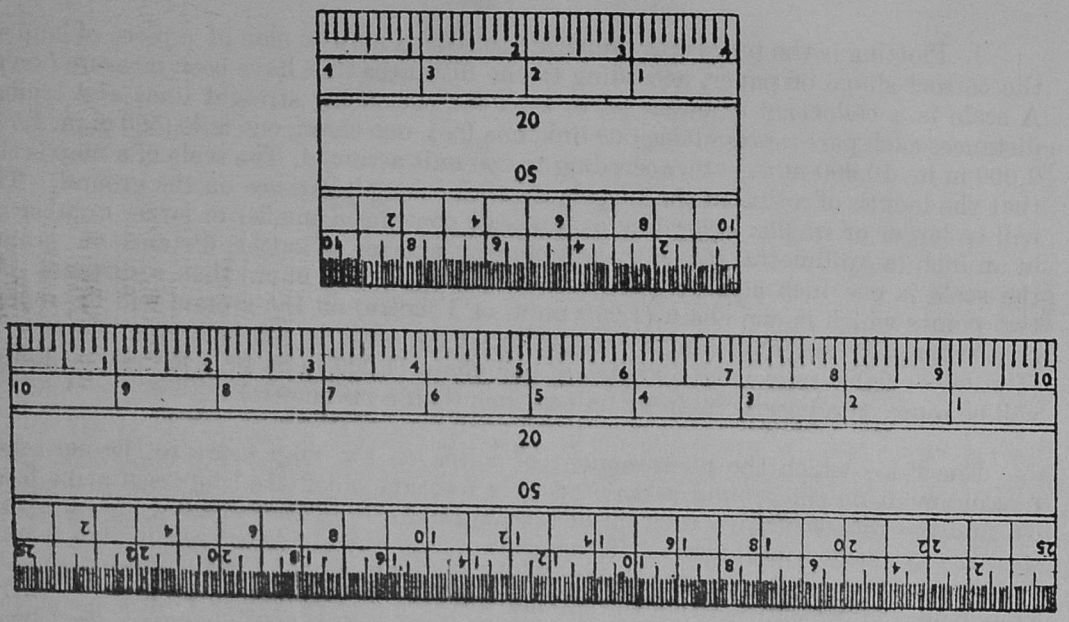
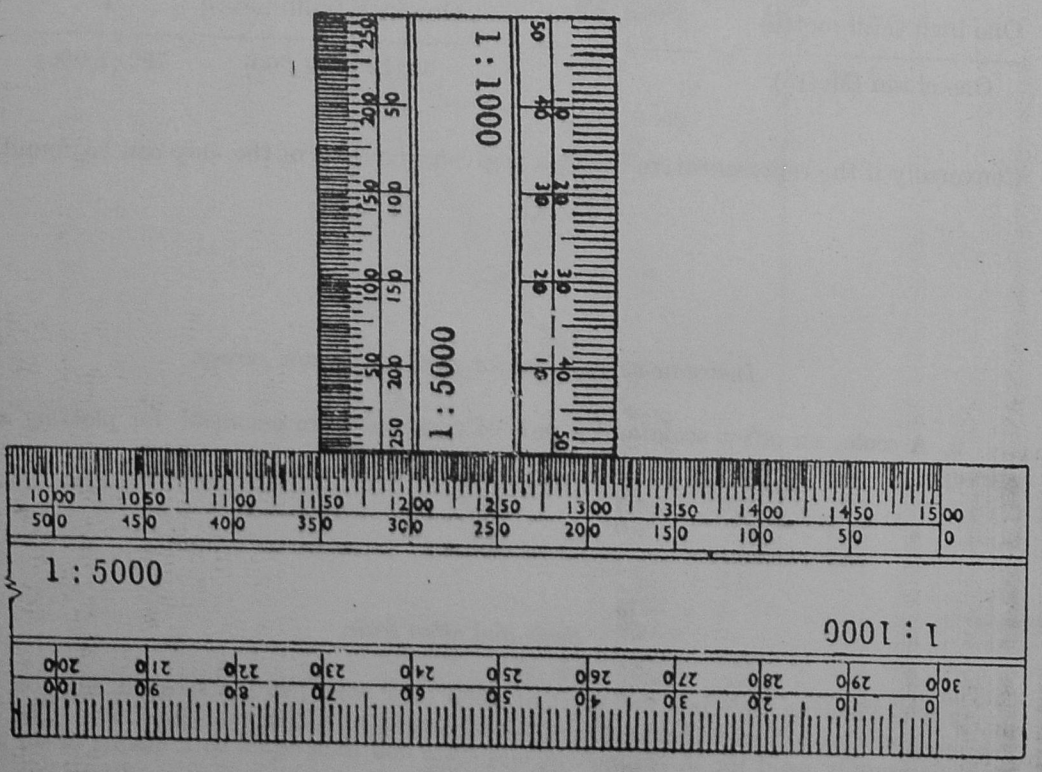


Fig. 36



4. For convenience in plotting offsets a short piece called the offset bit (see Fig. 36) marked with the same divisions is used with the plotting scale. It is made to slide along the edge of the plotting scale for the purpose of laying down on the paper, at right-angles to the line representing the chain line the offset distances measured in the field. The scale and offset bit thus correspond to the chain and offset pole. It will be seen therefore that in plotting a field measured with the chain only under the simple triangulation system, no offset bit is necessary.

Compasses or dividers.

5. The compasses or dividers (Fig. 37) consist of two legs movable about a joint so that their extremities may be sent at any distance from one another. The upper portion and the joint are usually made of brass, the legs of steel ending in fine points. They should be held at the top between the fore-finger and the thumb, with one or more fingers under the hinge to increase or diminish the distance between the points gradually and without a jerk. In plotting triangles draw the base first with the scale. Adjust the compasses on the scale to agree with the length of one of the sides and with one point on the corresponding end of the base, scratch lightly on the paper a portion of a circle with the other point of the compasses where you estimate the apex of the triangle will be. Now take off the scale the length of the remaining side and similarly scratch a portion of another circle taking as its centre the other end of the base.

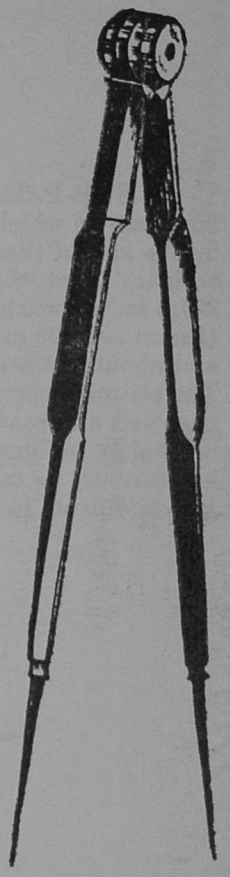


Fig. 37.

The apex of the triangle lies where the two circles intersect, and the sides can then be drawn in or out as required. A little consideration will show that very small portions only of the circles need be described and care should be exercised that the scratches on the paper are merely deep enough to be visible, so that the appearance of the plan is not spoilt by them (Figs. 38 and 39)

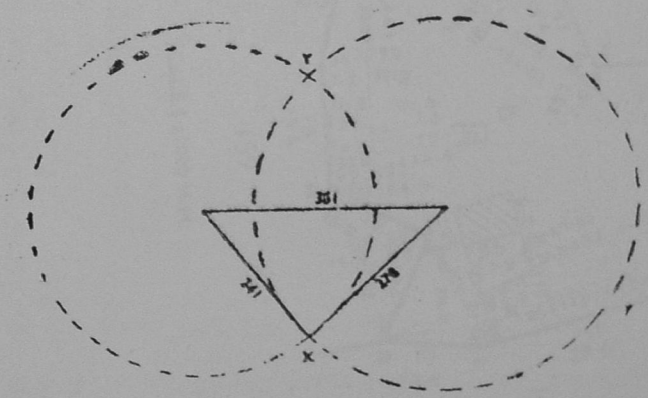


Fig. 38

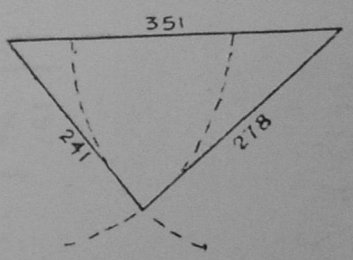


Fig. 39

Additional plotting instruments.

6. A drawing pen (Fig. 40) and a flat ruler for inking in pencil lines are additional aids to neat plotting though they are not indispensable.

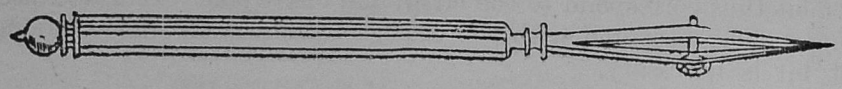


Fig. 40.

Method of plotting.

7. SUB-PARA :—1 The pointer indicating the north should first be drawn (Fig.41). The scale to which the map is to be plotted should next be decided. This is conditioned by the size of the paper and the area and shape of the field to be plotted. Thus on the ordinary sheet of paper to be used for field measurement books ($13\frac{1}{4}'' \times 10\frac{1}{2}''$ or 210 m.m.x 297m.m.) approximately 5 acres (2 hectares) can be plotted on the 80″ scale i.e. 1″=1 chain (1 m.m.=1,000 m.m.); 20 acres (8 Hectares) on the scale 1″=2 chains (1 m.m.=2,000 m.m.) and about 125 acres (50 Hectares) on the 16″ scale i.e. 1″=5 chains (1 m.m.=5,000 m.m.) The estimate cannot ofcourse be taken as a guide for long and narrow fields such as channels and roads. A narrow field 10 chains (200 meters) in length can be plotted ordinarily on one sheet of paper. When this is not possible, the field may be plotted in sections, or on larger sheets of paper which are folded to the size of a field measurement Book.

The scale is noted on the paper.

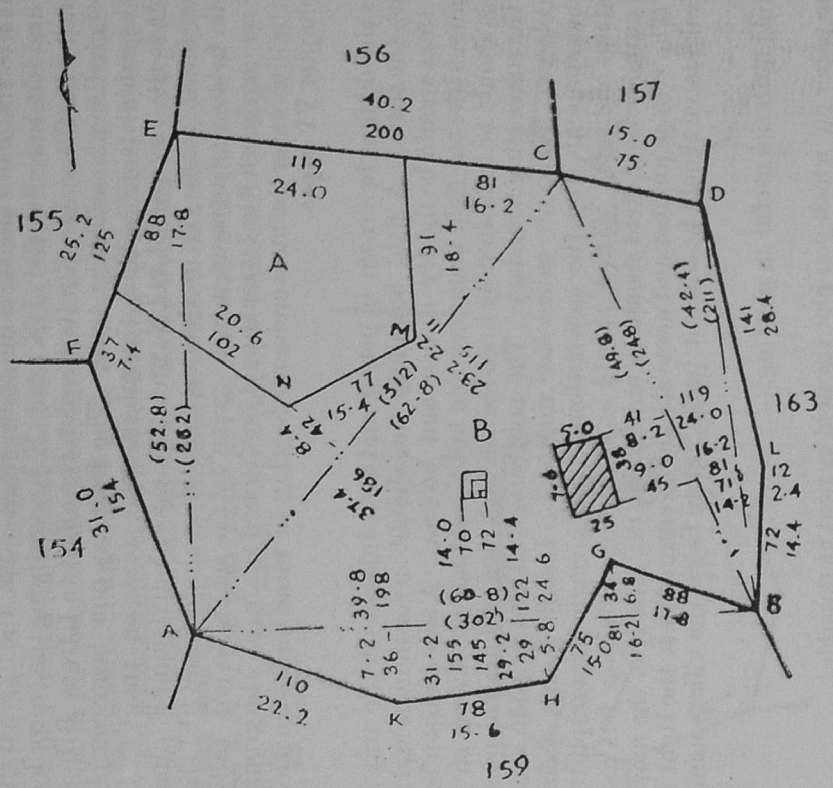
District

Taluk

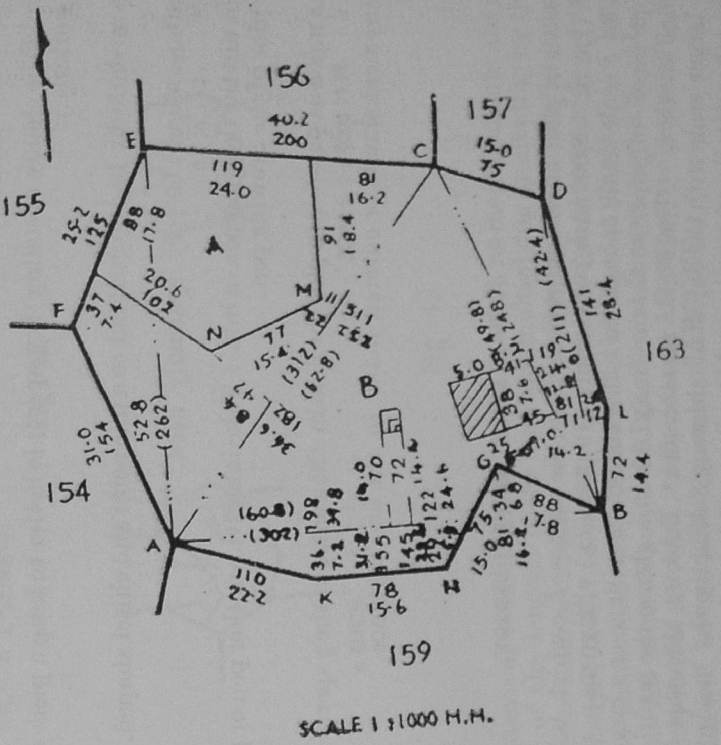
Village { No. / Name

S. No. 158

Area



1 INCH = 1 CHAIN



SCALE 1 :1000 M.H.

Fig. 41

The sides of the triangles should be first plotted, then offsets and lastly the outer boundaries of the field. For example in diagram No. 41 draw the diogonal AB and on it construct the triangle ACB. Then plot the triangles ABC, AFE and CDB and now the offsets from the diagonals to the bends situated on their sides. On the line AB the offsets are to G, H and K; draw the lines BG, GH, HK and KA, verifying the recorded distances with those obtained with the scale. Similarly plot the offset to L from BD; join BL and ID and verify their lengths with the scale. The field has now been completed. Next proceed to plot the sub-divisions. Mark the sub-division points on the "F" lines EC and EF plot the offsets to the corners M and N, and draw the sub-division "F" lines, verifying their lengths with the scale. If in thus verifying the sub-division "F" lines and also those of the whole field, the measurements given by the scales do not tally with those recorded in the rough sketch the latter should be checked again on the ground. Having now drawn all the lines enter the measurements bearing in mind the instructions given in paragraph 9 of chapter VI supra.

8. The lines should first be drawn in pencil and then inked with the drawing pen after being tested with the scale. A field boundary line should be continuous and think. The "G" and offset lines should be lightly drawn and broken. A sub-division boundary line should be continuous like the field boundary line but should not be drawn so thick. Trijunctions of fields should be indicated by lines half an inch long and drawn approximately in the direction of the converging boundary. The numbers of adjoining fields should be noted in appropriate places. These are called side numbers. Details if any, should be plotted last of all and be represented by the conventional signs given in paragraph 10 of Chapter VI Supra. District and taluk names should be entered near the top left hand corner of the map. The number of the field should be entered in the middle of the map right above the diagram. The village number and name should be entered near the right hand corner. The area when calculated should be entered immediately below the village name.

The following hints are useful in plotting:—

Keep the paper on which you plot the field as neat as possible.

To avoid the chance of soiling the paper it is better to keep a piece of paper under the hand when working.

Use a moderately hard pencil cut to a fine point and chisel shaped.

The rubber should be very sparingly used.

Do not dip the drawing pen in ink. Take ink with another pen or paper and insert it between the nibs of the drawing pen.

Try as much as possible to plot the field in the centre of the paper.

Measurement should be entered in ink in the first instance.

Enlargement and reduction.

9. The scale of plan should be governed by the purpose for which it is to be used. In the 16″ or 8″ (1m.m.=5,000m.m.) or (1m.m.=10,000m.m.) village map, we see plans of the fields drawn on a scale small enough to allow the whole village or a large part of it, to be shown on one piece of paper so that we may see at a glance the positions of the fields in relation to one another. The Field measurement Book on the other hand, is prepared on a much larger scale with the object of showing distinctly the measurements sub-divisions and the other details which it would be impossible to plot clearly on the village map.

10. If a plan be drawn to a scale of 1″=2 chains (1m.m=2,000mm) and it is required to enlarge it to the scale of 1″=1 chain (1mm=1,000mm) it is easy to understand that a line 1 inch (millimetre) long in the first will be represented by a line 2 inches (Millimetres) long in the second. The effect however upon the area of the plan is not that of doubling it, but of "Squaring" it. Thus a square whose sides are 1″ (millimetre) would be drawn with the sides of 2 inches (millimetre) but the area of the first would be 1 sq. inch (millimetre) whereas in the second it would be four square inches (millimetres). If a map drawn to scale 1 inch=5 chains (1mm=5,000 mm) is enlarged to scale 1 inch=1 chain (1mm=1,000) the second square would require sides 5 inches (4 millimetres) long and its area would be 25 square inches (25 square millimetres). Hence if a plan be enlarged its area varies as the square of the scales. Similarly if a plan be reduced, its area diminishes in the same proportion The area of the plan must not be confused with the area of the ground. The latter, of course will be the samo, but it can be represented on paper by pictures of any size (Fig. 41, 42, 43, 44).

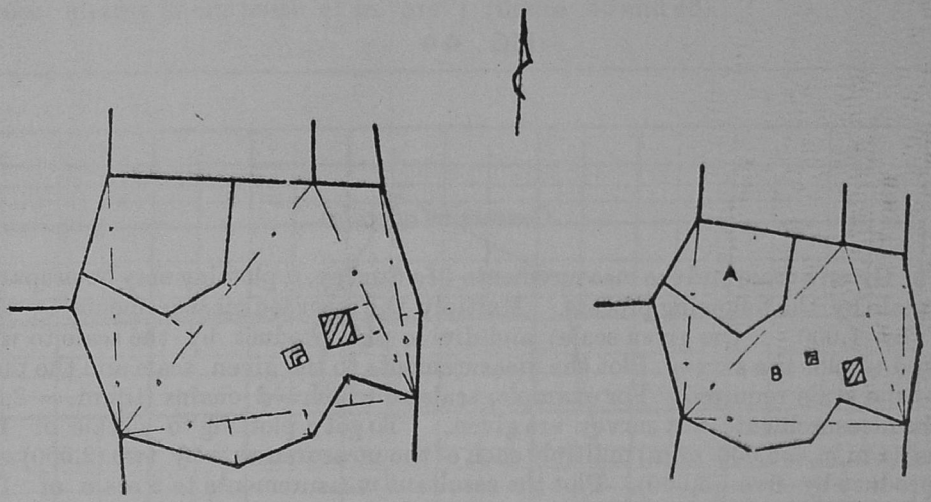


Fig. 42

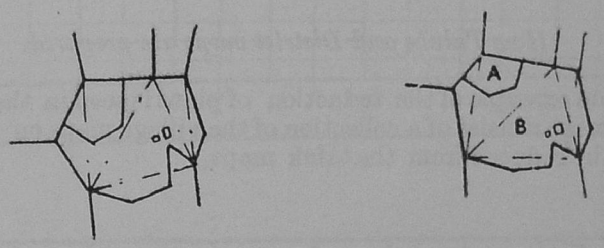


Fig. 43

11. Enlargements or reductions can be made when no measurements are recorded on a plan by scaling of the lengths of the lines and multiplying or dividing by the number of times it is required to enlarge or reduce them. The following method is also generally adopted See Fig. 44. Let ABCDEF be the figure which is required to be reduced to say, half its scale. From any point as A, draw lines to all the angular points of the figures. In AF, AE., AD., AC and AB mark off points M.L.K.H and G. such that AM, AL, AK. AH and AG may be exactly half of AF, AE., AD, AC and AB respectively and join M.L.K.H and G. Then AGHKLM will be one half the scale of ABCDEF.

If AGHKLM be the given figure and it is required to enlarge it to double its scale then the lines AG, AH, AK, AL and AM should be produced to double their lengths.

The figure formed by joining the points B,C,D,E and F will be on double the scale of AGHKLM.

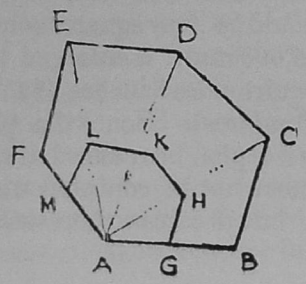


FIG. 44

Conversion of scales.

12. Given a scale and the measurements of a Survey, a plotting may be prepared to any other scale by the following process. Multiply the recorded measurements by the given scale (by 1,000 × the given scale) and divide the product by the scale to which it is required to plot the survey. Plot the measurements to the given scale and the map drawn will be the scale required. For example, scale of 1 inch = 2 chains (1m.m. = 2,000 m.m) and the measurements of a survey are given. To get a plotting to a scale of 1 inch=5 chains (1 m.m.=5,000 m.m) multiply each of the measurements by two (2,000) and divide the product by five (5,000). Plot the resultant measurements to a scale of 1 inch=2 chains and the map drawn will be to a scale 1 inch=5 chains (1mm=5,000 mm). The recorded and not the deduced measurements should be entered in the plotting.

How Taluks and District maps are prepared.

13. A very good example of the reduction of plans is seen in the maps of the taluk and district. Taluk maps consist of a collection of the village maps on a smaller scale and the district map is again reduced from the taluk maps.

CHAPTER IX.

Computation of Area.

After a field has been plotted, its area should be computed and recorded on the face of the sketch. The area may be computed either by using the area squar paper or by mathematical calculation.

Construction and use of the area square.

2. The area square is a piece of tracing cloth or tissue paper on which are neatly drawn or printed to the scale required, black ink squares each containing 10 cents, i.e., one-tenth of an acre (100 square metres or one are). These squares are again divided by red ink lines into 10 equal portions, each equivalent to one cent or one hundredth part of an acre (10 square metres or one tenth of an "are") (figure 45 and 46).

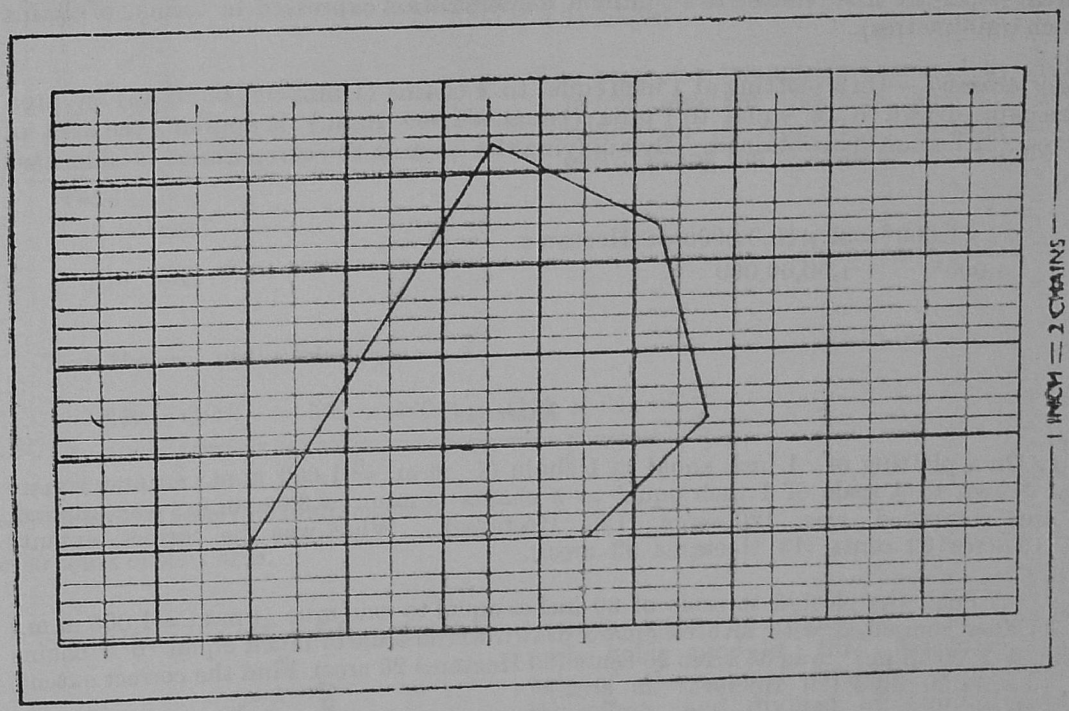


Fig. 45

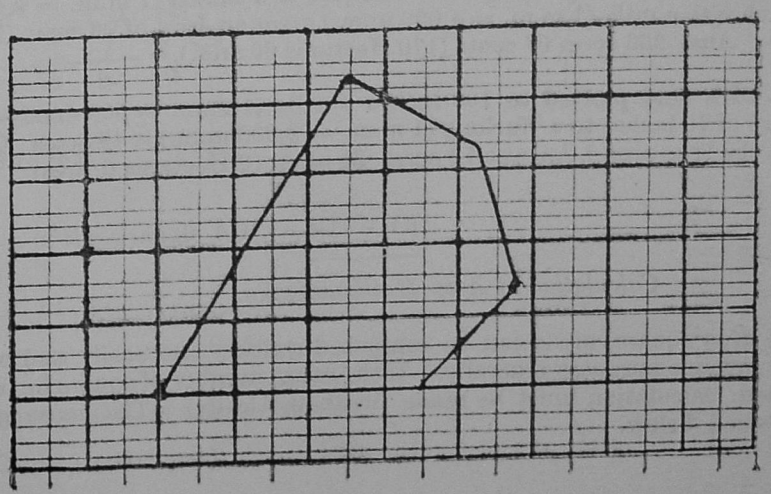


Fig. 46

Lay the area square paper over the plotting of the field, the area of which is sought, so that the boundary of the field is clearly visible and the extreme east or west of it at the corner of one of the 10 cents (are) squares while one of the sides of the field coincides exactly with a black line on the area square paper. The area is then found by counting the number of black and red squares contained within the boundary of the field. If the boundary line does not exactly coincide with a horizontal line of the area square nor is parallel to it equalise any irregularities by the eye so that the space within the field and that outside it may be equal to and compensate each other. *Procedure to be followed when scales of area square and plan differ.*

Paragraph 3.—It sometimes happens that the scale of the area square is different from the scale of the plan of the field, the area of which is required to be computed. In such cases, the correct area is obtained by multiplying the area actually obtained by the square of the scale on the plan and dividing the product by the square of the scale on the area square paper; care being taken that the scales of the plotting and the area paper are first reduced to a common denomination expressed in terms of chains per inch (millimetres).

For example.—On a plotting of 1 inch equal to 2 chains (1 mm=2,000 m.m.) an area square paper drawn to 16″ equal to 1 mile (1m.m.=4,000 m.m.) is applied, the area of 50 acres (32 hectares) is obtained. By applying the formula the correct area is $\frac{50 \times 4}{25} = 8$ acres.

$$\frac{32 \times 1{,}000^2}{4{,}000^2} = \frac{32 \times 10{,}00{,}000}{1{,}60{,}00{,}000} = 2 \text{ Hectares}$$

Exercises.

1. On a plotting of 1 inch equal to 1 chain (1 m.m. = 1,000 m.m.) an area square paper drawn to a scale of 1 inch equal to 3 chains (1 m.m. = 3,000 m.m.) was applied. The area computed was 120 acres (120 Hectares). What was the correct extent? Ans. 13 acres 33 cents (13 Hectares 33 ares.).

2. A field was plotted to scale of 80 inches equal to one mile (1 m.m.=1,000 m.m.) and its area computed with an area square drawn to the scale of 1 inch equal to 2 chains (1m.m. =2,000m.m.) was 65 acres 20 cents (65 Hectares 20 ares). Find the correct extent. Ans. 16 acres 30 cents (16 Hectares 30 ares.).

3. The application of area square of one inch equal to 3 chains (1 m.m. = 3,000 m.m.) on a plotting 16 inches to a mile (1 m.m. = 4,000 m.m.) gives an area of 96 acres (Hectares). Find the true area. Ans. 266 acres 67 cents (170 Hectares 66 ares.).

4. The area of a field plotted to 160 inches a mile (1 m.m. = 500 m.m.) computed with an area square of 10 inches to a furlong (1 m.m. = 2,000 m.m.) is 49 acres (Hectares) (4 cents). What is the true area ? Answer 12 acres 25 cents (3 Hectares 6 ares).

Calculation of Area Mathematically.

4. With the area square, areas can be computed quickly and easily and with sufficient accuracy for revenue purposes generally. If the exact number of square links (metres) is to be determined calculation must be made mathematically. The most important formulae are explained below.

Area of the Rectangle.

5. The area of a rectangle is obtained by multiplying the length by the breadth.

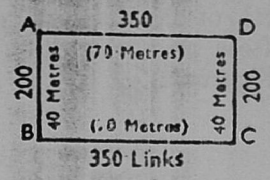


Fig 47

The area of the rectangle—

ABCD = AB × BC

= 200 × 350 = 70,000 Sq. links.

or 70 Cents.

(70 × 40 = 2,800 sq. metres or 28 ares).

6. *Area of a Triangle.*

The area of a triangle is obtained by multiplying together the base and the offset falling on it, from the opposite angle and dividing the product by two. Figure 48.

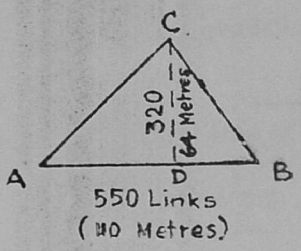


FIG. 48

Thus the area of the triangle

$$ABC = \frac{AB \times CD}{2} = \frac{550 \times 320}{2} = \frac{(110 \times 64)}{2}$$

= 88,000 Sq. Links (3,520 sq. metres).

or 80 cents or 35·2 ares.

Sometimes the offset falls outside the triangle as shown in figure 49. The same formula holds good in this case also. The base of the original triangle multiplied by the offset and divided by two, gives the area required.

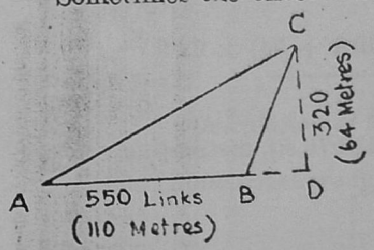


FIG. 49

The area of the triangle ABC = $\frac{AB \times CD}{2}$

$$= \frac{(550 \times 320)}{2} \quad \frac{(110 \times 64)}{2}$$

= 88,000 sq. links (3,520 sq. metres).

or 80 Cents (or 35·2 ares).

Area of a Quadrilateral with a Diagonal and offset on either side.

7. The area of a quadrilateral divided into two triangles by a diagonal with an offset taken on it for each triangle is obtained by multiplying the length of the diagonal with the sum of the offsets and dividing the products by wo. (Figure 50).

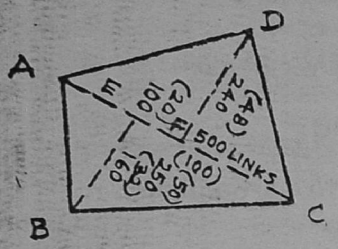


Fig. 50

$$\text{The area of ABCD} = \frac{AC \times (EB + FD)}{2} = \frac{500 \times (160 + 240)}{2}$$

$$\frac{(100 \times 32 + 48)}{2}$$

1,00,000 sq. links =(4,000 sq. metres). or 1 acre (40 ares).

Area of a Trapezoid

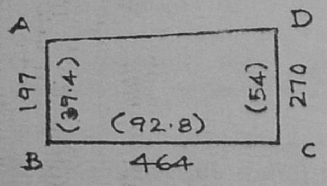


Fig. 51

8. The area of a trapezoid is obtained by multiplying half the sum of the parallel sides by the perpendicular distance between them.

$$\text{The area of the Trapezoid ABCD} = \frac{(AB + DC) \times BC}{2}$$

$$\frac{(197 + 270) \times 404}{2} \qquad \frac{(39{\cdot}4 + 54) \times 92{\cdot}8}{2}$$

= 108,344 sq. links = (4,333·76 sq. metres)

= 1 acre 8 cents = 43 ares.

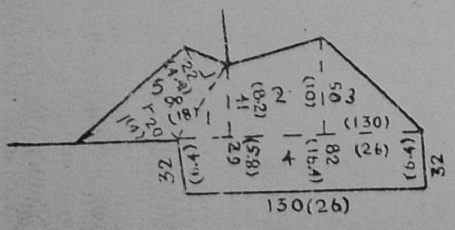


Fig. 52

9. To find the area of an irregular field such as that sketched in fig. 52. Imagine it to be made up of a number of separate figures, find the area each separately and add them together. First for convenience number the figures.

No. 1. is a right angled triangle and its area is

$$\frac{29 \times 41}{2} = 594\tfrac{1}{2} \text{ sq. links.}$$

2. is a trapezoid $\dfrac{(89 - 29) \times (50 - 41)}{2} = 2{,}411\tfrac{1}{2}$ Sq. links.

3. is a right angled triangle. $\dfrac{(130 - 82) \times 50}{2} = 1{,}200$ sq. links.

4. is a rectangle $130 \times 32 = 4{,}160$ sq. links

5. is a quadrilateral $\dfrac{90\ (22 \times 20)}{2} = 1{,}890$ sq. links.

Total area of field = 10,256 sq. links.

1. $\dfrac{5{\cdot}8 \times 8{\cdot}2}{2}$ = 23·78 sq. metres.

2. $\dfrac{(16{\cdot}4 - 5{\cdot}8)\ (10 + 8.2)}{2}$ = 96·46 sq. metres.

3. $\dfrac{(26 - 16{\cdot}4)\ 10}{2}$ = 48·00 sq. metres.

4. $26 \times 6{\cdot}4$ = 166·40 sq. metres.

5. $\dfrac{18\ (4{\cdot}4 \times 4)}{2}$ = 75·60 sq. metres.

410·24 sq. metres.

Calculation of the Chain and offset Distances in a Triangle.

10. Sometimes we find no offset measured in a triangle the area of which is required to be calculated mathematically. The chain and offset distances can be calculated from the measurement of the sides as follows :—

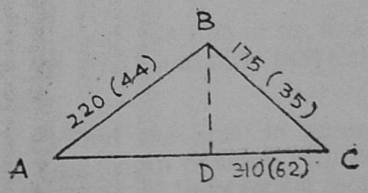


FIG. 53

Suppose it is required to find the lengths of AD and BD, the chain and offsets distances in the triangle A B C (Fig. 53).

The length of the A D is obtained by adding the square of A B its adjacent side to the square of AC the base of the triangle, subtracting from the result the square of B C, the sides opposite to A D, and dividing the remainder by twice the length of A C, the base.

AD is therefore =

$$\frac{AC^2 + AB^2 - BC^2}{2AC}$$

$$= \frac{310^2 + 220^2 - 17\,?^2}{2 \times 310} = \frac{62^2 + 44^2 - 35^2}{2 \times 62}$$

$$= \frac{96,100 + 48,400 - 30,625}{620} = \frac{3,844 + 1,936 - 1,225}{124}$$

$= 184$ links $= 36{\cdot}7$ metres.

The formula is arrived at as follows :—

$AB^2 = AD^2 + BD^2$

$BC^2 = BD^2 + DC^2$

$AC^2 = AD^2 + DC^2 + 2AD \times DC$

adding the first and third items and subtracting the second we get

$AC^2 + AB^2 - BC^2 = AD^2 + DC^2 + 2AD \times DC + AD^2 + BD^2 - BD^2 - DC^2$

$= 2AD^2 + 2AD \times DC = 2AD\,(AD + DC) = 2AD \times AC.$

$\therefore AD = \frac{AC^2 + AB^2 - BC^2}{2\,AC.}$ (by transposition)

This method of calculation is frequently referred to as the "N.O.S. problem" and its application to the replacement of missing stones will be found in Chapter XI Paragraph 3.

Calculation of area when offsets fall within or without the Field Boundary on the same diagonal

11. In some cases it happens that some of the offsets taken on a diagonal line the ends fall within, and others without the figure formed by the diagonal and the other sides of the field—Vide diagram No. 54. In such cases the field boundary line crosses the diagonal. The point of intersection of these two lines should be noted if it is required to calculate the area of the field mathematically. If this is not done in the field, the difference in area between the two triangles FC X and X EB can be ascertained by the following formula. Multiply the distance between the two offsets by the difference of the lengths of the two offsets and divide the product by two.

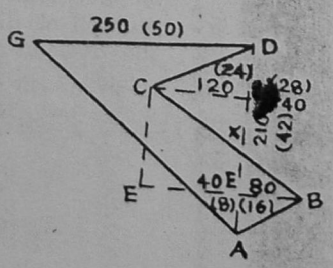


Fig. 54

The difference in area between FCX and XEB

$$-\frac{100\times(120-80)}{2} \quad - \quad \frac{(20\times24-16)}{2}$$

$$-\frac{100\times40}{2} \quad - \quad \frac{20\times8}{2}$$

$-2,000$ Sq. links. -80 Sq. metres.

This difference has to be added to or subtracted from the big triangle according as the length of the offset falling outside the triangle is longer or shorter than the offset falling within it.

In the present case the offset EB falling outside the triangle being shorter than FC, the difference in area 2,000 Sq. links (80 square metres) should be subtracted from the area of the big triangle A D G.

Proof of the above formula :—

In the figure draw CE^1 parallel to FE to meet BE

Produced at E^2.

Since C F E E^1 is a rectangle $CF=E^1E$ and C. $E^1=F.B$

Now the area of the triangle C F X =area of the triangle—

$$EB\,X-(CF\,X+C\,X\,EE^1)-(EBX+CXEE^1)=CF\,EE^1-CBE^1-CF\times FE-$$

$$\tfrac{1}{2}\,CE^1\times EB$$

$$-\frac{2\,CF\times FE-FE\times E^1B}{2}$$

$$-\frac{FE\,(2\,CF-E^1B)}{2}$$

$$-\frac{FE\,(CF+E^1E)-(E^1E+EB)}{2}$$

$$-\frac{FE\,(CF-EB)}{2}$$

Exercises in calculation of area.

1. Find the area in sq. links (metres) of a rectangle, the length and breadth of which are 289 (57.8), and 225 (45) links (metres) respectively. *Ans.* 65,025 Sq. links (260 sq. metres).

2. Find the area in acres and cents (Hectares and acres) of squares having the following length of sides. (*a*) 850 links (170 metres), (*b*) 98 chains 8 links (197·6 metres), (*c*) 20 chains 42 links (408·4 metres), (*d*) 52 chains 42 links (1040·8 metres)

Ans. (*a*) 7·22½ acres (2·89 Hectares), (*b*) 961·97 acres (384·79 Hectares), (*c*) 41·70 acres (16·70 Hectares), (*d*) 270·82 acres (108·33 Hectares).

3. Find the areas of triangles having the following dimensions.

(*a*) Base 456 links (91·2 metres) offsets 240 links *Ans.* 54,720 Sq. links (21,88·8 Sq. metres). (*b*) Base 246 links (49·2 metres) offset 118 links (23·6 metres) *Ans.* 14,514 sq. links (580·56 sq. metres). (*c*) Base 819 links (163·8 metres) offset 124 links (24·8 metres)

Ans. 50,778 sq. links (2,031·12 sq. metres).

4. Find the base of a triangle, the area of which is 97 cents (39 acres) and offset 125 links (25 metres). *Ans.* 1,552 links (312 metres).

5. Find the offset of a triangle, the area of which is 85 cents (36 acres) and base 120 links (37·8 metres) *Ans.* 899 links (191·4 metres).

6. Find the area of right angled triangles having the following dimensions:—

(*a*) Hypotenuse 6,214 (124·8 m.) side 329 (65·8 m.) *Ans.* 87,185 sq. links (36 acres).

(*b*) Hypotenuse 428 (85·6 m.) side 354 (70·8 m).

Ans. 42,657 sq. links (17 acres).

(*c*) Two sides 515 (103 m.) 694 (118·8 m.) respectively.

Ans. 1,62,966 sq. links (61 acres).

7. Find the areas of quadrilaterals having the following dimensions :—

(*a*) Diagonal 638 (107·6 m) perpendiculars 90 and 70 links (18 and 14 metres).

Ans. 43,040 sq. links (17 acres).

(*b*) Diagonal 629 (125·8 m.) perpendiculars 124 and 131 links (24·8 and 26·2 metres).

Ans. 30,197 sq. links (32 acres).

8. The two parallel links in a trapezoid are 104 and 82 links (20·8 and 16·4 metres) respectively and the perpendicular distance between them is 284 (56·8 m). Find the area of the trapezoid.

Ans. 26,412 sq. links (1,056 48 sq. metres).

9. The sum of the parallel sides in a trapezoid is 640 links (128 metres) and the perpendicular distance is 320 (64 metres). Find the area.

Ans. 1,02,400 sq. links (4,096 sq. metres).

10. The area of a trapezoid is 3 acres (1·2 Hectares) The sum of the two parallel sides is 384 links (76·8 metres). Find the perpendicular distance between the two parallel lines.

Ans. 1,563 links (312·5 metres).

11. The area of a trapezoid is 87 cents (36 acres). The perpendicular distance between the two parallel lines and the length of one of the parallel lines are 249 and 124 (49·8 and 24·8 metres) respectively. Find the other two sides.

Ans. 575 and 515 (115·8 and 104·2 metres).

12. The perpendicular distance between the two parallel lines in a trapezoid is 748 links. (149·6 metres) one of the parallel lines is 425 (85 metres) and the side opposite the right angle is 853 (170·6 metres). Find the area of the trapezoid.

Ans. 4,74,614 sq. links (18,985 sq. metres).

13 The two offsets of a trapezoid are 284 and 192 (56·8 and 38·4 metres) respectively. The side opposite the right angle is 392 (79·4 metres). Find the area of the trapezoid.

Ans. 90,673 sq. links (3,627 sq. metres).

14. Find the area of the triangles having the following sides by finding out the offset.

(*a*) 18 (3·6 metres), 25, 5, 36 (7·2 metres).

Ans. 198 sq. links (7.9 sq. metres).

(*b*) 538 (107·6 metres), 877 (155·4 metres), 929 (185·8 m).

Ans. 2,30,856 sq. links or 2·31 acres (9,234 sq. metres or 92 acres).

(*c*) 254 (50·8 metres), 369 (73·80 m), 425 (85 m).

Ans. 46,537 sq. links or 47 cents (1,861 sq. metres or 91 acres).

(d) 529 (106·8 metres), 326 (65·2 m.), 298 (59·6 metres)

Ans. 44 cents (17 acres).

(*e*) 698 (139·6 metres), 349 (69·8 metres), 620 (104 m).

Ans. 88 cents (35 acres).

(*f*) 297 (59·4 m.), 184 (36·8 m.) 315 (63 m).

Ans. 27 cents (11 acres).

15. A F E is a triangle, the side AF is 532 (106·4), FE 356 (71·2) and EA 449 (89·8). On the line AE the following offsets were recorded from bends B, C and D.

	E			E	
	398	75 D		79·6	15 D
C 121	295		C 24·2	59	
	224	86 B		44·8	19·2 B
	A			A	

Find the area of the figure A B C D E F and the measurements of AB, BC, CD and DE. *Ans.* AB=240 (48 M) BC=219 (43·8 M).

CD=221 (44·2 M) BE=91 (18·2 M).

Area 87 cents or 71 cents (35 acres or 28 acres) according as the point F is to the left or right of the line AE.

CHAPTER X

Main Steps in a Survey.

The object of this chapter is to explain the main Principles of Survey and to set out the important steps in a connected manner.

Survey in a wide sense may be divided into—(i) Topographical and (ii) Revenue or Cadastral—A topographical survey determines accurately geographical features such as rivers, streams, villages, etc. A revenue or Cadastral Survey deals with each individual holding, so that necessary particulars may be furnished to the Revenue Department in order to determine the correct annual assessment to be paid to Government. It is for more elaborate than a topographical survey and determines boundaries, tenure, area and reputed ownership of every holding. It also lays down the boundaries of porambokes and other government lands and thus affords a safeguard against encroachment. Further, every boundary in a Cadastral Survey is laid down under the Survey and Boundaries Act and thus acquires legal validity. Before the survey is made final under the Act, every registered holder is given an opportunity to object to any boundary laid down which concerns him. Thus, a Cadastral Survey is beneficial both to Government and the ryots.

The work of the Survey of India is confined mainly to Topographical Survey, while the Survey and Land Records Department of the State undertakes Cadastral Surveys.

Different steps in the survey of a village.

Survey fields are measured usually with the chain and cross staff; but in order to have a correct village map, a frame work for more accurate than that obtained with the chain and cross staff is necessary. A theodolite, the most accurate survey instrument available is used for the purpose. By observing angles and measuring traverses, an accurate frame work of the village is obtained and into the frame work are fitted the Survey fields which have been measured with the chain and cross staff and plotted as individual field snaps. Without such a frame work it would be impossible to Plot the Survey fields with any degree of accufacy, owing to the cumulative error in plotting a series of triangles with the scale. It has also to be borne in mind that the Survey is not confined to isolated villages, but covers whole taluks and Districts and very accurate village maps are essential for the compilation of the taluk and district maps. But the circuit around the village boundary will not suffice for this purpose, as there will be no proper check of the accuracy of the plotting of the survey fields in the interior. The village is, therefore, divided into a number of sub-circuits of about 100 or 200 acres (40 to 80 hectares) called khandams. These khandams affords a number of additional fixed points with which the corresponding points of the individual survey fields should tally. Besides this, the khandams helps in the localization of errors within a limited area. The khandam is, therefore only a conventional division to facilitate technical check and plotting of the village map. Once the survey is over and the accuracy of the work proved and the village map plotted, the khandam ceases to serve any really usefull purpose. It is for this reasons that missing khandams stations are no longer refixed with the theodolite. They are fixed, in the course of maintenance, only with the aid of the linear measurements of the survey fields.

As a preliminary to the actual theodolite work of traverse survey, boundary demarcation is done, when theodolite and field stones are planted along the boundary of the village and khandams. The main rules for boundary demarcation are (i) that points should be selected on the true village boundary and along khandam boundaries at intervals of about 20 chains (400 metres) so that the stations will be visible, one from the other

(ii) that the traverse lines should not be more than 10 chains (200 metres) away from the bends along the true village boundary and (iii) khandams should follow natural boundaries as far as possible and should be about 100 acres (40 hectares) in wet land and 200 acres (80 hectares) in dry. On completion of the traverse survey, the boundary sketches and traverse records are submitted to the Head Office, where the traverses are "set up" on Gale's traverse System and the accuracy of the work proved. A detailed description of Gale's traverse system is given in the Tamil Nadu Survey Manual, Volume I.

When a large tract is ordered for survey a more careful check is required, and the accuracy of the measurements of the traverse survey is proved by connecting the traverse with the G.T. stations of the Survey of India. From the values of the G.T. stations—furnished by the survey of India, we calculate the rectangular co-ordinates between pairs of G.T. stations, and compare these with the rectangular co-ordinates derived from our traverses. If these measurements tally within the allowance of one foot per thousand, we can guarantee the measurement of our Survey. Additional angular check is similarly required. When large tracts are taken up for survey azimuth observations are made at intervals of 40 or 50 stations, throughout the main circuit boundaries. If the direct bearings obtained by azimuth observations tally with the bearings calculated with the aid of the first bearing and subsequent angles the angular work is proved. Thus while the accuracy of the angular work is proved by the azimuth observations that of measurements is ensured by connecting the traverses with G.T. stations.

In view of the fact that the village, taluk and district maps are to be compiled with the greatest accuracy possible an elaborate check is exercised at every stage of the work. In spite of a considerable amount of direct check in the field by inspecting officers, no item of Survey work is passed, until it is finally subjected to a thorough test in the Head Office.

On completion of this check in the office, the frame-work of the village map is plotted with reference to the theodolite work and the individual fields are then fitted in. In order to avoid any cumulative error in the plotting of the village map, a convenient station is selected as the point of origin and every other traverse point is determined in terms of rectangular co-ordinates from the station, and plotted direct. Thus, to sum up, the main processes in the survey of a village are :—

(1) Boundary demarcation (village and khandams) Departmentally known as "A" work.

(2) Traverse survey or "B" work.

(3) Traverse computation—Process "C".

(4) Traverse Plotting—Process "D".

(5) Field demarcation—Process "E".

(6) Field measurement—Process "F".

(7) Plotting of village map—Process "G" and

(8) Finishing village map and area computation process—Process "H".

Different steps in the survey of a field.

The first step is the formation of the field after the location of holdings within it. The unit in a cadastral survey is the survey field and not the holding. If every holding were surveyed on a separate framework the cost would be enormous without any resultant advantage. Individual holdings are, therefore clubbed to form survey fields convenient both for survey and maintenance. As wet land usually contains more holdings than dry land, the area usually adopted is 5 acres (2 hectares) for a field in wet and 10 acres (4 hectares) in dry land with the provision that where the number of sub-divisions exceeds 20, the area

of a field should be less than 2 acres (80 ares) in wet and 4 acres (1 hectare and 60 ares in dry land. In an initial survey the area is roughly determined by pacing the length and breadth of the field. After the boundaries of the field have been so determined and laid down with reference to the existing bends a location sketch is prepared and the land Register written up after careful enquiry of the karnam and the ryots. In a resurvey the location sketch is prepared with reference to the existing survey records, after a verification of the boundaries on ground. The formation of fields is a simple matter as the extent of every old sub-division is available.

The main object in forming a survey field is to have holdings demarcated separately, but put together in the same unit of a convenient area, so that the fields formed may be laid down on the basis of an accurate frame work which would permit of being maintained adequately. For this reason, it is obvious that long narrow fields like roads and channels cannot be formed on the area. In such cases convenient length of about 10 chains is fixed for the formation of a field. Further exceptions to the general rule are single holdings which are over the prescribed extent of a survey field, or large porambokes, like hills, rivers, grazing ground, etc. In such cases, no attempt is made to split them up and when they cannot conveniently be measured with chain and cross staff, they are surveyed with an angular instrument and are then known technically as " Minor Circuit Fields ".

After the rough formation of the fields, and writing up the land register, the demarcation of boundaries should be taken up. The extremities of each line are the points of demarcation. The demarcation points detailed under " Points to be demarcated by field stones " in Chapter V are durably demarcated with field stones. At other points no regular survey stones are planted but every such point is accurately fixed by means of an offset on a " G " line run between field trijunctions or by means of a part measurement along a line joining the two bends. In demarcating a boundary, very minor bends are ignored altogether and other bends are equalised wherever possible. Where bends are appreciably large and cannot be ignored, regular boundaries can be laid down in many cases by the process known as " equalization of bends ". Here points are fixed and connected, ignoring intervening bends, so that the area gained by a registered holder in one place is excluded from his holding at some other point along his bund or limit of enjoyment. The object is to reduce the number of bends to be offsetted in survey and then refixed later, during maintenance.

Equalization of bends should not be resorted to when more than two holdings are involved, when the classification and tenure of the holdings are different or when trees exist along the boundary. In the case of porambokes the boundaries should be straightened by cutting off minor projections only, the less of which will not affect the poramboke and by including them with the adjoining holdings. Where the portions so excluded are of a considerable extent or valuable, they will be surveyed as sub-divisions of the adjoining field and registered as assessed waste. Demarcation is the most important process in the survey of a field. Good demarcation ensures regular boundaries reduces work and facilitates future maintenance.

After the boundaries of the field and its component sub-divisions are demarcated, the lines of demarcation or " F " lines as they are called are measured. The measurement of these " F " lines will not however be sufficient either to plot the field or to relay any important points when necessary. What is required, therefore, is a frame work which will afford plottable data for the field and which when carefully maintained, will enable any point to be fixed accurately on the ground. In the various system of survey the frame work has been different. In the system of simple triangles all bends were connected to form a series of triangles, and these triangles constituted the frame work for each survey field. In the block map system, there was no separate frame work for each field. The frame work covered a whole block of Survey fields and consisted of the arms of very large triangles. Trijunctions and bends were offsetted alike from the nearest arm of a triangle. The frame work was very unwidely and made maintanance extremely difficult. In the up-to-date diagonal and offset system each trijunction is connected with the next by " G " lines and triangles are completed by selecting convenient diagonals.

Fields and sub-division bends are offsetted on these " G " lines and diagonals. On completion of the measurement of a field, it is the duty of the surveyor to prove the accuracy of his work as far as possible which he does by calculating the distance between successive offsets and comparing them with the measured " F " line. Though it is not possible to check every " F " line by calculation as certain points are fixed on straight lines and some bends are offsetted on different " G " lines, the diagonal and offset system does afford an independent check of a substantial amount of the measurement work done by the surveyor. The Survey of the field is now over, the Surveyor will plot the field to a convenient scale and then compute the area of each sub-division with the area square paper. These processes have been explained fully in Chapters VII and IX above.

Observance of legal formalities under the Act.

A Cadastral survey is carried out under the legal provisions contained in the Survey and Boundaries Act, 1923 (Tamil Nadu Act VIII of 1923). These legal provisions ensure that the ryots are given due notice of the survey and are invited to co-operate by attending and furnishing necessary information regarding their lands. Every registered holder has an opportunity of verifying his boundaries as laid down at survey and of putting forward a complaint if he is aggrieved by the demarcation.

At the same time, the interests of Government are secured as the boundaries of porambokes finally decided in survey are legally valid unless altered by a decision of a civil court within three years from the date of the final notification under the Act. The previous Act, Act IV of 1897 was defective in that the finality of the Survey did not cover boundaries in respect of which no complaints were preferred in the course of Survey. This defect has been rectified in Act VIII of 1923 by the inclusion of an independent decision under section 9 (1) relating to boundaries in respect of which no dispute has been brought to notice.

Before a Survey is taken up a notification is published under section 5 for Government lands and boundaries between Government lands and lands which are not Government. In the case of proprietary estates, the notification for survey should be under section 17 (*a*) or 17 (*b*) according as to survey is ordered at the instance of the proprietor or by Government (i) for the better or more convenient assessment or levy of irrigation cess or (ii) for any other reason to be recorded prior to the issue of such notification.

A notification under section 6 or in the case of lands, in proprietary estates this section read with section 18 is issued by the survey officer appointed under section 4 and is an invitation to all persons having any interest in the land or in the boundaries of which the survey has been ordered, to attend either in person or by agent at a specified place and time and from time to time thereafter when called upon, for the purpose of pointing out boundaries and supplying information in connection therewith. Where the survey relates to one or more villages, it should be published in two successive issues of the District Gazette, and should also be affixed to village chavadi. Where the survey relates only to a part of a village the notification should contain particulars of the fields to be surveyed and publication in the village chavadi will be sufficient. In both cases, the fact of publication should be announced in the village by beat of tom-tom.

When a survey is made under section 5 of the Act, the cost of boundary pillars, hired labour charges, pay of stone accountants, plus 50 per cent of the aggregate of such amounts as surcharge to cover the cost of supervision, storage indenting and other miscellaneous items of work connected with the above are recovered from the registered holder. All costs incurred by the Local Government on account of a survey directed under clause (*a*) of section 17 shall be recoverable from the persons who have any interest in the estate, portion of estate or boundary of which the survey has been ordered, as an arrear of land revenue, the cost of a survey directed under clause (*b*) (i) and (ii) of section 17 shall be borne by the local Government unless otherwise provided by any law for the time being in force.

Under section 8 (i) the cost of the labour employed and of the survey marks used for any survey notified under section 5 shall be determined and apportioned in the prescribed manner among the persons who have any interest in the land or in the boundaries of which the survey has been ordered, and shall be recoverable from such persons as an arrear of land revenue. Notice of such determination and apportionment shall be given in the prescribed manner to the persons aforesaid. The Survey Officer works out the rate per acre (hectare) and intimates the demand to the collector of the district concerned. The Tahsildar should then prepare demand notices in duplicate under section 8 (i) showing the fields held by each person according to the latest village accounts and the charges recoverable for the survey thereof. This is sent to the village officers for collection. There is a right of appeal under section 8 (2) against the demand.

On completion of the measurements of the fields, the Survey Officer shall record his decision under section 9 (1) determining as correct and undisputed all boundaries in respect of which no dispute is brought to his notice. Notice of every decision of the Survey Officer under section 9 (1) shall be given to the registered holders of the lands the boundaries of which may be affected by the decision. These notices are issued under section 9 (2). They contain extracts from the field register relating to the holdings and should state the time within which and the officer to whom appeals should be preferred. Thus in addition to the opportunity offered under section 6 of being present and checking the demarcation initially made by the surveyor, every registered holder may verify his boundaries on receipt of the notice under section 9 (2) and prefer a land complaint if he is aggrieved. Where a registered holder has reason to believe that the demarcation made by the surveyor is incorrect, he need not wait for the final notice under section 9 (2) but may prefer a complaint at once even while the field work is in progress. The Survey Officer shall then take action under section 10 (1) make the necessary enquiry, and determine the boundary and record it in accordance with his decision. The Survey Officer shall record in writing the reasons for his decision. Notice of every decision of the Survey Officer under section 10 (1) shall be given in the prescribed manner to the registered holders of the lands affected under section 10 (2). Any person affected by a decision under sections 8, 9 or 10 may appeal to the prescribed officer within a period of three months from the date of service of the notice. From the sections of the Act noted above, it will be seen that while complaints preferred during field demarcation and survey are enquired into and decided first of all under section 10 (1) and then again on appeal, under section 11, there is only one decision for a land complaint preferred under section 9 (2). The reasons is that, in the latter case, there is actually a prior decision under section 9 (1) where the Survey Officer has actually recorded the fact that the boundaries were correct and undisputed. Hence a complaint preferred on receipt of the notice under section 9 (2) is really an appeal, which is decided under section 11 just as the appeal on an order passed under section 10 (1). The final notification under section 13 of the Act is issued after three months from the date of service of the notice under sections 9 (2) or 10 (2) and if any appeal is preferred after the appeal has been heard and decided. The notification declares the survey final unless set aside by a decree of Civil Court on suit instituted within three years from the date of the notification. The notification is published in the District Gazette and a copy is posted in the village chavadi.

The notification under section 5 should be published in the *Fort St. George Gazette* and in the District Gazette. The notification under section 6 should be published in two successive issues of the Gazette, to make sure that the commencement of survey is widely advertised and those under sections 6 and 13 only in the District Gazette.

CHAPTER XI.

Maintenance

The primary object of maintenance is to keep the permanent records handed over by the Survey Department upto date and useful in the day to day Revenue administration. In previous years, it was the practice of the Settlement department to take over the survey records, shroff them, fix the assessment, prepare the permanent diglott register with the information furnished in the Survey Land Register and then hand over all the connected records to the Revenue Department. The period of Settlement was fixed at thirty years, and at almost every resettlement it was found necessary to have a preliminary survey of some kind because of the unsatisfactory maintenance of the Survey records and the registry of holdings. On a thorough investigation it was found that it was well nigh impossible for the maintenance staff of Revenue Inspectors to cope with the work of incorporating the numerous changes in survey fields and sub-divisions and inspection and renewal of the survey marks. The arrears gradually swelled to a colosal figure and made it essential that some other agency should take over the work. On 1st April 1942 a new scheme was introduced under which maintenance work was transferred to professional surveyors. One or two surveyors were allotted to each taluk of town and a separate contingent called " the mobile staff " was employed on items of regular survey and on the clearance of the arrears of maintenance where necessary.

2. The present policy of the Government is to restrict resurvey of villages where it is found that the old frame work has completely broken down. The necessity for keeping the revenue records and registers quite up to date will now be clear. In the previous chapter it was explained that Survey was the basis for the collection of land revenue. Though the extent of every holdings is fixed at survey, and a fair rate of assessment determined, these Sub-divisions are not final. Changes take place in the following manner in the day to day revenue administration.

(i) Applications are received for the grant of land, registered in the accounts as assessed waste and these are dealt within the special register (No.4) of darkhasts maintained in the Taluk Office.

(ii) Registered holders sometimes relinquish portions of their holdings and these portions have to be sub-divided and the assessment fixed again for the area retained. Special register No.5, register of relinquishments, is the connected register dealing with these cases in Taluk Office.

(iii) Very many changes are due to transfer of registery of holdings on account of Sale, gift succession partition etc. These are dealt with under two sections in Register No.6 in the Taluk Office. Section I relates to cases forwarded by the registration department and section II includes all other cases detected either by the Karnam or Revenue Inspectors, or reported to the Tahsildar by the parties themselves. In view of the importance of correct registery, a special register called the "Enjoyment Register " with two subsidiary registers, is maintained by the village karnam. These registers clearly indicate whether the karnam has taken any real interest in detecting new cases and also serves as an indirect check on adangal and chitta.

(iv) Lands are frequently transferred from one head of classification to another from dry to wet, assessed waste to poramboke, poramboke to assessed waste etc, The register dealing with transfers from one head of classification to another in special register No. 7 in the Taluk Office.

3. Consequent on all these changes the connected survey records have to be corrected and kept upto date. The records maintained are—

(i) The permanent village register giving particulars of the description classification and tenure of each field and sub-division.

(ii) An atlas of field maps giving the measurement to scale of each Survey number and subdivision.

(iii) A village map which serves as a key to the field map both in office and in the field.

4. In order to maintain the revenue records and registration, the frame work of every survey field has also to be maintained ; and this is done by inspecting the survey marks periodically and renewing the missing stones. Now the maintenance of survey marks should be only auxiliary to the real maintenance of the revenue registers and records. To enable the maintenance of the latter boundaries and holdings have to be identified, and exact points must be readily available from which measurements can be taken with ease and rapidity. This can be done with proper survey marks existing on the ground. Unfortunately, the ryots do not look after the survey stones on their boundaries with the result that the maintenance of survey marks has become a real problem.

Description and use of the Records.

5. (i) The permanent village register or the " A " Register, is the authoritative record for settlement and revenue particulars of every field and sub-division in the village. It gives the tenure, Government or inam, dry, wet, unassessed or poramboke,source of irrigation, class and sort of soil taram, rate per acre (Hectare) extent and assessment of each field and subdivision. Reference to this records is necessary to ascertain the assessment on individual holdings and to dispose of cases of transfer of lands from one head to another.

(ii) The atlas of field maps contains plotted sketches of individual fields snowing the boundaries of all the component sub-divisions. A record of measurement of fields and sub-divisions is thus provided which serves to identify boundaries and settle disputes and enable Revenue officers to check the cultivation of each holding during azmoish or for any other reason. Each field map provides independent data which make it possible to relay any boundary on the ground when necessary to do so. The atlas of field maps is therefore the most essential record for maintenance.

(iii) The village map is a key to the field atlas. It acts mainly as an index to the field measurement book and shows the relative position of the survey field. Topographical details are inserted in the village map and this information makes it very valuable in the identification of fields by all inspecting officers. Once the particular field is identified, the individual field map is referred to for all other particulars required. The village map is drawn to a scale of 16" to the mile (1m.m. =5000 m.m.) and does not show sub-division boundaries under the metric system, the village maps are drawn to scale 1 m.m.=5000 m.m.

Steps in the maintenance of Survey marks.

Part 6 : In order to effect new sub-divisions, the frame work of the individual survey fields must be preserved. If a few stones in a village are missing, the points can easily be refixed with the data available, and the stones replaced; but if the number of missing stones reaches a very high percentage, it would be a laborious task to refix missing points and a resurvey would be the only solution. The frame work has, therefore, to be preserved carefully and this is done by a periodical inspection of the stones and by renewing the

missing stones promptly. It is the duty of every karnam to inspect a minimum of 1,000 stones a year subject to a maximum period of 3 years for a wet village and five years for a dry village. A very important change in procedure in the new scheme is that the repair of stones that are loose and require tamping with earth, is attended to by the karnams and other inspecting officers in the course of the actual inspection and not as a separate item of work. Previously the karnam merely noted the fact that particular stones required repair. It often happened that before the necessary notices were served on the parties and the Revenue Inspector found time to attend to the stone, it had either fallen or disappeared altogether with the result that elaborate measurements had to be taken to fix the point accurately. All this additional work is now saved by tamping the stone with earth immediately on finding it in need of repair. A detailed investigation made by survey officers in surveyed estates revealed the fact very impressively that the neglect of a periodical inspection and repair of stones resulted in the whole survey frame work breaking down and the necessity for complete resurvey.

7. The importance of this initial item of maintenance cannot be overstressed as without the frame work of the survey fields the elaborate village registers and accounts are practically worthless.

8. The records prepared for the inspection of stones are (i) the demarcation sketches and (ii) stone registers. A copy of the printed village map is cut up into blocks of survey fields and the maintainable stones in each field are numbered in a separate series. The principle followed is that stones should be numbered in the field bearing the lowest number. All theodolite stations other than minor circuit stations should be numbered in one series for each village. On completion of the preparation of demarcation sketches, Stone registers in the form prescribed in Appendix II to chapter I Part I, II Paragraph 4 are written up—Form A for theodolite stations and Form B for field stones. In the Stone register is entered particulars of (i) the survey number and serial numbers of the stone in the field (2) the survey fields and subdivisions, the holders of which are responsible for the maintenance of the stone (3) data of the karnam's inspection and result (4) data of inspection if replaced by the ryot and(5) data of verification of the karnams entry or renewal by the Maintenance Field surveyor.

9. In order to ensure that a genuine and systematic inspection is made by the village karnam, a check is exercised by the maintenance field surveyor who inspects a certain percentage of stones in different blocks from time to time. Regular inspection reports are written up by the maintenance field surveyor and the karnam's work is classified as "good" "fair" or "bad" and necessary action is taken by the Revenue Authorities in cases of unsatisfactory work. A very important point in connection with the inspection of stones is explained below. One of the objects of a survey is to afford a safe guard against encroachments on Government lands and in order to facilitate the detection of encroachments all bends of poramboke fields and sub-divisions are demarcated with stones. But when stones are inspected on poramboke boundaries it will not suffice merely to verify whether particular stones that are numbered in the demarcation sketch are existing or not. Experience has proved that the ryot who plans an encroachment endeavours to keep the fact of encroachment concealed, and generally raises a new bund and plants the survey stone very firmly in its new position. An intelligent check is therefore necessary in the course of stone inspections on Poramboke boundaries. The Inspector is now a professional surveyor and it is not difficult for him to tell at a glance of the field measurement book and the present with of the poramboke in question and whether there has been any encroachment or not. A check is often possible by calculating and then checking the actual measurements from bund to bund on opposite sides or where this is not possible the scaled measurement of the width of the channel or other poramboke at a particular place will be quite sufficient to disclose any substantial encroachment made by the adjoining ryot. Detailed measurements can then be taken if necessary. Hence it is one of the duties of the maintenance field Surveyor to report all cases of encroachments detected in the course of his stone inspection.

10. Under the provisions of the Tamil Nadu Survey and Boundaries Act every registered holder of Government land is bound to maintain, renew and repair all survey marks on the boundaries of his holding. Column (2) of the stone register referred to above shows the fields the owners of which are responsible for the maintenance of each stone. Notices are served under section 15 of the Act, on the registered holders concerned informing them that if the missing stones are not replaced within 15 days of the receipt of the notice, the stones will be planted by the maintenance staff and the cost recovered from them.

11. The technical procedure in the replacement of missing stones has been explained below. The most popular and accurate method of refixing a missing field trijunction is by the N.O.S. problem, which should be studied thoroughly by all students of survey.

Replacement of Missing Field Stones.

12. Every registered holder of land is bound by law to maintain in good repair all stones on the boundaries of his land, or to replace them if missing. It is also the duty of karnams to inspect the stones in their villages periodically and to note in the stone registers all stones which are missing. Stones which are missing or out of place have to be refixed. This is done by relaying on the ground the measurements recorded in the field maps. The best methods of doing this are explained below.

NOTE.—In these examples, it is assumed that stones from which measurements are to be relaid are themselves in their correct position. But this can never be assumed in practice and the position of such stones must invariably be verified by measurement of not less than two lines converging at each point.

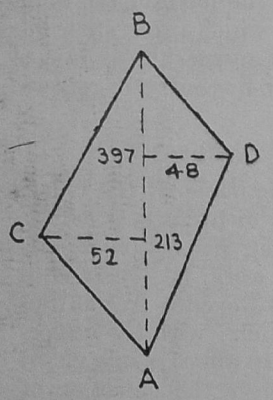


FIG. 55

13. *To relay a recorded offset.*—If the field map contains an offset to the missing stones all that is necessary is to relay this measurement on the ground. Thus if the stones at C and D are missing, while those at A and B are present, all that is necessary is to chain the line AB and lay off the offsets 52 at 213 and 49 at 397 with the cross staff.

14. The calculation of the chain and offset method—This method which is frequently referred to as the "N.O.S. problem" is more accurate than any of those described in subsequent sections and should therefore be used when ever possible. Suppose that in Fig. No. 56 the stones at A and C are present and that B is missing. There is no offset recorded from the line AC to B. But this can be calculated by the method explained in paragraph 10 of Chap. IX as follows:—

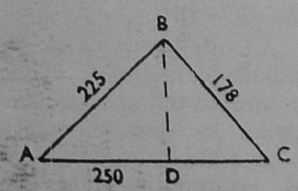


Fig. 56

The chain distance $AD = \frac{250^2 + 225^2 - 178^2}{2 \times 250} = 163$

The offset $BD = \sqrt{225^2 - AD^2} = 155$. We can then lay off this offset at this distance on the ground as in paragraph 2 above. It should be noted that in the same way the chain distance on the line AC produced can be calculated if the perpendicular from B falls beyond C.

15. The following further applications of the method are often useful:—

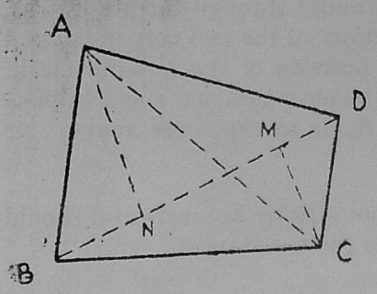


FIG. 57

(i) Suppose that the stones at B and D are missing while those at A and C are present. The lengths o the outer boundaries of the field and of one diagonal DB are given. We proceed to calculate the length of the other diagonal AC as follows: The distances DN and AN are calculated from the triangle ABD as explained above. Similarly the distances BM and MC can be calculated from the triangle BCD. We then know the distance MN and $AC^2=MN^2+(AN+MC)^2$. We can then calculate the offsets to B and D from the chain Line AC.

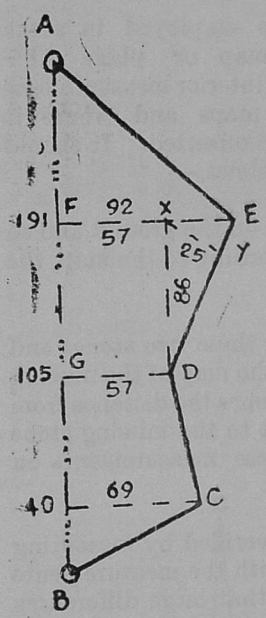


Fig. 58

(ii) Where a field map contains offsets measured as shown in the following diagram and stones at both the extremities of the "G" line AB are missing, to replace them the following method may be adopted:—Calculate the sides of the right angled triangle DXE with reference to the recorded chain and offset distances by means of the calculation of the chain and offset method calculate the chain and offset distance EY and YX with the help of these fix the point on the ground ; produce EX to a point at a distance of 57 links (11·4 metres) from X, i.e. to the point F. Set up the cross staff at D and sight X through one groove. Then measure 57 links (11·4 metres) in the direction of the chainline sighted through the other groove to the point G. With these two points on the chain line determined., the positions of A and B can be fixed, and counterchecked by any other recorded offset as to the point C.

In the above figure if B and D are in position, for example, and C is missing, it will be clear that BD can be calculated $\sqrt{105^2+57^2}$ $\sqrt{21^2+11\cdot4^2}$ and that C can be replaced by the second method shown above with reference to the measurements of the triangle BCD. In Block map and plane table areas, this method does away with the necessity for relaying long 'G' Lines.

The Intersection of perpendiculars Method.

16. In many cases, the existence of bunds, ridges or other visible marks enables the surveyor to guess approximately the position of the missing stone without actual measurement, the approximate point not differing from the true one by more than 30 links (6 metres). In such cases, the following process will be found quicker and easier. In Fig. 58 A and C are in site, B is missing. The measurements of AB and CB are given. On an inspection of the bunds forming the boundaries of the fields D is found to be the approximate position of the missing mark. Measure 320 (64 M) from A in the direction of D. At the 320th link (E) set up the cross staff, view A through one groove and direct flags to F and G through the other.

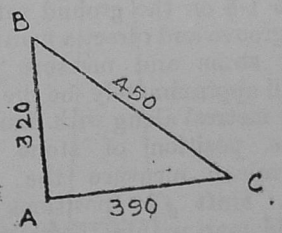


Fig. 59

Next measure 450 (90 metres) from C in the direction of E and at the 450th link (H) set up the cross staff, view C through one groove and direct flags to I and J through the other. X, the point of intersection of the two perpendiculars FG and IJ, in the position of the missing mark. AX and CX should be measured and slight adjustments if necessary, made as explained above.

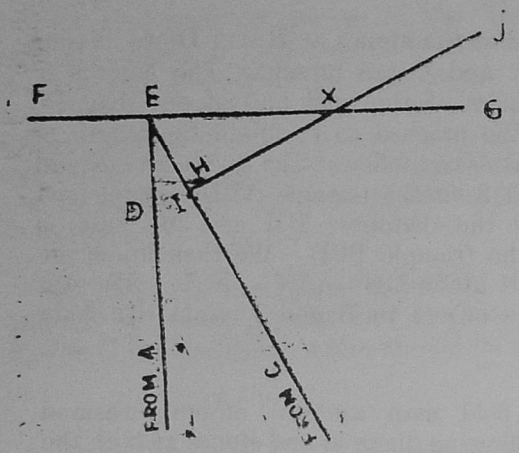


Fig. 59 - A

This method is not strictly accurate and should only be applied over short distances.

The Scale and bit method

17. This is only to be employed in areas surveyed on the block map or plane table systems of survey, where no interior measurements are recorded in the field maps and where it is often impossible to relay the long lines on which field points were offsetted. It should not be used when any other method is possible. The method is as follows:—

(i) With the help of the field map, find two stones that are still on the ground and so situated that the line joining them passes close to the place where, according to the map, the missing stones should be.

(ii) Place the wooden scale on the field map on the line joining these two stones and adjust the bit to form a right angle with the scale and the position on the map of the missing mark. Then read off the length of the straight line between the two stones the distance from either of the stones along this line, of the point that which the offset to the missing stone should be measured, and the length of the offset. Then lay out these measurements on the ground with the chain and cross staff.

The position of the missing mark thus determined should be verified by measuring its distance from the adjoining field stones and comparing the result with the measurements noted in the map. It should be shifted slightly where necessary so that large differences in one or more lines may be evenly distributed among all the lines meeting thereat.

(iii) Suppose stones numbers 3 and 4 are missing in diagram number 60 . Look for stones numbers 2 and 5 or 1 and 5. To measure between the two latter, if they exist, will probably be easier than between the two former as the field boundary will not have to be crossed and it may prove to be an inconvenient obstacle. Read off with the scale and offset bit distances 1A, A3, 1B and B4 on the field map. Suppose these distances to be 110 links (22 metres) 45 links (9 metres) 310 links (62 metres) and 175 links (35 metres) respectively. Measure 110 (22 metres) along with the line 1-5 on the ground set up the cross staff at the Point A, view 1 and 5 through one groove and direct a man through the other to stand at about the distance of the missing stone and measure 45 links (9 metres) in that direction. The point arrived at will approximately be the position of stone number 3. Similarly by measuring 310 links (62 metres) along with line 1-5 and then 175 (35 metres) at right anlges to the left the position of stone number 4 will be found. To verify the points thus determined measure the distance from stones numbers 5 and 2 and from each other. Shift the positions slightly till the measurements tally with those noted in the field map within the limit of error allowed. If either point is a trijunction as Number 4 in the sketch another check measurement may be made by consulting the maps of the adjoining survey field numbers 11 and 12. The position of a missing stone should always be verified by remeasuring atleast three lines wherever possible.

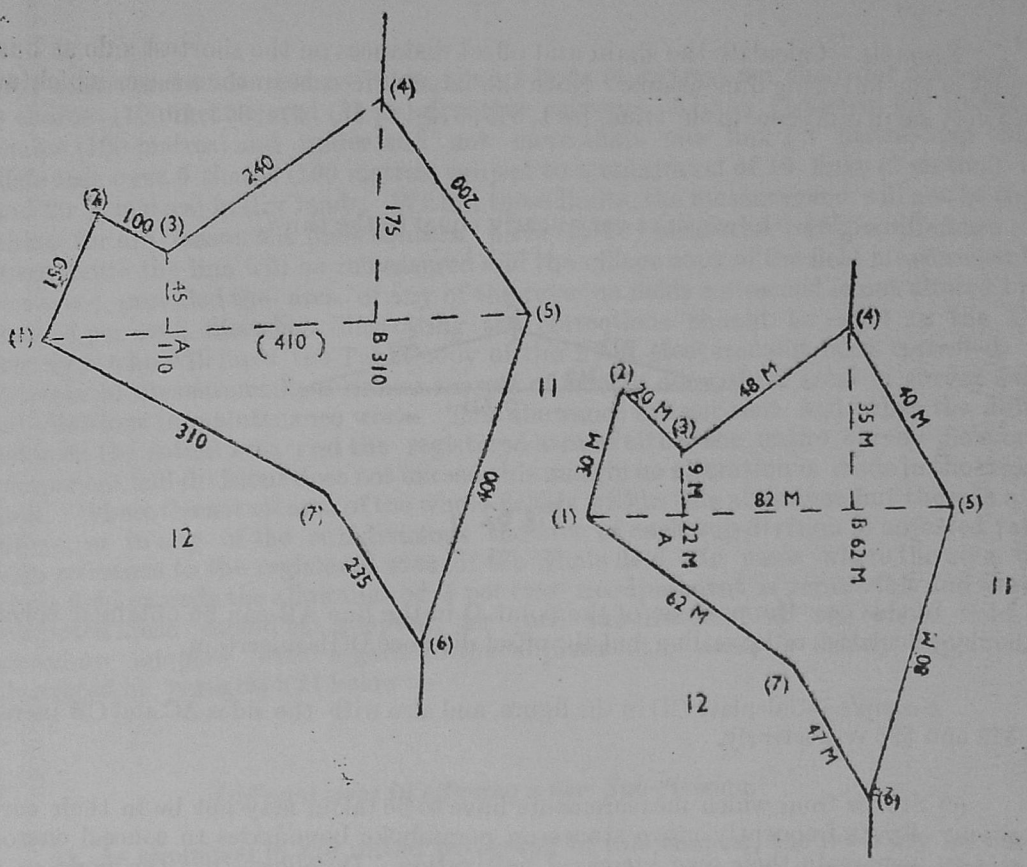


Fig. 60

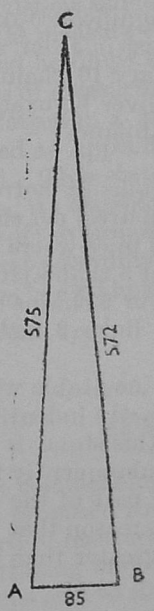


Fig 61

18. A certain amount of common sense is required for replacing missing stones correctly. It is usually possible to tell from the ground the spot where the stone should be. Unless the measurements lead to somewhere near this spot, some mistake has been made which should be rectified before proceeding further. The following points should be borne in mind :—

(*a*) Clerical errors are sometimes found in the mesaurements recorded in the field measurement books. Errors of 3 for 8 or 5, of 7 for 1, of 0 for 6 or 9 and vice versa are the commonest. These can often be detected by checking the plotting with a scale or by comparison with the measurement recorded for side fields.

(*b*) Ill conditioned triangles will not give accurate results whatever method is used. Those met with are of two kinds :—

1. Triangles with a small base. Thus in fig 61 the base AB is too short to enable us to use the stones at A and B as points from which to replace the stone at C whatever method we use. We can, however use the triangle for replacing the stone at A or B from the base BC or AC.

Example.—Calculate the chain and offset distances on the shortest side as base in triangles of the following dimensions. Note the large difference in the answer which arises from a very small difference in the triangles I, 575, 573,10 ; II. 574, 573, 10.

2. Triangle with two sides very nearly equal to the third.

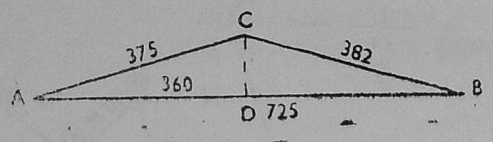


Fig 62

In this case the position of the point D in the line AB can be obtained correctly either by calculation or by scaling, but the offset distance DC is uncertain.

Example.—Calculate CD in the figure, and also with the sides AC and CB increased to 378 and 383 respectively.

(c) Stones from which measurements have to be taken may not be in their correct position. Ryots frequently move stones on poramboke boundaries to conceal encroachments or demarcate their own increased cultivation. It follows that the position of a stone replace should always be checked from the position of as many other stones as possible.

Survey Errors:

19. At this stage it is desirable to explain the extent significance of the practical error which is inevitable in measuring any line, and to distinguish it from what is known technically as a " Survey error ". It is obvious that if a boundary 10 Chains (200 metres) in length is chained twice the two measurements will hardly ever be exactly the same. An allowance is made for such practical error in survey and is as follows :—

In lines of 5 chains (100 metres) and under a margin of 3 links (6 metres) is allowed. In lines of over 5 chains (100 metres) a difference of one link (2 metres) per chain is allowed up to a limit of 10 links (2 metres). In measurement on diagonal lines where the cross staff has been used, or offset measurements the allowance is in lines of 5 chains (100 metres) and under a difference up to 4 links (.8 metres) and in lines of over 5 chains (100 metres) a difference of one link. (0·2. metre) per chain up to a limit of 10 links (2 metres).

In maintenance work a fair amount of cumulative error is inevitable when a missing field tri-junction is refixed, the point arrived at may not be exactly indentified with the point at survey owing to the practical error involved. Now, if this stone is two links out of its original position and if other stones in the same field are subsequently found missing and refixed with measurements taken from the first stone, then part of the original error of two links will be carried forward and so on. It is for this reason that the margin of error allowed in measurement in maintenance work is far greater than in the original Survey.

A discrepancy between the recorded measurements or between a recorded measurement and a measurement newly taken on ground should not be treated as an error unless it exceeds the limit of measurement error allowed. This limit is (*a*) in plane table block map and the older diagonal and offset surveys, 10 links (2 metres) in distance

of 5 chains and under and not more than 2 links (4 metres) per chain for distances of over 5 chains (100 metres) and (*b*) in all other surveys, 5 links (1 metre) for distance of 5 chains (100 metres) and under and not more than one link (·2 metre) per chain for distances over 5 chains (100 metres) subject to a maximum of 10 links (2 metres) in wet and 20 (4 metres) in dry lands. Within these limits, the measurement will not be corrected unless for any reason the lines concern have to be measured. If the difference exceeds these limits the line will be remeasured and the village copy of the field measurement Book corrected, provided the area of any of the revenue fields concerned is not altered by more than 5 per cent. Sketches illustrating the corrections should be sent to the District Surveyor who will have the Taluk copy of the Field Measurement book corrected. As in the case of measurement, a similar margin of error is allowed for areas of survey field and sub-divisions in maintenance work. This allowance is 5 per cent and when the difference between the actual area and the registered area of either the entire survey field or of its component sub-divisions does not exceed this margin no alteration is made in the registered area. Where the actual area of the whole field is within this allowance but there is a larger difference in any of the sub-divisions the area of each sub-division is adjusted rateably with reference to the registered area of the whole field. In cases where the area of the whole field exceeds the allowance of 5 per cent noadjustment is permissible and the newly computed areas should be adopted for each sub-division and the whole field. The procedure adopted with regard to the adjustment of areas is clearly explained and illustrated in paragraph 21 below :—

Different steps in effecting a new Sub-division.

20. As explained in the initial paragraph of this chapter, the necessity for effecting new sub-divisions in the course of maintenance work arises consequent on the sanction accorded for the changes in the special registers 4, 5, 6 or 7 as the case may be.

Register Number 8-A is a current register of all changes involving new survey fields and sub-divisions sanctioned in registers 4, 5, 6 or 7. Ordinarily the Maintenance field surveyor should measure the proposed sub-divisions on the ground but no new sub-divisions in registered holdings should be measured unless the limits are clearly defined by ridges. The process of measuring new sub-divisions briefly described below. The new sub-divisions are then plotted in a tracing taken from the field map and a sub-division statement in the form printed as Appendix VII to Paragraph 13 (*a*) of Chapter I of Part II of the Manual is prepared. This statement gives information regarding the present survey field or sub-division *i.e.*, its classification area, assessment and names of the registered holders and all particulars of the proposed sub-division, *i.e.*, dry, wet or poramboke, sub-division number of letter, extent according to the area square, adjusted extent, numbers and the names of proposed registered holders, signatures of parties and remark with regard to limits on ground, etc.

MEASUREMENT OF ORDINARY SUB-DIVISIONS.

Before commencing field work, a tracing of the map of the field in which the new sub-division is proposed to be measured should be taken from the field measurement book or other record of measurement prepared at the survey. In exceptional cases of long narrow fields the tracing may be only of the portions of the field map required to plot the new sub-divisions and to fix the terminal points of the "F" and "G" lines on which the new sub-division points are based. The tracings should be carefully compared with the field map to make sure that the measurements taken from it have been correctly copied and it should then be checked by scale. The lengths of the field and sub-division "F" line should be calculated mathematically whenever possible with reference to the recorded chain and offset distances and the lines should be remeasured if the calculated distances

do not agree with the recorded distances within the margin of error allowed as detailed in paragraphs supra, detailed under refixing of missing stones. The boundaries of the sub-division should then be indentified on the ground and the sub-division should be formed with special reference to the following instructions :—

(*a*) The boundaries of newly formed sub-divisions should always be as straight and regular as possible. Small bends in field bunds not forming the boundaries of whole fields should be ignored and the boundary should be taken as a straight line cutting across the bends and making the areas included and excluded on either side approximately equal. This should be done so long as the boundary now determined does not depart from the natural boundary by more than 10 links (2 metres) in wet land and 20 links (4 metres) in dry.

(*b*) Encroachments by one ryot on the land of another should be ignored, unless the area involved measures 5 cents (2 ares) or more.

(*c*) When sub-divisions are formed to differentiate wet land from dry or occupied lands from unoccupied or poramboke small strips of land covered by bunds, rocks, prickly pear, trees, etc., should not be excluded from the wet or occupied sub-division, if the portion so excluded does not form a compact area.

(*d*) Channels and paths not exceeding 20 links (4 metres) in width (unless they have been acquired under the land Acquisition Act or except in special cases to be determined by the Collector), shifting cart tracks and foot paths and roads under the control of the Public Works Department, passing through large tracks of reserved forests or other Government land should be treated as detailed and not as sub-divisions. Paragraph 14 (*d*) of Chapter I of Part VI of this Manual.

(*e*) Revenue officers who sanction sub-divisions should send back for correction all cases in which the instructions given above have not been followed.

How Sub-divisions should be measured :—

EXAMPLE I

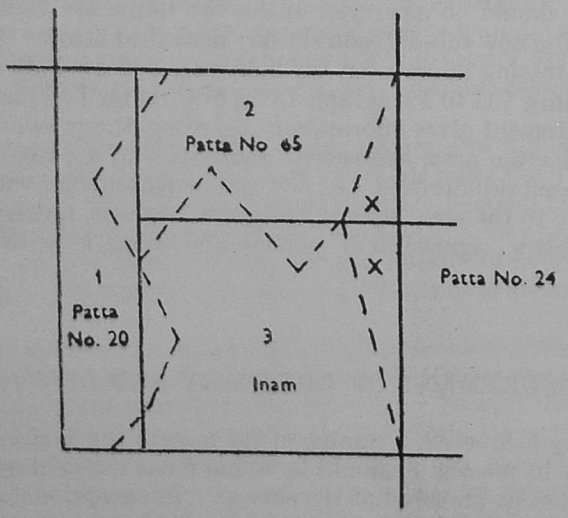


Fig. 63.

— — — — — — — — — — — — Bunds on ground.

———— Sub-divisions boundaries measured.

XX Encroachment of less than 5 cents (2 ares) enjoyed by adjacent registered holder No. 24.

EXAMPLE II.

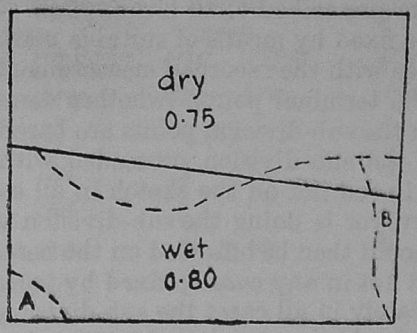


FIG. 64

The irrigable portion of the field shown in the diagram has been ordered to be transferred to wet. A is rocky ground measuring 2 cents (one are.) B is a bund covered with prickly pear. A and part of B should be included in the wet sub-division 2 and the boundary measured according to the straight line and not according to the dotted line — — — — —

EXAMPLE III

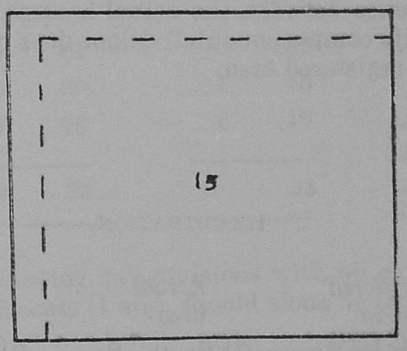


Fig. 65

Survey No. 15 is a waste field. A strip 10 links (1 metre) wide on two sides consist of a bund and a row of palmyra trees. The portion darkhasted for excludes this strip In disposing of the darkhast, the assigning officer should refuse to exclude such small strips or patches. Any portion excluded, must form a compact block convenient for future assignment.

No sub-divisions should be measured unless in the case of occupied sub-divisions the limits of occupation are indicated by ridges or other marks and in the case of other sub-divisions their boundaries are marked on the ground by lock splitting or in some other distinguishable way.

The terminal points of the F and G lines on which the new sub-division points are based should be verified by measuring at least two converging lines. If any such terminal points or the terminals of any line converging or them and required for their verification are not already demarcated with stones, their positions should first be fixed by means of suitable marks on the ground with the help of the recorded measurements. If, however any of these terminals are already demarcated with stones and these stones are found in need of

renewal they should be renewed before proceeding with the measurement of the sub-division, provided the officer measuring the sub-division is competent to do renewals and also notices under section 15 (2) of the Survey and Boundaries Act have already been served on the persons responsible and the prescribed time has expired. Otherwise, the correct position of the stones should first be fixed by means of suitable marks. If the actual measurements of the converging lines agree with the recorded measurements within the admissible margin of error the positions of the terminal points (whether demarcated with stones or not) of the F and G lines on which the sub-division points are based may be presumed to be correct and the measurements of the sub-division proceeded with. The actual measurements so obtained should be noted in red ink on the sketch in all cases in which maintenance field surveyor or any other surveyor is doing the sub-division work in the first instance. The new sub-division points should then be offsetted on the nearest convenient lines joining two trijunctions. They should not in any case be fixed by means of " Tie " lines ; care should be taken to measure separately in all cases the sub-division "F " lines of the new sub-divisions. The measurement should then be plotted into tracings of the field map above referred to. The figures representing the measurements of " F " and " G " lines should be written in the sub-division sketch so as to point to north or east as near as may be except in the case of chain and offset distances of " G " lines which should be entered in the direction in which the " G " line was measured. The areas of the new sub-divisions should be computed by area square paper. In cases in which an already existing sub-division has been subdivided, if the total of the areas of the new sub-divisions differs from the registered area of the sub-division that has been sub-divided by more than 5 per cent, areas of the remaining sub-divisions in the field should also be computed by area square paper. The areas thus computed should be noted in column (8) of the subdivision statement *vide* enclosure 1. These areas should then be compared with the registered areas and adjusted as follows, the adjusted areas being noted in column (9) of the sub-division statement.

(*a*) Where the difference between the actual area and the registered area of either the entire survey field or of its component subdivisions does not exceed 5 per cent, no alteration should be made in the registered area.

ILLUSTRATION.

Sub-division.	*Registered area* ACS. CTS. *Ha.—Ares.*	*Actual area* ACS. CTS. *Ha.—Ares.*	*Adjusted area* ACS. CTS. *Ha.—Ares.*	*Final area to be adopted* ACS. CTS *Ha.—Ares.*
(1)	(2)	(3)	(4)	(5)
1	7 51	7 85	.. ..	7 51
2	0 85	0 87	.. ..	0 85
3	2 32	2 30	.. ..	2 32
Total ..	10 68	11 02	.. ..	10 68

(*b*) Where the actual area of the entire survey field does not differ from the registered area by more than 5 per cent, but the actual area of any of the component sub-divisions differ from the registered area by more than that limit, the areas of each of the subdivisions should be adjusted rateably with reference to the registered area of the whole field and the areas adjusted should be adopted.

ILLUSTRATION.

Sub-division.	*Registered area* ACS. CTS. *Ha.—Ares.*	*Actual area* ACS. CTS. *Ha.—Ares.*	*Adjusted area* ACS. CTS. *Ha.—Ares.*	*Final area to be adopted* ACS. CTS. *Ha.—Ares.*
(1)	(2)	(3)	(4)	(5)
1	3 34	2 85	2 74	2 74
2	1 56	2 91	2 79	2 79
3	1 25	0 89	0 86	0 86
4	1 82	1 65	1 58	1 58
Total ..	7 97	8 30	7 97	7 97

(*c*) Where the actual area of the entire survey field differs from the registered area by more than 5 per cent no adjustment is permissible but actual areas should be adopted for the entire survey field and for its component sub-divisions.

ILLUSTRATION.

Sub-division.	*Registered area* ACS. CTS. *Ha.—Ares.*	*Actual area* ACS. CTS. *Ha.—Ares.*	*Adjusted area* ACS. CTS. *Ha.—Ares.*	*Final Area to be adopted* ACS. CTS. *Ha.—Ares.*
(1)	(2)	(3)	(4)	(5)
1	0 91	0 88	.. ..	0 88
2	1 39	1 40	.. ..	1 40
3	6 93	6 10	.. ..	6 10
Total ..	9 23	8 38	.. ..	8 38

NOTE.—In the case of existing sub-divisions with an extent of 20 cents (8 ares) and less differences of more than 2 cents (1 are) should alone be reckoned as errors in area.

(*d*) The above instructions apply also to cases where new sub-divisions are created in an entire survey field or in an already existing subdivision.

A sub-division statement should be prepared in the form given in Appendix VII to chapter I of Part II and attached to the sub-division sketch. The sub-division sketch and statement Constitute the sub-division records.

Poramboke and land Acquisition subdivisions should be demarcated durably before measurement.

Whenever a new sub-division has to be made in a survey field the karnam should report whether there are subdivisions in the field fit for clubbing and if so whether the holder thereof has any objection to their being clubbed. The maintenance tield surveyor should take the opportunity to club all the sub-divisions in that field which are of the same description and soil and taram and which have come into the possession of one and the same individual and should alter the registry accordingly.

But subdivisions in Inam fields covered by different title deeds should not be clubbed. Subdivisions should not be clubbed, if the ryot objects and subdivisions in Inam fields covered by different title deeds should not be clubbed. When subdivisions are clubbed either on

account of indentity of ownership or for other reasons the clubbed subdivision should be denoted by the lowest number of the subdivision clubbed. Remarks should be made against each such subdivision in the tracing of the field and in the subdivision statement to the effect that the subdivision has been clubbed with the subdivision having the revised number. The subdivisions comprised in the clubbed subdivision should also be noted in the sub-division statement against the number denoting the clubbed subdivision. If all the subdivisiors in the field are clubbed, the field should be simply denoted by the original survey number of the field. Copies of the remarks made in the tracing of the field map and in the subdivision statement including particulars of the old subdivisions corresponding to the clubbed sub-division should be entered in the statement of subdivisions furnished to the Registration Department.

When there is a survey error in the field in which a new survey field or subdivision has to be measured the survey should not be undertaken until after the error has been corrected in accordance with the rules in chapter I of Part II.

Notations of Sub-divisions and new Survey Fields.

Paragraph 22 (a).—The notation of new subdivisions of registered holdings will depend on the notation of the survey fields and sub-divisions in the printed diglott register and should be such as to indicate the plot from which the new subdivision is made. If, in the diglott register, subdivisions are denoted by numbers, new subdivisions should be denoted by letters and vice versa, e.g. (i) new subdivisions of existing subdivision No. 14–1 should be denoted as 14–1 A, 14–1 B, etc., (2) new subdivisions of existing subdivision No. 14–1 A should be denoted as 14–1–A1, 14–1–A2, etc. New subdivision of existing S. No. 14 should generally be denoted as 14–1, 14–2, etc., unless the district practice has been to use letter e.g., 14/A, 14/B in which case this practice may continue, the main object being to indicate clearly the origin of each subdivision, to preserve continuity of revenue records, and to facilitate search for, and identification of registered assurances.

In the case of asssessed and unassessed waste lands and porambokes the subdivisions formed out of entire survey numbers will be numbered serially as subdivisions 1, 2, 3, etc. New subdivisions in existing subdivisions will be assigned numbers serially in continuation of the last registered subdivision of the survey field of which it forms part, the remaining portion of the parent sub-division retaining its original numbers.

(*b*) Further sub-divisions of post settlement subdivisions should be denoted by numbers or letters, according as the post settlement subdivisions are denoted by letters or numbers respectively.

(*c*) Any new field formed should be numbered in continuation of the last survey number of the village. Where it is necessary to club two or more old fields into one new field only the lowest number should be retained and a note made in the village map, field measurement book and "A" register that "S. Nos. are clubbed S. No. ."

In cases where more than 26 subdivisions are formed in an existing subdivision and the new subdivisions are to be denoted by letters the first 26 subdivisions will be denoted by the letters A to Z and the further subdivisions by letters AA, AB, etc.

Measurement of small superfluous bits in porambokes for purposes of assignment.

Paragraph 23.—In districts which are not about to be resurveyed, poramboke boundaries will require to be revised from time to time with due regard to the requirements of the villagers and to the desirability of securing straight and simple boundaries. The portions to be so excluded from poramboke fields should only be surveyed as subdivisions of the poramboke fields except when they are petty in extent [5 cents (2 ares) or less] or long

and narrow or for any other reason their retention in the accounts as subdivisions is undesirable. In the excepted cases the superfluous portions of the poramboke fields should be added on to the adjacent fields, the boundaries of which should, therefore be revised as also the boundaries of the poramboke fields. That is to say, the poramboke fields and the affected adjacent fields should be resurveyed. These fields will retain their original numbers only. For detailed instructions see Board's standing order No. 26, 8 (c) measurement of a subdivision of a required area from a given field.

Paragraph 24.—Case No. 1. To cut off from a given field a portion containing a required area with a part of the boundary of the given field as one of its sides.

Let it be required to cut off from ABCDEFG an extent of 5½ acres (2 hectares 20 ares) with a part of AB as one of its sides.

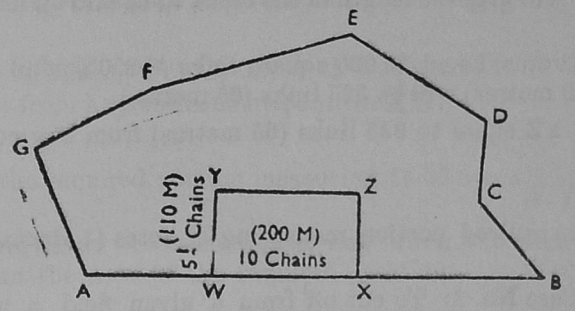


Fig. 66.

On the line AB, select two convenient points W and X and measure the distance between them, say 10 chains (200 metres).

From W and X, lay off offsets WY and XZ of equal length.

The area of the required portion in square links (metres) divided by the length in links (metres) of the line WX will give the length of each of the offsets.

This 5½ acres (2 Hectares 20 ares) i,.e. 550,000 Square links (22,000 square metres) divided by 10 chains, i.e. 1,000 links will be 550 links or 5½ chains (110 metres).

Then measure YZ and see that it is the same length as WX i.e. 10 chains (200 metres).

The rectangle WXZY is the required portion, measuring 5½ acres (2 Hectares 20 ares) cut off from the given field.

Paragraph 25.—Case No. 2 : To cut off from a field a portion containing a required area with parts of two adjoining boundaries of the given fields as two of its sides.

Let it be required to cut off from ABCDEFG an extent of 2½ acres (1 Hectare) with AV and AW parts of AB and AG as two of its sides.

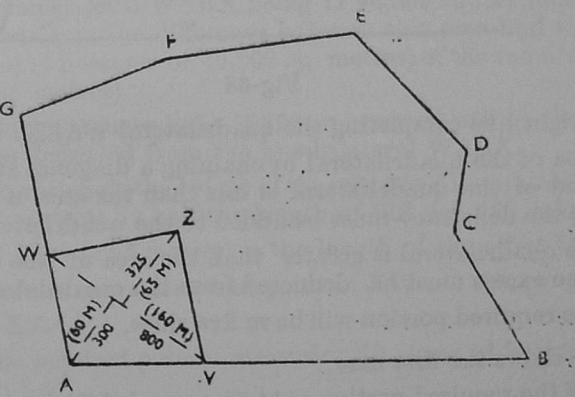


Fig. 67.

Measure the straight line VW forming the triangle WAV and let it be 8 chains (160 metres).

From VW measure the offset XA and let it be 3 chains (60 metres).

The area of the triangle WVA $\frac{800 \times 300}{2}$ square links or 1·20 acres (48 ares).

Deduct this extent 1·20 acres (48 ares) from the total area of the required portion, i.e., 2·50 acres (1 Hectare).

The balance 1·30 acres (52 ares) will be the area of another triangle to be formed on the other side of the line VW.

The balance area, in square links (square metres) divided by half the length, in links (metres) of the line VW will give the length of the offset to be laid off on the line VW to form the other triangle.

Thus 1·30 acres (52 ares) i.e., 1,30,000 square links (5,200 square metres) divided by 4 chains i.e., 400 links (80 metres) will be 325 links (65 metres).

Lay out the offset YZ equal to 325 links (65 metres) from any convenient point Y in VW.

Measure WZ and VW.

The AVZW is the required portion measuring $2\frac{1}{2}$ acres (1 Hectare) cut off the given field.

Paragraph 26.—Case No. 3: To cut off from a given field a portion containing a required area, with the whole of one boundary and parts of two boundary lines of the given field as Three of its sides.

Let it be required to cut off from ABCDEFG a portion with AB and BX and AW parts of BC and AG as three of its sides.

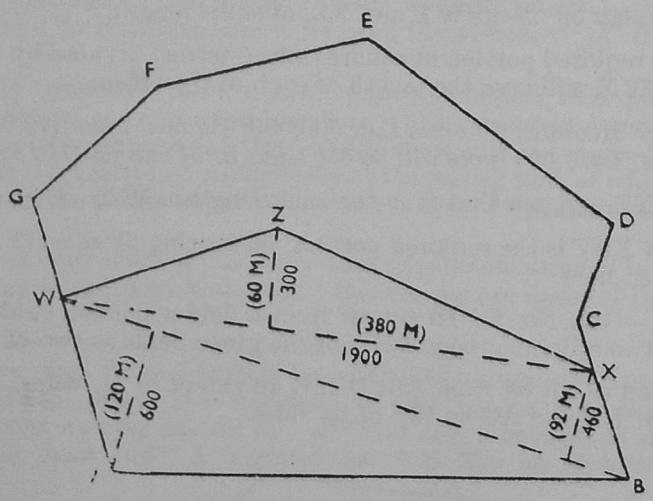


Fig-68

First draw a straight line completing the quadrilateral WABX.

Then find the area of the quadrilateral by chaining a diagonal and taking two offsets. If the area thus found of the quadrilateral is less than the area of the required portion, a triangle containing the deficiency must be added to the quadrilateral.

If the area of the quadrilateral is greater than the area of the required portion, a triangle containing the excess must be deducted from the quadrilateral.

In both cases, the required portion will have five sides.

The above figure shows the first case.

Let the area of the required portion =14·30 acres (5·72 hectares).

Let the length of WX =1,900 Links (380 metres).

Let the length of diagonal WB =2,160 Links (432 metres)

Let the offset taken on BW to the Point X =460 Links (92 metres)

Let the offset on BW to the Point A =600 Links (120 metres)

Then the area of the quadrilateral WABX $=2,160 \times \frac{(460+600)}{2}$ square links=

11,44,800 square links (45,792 Sq. M)

Deduct this extent 11,44,800 square links (45,792 sq. metres from 14·30 acres (5·72 hectares) or 14,30,000 square links (57,230 square metres).

The balance 2.85,200 square links (11,408 square metres) will be the area of the triangle WAZ which should be added to the quadrilateral WABX.

In order to form this triangle, the length of the offset to Z is obtained by dividing 2,85,200 square links (11,406 square metres) by half the length of WX, viz 950 links (190 metres).

The quotient 300 links (60 metres) is the length of the offset to Z.

Lay out the offset from any convenient point in XW.

Measure WZ and XZ.

Then ABSZW is the required portion measuring 14·30 acres (5·72 Hectares) Cut off from the given field.

The following figure shows the second case, i.e., when the area of the quadrilateral WABX is greater than the area of the required portion:—

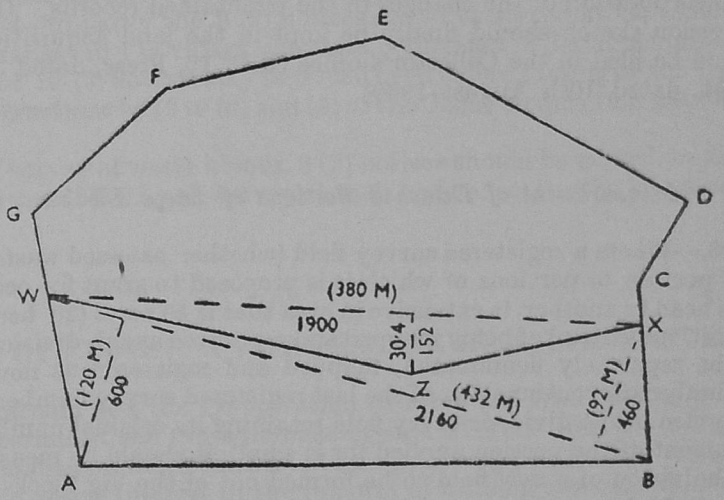


Fig 69.

Let the area of the required portion be 10 acres. (4 Hectares.)

The area of the quadrilateral WABX being 11,44,800 square links (45,792 sq. metres) as shown in the previous case the difference between this area and the area 10 acres or (10,00,000 square links) (4 hectares or 40,000 sq. metres) of the required portion is 1,44,800 square links (45,972 sq. metres).

The difference 1,44,800 square links (5,792 sq. metres) will be the area of the triangle WZX which should be deducted from the quadrilateral WABX.

In order to form this triangle the length of the offset to Z is obtained by dividing 1,44,800 square links (5,792 sq. metres) by half the length of WZ viz. 950 links (190 metres).

The quotient 152 links (30·5 metres) is the length of the offset to Z.

Lay out the offset from any convenient point in XW.

Measure WZ and XZ.

The ABXZW is the required portion measuring 10 acres (4 hectares) out off from the given field.

MEASUREMENT OF NEW ROADS, RAILWAYS AND CHANNELS OF 50 LINKS (10 METRES) AND OVER IN WIDTH.

Paragraph 27.—Where lands are acquired for permanent occupation such asin cases of new railways, roads and channels of 50 links (10 metres) and above in width and in cases of permanent widening or extension by the acquisition of fresh land of such railways, roads andchannels the fields affected by the change need not be completed resurveyed though it involves the complete obliteration of existing field boundaries. The survey should be carried out on the general lines laid down in section IV of chapter IV. The records to be prepared in these cases are—

(i) Two sets of temporary subdivision sketches and subdivision statements showing all the subdivisions newly formed in respect of portions of survey fields acquired and sketches of the new fields formed, if any.

(ii) One set of permanent sketches and statements of changes due to land acquisition showing the amalgamation of subdivisions after acquisition in a form as per the specimen. Three sets of permanent sketches should be prepared in the case of proprietary areas as two copies are required for insertion in the village copies of the Field measurement book. In all cases where new fields have been formed, one more copy of the permanent sketch should be prepared for transmission to the Central Survey Office.

The temporary sketches are prepared for the purpose of award and the permanent sketches are for incorporation of the changes in the maintained records. One copy of the temporary subdivision sketch should finally be kept in the land acquisition file and the second copy should be filed in the Collector's office (B.P. 19, Press, dated 30th June 1947 and B.P. Mis. 994, dated 10th August 1950).

Measurement of Detached Portions of Large Blocks.

Paragraph 28.—Where a registered survey field (whether assessed waste or unassessed or poramboke) a portion or portions of which it is proposed to grant for occupation or for transfer from one head to another, is extensive in area that is 50 acres (20 hectares) or more such portion or portions instead of being mapped and registered as sub-division of the survey number should be separately demarcated, mapped and registered as new survey fields being assigned numbers in continuation of the last registered survey number of the village, the remaining portion of the divided survey field retaining its original number. However, in cases of assignment, if the portion applied for is small, it should be measured wherever possible as a subdivision of a new field to be formed out of the big blocks, the new field being about 5 acres (2 hectares) in wet and 10 acres (4 hectares) in dry or such lesser extent as the state of the ground will admit, having due regard to probable future requirements. The new field should invariably be surveyed on the diagonal and offset method and some of its important bends should be offsetted on a convenient diagonal or diagonals of the original survey field so that the new field can be plotted in the sketch for the old field. Particular care should be taken to form well shaped fields in all cases. In addition to separate sketches for new fields formed in a waste block, a sketch should be prepared for the block itself showing the new fields plotted in it.

Formalities under the Survey and Boundaries Act.

The particular cases requiring the observance of the formalities under the Act in the course of maintenance have been enumerated above in the paragraph dealing with the measurement of new sub divisions. It will be noticed that the formalities begin with the publication of the notification under section 6 and that no mention at all has been made of any notification under section 5. The reason is explained below. No survey of Government

land or of a boundary between Government land, and land which is not Government is legally complete and final, without an initial notification in the *Fort St. George Gazette*, under section 5. But the publication of such a notification separately, every time a new survey field or a sub-division affecting a poramboke boundary is measured or an existing field boundary altered, would be very Irksome and would hold up the incorporation of changes in the accounts; and after all the essence of efficient maintenance lies in the prompt correction of the village registers so as to keep pace with the flow of changes in the course of revenue administration. For this reason, Government have published a general notification under section 5 which covers all items of maintenance work. This notification is always in force; and even when the final notification under section 13 is published for a particular boundary the general notification submits and further boundaries in the same village may subsequently be dealt with commencing with the notification under section 6.

In this connection, it will also be noticed that in the list of cases requiring the observance of legal formalities, new boundaries between private holdings have been omitted. Here again the omission is deliberate in order to facilitate the speedy incorporation of changes in the accounts. Such subdivisions in registered holdings will arise on transfers of registry dealt with in special register Number 6 of the Taluk Office; and the percentage of such cases to the total number of subdivisions effected in maintenance may will be gauged at 80 per cent. Also as a precautionary measure, the signature of the petitioner and the other parties, if possible are obtained in the subdivision statements. As the consent of almost all the parties is obtained, the likelihood of disputes is minimised.

In cases of subdivisions requiring the observance of formalities under the Survey and Boundaries Act ordinarily the 9 (2) notices are to be served at the time and after the incorporation of changes in the village accounts. In cases of Land Acquisition, however, the 9 (2) notices or 10 (2) notices may be issued even before passing of the award in accordance with the instructions in 13 iv (*a*) and (*b*) of the Land Acquisition Manual.

In the case of survey of waste blocks, 9 (2) notices should be served on the holders of land on the perimeter of the block surveyed with reference to the latest adangal of the village.

CO-OPERATION OF RYOTS : A VITAL FACTOR IN MAINTENANCE.

An efficient karnam and the Co-operation of ryots are vital factors in maintenance work. The rules permit of the ryots purchasing stones direct from the village depot and also of having the assistance of the karnam in fixing missing points. The village karnam is expected to take an active interest in the renewal of missing stones, explain to the ryots why it is necessary that they should maintain their stones and help them where they have any difficulty in finding the missing points and see that large arrears are not left behind. The ryots are also expected to apply promptly to the Tahsildar for subdivisions when portions of holdings change hands and the karnams should also induce the ryots to see that they do so. All survey and Revenue Officers, should therefore endeavour to explain to the ryots how survey and maintenance are primarily in their own interest, and they should insist on the karnams doing their legitimate portion of the work.

ENCLOSURE.

Statement of sub-divisions in the VILLAGE TALUK DISTRICT

Number of the present survey field or sub-division.	Its classification, survey area and assessment.			Names of present registered holders.	Particulars of the proposed subdivision												
	Dry, wet or Poramboke.	Survey Area.	Assessment.		Dry, wet or poramboke.	Sub-division number or letter.	Extent according to the area square,	Adjusted extent with reference to column 3	Assessment.	Name of proposed registered holders.	Signature of parties	Are there well defined boundaries on the ground and whether the sub-divisions have been duly demarcated where necessary.	Reasons for omission if any on the part of parties to sign in col. 12.	Remarks Reasons for sub-divisions	Number of sub-divisions in the field fit for clubbing and whether the holder thereof has any objections to their being clubbed.
(1)	(2)	(3) AC. C. / HA. A.	(4) RS. P.	(5)	(6)	(7)	(8) AC. C. / HA. A.	(9) AC. C. / HA. A.	(10) RS. P.	(11)	(12)	(13)	(14)	(15)	(16)
25.1	Dry ..	1.10	0·69	..	Dry ..	25·1A	0.09	0·09	0·06	..	..	..	..	..	..
					Railway Permanent.	1.B	0.26	0·26	..	..	..	..	..	..	..
					Railway Temporary.	1·C	0·49	0·48	..	..	..	..	..	..	..
					Dry	1.D	0·27	0·27	0·19	..	..	..	..	..	..
							1.11	1·10							
25.2	Dc. ..	1·05	0·69	..	Dry	25 2A	0·12	0·12	0·06	..	..	..	..	..	..
					Railway Permanent.	2B	0·29	0·29	..	..	..	..	..	..	..

					Railway Tem- poarry.	2C	0·40	0.39	..	..	..	..	..	..	..
					Dry	2D	0.25	0·25	0.19	..	..	..	..	..	..
							1·06	1.05							
Do	Do.	1·50	0·15	..	Dry	26 1	0·48	0.47	0.31	..	..	..	..	..	..
					Railways Perma- nent.	7	0·59	0·57	..	..	..	..	..	..	..
					Railway Tem- porary.	2	0·47	0.46							
							1·54	1·50							

Statement of changes due to Land Acquisition.

Particulars of Land before Change.					Total number of Sub-divisions or new fields sanctioned.	Particulars of Land after Change.					Name of proposed registered holders.	Remarks.
Survey number.	Sub-Division number.	Description.	Area.	Assessment.		Survey number.	Sub-division number.	Classification.	Area.	Assessment.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
			AC. C. / HA. As.	RS. P.					AC. C. / HA. As	RS. P.		
25	1	Dry ..	1·10	0·69	..	25	1A	Dry	0·09	0·06	Patta.	....
							1B	Government. Poramboke.	0.55		Railway Permanent.	1B and 2B Clubbed.
							1C	Do.	0·87		Railway Temporary.	1 C and 2C Clubbed.
							1D	Do.	0.27	0·27	Patta.	....
									1·78	0·53		
25	2	Dry	1·05	0·69	..	25	2A	Dry	0·12	0·06	Dry.	....
							2B		..	..	....	Clubbed with 1B.
							2C		..	..	....	Clubbed with 1C.
							2D	Dry	0·25	0·19	Dry.	....
									0·37	0·25		

26	..	Dry	..	1·50	1·50	..	26	1	Dry ..	0·47	0·31	Patta.	--	
								2	Government Poramboke.	0·57	..	Railway permanent.	--	
								3	Do.	0·46	..	Railway temporary.	--	
										1·50	0·31			

Madras,
6th June 1970.

(Sd.) ——,
For *Deputy Director of Survey and Land Records, Madras.*

LIST OF AGENTS FOR THE SALE OF TAMIL NADU GOVERNMENT PUBLICATIONS

IN MADRAS CITY

1. Account Test Institute, Egmore, Madras-8.
2. The City Book Company, Madras-4.
3. Higginbothams (Private) Limited, Madras-2.
4. P. Varadachary and Company, Madras-1.
5. C. Subbiah Chetty and Company, Madras-5.
6. The Universal Book House, Moore Market, Madras-1.
7. C. Sitharaman and Company, Madras-14.
8. Mohan Pathippagam and Book Depot, Madras-2.
9. C. Venkatesan Chetty and Company, No. 8-C, Pycrofts Road, Madras-5.
10. The South India Saiva Siddhanta Works Publishing Society, (Tirunelveli) Limited, Madras-1.
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12. New Century Book House (Private) Limited, Madras-2.
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1. A. Venkatasubban & Company, Vellore (North Arcot) District.
2. Bharathamatha Book Depot, Thanjavur (Tanjore District).
3. P. V. Nathan & Company, Kumbakonam (Tanjore) District.
4. Appar Book Stall, Thanjavur.
5. P. N. Swaminathan and Company, Bazaar Street, Pudukkottai.
6. Palaniappa Bros., Tiruchirappalli-2.
7. S. R. Subramania Pillai, Tirunelveli Junction.
8. B. Aruldoss, Villupuram (South Arcot District).
9. Vasantham Stores, Booksellers, 9/31, Cross Cut Road, Coimbatore-12.
10. Mercury Book Company, 20, Karuppa Gounder Street, Coimbatore-1.
11. S. M. Jegannatham Book House, 35, Nandhi Koil Street, Tiruchi-2.
12. Ganesh Stores, South Car Street, Sivakasi.
13. Mary Martin, Booksellers, Kotagiri (The Nilgiris).
14. A. K. Chandriah Chettiar & Sons, Salem-1.
15. Parameswari Book Shop, No. 45D, Old Market Street, Salem.
16. Meenakshi Pathippagam, Pudukkottai.
17. K. V. Narayana Iyer & Sons, Dindigul, Madurai District.
18. Jayakumari Stores, Nagercoil (Kanyakumari District).
19. Baby Stores, Booksellers, Villupuram (South Arcot District).
20. Dinamani Stores, No. 3/1, Old Post Office Road, Coimbatore-18.
21. Kumaran Book Depot, Booksellers, Erode-1.
22. Vela Book Company, No. A, Annaji Rao Street, Erode-1.
23. Ramamani Stores, 6-A, Raja Street, Coimbatore-1.
24. Ajantha Book Centre, Salem-1.
25. Sri Vidya, 63, Tennure High Road, Tiruchy-2.
26. Sri Ramavilas Book Shop, 90, Amman Sannathi, Madurai-1.

IN OTHER STATES

1. Jain Book Agency, New Delhi-1.
2. International Book House, Trivandrum.
3. The Book Syndicate, Hyderabad.
4. Labour Law Publications, Hyderabad.
5. Puthaghaleyam, Pondicherry.
6. Prabu Book Service, Gurgaon, Haryana.
7. K. P. Bagchi & Company, 286, B. B. Ganguli Street, Calcutta-12.