I. SLATE

A. Description

Roofing slate is a dense, tough, durable rock material which is practically non-absorbent, having a porosity generally of 0.15 to 0.4 percent.

The principal property of slate is its natural "cleavage," which permits it to be easily split in one direction. A second direction of fracture, usually occurring at right angles to the cleavage is called the "grain." Roofing slates are commonly split so that the length of the slate runs in the direction of the grain.

The surface texture of slate after it is split for commercial use depends upon the characteristics of the rock from which it is quarried. Many slates split to a smooth, practically even, uniform surface while others split to a surface that is somewhat rough and uneven. As a result a wide range of surface effects is available for the appearance of slate roofs.

Some slate contains narrow "ribbons" of rock that are different in chemical composition and color from the slate itself. If the chemical composition of these ribbons does not weaken the slate and if the color is not objectionable, "ribbon" slates are acceptable for use. Slate which has been trimmed so that the ribbons are eliminated is known as "clear slate." Slate which contains acceptable ribbons is sold as "ribbon stock."

B. Colors of Roofing Slate

The color of slate is determined by its chemical and mineralogical composition. Since these factors differ in various regions, it is possible to obtain roofing slates in a variety of colors and shades. To relieve the monotony of a flat uniform roof color, various shades of the same colored slate may be used to provide interesting color patterns when applied up and down the roof, across the roof, or interspersed throughout the roof. The diversity in shades of color makes slate a valuable material in the creation of an aesthetically appealing roof.

Exposure to weather causes all slate to change slightly in color. The degree of color change varies with different slates. Those slates which exhibit minimal color change are classified as "permanent" or "unfading" slates. Those slates which exhibit a more obvious color change are known as "weathering" slates. Weathering slates offer the designer another variation in roof color.

When color is an essential consideration in roof design, architects and owners should consider the source of the slate, its potential for color change and the effect of weathering on the slate to be used. Quarry operators know from experience the probable degree of color change to be expected from the various slate materials obtained from their quarry. Their advice on the proper slate to be selected for a specific project should be consulted.

For the purpose of classifying the basic natural colors of roofing slate now available in large quantities for general use, the Division of Simplified Practice of the Department of Commerce recommends the following color nomenclature for slate materials:

BASIC SLATE COLORS			
Black Blue Black	Grey Blue Grey	Purple Mottled Purple and Green	Green Red

When selecting a slate color from a manufacturer, the color should be preceded by the word "unfading" or "weathering" to designate the color change that may be expected for a particular material.

C. Active Slate Quarries

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C. Active Slate Quarries

D. Standards for Slate

The establishment of one standard slate classification for all parts of the United States is impossible since some types of slate contain ribbons, others are clear, some have a rough surface, others a smooth surface, etc. To satisfy the need for slate classification, the National Slate Association has established various standards for commercial slate. The standards established by this association ensure that slate products meeting their standards will contain the characteristics essential for quality slate roofing. Therefore, architects and designers should specify that slate materials meet the grading standards of the National Slate Association.

E. Quantities of Slate Per Square

In the United States slate is sold by the "square." A square of roofing slate is defined by the U.S. Department of Commerce, National Bureau of Standards, in Simplified Practice Recommendation No. 14, as follows:

> "A square of roofing slate means a sufficient number of slate shingles of any size to cover 100 square feet of plain roofing surface, when laid with the approved or customary standard lap of 3 inches. Slates for surfacing flat roofs are usually laid tile fashion, without lap, in which case a square of slate would cover an area greater than 100 square feet."

The quantity of slate per square varies from 686 pieces of 10 inch x 6 inch slate to 98 pieces of 24 inch x 14 inch slate. (These quantities include an allowance for the 3 inch lap.)

It should be noted that for low-sloped roofs, where a 4 inch lap is required, an additional quantity of slate must be provided. For steep roofs or siding, where a 2 inch lap is sufficient, fewer slates will be needed. Slate, however, is always sold on the basis of the number of slates needed both to cover the roof and to satisfy the 3 inch lap requirement.

The following table shows the sizes for standard 3/16 inch thick slate, the minimum number of slates required per square, the respective exposures for the slates listed and the weight (per square) of the nails used to secure each size of slate.

SCHEDULE FOR STANDARD 3/16" THICK SLATE

Size of Slate (in.)	Slates Per Square	Exposure with 3" Lap	Nails Per Square (lbs.)	(ozs.)	Size of Slate (in.)	Slates Per Square	Exposure with 3" Lap	Nails Per Square (lbs.)	(ozs.)
26x14	89	11-1/2"	1	0	16x14	160	6-1/2"	1	13
					16x12	184	6-1/2"	2	2
24x16	86	10-1/2"	1	0	16x11	201	6-1/2"	2	5
24x14	98	10-1/2"	1	2	16x10	222	6-1/2"	2	8
24x13	106	10-1/2"	1	3	16x9	246	6-1/2"	2	13
24x11	125	10-1/2"	1	7	16x8	277	6-1/2"	3	2
24x12	114	10-1/2"	1	5					
					14x12	218	5-1/2"	2	8
22x14	108	9-1/2"	1	4	14x11	238	5-1/2"	2	11
22x13	117	9-1/2"	1	5	14x10	261	5-1/2"	3	3
22x12	126	9-1/2"	1	7	14x9	291	5-1/2"	3	5
22x11	138	9-1/2"	1	9	14x8	327	5-1/2"	3	12
22x10	152	9-1/2"	1	12	14x7	374	5-1/2"	4	4
20x14	121	8-1/2"	1	6	12x10	320	4-1/2"	3	10
20x13	132	8-1/2"	1	8	12x9	355	4-1/2"	4	1
20x12	141	8-1/2"	1	10	12x8	400	4-1/2"	4	9
20x11	154	8-1/2"	1	12	12x7	457	4-1/2"	5	3
20x10	170	8-1/2"	1	15	12x6	533	4-1/2"	6	1
20x9	189	8-1/2"	2	3					
					11x8	450	4"	5	2
18x14	137	7-1/2"	1	9	11x7	515	4"	5	14
18x13	148	7-1/2"	1	11					
18x12	160	7-1/2"	1	13	10x8	515	3-1/2"	5	14
18x11	175	7-1/2"	2	0	10x7	588	3-1/2"	7	4
18x10	192	7-1/2"	2	3	10x6	686	3-1/2"	7	13
18x9	213	7-1/2"	2	7					

TABLE I
Schedule for Standard Slate

F. Slate Weight

A square of slate on the roof (i.e., enough slate to cover 100 square feet of roof surface, including the standard 3 inch lap) will vary from 650 to 8,000 pounds, depending on the thickness of each slate (from 3/16 inch to 2 inches).

Slates of commercial standard thickness (approximately 3/16 inch) will weigh from 650 to 750 pounds per square. The dead load weight of slate per square, however, may be estimated at a maximum of 800 pounds per square (or 8 pounds per square foot) when the weight of the slate, felt and nails is combined.

Slate products vary in weight due to the different sizes and colors of slate products available for use and the quarries from which they are obtained. The following table shows the weights (per square) of slate products of different thicknesses for both sloped and flat roofs. The actual weight variations of slate products may be from 10% above to 15% below the weights shown in the table.

Slate Thickness (in.)	Sloping Roof With 3" Lap (Pounds Per Square)	Flat Roof Without Lap (Pounds Per Square)
3/16"	700 lbs.	240 lbs.
3/16"	750 lbs.	250 lbs.
1/4"	1,000 lbs.	335 lbs.
3/8"	1,500 lbs.	500 lbs.
1/2"	2,000 lbs.	675 lbs.
3/4"	3,000 lbs.	1,000 lbs.
1"	4,000 lbs.	1,330 lbs.
1-1/4"	5,000 lbs.	1,670 lbs.
1-1/2"	6,000 lbs.	2,000 lbs.
1-3/4"	7,000 lbs.	
2"	8,000 lbs.	

TABLE II
Average Weight of Slate Per Square (100 sq. ft.)

II. TYPES OF SLATE ROOFS

A. General Classification

Slate roofs may be classified into three general categories:

- Standard Slate Roofs
- Textural Slate Roofs
- Graduated Slate Roofs

B. Standard Slate Roofs

Standard Slate Roofs are those roofs composed of standard commercial slate (approximately 3/16 inch thick), having one uniform length and width and having square tails or butts laid to a line. Standard commercial slate may be used to form a variety of designs on the roof and are suitable for any building where a permanent roofing material is desired at a minimum cost. Standard Slate Roofs differ from other slate roofs only in the texture or appearance of the roof. If desired, the butts or corners of each slate may be trimmed to give a diamond, hexagonal or "Gothic" pattern for all or part of the roof. Variety in the pattern of Standard Slate Roofs is sometimes attained by laying two or more sizes of standard commercial slate over the same area.

C. Textural Slate Roofs

Textural Slate Roofs are composed of textural slate, which is usually rougher in texture than standard slate. Textural slates are produced with uneven butts and with variations in thickness and size. In general, the term "textural slate" is not applied to slate over 3/8 inch in thickness. Varying shades of textural slate are frequently used to enhance the color effect of the roof. In addition to the basic colors of textural slate, other colorings, such as bronze or orange, may also be obtained in limited quantities. Textural Slate Roofs are aesthetically pleasing due to the variations in texture and color attainable with textural slate.

D. Graduated Slate Roofs

Graduated Slate Roofs combine the artistic features of the Textural Slate Roof with variations in thickness, size and exposure. In Graduated Slate Roofs, the thickest and longest slates are placed at the eaves. As the slate courses progress to the ridge, slates of gradually diminishing size and thickness are used, creating the "graduated" effect. Slates for roofs of this type can be obtained in any combination of thicknesses from 3/16 inch to 1-1/2 inches. Heavier slates are available if desired.

Graduated Slate Roofs may be installed in a wide variety of patterns. The fact that they are specially designed to harmonize with the general character of the building of which they become a part or to meet exacting construction requirements has earned this type of slate roof the title of "the custom-made roof of the industry." In fact, some producers and distributors for graduated slate roofs maintain a special design staff to assist architects in designing the most suitable and satisfactory Graduated Slate Roofs.

III. APPLICATION OF SLATE

A. Application Guidelines

The following is a list of general guidelines for the application of slate products.

1. Slate application should be handled by a knowledgeable contractor employing well trained, experienced workmen.

2. No through joints should occur from the roof surface to the felt. The joints in each slate course should be well separated from those below; otherwise, water may migrate through the joints and cause felts to disintegrate and leaks to develop in the roof.

3. Where slates of random width are used, the overlapping slate should be jointed as near the center of the underlying slate as possible and not less than 3 inches from any underlying joint. (See Figure 1.)

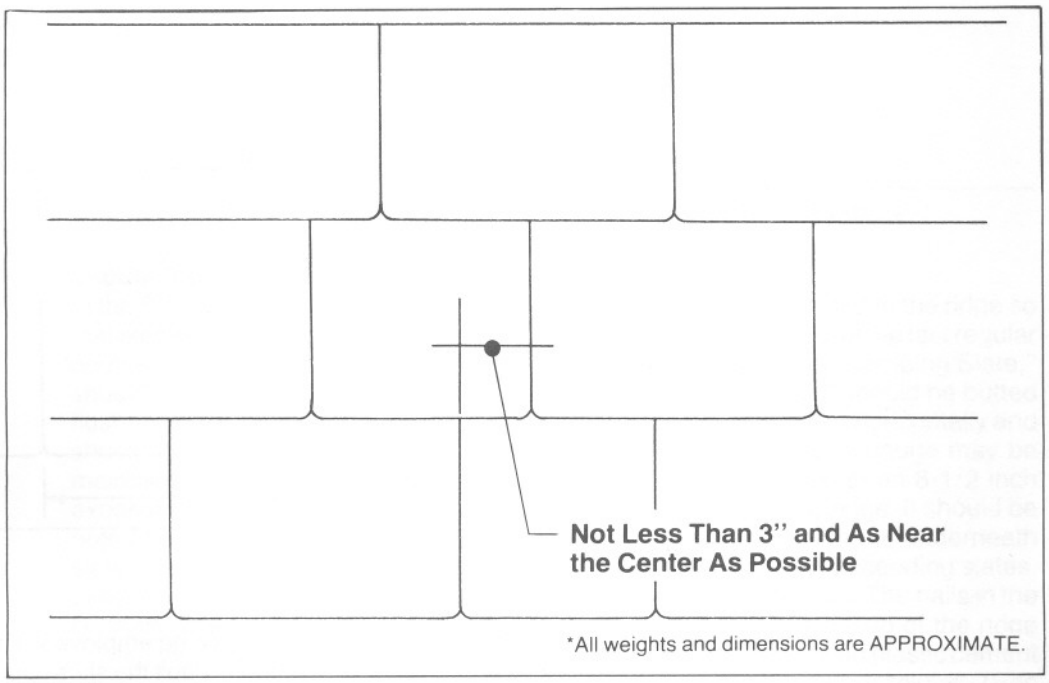

FIGURE 1
Proper Jointing

4. Where all slates are of one width, the requirement noted in #3 above is easily attained by starting every other course with a half-slate or, where available and practical, with a slate that is one and one-half times the width of the other slates as shown in the following figure.

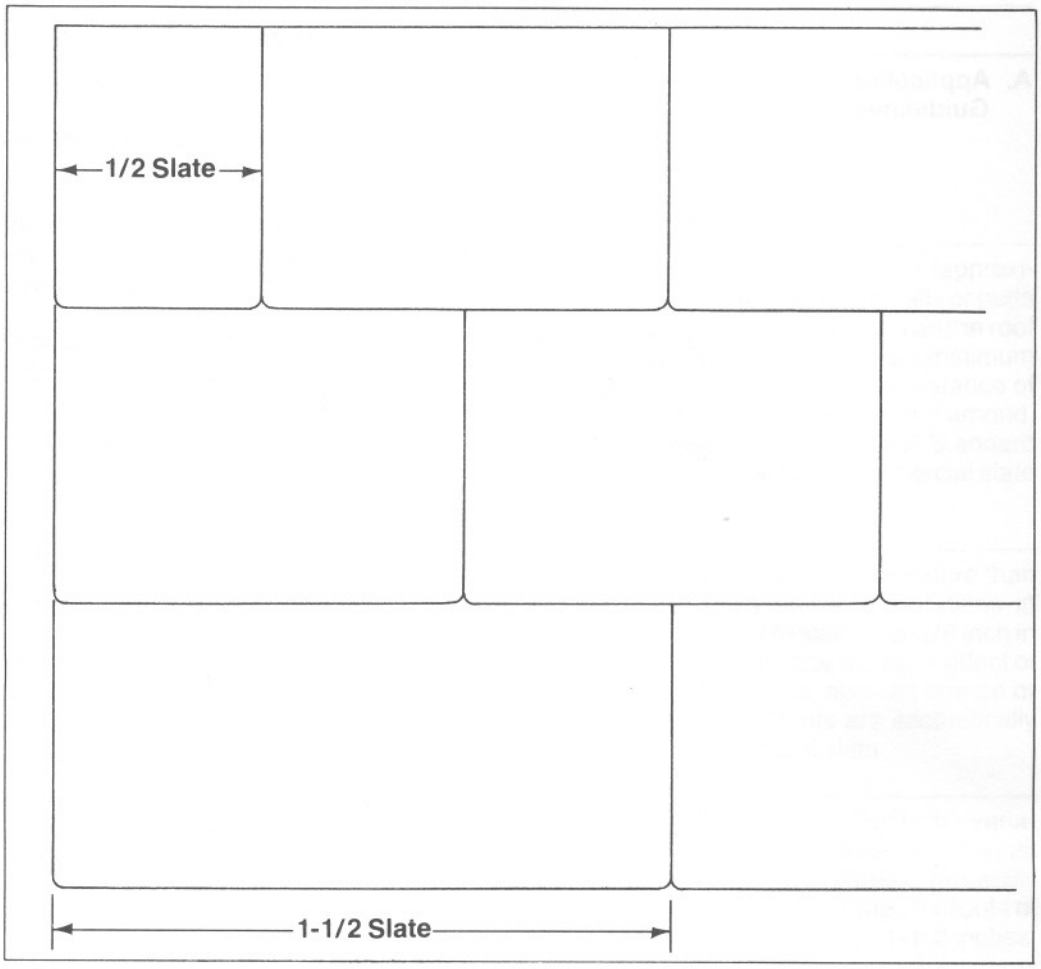

FIGURE 2
Starting Slate

5. For most roofs a standard 3 inch lap should be employed. The standard 3 inch lap refers to the portion of an individual slate that overlaps the slate course below it. Employing a lap of less than 3 inches reduces the amount of material over which water may be blown and, thereby, increases the possibility of leaks occurring in the roof.

   For steeper roofs, such as the Mansard Roof and other roofs nearly vertical in plane, a 2 inch lap will usually be sufficient.

B. Slate Exposures

The "exposure" of a slate is the portion not covered by the next course of slate above and is, thus, the length of the unit exposed to the weather. The proper exposure to use for each slate is obtained by deducting 3 inches from the length of the slate and dividing that number by two. For instance, the proper exposure for a 24 inch slate is:

24 inches − 3 inches = 21 inches ÷ 2 = 10-1/2 inches

The following table shows the proper exposures for various lengths of slate.

Length of Slate	Slate Exposure
24''	10-1/2''
22''	9-1/2''
20''	8-1/2''
18''	7-1/2''
16''	6-1/2''
14''	5-1/2''
12''	4-1/2''
10''	3-1/2''

TABLE III
Slate Exposures for Roof Slopes of 8'' to 20'' Per Foot (with 3'' Lap)

C. Slate at Ridge Locations

Slate may be applied to the ridge of a roof in one of the two following methods.

1. **Saddle Ridge Method**
   In the Saddle Ridge Method, regular roofing slates should be extended to the ridge so that pieces of slate on the opposite sides of the roof butt flush. On top of the last regular course of roofing slate at the ridge, another course of slate, called "Combing Slate," should be laid, and pieces of slate on the opposite sides of the roof should be butted flush. The Combing Slate should usually be laid with the grain running horizontally and should be of such width that an approximately uniform exposure or gauge may be maintained. For example, if 20 inch x 12 inch slates are applied with an 8-1/2 inch exposure, 12 inch x 8 inch slates should be laid horizontally on the ridge. It should be noted that the Combing Slates should overlap and break joints with the underneath slate. In this way all nails in the Combing Slate are covered by the succeeding slates, except for the nails in the last slate, which is called the "finishing" slate. The nails in the finishing slate should be covered with plastic cement. The joints on top of the ridge formed by the butted edges of the Combing Slate should be filled in with plastic cement when conditions are such that these joints will be subjected to heavy rainfall. (See Figure 3.)

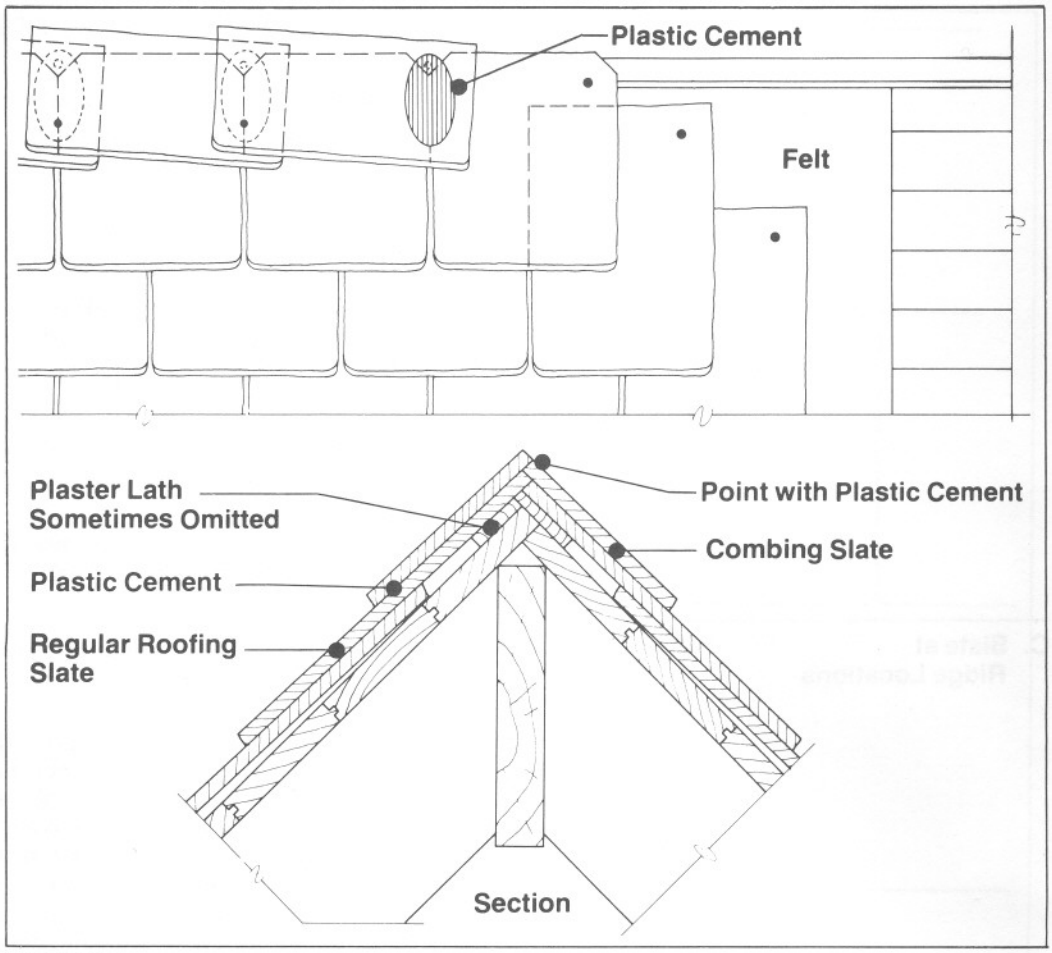

FIGURE 3
Saddle Ridge

Note: Many architects prefer to keep the grain of the slate vertical, using Combing Slate that is the same width and exposure as the regular slate used on the roof. In such cases, the starting slate should be a "slate-and-a-half" in width rather than a "half-slate" in width.

A variation of the Saddle Ridge is known as the "Strip Saddle Ridge." This type of ridge should be laid in a manner similar to Saddle Ridges except that the Combing Slates should not overlap; rather, they should butt flush and be attached with four nails. The Combing Slate for Strip Saddle Ridges may be the same width as the regular slate used on the roof or narrower if the designer wishes. The four nails should be covered with plastic cement, and the edges of the Combing Slate should be set in plastic cement. (See Figure 4.)

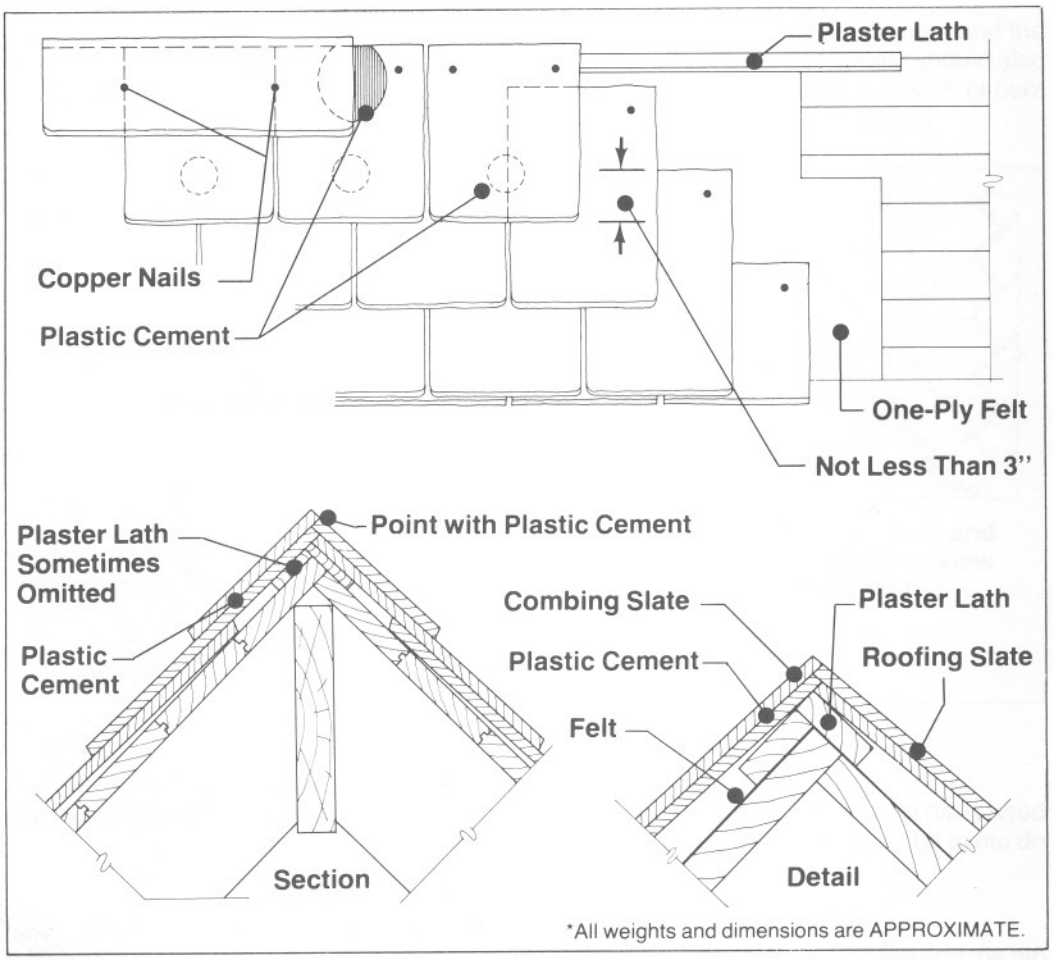

FIGURE 4
Strip Saddle Ridge

2. **Combing Ridge Method**
   In the Combing Ridge Method, slates should be laid in the same manner as in the Saddle Ridge Method, except that the Combing Slate of the north or east side should extend beyond the ridge line not more than 1 inch. In this type of ridge, the grain of the Combing Slate may run vertically or horizontally. In either case, the edge of the slate should be set in plastic cement, and the nails should be covered with plastic cement. It is recommended that the top or combing course project 1/16 to 1/8 inch above the under top courses to obtain a uniform finish and to allow easier filling in with plastic cement.

   A variation of the Combing Ridge is known as the "Coxcomb Ridge." In this type of ridge, the Combing Slates alternately project on either side of the ridge. (See Figure 5.)

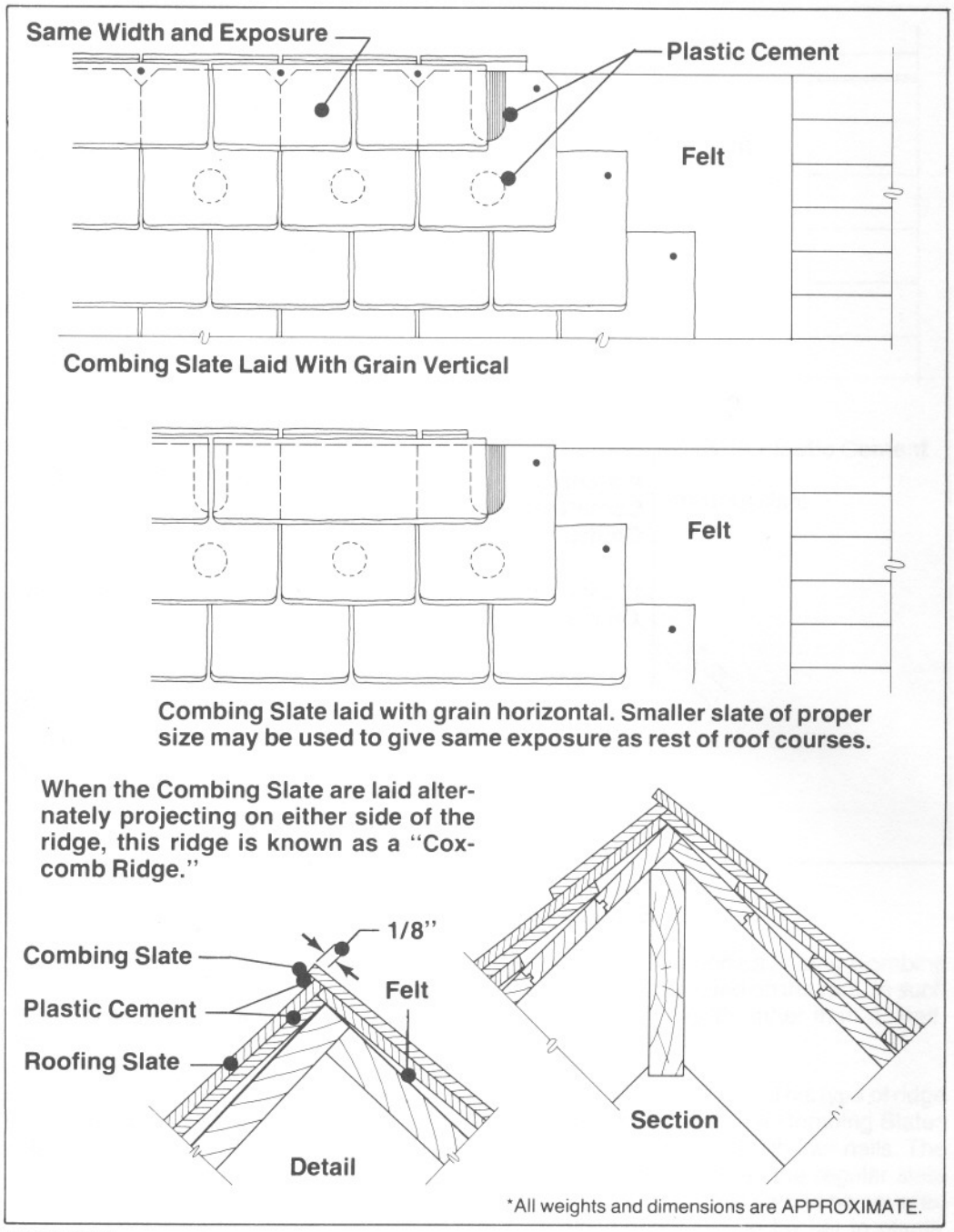

FIGURE 5
Combing Ridge

D. Forming Hips on Slate Roofs

Various methods exist for forming hips on slate roofs. The following is a discussion of the most common types of hips.

1. **Saddle Hips**
   Saddle Hips may be formed by placing either a one or two piece lathwork (for supporting a coat of plaster) or a 3-1/2 inch cant strip on the roof sheathing and running the regular roofing slate up to this strip. On top of the lathwork or cant strip, hip slates (usually of the same width and exposure as the regular slates used on the roof) should be laid.

   Four nails should be used to fasten the hip slates to the roof. The nails should be driven into the lathwork or cant strip. They should NOT be driven between the joints of the roof

sheathing. The heads of the nails should then be covered with plastic cement and the lower part of the next slate embedded in the plastic cement. Plastic cement should also be placed at the joint where the regular roofing slates butt against the lathwork or cant strip and on the peak of the hip before the hip slates are laid. (See Figure 6.)

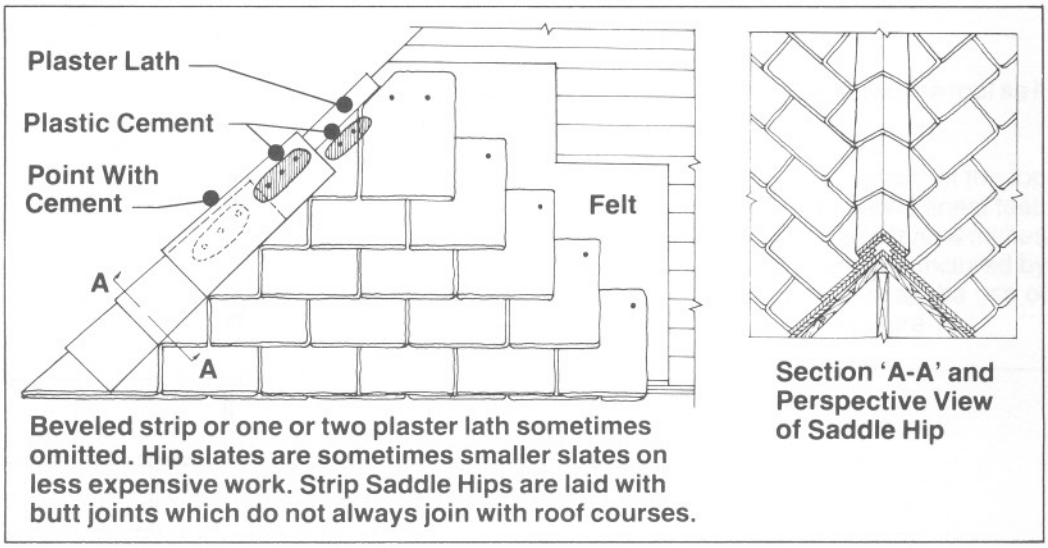

FIGURE 6
Saddle Hip

A variation of the Saddle Hip is known as the "Strip Saddle Hip." This type of hip is used on less expensive work and may be formed from narrower slates whose butt joints do not necessarily line up with the slate course of which it is a part.

2. **Mitred Hips**
Mitred Hips may be formed by applying the slate that forms the roof courses and the hip on one plane. The hip slates should be cut accurately to form tight joints, and the joints should be filled in with plastic cement. The nail holes of each slate should fall under the succeeding hip slate.

Metal or strip flashings may be woven into each course of Mitred Hips, but this is usually unnecessary if proper care and workmanship are exercised in cutting, fitting and embedding the hip slates. (See Figure 7.)

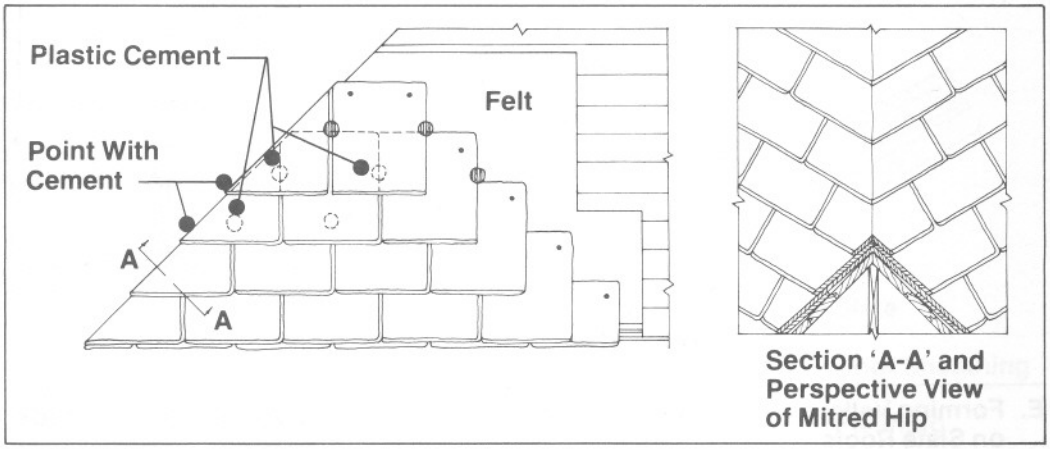

FIGURE 7
Mitred Hip

SADDLE HIP AND RIDGE AND MITERED HIPS SHOULD BE COPPER STEP FLASHED

A variation of the Mitred Hip is known as the "Fantail." This type of hip should be laid in the same manner as the Mitred Hip, but the bottom edge of the hip slate should be cut at an angle to form a fantail. (See Figure 8.)

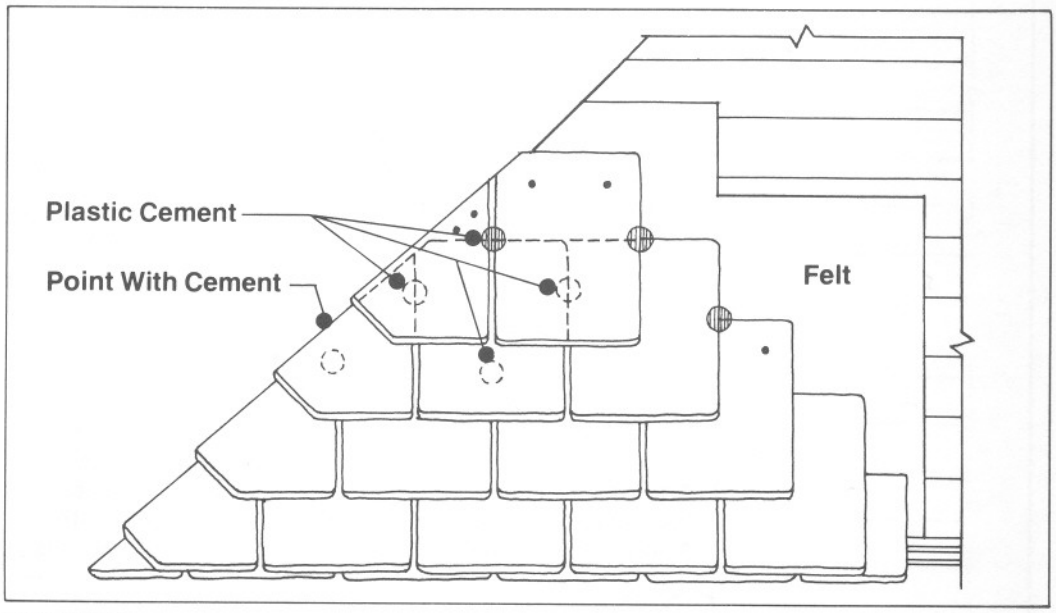

FIGURE 8
Fantail Hip

3. **Boston Hips**
   Boston Hips may be formed by weaving the hip slates into the regular courses of roofing slate. The nails should be covered with plastic cement, and the lower part of the succeeding slates should be embedded in plastic cement. (See Figure 9.)

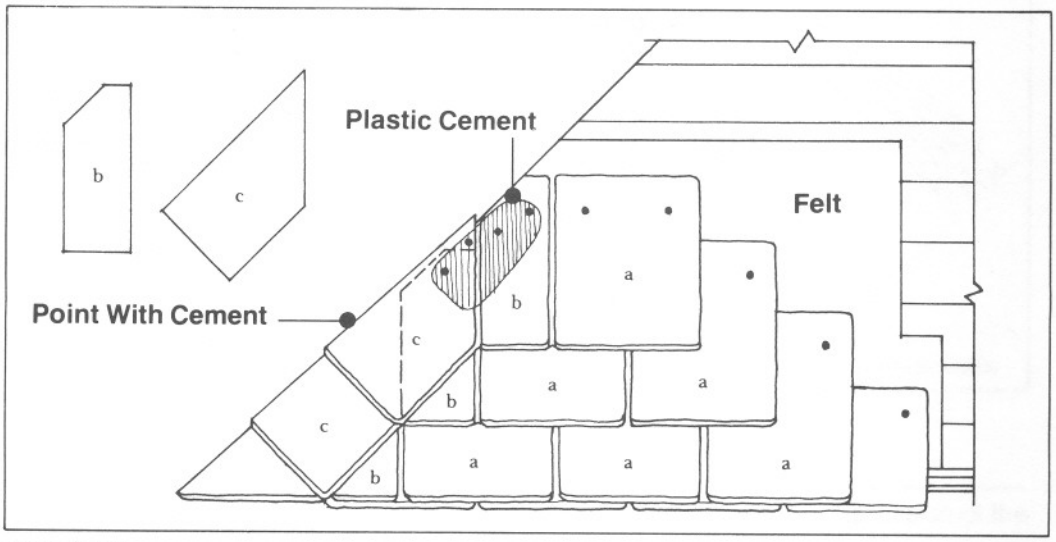

FIGURE 9
Boston Hip

E. Forming Valleys on Slate Roofs

The following is a list of the common types of valleys formed on slate roofs.

1. **Open Valleys**
   Open Valleys are formed by laying strips of sheet metal in the valley angle and lapping the slate over the sheet metal on either side, leaving a space between the edges of each slate to channel water down the valley angle. The width of the valley, or the amount of space between the slate edges, should increase uniformly down the valley.

The amount of this taper should be 1 inch for every 8 feet. For example, in a valley 16 feet long, the distance between slates should be 2 inches greater at the bottom of the valley than at the top, as the width increases at the rate of 1 inch for every 8 feet on each side of the valley. The difference in the width of the upper end of the valley and the lower end of the valley (referred to as the "taper"):

- Allows slate to be laid closer to the valley at the upper end
- Allows for the increase in water received at the lower end
- Allows any ice that may form on the roof to free itself and slide down the roof as it melts.

Slate application should begin 2 inches from each side of the valley center at the top and should taper away from the center at the rate of 1/2 inch for every 8 lineal feet. Metal flashing of sufficient width to extend up under the slates not less than 4 inches (preferably 6 to 8 inches) should be installed. The flashing must not be punctured by slating nails. Since the properties of slate make it a long lasting material, the use of copper or stainless steel is recommended for all flashing work. (See Figure 10.)

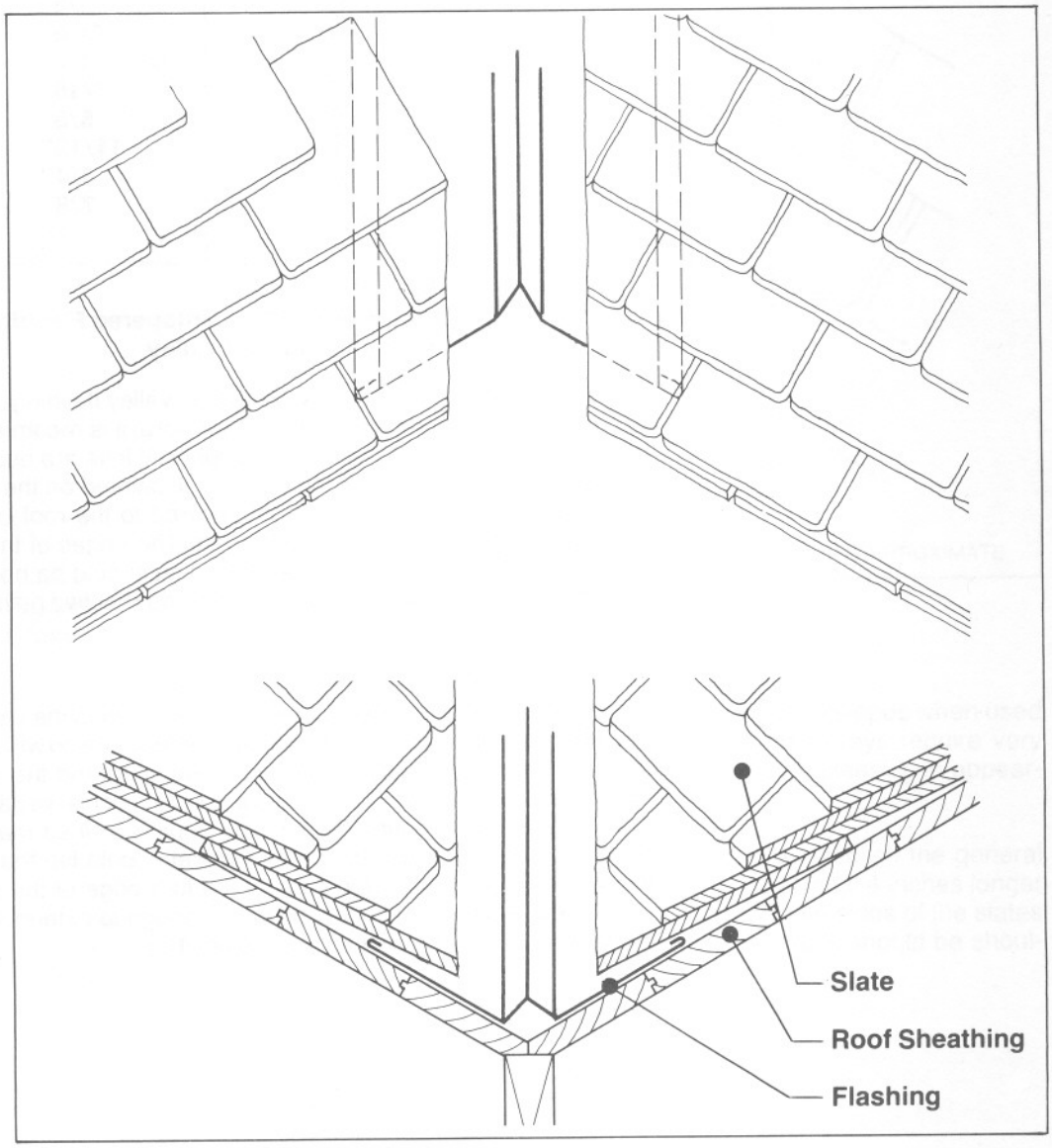

FIGURE 10
Open Valley

Where the two roof sections forming the valley have considerable difference in slope, causing a large variation in the volume of water that will be delivered into the valley, the metal flashing should be crimped or incorporated with a standing seam to break the force of the water from the steeper slope and to prevent water from being driven up under the slates on the opposite slope.

The increase in the valley's width must be considered in the placement of flashing strips. Valley flashing strips should be shorter than 8 feet in length. The width of each strip should be increased 1/2 inch per foot to accommodate the valley taper. (See Table IV.)

Length of Sheets (in.)	Increase in Width (in.)
24"	1/4"
30"	5/16"
36"	3/8"
42"	7/16"
48"	1/2"
54"	7/16"
60"	5/8"
66"	11/16"
72"	3/4"
84"	7/8"
96"	1"

TABLE IV
Increase in Width of Untapered Flashing Sheets in a Tapered Valley

Condensation forming on the underside of valley flashings, when not free to run off or evaporate, may damage the metal. Therefore, it is recommended that the use of felts be omitted under metals other than copper. If felts are used under metals other than copper, however, the metal should be well painted on the underside. For high-grade work, the copper sheets should be secured to the roof boards and felts with metal cleats spaced from 8 to 12 inches apart. The edges of the sheets should be turned back 1/2 inch, and the bent end of the cleat should be hooked under this edge. The cleat should then be nailed to the roof boards with two nails and the cleat bent over to cover the nails.

2. **Closed Valleys**
Closed Valleys are formed by laying the slate tight to the valley line and placing pieces of metal under the slate. The size of the metal sheets to which the slate will be attached should be determined by the length of the slate and the slope of the adjoining roof section. Each metal sheet should be laid out in such a way as to extend 2 inches above the top of the slate course that will be applied to it so that the sheet may be nailed directly to the roof deck. Each metal sheet should lap the sheet below by at least 3 inches and should be set in back of the butt edge of the slate above in order to be concealed. Each sheet should be wide enough to extend 4 inches from the center of the valley to the roof surface. (See Figure 11.)

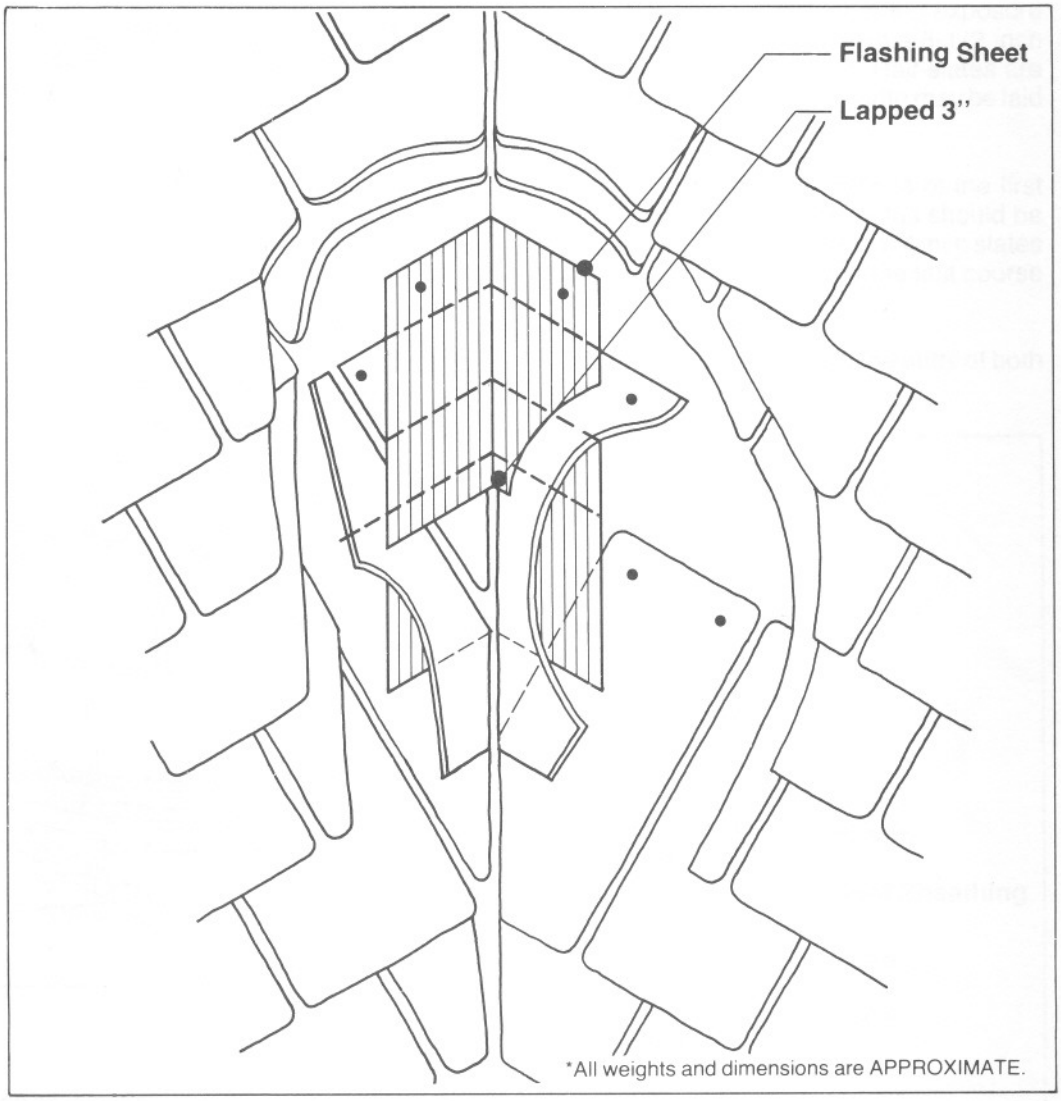

FIGURE 11
Closed Valley

3. **Round Valleys**
   Round Valleys form a pleasing transition between two intersecting slopes when used with the Graduated or Textural Slate Roof. However, Round Valleys require very careful workmanship in order to ensure that the roof will be both pleasing in appearance and watertight.

   Round Valley slates require a suitable foundation in order to establish the general valley contour. The valley slates for Round Valleys should be at least 4 inches longer than the slates used in the corresponding courses of the roof. The sides of the slates should be trimmed to the proper radius, and the tops of the slates should be shouldered to make the slates lay flat. (See Figure 12.)

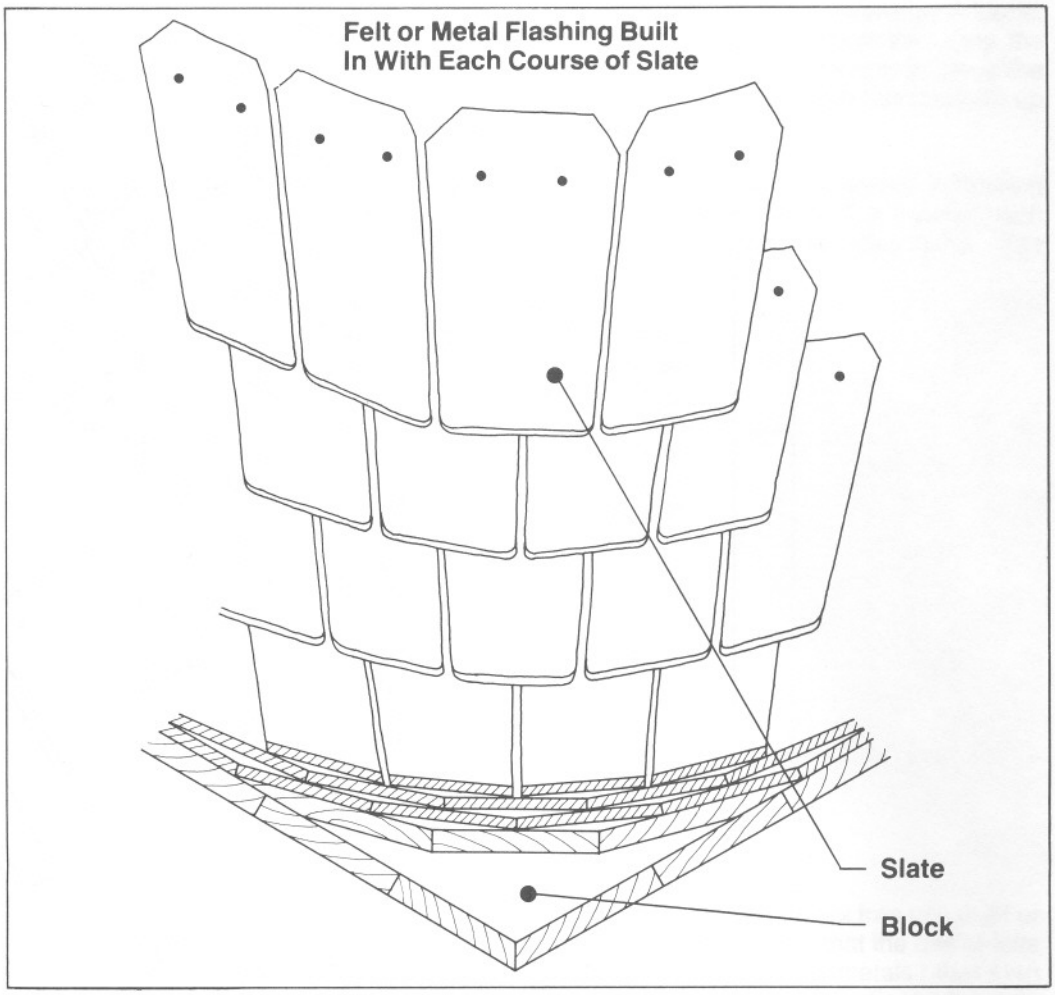

FIGURE 12
Round Valley

Round Valley slates are sometimes embedded in plastic cement. If proper care is used in the trimming and fitting of slates, no flashings should be necessary. Where workmanship is not dependable, however, flashings of metal or prepared roofing material cut to the proper radius should be used as a precautionary measure. Flashings should always be used wherever ice may form.

Round Valleys have a maximum radius at the eaves that gradually diminishes to practically zero at the ridge. For appearance, as well as to facilitate laying the valley slates, the distance of the valley across the eaves should be not less than 26 inches. If roof conditions will not permit this distance, the Canoe Valley should be used.

4. **Canoe Valleys**
   The Canoe Valley is a variation of the Round Valley and is laid in the same manner, except that the radius at the eaves and ridge is practically zero. The radius at the eaves and ridge should gradually be increased until it reaches a maximum radius half way between the eaves and the ridge.

F. Slate at Eaves and Gables

The following procedure should be used when applying slate at eaves and gables.

1. The under-eaves course of slate should be attached to a cant strip of suitable thickness (determined by the thickness of the slate) to enable the second course of slate to be properly aligned. In the case of a cornice, the slate should project approximately 2 inches beyond the taper strip, sheathing or finishing slate.

2. The length of the under-eaves slates is computed by adding 3 inches to the exposure being used for the regular slates. Thus, if 16 inch slates are applied with a 6-1/2 inch exposure, the length of the under-eaves slates should be 9-1/2 inches. Half-slates are sometimes used for this purpose; otherwise, roofing slates of the proper width may be laid horizontally.

3. The thickness of the under-eaves course should be one half the thickness of the first course. Therefore, if the first course is 3/4 inch in thickness, 3/8 inch slates should be used for the under-eaves course. If the first course is 1/2 inch in thickness, 1/4 inch slates should be used. (In some cases, however, the under-eaves course and the first course are the same thickness.)

4. The first course of slate should be laid over the under-eaves course with the butts of both courses flush and the joints broken. (See Figure 13.)

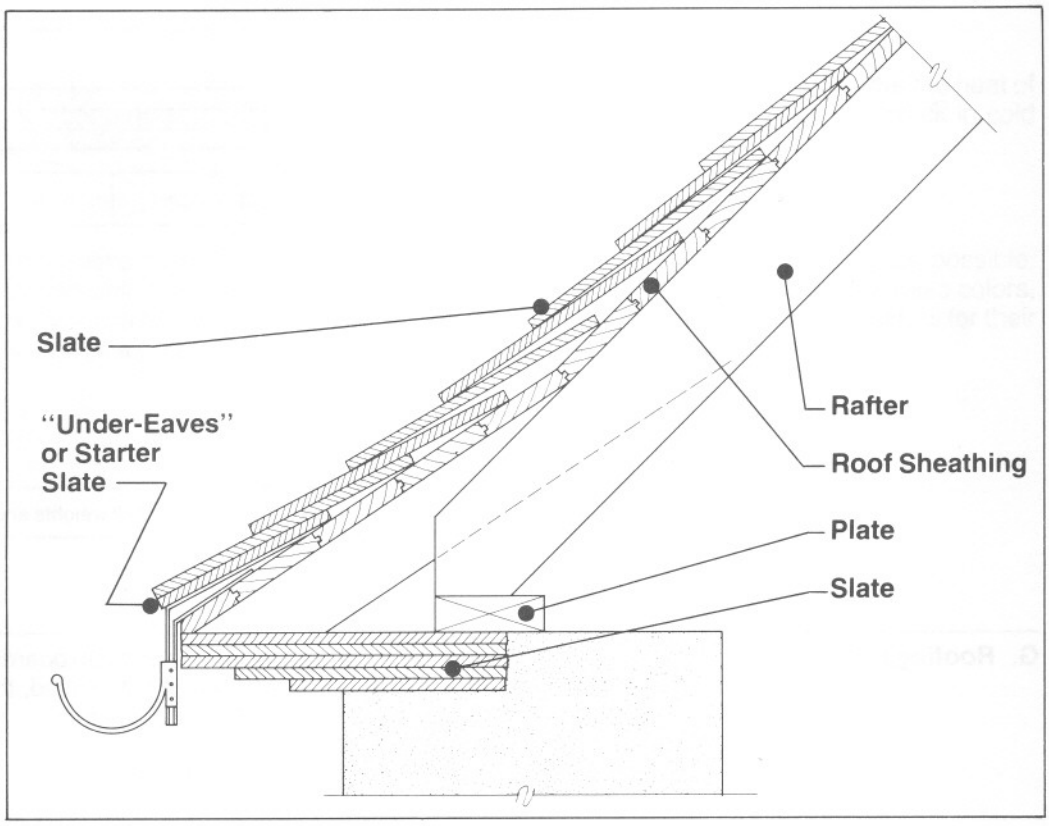

FIGURE 13
Slate at Eaves

Where a roof changes from a low slope to a steeper slope, as in the case of a Gambrel Roof, the slate of the lower sloped roof section above should project 2 inches to 2-1/2 inches beyond the steeper roof section below. A taper strip should also be used to attach the slate of the lower sloped roof section (just as at the eaves).

At gables the slate should overhang the finishing slate of the verge board by not more than 1 inch. Where close-slipped gables are used or the gable construction is such that the gable slates will have ample nailing area, this dimension may be increased, but the projection should be slight to retain a good roof appearance. "Gable-End Slates" or "Barge Slates" may be laid in many interesting patterns under regular slate courses along gable ends to achieve a shadow effect. If Barge Slate is used for this purpose, the lower outer edge of all Barge Slates should be cut at a 45° angle to form corners. (See Figure 14.)

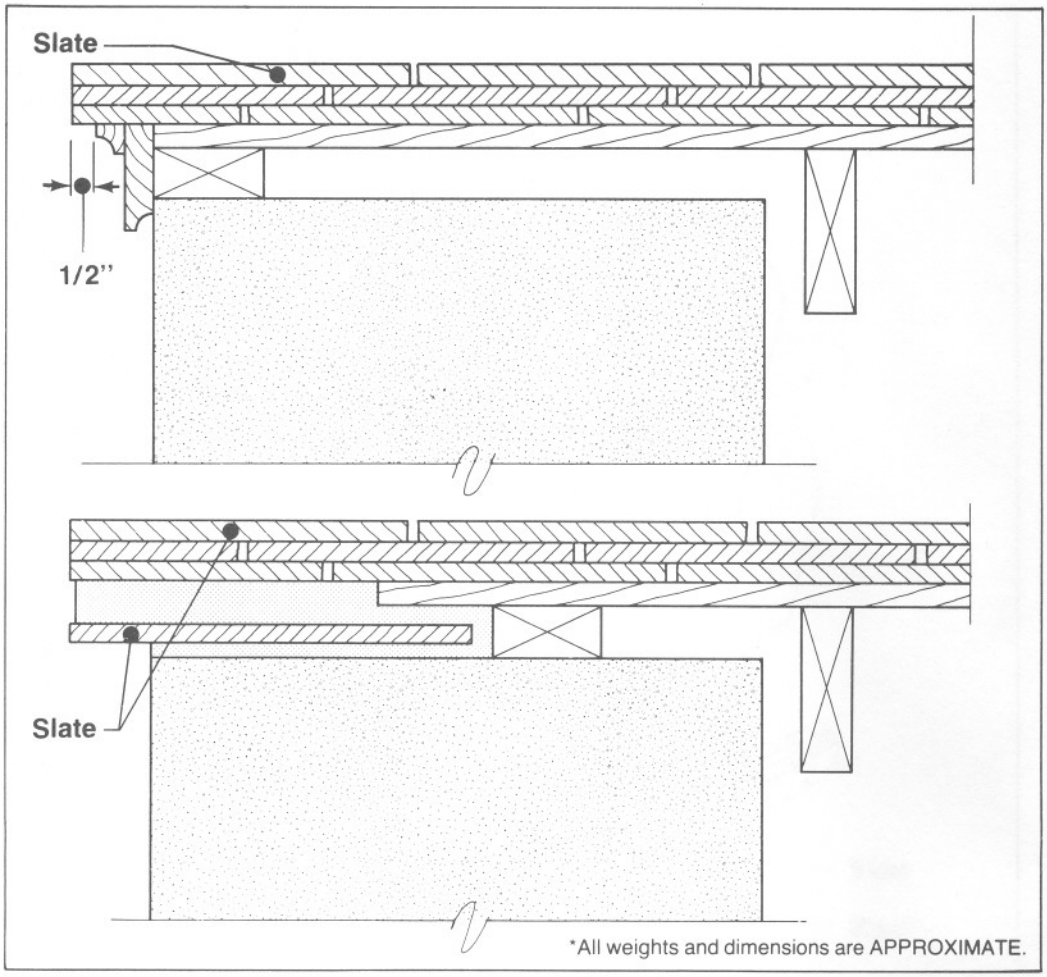

FIGURE 14
Slate at Gable

G. Roofing Felts

A watertight Standard Slate Roof can be laid on open lath boards instead of on felt, as is often done on buildings where heat is not required. If felt is used, the thickness of the felt has a relatively minor effect on the watertight integrity of the roof.

Roofing felt serves two distinct purposes in slate roofing:

- If placed as soon as the roof is sheathed, felt will protect the building from moisture entry until the slates are laid.
- It forms a cushion for the slate. This cushion is especially important where thick slates are used. For Standard Slate Roofs, a No. 30 felt should be applied. For Graduated Slate Roofs, two layers of felt should be applied, and the joints and laps of the felts should be staggered. As with tile, whenever slate is laid on a roof with a minimum slope of 4 inches per foot or less, a double-layer of felt set either in mastic or hot asphalt is recommended to ensure a watertight roof.

Felts for use in slate roofing should be either:

- Unperforated asphalt saturated felts, or
- Asbestos felts.

The following is a list of general guidelines for applying felts for slate roofing purposes.

1. Felts should be laid in horizontal layers with the joints lapped toward the eaves and at the ends.

2. A lap of at least 3 inches should be employed, and the edges of the felts should be well secured to the surface over which the felts are laid.

3. A lap of not less than 2 inches should be employed over the metal lining of valleys and gutters.

4. Over all hips and ridges, felts should be extended at least 12 inches to form a double thickness.

H. Plastic Cement

Plastic cement is used under slates at hip and ridge locations to help secure those slates which are usually smaller than regular roofing slates and which cannot be easily nailed. Plastic cement is also used for pointing the peaks of hips and ridges.

The following requirements should govern the selection of plastic cement:

- It should be waterproof.
- It should have a high melting point to prevent the slates from slipping under the heat of the sun, and a low freezing point so that it will not become brittle and crack in cold weather.
- It should be oily and sticky in order to adhere thoroughly to the roof.

The plastic cement selected should match the color of the slate as nearly as possible. Certain colors of plastic cement, however, may fade with exposure. To avoid these colors, designers and contractors are encouraged to contact experienced slate contractors for their advice on a particular color of plastic cement.

IV. NAILING PROCEDURES

A. Nail Holes

Every slate prepared for commercial use should have at least two nail holes provided in the slate for attachment purposes. Generally, two holes are machine-punched in all architectural roofing slate that is 1/4 inch or more in thickness. (Hole punching should be preformed at the quarry.) This procedure is also followed for commercial standard slate when so ordered. Four holes should be punched in slates that have a thickness of 3/4 inch or more and are more than 20 inches in length. Holes are punched 1/3 below the upper end of the slate and 1-1/4inches to 2 inches from the edge. Where four holes are punched in a slate, the two additional holes are usually punched about 2 inches above the regular holes.

Machine punching of nail holes is preferable to "hand punching." (Hand punching of nail holes usually involves the use of the double head slater's hammer, one head of which is in the form of a long prong.) Hand punching nail holes in slates on the job in order to prepare the slates to fit hips and other areas is, of course, necessary.

B. Requirements

The majority of slate roof failures over a period of years may be attributed to the punching of nail holes, the nailing of slates, or the nails themselves. The following diagrams show examples of proper and improper slate nailing.

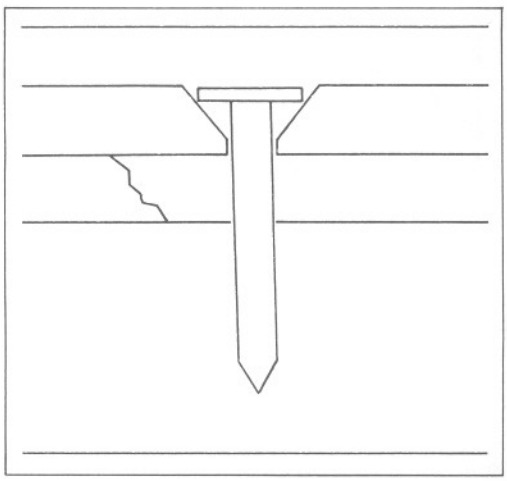

FIGURE 15
Proper Nailing

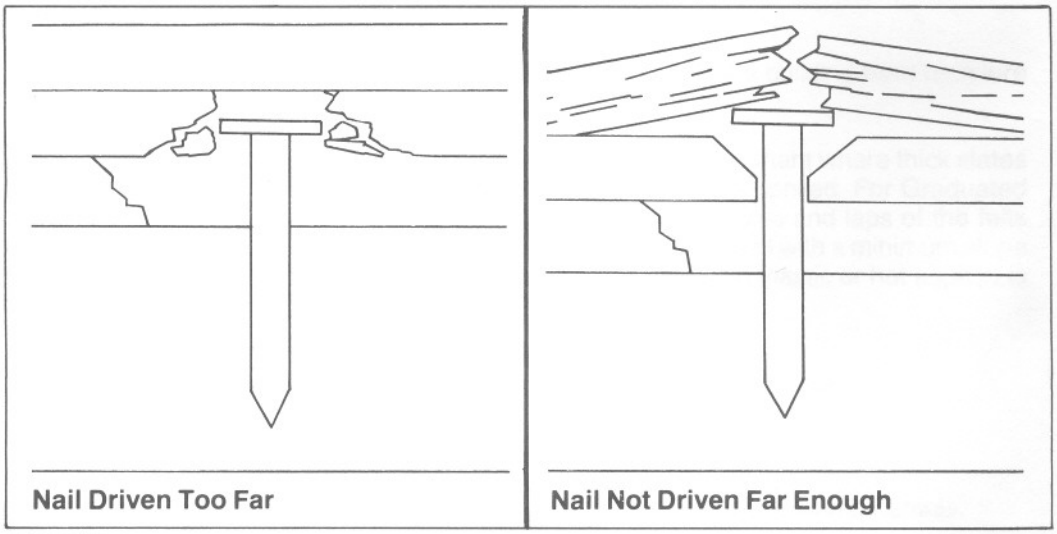

FIGURE 16
Improper Nailing

The use of shingle nails instead of slating nails for the attachment of slates is discouraged. Architects should insist that only copper slating nails be used for slate application.

The following is a list of general requirements for the selection of nails for slate roofing purposes.

1. For all practical purposes, ordinary diamond point nails and smooth shaft nails are satisfactory for slate nailing; needle point nails are UNSATISFACTORY for slate nailing.

2. Under ordinary conditions, the following gauge nails should be used for the various types of slate listed.

   - **3d** nails should be used for commercial standard slates up to 18 inches in length.
   - **4d** nails should be used for commercial standard slates longer than 18 inches.
   - **6d** nails should be used at hip and ridge locations.

   Thicker slates require longer and heavier gauge nails. The proper size nails for thicker slates may be determined by multiplying the thickness of the slate by 2 and adding 1 inch. For example, if 3/8 inch slate is used, 1-3/4 inch nails should be used.

3. Nails should be long enough to penetrate the roof sheathing. Thus, a 1/4 inch slate will require a **4d** nail that is 1-1/2 inches long. Where the underside of roof boards is exposed to view, as is sometimes the case in overhanging eaves, the nails should be long enough to penetrate the roof sheathing but not so long that they may be driven through the sheathing.

V. FLASHINGS

A. Requirements

Flashings should be used around all roof surface projections and at all surfaces against which the roof abuts, such as walls, parapets, dormers, sides of chimneys, etc. The first consideration for the selection of flashing materials should be durability. The materials which have proven to be durable flashing materials are copper, tin, lead, galvanized iron, zinc and stainless steel.

B. Avoiding Galvanic Action

When dissimilar metals are placed in contact with one another in the presence of an electrolyte, galvanic action will result, which can cause electropositive metals to deteriorate. The possibility of galvanic action occurring between copper and iron or steel should be carefully avoided by the use of proper insulation. Insulating the copper may be achieved in three ways:

- Covering the steel member with asbestos insulation, as is frequently done in skylight construction
- Placing strips of sheet lead between the two metals, as is done when new copper gutters are placed in old iron hangers
- Heavily tinning the iron, as is often done with iron or steel gutter and leader supports.

C. Base Flashings

Flashings which are used over or under the roof coverings and are turned up on the vertical surface are called "base flashings." The following are general requirements for the installation of base flashings on slate roofs.

1. Base flashings should extend under the uppermost row of slate the full depth of the slate or at least 4 inches over the slate immediately below the metal.
2. The vertical leg of the metal should be turned up not less than 4 inches and preferably 8 inches on the abutting surface. Where a vertical surface butts against the roof slope, the base flashing should be built into each course of slate as it is laid, turning the metal out 4 inches on the slate and at least 8 inches above the roof.
3. If the roof stops against a stuccoed wall, a wood strip, 4 inches wide and having a bevelled top edge, should be secured to the wall. The base flashing should then be turned out over the slate at least 4 inches and bent up vertically at least 3 inches on the board.
4. Except in unusual cases, the base flashing should be turned out 4 inches on the roof surface and from 6 to 8 inches on the vertical surface for either sloping or flat roofs.
5. Base flashings should be used where posts, flagpoles, scuttles, etc., project through the roof. Vent pipes require base flashings either in the form of special sleeves or in one of the numerous patented roof flashing devices.

D. Cap Flashings (Counterflashings)

Metal built into the vertical surface of a roof and bent down over the base flashing is termed "cap flashing" or "counterflashing." The following are general requirements for the installation of cap flashings (or counterflashings) on slate roofs.

1. Where the base flashing is not covered by vertical slate, siding, etc., a cap flashing should be built into the masonry joints not less than 2 inches, extending down over the base flashing 4 inches, and the edge bent back and up 1/2 inch.
2. Reglets in stone or concrete are usually approximately 1 inch wide and 1 inch deep. The flashing for reglets should be formed and laid in the bottom of the cut and thoroughly anchored and caulked.
3. Flashing hooks should be used to secure step flashings, and the vertical legs of the flashing should be secured with roofer's cement colored to match the masonry. Soldering of step flashings is recommended.

4. The edges of all exposed and unfastened flashings should be turned under 1/2 inch to give the strip stiffness against wind. This fold in the flashing holds it in place and prevents snow from packing in under the flashing.

E. Illustrations

The following illustrations show proper flashing procedures for slate roofs.

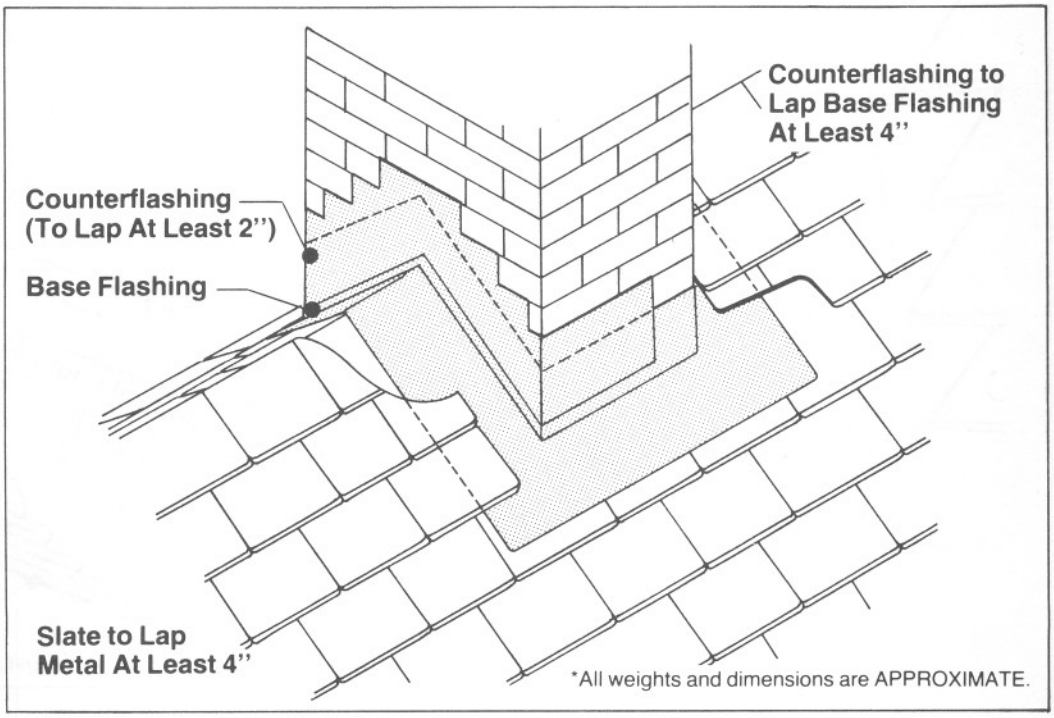

FIGURE 17
Flashing for Chimney on Ridge

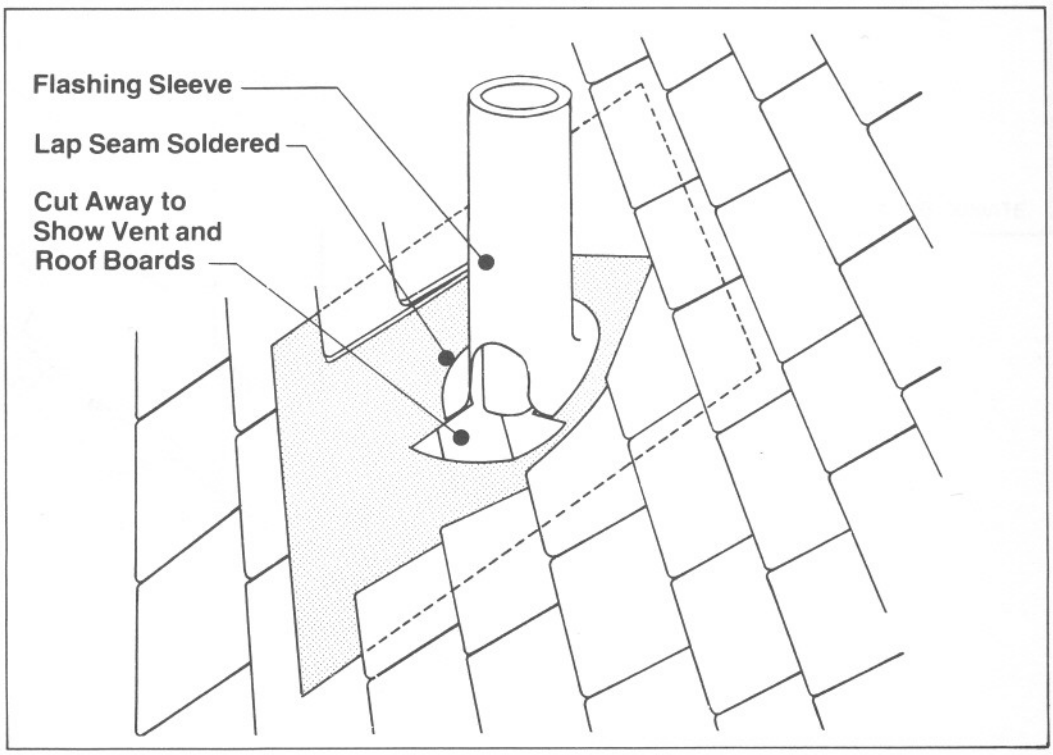

FIGURE 18
Flashing for a Vent Pipe

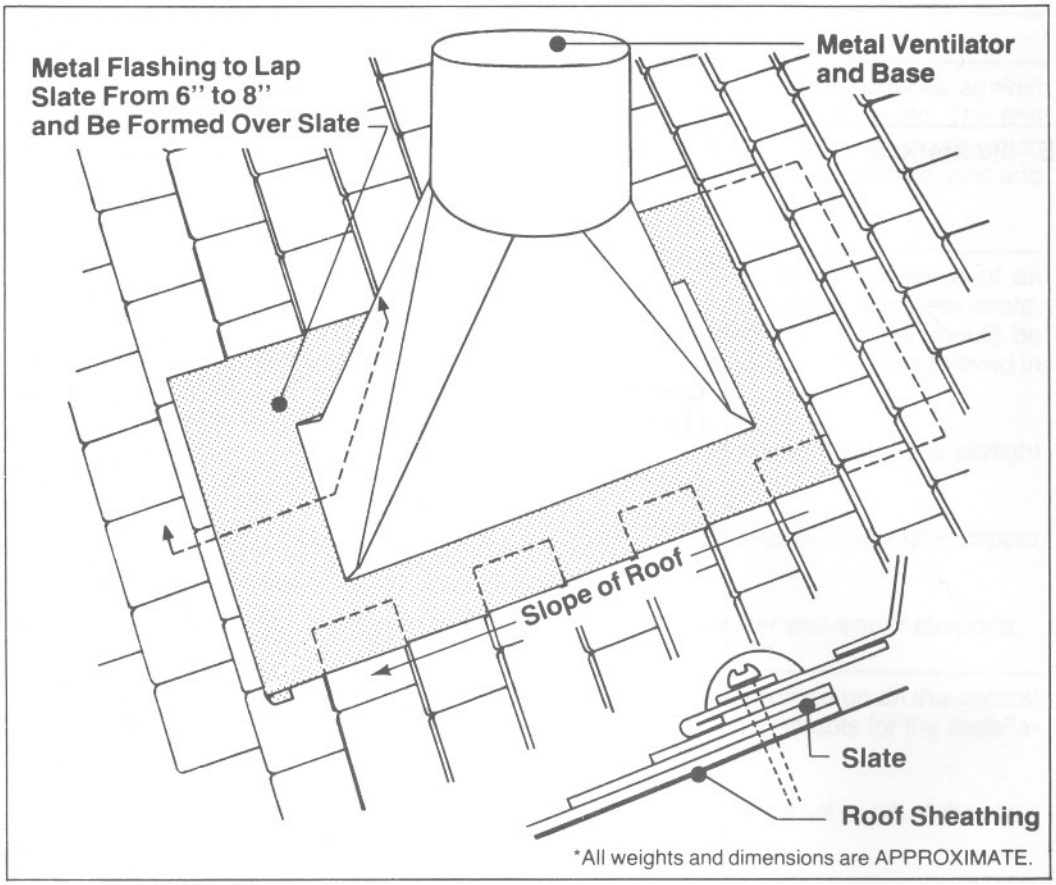

FIGURE 19
Flashing for a Ventilator

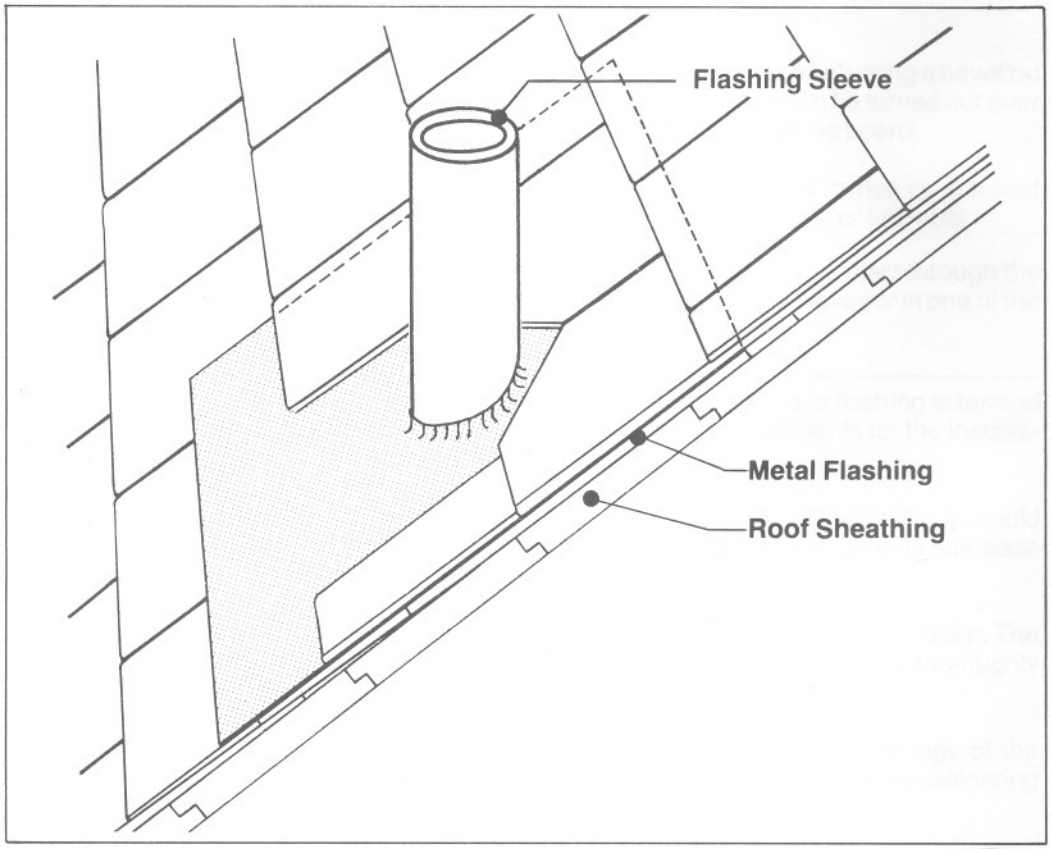

FIGURE 20
Flashing for Soil Stack

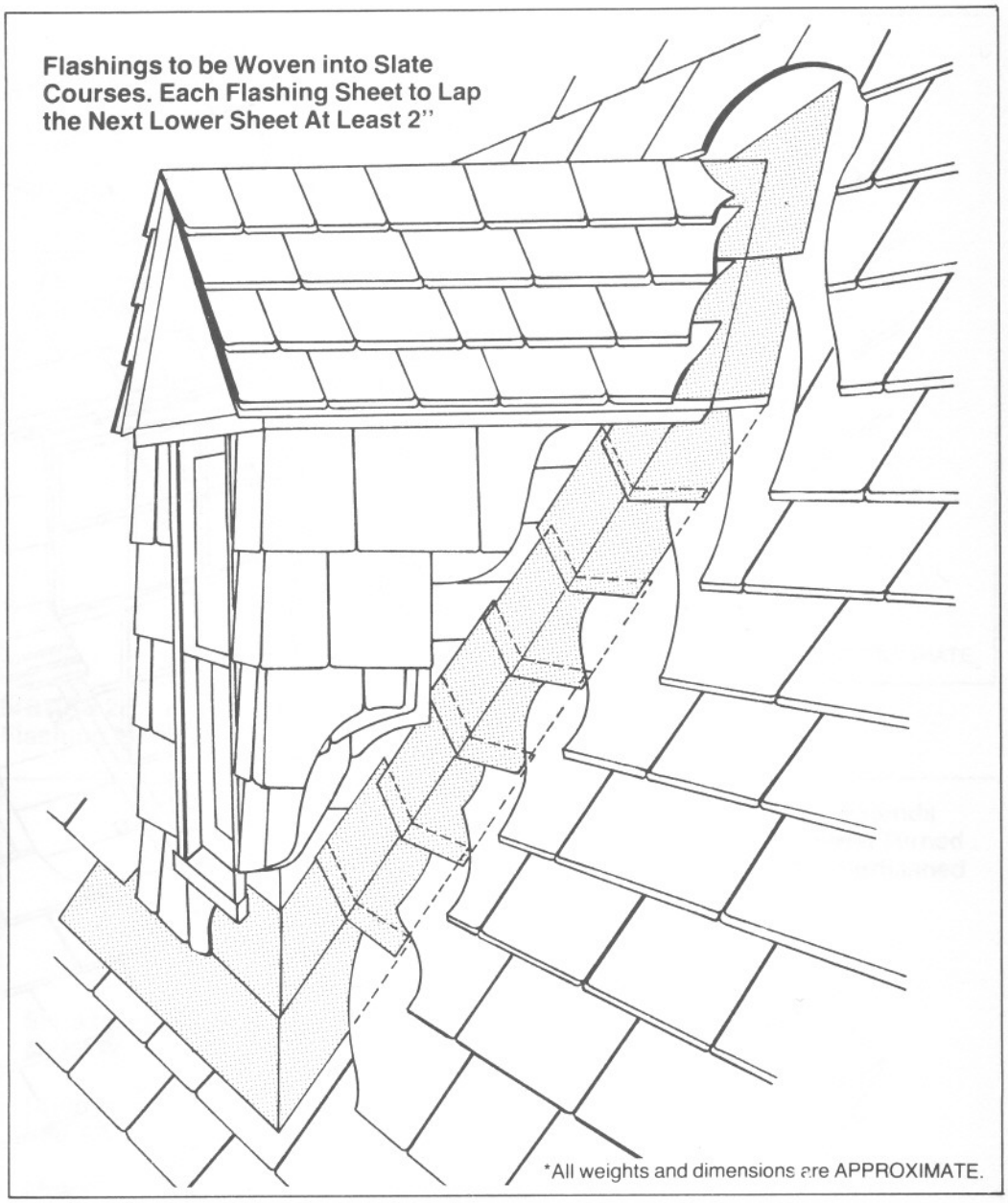

FIGURE 21
Built-In Base Flashing for a Dormer Window

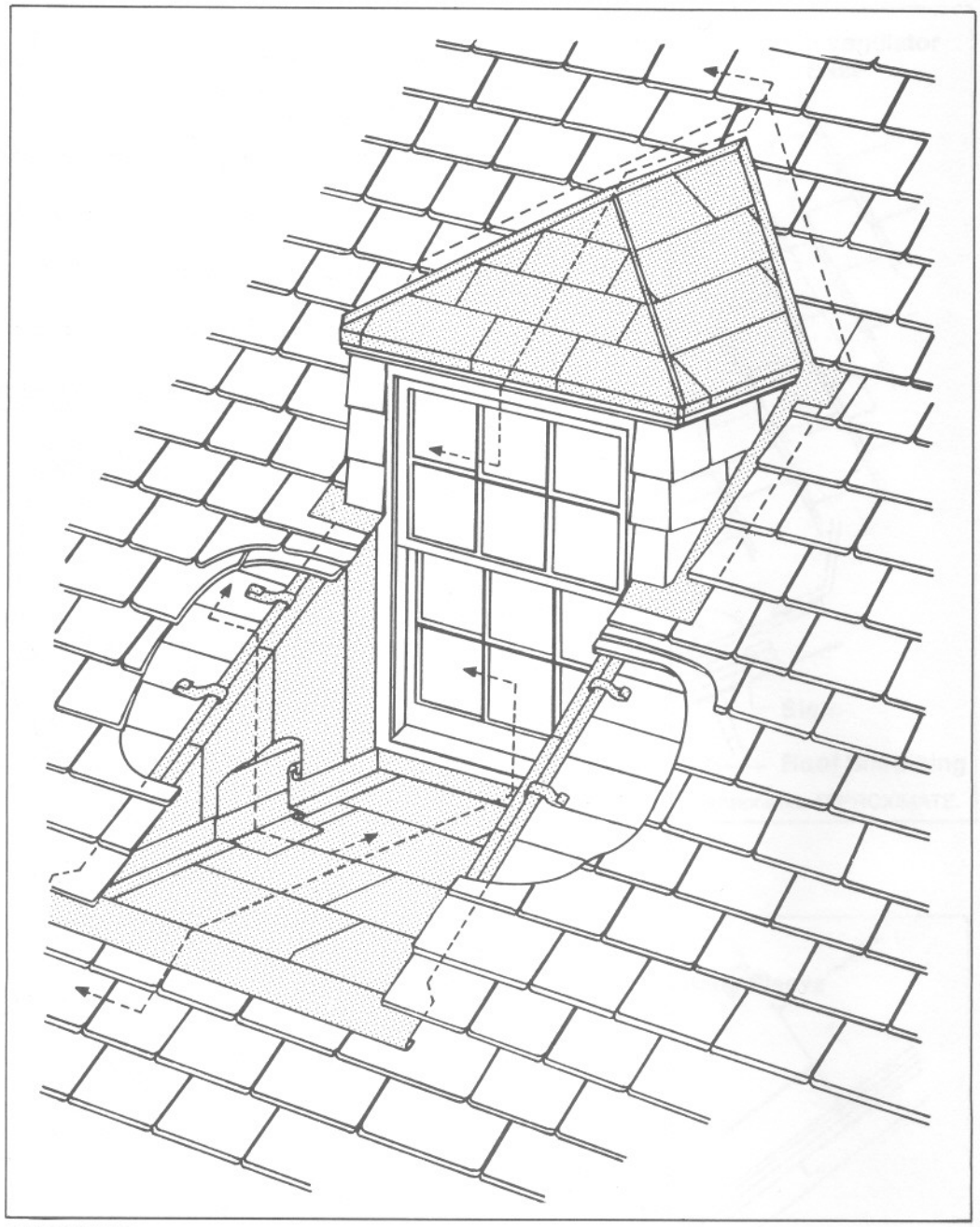

FIGURE 22
Flashing for a Recessed Dormer Window

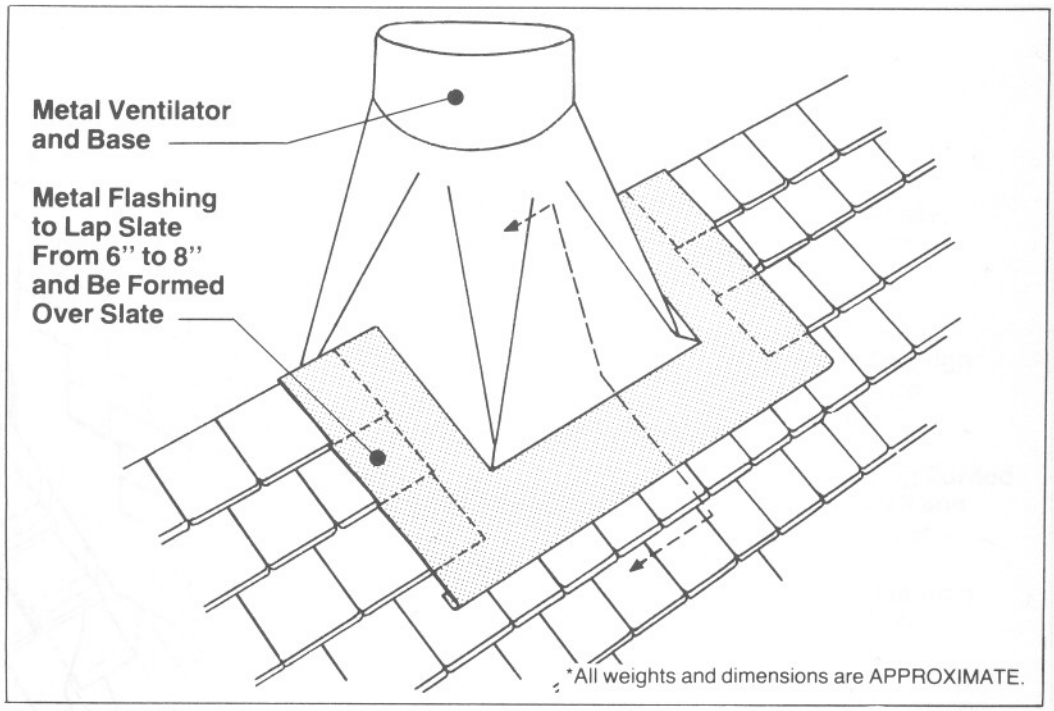

FIGURE 23
Flashing for a Ventilator at Ridge

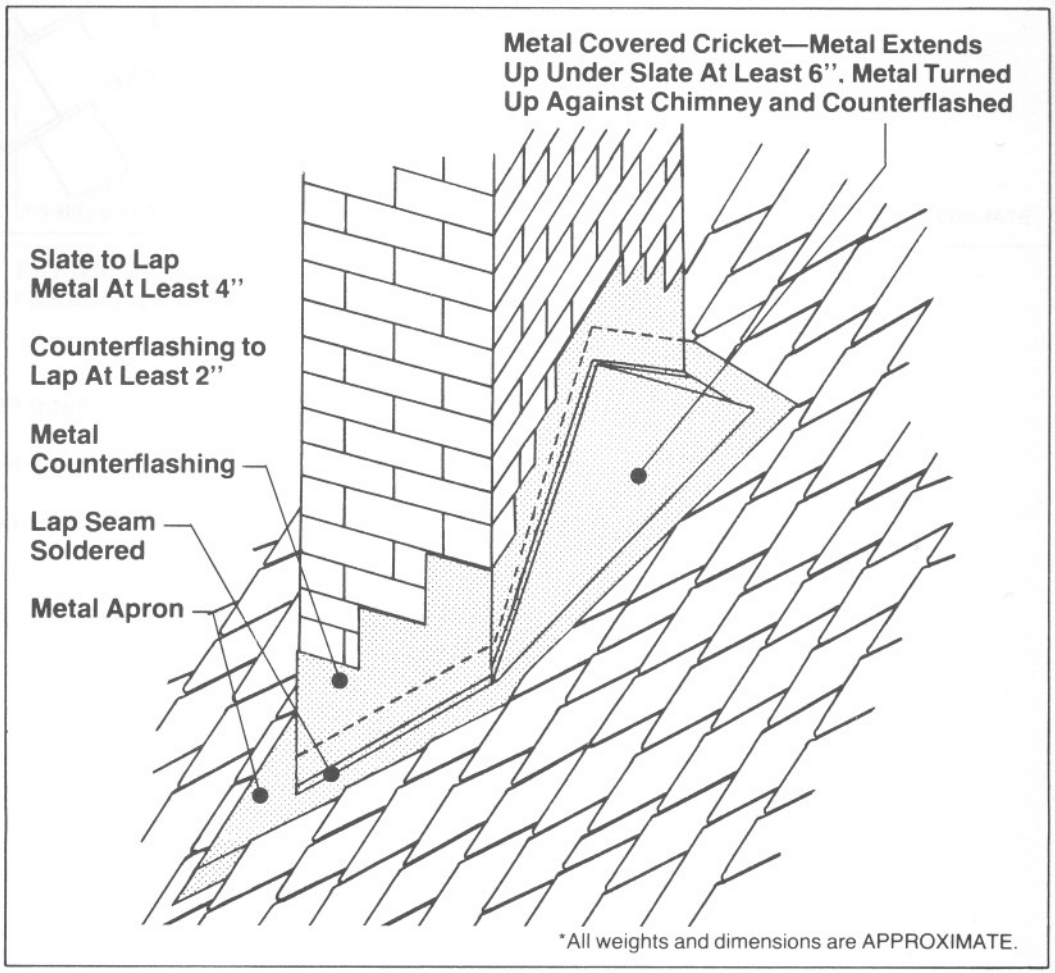

FIGURE 24
Flashing for a Chimney

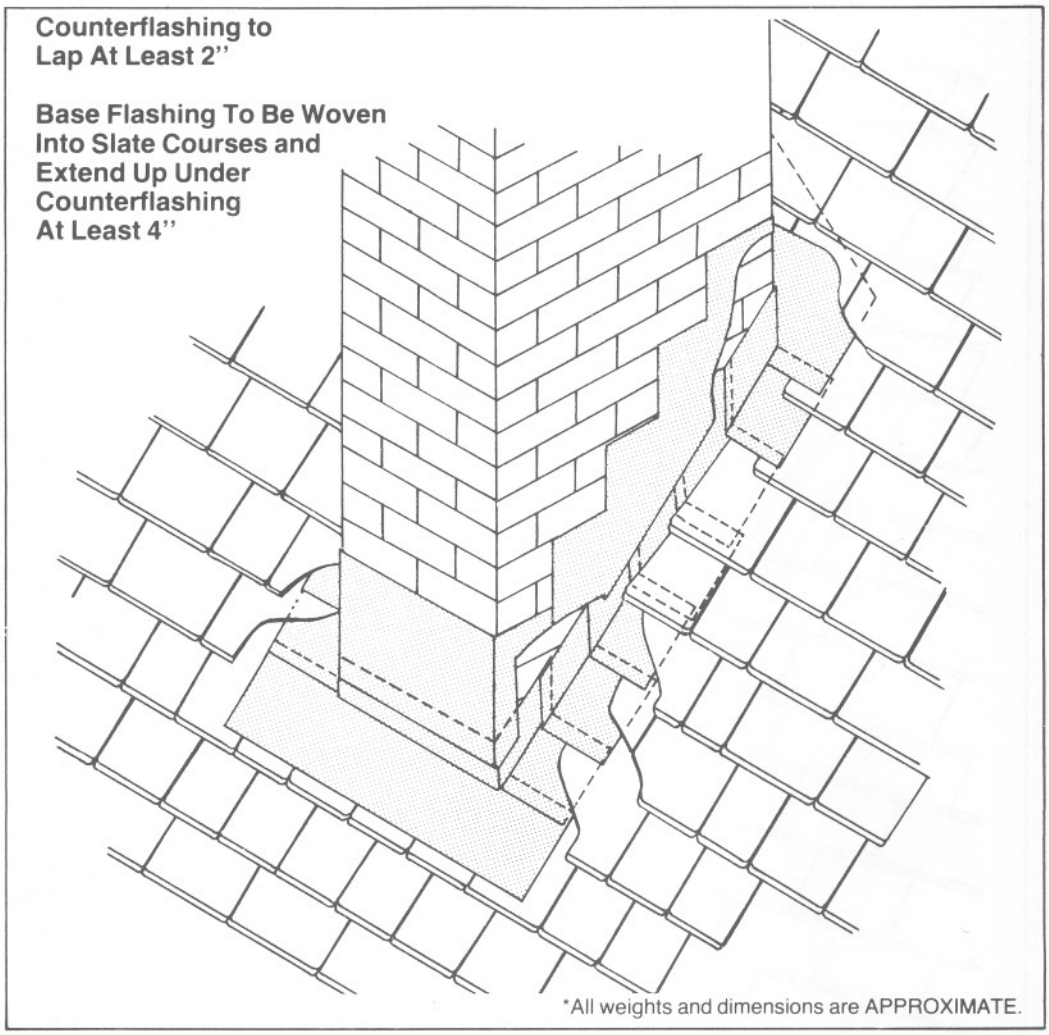

FIGURE 25
Built-In Base Flashing for a Chimney

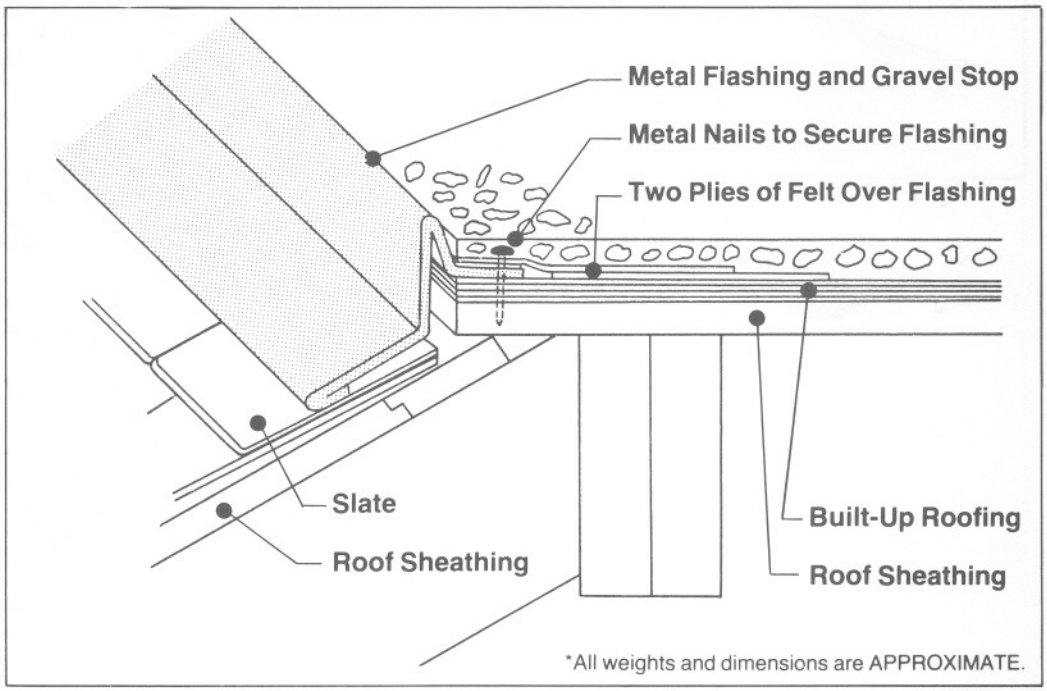

FIGURE 26
Flashing for Edge of Composite Roof Above a Sloping Slate Roof

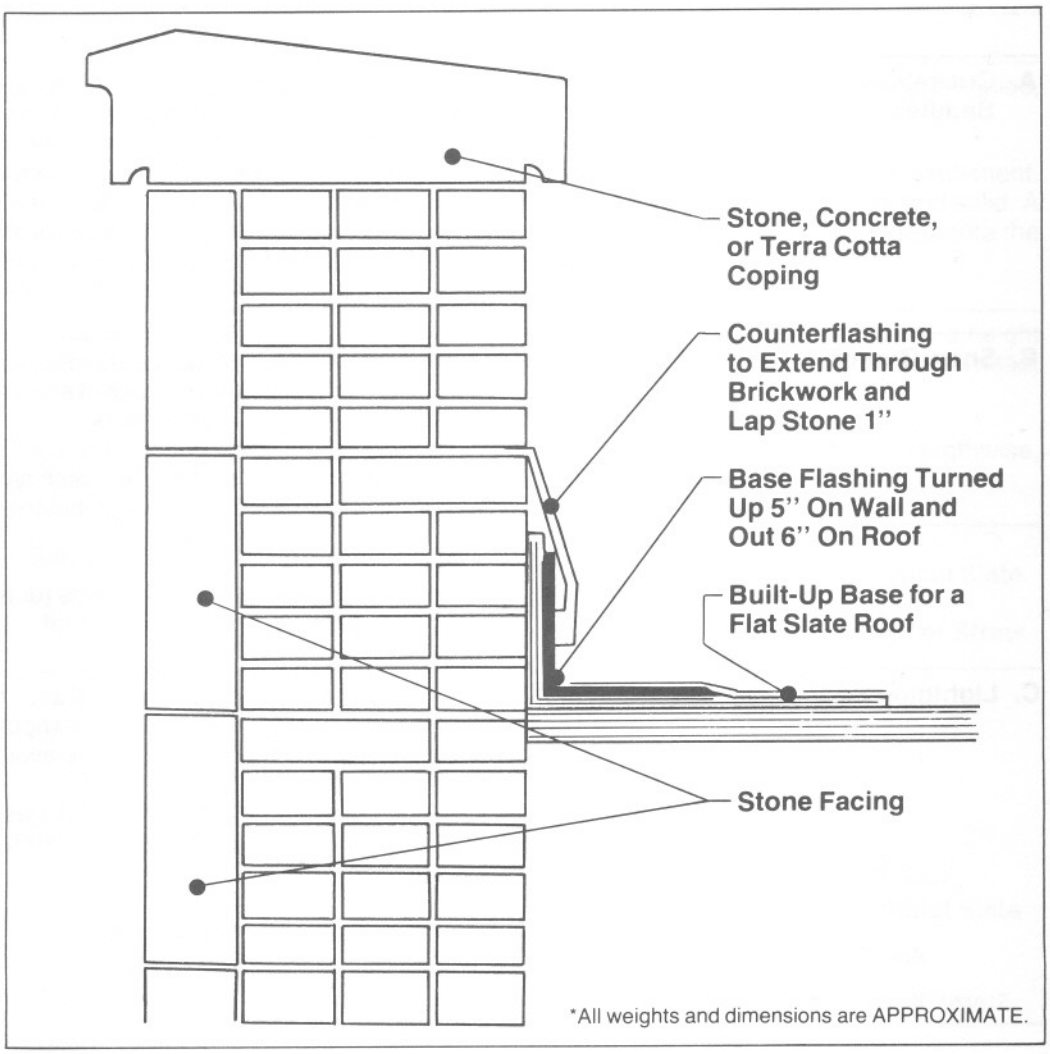

FIGURE 27
Flashing for a Brick Parapet Wall Faced with Stone

VI. ACCESSORIES FOR SLATE ROOFS

A. Crickets or Saddles

Where a chimney or other vertical surface projects through the roof surface at a right angle to the slope of the roof, a cricket (sometimes referred to as a "saddle") should be built into the roof to divert water away from the back of the vertical member. If the roof is constructed of wood, the cricket (or saddle) should be of light rafter construction covered with sheathing boards, paper and sheet metal. If the cricket area is large and exposed to view, it should be slated the same as other roof areas. Open type valleys should be formed with the main roof at cricket areas. The size of the cricket is largely determined by the roof condition. Usually the slope of the cricket should be the same as the slope of the roof.

B. Snow Guards

Snow guards are necessary accessories for most slate roofs in sections of the country where the rate of snowfall is sufficient to accumulate masses of snow and ice on the roof, which can slide from the roof onto lower roof surfaces and gutters.

Snow guards are manufactured in various forms, and each type requires different methods of application. They may be obtained from slate distributors, quarriers of roofing slate or manufacturers.

Only non-ferrous metals should be used for snow guards (or any slate roof accessories) to prevent rust stains from marring the appearance of the roof.

C. Lightning Rods

It is important that all lightning rods be properly grounded at all times. All connections should have very low contact resistance. Tips of lightning rods should be silver, gold or platinum plated, and sharp bends in the conductor cable should be avoided.

All extensive masses of metal, such as water pipe systems, gas pipe systems or cast iron soil pipe systems, should be connected to the ground by soldered connections of not less than No. 10 B & S wire, preferably stranded.

It is generally assumed that a lightning rod protects the area within a 45° cone, whose apex is the tip of the rod itself.

VII. PILING SLATE

A. Requirements

In piling slate the important factors are the foundations of each pile, starting the piles, arrangement of the piles and individual slates, and the separation of the tiers.

The tiers of slate can be kept level only if the foundation is level and free from settlement. The earth foundation upon which the slates are to be piled should be level, dry and solid. A layer of wood plank material 2 inches thick will keep the slate off the ground, distribute the load and assist in maintaining straight and even piles.

B. Piling Procedures

When piling slate the first tier should be started by laying one pile of slate flat to a height equaling the width of the slate being piled. For example, when 20 inch x 12 inch slate is used, the flat pile of the first tier should be 12 inches high.

The slates following the first tier should be placed in an upright position, on edge lengthwise, and should be kept as straight and vertical as possible. (See Figure 28.)

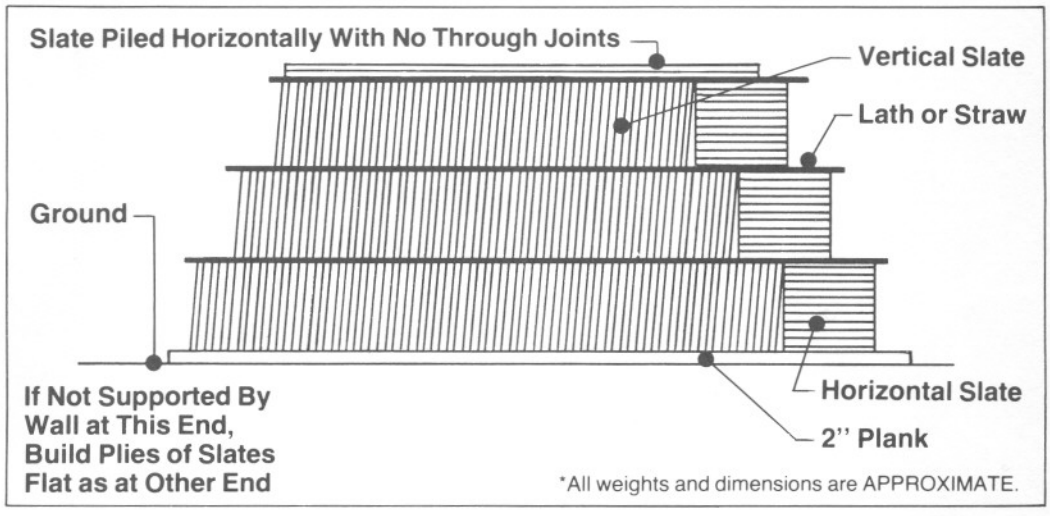

FIGURE 28
Proper Method of Piling Slate

During inclement weather conditions, piled slate should be covered with a tarp during storage.