

## Chapter 1

### 4. SETTING OUT RIGHT ANGLES AND PERPENDICULAR LINES

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[4.1 Setting out Right Angles: the 3-4-5 Method](#)

[4.2 Setting out Perpendicular Lines: the Rope Method](#)

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In survey work, it is often necessary to set out right angles or perpendicular lines on the field. In the sections that follow, a few practical methods indicate how this can be done. These methods include:

- the 3-4-5 method: used to set out a right angle from a certain point on the base line;
- the rope method: used to set out a line perpendicular to the base line, starting from a point which is not on the base line;
- the single prismatic square and the double prismatic square: used to set out both right angles and perpendicular lines.

#### 4.1 Setting out Right Angles: the 3-4-5 Method

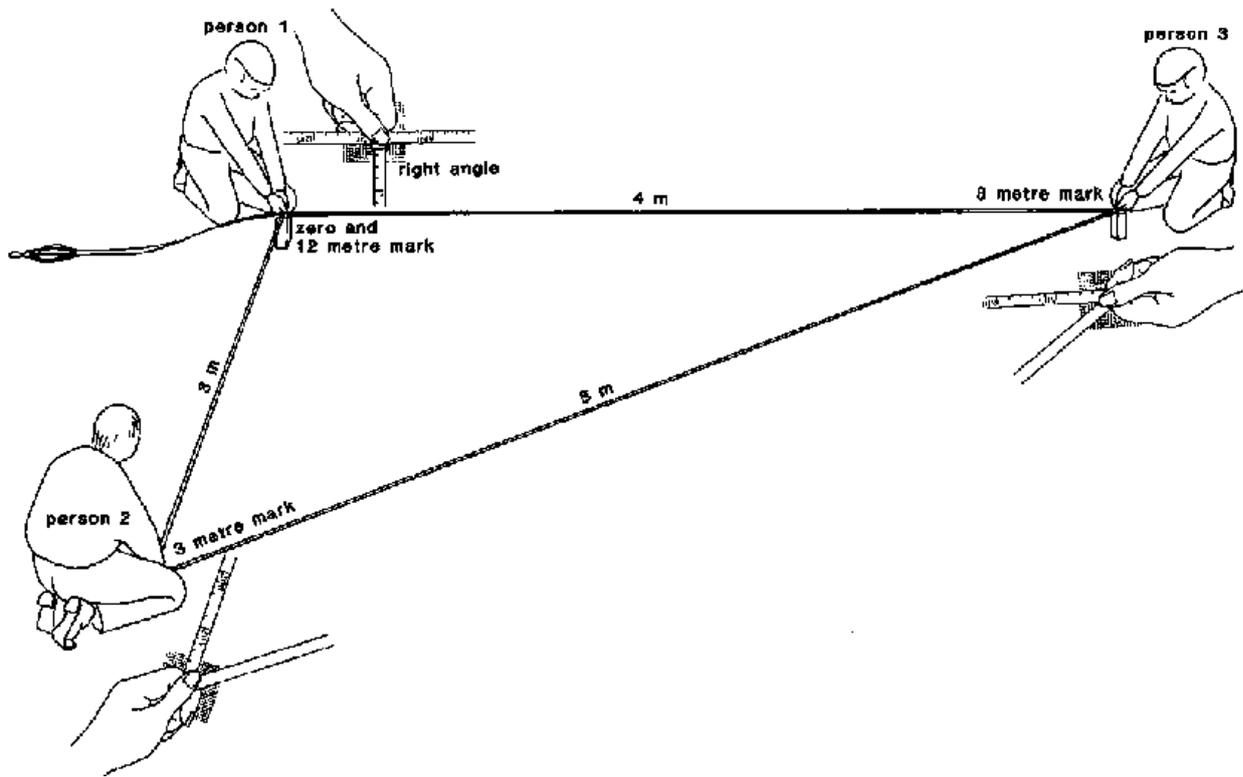
To set out right angles in the field, a measuring tape, two ranging poles, pegs and three persons are required.

The first person holds together, between thumb and finger, the zero mark and the 12 metre mark of the tape. The second person holds between thumb and finger the 3 metre mark of the tape and the third person holds the 8 metre mark.

When all sides of the tape are stretched, a triangle with lengths of 3 m, 4 m and 5 m is formed (see Fig. 20), and the angle near person 1 is a right angle.

NOTE: Instead of 3 m, 4 m and 5 m a multiple can be chosen: e.g. 6 m, 8 m and 10 m or e.g. 9 m, 12 m and 15 m.

**Fig. 20 The 3-4-5 method**

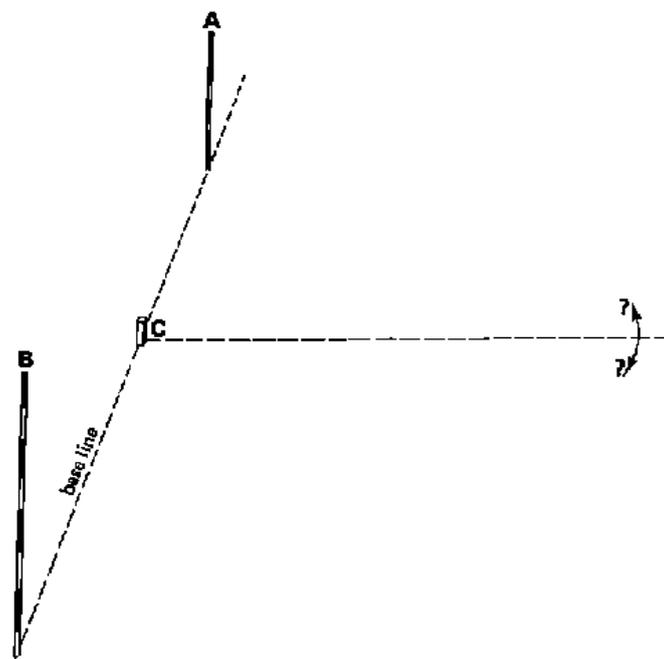


**EXAMPLE:** Setting out a right angle

Step 1

In Fig. 21a, the base line is defined by the poles (A) and (B) and a right angle has to be set out from peg (C). Peg (C) is on the base line.

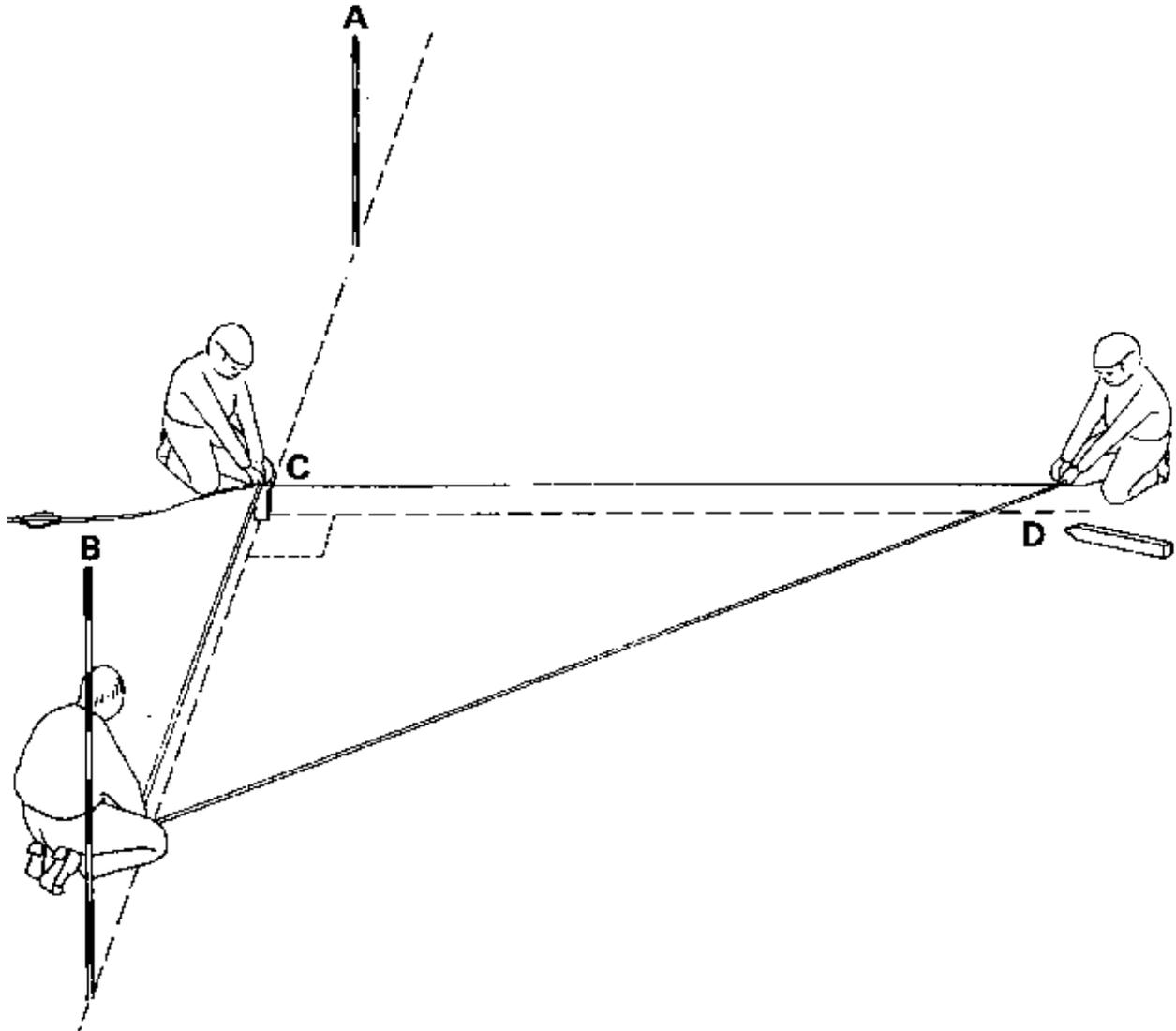
**Fig. 21a Setting out a right angle, Step 1**



## Step 2

Three persons hold the tape the way it has been explained above. The first person holds the zero mark of the tape together with the 12 m mark on top of peg (C). The second person holds the 3 m mark in line with pole (A) and peg (C), on the base line. The third person holds the 8 m mark and, after stretching the tape, he places a peg at point (D). The angle between the line connecting peg (C) and peg (D) and the base line is a right angle (see Fig. 21b). Line CD can be extended by sighting ranging poles.

[Fig. 21b Setting out a right angle, Step 2](#)



Instead of a measuring tape, a 12 m long rope with clear marks at 3 m and 8 m can be used.

## **4.2 Setting out Perpendicular Lines: the Rope Method**

A line has to be set out perpendicular to the base line from peg (A). Peg (A) is not on the base line.

A long rope with a loop at both ends and a measuring tape are used. The rope should be a few metres longer than the distance from peg (A) to the base line.

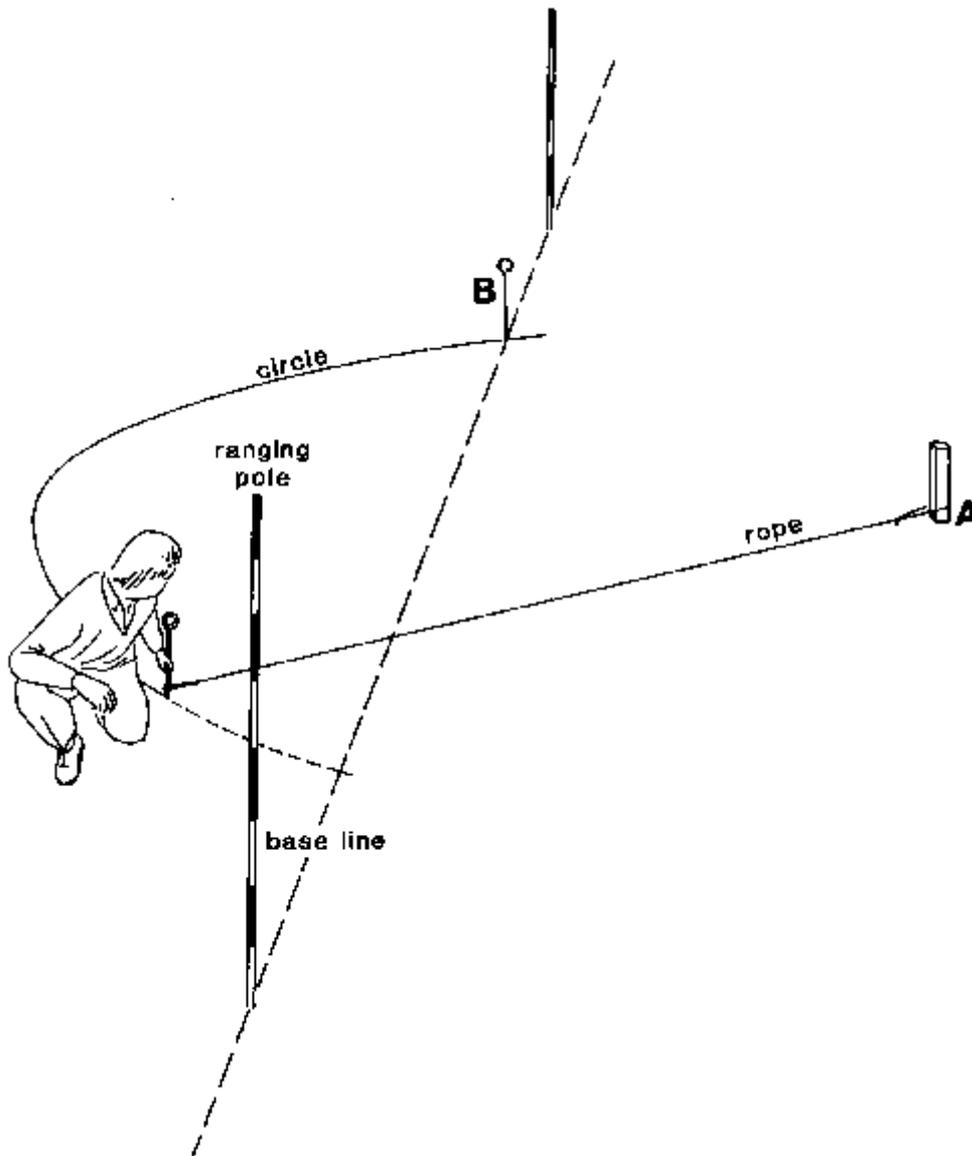
### Step 1

One loop of the rope is placed around peg (A). Put a peg through the other loop of the rope and make a circle on the ground while keeping the rope straight. This circle crosses the base line twice (see Fig. 22a). Pegs (B) and (C) are placed where the circle crosses the base line.

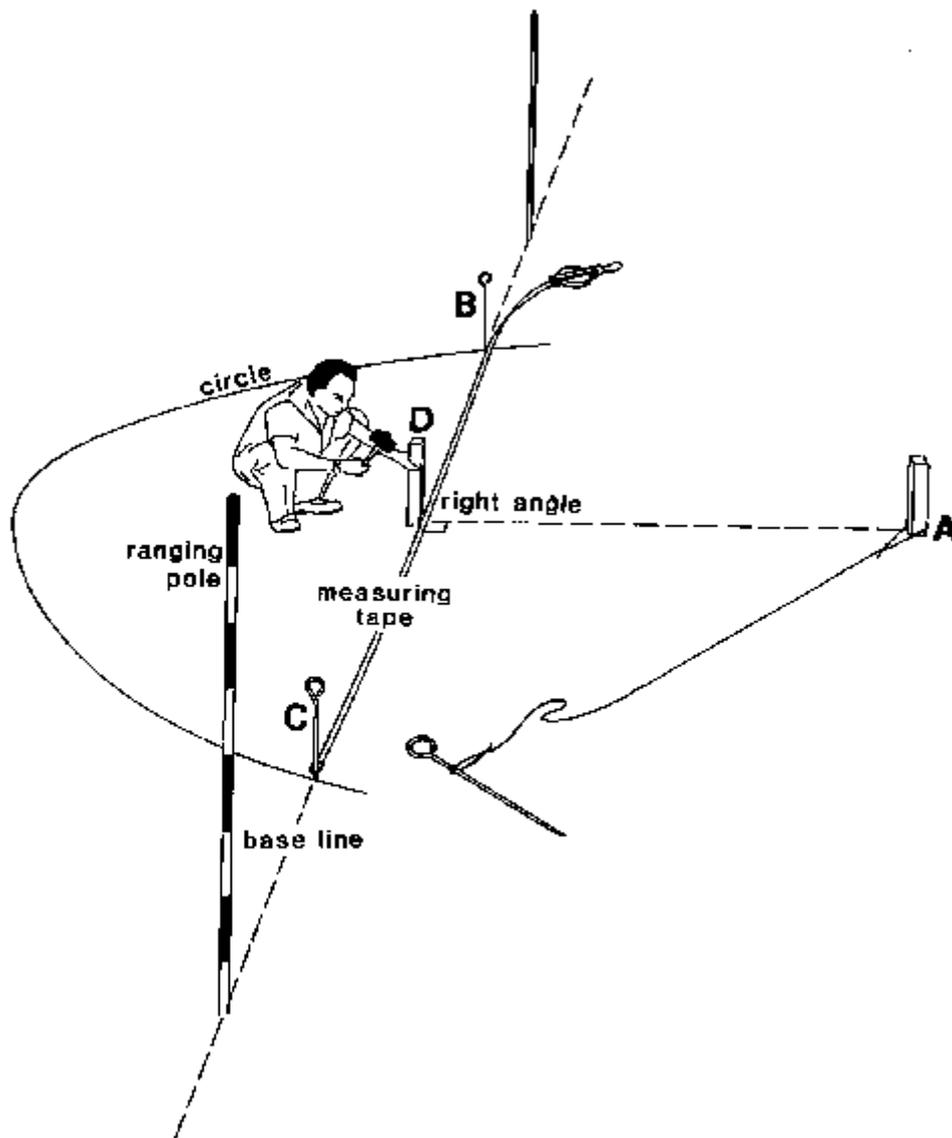
### Step 2

Peg (D) is placed exactly half way in between pegs (B) and (C). Use a measuring tape to determine the position of peg (D). Pegs (D) and (A) form the line perpendicular to the base line and the angle between the line CD and the base line is a right angle (see Fig. 22b).

**Fig. 22a Setting out a perpendicular line, Step 1**



**Fig 22b Setting out a perpendicular line, Step 2**



## 4.3 Optical Squares

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### [4.3.1 The single prismatic square](#)

### [4.3.2 The double prismatic square](#)

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Optical squares are simple sighting instruments used to set out right angles. They can be provided either with mirrors or with one or two prisms. Because of practical difficulties in using squares with mirrors, they have been replaced by squares with prisms: "prismatic squares". There are two major types of prismatic squares: single prismatic squares and double prismatic squares; both will be dealt with in the sections which follow.

### 4.3.1 The single prismatic square

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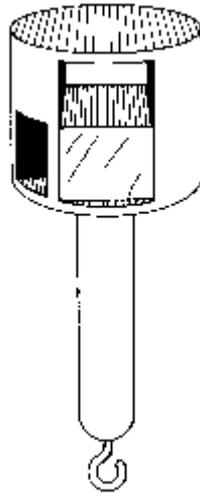
#### [4.3.1.1 Setting out right angles](#)

#### [4.3.1.2 Setting out perpendicular lines](#)

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The prism of the single prismatic square is fitted in a metal frame with a handle. Attached to the handle is a hook to which a plumb bob can be connected (see Fig. 23). The special construction of the prism enables to see at right angles when looking through the instrument. The single prismatic square or single prism can be used to set out right angles and perpendicular lines.

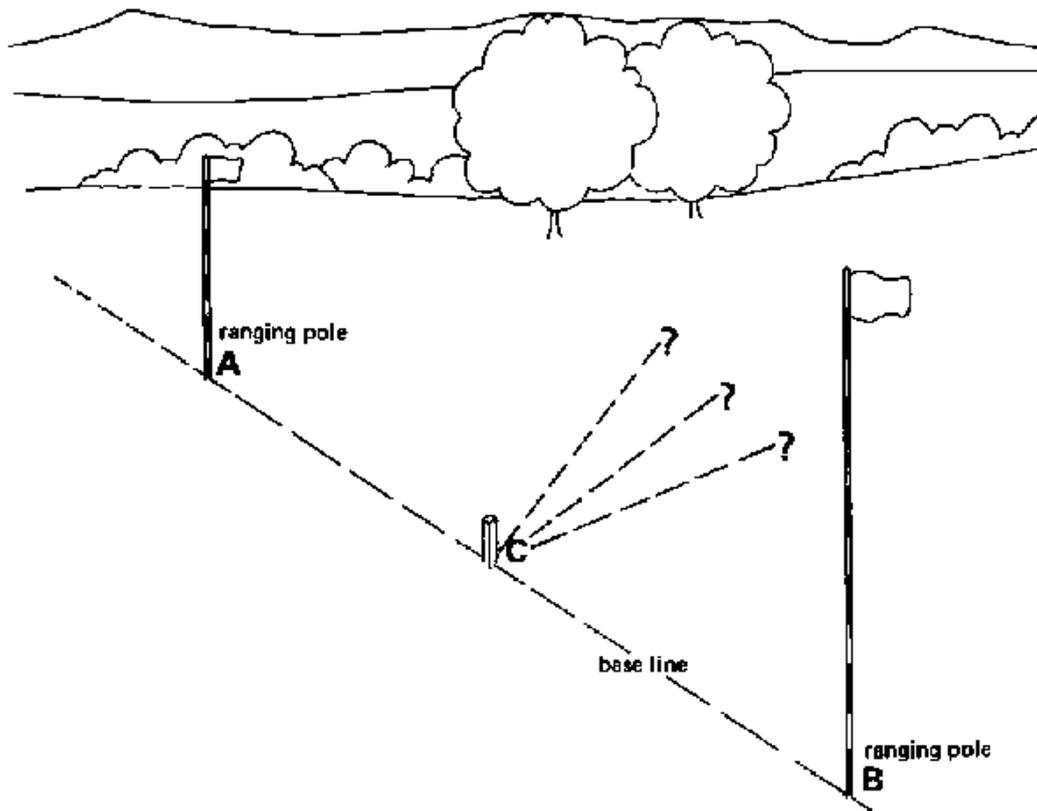
**Fig. 23 A single prismatic square**



#### 4.3.1.1 Setting out right angles

In Fig. 24, peg (C) is on the base line which is defined by poles (A) and (B). A right angle has to be set out, starting from peg (C).

**Fig. 24 Setting out a right angle**

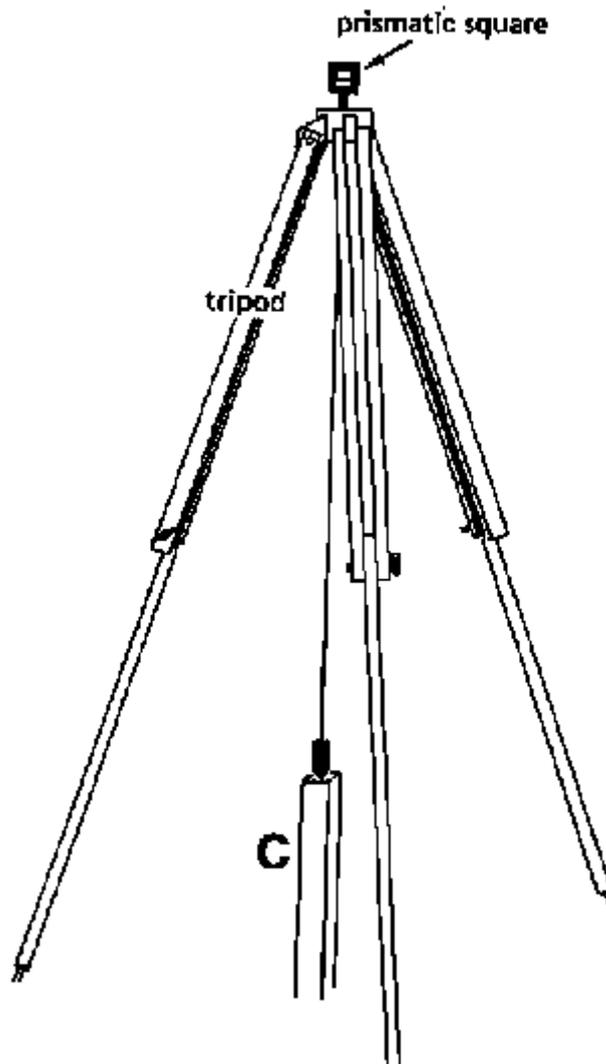


The procedure to follow is:

### Step 1

The prismatic square has to be placed vertically above peg (C). This can be achieved by using a plumb bob. The instrument can be hand-held by the operator, but even better is to install the instrument on a tripod (see Fig. 24a).

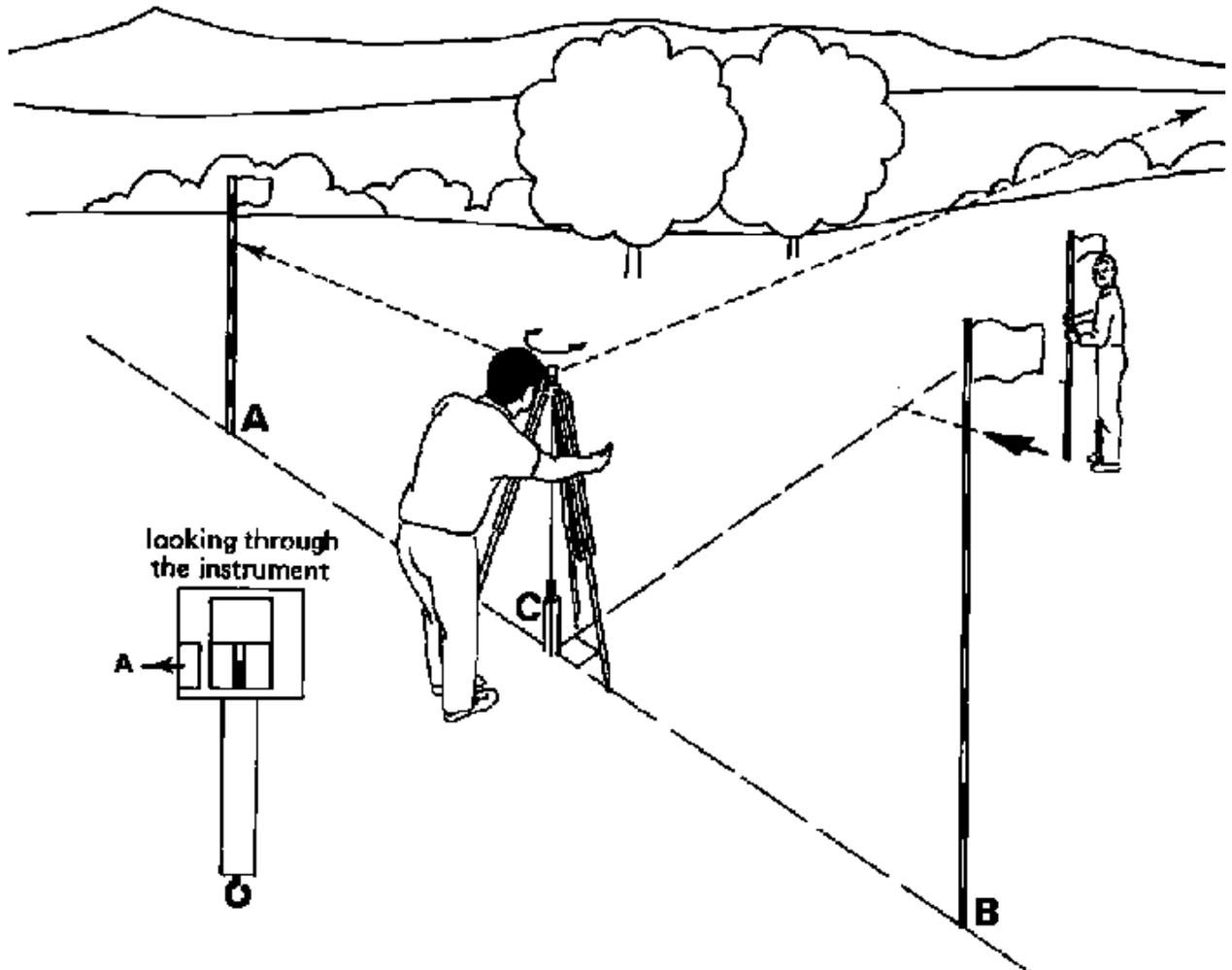
**Fig. 24a Setting out a right angle, Step 1**



### Step 2

The instrument is slowly rotated until the image of pole A can be seen when looking through the instrument (see Fig. 24b).

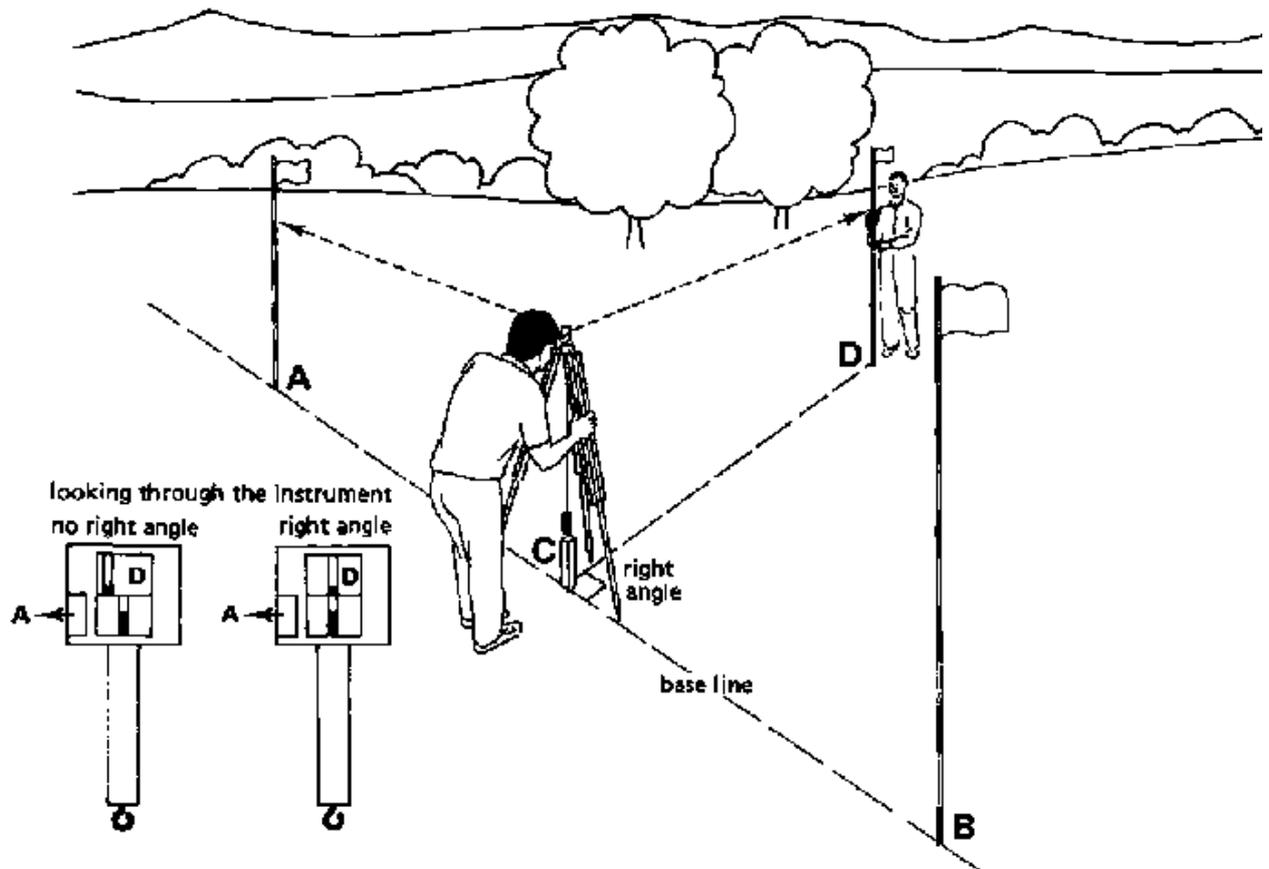
Fig. 24b Setting out a right angle, Step 2



Step 3

An assistant should hold pole (D) in such a way that it can be seen when looking through the opening just above the prism. At the indication of the operator, pole (D) is slightly moved so that pole (D) forms one line (when looking through the instrument) with the image of pole (A) (see Fig. 24c). The line connecting pole (D) and peg (C) forms a right angle with the base line.

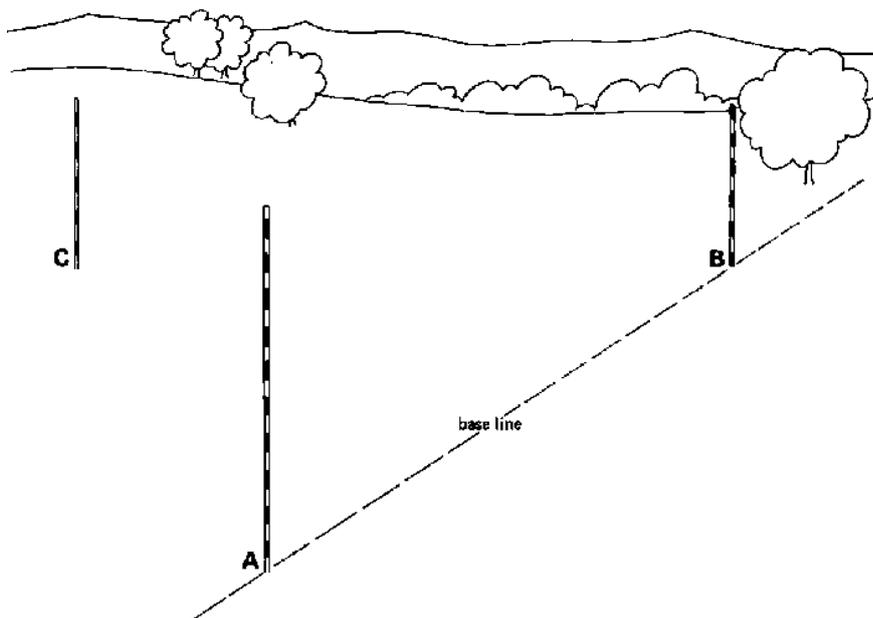
[Fig. 24c Setting out a right angle. Step 3](#)



#### 4.3.1.2 Setting out perpendicular lines

In Fig. 25, the base line is defined by poles (A) and (B). A line perpendicular to the base line has to be set out from pole (C); pole (C) is not on the base line.

[Fig. 25 Setting out a perpendicular line](#)

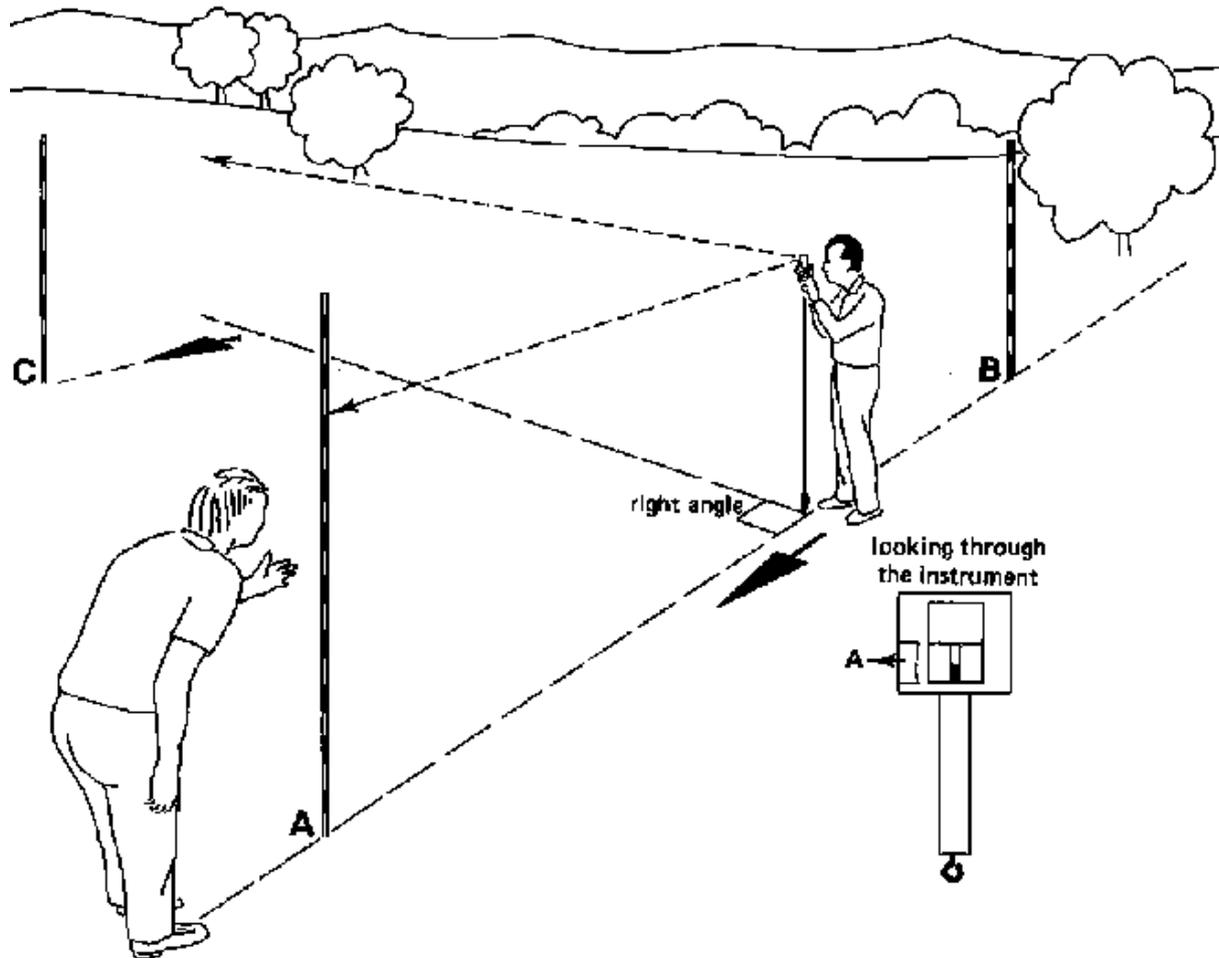


The procedure to follow is:

### Step 1

The operator should stand with the instrument on the base line (connecting A and B). To check this, the assistant, standing behind pole (A) (or B), makes sure that the plumb bob, attached to the instrument, is in line with poles (A) and (B) (see Fig. 25a). The operator then rotates the instrument until the image of pole (A) can be seen.

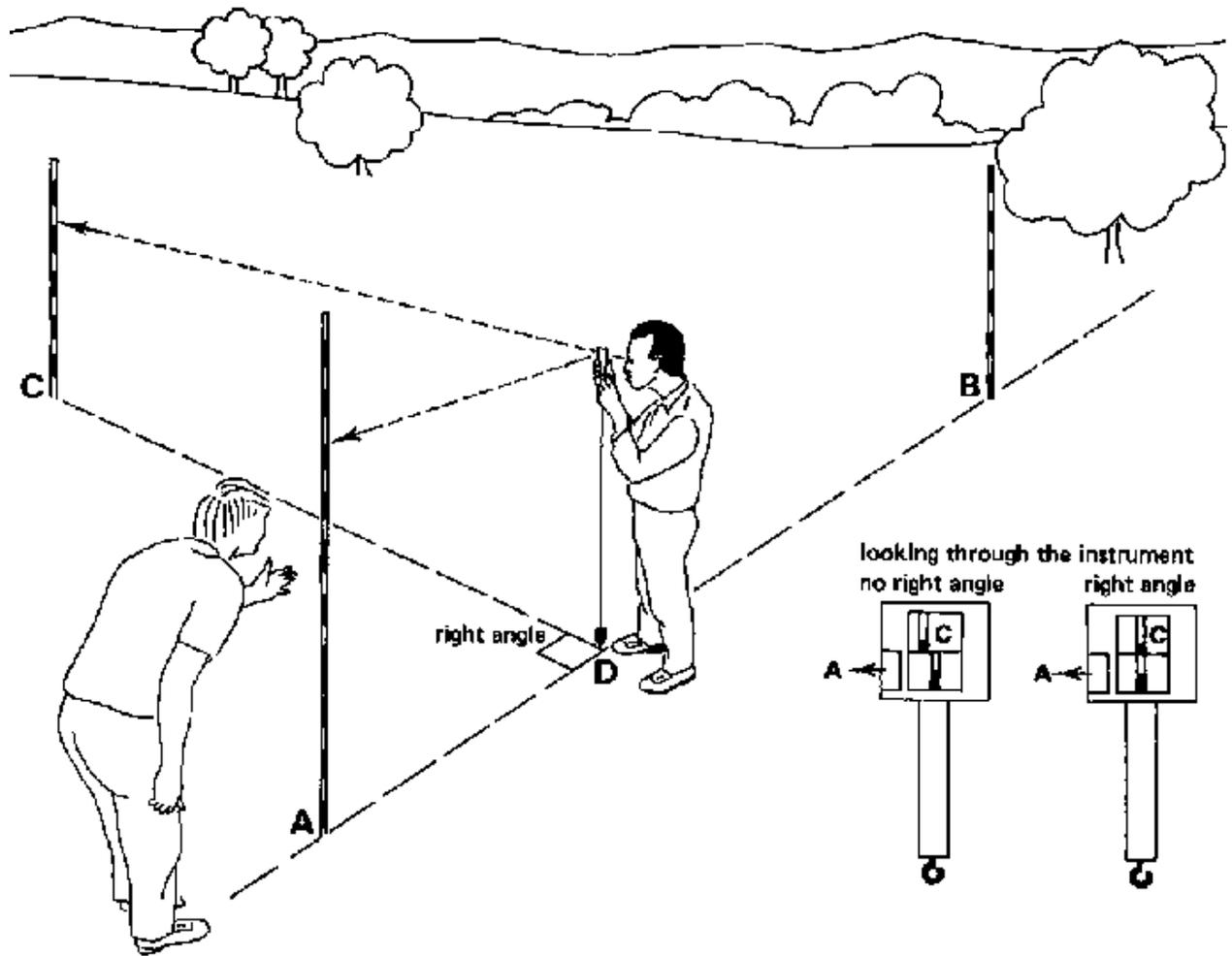
[Fig. 25a Setting out a perpendicular line, Step 1](#)



### Step 2

The operator then moves the instrument along the base line until he finds a position for which (when looking through the instrument) pole (C) is in line with the image of pole (A) (see Fig. 25b). While searching for the right position, the operator must keep the instrument always in line with poles (A) and (B). This is done under the guidance of the assistant standing behind pole (A).

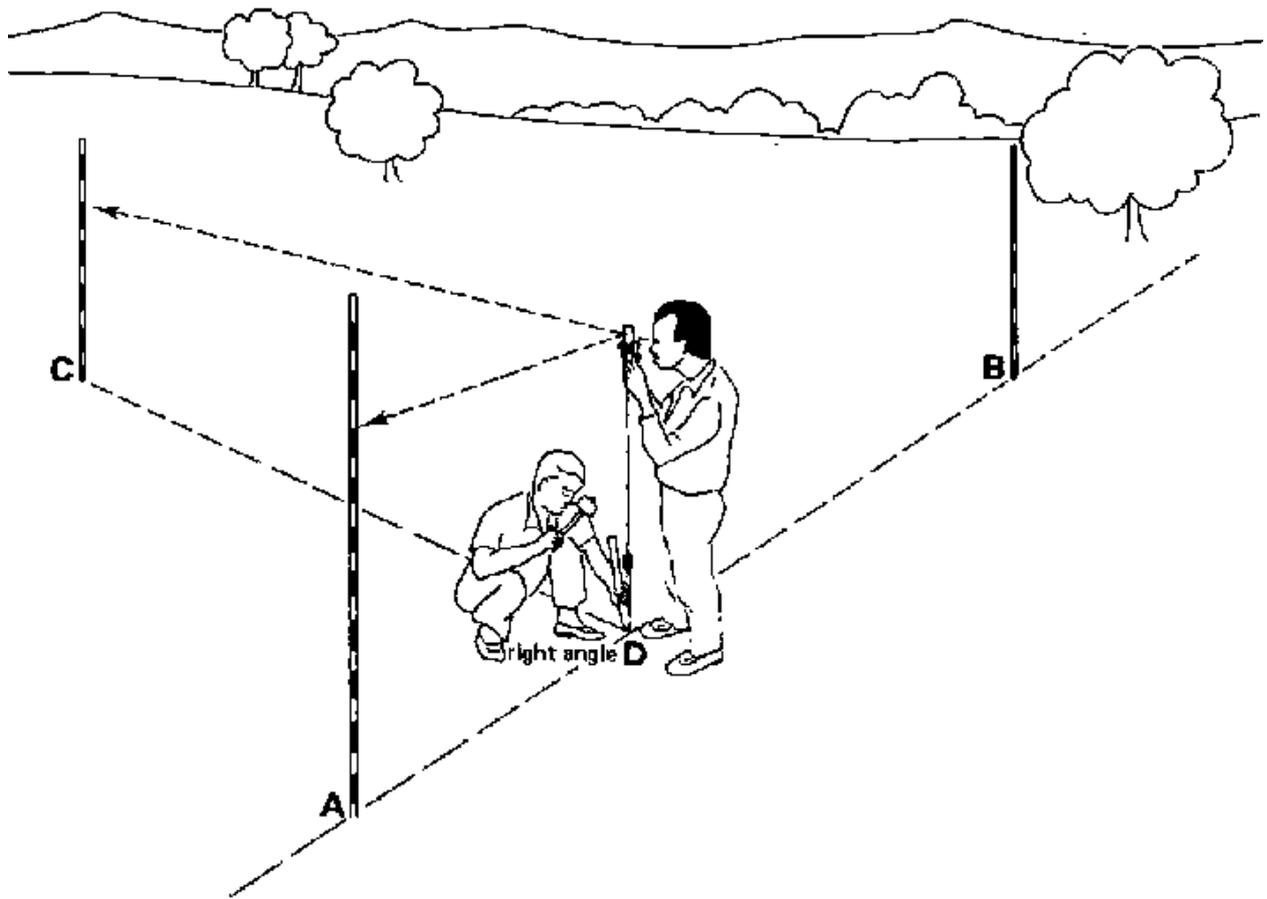
Fig. 25b Setting out a perpendicular line, Step 2



Step 3

When the correct position of the instrument is found, peg (D) is placed right under the plumb bob. The line connecting pole (C) and peg (D) is a line perpendicular to the base line (see Fig. 25c).

[Fig. 25c Setting out a perpendicular line, Step 3](#)



### 4.3.2 The double prismatic square

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#### [4.3.2.1 Setting out right angles](#)

#### [4.3.2.2 Setting out perpendicular lines](#)

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The double prismatic square, also called double prism, has two prisms. The two prisms are placed in such a way that it is possible to look at the same time at a right angle to the left and to the right; in addition the observer can look straight ahead of the instrument through openings above and below the prisms (see Fig. 26). It is thus possible to see the base line and the perpendicular line at the same time; no assistant is needed to check if the operator is standing on the base line, as is the case with the single prismatic square.

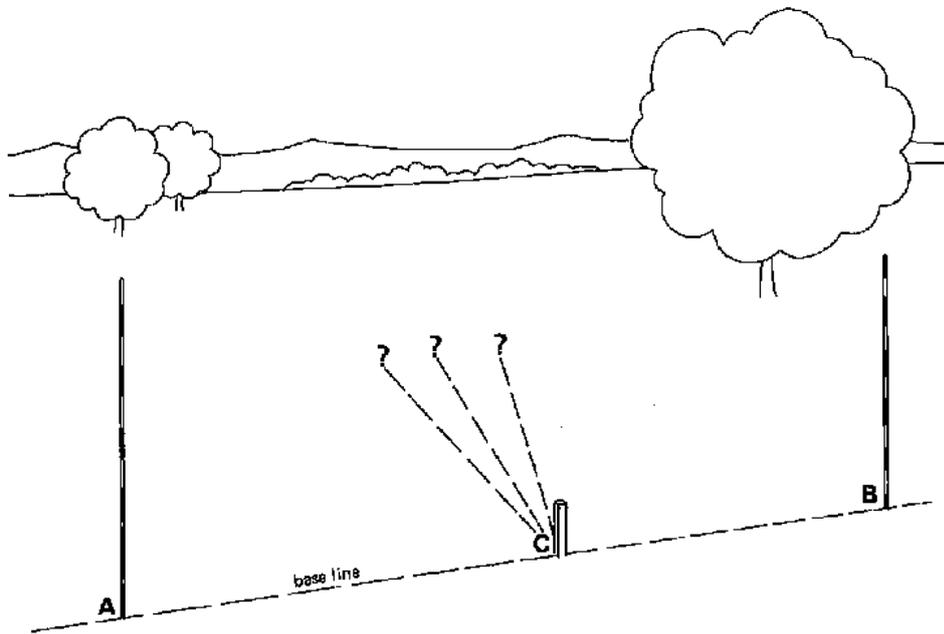
[Fig. 26 A double prismatic square](#)



### 4.3.2.1 Setting out right angles

In Fig. 27, peg (C) is on the base line connecting poles (A) and (B). A right angle has to be set out from (C).

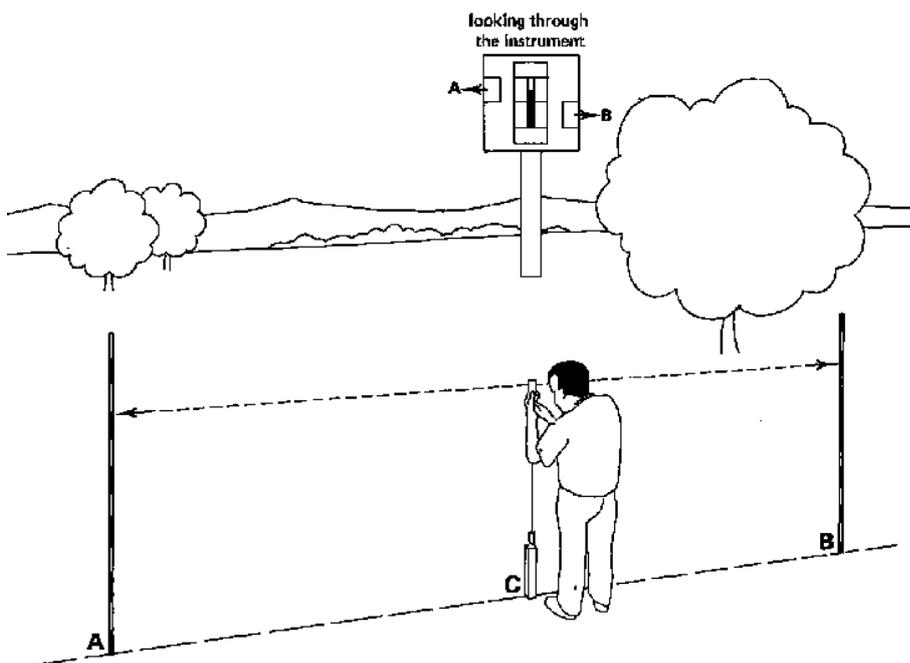
[Fig. 27 Setting out a right angle](#)



#### Step 1

The observer holds the instrument vertically above peg (C) on the base line. This can be checked with the plumb bob (see Fig. 27a) The instrument is slowly rotated until the image of pole (A), is in line with the image of pole (B) (see Fig. 27a).

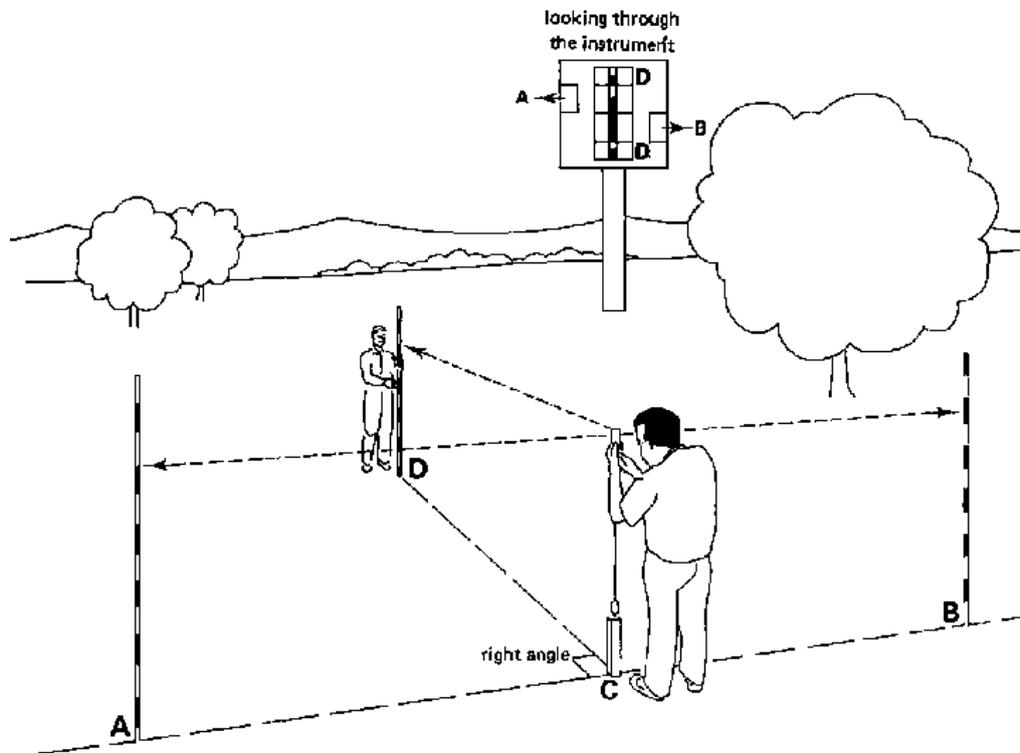
[Fig. 27a Setting out a right angle, Step 1](#)



## Step 2

The observer then directs the assistant, holding pole (D), in such a way, that seen through the instrument, pole (D) forms one line with the images of poles (A) and (B) (see Fig. 27b) The line connecting pole (D) and peg (C) forms a right angle with the base line.

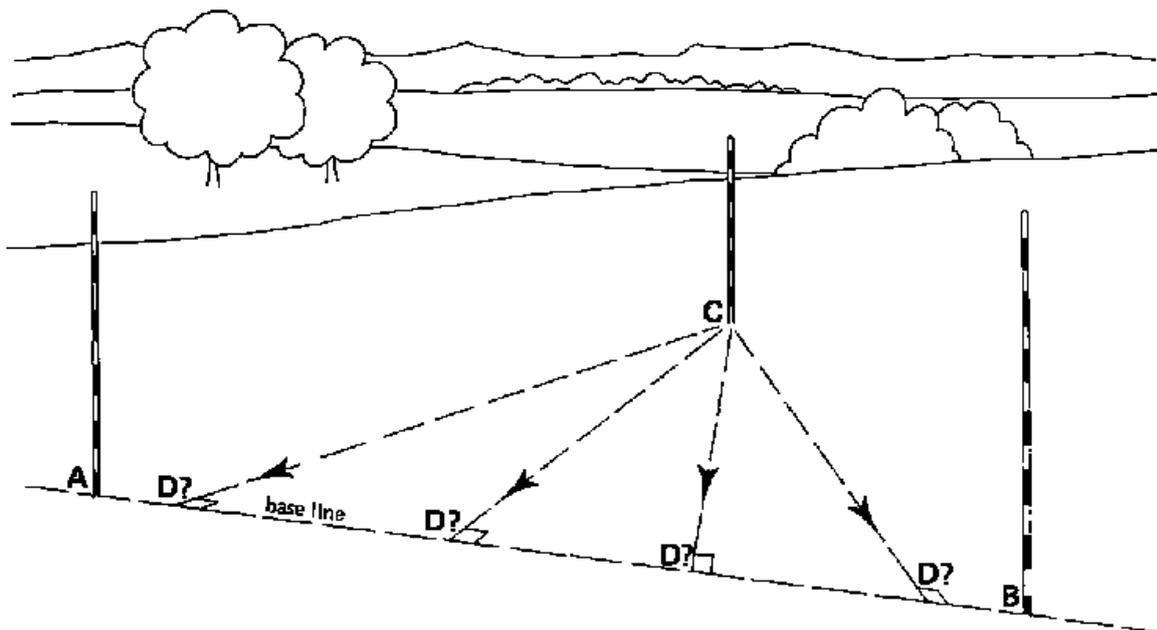
[Fig. 27b Setting out a right angle, Step 2](#)



### 4.3.2.2 Setting out perpendicular lines

In Fig. 28, the base line is defined by poles (A) and (B). A line perpendicular to the base line has to be set out from pole (C) which is not on the base line.

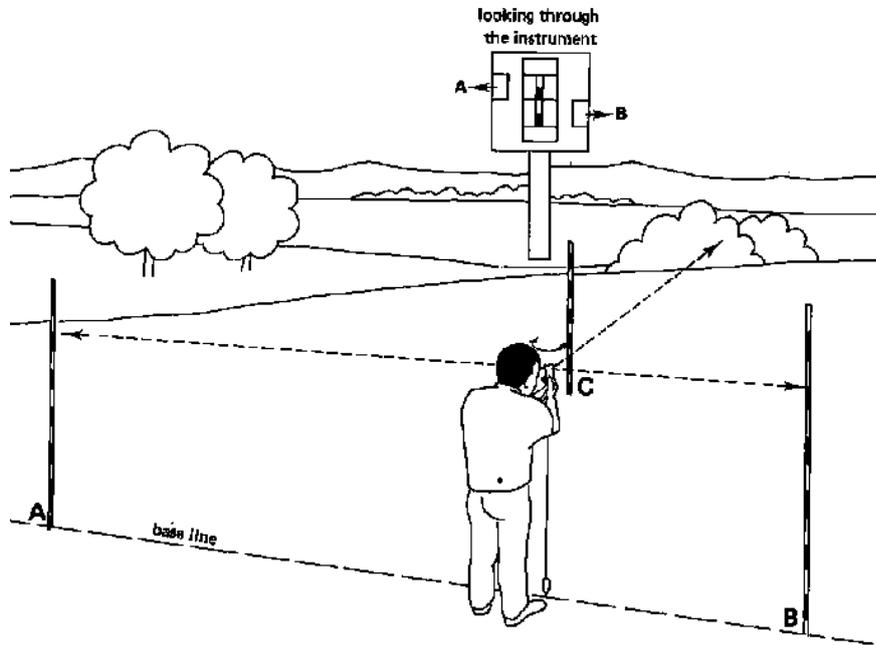
[Fig. 28 Setting out a perpendicular line](#)



## Step 1

Looking through the instrument the observer moves slowly trying to find a position on the base line. When the images of both poles (A) and (B) appear, the observer stops and rotates the instrument slowly until the images of poles (A) and (B) form one line (see Fig. 28a). The instrument is then in line with poles (A) and (B) of the base line.

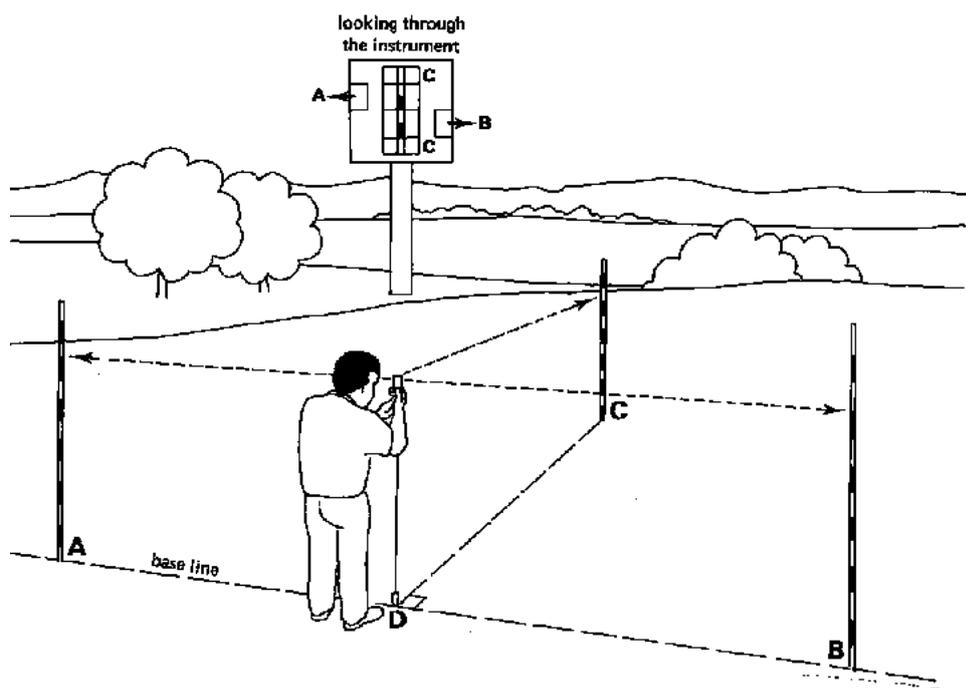
[Fig. 28a Setting out a perpendicular line, Step 1](#)



## Step 2

The observer moves along the base line towards pole (A) or pole (B). He stops when pole (C) can be seen through the instrument and forms one line with the images of poles (A) and (B) (see Fig. 28b).

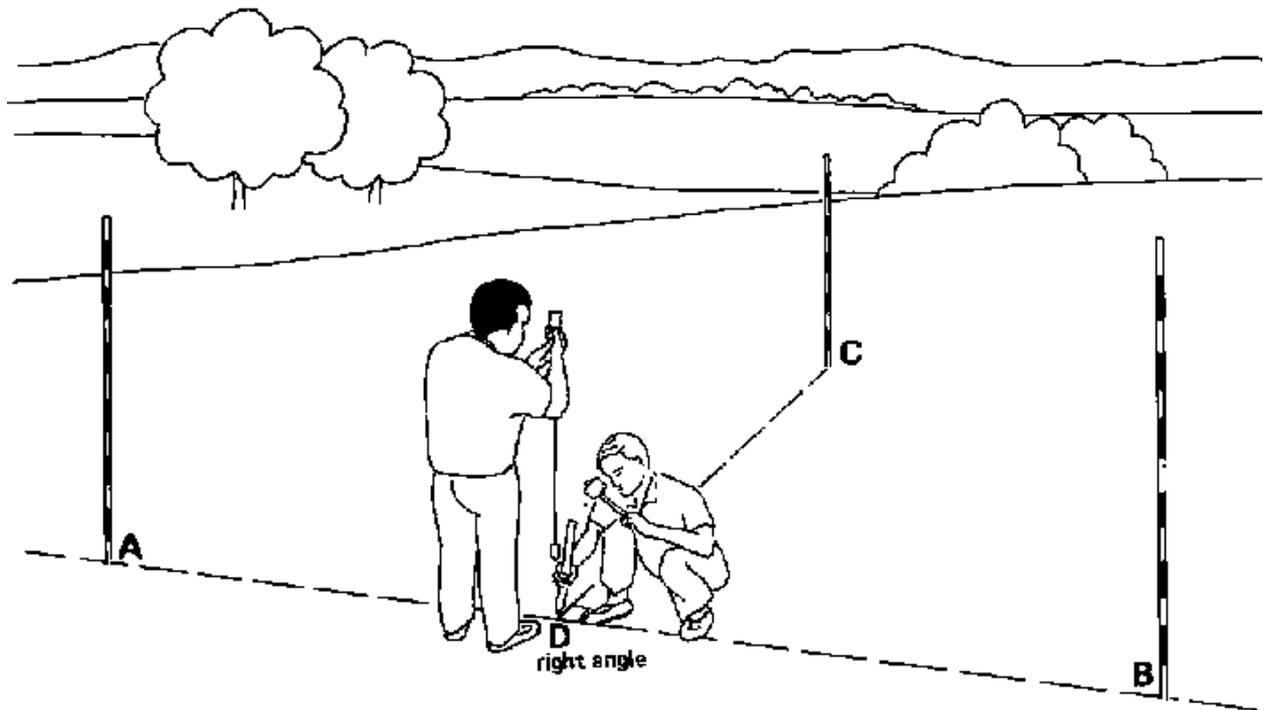
[Fig. 28b Setting out a perpendicular line, Step 2](#)



### Step 3

When the correct position of the instrument is found, peg (D) is driven into the soil right under the plumb bob. Peg (D) and pole (C) form the line perpendicular to the base line (see Fig. 28c).

**Fig. 28c Setting out a perpendicular line, Step 3**



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