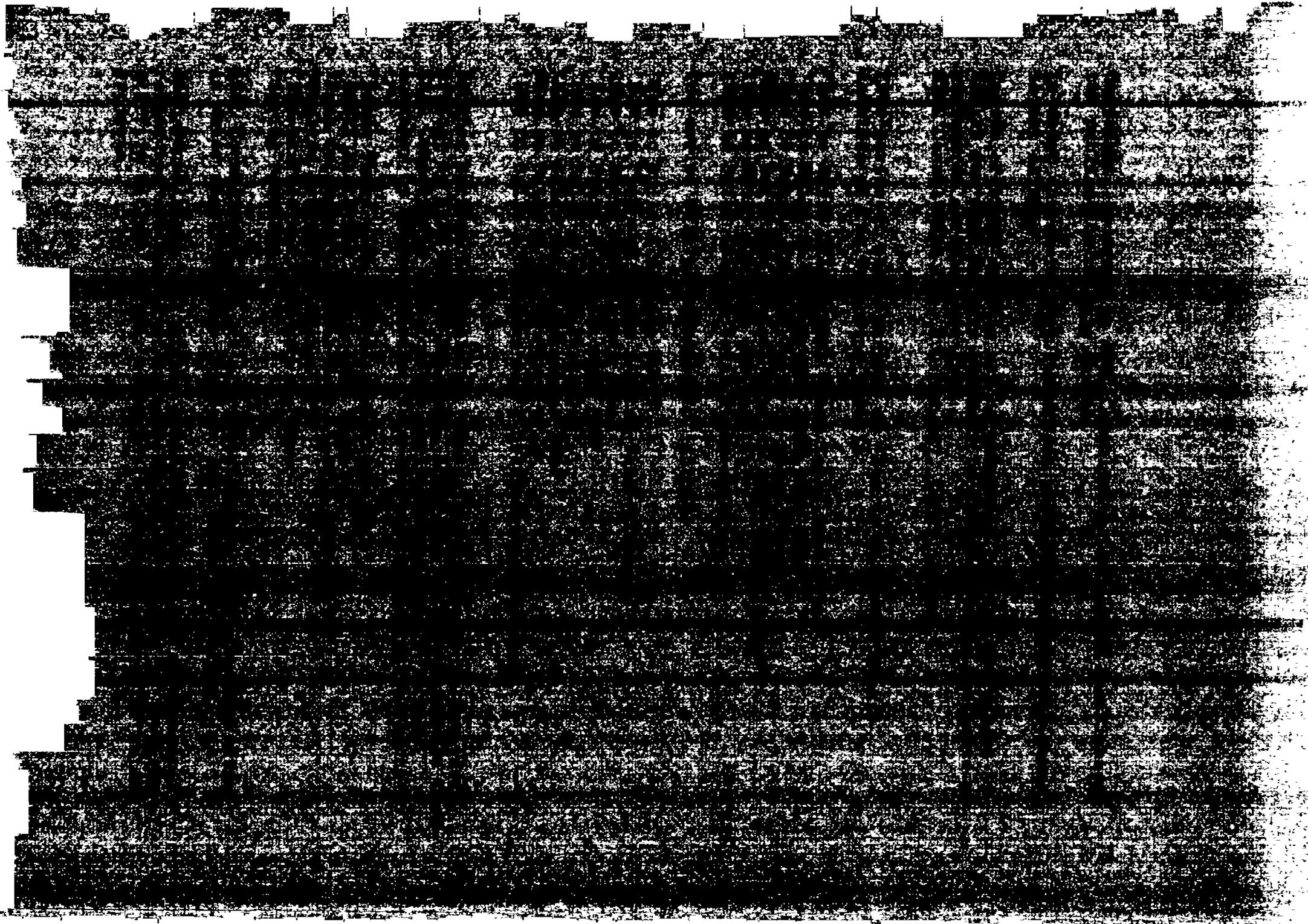


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INTRODUCTION

These photo-manuals are illustrated with many photographs, accompanied by clear and short text, to describe step-by-step how to build various types of structures for harvesting rainwater.

This method of using a short series of consecutive photos with brief text to explain various construction methods for training artisans and supervisors has proved successful on several occasions.

The techniques explained in this manual are based on the author's experience of training more than 500 artisans and contractors in designing and building water projects in Africa since 1974.

It is hoped that this manual will assist water programmes as well as local contractors and clients, in building long-lasting water projects which will provide water for people and livestock.

BENEFITS OF V-SHAPED GUTTERS WITH SPLASH-GUARDS.

In an attempt to solve the problem of fitting long lengths of gutters to uneven roofs, often without fascia boards, that exist at rural schools, the author invented this V-shaped gutter and its splash-guard in 1986.

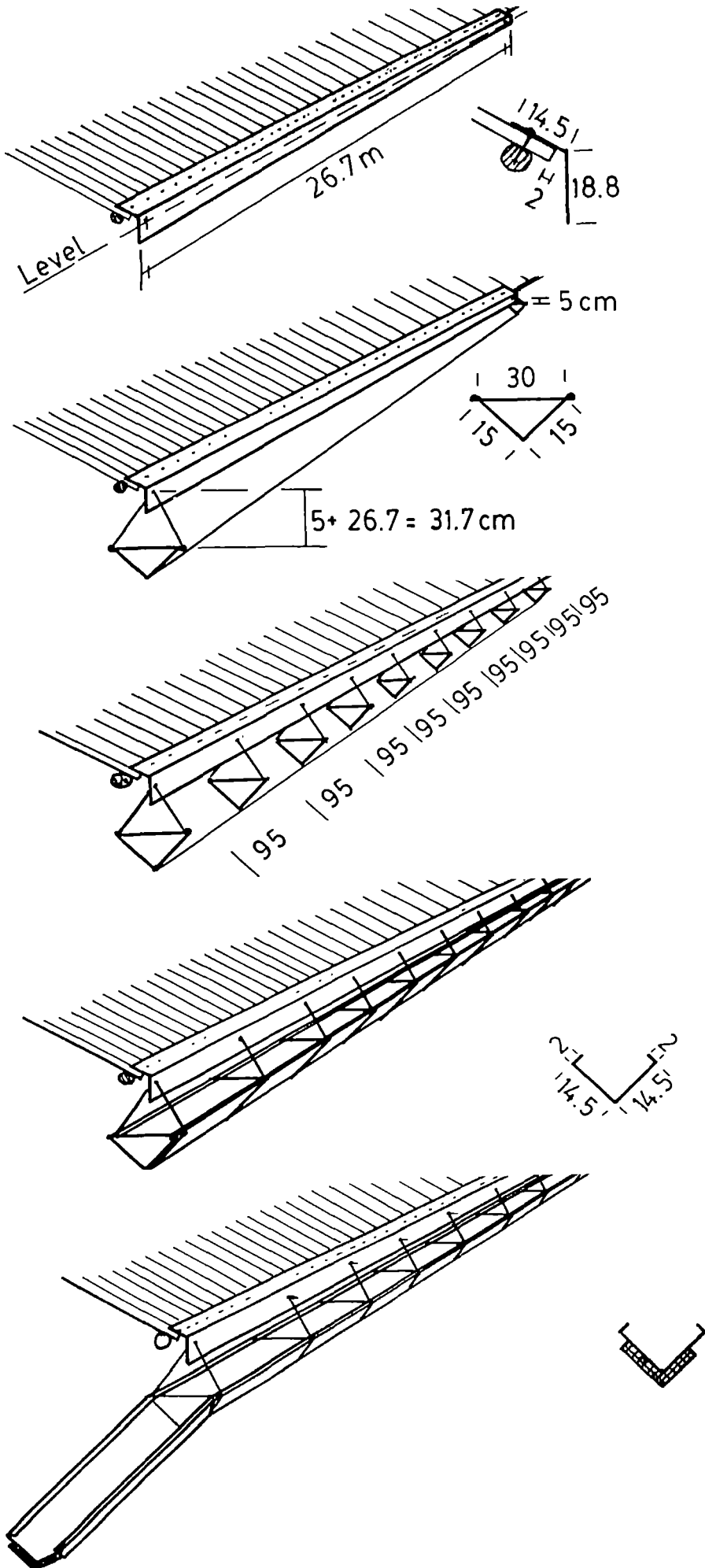
Since then more than 1000 school buildings have been fitted with 50 metres of this gutter and splash-guard by various agencies in Kenya.

The V-shaped gutter and its splash-guard are recommended for these reasons:

- 1) This V-shaped gutter is easy to manufacture on the construction sites or at youth polytechnics, thus creating employment in the rural sector.
- 2) The gutter is easy to install on buildings of any length, even when the roofs are uneven or the building is not horizontal.
- 3) The gutter delivers rainwater run-off far more efficiently than ordinary gutters, because:
 - * the gutter's cross volume is greater
 - * the splash-guard prevents any wastage of rain water from the roof
 - * the gutter's gradient towards the tank is 1 cm. per 1 m. which prevents overflow from the gutter
 - * the water enters the tank by an extension of the gutter which reduces the possibility of blockage and spill-over with a conventional down-pipe.
- 4) The V-shaped gutters are cheaper and stronger than any other gutters on the market because they are locally made and do not require fascia-boards or gutter brackets. The gutters are fixed to the splash-guards with wires.

STANDARD DESIGN

OF V-SHAPED GUTTERS AND SPLASH-GUARDS



14 lengths of gutters with overlaps of 10 cm. gives a total length of 26.7 metres.

26.7 metres of gutters on both sides of a roof which is 8 metres wide gives a roof area of 214 square metres.

A rainy season of 240 millimetres on 214 square metres roof produces 51,360 litres of water minus wastage 10% = 46,224 litres.

The slope of the gutters should be 1 cm. per 100 cm.

Two gutters are fixed 5 cm. from each end of the fascia board with a horizontal distance of 26.7 cm.

Gutter hangers are fixed to the roof with a distance of 95 cm. They will the gutters which is 200 cm. long minus 10 cm overlaps = 190 cm. at their joints and middle.

Down-gutters are extensions of the gutters but supported by 4"x1" timbers nailed together as a V.

**BILL OF QUANTITY
FOR 50 METRES OF V-GUTTERS WITH SPLASH-GUARDS**

Item	Quantity
LABOUR	
Provided by organization:	
A-Contractor.....	3 days = US\$ 14
B-Contractor.....	3 days = " 10
Trainee.....	3 days = " 6

Skilled labour	9 days = US\$ 32.
=====	

MATERIALS	
Provided by organization:	
Plain galvanized iron sheets, 26 or 28 gauge, 100 cm. x 200 cm. for 60 strips.	20 sheets
Galvanized wire, 3 mm.(g. 10), for 60 hangers...	2 kg.
Galvanized wire, 1 mm.(g. 18), for tying hangers	1 kg.
Galvanized roofing nails, 3", for splash-guards.	4 kg.
Plain nails, 3", for nailing down-pipes.....	2 kg.
Timber for down-pipes, 4" x 1".....	18 metres
Wood-preservative for down-pipe timbers.....	2 litres
Bitumen paste (Lordex) for joints between gutters	2 kg.

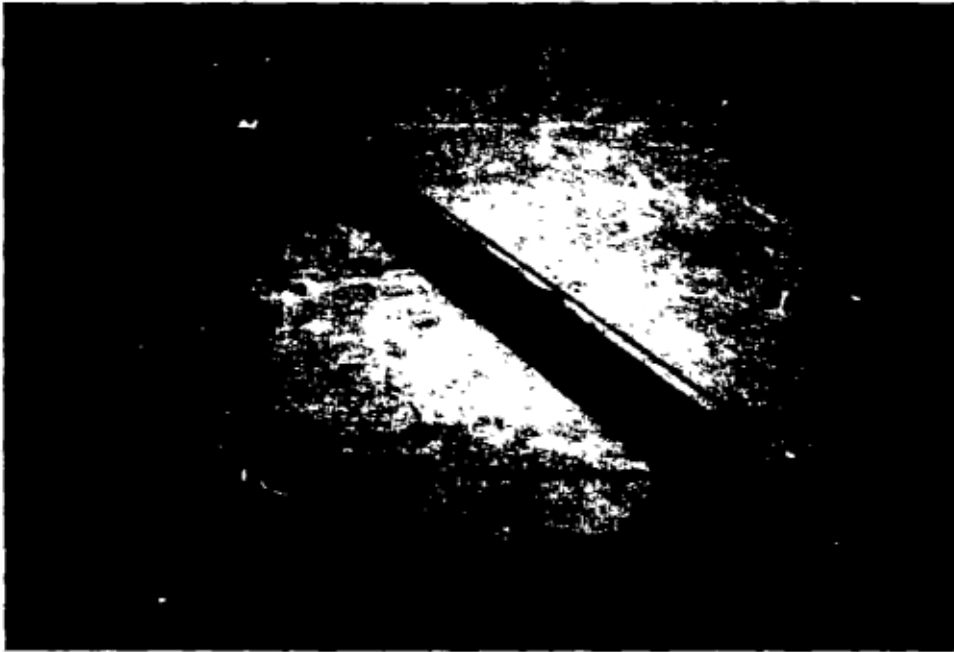
Cost of materials	US\$ 146.
=====	

Total cost of 50 metres of V-gutters with splash-guard US\$ 178
=====

TOOLS AND EQUIPMENT FOR GUTTERS

Item	A-Contractor	B-Contractor
Tin snips.....	1	1
Mallets.....	1	1
Pliers.....	1	1
Carpenter's hammer....	1	
Hacksaw.....	1	
Carpenter's chisel....	1	
Crowbar.....	1	
Transparent hosepipe..	30 metres	
Collapsible ladder....	1	
Gutter-bender tool....	1	

GUTTER-BENDING TOOL AND COLLAPSIBLE LADDER



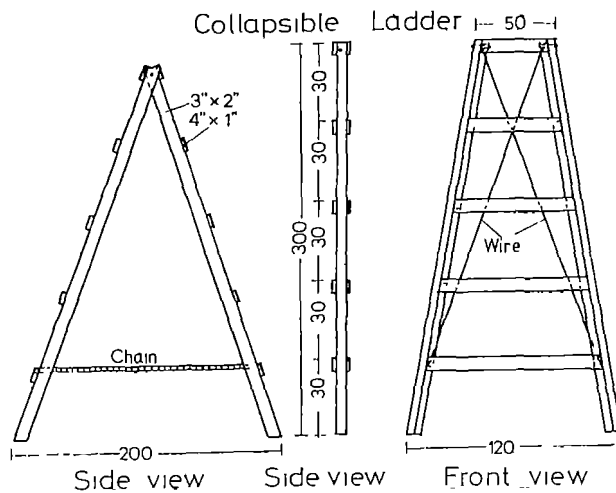
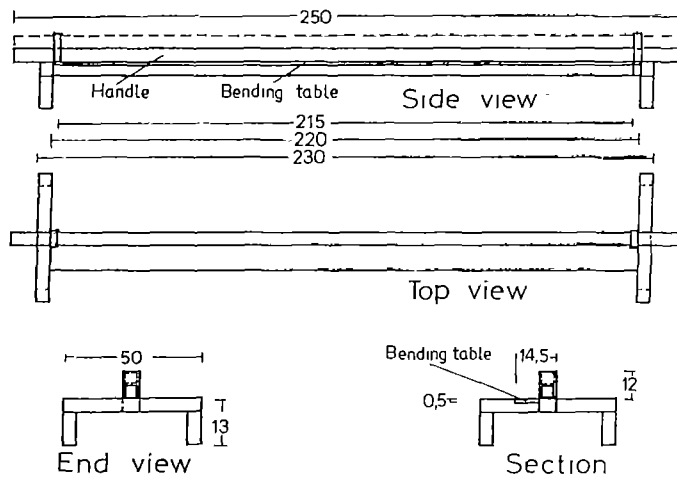
1) A tool, called a gutter-bender, is needed for bending iron sheets to make gutters and splash-guards.

It is made of square iron tubes, 2" x 2", which are welded together (see page 5).

The long upper tube is called the handle.

A bending table consisting of a 215 cm. length of flat iron and being exactly 9.5 cm. wide is welded onto the lower tube.

Gutter-bending Tool



CUTTING IRON SHEETS & MAKING THE SPLASH-GUARDS



2) Gutters and splash-guards are made from plain galvanized iron sheets of 26 or 28 gauge. These sheets are 100 cm. x 200 cm.

20 sheets are cut into 60 strips (33.3 cm x 200 cm) for the standard size of roof catchment which will fill a 46 cubic metre water tank from 230 mm. of rainfall (50 m gutters x 4 m roof x 230 mm rain = 46,000 litres).



3) Place a strip of sheeting on the bending table and push it under the handle of the gutter bender so that the rear edge of the sheet is flush with the rear edge of the bending table.

Place a foot firmly on each handle of the upper tube to hold the sheet in position.



4) Bend the sheet protruding in front of the handle upwards by using hands and mallets.

The sheet should be bent to an angle equivalent to the slope of the roof so that the lower part of the sheet is vertical when the splash-guard is nailed on the roof.

Bend a total of 28 strips like this to provide the required 54 metres of splash-guards.

MAKING THE GUTTERS



5) The required 32 gutters are bent as follows: Place a strip of sheeting on the bending table with the edge protruding 2 cm. in front of the handle.

Place a foot firmly on each end of the handle to hold the sheet in a firm position. Bend the protruding strip of sheet upwards with hands and mallets until it lies flat against the handle.



6) Pull the sheet from under the handle and turn it around.

Place the sheet on the bending table with the bent corner upwards and flush with the rear edge of the bending table. (That is 14.5 cm. from the front of the handle.)



7) Place a foot firmly at each end of the handle to hold the sheeting in position and bend the sheet upwards with hands and mallets until the sheet lies flat against the handle.

MAKING THE GUTTERS



8) Pull the bent corner of the sheet backwards and align it to be flush with the rear edge of the bending table.

Keep the sheet in firm position by placing a foot at each end of the handle.

Bend the protruding edge about 2 cm. upwards until it lies flat against the handle.



9) One gutter is now completed.

Bend a total of 32 sheets this way for the required 28 sheets of gutters and 4 sheets for down-gutters.

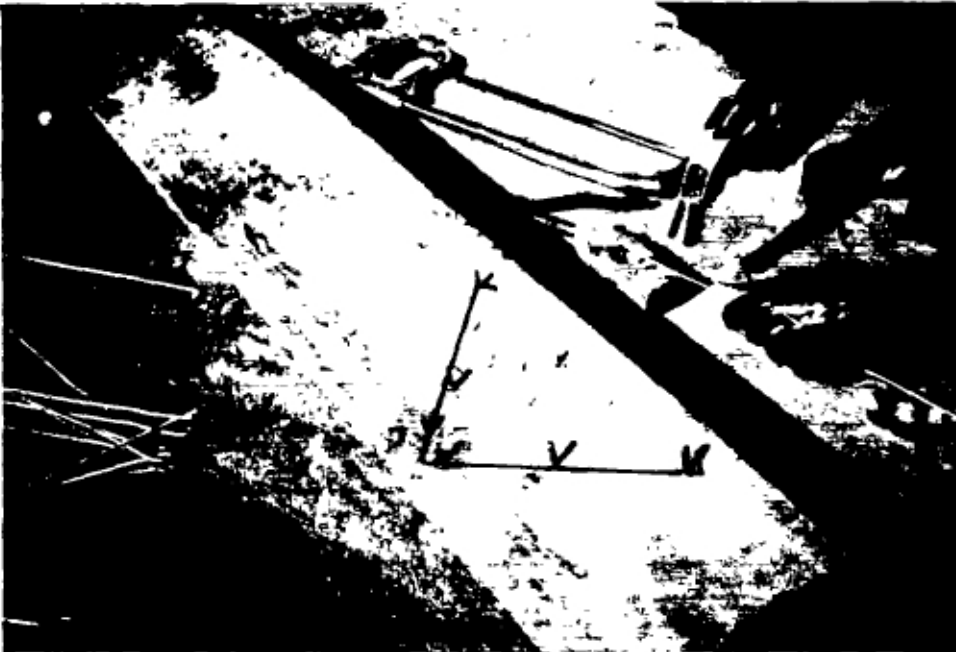


10) For the 28 gutters required a total of 60 gutter hangers are needed.

Gutter-hangers are made of 3 mm. galvanized wire cut into lengths of 70 cm.

Gutter-hangers should fit tightly around the gutters to prevent any twisting of the gutters when fitted.

MAKING GUTTER-HANGERS



11) The exact shape of the gutter is drawn on a piece of timber. Ensure that the corners of the drawn gutter are 90 degrees.

Nails without heads are then nailed along the drawn line of the gutter as shown here.

An eye is then made on one end of each length of wire.



12) Fit the eye of the wire onto the nail at the upper left hand corner of the outline of the gutter and lay it along the line of the left side of the gutter.

Bend the wire sharply around the nail at the bottom of the outline of the gutter.

Place the remaining length of wire along the line of the right side of the outline.



13) Turn the wire around the nail at the upper right end of the gutter and take it to the first nail, thereby completing a triangle.

Turn the last end of the wire around that nail, onto which the eye of the wire is placed, so that it forms a second eye.

Test that it fits the gutter before the remaining 59 gutter-hangers are made. The first gutter-hanger is now ready.

INSTALLING THE SPLASH-GUARDS



14) This photo shows how the splash-guards and gutters look when they are fitted to the uneven roof of an old school.

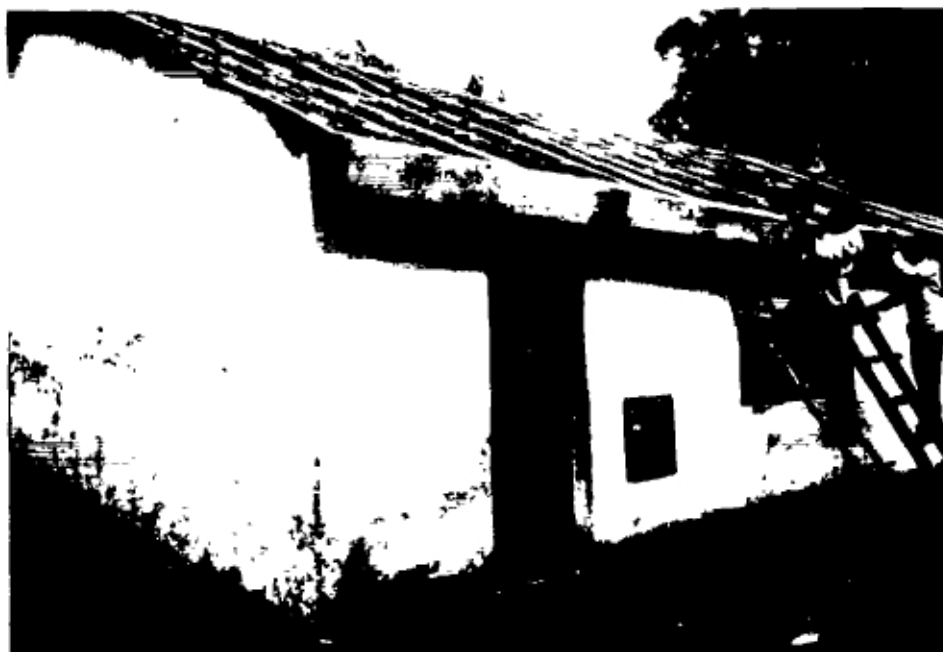
As can be seen the splash-guards are following the uneven line of the roof while the gutters are sloping evenly towards the tank.

15) Divide the 28 splash-guards, 14 for each side of the roof.

Fix with roofing nails the splash-guards onto the roofing sheets with overlaps of 10 cm.

The splash-guard should protrude 2 cm. from the end of the roofing sheet.

The length of 14 nailed splash-guards is 26.7 m.



16) To measure a slope of 1 cm per 100 cm for the gutters an exact horizontal level has to be marked at each end of the splash-guards.

Hold the ends of a hose-pipe filled with water up to the ends of the splash-guards.

Fill up the hosepipe with water until the water level is about 5 cm. below that corner of the splash-guard being furthest away from the tank. Mark the water level in the hosepipe onto each end of the splash-guard and that gives two exact horizontal marks.



INSTALLING THE GUTTERS



17) The slope of the gutters will be 26.7 cm. because the length of them is 26.7 m. (1 cm. per 1 m.).

The top of the hanger nearest to the tank is nailed onto a piece of timber 26.7 cm. below the horizontal mark.

The top of the second hanger is tied at the level of the horizontal mark at the other end of the splash-guard.

A tight string is tied between the bottoms of these 2 gutter-hangers to show the bottoms of the hangers to be fixed in between.



18) Holes for the hangers are punched for every 95 cm. just below the corner of the splash-guards

The first hole is punched 5 cm. from the end of the splash-guard which is nearest the tank.

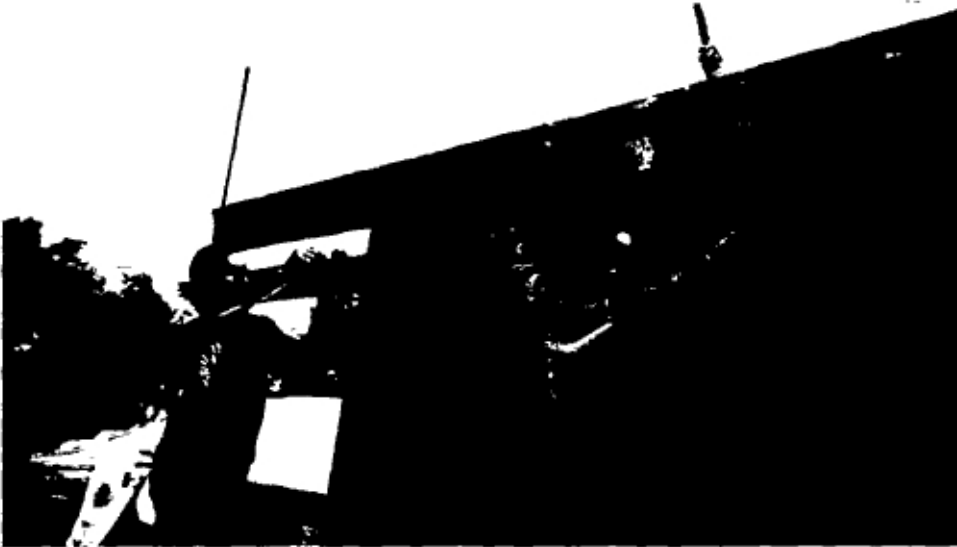


19) 28 of the gutters are fitted with a gutter-hanger in the middle and a second hanger 5 cm. from one of the ends.

Two of the gutters are fitted with one more hanger 5 cm. from the other end.

50 cm. lengths of 1.5 mm. galvanized wire are tied to the two eyes of each hanger. The gutters are now firmly fixed in the hangers.

INSTALLING THE GUTTERS



20) The first gutter is then tied to the corresponding holes in the splash-guard using the length of wire which is attached to the eyes of the hangers.

The height of the gutter is determined by the string pulled tight between the first and last hangers.

The gutter should hang 1 mm. above the string. Ensure that the string is straight all the time.



21) The remaining gutters are positioned in the same way. Each is laid on the previous gutter with an overlap of 10 cm.

If the overlap is made smaller or larger the holes in the splash-guard will not fit.

Each joint of the gutters is given a coat of bitumen paste to seal it.



22) Once the gutters are in place, all that remains is to close the far end of the gutter and to fit the down-gutters.

INSTALLING THE GUTTERS



23) The upper end of the gutter is closed by making 10 cm. cuts along the 3 angles of the gutters and -



24) - bending the two bigger sides inwards so that they form the end of the gutter.

Make 6 vertical cuts, each being 1 cm. deep, into the top of the ends.

Bend the 1 cm. tongues of the cut ends to the sides with pliers and flatten the edge with a hammer.



25) Cut off the two strips on the end of each edge of the gutter and bend the corners inwards.

This will form a closed end, without the need for soldering.

INSTALLING THE DOWN-GUTTERS



26) The two down-gutters are an extension of the roof gutters and are supported by two lengths of 4" x 1" timbers nailed into a V-shape. These timbers should be treated with wood-preservative before being nailed together.

The gutters are fitted in the V-shaped timbers. Only the top edge of the gutters are nailed to the timbers.



One end of the gutters are tied to the splash-guard and the purlin of the roof. The other end of the gutters rests loosely on the tank.

27) A sieve for the inflowing water is made of chicken or coffee mesh formed over a tin and tied together with a piece of wire. A hole, with a diameter of 15 cm. is cut in the dome at the end of the down-gutter's highest position.



28) The sieve is fitted into the hole and a collar of mortar is built around the hole.

A seat is made in the collar on which the down-gutter will rest loosely to allow it to be lifted out before the rains so that dust and dirt from the first shower in a season can be diverted away from the tank.

The gutter is now ready for rainwater to fill the tank



