

GOVERNMENT OF MAHARASHTRA



THE
BERAR LAND RECORDS
AND SURVEY MANUAL

VOLUME III

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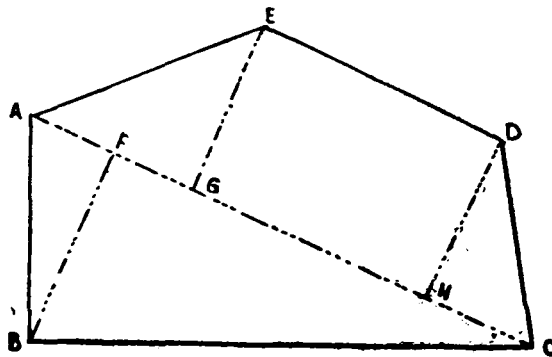
4. Two instruments are therefore required—

- (a) One to divide the area into triangles and trapezia.
- (b) A second of measure the lengths of the bases and perpendiculars. The instruments are the *cross-staff* or optical square and the *chain*.

5. The cross-staff in its simplest form consists of a 6" square and $1\frac{1}{2}$ " thick piece of wood having in it 2 fine grooves $\frac{1}{4}$ " deep at right angles to each other and it is fixed horizontally on the top of an iron shod pole some 5 feet high. In an improved form which is commonly in use the head is made of iron with four flaps bent at right angles and containing slits which serves the purpose of the grooves. The cross-staff has been, to some extent, superceded by the Optical Square which is a round or wedge-shaped hollow brass box of 2" diameter or sides and $1\frac{1}{4}$ " depth having a handle about 3" long fixed below it and within which 2 mirrors are set at an angle of 45° to each other. Above these mirrors there are two rectangular openings and the third side is open to be turned towards the object to the offsetted to.

To divided up any area into right angled triangles and trapezia with this instrument it is only necessary to take a base line from one corner of the area to another : then by moving down this base line with one groove of the cross-staff in the same straight line right angles can be observed to all the corners of the area in turn by means of the other groove and the whole area thus divided up into right angled triangles and trapezia.

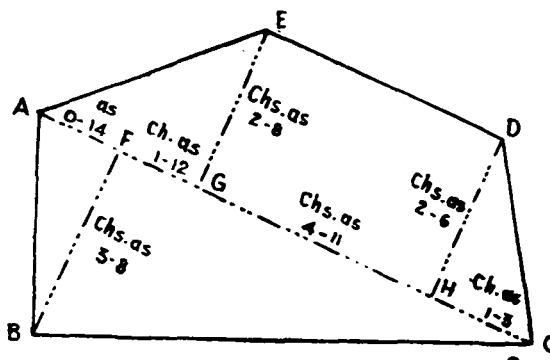
Thus—



To divide the area ABCDE into right angled triangles and trapezia it is only necessary to fix a base line AC ; then by moving along from A to C right angles can easily be formed to the points B, E, and D and the points F, G, and H fixed.

The area is now divided into the right angled triangles AFB, BFC (or ABC), DHC and EGA and the trapezium EGHD. We have then only to measure their bases and perpendiculars with chain and the area of the whole can be found by simple calculation.

6. The chain is 33 feet long with 16 links of galvanized iron joined together by rings of the same metal. Each link is $2\frac{1}{16}$ feet in length and as a measure of length is called an *anna*. Measurements of lengths are expressed in *chains* and *annas* : thus 3 chs. 2 as ; 4 chs. 8 as ; and so on.



THE BERAR LAND RECORDS AND SURVEY MANUAL

CHAPTER I

GENERAL PRINCIPLES

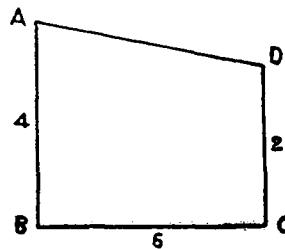
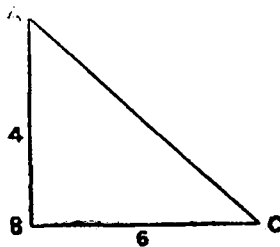
Definitions—

- (i) *Area* means the superficial contents of any plane geometrical figure.
- (ii) An *angle* is a bend or corner formed by two straight lines meeting or crossing each other.
- (iii) When a straight line stands upon another straight line and makes the two adjacent angles equal, the angles are said to be *right angles*. The horizontal line is called the *base* and the line which stands on it is called the *perpendicular*.
- (iv) A field bounded by straight lines cannot have less than three sides. If a field is bounded by three straight sides, its shape is a *triangle*. If it has four straight sides, it is a *quadrangle* or *quadrilateral*.
- (v) A triangle is said to be *right angled* when one of its angles is a right angle. The side opposite to the right angle is called the *hypotenuse*.
- (vi) A quadrilateral which has all its sides equal and all its angles right angles is called a *square*.
- (vii) A quadrilateral which has only one pair of sides parallel is called a *trapezium*.
- (viii) The *base line* is a straight line, selected in a field on which observations are taken to all the corners of the field, to determine the lines at right angles to its from each corner. Such lines are called *offsets*.

2. Measurement by chain and cross-staff is based upon two simple propositions—

- (a) The area of a right angled triangle is equal to the base multiplied by half the perpendicular.
- (b) The area of a trapezium is equal to the base multiplied by half the sum of the perpendiculars.

Thus—



The area of ABC = $6 \times \frac{4}{2} = 12$ and the area of ABCD = $6 \times \frac{4+2}{2} = 18$.

3. In order therefore to measure any piece of ground, it is only necessary to divide up the area into right angled triangles and trapezia and measure their bases and perpendiculars; and the areas of these triangles and trapezia individually can then at once be found by multiplication and the area of the whole by adding the separate areas together.

To return to the example given. Taking the chain we measure from A to F and the length is found to be 14 annas. We next measure from F to B and the length is 3 chs. 2 as. From F to G the length is 1 ch. 12 as. and from G to E 2 chs. 8 as. Similarly GH, HD and HC are measured, the lengths being 4 chs. 11 as., 2 chs. 6 as. and 1 ch. 3 as., respectively.

The area ABCDE has now been divided into four right angled triangles and one trapezium, and their bases and perpendiculars have been measured. It only remains therefore to calculate the area.

7. Here it is necessary to state the square measures of the revenue survey. They are—

Prati annas
Annas
Gunthas
Acres

The table of square measures is—

16 prati annas = 1 anna
16 annas = 1 guntha (121 sq. yds.)
40 gunthas = 1 acre (4,840 sq. yds.)

Their relation to the measures of length is—

Annas \times annas = Prati annas
Chains \times annas = Annas
Chains \times chains = Gunthas
40 square chains \times 1 acre.

Thus—

Example 1.—To multiply 3 chs. 6 as. by 2 chs. 5 as.—

$$\begin{array}{r}
 \text{Chs. as.} \\
 \begin{array}{r}
 3 \ 6 \\
 2 \ 5 \\
 \hline
 6 \ 12 \ 0 \\
 1 \ 0 \ 14 \\
 \hline
 7 \ 12 \ 14
 \end{array} \\
 \hline
 \text{Gs. as. pr. as.} \\
 \hline
 7 \ 12 \ 14 = 7 \ 12 \ 14
 \end{array}$$

Example 2.—To multiply 10 chs. 12 as. by 5 chs. 9 as.—

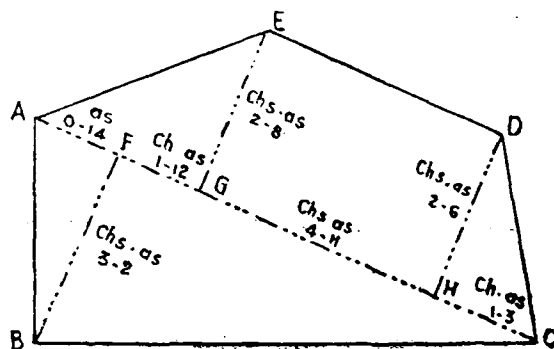
$$\begin{array}{r}
 \text{Chs. as.} \\
 \begin{array}{r}
 10 \ 12 \\
 5 \ 9 \\
 \hline
 1 \ 13 \ 12 \ 0 \\
 \ 6 \ 0 \ 12 \\
 \hline
 1 \ 19 \ 12 \ 12
 \end{array} \\
 \hline
 1 \ 19 \ 12 \ 12 = 1 \text{ ac. } 19 \text{ gs. } 12 \text{ as. } 12 \text{ pr. as.}
 \end{array}$$

As a matter of fact in making up the final areas after calculation, over 8 prati annas are counted as one annas and 8 prati annas or under discarded. Hence in the above two cases the actual areas would be stated as—

Example 1.—7 gs. 13 as. (14 prati annas being counted as 1 anna).

Example 2.—1 ac. 19 gs. 13 as. (12 prati annas being counted as 1 anna).

8. To return once more to our example. We have to find the areas of—



AFB }
 BFC } right angled triangles
 DHC }
 EGA }
 EGHD } trapezium.

As explained in paragraph 2, the area of a right angled triangle = the base \times half the perpendicular. The area of AFB therefore

$$= 14 \text{ as.} \times \frac{3 \text{ chs. } 2 \text{ as.}}{2} \text{ or } 1 \text{ ch. } 9 \text{ as.}$$

Working out this sum—

Chs. as.		
0	14	
1	9	
0	14	0
0	7	14
1	5	14

Similarly the area BFC equals 1 ch. 12 as. + 4 chs. 11 as.

$$+ 1 \text{ ch. } 3 \text{ as. or } 7 \text{ chs. } 10 \text{ as.} \times \frac{3 \text{ chs. } 2 \text{ as.}}{2} \text{ or } 1 \text{ ch. } 9 \text{ as.}$$

Chs. as.		
7	10	
1	9	
7	10	0
4	4	10
11	14	10

Or the area of ABC equals 14 as. + 1 ch. 12 as. + 4 chs. 11 as.

$$+ 1 \text{ ch. } 3 \text{ as. or } 8 \text{ chs. } 8 \text{ as.} \times \frac{3 \text{ chs. } 2 \text{ as.}}{2} \text{ or } 1 \text{ ch. } 9 \text{ as.}$$

Chs. as.		
8	8	
1	9	
8	8	0
4	12	8
13	4	8

and the area DHC equals 1 ch. 3 as. $\times \frac{2 \text{ chs. } 6 \text{ as.}}{2}$ or 1 ch. 3 as.

Chs. as.		
	1	3
	1	3
<hr/>		
1	3	0
	3	9
<hr/>		
1	6	9
<hr/>		

and of EGA—

(14 as. + 1 ch. 12 as. or 2 chs. 10 as. $\times \frac{2 \text{ chs. } 8 \text{ as.}}{2}$ or 1 ch. 4 as.

Chs. as.		
	2	10
	1	4
<hr/>		
2	10	0
	10	8
<hr/>		
3	4	8
<hr/>		

There remains the trapezium EGHD. As explained in paragraph 2 the area of a trapezium = the base $\times \frac{1}{2}$ the sum of the perpendiculars. Hence the area of EGHD

= 4 chs. 11 as. $\times \frac{2 \text{ chs. } 8 \text{ as.} + 2 \text{ chs. } 6 \text{ as.}}{2}$ or 2 ch. 7 as.

Chs. as.		
	4	11
	2	7
<hr/>		
9	6	0
2	0	13
<hr/>		
11	6	13
<hr/>		

9. Adding these totals together the result is the area of the whole—

		Gs. as. pr. as.	
AFB	=	1	5 14
FBC	=	11	14 10
DHC	=	1	6 9
EGHD	=	11	6 13
EGA	=	3	4 8
		<hr/>	
		29	6 6 = 29 gs.
		<hr/>	

But in making up the final area, over 8 annas count as 1 guntha and 8 annas or under are discarded. Hence in the present example the final area will be 29 gunthas.

By the means described above the area of any piece of ground of a reasonable size can be found. There are of course intricacies which will be dealt with later on but the basis of all measurement by chain and cross-staff is the same. Other details are merely refinements.

CHAPTER II

SURVEY INSTRUMENTS AND THEIR USE

The Chain.—The chain is used to measure the distance along a straight line on the ground between two flags. As already stated the chain is of galvanized iron and is composed of 16 links (called annas) joined together by rings. It has a brass handle at each end. Its total length is 33 feet. Each chain is tallied at every two links from either end with galvanized iron tallies pointed, single-notched, double-notched or treble-notched according as the tally lies at 2nd or 14th, 4th or 12th, 6th or 10th links to facilitate the counting of the annas. In the middle of annas eight is attached a tally having four notches. The chain is liable to many errors chiefly on account of the rough usage to which it is often subjected, resulting in bent links, broken rings, etc. At beginning of every season, therefore, every measurer should test his chain, means of the 4 annas rod, which is a piece of wood exactly 4 annas in length. To test the chain, a distance of 16 annas should be measured carefully with the testing rod on a level piece of ground and the distance marked out by driving a wooden peg firmly into the ground at each end. The chain should then be stretched between these two pegs. If it exactly occupies the space between the pegs, the chain is accurate. If it is found incorrect the measurer must be careful to make the necessary allowances in the ensuing measurement and also to have the chain repaired correctly at the earliest opportunity.

The standard distance of 33 feet thus marked by the measurer, should constantly be checked by the Superior Land Record Staff during tours by means of steel tape.

2. The proper manipulation of the chain is of the utmost importance and must be thoroughly mastered before the measurer learns to use the cross-staff or optical square because carelessness in using the chain is certain to lead to large errors in the total measurements.

3. The first principle to be observed is *always to keep the chain straight down the line between the two flags A and B*—

A—————C—————B

In order to attain this object it is necessary, before starting chaining, to place a third flag C in the straight line (*shista*) between A and B. For this purpose the measurer should stand behind the flag A and move the flag C until it exactly covers the flag B, both the flags being held vertical. The measurer then commences chaining from A, always seeing that the front end of the chain is exactly in a straight line with flags C and B. If the chainmen are allowed, at any time, to wander off this straight line the measurement of the distance between the two flags at once becomes too long and inaccurate.

4. The chain is dragged by two chainmen called respectively the *backman* and the *foreman*. The latter is provided with 10 iron spikes (called *arrows*) with which to mark off full chains as they cover the line.

In dragging the chain—

(a) The backman places the handle at his end against the flagstone, pit, etc., which marks the point of departure, the measurer standing behind him.

(b) The foreman then stretches out the chain tight and flat upon the ground, the measurer directing him to move right or left until the chain lies quite straight in the desired direction.

(c) The foreman then sticks an arrow into the ground at his end of the chain (or if the ground be very hard makes a cross thus ×) and lays the arrow beside it.

(d) The chain is then moved forward at the order of the measurer pulled by the foreman, being swung a little to one side so that the arrow may not be moved from its position. The process described above is then repeated.

(e) As the chain is moved forward the backman picks up the arrows one after the other until the measurement is complete. The total number of chains measured can then be found from the number of arrows in the hand of the backman (those in the hand of the foreman being also counted as a measure of check) and the number of annas counted from the chain as it lies on the ground, a half anna or under being disregarded, and over half an anna being taken as one full anna. If the measurement completes a full chain then one more chain must be added to those reckoned by the arrows in the hand of the backman.

(f) When the distance to be measured exceeds ten chains, then, as soon as the tenth arrow has been picked up by the backman, the 10 arrows should be counted by the measurer and handed over to the foreman who will stick one arrow in the ground at the end of the chain and then

proceed as before. At the same time the backman should pick up a small stone to indicate that 10 arrows have been handed over by him to the foreman, and he should similarly pick up an additional stone for every subsequent 10 arrows handed over by him.

(g) In order to mark the point on the stright line to which the measurement is taken a pit is then dug by the pickman at the end of the complete anna. Thus if the measurement on the chain reads $14\frac{1}{2}$ or $14\frac{1}{4}$ annas this will be taken as 14 annas and the pit dug at the end of the 14th anna : but if the measurement reads between $14\frac{1}{2}$ and 15 annas then this will be taken as 15 annas and the pit dug accordingly.

(h) The arrows in the hands of the foreman are then retruned to the backman after the distance required has been measured.

5. All this sounds very complicated, but after a little practice the work becomes mechanical. It is essential, however, that it should become mechanical in the right way, and in this connection the following points are worthy of particular notice :—

(a) The measurer must invariably walk *behind* the chainmen and direct them what to do. The practice of certain measurers who go on ahead taking offsets and leave their chainmen to follow at their leisure is strongly to be deprecated. Incorrect measurement is bound to be the result.

(b) After a measurement is taken the measurer should invariably ask *both* chainmen how many arrows they have got and see that their answers are correct. This is the only way to check mistakes arising from dropped arrows, errors in counting on the part of the backman, etc.

(c) The measurer must always see that the backman returns his arrows to the foreman before a new measurement is commenced. Many mistakes arise from the backman omitting to give back his arrows, with the result that they are wrongly counted in the next measurement also.

(d) The measurer should use as few words as possible in issuing orders to the chainmen. The only words necessary are the following :—

- Stretch out the chain.
- Right or left (to the foreman).
- Stick in the arrow.
- Move on.

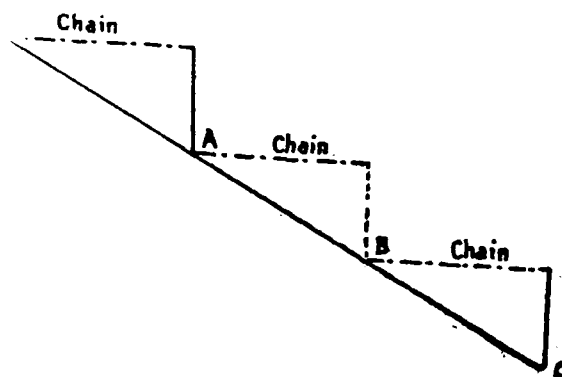
And on the completion of a measurement—

- How many arrows have you ? (To the backman).
- How many arrows have you ? (To the foreman).
- Return the arrows (To the backman).
- Dig a pit (to the pickman).

If the measurer learns to use these words mechanically in their invariable sequence the chance of mistakes occurring will be very considerably lessened.

6. It may be noted that chain measurements are meant to be taken over flat superficial areas only. Hence if a measurement has to be made, for example, over a mound or other obstacles, the chainman must be ordered to hold the chain horizontally in the air and the point on the actual line for fixing arrow must be determined by dropping a stone or an arrow perpendicularly from the end of the chain. In case of uneven and steep slope, it will be found more convenient to use the chain by parts.

7. Chaining up or down the side of a slope which is more or less uniformly steep should be carried out, as shown in the sketch below :—



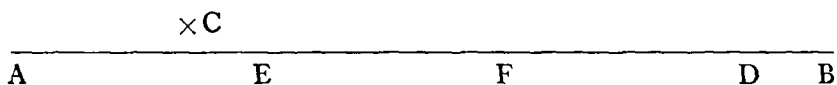
in a series of steps, the chain being held out horizontally by the backman or foreman according as measurement is proceeding up or down hill, and the points A, B and C fixed by dropping the arrow or stone as described above.

8. The cross-staff.—The use of the cross-staff or optical square is to determine points in the base line at which perpendicular from the corners fall on it. In using the cross-staff or optical square the first essentials are (a) accuracy and (b) quickness.

These can be attained only by continual practice in the field and by the careful observance of certain principles which are mentioned below.

9. If AB be the base line and C the point to which an offset is to be taken, then the object is to find the point E as quickly as possible, from which a line is drawn to C at right angles to AB. This point (E) is the place where, if one pair of slits or groove of the cross-staff points directly down the base line AB, then the other pair of slits or groove points directly along the line EC.

An intermediate flag D should first be placed in the base line in the manner described in paragraph 3 of this chapter. The measurer should then chain along the base line starting from A till he comes approximately opposite the point C. In order to see whether he is nearly opposite the point C, the measurer should stand on the base line facing flags D and B and should then look over his shoulder in the direction of flag C. When he sees flag C in a line with his shoulder he is approximately in the right position and should drive the cross-staff in the base line, fix one pair of slits or groove in the line AB and look through the other pair of slits or groove towards C. He will probably find that he is a few annas from the correct position.



He should then at once estimate how far forwards or backwards he must go to find the correct position. He should then move the cross-staff backwards and forwards along the base line till the flag C appears in the centre of the pair of slits or groove. After a little practice, two or at most three, trials should be sufficient to take him to the correct point.

To sum up—

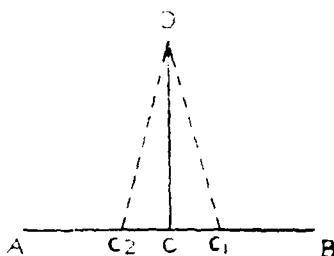
- (a) Fix the position of the base line and place a third flag exactly on the base line at an intermediate point.
- (b) Keep the chain straight down the base line.
- (c) Before attempting to take the angle, fix upon a position approximately correct.
- (d) If it be wrong, decide quickly how far you are out. The longer the offset of course the greater the distance the measurer will have to move backwards or forwards if incorrect the first time.

10. How to test the accuracy of a cross-staff.—The measurer should stand on a flat piece of ground and fix 3 flags A, B and C in a triangle at distances of 10 to 15 chains apart. He should stand in the straight line between any two of them (A and B) and then fix his cross-staff so that he can see the two flags A, B through one pair of slits or groove and the third flag C through the other pair of slits or groove then, without changing the position of the cross-staff, he should turn it through 90° so as to see the flags A and B through the second pair of slits or groove. He should then look through the first pair of slits or groove in the direction of flag C. If the flag C is visible exactly in the middle of the slits or groove then the cross-staff is accurate. If, however, the flag C is not visible exactly in the middle of the slits or groove or cannot be seen at all through the slits or groove the cross-staff is inaccurate and should be returned.

In some cases, the slits being too broad, the flag to which the offset is to be taken is visible even though the cross-staff be shifted 4 annas or more on either side of the correct position on the base line. In such cases also the cross-staff should be treated as inaccurate and returned.

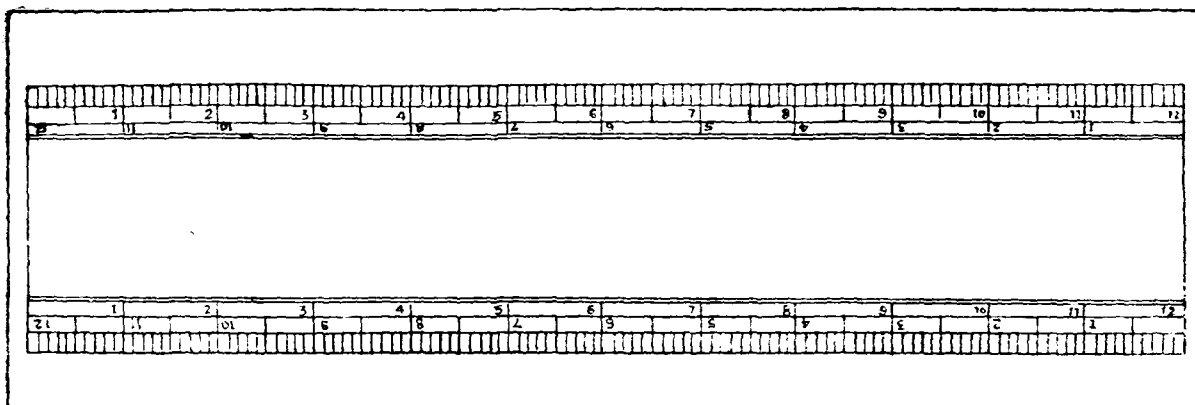
11. How to test the accuracy of an optical square and to adjust it.—To test the accuracy of an optical square, select a flat piece of ground and on it lay out a straight line measuring one and a half chains in length between flags A and B, *vide* figure on next page stand at point C which should be marked on the ground, on the line midway between flags A and B. Facing flag A take an offset by means of the square not exceeding 5 chains to flag D. Turn round while standing at point C and facing flag B, sight flag D. If the flags B and D coincide through the optical square the instrument is correct. If they do not, it is incorrect and needs

rectification. In the latter case, move along the line AB. If C_2 is the point from where flags B and D can be made to coincide, mark the point on the ground. Bisect the length $C_1 C_2$ at C. CD will then make a true right angle with AB. Stand at point C and adjust the instrument by manipulating the screws at the backs of the mirrors until flags A and B can be made to coincide with flag D from either direction through the optical square.



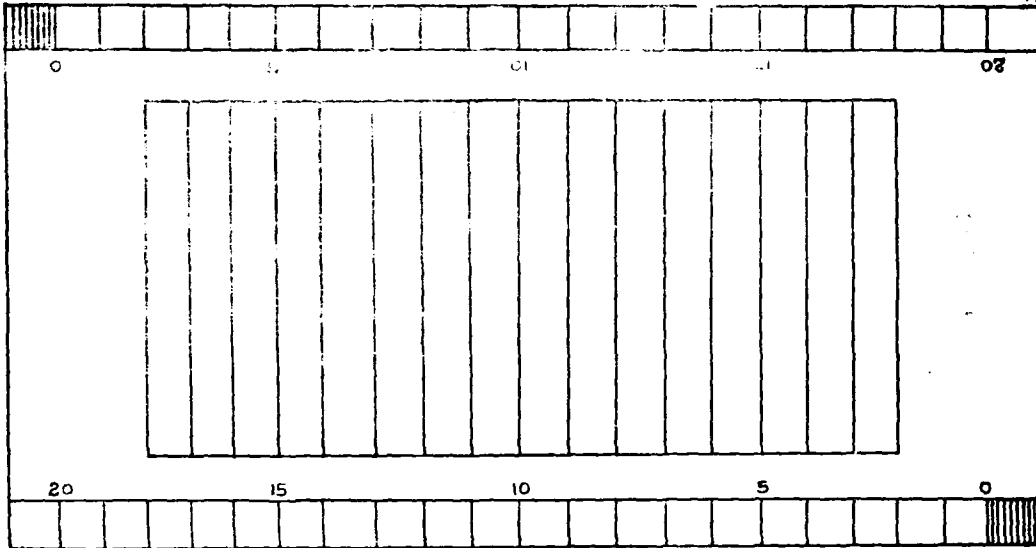
12. The scale.—The scale used in plotting is usually 6 inches or 12 inches in length and is divided into $\frac{1}{20}$ of an inch. Such a scale is called a “scale of twenty”.

In addition to this, a smaller scale 3 inches in length, called the *offset scale* is used for drawing offsets. It is essential that both these scales should be correctly graduated, and they should be examined carefully before being brought into use.



13. Drawing compass or divider.—The divider is used to transfer distances from the scale to the paper and to describe arcs and circles. The distances are taken off the scale by this instrument and the points are marked in pencil on the plotting paper and then joined and inked in. Before using the divider it should be seen that the points are sharp and fine and when closed should fall over each other forming, as it were, one point, and that the legs are not loose.

14. Area comb.—The area comb consists of a brass or card-board frame with a set of parallel and equidistant threads running across it. The distance between each of the threads is $\sqrt{10}$ of an inch which represents approximately 6 chs. $5\frac{1}{4}$ as. on a scale of 20 chains to an inch. Along the top and bottom of the frame, scales of 20 sections are marked out, the length of each section being equal to the distance between the threads, *i.e.*, representing approximately 6 chs. $5\frac{1}{4}$ as. on a scale of 20 chains to an inch.



Thus a square drawn on each section would have an area of 6 chs. $5\frac{1}{4}$ as. \times 6 chs. $5\frac{1}{4}$ as. or exactly 40 gunthas (1 acre). One of the sections at the end of each scale is divided into 10 equal sub-sections each of which representing approximately $1/10$ of 6 chs. $5\frac{1}{4}$ as. on a scale of 20 chains to an inch. The use of the area comb is to divide any figure into strips each being (on scale of 20 chains to an inch) 6 chs. $5\frac{1}{4}$ as. broad. Then the area of each strip is easily ascertained from its length, thus—

The area of a strip 1 sub-section in length is—

$$1/10 \times (6 \text{ chs. } 5\frac{1}{4} \text{ as.}) \times (6 \text{ chs. } 5\frac{1}{4} \text{ as.}) = 4 \text{ gunthas}$$

Similarly the area of a strip 2 sections in length is—

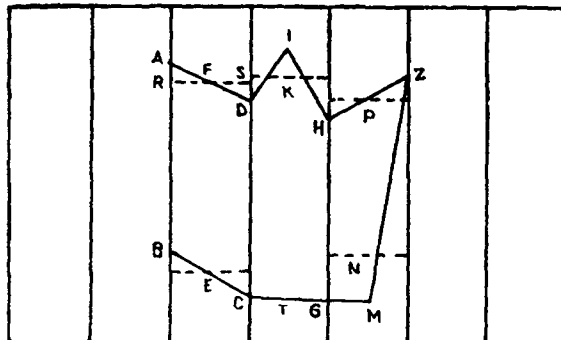
$$2 \times (6 \text{ chs. } 5\frac{1}{4} \text{ as.}) \times (6 \text{ chs. } 5\frac{1}{4} \text{ as.}) = 80 \text{ gunthas (2 acres).}$$

The area of a strip 3 sections 2 sub-sections in length is—

$$3/10 \times (6 \text{ chs. } 5\frac{1}{4} \text{ as.}) \times (6 \text{ chs. } 5\frac{1}{4} \text{ as.}) = 310 \times 40 \text{ gunthas} = 3 \text{ acres } 8 \text{ gunthas ; and so on.}$$

Thus each section on the scale represents an area of 1 acre, and each sub-section an area of 4 gunthas.

To find the area of a field the area comb is placed over a map drawn to scale so that one of the threads coincides with a side (AB) of the field as shown in the sketch. Commencing with the strip ABCD, one leg of the divider is placed at E midway between B and C, and the other leg is stretched up to the point F midway between A and D.



Keeping the distance in the divider and taking up the second strip DCGHI, the upper leg of the divider is placed at T and the lower is a line parallel to the threads and the upper leg is then extended to the point K. Still keeping the distance in the divider, the third strip is taken up in a similar manner. The divider is then taken off and placed over the scale. Then as explained above, the number of sections covered will represent acres and the number of sub-sections 4 gunthas each. Suppose the dividers are found to cover 5 sections and 3 sub-sections then the area of the field is 5 acres and 12 gunthas. If the scale of the map is 10 chains to an inch, then each section will represent $\frac{1}{4}$ acre, *i.e.*, 10 gunthas and each sub-section one guntha.

If the area of the field is more than can be taken in a single stretch of the divider, the area should be calculated in two or more operations.

Dharsod.—When the side of the field runs slanting across the threads, or has a bend between two threads of the area comb, it becomes necessary to make a *dharsod*, *e.g.*, in the example given, when the divider is placed at points E and F the portion FDS which does not form part of the field is included, while the portion AFR which forms part of the field is excluded. The portion excluded must always be equal to the portion included, *i.e.*, the point F must be taken exactly half way between A and D. Similarly the *dharsod* be made in the case of the other two strips as will be seen from the dotted lines marked in the sketch. The *dharsod* must always be made with the greatest care because the accuracy of the area depends entirely upon the *dharsod* being made correctly.

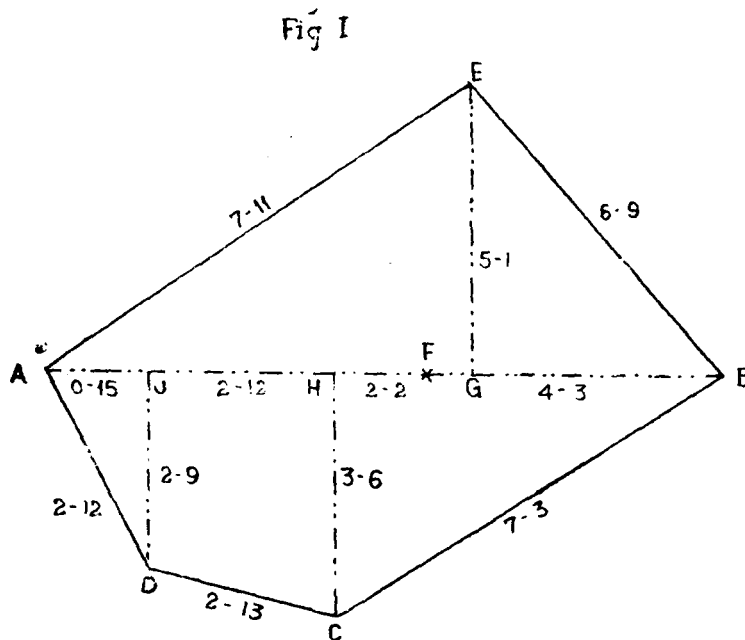
CHAPTER III

MEASUREMENT OF FIELDS

Having learnt the proper methods of using the chain and cross-staff or optical square, the measurer can now proceed to the measurement of a field. It may be noted that all the *practical* work which will have to be carried out by Revenue Inspectors will usually be in connection with areas already surveyed and mapped, *i.e.*, survey numbers. Before, however, he can proceed to the study of the special problems involved thereby, the Revenue Inspector must learn the ordinary technique of field measurement and how to avoid ordinary difficulties involved in the use of the cross-staff or optical square and chain.

2. Measurement of a field.—The measurement of an ordinary field being the foundation of the art, this will be described in detail.

(a) The Revenue Inspector will be provided with a cross-staff or optical square, chain and 10 arrows and a field book in which to note the measurements. He will also have a number of flag-holders bearing poles to mark the base line and offsets, 2 chainmen and a pickman. For these he can use the village mahars or if necessary he can engage hired labour.



(b) He will first go round the boundaries of the field to be measured and mark on the ground the corners, and any bends between the corners of the field. In Fig. I, A, E, B and C are the main corners and D is a bend. Any bend of more than two annas out of the straight line is to be measured, and any bend of less than two annas is to be ignored (*i.e.*, the boundary line is to be taken as straight). A bend is observed by placing two flags at the two corners on the boundary line in which the bend exists. In order to ascertain the correct position of a bend the measurer must walk along the boundary line and see at what point the line turns. The point of turning is the point to be marked as a bend. It is entirely wrong for the measurer to stand in the middle of the field and tell the flagmen vaguely to go to a certain corner or bend. He must *personally* station the man at the exact spot. In the sketch given, flags will be placed at the points A, D, C, B and E. In order to mark these points, pits will be dug by the pickman and the flag poles stationed in them.

(c) The measurer will next proceed to select the *base line*. This should generally be the longest line between any two corners of the number, as A, B, and should, wherever possible, be chosen in such a way that all corners of the field can be conveniently observed from it.

(d) Having decided on the base line, the intermediate *base line pole* will next be fixed, say at point F as explained in Chapter II, paragraph 3. A pit will be dug to mark the position of F.

(e) The measurer will next draw a long broken line in his *field book* to represent the base line in such a way that the north will come at the top of the page.

(f) He can now start to measure, taking care first to count the arrows in the hands of the foreman to see that there are exactly 10. Beginning from the point A he will measure up to and take the offset at the point J, chaining and offsetting being carried out as described in Chapter II.

(g) After fixing the point J, he will enter in his field book the measurement in chains and annas.

(h) He will then go to D and measure from D to J, draw the offset in his field book in a broken line and write down the measurements. DA will then be joined by an unbroken line.

(i) He will then take offsets to the corners C and E and measure the length of the base line from J to H and H to G and G to B and also measure the length of the offsets CH and EG in the same way as in the case of the first offset, the offsets and the base line being marked in his field book, as soon as each measurement is complete and the boundary lines AE and EB, BC and CD drawn. The boundary line should be joined as soon as the measurement of each offset is complete.

(j) After the offsets and base lines the boundaries of the field will be measured and the measurements entered in the field book. The measurements of the boundaries are not required for calculation of areas, but they are taken in order to check the measurements of the offsets and base lines.

(k) Although the (*tippan*) rough sketch made in the field is not drawn to scale, still the measurer should draw the base line and offsets roughly in proportion to their respective measurements.

(l) At the top of the *tippan* details of the name of village, survey number, the name of the occupant and the date of the survey should be given. Also any nalla or road passing through the field should be shown. Similarly any well, house or valuable fruit-tree standing in the field should be marked in the manner described in Appendix II.

Care and regularity in carrying out the measurement of a simple field are the basis of the art of good measurement. Once this is thoroughly learnt so that every operation becomes automatic, then the rest is easy. Every measurer in training should therefore be thoroughly grounded in simple measurement before he is allowed to proceed further. In the following pages it will be presumed that this has been done and only the details necessary to explain the particular case will be given.

3. Measurement of a Field on two base lines.—It will sometimes be found inconvenient for various reasons to measure a number on one base line, *e.g.*, the offsets from one base line may be very long and long offsets are to be avoided as making for inaccuracies. Offsets should not ordinarily exceed 10 chains in length.

In such case the measurer will select two or more base lines as may be necessary and take the offsets to the corners from them (*vide* Figs. II and III). If offsets to all points were taken on one base line, *viz.*, AB or ED in Fig. II or ED in Fig. III, some of the offsets would be very lengthy, would take a long time to measure and would be liable to give inaccurate results. The general principle to be followed is that when there are numerous berds in a field or where the field is of great length separate base lines should be adopted so as to avoid unduly long offsets and long base lines. Care should, however, be taken to see that no offsets necessary for area calculation and map drawing are omitted; for instance, in Fig. II, if the offsets EF and CG were not taken the area could not be worked out and the map could not be drawn. Similarly in Fig. III if the offset AB were not taken from the base line EF as well as the offset AC from the base line DE, the area could not be worked out and the map could not be drawn.

4. To measure two numbers on one base line.—The only precaution to be observed is that the measurer must mark the point where the dividing boundary of the numbers cuts the base line and take measurements along the base line from the next preceding offset to that point and from that point to the next succeeding offset. The quickest way to find this point is for the measurer, after taking the offset from C to D, to go to the point D and move a flag-holder up the

base line till the flag post is in a straight line on the base line at E between D and F (*vide* Fig. IV).
The other method of fixing this point is as follows:—

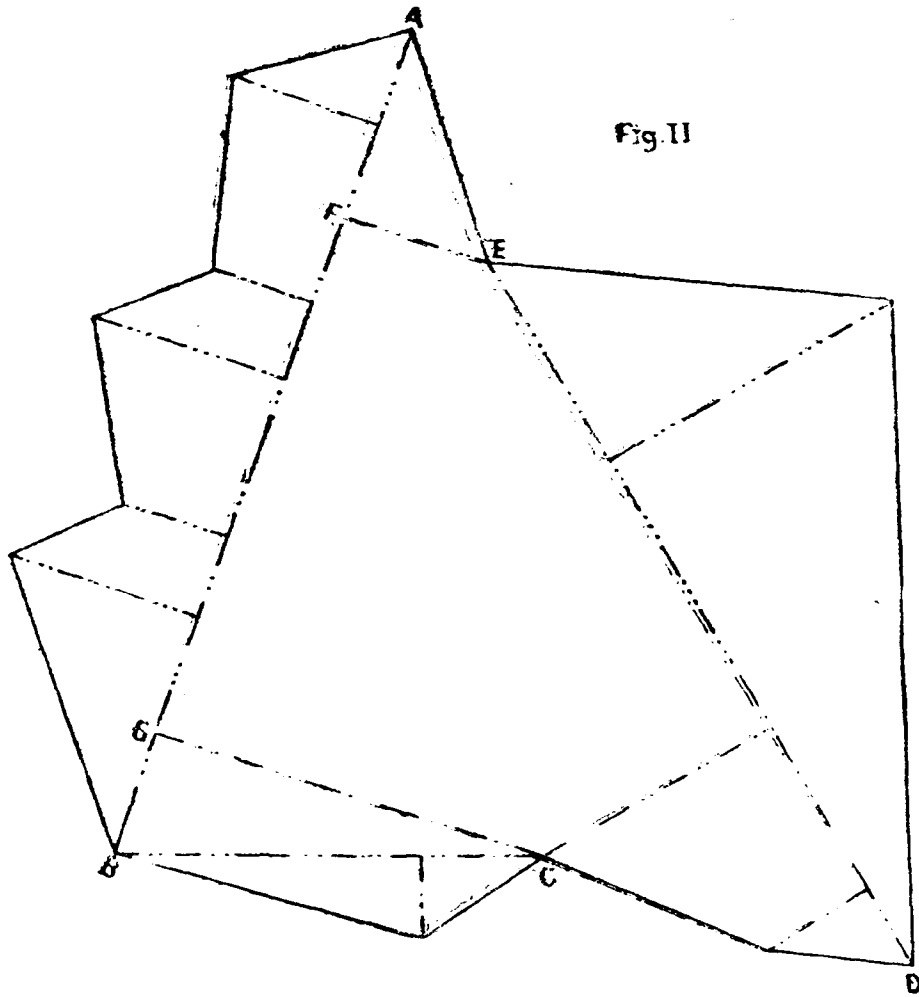


Fig. III

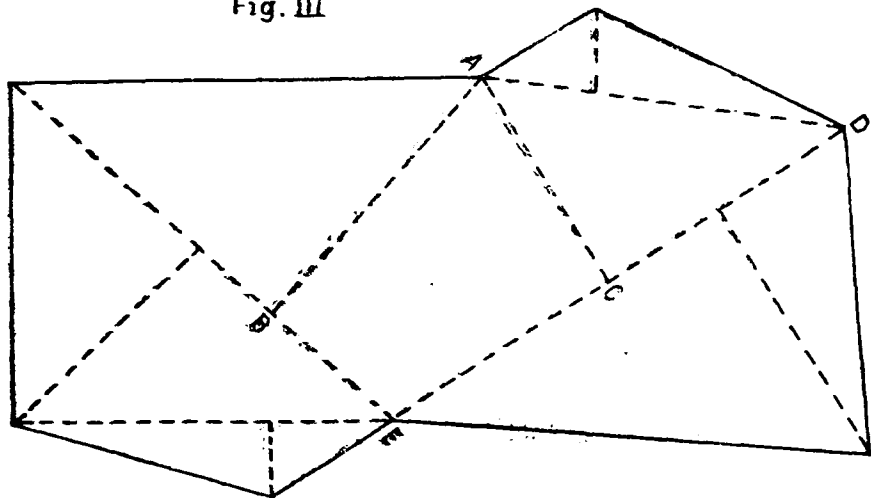


Fig. IV

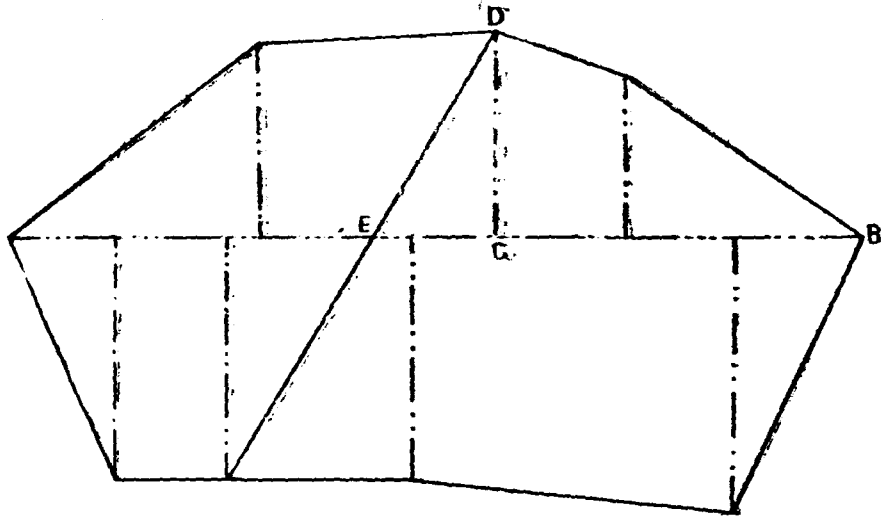
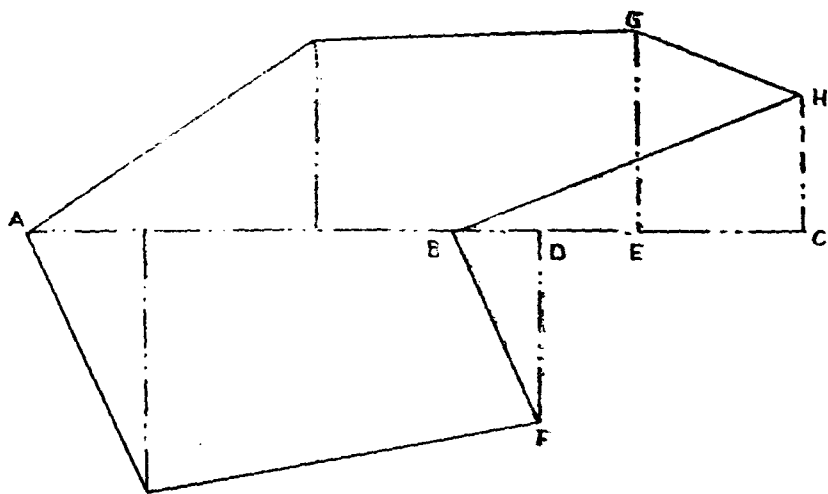


Fig. V



The measurer fixes his cross-staff in the base line and turns it until he can see the point D through the grooves. If the point F is also visible then the cross-staff is at the point of intersection (E). If not, then the measurer moves the cross-staff along the base line till he comes to the point which is in the straight line (*shista*) between D and F.

5. Measurement on an extended base line.—Some fields are so irregularly shaped that an offset cannot be taken conveniently to some of the corners from a base line lying wholly within the field. In such cases the base line must be extended and the necessary offsets taken from the extended line. Thus in Fig. V the base line AB will be extended to C and offsets taken at D, E and C to the corners at F, G and H.

The measurer must in such instances take great care in drawing in the boundary lines of the field in his field book; otherwise he will be very liable to draw the boundary from F to C and C to H instead of from F to B and B to H.

6. Measurement on the *adhar regh* (principal village base line).—Whenever an *adhar regh* passes through a survey number, it should be taken as base line for the measurement of the field as it is useful in drawing the map of the village. In Fig. VI, AB is a part of the *adhar regh* which starts from one extremity of the village and passes on to the other.

7. Avoiding an obstacle in the base line.—It occasionally happens that the most convenient base line is obstructed by an obstacle such as a well or small tank, etc., which cannot directly be chained across. The measurer therefore has to go round it as shown in Fig. VII. After taking the offset at C, he chains to any convenient point E short of the obstacle. From E he sets off a right angle with the cross-staff or optical square from the base line to any point F and from EF he sets off a right angle to any point G and from GF at right angle to the base line cutting it at H. Then GF (2 chs. 4 as.)=HE which is the distance required to be measured.

A second method is as follows:—

Fix any two convenient points C and D (Fig. VIII). Measure CE and DE and prolong these lines till $EF=EC$ and $EG=ED$. Then the distance $FG=DC$.

8. Avoiding an obstacle in the offset.—In Fig. IX, the offset to the corner A cannot be taken from the point B as the flag at point A is not visible owing to the tree standing on the offset line. The measurer must therefore go ahead up to the point C. From C he sets off a right angle with the cross-staff from the base line to any point D and on the line CD he takes an offset to the point A. Thus CD (6 chs. 8 as.)= BA which is the distance required.

9. Measuring different classes of land in the same field.—Sometimes different classes of land are included in the same field and it becomes necessary to find the area of each separately. Thus Fig. X shows a piece of rice land enclosed within Jirait number.

In order to measure these area separately, the measurer has only—

(a) to fix the corners of the boundary between the different classes of land and take the usual offsets to them from the base line, and

(b) to make and fix by measurement on the base line the point at which the dividing boundary of the different areas crosses it, if it does cross.

Thus, in Fig. X, in addition to fixing the corners from the base line AB in the ordinary way, the points C and D where the boundary of the rice land crosses the base will be fixed from EF and GH as described in paragraph 4 above.

10. To measure a tank.—As it is impossible to measure through a tank, the measurer has to go round it. He should select a base line—as AB in Fig. XI—and take offsets to the proximate corners of the tank as at E and F. He will then raise another base line at right angles from AB—as AC—and take an offset to the corner at D. Similarly the base CG will be raised at right angles to AC, and the base GB at right angles to CG and offsets taken to the corners of the tank; then ACGB is a rectangle and its area can be found at once. Then to find the area of the tank it is only necessary to calculate the area of the small figures NALE, ELJ, FJM, etc., and deduct them from the total area of ACGB. The remainder will be the area of the tank.

The above method should also be adopted in the case of a *pan* garden or any thick plantation through which it is impossible to take a chain.

11. To measure a tank in a survey number.—In a case such as that shown in Fig. XII, it is only necessary to take an offset—such as CD—as the base and measure round the tank as described in the last example.

Fig. VI

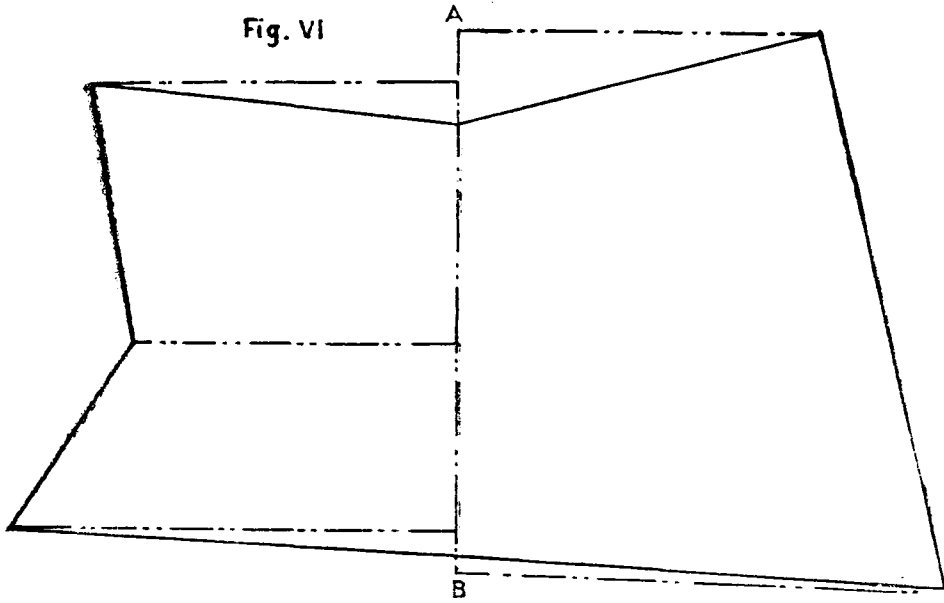


Fig. VII

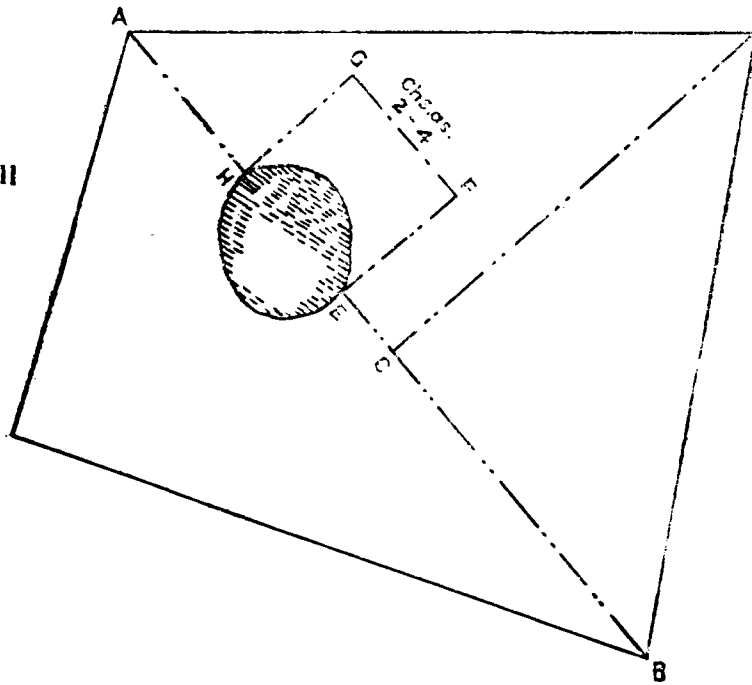
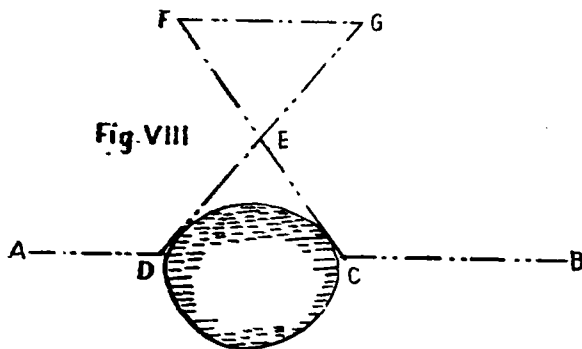


Fig. VIII



It may be noted that in order to find the area of the number an offset is required to F from the base AB. The length of this offset can be found easily by taking an offset at E to F from DG as base line and adding the length EF to the length DC which will give the length of the offset required, since $DC = EH$.

It is to be noted that in this case the boundary line BI is at right angles to the base line AB and this is indicated by a plus mark as shown in the figure.

12. To measure houses in a survey number.—The principle is the same as in the last example with the difference that you cannot see through a house and hence more intricate base lines are required, provided it is to remain open. Thus, in Fig. XIII, had the houses marked S and T been tanks one base line could have been taken from A to C, whereas two base lines are actually required. The measurements, however, are made in the same way as in the case of a tank, *i.e.*, by raising subsidiary base line from the original base, taking offsets to all the corners, and finding the area of the house by deduction.

In the case of an open plot to be given out for any public purpose, the measurement of the plot can be made from the interior. For fixing the position of the plot in the map of the survey number it is only necessary to take offsets to two of its corners. Suppose in Fig. XIII, FGHI and KJLMNP and the two plots which are to be measured. The plots will be measured from interior as shown by the offsets and base lines in the sketch and their relative positions in the field will be found by taking offsets to two corners only. As the plot JLMNPK lies close to the base line, offsets are taken from the base line, while in the case of the plot FGHI offsets are taken from the boundary line BC.

13. To measure a road in a number.—All that the measurer has to do is to take offsets to the corners of the road as in Fig. XIV.

When a road passes straight through a survey number as in Fig. XV, there is no necessity to set up the base line on which the survey of the field is based. In this figure A, B, D, C are permanent marks in the field. Take the measurements BE, EG, GA, DF, FH and HC. Take EF (one side of the road) as the base line and take offsets to the points G and H. The position of the road is thus determined and the area can be calculated.

It may be noted that detailed measurements are necessary only in the case of pukka built roads. In the case of cart tracks, merely the length and breadth of the track is measured roughly after the whole number has been measured. In both cases the area of the road is shown as *kharab* and included in the total area of the number (*vide* Fig. XVI). In order, however, to show the position of the road in the field the necessary measurements along the boundary line, *i.e.*, AB and DE in the figure, will be taken in the field and recorded in the tippan. The breadth of the road will also be recorded at each end of the road.

14. To measure alluvion, diluvion and encroachments.—First fix the old boundary line (AGB) of the field bordering on the nalla or river. Then take any convenient base line and measure the accretion or the portion washed away and find out the area.

In the example given (Fig. XVII) the old base line EF is first set up and then the marks A and B and all the bends between them are relaid by measurements taken from the survey tippan (a copy of which will be supplied to the Revenue Inspector on his report). When that is done the line of the alluvial area is marked out in the field in accordance with the line of actual cultivation (CD), all the bends between C and D being duly marked. Then AB is taken as the base line and the offsets to all the bends between the points A and B and the points C and D are measured and from them the area of the alluvial accretion is calculated. Similarly in the case of diluvion the position of the original marks are fixed first and then the area washed away determined. Similarly, when an encroachment is to be measured, the positions of the old marks are first fixed and then the area encroached upon measured.

15. To cut a given area off a field.—Let ABCKHD (Fig. XVIII) represent a field measuring 12 acres. A piece of land measuring 4 acres is to be partitioned in the northern portion by a straight boundary from west to east. Measure the northern boundary line AD. Suppose it is 24 chains. Divide this distance by the area to be cut off, *i.e.*, 4 acres = 160 gunthas; the quotient is 6 chs. 10 as. 10 p. as., *i.e.*, 6 chs. 11 as. Measure a length of 6 chs. 11 as. along the side of the field from A to E. Take a base line ED and on this base line take an offset to A. Suppose the measurement of the base is 3 chs. 15 as. and that of the offset 5 chs. 6 as.; complete the measurement of the base line up to the point D. The total length from ED is 27 chs. 5 as. Work out the area of the triangle EAD. It comes to 73 gs. 6 as. 7 pr. as.

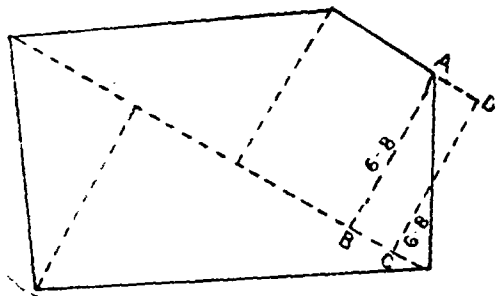


Fig. IX

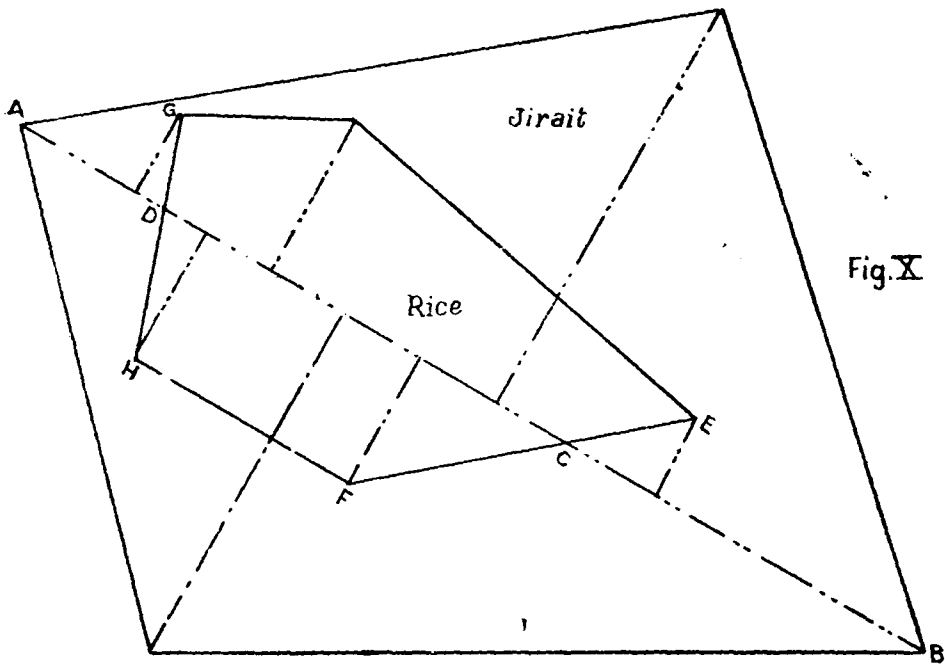


Fig. X

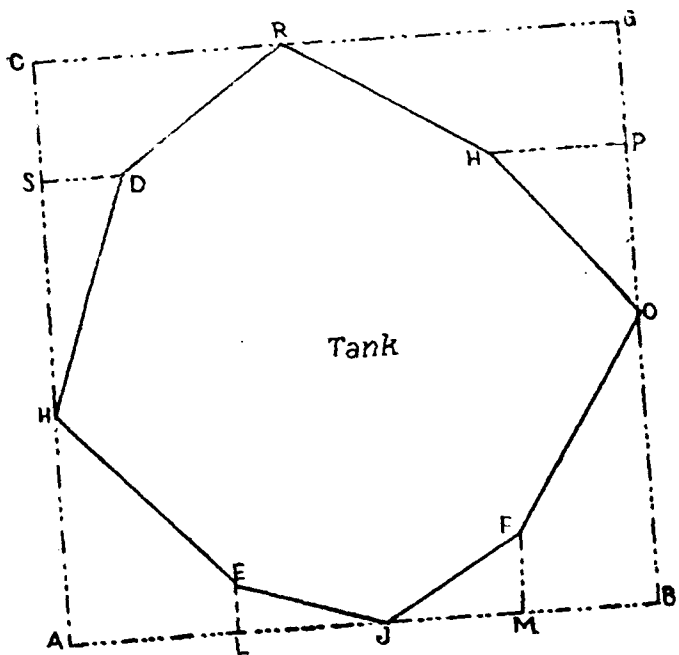


Fig. XI

Fig. XII

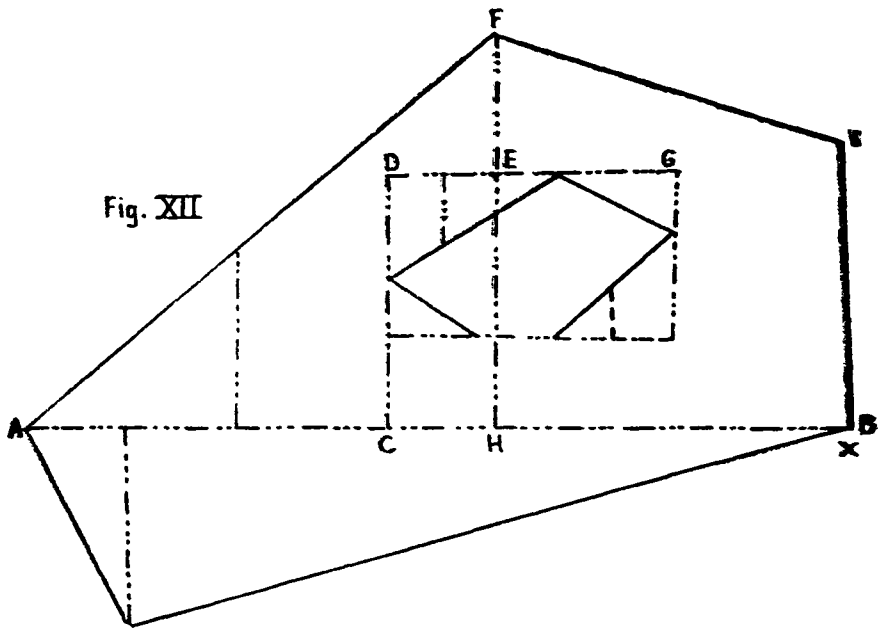
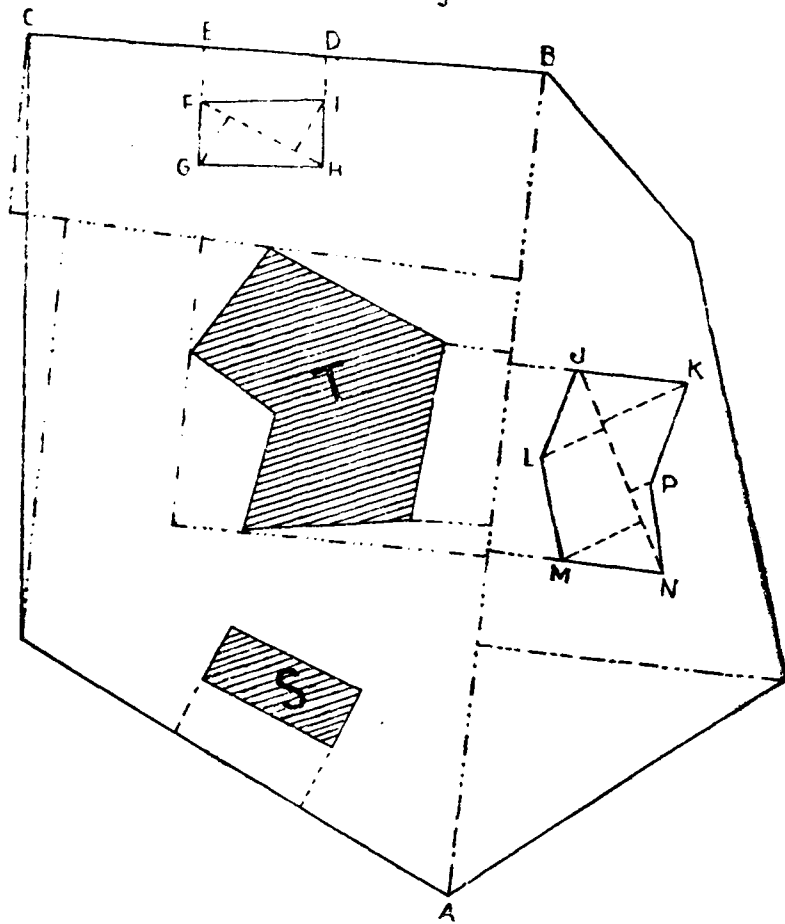


Fig XIII



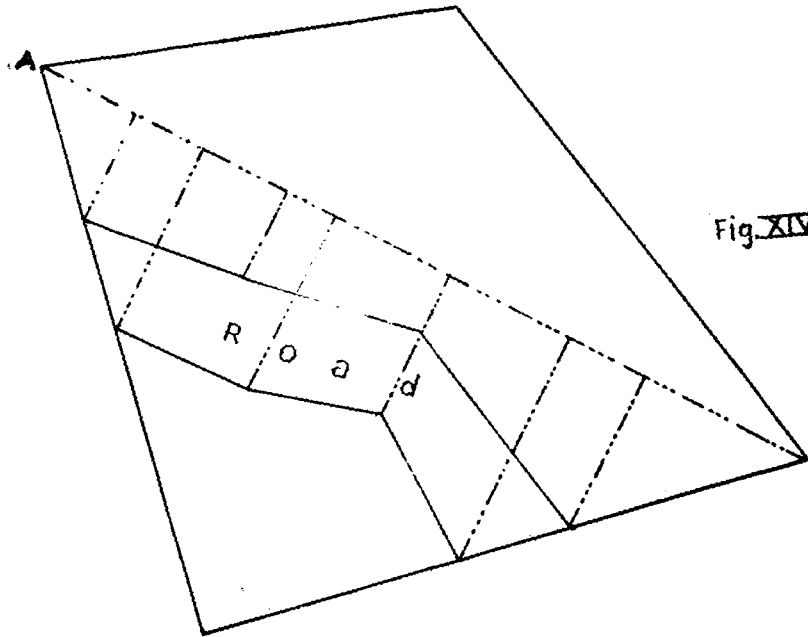


Fig. XIV

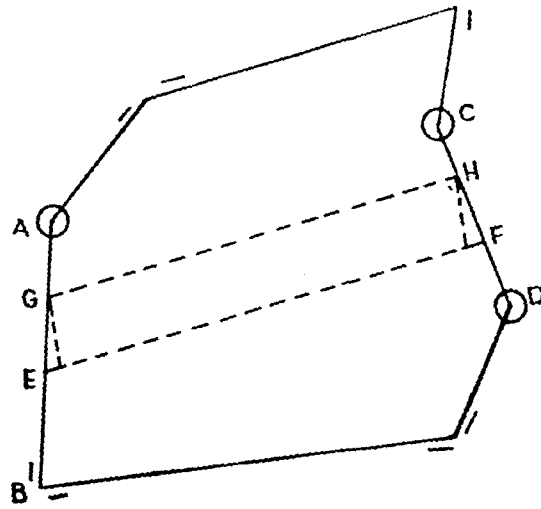


Fig. XV

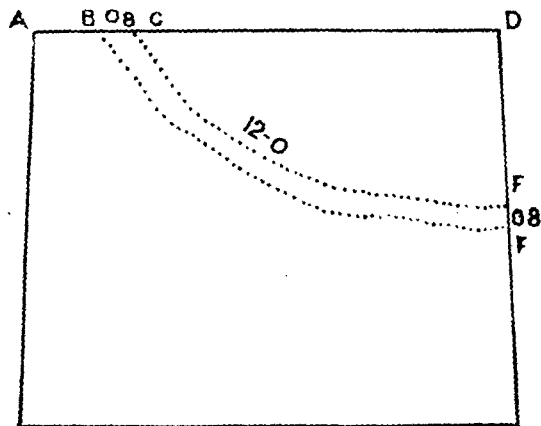


Fig. XVI

Deducting this from 160 gunthas, we get 86 gs. 9 as. 9 pr. as. Thus we require 86 gs. 9 as. 9 pr. as. to make up 4 acres. The measurement of the base line is 27 chs. 5 as. Now it is required to find out the length of the offset which would form a triangle of 86 gs. 9 as. 9 pr. as. on a base line of 27 gs. 5 as. Divide 86 gs. 9 as. 9 pr. as. by 27 ch. 5 as., the quotient is 3 chs. 2 as. 11 pr. as. This is half the length of the offset. Thus the length of the offset will be 6 chs. 5 as. 6 pr. as., *i.e.*, by *dharsod* 6 chs. 5 as. Thus if an offset of 6 chs. 5 as. is taken to a point on the boundary line DH, say at point F, the portion AEFD will measure 4 acres.

An alternative method where the dividing boundary is not required to be straight is as follows :—

Let ABCDEFG (Fig. XIX) be the plot of land containing 11 acres; it is required to take off a piece that shall contain 5 acres. Join any points such as C, F (which we may suppose to be nearly the partition line) and find the area of DEFC which, we may suppose, is less by 1 acre 25 gunthas than the area required to be cut off.

Measure the line FC which suppose to be 25 chains. Divide 1 acre 25 gunthas by $12\frac{1}{2}$ (half of FC) and the quotient $5\frac{1}{5}$ chains will be perpendicular for a triangle whose base is 25 chains and area 65 gunthas = 1 acre 25 gunthas. Draw the lines FH, HC and DEFHC will be area of 5 acres required.

If the area DEFC is found to be greater than that required to be cut off, then the triangle should be measured on the opposite side of the line FC to that shown in the sketch.

16. To find by area comb the approximate position of the boundary line which will divide off a given area from a field.—In Fig. XX, the field ABCDE, area 20 acres, is to be divided into two equal parts by straight line running approximately north and south. Draw a map of the Survey No. on a scale of 10 chains to an inch and place the area comb on the map with the threads running north and south. Starting from the side AE take the area of the field on the dividers until a line (say FG) is reached where the distance on the divider shows an area of 10 acres. Mark the points FG on the map and ascertain the distances FG and EG by scale. The points F and G can now be marked in the field and measured by offsets, the exact area of the portions AFGE and FGDC found by calculation, and then the line FG can be moved if necessary a few annas in either direction to the position at which it divides the field into two equal portions.

17. To measure over an obstacle which cannot be crossed.—It is desired to measure the breadth of the river at AB (Fig. XXI). At the point A, a perpendicular of a convenient length AC—say 2 chains—should be set out to AB. Then at half of AC, *i.e.*, 1 chain a flag should be set up at D. Then from C a perpendicular CE should be set out to AC and a point E fixed thereon in such a way that BDE are in one straight line. Then CE (5 chs.) = AB, which is the distance required.

Had the breadth at LF to be found, then the line LF would be extended to G = 2 chs. the perpendicular GH drawn and the point M found as described. Suppose HM to be 8 chs. Then HM = FG. Deduct from HM the length of LG (2 chs.) and the remainder 6 chs. is the length of FL.

18. To measure a field, a part of which having been converted to non-agricultural purposes is included in the town survey.—In case the original base line passes outside the converted portion, the boundary thus altered can be measured by simply taking offsets to the new corners on the same base line (Fig. XXII). But if the original line passes through the converted land, a fresh base line AB (Fig. XXIII) should be fixed in the unconverted land in such a way that no portion of it will be blocked up by construction of buildings in the converted portion. From this base line offsets to the corners of the agricultural land should be taken.

CHAPTER IV

THE USE OF SURVEY TIPPAN

The practical measurement work of the Revenue Inspector is concerned chiefly with areas already measured and included in Survey Nos. which have either to be sub-divided (*e.g.*, when land is acquired for a public purpose or on partition) or re-measured (*e.g.*, in the case of boundary disputes) or to which land has to be added (*e.g.*, in the case of the formation of alluvial lands on the banks of rivers or streams). Now in the case of the sub-division of or addition to Survey Nos. it is obviously necessary that the boundaries of the numbers should be known before measurement is made, otherwise the measurements of the Revenue Inspector will not correspond with those recorded in the survey records and discrepancies will arise which will have to be reconciled. In the majority of cases it is easy to recognize boundaries of Survey Nos. by the boundary marks—though even these are often wrong—but sometimes either some or all the boundary marks of a field are missing. In such cases it is necessary that the Revenue Inspector should know how to fix the missing boundaries, otherwise he will be unable to say where one Survey No. ends and another begins.

2. Again in the case of boundary disputes by the very nature of the case the Revenue Inspector must know how to fix the boundaries of the Survey No. as that is the matter in dispute.

3. Hence before proceeding further the Revenue Inspector must learn how to fix the boundaries of Survey Nos. according to the survey measurement records. These consist of—

- (a) The tippan book containing rough sketches (tippans) made in the field of each Survey No.
- (b) The plot and area (*kshetra*) book containing plots drawn to scale and area calculations and also deductions on account of pot *kharab* and the measurements of the main village base line (*adhar regh*).
- (c) The classification (*prati*) book containing the classification record of each field, together with copies of the plots and areas taken from the *kshetra* book.
- (d) The village map.
- (e) The *akarband* showing the area rate and measurement of each field.
- (f) The *faisal patrak* showing, in addition to the details of the *akarband*, the names of the occupants of each field.

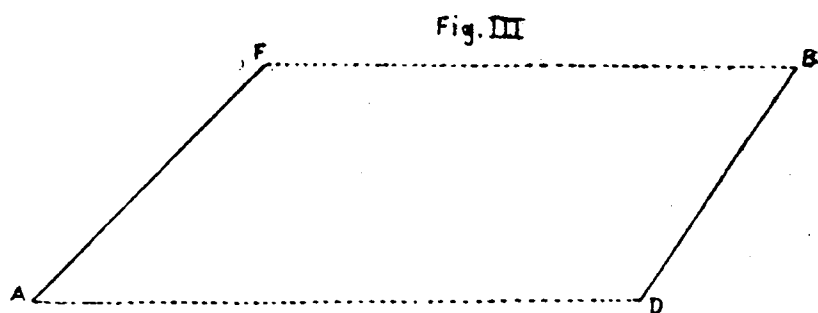
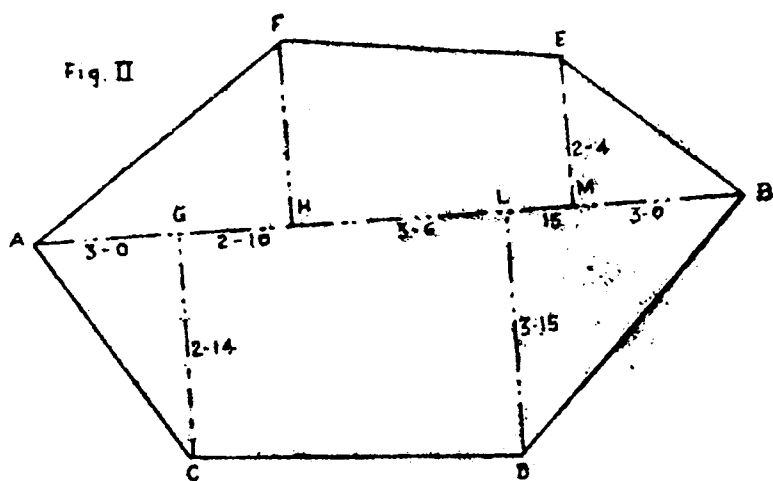
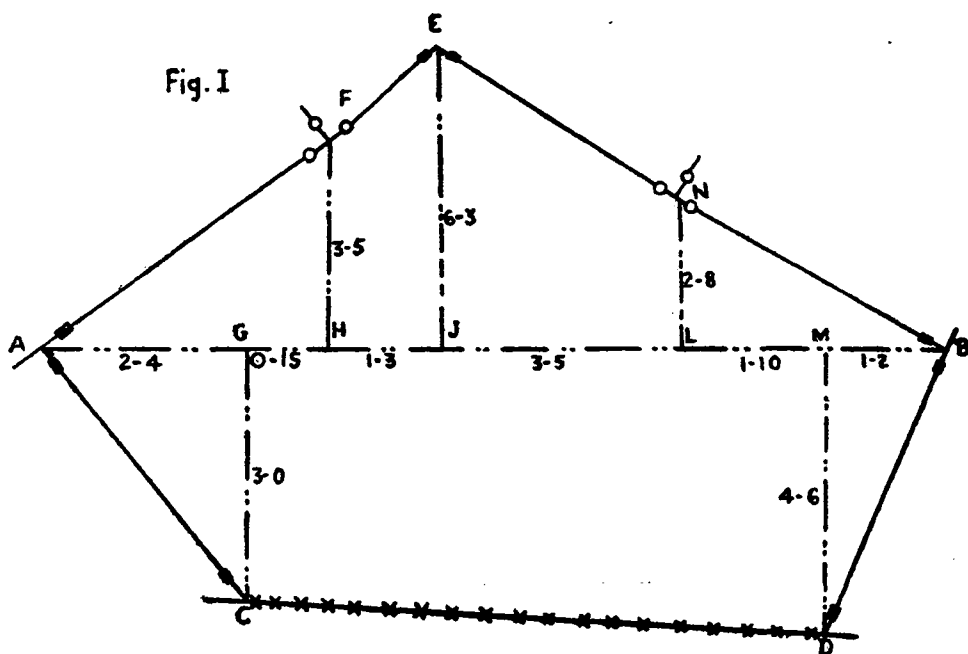
For the purpose of carrying out measurements the Revenue Inspector is supplied only with copies of tippans from the tippan book when the village map is available in the village.

NOTE.—For instructions regarding the preparation of tippan utaras, please see rule 21 in Chapter VII.

4. The *survey tippan* shows the old base lines and offsets with their measurements and Wasla Nos. and also the boundary measurements (*bandh maps*) and boundary marks and the local name of the field. The adjoining numbers, etc, are also shown and the class of the land. By means of the tippan the Revenue Inspector can compare the measurements shown therein with the condition of things existing in the field.

5. **To fix the boundaries of a field in accordance with the tippan.**—To do this, the Revenue Inspector has first to set up the old base line (or lines) at the corners or other points shown in the tippan. Then measuring along these lines he takes offsets at the distances shown therein and measures out the lengths in accordance with the tippan measurements. The points thus fixed will be the corners of the number according to the survey measurements. If the corners of the field as now in existence do not agree with those fixed in accordance with the survey measurements, then either there is encroachment or else a mistake in the original measurements.

Thus in the example given on the next page (Fig. I) the measure has to fix the boundaries of a Survey No. ACDBEF according to the measurements shown. To accomplish this he will first find in the field the two ends of the old base line AB and set up flags in the ordinary way. Then starting from A he will measure 2 chs. 4 as. to the point G and from G will lay out an offset measuring 3 chs. 0 a., thus fixing the point C according to the tippan. Similarly by measuring 0 ch. 15 as. from G to H and laying out therefrom an offset of 3 chs. 5 as. the point F will be fixed. In the same way the remaining points can also be fixed.



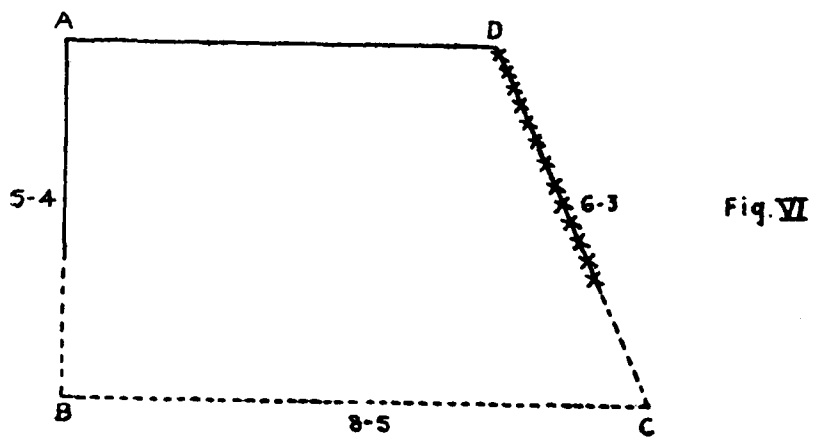
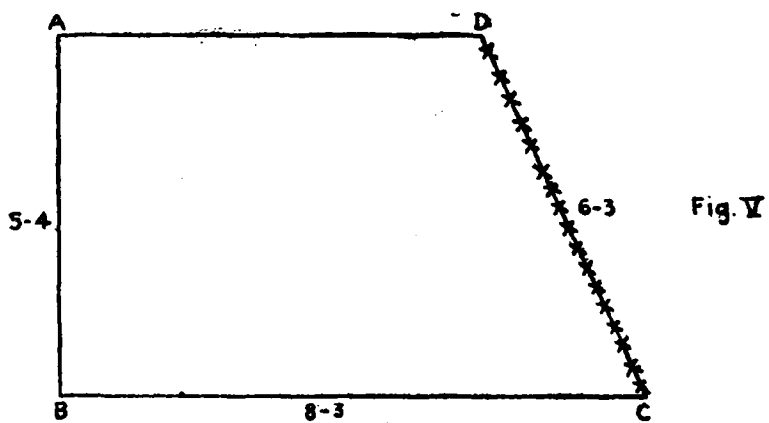
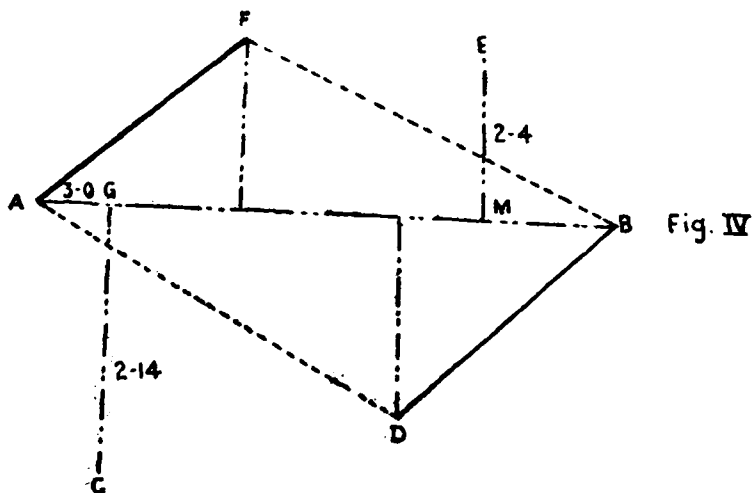


Fig. VII

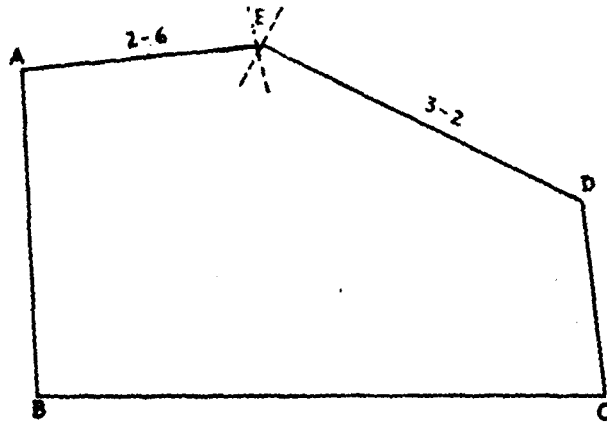


Fig. VIII

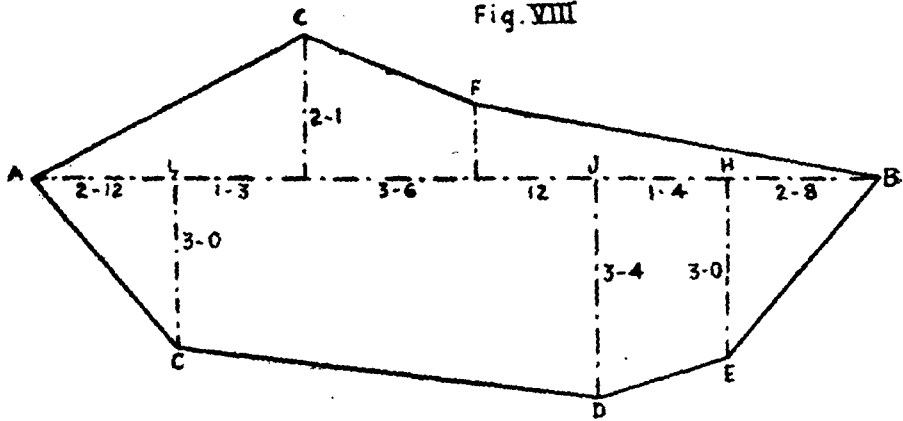
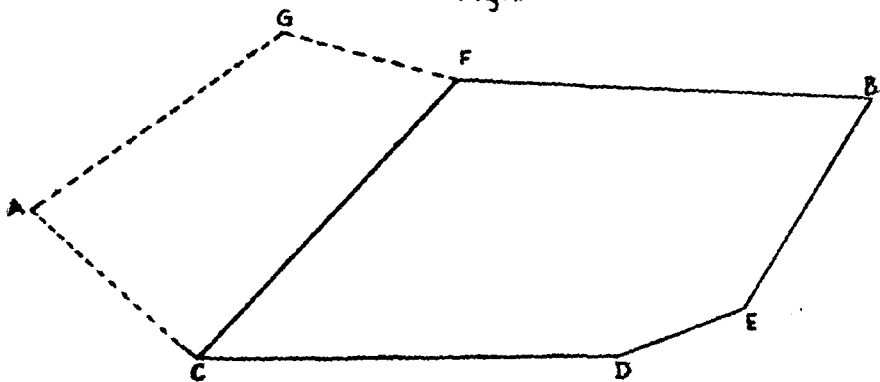


Fig. IX



6. In cases where the boundaries of the number as found in the field agree with the measurements recorded in the tippan no difficulty is experienced. This is, however, not always the case, and the following complications may arise due either to changes in the boundaries of Survey Nos. since the original measurements were made, or to the incorrectness of the original measurements themselves :—

- (a) The present position of corners may not agree with the measurements.
- (b) Owing to a similar change either one or both ends of the original base line may not be discoverable.

The method of dealing with these difficulties is illustrated by the following examples.

7. **To fix the boundary when a corner is found out of place.**—*First Example.*—The boundary according to the tippan is as shown in Fig. II, but in the field is as shown in Fig. III, *i.e.*, the corners A, D, B, F are intact, but the boundary marks at the corners C and E have disappeared.

To relay the old boundary the measurer has only to set up the old base line AB (Fig. IV). Then by starting from A and measuring 3 chs. 0 a. along AB and laying out an offset of 2 chs. 14 as. the missing point C is fixed and by fixing the point M on the base line and laying an offset of 2 chs. 4 as. the point E is fixed. At the same time, in order to verify that the base line has been correctly laid down the measurer must take offsets to the points F and D and see that the old measurements agree with those actually obtaining in the field. He must also see that the total length of the base line agrees with that shown in the tippan.

Second Example.—How to fix corners by measurements of the boundary line (*bandh maps*).

Fig. V shows the boundaries according to the tippan and Fig. VI as they exist in the field.

It may not always be necessary to fix the old base line in order to find a missing corner, *e.g.*, suppose the corners A and D are in existence, that B and C cannot be found, but that there are in the field boundary strips or hedges running in the direction of AB and DC; then the measurer has only to measure 5 chs. 4 as. from A along the strip or hedge and 6 chs. 3 as. from D and the points B and C may be taken as fixed, AD and BC being measured as a check.

Third Example.—How to fix corners by intersection (Fig. VII).

Suppose the corner E be lost. Then measuring 2 chs. 6 as. from A and 3 chs. 2 as. from D, the corner E will be found at their point of intersection.

8. **To fix the boundary when one end of base line is not in existence.**—Sometimes the old base line cannot be set up directly, as one end may have been lost owing to a change of boundary. In this case the measurer has to set it up by means of the offsets.

Thus in the example given (Figs. VIII and IX) the boundary marks at A and G are missing, but the marks at C, D, E, B and F are still intact. In this case the measurer will first fix the point H by intersection by measuring 2 chs. 8 as. from B and 3 chs. 0 a. from E and finding the point where they meet (1st stage). He will then produce the line BH (2nd stage) and if the offset therefrom at J to the point D is found to be 1 ch. 4 as. and is 3 chs. 4 as. in length he will know that he has laid down the old base line correctly and can proceed to fix the other corners of the number by producing the base line and taking offsets according to the tippan. The point A will finally be fixed by a measurement of 2 chs. 12 as. along the base line from the point L at the offset to C.

It may however be for some reason impossible to find the point A in the method just described, in which case the safest way of solving the difficulty is to obtain the tippan of the adjoining No. and fix the point from the measurements given therein. Other methods will also suggest themselves, *e.g.*, the length of FA can be found by calculation (*vide* Chapter V) and the point A fixed by the intersection of CA and FA.

In such cases the measurer must use his ingenuity to get out of his difficulties.

9. **To fix the base line when both ends of the base line are lost.**—In such cases also the Revenue Inspector has to rely more or less on his own ingenuity. Thus in the example given (Figs. XI and XII), both A and B are lost; the corners C, D, E, F and G alone remained fixed. In this case probably the simplest way of discovering the points A and B would be to make intersection of measurements (2 chs. 6 as. and 2 chs. 8 as.) from G and C to find A and (of 3 chs. 4 as. and 4 chs. 1 a.) from D and E to find B as in Fig. XIII.

Method of measurement

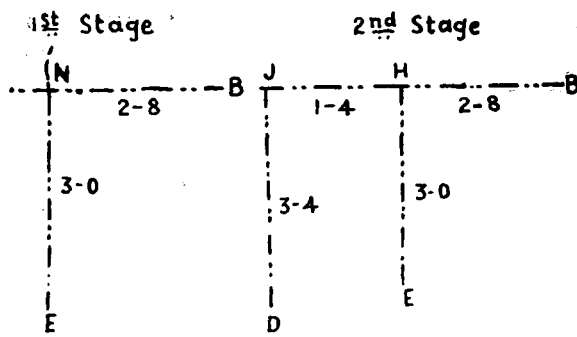


Fig. X

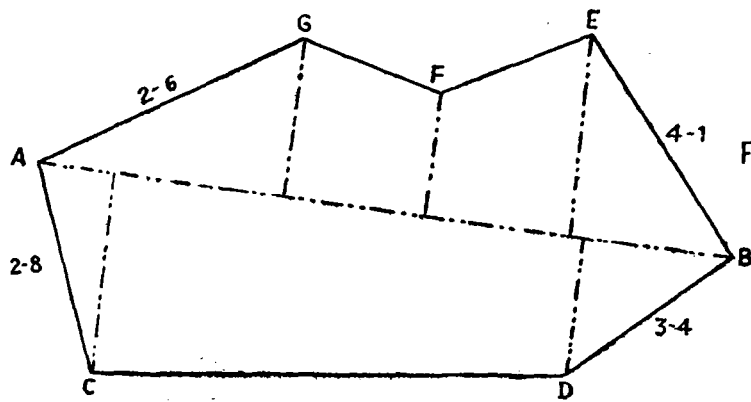


Fig. XI

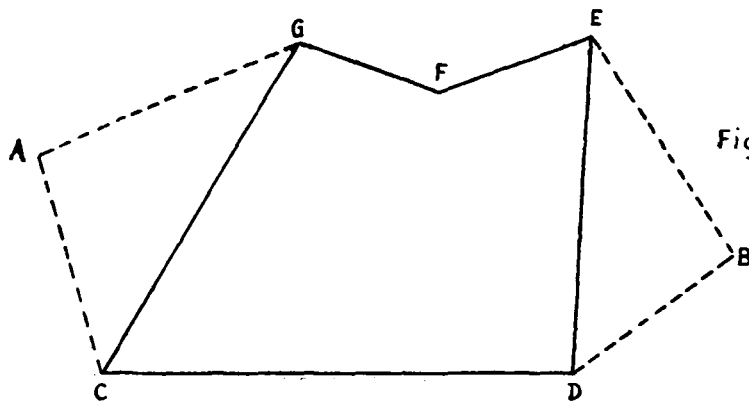


Fig. XII

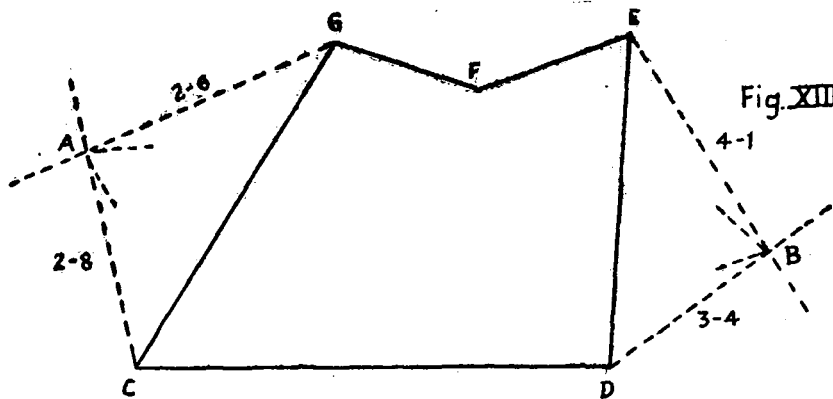


Fig. XIII

Or the tippans for the adjoining Survey Nos. may be obtained and the points fixed from these numbers.

10. To set up a base line where one end of the base line is not visible from the other although neither of them is lost.—This occurs when one or either of the flags at the two ends of the base line are in low land and high land intervenes between them. In such a case the measurer should stand at an intermediate point from which he can see the two end flags. He should then fix his cross-staff at a point in the straight line (*shista*) between the two end flags and erect a flag at this point which will be visible from either end.

11. The village map.—The village map is a survey record inasmuch as it purports to show all the Survey Nos. of a village drawn to a scale of 20 chains to an inch. Hence if it were accurate, it would be exceedingly valuable in cases where the survey record had been lost as the measurements of the numbers could be reconstituted by scale therefrom. For many reasons however the map must not be entirely relied upon and hence as to be used with great caution.

12. To use the village map as a survey record.—The village map being drawn to scale it follows that we have only to apply the scale to the figures of the numbers contained therein in order to extract the measurements. Thus in Fig. XIV which is drawn on a scale of 20 chains to the inch, by applying the scale to side AB we find that its length is 8 chains. Similarly the length of BC will be found to be 13 chs. 8 as. of DC 5 chs., of DE 11 chs. and of EG 6chs. 4as.

Again a survey tippan can be formed by drawing a base line and offsets and writing in the measurements after scaling them off. Thus in Survey No. 4 (Fig. XIV) the base line DG is drawn and offsets therefrom to the corners H, F and E. The measurement of the base lines, offsets and *bandh maps* can then at once be scaled off and a survey tippan is ready. But this method is to be used only when no other survey record is forthcoming.

13. To enlarge a number to scale from the village map.—It is occasionally found necessary to obtain a scale map on a larger scale than that of the ordinary village map and by the method illustrated in Fig. XV the necessary enlargement can be made to any scale required.

The number is first pricked off from the village map (*i.e.*, the map is laid on a clean sheet of paper and pinholes pricked on to the latter through the corners of the number in the map). These pinholes are then joined up and a duplicate of the map thus produced. Any central point is then selected and rays drawn out through the corners of the number. Lengths are then marked off thereon equal to the distance from the central point to the corners as many times as the enlargement requires. By joining up these points the enlargement required is produced.

Another method is to draw a base line and offsets inside the pricked off sketch and, then by doubling or trebling the lengths so obtained, the original can be reproduced on double or treble scale.

Fig. XIV

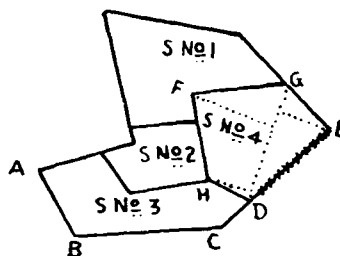
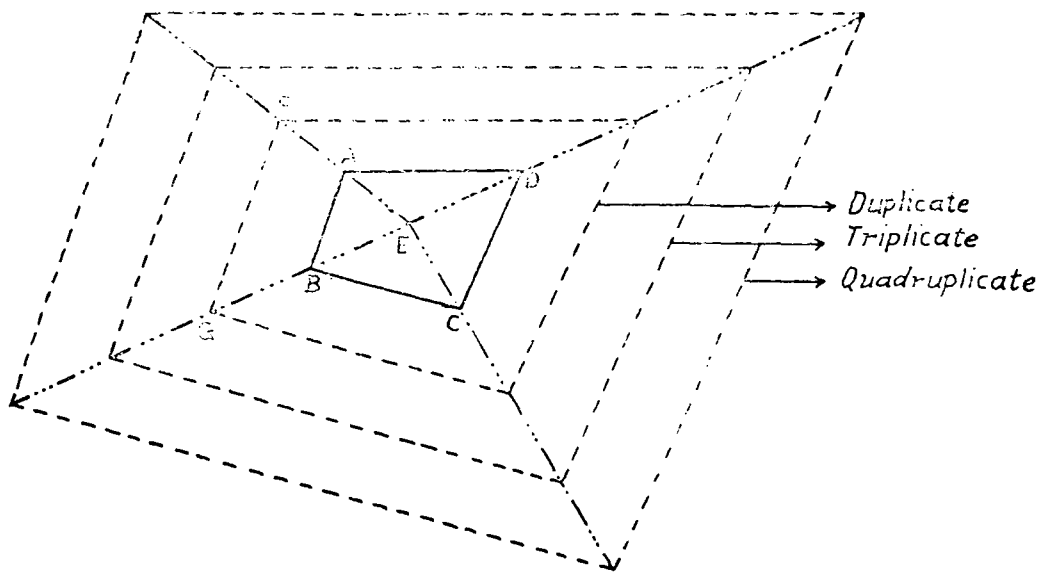
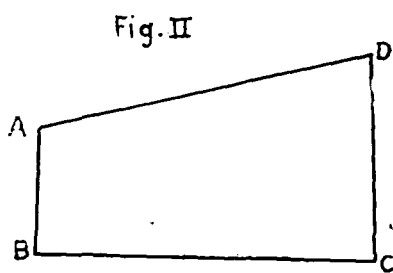
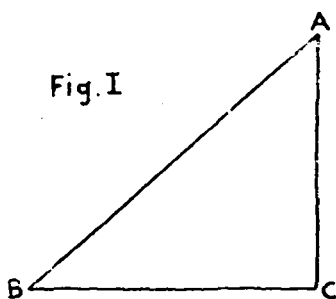


Fig. XV





Warga Mul

		Anna 1	Annas 2	Annas 3	Annas 4	Annas 5	Annas 6	Annas 7														
Chs.	Gs.	Pr.			Pr.			Pr.			Pr.			Pr.								
		Gs.	As.	as.	Gs.	As.	as.	Gs.	As.	as.	Gs.	As.	as.	Gs.	As.	as.						
..	..	0	0	0	0	0	4	0	0	8	0	1	0	0	1	8	0	2	4	0	3	0
1	1	1	2	0	1	4	4	1	6	8	1	9	0	1	11	8	1	14	4	2	1	0
2	4	4	4	0	4	8	4	4	12	8	5	1	0	5	5	8	5	10	4	5	15	0
3	9	9	6	0	9	12	4	10	2	8	10	9	0	10	15	8	11	6	4	11	13	0
4	16	16	8	0	17	0	4	17	8	8	18	1	0	18	9	8	19	2	4	19	11	0
5	25	25	10	0	26	4	4	26	14	8	27	9	0	28	3	8	28	14	4	29	9	0

This calculation proves that the measurements are correct as the length of the *bandh map* as measured in the field agrees with that found by calculation.

Similarly, after measuring the offset from F to E the measurer may compare the measurement of the *band map* and offset with that of the base according to the 2nd proposition in paragraph 1 thus—

	Gs. As.
(a) Square of <i>bandh map</i> 5 chs. 6 as. =	28 14
(b) Square of base 2 chs. 4 as. =	10 15
+ 1 ch. 1 a. = 3 chs. 5as.	17 15
Deducting (b) from (a) =	17 15
Square root of 17 gs. 15 as. = 4 chs. 4 as. = offset F.E	17 15

Hence the measurements again are proved to be correct.

On measuring up to the point D however and taking the *bandh map* (5 chs. 12 as.) to E the measurer on comparing the measurements of the base (3 chs. 0 a. + 1 ch. 6 as. = 4 chs. 6 as.) and the offset (4 chs. 4 as.) with the *bandh map* (5 chs. 12 as.) finds—

	Gs. As.
Square of base (4 chs. 6 as.) =	19 2
Square of offset (4 chs. 4 as.) =	18 1
<i>Add together</i> =	37 3

Then square root of 37 gs. 3as = 6 chs. 2 as. which should agree with the *bandh map* (5 chs. 12 as.) but does not. Hence there must be an error in measurement somewhere which the measurer can then proceed to investigate at once instead of waiting to discover it when he comes to plot the number in office, the result of which would be either a second visit to the field or else a tampering with the measurements to make them agree.

In the same way, the whole of the measurement can be compared by the measurer as he goes along, and at the end he can be certain of the absolute accuracy of his work.

3. To fix the point at which the base line cuts the boundary of the field when the ends of the boundary cannot be seen owing to an obstacle.—In Fig. IV, the points A and E are not visible from F owing to trees on the boundary and the distance GF and FH are therefore required to be found by calculation. FH is found by the following proportion sum:—

$$FH : HE :: IH : AI + HE$$

$$\text{Thus } FH = \frac{4 \text{ chs. } 0 \text{ a.} \times 18 \text{ chs. } 0 \text{ a.}}{16 \text{ chs. } 0 \text{ a.}} = 4 \text{ chs. } 8 \text{ as.}$$

and GF is found by deduction of FH from GH.

$$\text{Thus } GF = 6 \text{ chs. } 0 \text{ a.} - 4 \text{ chs. } 8 \text{ as.} = 1 \text{ ch. } 8 \text{ as.}$$

The distances AF and FE are then found from the right angled triangles AIF and FHE, and, adding these two distances together we get the total *bandh map* AE. This distance can also be determined directly by the following formula:—

$$AE = \sqrt{(AI + EH)^2 + IH^2}$$

4. To find out the exact position of a given point in the boundary line of a field when, owing to the boundary line being covered with prickly pear or other thorny trees, no measurement can be taken along the boundary line nor can one end of the boundary line be seen from the other.—In Fig. V, AB is the boundary line of the field. The position of the point C which is at the distance of 20 chains from A is to be fixed in the straight line between A and B. Take any base line AD on the side on which the land is free from jungle or any obstacle. Take an offset on this base line to the point B. E is the point from which offset is taken. Measure the length AE and EB and calculate the distance AB. The distances AF and FC then found by proportion and an offset taken from F fixes the point C.

Fig. III

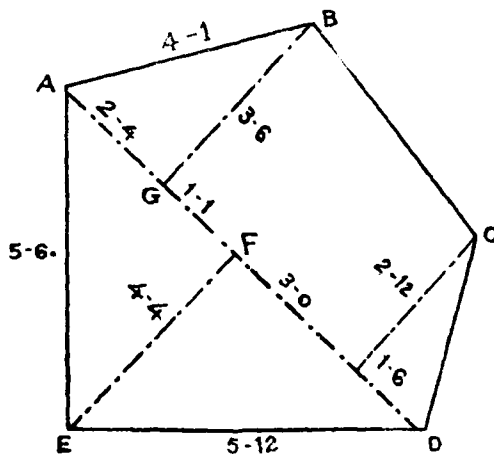


Fig. IV

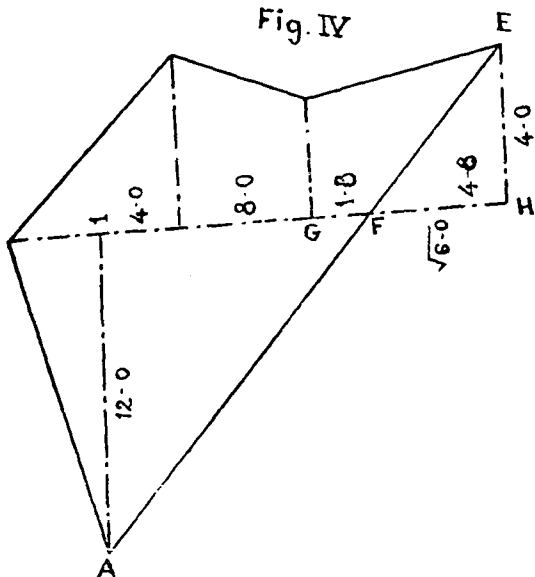


Fig. V

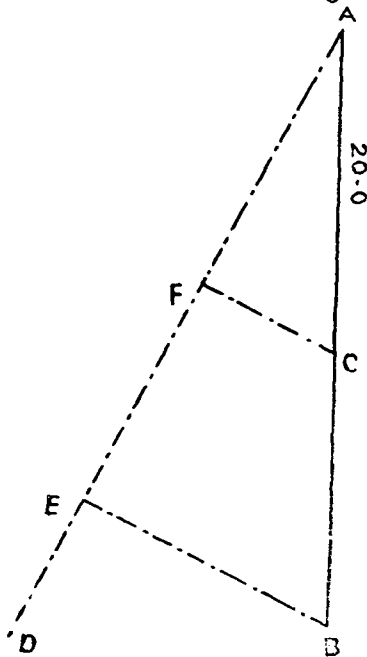
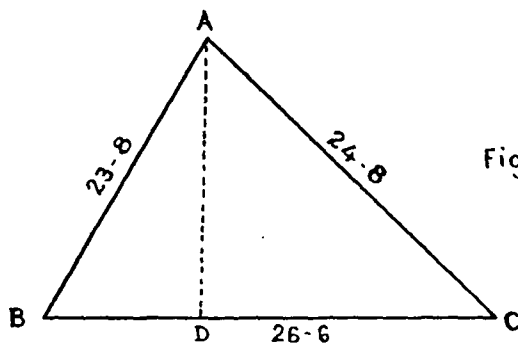


Fig. VI



5. When the measurements of the three sides of a triangle are given, to determine the point at which a perpendicular drawn from one corner cuts the base and also the length of the perpendicular.—In Fig. VI, if D be the point at which the perpendicular from A meets the base BC then the distance BD and DC are determined by the following formula:—

$$(1) \quad CD = \frac{1}{2} \left\{ BC + \frac{(AB + AC) \times (AC - AB)}{BC} \right\}$$

$$(2) \quad BD = \frac{1}{2} \left\{ BC - \frac{(AB + AC) \times (AC - AB)}{BC} \right\}$$

$$(3) \quad AD = \sqrt{AB^2 - BD^2} \quad \text{or} \quad \sqrt{AC^2 - DC^2}$$

Thus in the example given $DC = 14$ chs. 2 as. and
 $BD = 12$ chs. 4 as.

If the perpendicular falls outside the base, as in Fig. VII the same rule holds.

If the angle at A is at right angles (Fig. VII) the distances BD, DC and the length of the perpendicular AD are given by the following formula:—

$$BD = \frac{AB^2}{BC}$$

$$CD = \frac{AC^2}{BC}$$

$$AD = \frac{AB \times AC}{BC}$$

The practical use of these formulae is illustrated by the examples given in the following paragraphs.

6. To set up the base line when the boundary marks at one end are missing.—In Fig. IX, the boundary stones at A are missing. In the right angled triangle DEC, of which all the sides are known, draw a perpendicular from E to the base DC and calculate the distances DF and FC and the perpendicular EF from the formula given in the previous paragraph:—

$$\text{Thus } DF = \frac{15 \times 15}{20} = 11 \text{ chs. 4 as.}$$

$$FC = \frac{13 \text{ chs. 4 as.} \times 13 \text{ chs. 4 as.}}{20} = 8 \text{ chs. 12 as.}$$

$$EF = \frac{15 \text{ chs.} \times 13 \text{ chs. 4 as.}}{20} = 10 \text{ chs.}$$

The point E can then be fixed in the field by an offset from F and the base line set up along the line CE. The base line should then be checked by means of the offset BG.

[NOTE.—This method is alternative to that given in paragraphs 8 and 9 of Chapter IV, and is brought into use when the methods described there fail.]

7. To set up the base line when the boundary marks at both ends are missing.—In Fig. X, BD is the old base line and the boundary marks at B and D are missing. Join AC and calculate its length from the formula $AC = (AG + CH)^2 - GH^2$.

Then in the triangles ABC and ADC, of which all the sides are known, calculate the distance AE, EC, ED and AF, FC, BF.

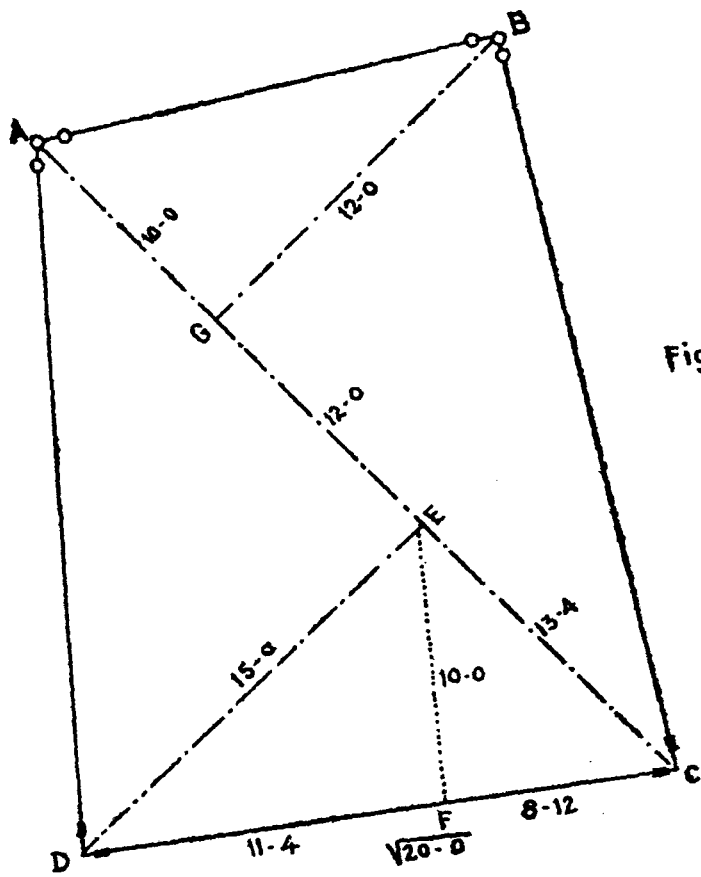
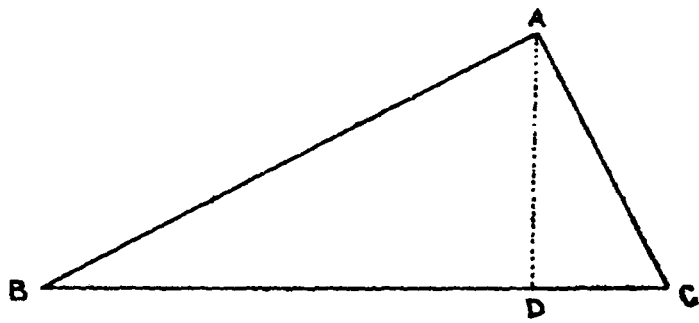
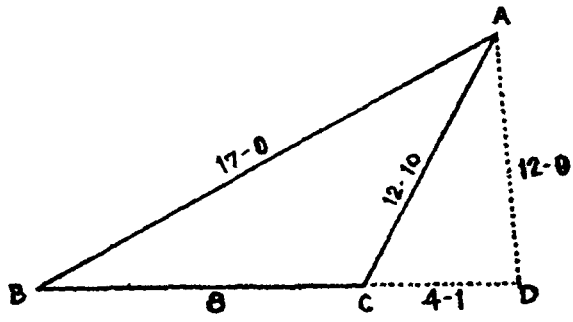
$$\text{Thus } AE = \frac{1}{2} \left\{ 22 \text{ chs. 6 as.} - \frac{(14 \text{ chs. 2 as.} + 13 \text{ chs. 7 as.}) \times (14 \text{ chs. 2 as.} - 13 \text{ chs. 7 as.})}{22 \text{ chs. 6 as.}} \right\}$$

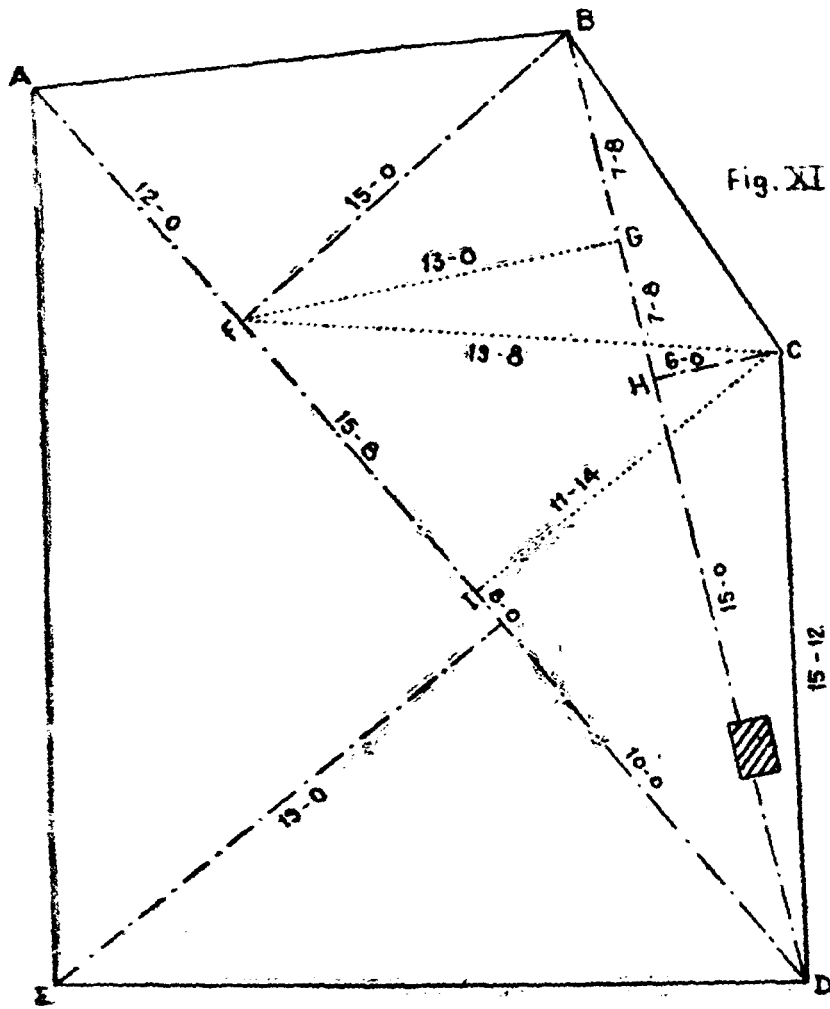
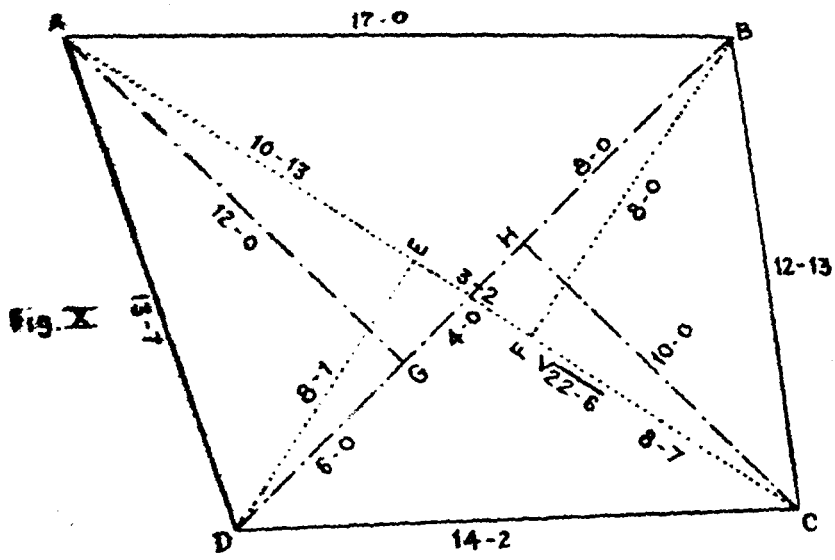
$$= 10 \text{ ch. 13 as.}$$

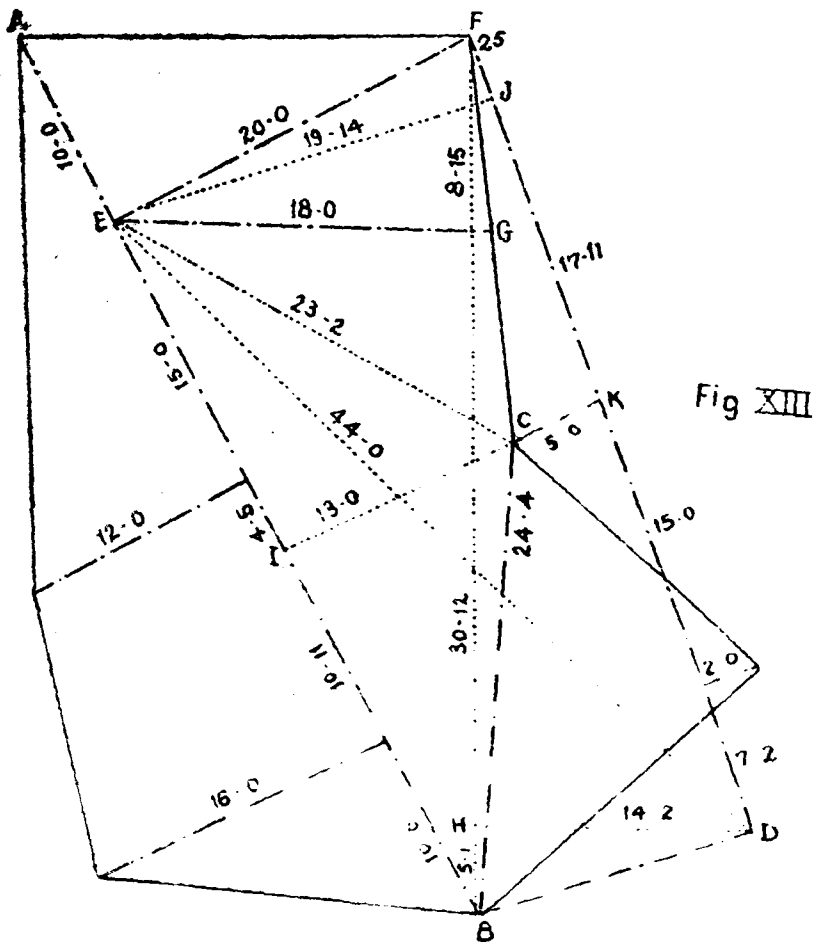
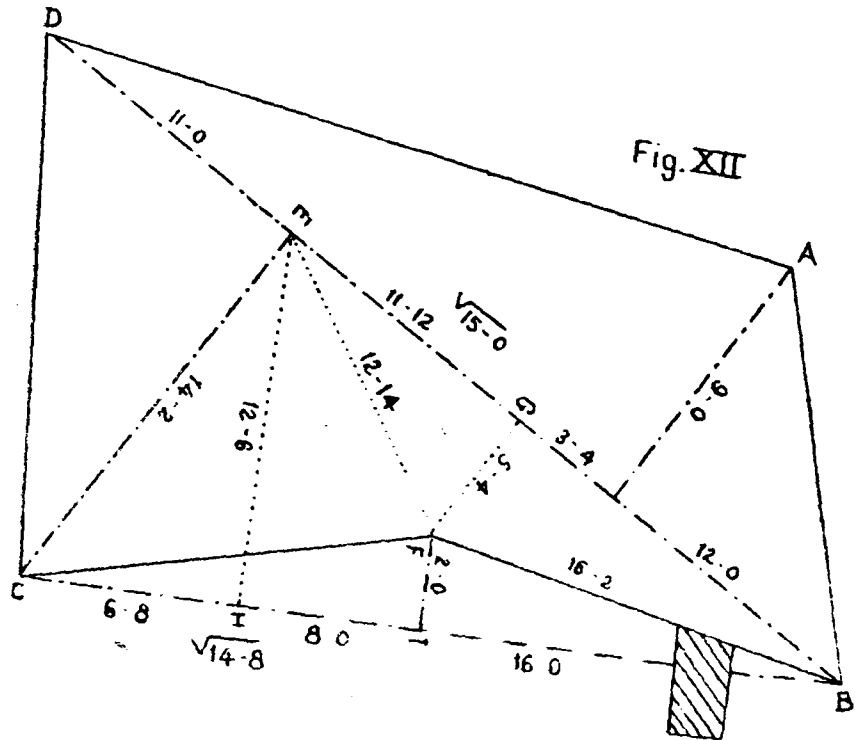
$$EC = \frac{1}{2} \left\{ 22 \text{ chs. 6 as.} + \frac{(14 \text{ chs. 2 as.} + 13 \text{ chs. 7 as.}) \times (14 \text{ chs. 2 as.} - 13 \text{ chs. 7 as.})}{22 \text{ chs. 6 as.}} \right\}$$

$$= 11 \text{ chs. 9 as. and so on.}$$

Then using AC as the base line the points B and D can be fixed by means of offsets from and F.







8. To fix the position of a point to which an offset cannot be taken owing to an obstacle in the base line or some other reason.—*Example 1.*—In Fig. XI, there is a building standing on the original base line BD which cannot therefore be set up in the field. The point C is to be determined by calculating the length of the offset CI from the new base line AD and also the distance ID. First from the right angled triangle FBD calculate the length of the perpendicular FG and the distance $GH=(BH-BG)$.

Then calculate the distance FC from the formula—

$$FC=\sqrt{(FG+CH)^2+GH^2}.$$

Then from the triangle FCD calculate the distance CI and ID which are required.

Example 2.—In Fig. XII, the original base line BC cannot be set up owing to the obstruction of a building. The point F is therefore to be determined by an offset from the base line BD.

In the right angled triangle EBC calculate the length of the perpendicular EH and the distance $HI=CI-CH$; then calculate EF from the formula $EF=\sqrt{(EH-HI)^2+IH^2}$.

Then from the triangle EBF calculate the distance BG and the offset FG.

Example 3.—In Fig. XIII, the original base line FD cannot be set up. The point C is to be determined by an offset from the base line AB. First from the right angled triangle FBE and FBD calculate the perpendiculars EG and HD and the distance $GH=FH-FG$.

Then calculate the distance ED= $\sqrt{(EG+HD)^2+GH^2}$.

Then in the triangle EDF calculate the length of the perpendicular EJ. Then the length of EC is found from the formula—

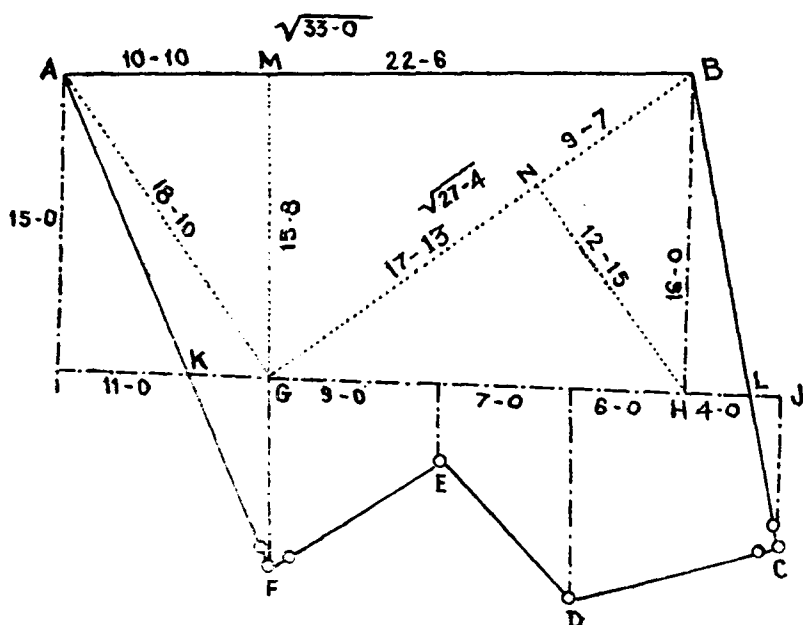
$$EC=\sqrt{(EJ-CK)^2+JK^2}.$$

Then from the triangle ECB the required distances BI and IC can be calculated.

9. To set up a base line which does not pass through a corner of the field when the boundary marks along one side of the field are missing.—In Fig. XIV the boundary marks at C, D, E and F are missing and the points K and L on the base line cannot therefore be determined in the field. Join AG and GB and calculate their lengths from the right angled triangles AGI and BGH. Then from the triangle BGA calculate the length of the perpendicular GM and the distance AM, and from the triangle BGH calculate the distance GN and the perpendicular NH.

The point G can then be fixed in the field by an offset from M and then the point H by an offset from N. The two points G and H determine the base line which should be tested by means of the offsets AI and BH.

Fig. XIV



CHAPTER VI

PLOTTING AND CALCULATION OF AREAS

Simultaneously with the training in the actual field work of measurement the Revenue Inspector must learn how to prepare the measurement record. This consists of—

- (a) The kacha tippan.
- (b) The pukka tippan or plot (*kshetra*).
- (c) The calculation of the area (*waslewar*).

2. **The kacha tippan.**—This is the rough sketch, not drawn exactly to scale, showing the measurements as recorded in the field. The form in which it is usually prepared and the details given therein are shown in Fig. I. These details comprise—

- (a) The outline of the Survey No. in unbroken lines, and base line and offsets in broken lines.
- (b) The measurements.
- (c) The Wasla Nos., *i.e.*, the numbers of the different trapezia or triangles, in red ink.
- (d) The numbers of the adjoining Survey Nos. and the direction of the boundaries between them.
- (e) The boundary marks.
- (f) The direction north is shown at the top by the letter N.

3. **The pukka tippan or plot (Fig. II).**—This contains the same details as the kacha tippan except that—

- (a) the sketch of the Survey No. is drawn to scale.
- (b) no measurements are shown except those of the *bandh maps*.

4. The village map in Berar is drawn on a scale of 20 chains to an inch, that is to say, each of the smallest divisions ($\frac{1}{20}$ inch) on the scale represents one chain (33 ft.) on the ground; but plotting work is frequently done on a scale of 10 chains to an inch in which case each of the smallest divisions on the scale represents $\frac{1}{2}$ chain, *i.e.*, 8 annas or $16\frac{1}{2}$ feet. Small fields are sometimes plotted on a scale of 5 chains to an inch, that is to say, each of the smallest division on the scale represents $\frac{1}{4}$ chain or four annas ($8\frac{1}{4}$ feet).

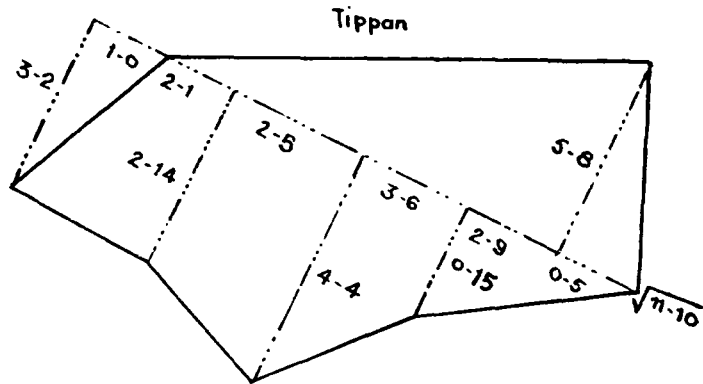
5. **To plot a number on one base line—**

- (a) First any broken line of sufficient length is drawn to represent the base line. It should be drawn so that the north side of the field comes at top of the page.
- (b) Next, starting from one end of the base line, the distance to each of the offsets is taken off the scale with the compasses and laid down on the base line. In order to check the correctness of the work the total length of the base line should be taken off the scale and compared with the sum of the lengths of the bases of the waslas. The total should be noted in the tippan just at the end of the base line as shown in Fig. III.
- (c) Next, the offsets should be plotted in. Great care should be taken in laying off the right angles for the offsets. By means of the graduations on either side of the offset scale this can be done. Thus in Fig. IV, if an offset is to be drawn from a point G in the base line AB the offset scale is laid across the base line at the point G so that corresponding graduations on either side (No. 2 in the figure) exactly cover the base line, and the offset is then drawn from G along the offset scale.

For this purpose it is essential that the offset scale should be accurately made so that corresponding graduations on either side are exactly opposite one another; otherwise an accurate right angle will not be obtained.

- (d) In order to check the correctness of the offsets plotted the measurements of the *bandh maps* should be scaled off.
- (e) Lastly the boundaries of the number should be drawn in.
- (f) After looking the pencil work over carefully the whole should be inked in, the base line and offsets being shown in broken, and the boundaries in unbroken, lines.
- (g) The Wasla Nos. should be then written in red ink, the measurements of the *bandh maps* only shown thereon and the other details added as given in paragraph 3.

Fig. III



Kshetra
Scale of 5 chains

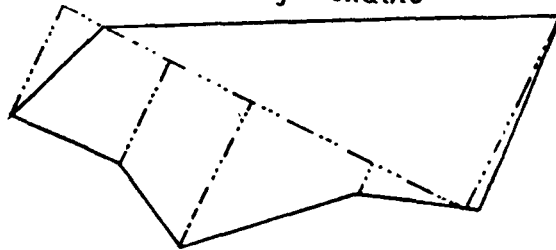


Fig. IV

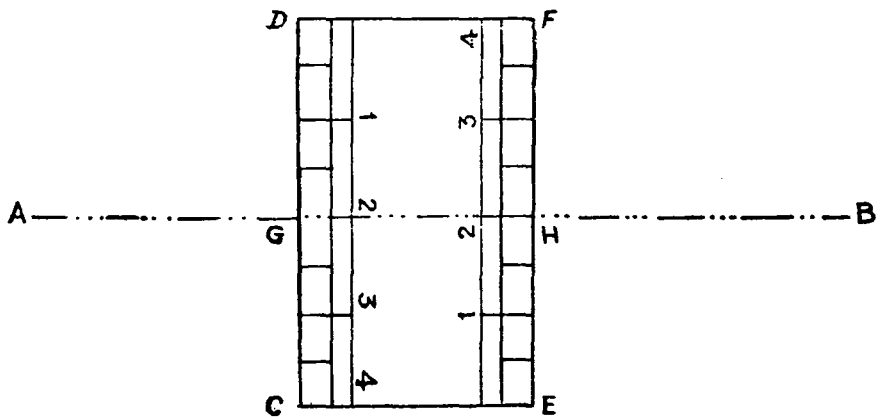
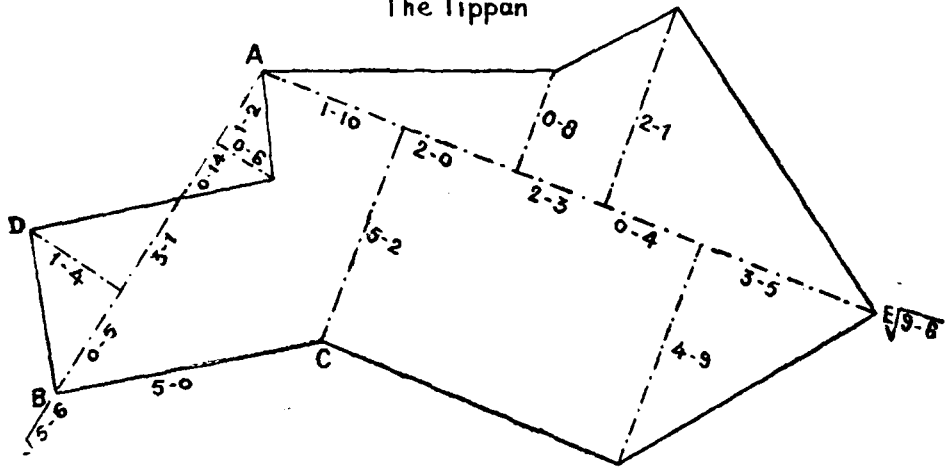
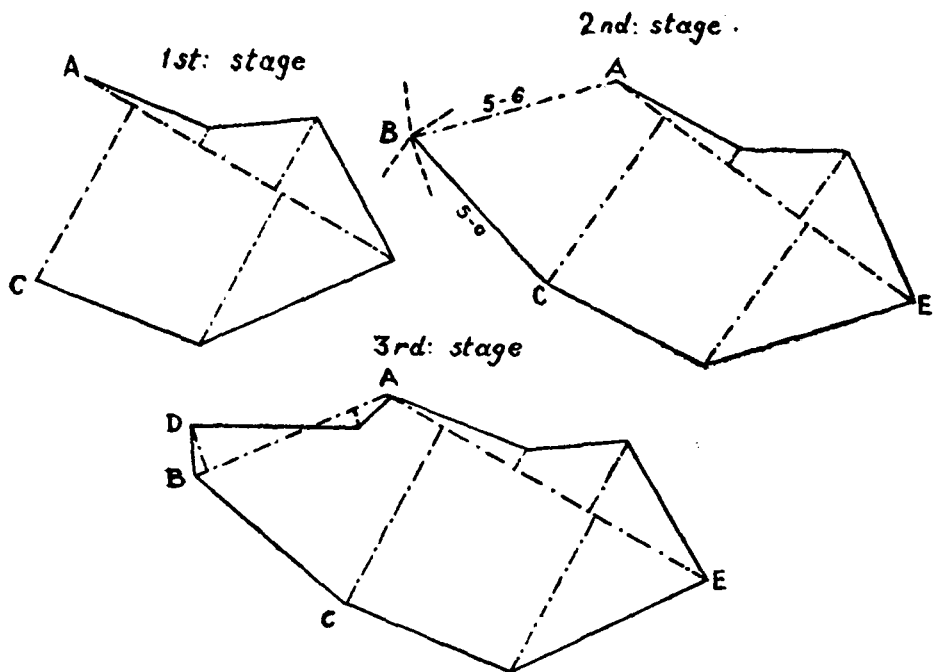


Fig. V
The Tippan



The Kshetra
Scale of 5 Chains to 1 Inch.



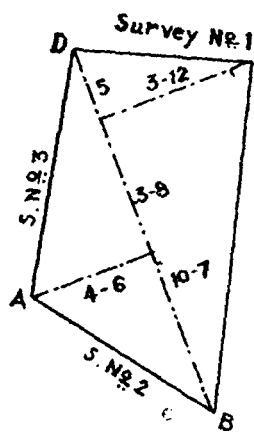
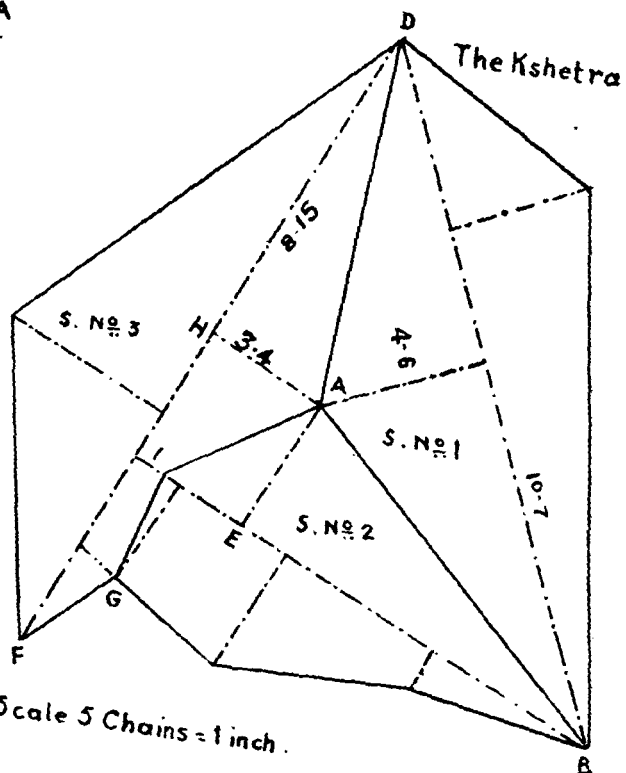
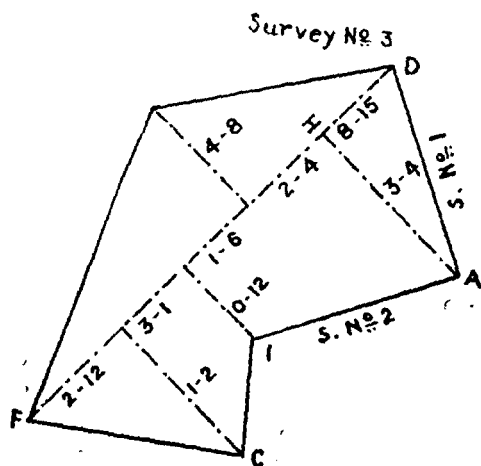
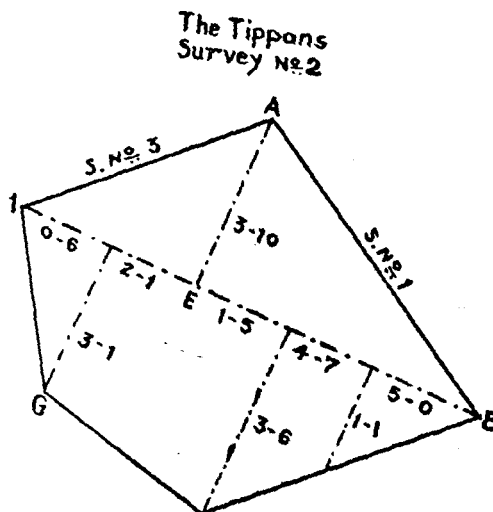


Fig. VI



Scale 5 Chains = 1 inch.

6. **To plot a survey number on two base lines.**—When a number has been measured on two base lines both cannot be laid down *direct* on the plotting paper as they are independent of one another. In Fig. V the base line AE would first be laid down and the offsets plotted from it (1st stage). Thus the points A and C will be fixed. These points being fixed the point B can then be fixed by intersection of the lines CB and AB taken off by scale (2nd stage). AB is then joined and forms the second base from which the remaining offsets can be plotted (3rd stage).

[NOTE.—The point of intersection (B) is the point where arcs drawn by the compasses with A and C as centres and 5 chs. 6 as. and 5 chs. 0 a. as radii, respectively, intersect.]

7. **To plot together two or more Survey Nos. measured on individual base lines.**—Occasionally it is found necessary to make a consolidated map of two or more numbers, *e. g.*, as in the village maps. When they have all been measured on the same base line, plotting can be done in the ordinary way, but when the base lines are independent the method of intersection has to be employed, *e. g.*, say the three numbers shown on the opposite page are to be plotted together. Then—

- (a) first plot Survey No. 1 (Fig. VI);
- (b) then from the points A and B fix the point E by the intersection of the two lines AE, BE;
- (c) the base line BEI, of Survey No. 2, can then be drawn and the number plotted upon it; and
- (d) in order to plot Survey No. 3 the point H must be fixed by intersection of the lines DH, AH. The base line DHF can then be drawn through the point H, and the number plotted upon it.

8. A consolidated map of more than 10 Survey Nos. cannot be drawn accurately unless a base line is taken from one extremity of the block of fields to the other. Thus at the commencement of the original survey of a village a single base line is laid down and measured from one extremity of the village boundary to the other in order to ensure accuracy in the village map. This base line is called the *adhar regh*.

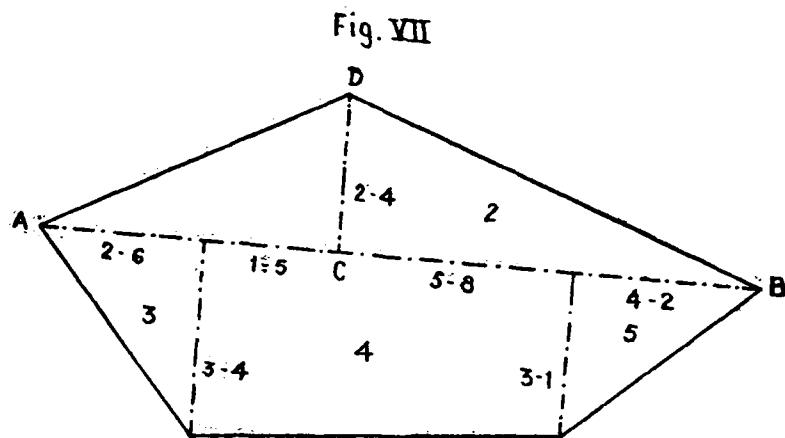
Area calculation of Fig. VII

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Prati as.
1	△	2·6 1·5	3·11	2·4	2·4	1·2	4	2	6
2	△	5·8 4·2	9·10	2·4	2·4	1·2	10	13	4
3	△	2·6	2·6	3·4	3·4	1·10	3	13	12
4	□	1·5 5·8	6·13	3·4 3·1	6·5	3·2½	21	8	½
5	△	4·2	4·2	3·1	3·1	1·8½	6	5	1
Total ..							46	10	7½
<i>i.e.</i> , 1 acre 7 gunthas.									

NOTE.—Wasla Nos. 1 and 2 can also be taken as one Wasla, taking AB as length and CD as offset.

9. Calculation of areas—

- (a) The general method of calculating areas has already been explained in Chapter I. To recapitulate shortly, in order to find the area of a simple field it is only necessary to find the areas of the trapezia and triangles composing it by multiplying the base by half the perpendicular in the case of triangles, and by half the sum of the perpendiculars in the case of trapezia, and to add up to the totals.
- (b) In working out the total area of the Waslas, areas over 8 prati annas are counted as 1 anna, and 8 prati annas or under are discarded.
- (c) In making out the final area of the number, areas over 8 annas are counted as 1 guntha, and 8 annas or under are discarded.
- (d) On the opposite page is shown the method of working out the area of the field of which Fig. VII below is the tippan.



Example 1

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Prati as.
1	△	1-4 } 3-2 }	4-6	0-12	0-12	0-6	1	10	4
2	□	0-8 } 1-1 } 1-1 }	1-9	0-12 } 1-2 } 2-12 }	1-14	0-15	1	7	7
3	□	2-0 }	3-1	4-2 }	6-14	3-7	10	8	7
4	△	0-14 } 4-2 }	5-0	4-2	4-2	2-1	10	5	0
5	△	4-2 } 0-14 }	4-2	1-14	1-14	0-15	3	13	14
6	□	2-0 } 1-1 } 0-8 }	7-9	1-14 } 3-8 }	5-6	2-11	20	5	3
7	△	3-2 } 1-4 }	1-4	3-8	3-8	1-12	2	3	0
							50	5	3
				<i>Deduct</i>					
8	□	1-1	1-1	2-12 } 1-2 }	3-14	1-15	2	0	15
					<i>Balance</i>		48	4	4

i.e., 1 acre 8 gunthas.

Example 2

1	□	0-12 } 1-4 }	2-0	1-2 } 2-4 }	3-6	1-11	3	6	0
2	□	3-4 } 5-2 }	8-6	2-4 } 4-4 }	6-8	3-4	27	3	8
3	△	2-4 } 2-4 }	2-4	4-4	4-4	2-2	4	12	8
4	△	5-2 } 3-4 } 1-4 }	11-14	3-2	3-2	1-9	18	8	14
							53	14	14
				<i>Deduct</i>					
1	△	0-12	0-12	1-2	1-2	0-9	0	6	12
					<i>Balance</i>		53	8	2

i.e., 1 acre 13 gunthas.

Example 3.

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Prati as.
1	□	0.8	16.15	5.0	10.8	5.4	88	14	12
		16.7		5.8					
2	□	3.12	3.12	5.8	11.8	5.12	21	9	0
			6.0						
3	△	0.4	0.4	6.0	6.0	3.0	0	12	0
4	□	0.4	21.11	5.0	11.4	5.10	121	15	14
		0.4							
		3.12							
		16.7							
		0.8							
		0.8							
Total ..							233	3	10
<i>Deduct</i>									
1	△	0.8	1.0	6.4	6.4	3.2	3	2	0
		0.8							
2	△	0.8	0.8	5.0	5.0	2.8	1	4	0
3	△	0.4	0.4	5.0	5.0	2.8	0	10	0
Balance ..							228	3	10

i.e., 5 acres 28 gunthas.

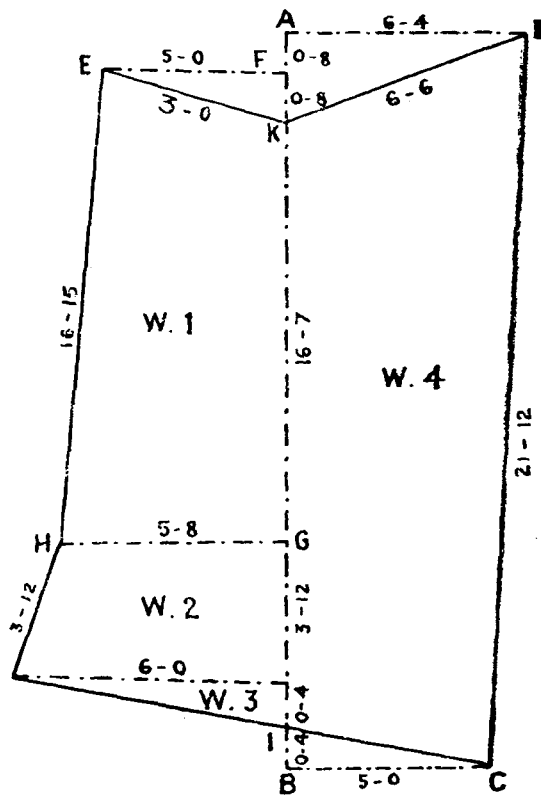
Example 3

In Fig. X, Wasla No. 1, EFGH, includes the triangle EFK which does not form part of the survey number.

Similarly Wasla No. 4, ABCD, includes the triangles DAK and CBI which do not form part of the survey number.

These three triangles therefore form wazai waslas which must be deducted from the total area of the waslas.

Fig X



Example 4

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Prati as.
1	△	1-0	1-0	5-5	5-5	2-10½	2	10	8
2	□	2-10	2-10	5-5	15-7	7-11½	20	4	3
3	△	3-0	5-0	10-2					
4	△	2-0		2-0	0-9	0-9	0-4½	0	9
5	□	2-4	2-4	0-9	1-5	0-10½	1	7	10
6	□	3-0	3-0	0-12					
7	□	3-8	3-8	1-0	2-2	1-1	3	11	8
8	△	8-12	8-12	1-2					
9	△	12-3	16-11	10-2	10-2	5-1	84	7	11
10	△	3-0							
11	□	1-8	1-8	3-0	12-12	6-6	19	2	0
12	△	3-0	3-0	9-12					
		2-10	15-13	9-12	9-12	4-14	77	1	6
		1-0							
Total ..							220	6	10
<i>Deduct</i>									
1	△	4-12	4-12	0-5	0-5	0-2½	0	11	14
2	□	1-8	1-8	0-5	0-11	0-5½	0	8	4
3	□	1-4	1-4	0-6					
4	△	11-1	11-1	0-4	0-4	0-2	1	6	2
5	△	0-8	3-8	0-6	0-6	0-3	0	10	8
		3-0							
Balance ..							216	11	10
<i>i.e., 5 acres 17 gunthas.</i>									

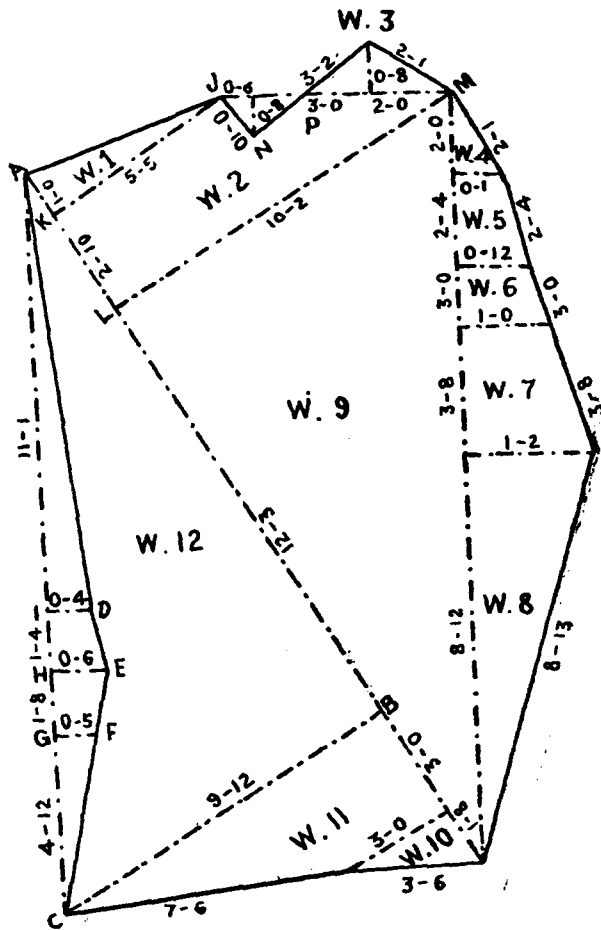
Example 4

In Fig. XI, the field has been measured on four separate base lines.
 Wasla No. 12, ABC, includes the area ADEFC which does not form part of the survey number.

Similarly Wasla No. 2, JKLM, includes the area JNP which does not form part of the survey number.

The area ADEFC forming four wazai waslas and the area JNP forming a fifth wazai wasla are to be deducted from the total area of the waslas.

Fig. XI



Example 5

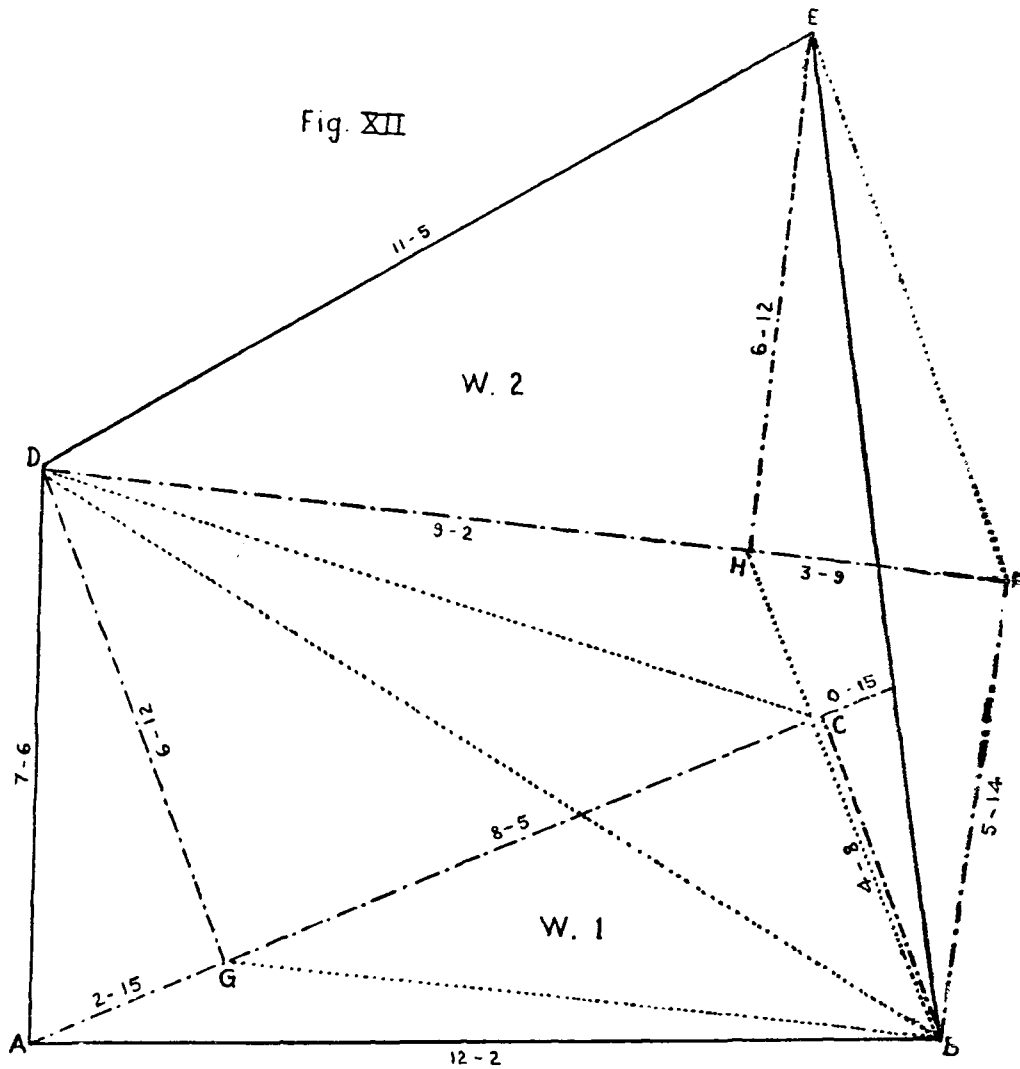
Number of Wasla	Kind of Wasla	Base		Offset			Area			
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Prati as.	
1	□	2.15 8.5	11.4	6.12 4.8	11.4	5.10	63	4	8	
2	□	9.2 3.9	12.11	6.12 5.14	12.10	6.5	80	1	7	
Total							..	143	5	15
				<i>Deduct</i>						
1	△	3.9	3.9	5.14	5.14	2.15	10	7	7	
2	△	8.5	8.5	4.8	4.8	2.4	18	11	4	
Balance							..	114	3	4

i.e., 2 acres 34 gunthas.

Example 5

In Fig. XII, Wasla No. 2, BDEF, includes the area BCD which has already been included in Wasla No. 1, ABCD, and also includes the area BFE which does not form part of the survey number.

The triangles BCD and BEF therefore form wazai waslas which are to be deducted from the total area of waslas 1 and 2. The area of BDC is equal to that of BGC as they stand on the same base and between the same parallels. Similarly the area of BFE equals that of BFH.



Example 6

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Prati as.
1	△	7-0	17-10	3-2	3-2	1-9	27	8	10
		1-12							
		8-14							
2	△	7-0	7-0	11-12	11-12	5-14	41	2	0
3	□	1-12	10-10	11-12	12-9	6-4½	66	11	13
		8-14		0-13					
4	△	8-2	8-2	3-13	3-13	1-14½	15	7	13
5	△	2-10	13-4	3-6	3-6	1-11	22	5	12
		4-12							
		5-14							
Total ..							173	4	0
				<i>Deduct</i>					
1	△	5-14	5-14	2-6	2-6	1-3	6	15	10
2	□	4-12	4-12	2-6	4-11	2-5½	11	2	2
				2-5					
3	□	2-10	2-10	2-5	5-11	2-13½	7	7	7
				3-6					
4	△	6-12	14-14	1-4	1-4	0-10	9	4	12
		8-2							
5	△	8-2	14-14	3-13	3-13	1-14½	28	5	11
		6-12							
6	△	8-14	8-14	0-13	0-13	0-6½	3	9	11
							66	13	5
Remainder ..							106	6	11

i.e., 2 acres 26 gunthas.

Example 7

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Pratis.
1	△	3.12 5.11 10.5	19.12	7.4	7.4	3.10	71	9	8
2	△	5.14 13.1	18.15	4.6	4.6	2.3	41	6	13
3	□	10.5	10.5	2.14 10.8	13.6	6.11	68	15	7
4	□	2.13	2.13	7.4 3.2	10.6	5.3	14	9	7
5	□	5.5	5.5	3.2 3.12	6.14	3.7	18	4	3
6	△	2.8	2.8	3.12	3.12	1.14	4	11	0
7	△	5.11 3.12	9.7	10.8	10.8	5.4	49	8	12
Total ..							269	1	2
<i>Deduct</i>									
1	△	2.13 5.5 2.8	10.10	7.4	7.4	3.10	38	8	4
2	△	10.5 5.11	16.0	2.14	2.14	1.7	23	0	0
Balance							207	8	14
<i>i.e., 5 acres 8 gunthas.</i>									

Example 7

Number of Wasla	Kind of Wasla	Base		Offset			Area		
		Lengths	Sum of the lengths	Offsets	Sum of the offsets	Half the sum of the offsets	Gunthas	As.	Pratis.
1	△	3-12 5-11 10-5	19-12	7-4	7-4	3-10	71	9	8
2	△	5-14 13-1	18-15	4-6	4-6	2-3	41	6	13
3	□	10-5	10-5	2-14 10-8	13-6	6-11	68	15	7
4	□	2-13	2-13	7-4 3-2	10-6	5-3	14	9	7
5	□	5-5	5-5	3-2 3-12	6-14	3-7	18	4	3
6	△	2-8	2-8	3-12	3-12	1-14	4	11	0
7	△	5-11 3-12	9-7	10-8	10-8	5-4	49	8	12
Total ..							269	1	2
<i>Deduct</i>									
1	△	2-13 5-5 2-8	10-10	7-4	7-4	3-10	38	8	4
2	△	10-5 5-11	16-0	2-14	2-14	1-7	23	0	0
Balance							61	8	4
Balance							207	8	14
<i>i.e., 5 acres 8 gunthas.</i>									

Example 7

In Fig. XIV, Wasla No. 1, CAB, includes area GFB which does not form part of the survey number.

Wasla No. 2, AHE, includes the area AFGD which has already been included in Wasla No. 1.

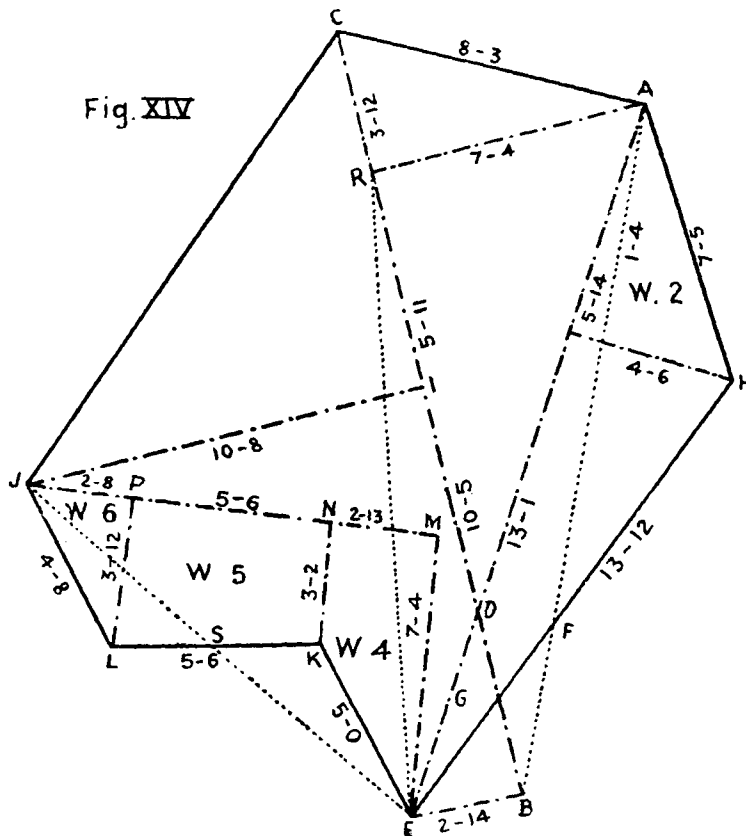
Wasla No. 3, IBEJ, includes the area DGE which has already been taken in Wasla No. 2, and the areas GBE and SKE which do not form part of the field.

Wasla Nos. 4, 5 and 6, EMNK, KNPL and LPJ, respectively, are redundant except the triangle JSL.

The following wazai waslas are therefore to be deducted from the total area of Waslas 1—7:—

(1) JME.

$$(2) \left\{ \begin{array}{l} \text{AFGD} \\ \text{GFB} \\ \text{GBE} \\ \text{DGE} \end{array} \right\} = \text{ABE} = \text{RBE}.$$



CHAPTER VII

SUB-DIVISION MEASUREMENT

The chain and cross-staff or optical square system is the foundation of all measurement work and every measurer must receive a thorough training therein. But, for the purpose of measuring sub-divisions formed within survey numbers by private partition or otherwise, there is an alternative method, *viz.*, the boundary measurement or *bandh map* system. In this system measurement along the boundaries of the field takes the place of measurement along base lines and offsets for the determination of the sub-division boundaries, while the area comb takes the place of the *waslewar* calculation for finding the sub-division areas. This method is quicker than measurement by chain and cross-staff and is sufficiently accurate for practical purposes. Hence it is to be employed in sub-division measurement work whenever the circumstances of the case permit.

2. The principle of the system may best be explained by an illustration.

Figure I is the tippan of Survey No. ABCD which the occupant have divided into two shares. The position of the boundary EF between the two shares and the area of each share are to be found. Under the chain and cross-staff system, offsets would be taken from the base line AC to the points E and F and the area of each sub-division worked out from the *waslas*. Under the *bandh map* system, the measurer simply measures the distance along the boundary from A to E and E to B and then from D to F and F to C. He then draws a plot to scale and ascertains the area of each sub-division (AEFD and EBCF) by area comb.

In taking *bandh maps* there are three important principles which must be rigidly observed—

- (i) *Bandh maps* may be taken only along a straight line between two survey boundary marks which are clearly standing in their proper place, or have previously been fixed by chain and cross-staff.
- (ii) The flag marking the end of the sub-division boundary (E) must be placed exactly on the straight line between the boundary corner flags (A and B)—and the chain must be drawn along the straight line as explained in Chapter II, paragraph 3.
- (iii) The complete distance from one boundary mark (A) to the other (B) must be chained and not only one portion of the boundary (AE or BE) and the total *bandh map* must agree with that shown in the survey tippan.

The procedure to be adopted for the measurement of sub-divisions is described in detail below.

3. The survey tippans of the survey numbers containing sub-divisions are to be copied on the left hand side of the Record-of-Rights tippan book, and on the right hand side an approximate sketch of the survey number in which will be shown the sub-division boundaries in red ink, and all new measurements taken in order to fix these boundaries.

NOTE.—The measurer must take the tippan book itself with him into the field and not merely a rough pencil sketch, and all measurements must be recorded at the time they are taken, on the sketch of the survey number which is drawn on the right hand side of the tippan book.

4. In the field the measurer will first go round the boundaries and see that the boundary marks are intact. At the same time he will ascertain the position of the sub-division boundary, and observe whether there are any bends in it.

NOTES.—(i) The boundaries of sub-divisions are to be taken according to the line of cultivation as visible in the field and pointed out by the occupants. For this purpose it is necessary that the occupants of all sub-divisions should be present in the field during measurement. The names of the occupants or their representatives present at the time of measurement should be written at the top of the right hand page of the tippan book.

(ii) When the line of actual cultivation is not clear, the boundary agreed on by the occupants on the either side should be taken. In cases where dispute arises the following procedure should be adopted:—

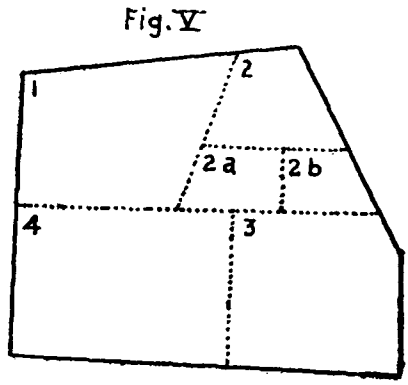
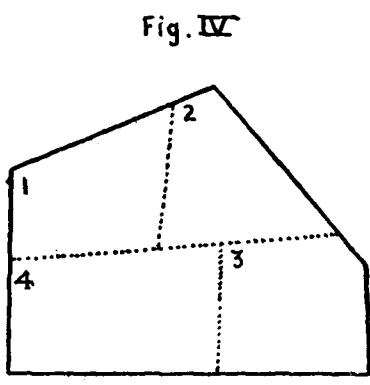
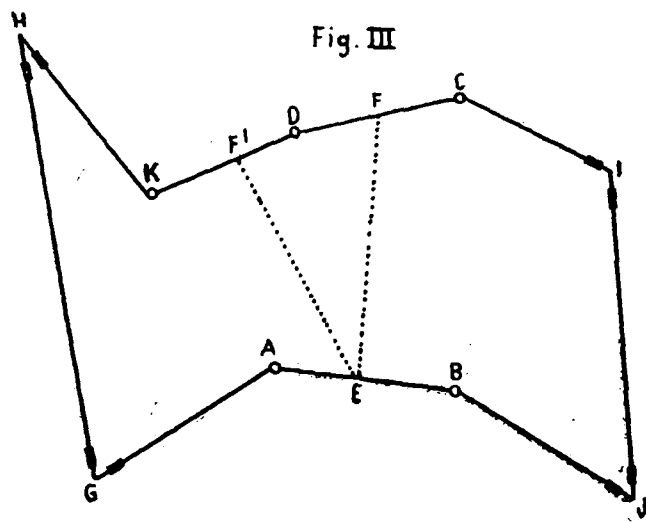
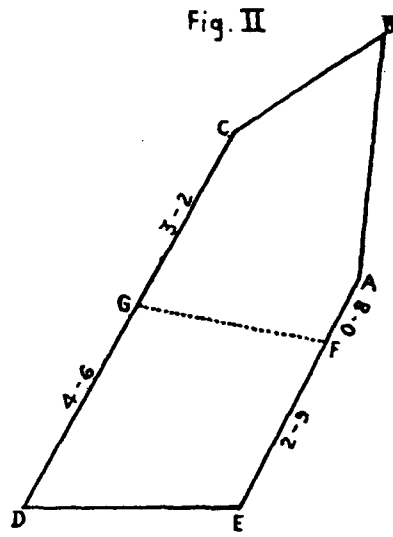
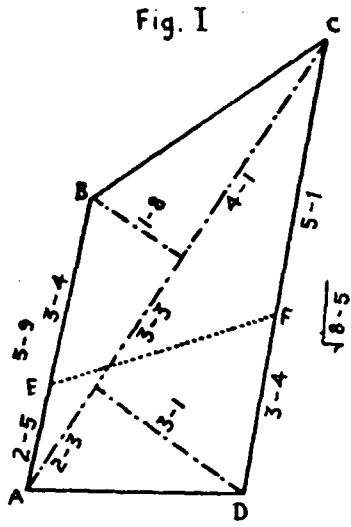
(a) Where the boundary line of present cultivation is obvious or is admitted by the occupants, this should be taken.

(b) Where the position of the boundary of present cultivation is disputed it should be decided with the aid of the village panch and the sub-divisions measured accordingly.

(iii) In cases where the positions of the boundary claimed by the parties on either side to be correct are more than 8 annas apart, the boundary claimed by each should be ascertained by measurement and a separate tippan should be prepared, showing the boundary according to each party, and should be sent to the Tahsildar, together with a note explaining clearly each party's claims.

For the purpose of calculating the area, the boundary of actual cultivation visible in the field or settled by the aid of the panch, as the case may be, should be adopted.

(iv) Where occupants who have been cultivating jointly wish to have the land divided in proportion to their respective shares, they should be informed that they should get the field divided themselves, if necessary, with the aid of the Civil Court, and that when the partition has been entered in the Mutation Register the sub-divisions will be measured by the measurer, and similarly in the case of occupants who are cultivating separately, but wish their land to be re-partitioned.



5. Having fixed the position of the sub-division boundaries, the measurer will then place flags at two corners (A and B in Fig. I) and a third flag at the end of the sub-division boundary E in a straight line between the flags at A and B. Starting from A he will then take measurements from A to E and E to B and see that the total agrees with the *bandh map* shown in the survey tippan. He will then measure in the same way the distances DF and FC.

NOTES.—(i) When the boundary marks of the survey number are intact, it is not necessary to fix them by taking offsets from the base line unless there is a discrepancy between the *bandh map* found by measurement and that shown in the survey tippan in which case the old base line must be set up and the marks properly fixed.

(ii) When some of the boundary marks are missing or out of place those necessary for measuring the sub-division must be fixed from the survey tippan. For example, in Fig. II if any of the marks A, E, D or C are missing they must be fixed before the *bandh maps* AF, FE, etc., can be taken. But if only the mark B which is on the bank of a nalla is missing there is no need to fix it as it is not used in the measurement of the sub-divisions.

(iii) When the points from which *bandh maps* are to be taken, are marked by boundary stones, these stones must first be tested by measurement from a corner marked by earthen boundary marks or else by offset from the base line. For instance in Fig. III the points A and B must be tested by the measurements JB and GA before the sub-division boundary E is fixed by *bandh maps* from A to B.

6. The measurements required to fix the sub-division boundary are to be entered in the sketch on the right hand side of the tippan book and the boundary between the sub-divisions is drawn in red ink. Where there are numerous bends in the boundary of the survey number the measurer must take care not to mark the sub-division boundary in the wrong side, for instance, at F' in Fig. III.

The boundary marks and the numbers of adjoining survey numbers should be shown in the tippan book, also plots, wells, kothas and all valuable trees.

7. The measurer will then, in the sketch on the right hand side of the tippan book, assign a separate serial number to each sub-division in the north-west corner in order from west to east and north to south (*vide* Fig. IV) and underneath will record in tabular form the sub-division number area, serial entry in Mutation Register and name of occupant.

Where a pre-existing sub-division has been sub-divided the new sub-divisions should be distinguished by letters, *e.g.*, sub-division No. 2a, 2b, etc. (*vide* Fig. V). When two sub-divisions are amalgamated owing to their coming into the possession of one occupant, the new sub-division so formed will be given the number of the sub-division held by the occupant who acquired the other sub-division. Thus in a survey number containing 6 sub-divisions, if the occupant of sub-division 5 acquires the adjoining sub-division 2, the resulting combined sub-division is given the number 5, while, if the occupant of sub-division 2 acquires sub-division 5 the combined sub-division is given the number 2. In either case the numbers of the other sub-divisions (1, 3, 4 and 6) will remain unchanged. Where all the sub-divisions in a survey number come into the possession of one occupant the sub-divisions will be cancelled, but the map will not be removed from the plot book.

NOTE.—When measuring new sub-divisions in fields which were previously sub-divided the measurer should always prepare a new sketch of the survey number on the right hand side of the tippan book and record the new measurements therein.

8. On return from the field the measurer will prepare a map drawn to scale of each survey number newly sub-divided with its sub-divisions on a separate sheet of paper 12" × 9". The map will show—

- (i) In broken black lines the survey base lines and offsets, if any.
- (ii) The figures of all measurements both old and new.
- (iii) In black ink the boundaries of the survey number and in red ink* the boundaries of sub-divisions.

Where sub-divisions previously existed it will be sufficient to insert the new sub-division boundaries and such measurements as were necessary to determine them into the old plot of the survey number and its sub-divisions. All corrections will be made by crossing out the previous lines. Erasures must on no account be made on these maps. If the changes are complicated, the map should be re-drawn.

*In the diagrams red lines are represented by a dotted line thus,

Fig. VI

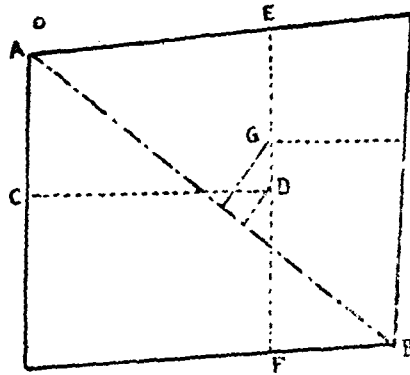


Fig. VII

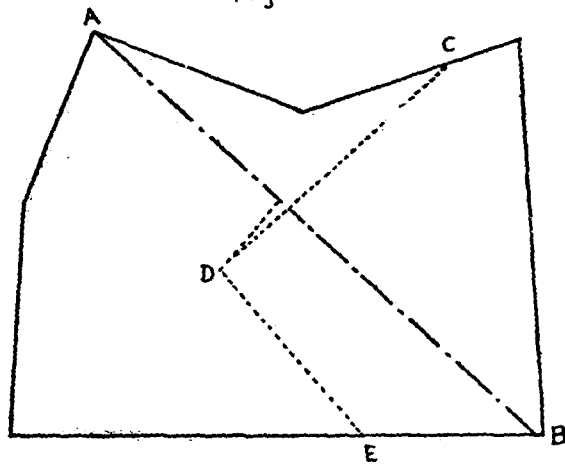
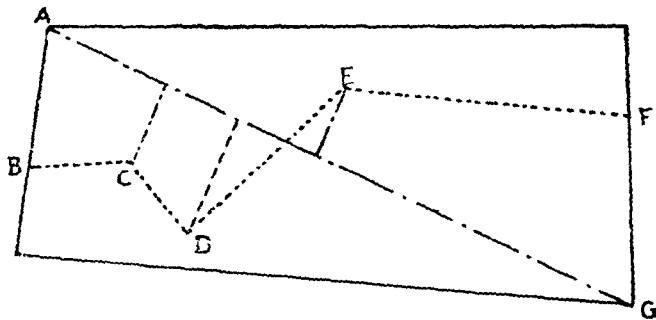


Fig. VIII



The following set of scales will be used for the maps :—

<i>Area of survey number</i>	<i>Scale</i>
5 acres and above	10 chains to an inch.
1 to 5 acres	5 „ „
Below 1 acre	2½ „ „

The scale used should be shown at the foot of each map, which should be signed by the measurer.

9. The measurer will then ascertain the area of the sub-divisions by area comb. For this purpose it is essential that the maps should be accurately drawn. If the sum of the areas of sub-divisions differs from that of the survey number by more than 2 per cent, the old calculation should be checked and if, after correction of any mistakes detected, the difference still exceeds 2 per cent, the map must be re-drawn. When the difference is less than 2 per cent, it should be distributed amongst the several sub-divisions in proportion to the area of each, so that the sum of the areas of the sub-divisions exactly equals the area of the whole survey number.

10. When all the new sub-divisions in a village have been measured the new survey numbers (if any) and sub-divisions should be entered in the index to the tippan book which is maintained in the following form :—

Page of tippan book	Survey No.	No. of sub-divisions	Remarks
(1)	(2)	(3)	(4)

11. Where sub-division boundaries intersect at points lying in the interior of the survey number the points of intersection must be fixed by offsets from the base line. Thus in Fig. VI the points D and G are to be fixed by taking an offset on the old base line AB and not by taking *bandh maps* along the line EF.

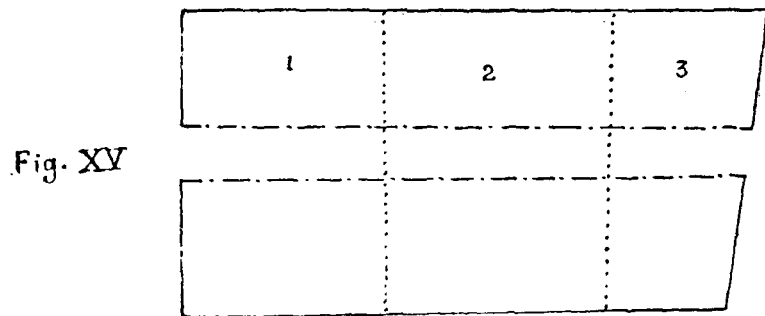
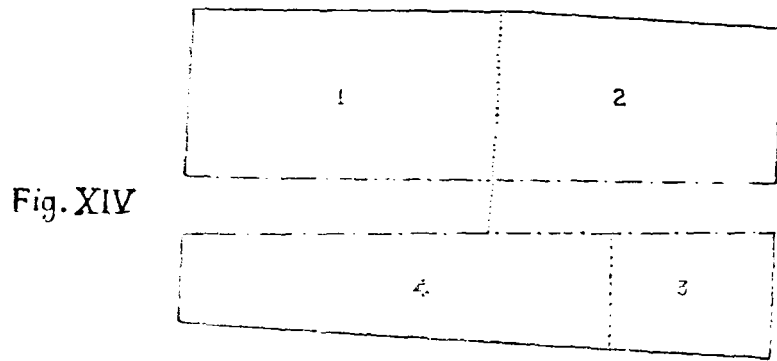
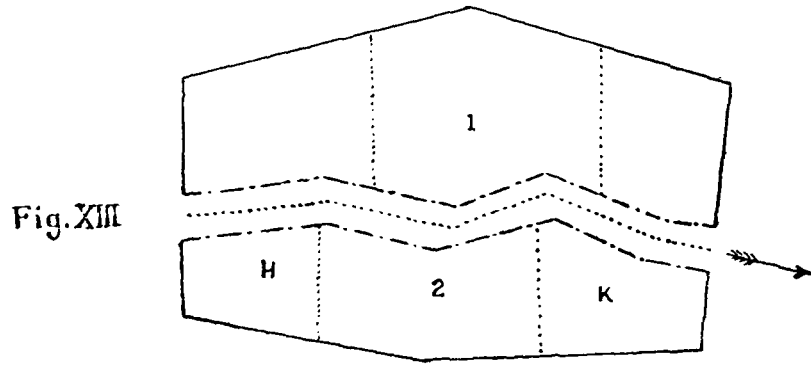
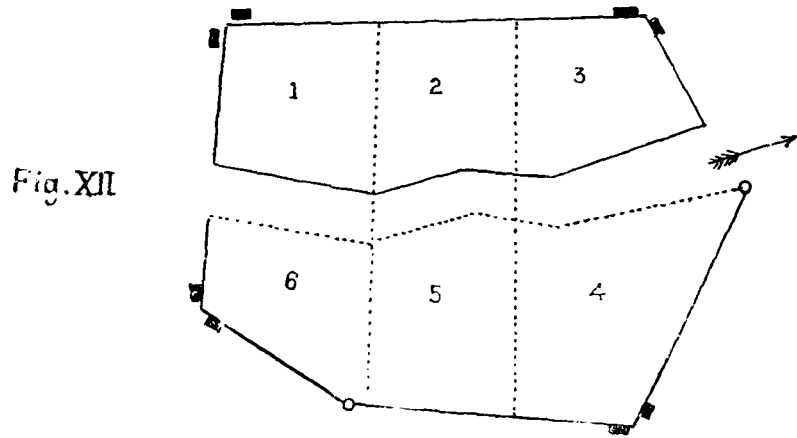
12. Where there are bends in a sub-division boundary it is necessary to fix a base line and determine the position of all the bends by offsets (*Vide* Figs. VII and VIII).

As a rule the old survey base line should be utilized for the new offsets, but a new base line may be taken in the following cases :—

- (i) When the old base line does not pass through any corners of the field, for example, in Fig. IX.
- (ii) When there are serious obstacles which make it difficult to set up the old base line.
- (iii) When the old base line would necessitate taking offsets of more than 10 chains in length.

The new base line should, however, always be chosen so that its measurements can be verified from old survey measurements by calculation. For instance, in Fig. IX the line DC is suitable for the new base line as its length can be verified by calculation from the measurements of DI, CH and HI recorded in the old survey tippan.

13. In some cases it is quicker to fix the sub-divisions by offset than by *bandh map*. In the field shown in Fig. X where there are numerous bends in the sides from which the sub-division boundaries start, the boundary stones will require to be tested by offsets from the base lines IJ and KL and the position of the sub-division boundaries can most conveniently be fixed at the same time by offsets from these base lines.



20. Checking work during the rains.—The *Barsat Tapasni* will be carried out at District Headquarters under the supervision and check of the Assistant Superintendent of Land Records and will consist of the following items :—

- (i) Verification of maps and areas.
- (ii) Preparation of *gat* maps, *i.e.*, maps drawn to scale showing only the boundaries of the survey numbers and sub-divisions. These *gat* maps are kept by the patwari and supplement the village map.
- (iii) Correction of mistakes in the survey records.
- (iv) Preparation of *tippans* and maps for the next field season's work.

The map of each survey number and its sub-divisions will be examined in detail. The length of every base line and offset and also the right angles will be verified and the area of each sub-division checked by area comb, differences of less than 2 per cent being ignored.

The work of one measurer will be examined by another measurer and corrected where necessary and initialled by the verifying measurer, who will affix his signature in the *tippan* book below each survey number verified by him. If the map contains mistakes, or erasures, it should be re-drawn.

Gat maps will be drawn on the same size papers as that used for the plot, *viz.*, 12" × 9" and will show only the boundaries of the survey number and sub-divisions, but no base lines offsets or measurements and will be picked off from the survey number plots. Not more than 2 survey numbers should be drawn on one sheet, and the scale should be shown on each sheet. The new plots and *gat* maps should be inserted in the plot books and patwaris' *gat* books, respectively, in their proper places in serial order. *Gat* maps should show all boundary marks, numbers of adjoining survey numbers and sub-divisions and topographical features, such as trees and wells. The scale of work will be as follows :—

- | | | |
|---|---------|--------------------------|
| (1) Cross checking | | 20 sub-divisions a day. |
| (2) Preparation of <i>gat</i> maps for patwaris | | 50 sub-divisions a day. |
| (3) Comparing of <i>gat</i> maps by checking measurements on the plots by scale and dividers. | | Do. |
| (4) Correction of record-of-rights, <i>tippans</i> and plots.. | | 20 sub-divisions a day. |
| (5) Preparation of <i>tippan utaras</i> | | 15 survey numbers a day. |
| (6) Verification of <i>tippan utaras</i> | | 20 survey numbers a day. |
| (7) Plots of numbers containing new sub-divisions to be measured in the coming season. | | 7 plots a day. |

21. Preparation of *tippan utaras*.—The rules now require that a copy of all measurements of a survey number shall be given to an applicant whether he asks for all or only a part.

In the survey numbers containing sub-divisions the measurements are contained in two separate records, the revenue survey *tippan* books and the record-of-rights *tippan* books.

For preparing a copy the general rule is that the measurements from both records are to be recorded in a single *tippan*, the original survey measurements being shown in *black*, and sub-division measurements in *red*. There is usually no difficulty in doing this where sub-divisions have been measured on a *bandh map*. Where, however, there are a number of sub-divisions or the measurements are so many or so complicated that they cannot be combined without confusion, separate *tippans* should be prepared on the same sheet.

In preparing all *tippan utaras* the following instructions must be strictly observed :—

- (1) All *tippans* must face north unless the width of the survey number from east to west is so great that it cannot be got on the paper.
- (2) The outline of the number should be drawn, not from the *tippan* books but from the plot or map so as to make the *tippan* represent roughly the actual shape of the field. Slight bends may be exaggerated in order to give room for the measurement.
- (3) All measurements must be written from east to west.
- (4) Sub-division numbers must be written double size to prevent their being confused with measurements.
- (5) No part of the *tippan* must come within half an inch of the margin of the paper.
- (6) For annas, numerals and not symbols, must be used.

CHAPTER VIII PRACTICAL MEASUREMENTS

The practical measurement work of the Revenue Inspector chiefly consists of the following kinds :—

- (1) Partition in execution of a Civil Court's decree.
- (2) Fixing the position of missing marks in a survey number either on application of the occupants or in the course of ordinary work such as of boundary mark inspection.
- (3) Boundary disputes.
- (4) The measurement of land to be acquired for public purposes, such as railways (unless special arrangements are made), roads, schools, etc.
- (5) Measurement of lands appropriated to non-agricultural purposes.
- (6) Measurement of waste lands to be given out for cultivation.
- (7) Measurement of changes caused by alluvion or diluvion.
- (8) Measurement of encroachments.
- (9) Measurement of melon beds.

In sending up the correspondence after disposal the Revenue Inspector must attach a tippan and a plot showing all the necessary details. On these tippans and plots all new boundary lines must be shown in red ink.

The procedure for each class of case is detailed in the following paragraphs.

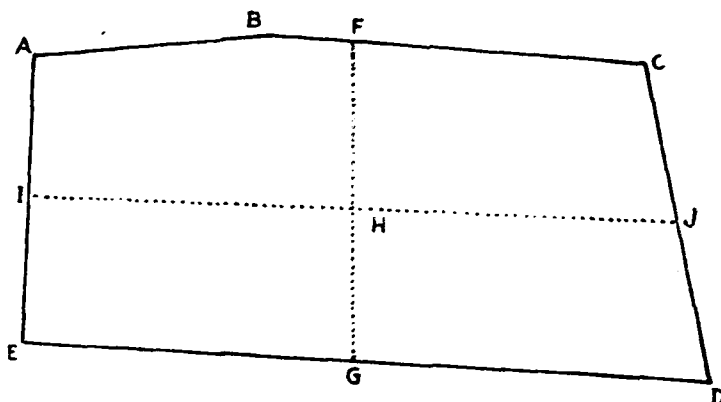
2. Partition on a Civil Court's decree.—(a) The partition will be effected in accordance with the terms of the decree, *viz.*, the boundary lines of the divisions to be made will be laid down north to south or west to east as directed in the decree.

(b) Divisions of required area will be made by any of the methods described in paragraphs 15 and 16 of Chapter III.

(c) The areas partitioned will be formed into sub-divisions and not into separate survey numbers. They will be measured and mapped in the manner described in Chapter VII.

(d) If the field to be partitioned consists of varying soils the boundary should be chosen so that as far as possible each sub-division contains equal areas of the different soils. This should be done with the assistance of the village punchas and with the agreement of the parties.

Example—



The field ABCDE is to be divided into two equal shares. The portion to the north of the line IJ consists of inferior soil called *barad*, while the soil to the south of the line IJ is of superior quality. If the field were divided into two equal areas by the line IJ the partition would not be equitable. The dividing line FG is therefore selected so as to run approximately at right angles to the boundary between the two soils, one party being given the portion AEGF, and the other party the portion FCDG, each of which contains an approximately equal area of the two classes of soil.

(e) In all cases the agreements of the parties to the partition must be taken and enclosed with the report.

(f) The date on which the measurements were taken and the names of the parties and the panchas present should be recorded at the top of the tippan.

(g) The labour charges of flag-holders and chainmen will be paid by the parties to the partition.

(h) The Revenue Inspector will, in his report as also in his weekly diary, state the number of days spent by him in the work.

3. Fixing the position of missing or displaced boundary marks and disputed boundaries.—(a) The correct position of missing or displaced boundary marks should be fixed by means of the measurements in the survey tippan as explained in Chapters IV and V. The work should be carried out in presence of the occupants concerned whose agreements should be taken.

(b) Missing boundary marks must be erected in the Revenue Inspector's presence and not left to be put up by the occupants afterwards.

(c) If the work is done on application, the cost of labour employed in measurement work and the erection of new boundary marks will be paid by the applicant.

(d) A tippan should be prepared showing the measurements made by the Revenue Inspector in order to fix the missing or displaced marks.

(e) If there is a dispute regarding the boundary, two cases arise—

(i) The marks may be found by measurement to be in the proper place, in which case a report to this effect will be made.

(ii) If the boundary marks are found to be displaced or missing, a tippan and plot showing the survey boundary in black ink and the new or disputed boundaries in red ink should be prepared and submitted with a detailed report. If the parties come to any agreement, this agreement will be taken and submitted with the report. The boundary marks will afterwards be erected in accordance with the orders passed.

NOTE.—When the parties agree to accept the old survey boundary line, the marks may be erected on spot.

4. Acquisition of land for railways and pukka roads.—(a) Measurements will be made in presence of the Public Works Department or Railway Officer concerned.

(b) The measurements will be made on the *bandh map* system described in Chapter VII, and the area taken up found by area comb after drawing a plot of each survey number separately. This area will be shown separately in the tippan and treated as pot-kharab.

(c) A separate map will be prepared from the plots for every village affected. The map should be on a scale not less than 10 chains to the inch. It should show all the boundaries of every survey number in which any part of the land to be acquired lies.

(d) The boundaries of the area to be acquired should be plotted on the village map in pencil by the Revenue Inspector. The Revenue Inspector and the Public Works Department or Railway Officer will then calculate the areas to be acquired, compare their results and adjust any differences exceeding the following limits :—

	<i>Per cent</i>
Under 3 acres	5
From 3 to 5 acres	4
From 5 to 7 acres	3
Over 7 acres	2½

After the case has been finally disposed of, the boundaries of the area acquired, which have been shown in pencil on the village map, will be inked over in red by the Revenue Inspector.

7. Measurement of waste land to be given out for cultivation.—(a) No survey number consisting of land to be used for agricultural purposes only shall henceforth be formed with an area of less than five acres except in case of land acquired for public purposes or set aside for special purposes, when the minimum shall be one acre.

(b) Boundary lines of the survey numbers to be formed will be made straight as far as possible.

(c) If a large block is to be measured, an *adhar regh* must be taken between points already fixed on the village map. The fields through which the *adhar regh* passes will be measured on it and the remaining fields each measured on a separate base line.

(d) Boundary marks will be erected in accordance with the instructions in paragraph 12 below.

8. Measurement of changes due to alluvion and diluvion.—(a) Land formed by alluvion or lost by diluvion is not to be measured unless it exceeds one acre.

(b) Alluvial land and land lost by diluvion will be measured in the manner described in paragraph 14 of Chapter III. In both cases boundary marks will be erected at the corners of the new boundary.

(c) The alluvial area will be amalgamated with the adjoining survey number or sub-division unless it is put to auction and sold to a person other than the occupant of the adjoining survey number or sub-division, in which case it will be formed into an additional sub-division of the adjoining survey number.

9. Measurement of encroachments on Government land.—(a) The boundary of the survey number, the occupant of which has made an encroachment, will first be fixed in the field and then the area encroached upon measured.

(b) A tippan and a plot showing the boundary of the encroached area in red ink lines will be prepared and submitted along with the report to the Tahsildar.

(c) The old survey boundary line will be restored by erecting the boundary marks in their proper places and destroying any which were misplaced. The fact that this has been done should be mentioned in the report.

10. Measurement of melon beds.—Melon beds being in the bed of a river do not form part of a survey number. As the plots to be given out are rectangular, no base line need be taken. Measurements of the boundary lines of each plot are sufficient for the purpose of calculating the area. The Revenue Inspector should enclose the tippan with his report.

11. Formation of new survey numbers.—No new survey numbers are to be formed except in the following cases :—

(i) Land taken up for public purposes such as public buildings, threshing floors, burial grounds, etc.

(ii) Waste land given out for cultivation.

(iii) Survey numbers exceeding 30 acres which may be divided into two or more survey numbers to reduce the area below 30 acres.

All other cases shall be dealt with by the formation of sub-divisions in or addition of sub-divisions to existing survey numbers.

When any new survey number is formed it should be given the number next after that of the last survey number in the village.

12. Rules for the erection of boundary marks.—(a) The boundaries of all villages and survey numbers shall consist of an unploughed strip on *dhura* $4\frac{1}{2}$ feet broad or in the alternative a ridge, fence or wall as provided by rule 12, issued under section 125 of Berar Land Revenue Code, 1928.

(b) Near each corner of a survey number shall be erected 2 mounds (warulies) pointing along the field boundaries. The dimensions of such warulies shall be—

Length—10 feet.

Breadth at base—5 feet.

Breadth at top— $\frac{3}{8}$ foot.

Height—3 feet.

(c) When the length of a boundary exceeds 25 chains, one intermediate stone or waruli shall be erected on such boundary unless the boundary is clearly defined by a hedge, fence or wall.

(d) At each bend of more than 4 annas in the boundary of a survey number shall be erected a stone not less than 6 inches square and 2½ feet in length of which at least 2 feet shall be sunk in the ground.

(e) When the corner of a survey number falls near a nalla where mounds would be liable to be washed away, stones as prescribed in rule (d) may be used instead of warulies to demarcate the boundary. In that case one stone shall be fixed at the corner and another stone or a waruli on each boundary line at a distance of 8 annas (16½ feet) from the corner.

(f) In villages where the holders of not less than three quarters of the occupied land in the village desire it, a system of single boundary marks may be introduced in place of those prescribed in rules (b) to (e); such single boundary marks may be of the following descriptions:—

- (i) Stones not less than 3 feet long and 7 inches square embedded in rubble and mortar, with not more than one foot above the ground level.
- (ii) Masonry pillars of cement, mortar or burnt brick in cement mortar one foot square and three feet high of which two feet must be embedded in the ground with the foundations stepped down.
- (iii) Of such other descriptions as may be approved from time to time by the Governor in Council.

One such boundary mark shall be fixed at each corner of a survey number and at each bend of more than 4 annas in its boundary and in the middle of each boundary exceeding 25 chains in length.

(g) If a mound is to be cancelled it should be cut through to a length and depth of one anna.











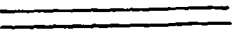
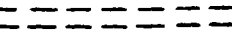
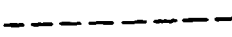
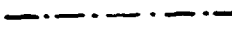
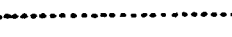
APPENDIX I

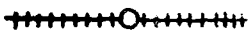














Glossary of Measurement Terms

Marathi	Explanations
Bandh map The length of the boundary of a field between any two corners.
Gunakar	.. Multiplication.
Kshetra	.. The plot or measurement sketch of a survey number drawn to scale.
Kshetra book	.. The book containing such plots.
Lambi	.. The base line.
Rundi	.. An offset.
Tippan	.. The sketch of a number, not drawn to scale, but showing the measurements.
Tippan book	.. The measurement book containing such sketches.
Warga Mul	.. The ready reckoner of squares and square roots (<i>vide</i> Chapter VI).
Wasla	.. The triangles and trapezia into which survey numbers are divided by the cross-staff.
Wazai Wasla	.. A wasla formed by an offset passing outside the number and which has to be deducted in calculating the area.

APPENDIX II

Signs used in connection with Survey Work

- | | | |
|------|---|--|
| (1) |  | A well with one water lift (mot). |
| (2) |  | A well with two lifts (mots). |
| (3) |  | A well without a lift but in repair and formerly used for irrigation. |
| (4) |  | A well with steps. |
| (5) |  | A well without a lift and steps and never used for the purposes of irrigation. |
| (6) |  | A dry well but in good repair. |
| (7) |  | An old dry well out of repair. |
| (8) |  | A tank. |
| (9) |  | A large stream or river. |
| (10) |  | A small nalla. |
| (11) |  | A made road which forms the boundary of a survey number. |
| (12) |  | A road which passes through a survey number. |
| (13) |  | Single cart-track passing through a survey number. |
| (14) |  | Two annas footpath passing through survey number for loaded animal. |
| (15) |  | One anna foot path passing through survey number for public. |

- (16)  Railway line.
- (17)  Earthen mounds (warulis) which constitute the boundary marks of survey numbers.
- (18)  Stone boundary marks.
- (19)  A hedge forming the boundary of a survey number.
- (20)  Forest boundary mark.
- (21)  Trigonometrical station.
- (22)  Theodolite station.
- (23)  A temple.
- (24)  A house.
- (25)  A tower.
- (26)  A toddy tree.
- (27)  A mango or a tamarind tree.
- (28)  A banyan tree.
- (29)  Any tree.
- (30)  A hill.