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LEAD INDUSTRIES ASSOCIATION, INC.

292 MADISON AVENUE

NEW YORK, N. Y. 10017

TELEPHONE — AREA CODE 212

OR 6-6060

March 15, 1965

SUBJECT: ROOFING HANDBOOK

To Members of the Lead Industries Association, Inc.:

We've enclosed a copy of the new ROOFING AND FLASHING HANDBOOK. It has been published as an authoritative source of information on this subject and is intended for roofing contractors primarily. We also expect that it will be used by architects, construction specification writers, and others in the building field.

While similar publications dealing with other roofing materials exist, there has been no such source for lead, to our knowledge. Thus the publication fills an obvious niche. As a maiden effort, it may profit by minor changes or additions. While we do not foresee any need for reprinting we would appreciate any suggestions for improvement, should a second edition be undertaken.

A quantity of 20,000 has been printed and will be distributed to our architectural, building, and contractors list. The publication will also be publicized and advertised in roofing and building magazines.

You are welcome to 25 copies or less without charge. Additional copies in bulk may be purchased at our cost of $15.00 per hundred.

Sincerely,

E. D. Martin

E. D. Martin, A.I.A.
Manager, Architectural Services

EDM:mc
Enc.

Look Ahead with Lead

Look Ahead with Lead

LEAD ROOFING AND FLASHING

A practical guide to preferred techniques for roofing contractors and architects

table of contents

The details included in this booklet are not intended to show all existing methods of forming or joining lead. For the most part these methods are common to all other kinds of sheet metal. Rather the object has been to illustrate the simplest and most usual methods, designed to take fullest advantage of lead's many desirable properties.

Drawings are diagrammatic only. For the sake of clarity, roofing felts and paper, walking in joints, etc., have been omitted. The complete specifications on page 16 should be referred to for these items.

ARCHITECTURAL DEPARTMENT • Lead Industries Ass'n, Inc. • 292 Madison Ave. • N. Y., N. Y. 10017

A.I.A. 12-C & 12-H
CSI Div. 7

FLASHING

The three basic necessities for human existence are food, clothing, and shelter. Since the weather is one of man's worst natural enemies he soon learned that shelter, a roof over his head, was one essential he needed for survival. No one knows just when lead came into use for this purpose since that date is lost in antiquity. There are however several lead roofs still in existence which have seen a millennium each and one, on Hagia Sophia, has seen 1,400 years pass into history. Today we do not build with such historical perspective, nor do we need to. Even the lead used has been improved. Where ancient buildings used 1/8" thick soft lead, today's lead roof is 3/64" thick hard (antimonial) lead alloy—as strong and even stiffer. The presence in our country of a number of hard lead roofs which have served a quarter century or more, with no charge recorded against them even for maintenance, is proof that lead as a modern building material is continuing to provide those qualities most important today just as it has answered different needs in differing climates for countless generations past. Among these qualities today, in addition to longevity and positive protection against the weather, are freedom from maintenance and replacement charges, resistance to fire and a proper contribution to the beauty of the finished structure.

Lead's appeal to architects, engineers and builders for these purposes largely arises from its great durability, ease of installation and the fact that it does not cause unsightly stains or discoloration on adjacent materials. Its pleasing grey color blends well with any color scheme. Lead's long life makes its ultimate cost extremely low.

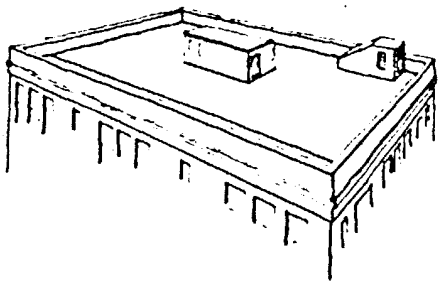
Purely as a roofing material, lead falls into the category of "multiple unit" systems as distinct from "membrane" types. Multiple unit systems are those, as the name implies, which are made up of smaller plates, panels, sheets or shingles.

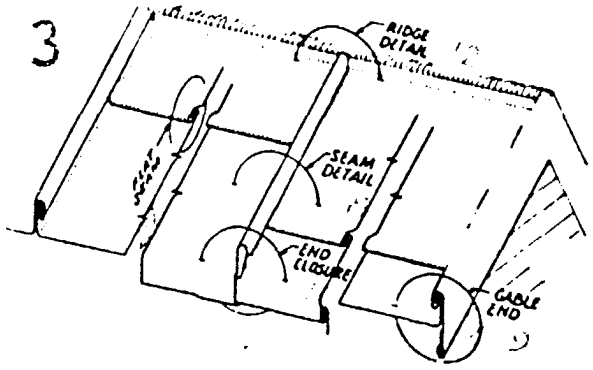
Membrane types include built-up or laminated coverings involving large unbroken surfaces depending on tightness of construction for watertightness.

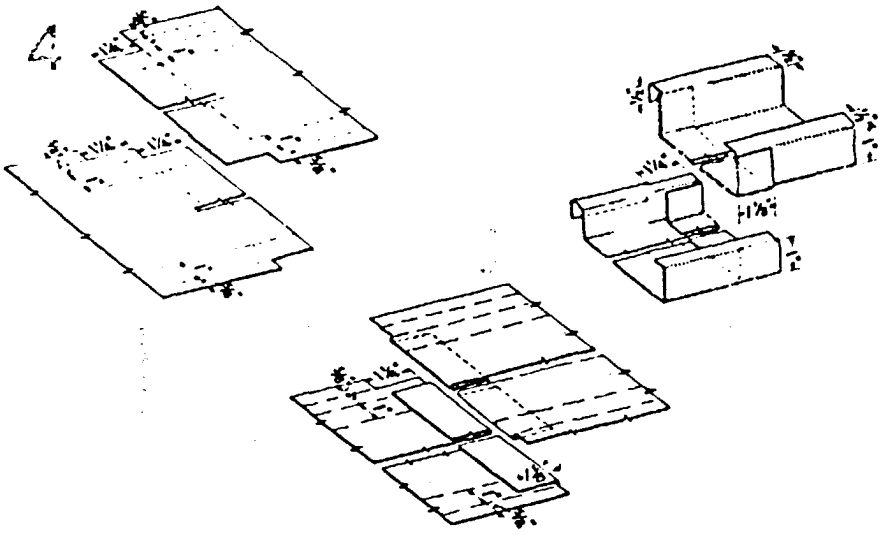
Quite the reverse is true in the case of the multiple unit system where loose lock joints are required to allow for movement of adjacent sheets due to thermal expansion. In order to solve this problem, several means are used in jointing sheet lead in particular, and any sheet metal in general. Each joint is equally effective for the purpose for which it was designed. The inherent advantage of course is that every joint is an expansion joint and labor is saved by reason of the fact no joint needs to be either soldered or welded (burned).

1 Multiple Unit

2 Membrane







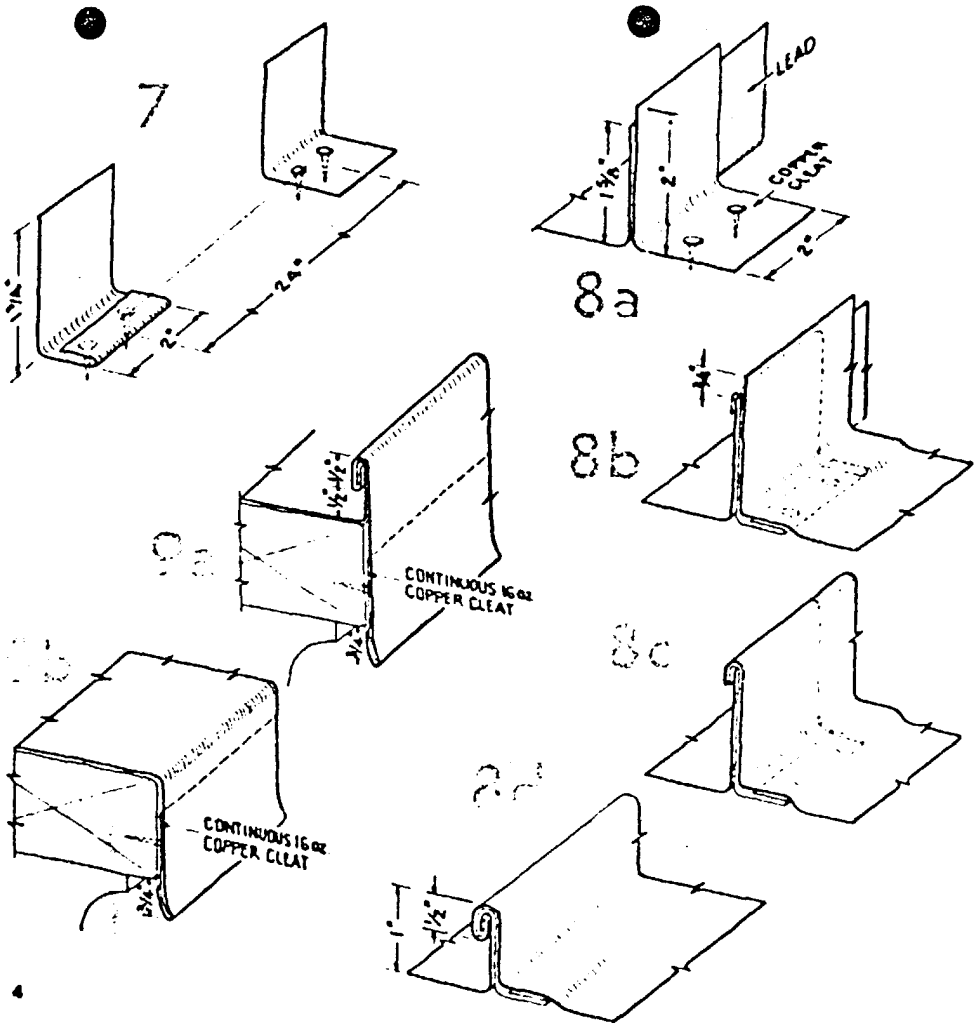
The first illustration shows the formation and fastening of a "standing seam." Standing seams are used to join long dimensions of sheets in the direction of roof slope. Sheets should not exceed 16 square feet in area and are usually 3 lb hard lead.

Forming Sheets

Opposing ends of sheets are cut in flat pattern as shown. By cutting in this manner, excessive bunching of metal is avoided at intersections of cross locks and standing seams.

The upper end of each sheet is turned up and back on itself 1-1/4 inches. The lower end is turned down and back by the same amount. Leather belting as illustrated on page 14 should be used to prevent crimping where bends at right angles cross each other.

Upstands in both sheets are formed with the top 1-1/4 inches on one side turned horizontally outward and the outer 5/8 inch of this flange turned downward. The other side of the sheet is turned vertically upward 1-5/8 inches, with the top 5/8" turned horizontally inward.



Normally the sheets of lead roofing are secured by means of 16-oz hard copper cleats folded into the seam at 24-inch intervals. They are 2 inches wide, 4 inches long, nailed with two hard copper wire nails and with sufficient metal remaining on the nailed end to turn back over the nail heads for protection of the lead lying over the nails.

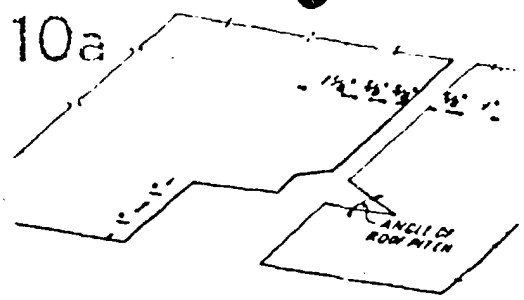
Successive folds in formation of a standing seam are illustrated.

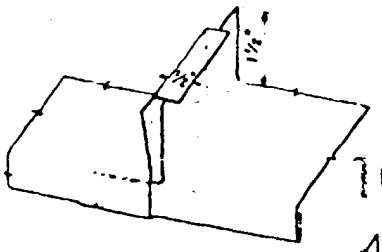
If the roof ends in a standing seam at the gable, the method shown is used to finish along the rake of the roof. A strip is simply locked to the upstand of the last sheet to form a standing seam and, at its lower edge, to a continuous cleat.
If no standing seam occurs at the gable, the last roof sheet is turned over the edge and loose-locked to a continuous cleat.

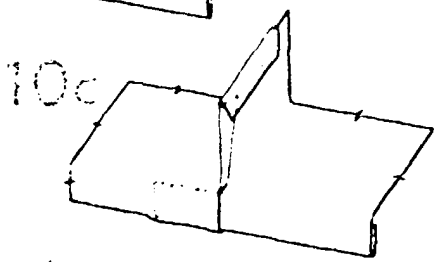
To close the ends of standing seams, cut the end of one sheet on an angle equal to the roof slope as shown in flat pattern. Successive folds, as illustrated, will provide a watertight closure at gutter, eave or valley.

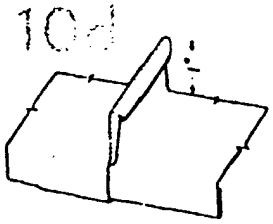
Regardless of the type of ridge, the top roof sheets are laid out as shown in flat pattern.

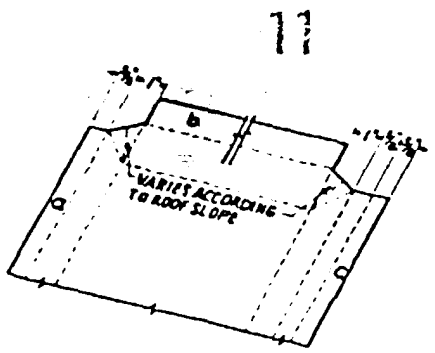
Sheets on opposite slopes finish almost against each other but with about 1/4-inch separating them. Cleats are provided at 24-inch intervals and locked over the flange "b" of the roof sheets. These may be double width and split so that half locks to the sheet on one slope and halt to the sheet on the opposite slope. A cap in 8-foot lengths is loose-locked to the flanges at the top of both roof sheets.

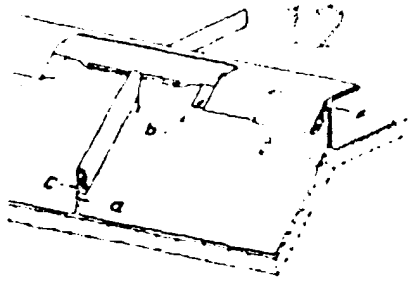










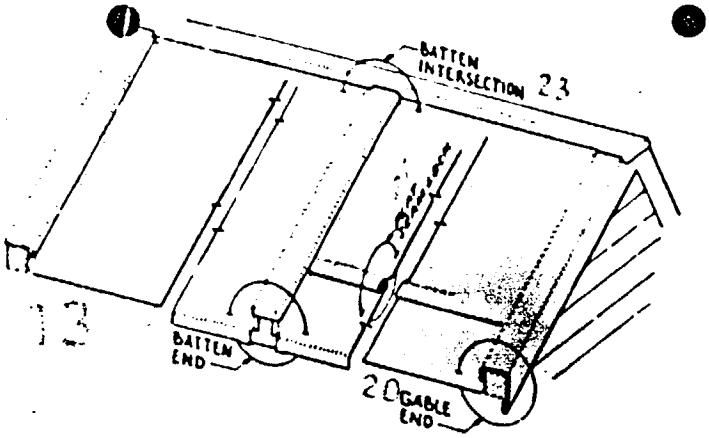


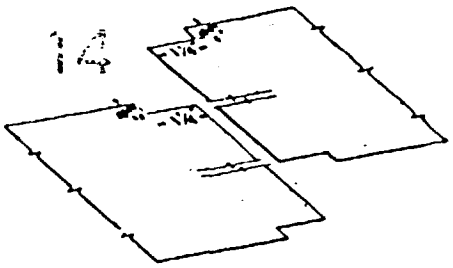
The "batten seam" roof is generally used for large sloping areas and is applicable to the same type of structure as the standing seam. It may be preferred alone but is sometimes combined with the standing seam for architectural effect.

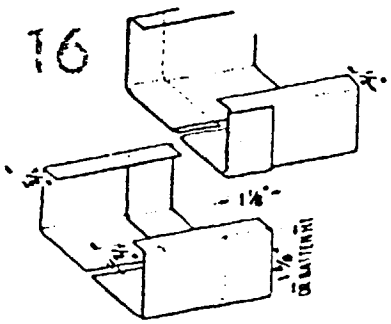
Opposing ends of sheets are cut in flat pattern as shown. Sheets should ordinarily have a maximum size of 16 square feet and are usually 3 lb hard lead.

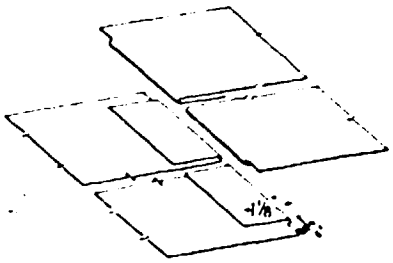
The upper end of each sheet is turned up and back on itself 1-1/4 inches. The lower end is turned down and back by the same amount.

Leather belting, as illustrated on page 14 should be used to prevent crimping where bends at right angles cross each other. All bends should be made without removing the belting. Each side of the sheet should be bent up a height equal to the height of the batten being used. Another bend is made at the top of each upstand so that the top 5/8 inch turns inward toward the center of the sheet.









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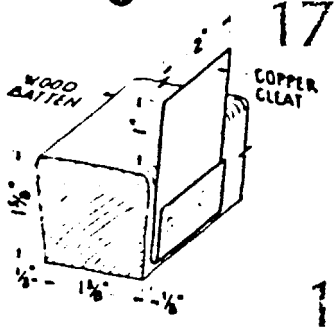

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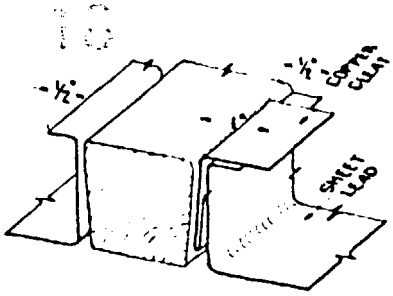

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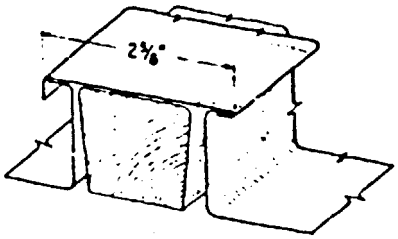

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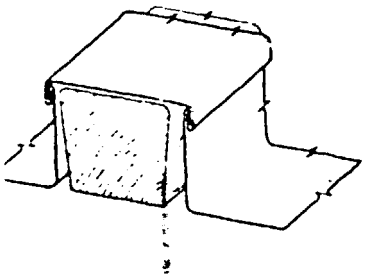

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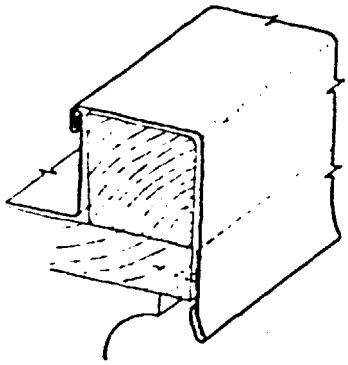


Battens are normally wood 2 x 2 formed with a slightly narrower base as illustrated. This shape allows a built-in clearance for the lead at the bend of the upstand against the batten. Battens may be bolted, nailed or screwed to the roof substrate but care should be taken to ensure all such fastenings are countersunk. Copper cleats, not less than 3 inches wide, are fastened to the sides of the batten at 24-inch intervals and are staggered on either side. Copper cleats are also fastened to the batten top and folded into the seam joining lengths of batten cap.

Sides of lead sheets are turned up against the batten and cleat to a height of 1/2 inch above the batten and both are turned down into a horizontal flange.

Finally, batten caps are placed over the battens in maximum lengths of 8 feet and the edges finally formed into a lock by bending down the projecting flanges against the sides of the batten.

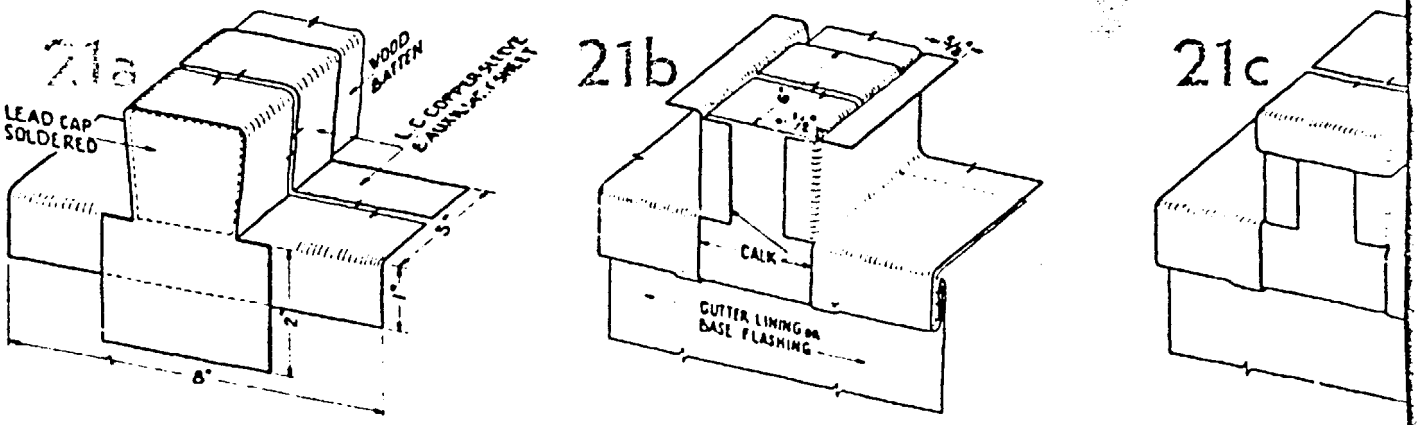
At the gable end a 16-ounce copper edge strip is nailed to the rake batten. The batten cap is then formed in the usual way on the roof side but is extended on the gable side and locked to the edge strip as shown.

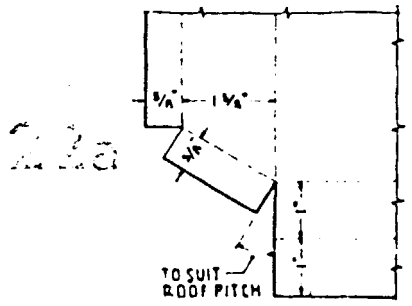
At eaves or gutters battens are finished with an auxiliary flashing and sleeve of lead coated copper soldered together in the shop for each batten end. This assembly is slipped over the end of the batten with the auxiliary flashing turned down into the gutter. The auxiliary flashing should be 6 x 8 inches.

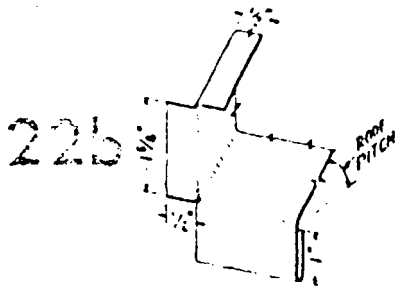
The roof sheet upstands (22) are finished in the usual way except the flaps at their lower ends are folded around the ends of the batten after being well bedded in non-hardening compound. The roofing sheet is turned down along its lower edge and locked to the gutter lining as well as the lower edges of the auxiliary sheets where they occur.

Flaps at the lower ends of the upstands are held in place by the lower end of the batten cap which is also turned over the end of the batten.

Roofing sheets, cut to the flat pattern shown (22a), are formed (22b) and installed over the lead coated flashing sheet.





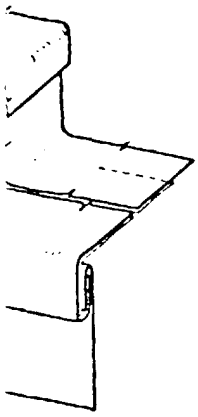


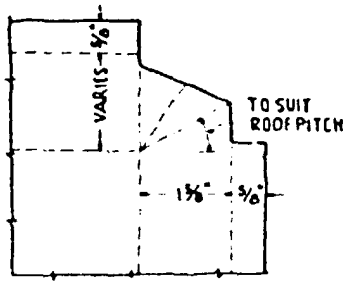
The batten intersection shown is not only a method of finishing a batten seam at ridge or hip but is a useful device for creating patterns in roofing: "chevron," "herring bone" or any of many other variations the designer may choose. Corners of each sheet should be cut as shown in flat pattern which will enable them to be folded into "pig ear" intersections at each corner.

Where the ridge is a batten, this batten must be at least equal in height to the vertical height through the center of the sloping batten.

Ridge or hip caps are installed in 8-foot maximum lengths with loose locks at joints and fastened by cleats nailed to the top of the ridge between each pair of roof battens. Ridge or hip caps will ride over batten caps on slopes.

Batten seams are easier to install and generally better than standing seams. They impart rigidity and provide better means for movement of the metal sheets.





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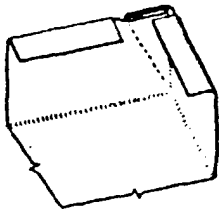

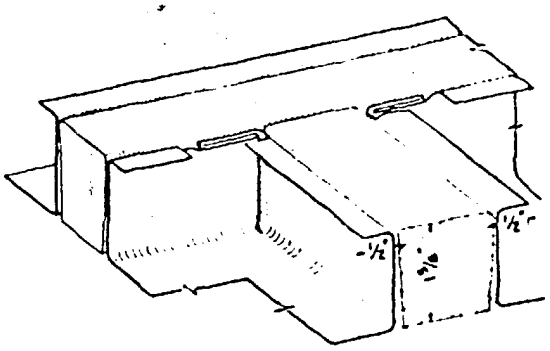

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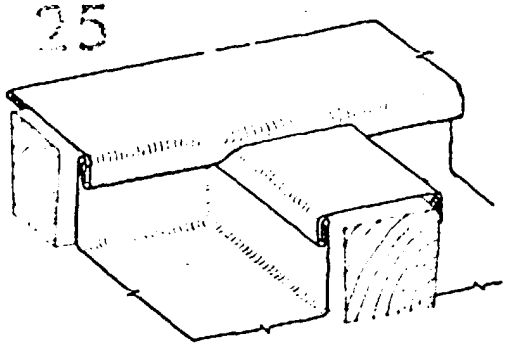
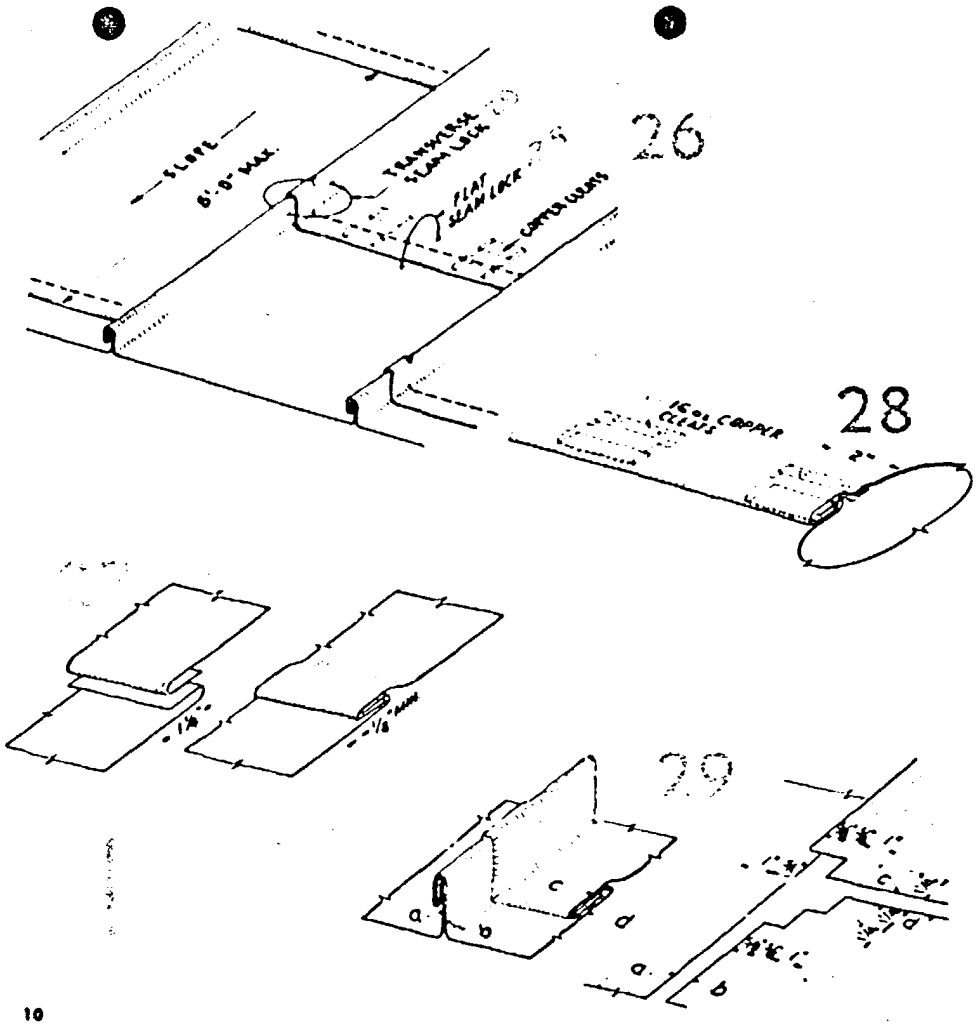




In either the standing seam (illustrated) or the batten seam roof, the cross seams at right angles to them, or to the slope, should be "flat seams". Flat seams are always made in the direction of flow and filled with compound. They should be staggered on either side.

They are simply made by folding over the edges of adjoining sheets in opposite directions and then hooking together.

Flat seams are fastened by means of two copper cleats folded into the seam for each bay in width. On steep slopes, continuous cleats should be used.

Flat seams are finished at either side against a standing seam or batten by turning up the flat seam, as illustrated, and folding it into the upstand of the adjoining sheet at standing seam, or into the cap at a batten. Where the flat seam is folded under the other sheet at the standing seam, the multiple thicknesses of lead may be cut away flush with the top of the standing seam. The other sheet covers and waterproofs the joint.

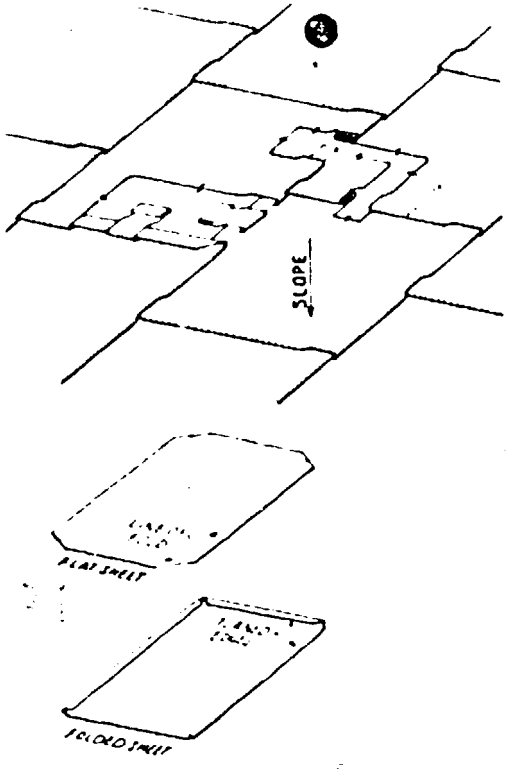
Flat seams may also be used to create special patterns. A diamond pattern is easily accomplished.

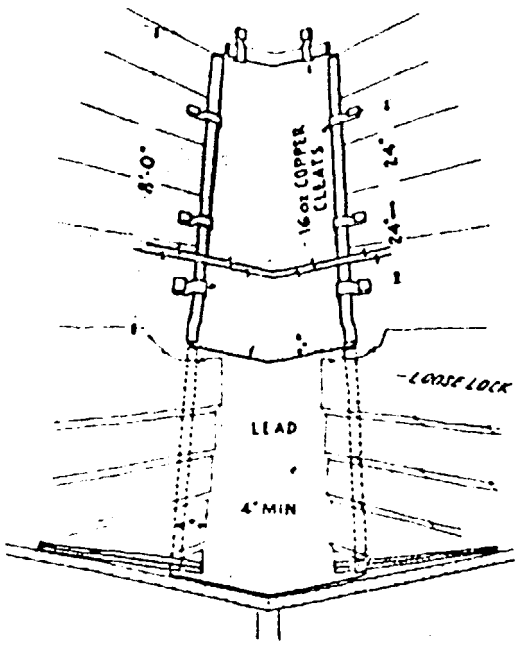
Sheets in this case may be used with all dimensions equal.

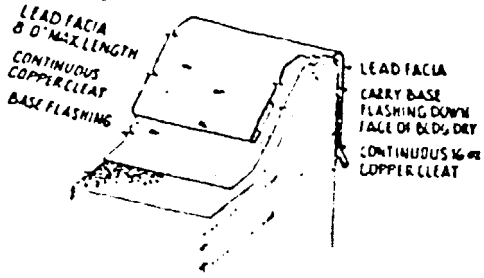
Pattern for flat seam roof shown in 30.

In open valley flashings lead sheets are installed in 8-foot maximum lengths. Hard copper cleats are folded into the sides at 24-inch intervals. Two cleats are used to secure the starter sheet at the top and two should be folded into each loose-locked joint between sections. The exposed part of the valley should be at least 4-inches wide at the top and tapered so that it becomes about 1 inch wider for each 8 feet toward the gutter. This taper reduces the chance of clogging. Valley flashing should extend at least 4 inches under the roofing.

Probably a major source of difficulty in built-up roofing is caused by moisture entrapped during or after construction of the roof. This is especially true at the juncture of the flat roof surfaces with the vertical exterior walls. Roofing is frequently finished with cant strips and left for the arrival of the sheet metal contractor who installs the metal facia. The details shown will eliminate the danger of moisture penetration should bad weather intervene between roofing and sheet metal installations.





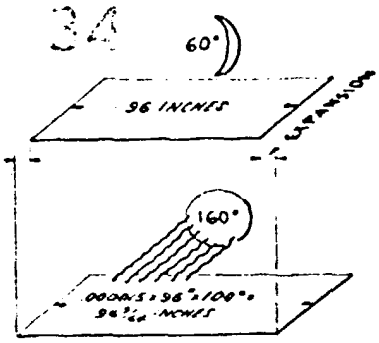


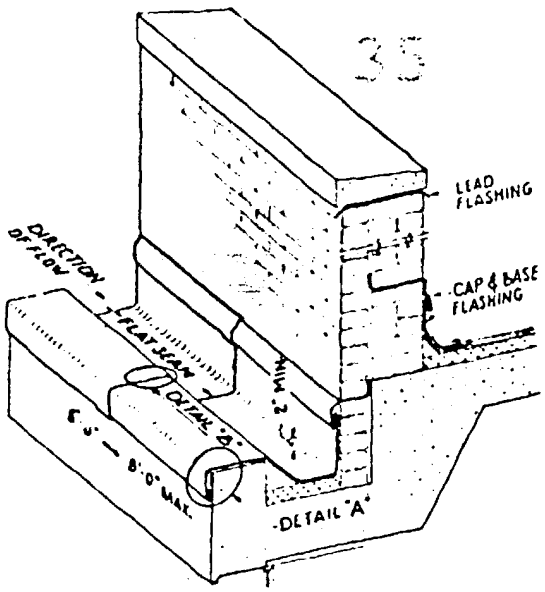
Maximum areas of hard lead roofing sheet should be 16 square feet. Good practice indicates a maximum length in this case should be 8 feet. The coefficient of linear expansion of antimonial (or "hard") lead is .000015 inches per inch, per degree of Fahrenheit. This means that for a sheet 8 feet long and a potential temperature change on a sunny day of as much as 100°, the lead will expand roughly 1/8 inch, the normal clearance to be provided in any formed joint.

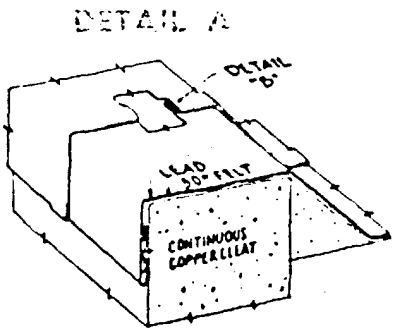
Cornice coverings and gutter linings should be installed in not greater than 8-foot lengths. Sections should be loose-locked together with flat seams calked and formed in the direction of flow. Detail "A" shows one method of fastening the lead sheet at the outer edge of the cornice by locking it to a continuous copper cleat. This is the preferred method.

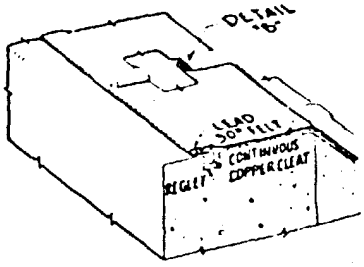
An alternate method (Alternate Detail A) employs a continuous copper cleat calked into a reglet formed in the cornice. Lead or lead wool plugs are used at 12-inch intervals to calk the cleat into the reglet. The intervening space is filled with calking compound.

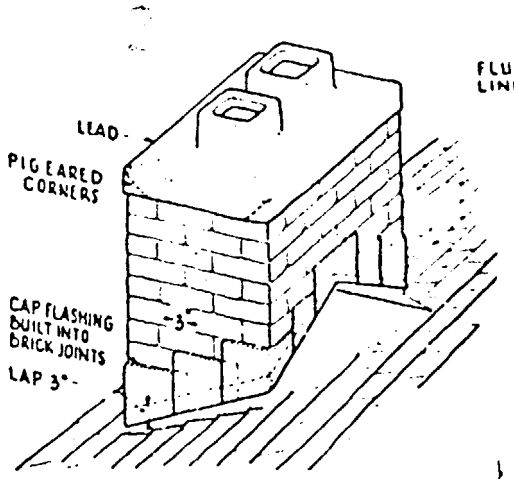
At the wall or parapet the lining is loose-locked to the wall flashing. This lock should be made at least 2 inches above the highest point of the cornice.

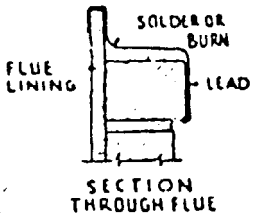




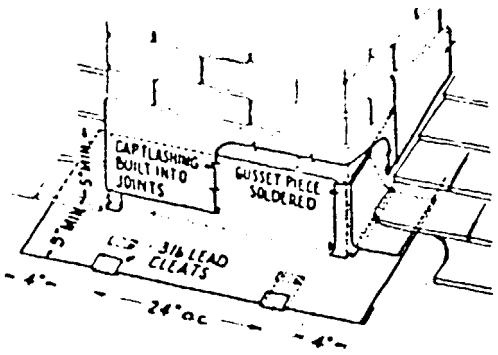


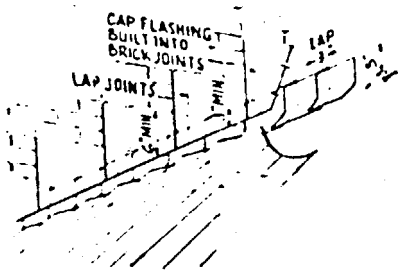






SECTION THROUGH FLUE





Methods of protecting brick chimney stacks with lead flashings consist of a front apron, stepped side flashings and a metal covered cricket to the rear.

Lead is the only common metal suitable as a chimney cap because it is practically unaffected by fumes. If not too large, the cap may be made of one piece. The lead is turned down about 2 inches inside the chimney. Corners are pig-eared and the lower edge may be turned under, as shown in section, or loose-locked to a continuous cleat fastened to the brickwork.

Base flashing at the front of the chimney is a single piece. It turns up the chimney at least five inches and out on the roof the same amount. It is held in place by cleats as shown. It is cut four inches wider than the chimney at either end. After the upstand is formed against the chimney, these 4-inch ends are slit down to form flaps. These run back under the slates or shingles and are joined to the upstand by a gusset piece soldered into the open corner.

Side flashings consist of base flashing pieces, one to each course, each lapping the one below by 3 inches with upstands turned a minimum of 5 inches up the wall or chimney. The upper edges of cap flashings over these should be calked into the masonry joints.

PRACTICAL TIPS

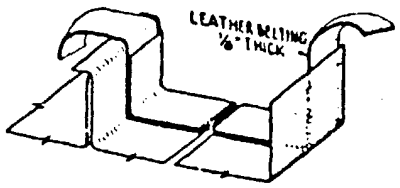
Leather or web belting about 1/8-inch thick laid along the fold before turning the edge of a sheet in making a loose-lock, will facilitate a second fold at right angles to the first. The belting will allow the lock thus formed to remain open without crimping.

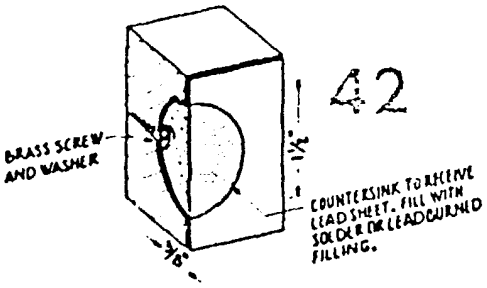
Lead cuts easily. A quick way to cut lead into several strips along straight lines is to start by scoring lines about half way through three separate sheets. Then cut all the way through for a few inches at the ends only of the two outer sheets and roll all three sheets together.

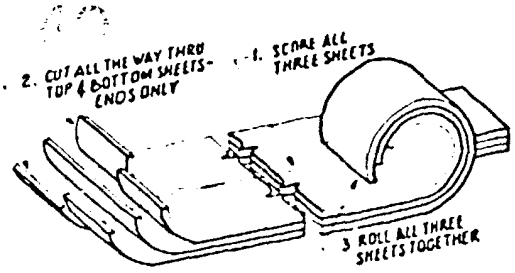
Concealed support is possible in some installations by means of 4 inch square tabs as illustrated. These tabs are burned or soldered to the back of the sheet at intervals and then inserted through slots provided and fastened from the rear.

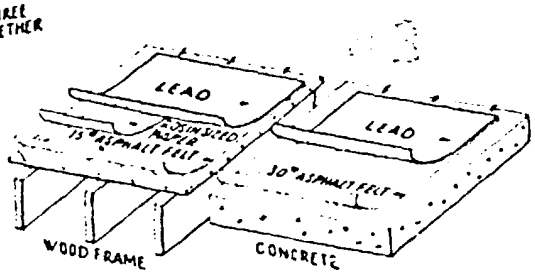
Another concealed fastening consists of countersinking brass screws with washers and filling the countersink with solder or lead burned filling.

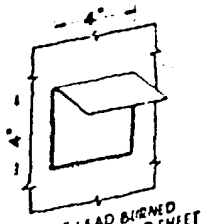
In all cases lead should be underlaid with at least 15 lb asphalt impregnated felt, laid dry and lapped 2 inches at joints, followed by a layer of rosin sized paper (optional).

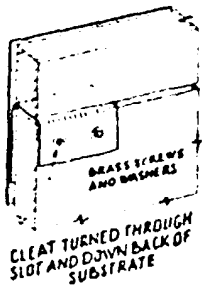












SHEET SIZES AND JOINTING

Roofing sheets between batten or standing seams, should be limited to about two feet. In the other direction, that is, in the direction of slope, lengths may be eight feet. As a rule of thumb, the maximum sheet size should be 16 square feet for roofing with a minimum width of 2 feet. Where flashing sheets are frequently reinforced by longitudinal bends or upstands, they may also be as long as 8 feet. Joints along batten, or standing seams or across the direction of roof slope should be flat, loose locks with turnovers of about 1-1/4 inches. In cases of extreme exposure, they should be filled with non-hardening compound. On steeply pitched surfaces, simple overlaps of 6 inches or more may be used instead of loose locks. These laps should be set in non-hardening compound.

CORROSION RESISTANCE

Lead protects itself from corrosion by developing a surface film or patina on exposure to weather or the usual concentrations of industrial fumes, salt spray, etc. The insoluble chemicals which form this film do not wash off or abrade away. Thus there is no measurable corrosion of the exposed lead.

DISSIMILAR METALS-ELECTROLYSIS

Dissimilar metals, when in contact in the presence of an electrolyte, set up galvanic action resulting in the deterioration of one of them. The following table lists common commercial metals in the electrochemical series:

1. Aluminum	5. Nickel
2. Zinc	6. Tin
3. Steel	7. Lead
4. Iron	8. Copper

When any two metals in this list are both in contact with an electrolyte, the one with lower number will be corroded. For example, if number 1. and number 7. are in contact, the aluminum will be corroded. As a practical matter, the environment usually forms a chemically inert surface film, or patina, on the lead. This protects the other metal from galvanic corrosion. The only exception among common building materials is aluminum, which corrodes severely in contact with lead.

As a general principle, dissimilar metals far apart on the electrolytic scale, should never be used in contact with each other. Where such contact is unavoidable, insulators should be used. The most common is a heavy brush coat of asphalt paint but asbestos or building papers or felts are also effective.

KIND and WEIGHT of LEAD to USE

For roofing and flashing purposes hard lead should be specified. Hard lead contains not more than 6% nor less than 4% antimony and the rest lead. The correct weight to use is noted in the spec. Lead is specified by weight per square foot. One square foot of lead nominally 1/64 inch thick weighs one pound. Each additional 1/64 inch increment adds one pound per square foot in weight.

In general, 3 lb hard lead is used for roofing, flashing, gutter linings, ridges, hips, valleys, copings, base flashings and uses where large areas are involved or exposure severe. For small pieces, as in stepped cap flashings or for "soakers" (small pieces interwoven with shingles or slate) or on small residential roofs, over bay windows, dormers, doorways, cupolas, porches, etc., 2-1/2 hard lead may be used.

Pounds Per Sq. Ft.	Actual Thickness	App. Thickness in Inches Decimal	Fraction
2		.0312	1/32
2-1/2		.0391	5/128
3		.0468	3/64
3-1/2		.0547	7/128
4		.0625	1/16
5		.0781	5/64
6		.0937	3/32
8		.1250	1/8
10		.1563	5/32
12		.1875	3/16
14		.2188	7/32
16		.2500	1/4

LIA23280

SPECIFICATIONS

SHORT SPECIFICATION

Unless otherwise particularly specified, all sheet metal work shall be 2½ lb hard sheet lead, and all material and labor in connection therewith shall be executed in strict conformity with the recommended practice and Standard Specification of the Lead Industries Association, which specification is hereby declared and made a part of this specification, with the same force and effect as if written herein in full.

STANDARD SPECIFICATION

MATERIALS

Unless noted otherwise, all lead shall be hard lead containing not less than 4% or more than 8% antimony, and the remainder shall be lead. Sheet lead shall be free from pits, dents, buckles, waves, scratches, grit, foreign matter, porosity, and other injurious defects. All lead shall be 3 lb hard lead except where heavier specified otherwise and except as follows:

1 - Where flashings may be 2½ lb hard lead: Step flashing, counterfold top flashing, closed valley flashing, cap flashing, window and door head and sill flashing, chimney cap flashing, gutter lining where gutters are not over 6" wide, gable end flashing, column cap and base flashing, base flashing (where no heavy weight rests on same).

2 - Where roofing may be 2½ lb hard lead: Small standing seam roofs where seams are not greater than 15" o.c. Batten roofing where battens are spaced not over 18" o.c.

No sheet shall exceed 16 square feet in area. Flashing sheets shall be not over 8'0" long. Sheets and flat surfaces more than 12" wide without longitudinal beads reinforcing them shall be not over 6'0" in length.

COATING FOR CONTACTS WITH CEMENT OR CONCRETE

(a) Back asphaltum brush coating, as made by _____.

(b) Layer of 30 lbs asphalt impregnated rag felt.

ROOFING FELT

(a) Under all lead roofs lay 15 lb per square building felt, as made by _____.

CLEATS & NAILS

(a) Cleats shall be—16 oz. copper (or) 3 lb. hard lead.

(b) Hard copper wire nails.

SOLDER

(a) 50-50 solder for hard lead—Standard Specification of the A.S.T.M., B32-60aT.

JOINT & SEAM COMPOUND

(a) Vulcatex #720L or Kenkit non-hardening compound.

LAYING & WORKMANSHIP

EXAMINATION OF SURFACES

(a) All defects found on surfaces prepared by other trades to receive lead roofing shall be reported to the Architect in writing. The Architect will cause all defects to be remedied. The commencing of work by the Contractor indicates his acceptance of the surfaces.

TYPES OF ROOFS

(a) Roofs shall be—standing seam (or) batten (ribbed)—spaced _____ o.c. (preferably 18").

(b) Battens, as set by others, shall be _____" wide at top tapered to _____" wide at the bottom and _____" high at center, with the top edges slightly rounded.

(c) Finished standing seams shall be _____" high when completed (not less than 1").

LEAD PROTECTION

(a) Use care in handling this material so as to prevent warping, bruising, or sharp bends.

(b) Paint all lead work which is to come in contact with new or green cement, or concrete, work with one heavy coat of asphaltum or felt on side which is to make the contact.

SEAMS & JOINTS

(a) Sheets shall be joined by loose locks or overlaps made in the direction of flow, which shall be filled with non-hardening compound where there is possibility of water, snow, or ice standing or driving into the joints. Where bends in sheets cross the seams, the sheets shall not be notched to facilitate seaming.

1—Flat lock seams shall finish at least 1" wide.

2—Lap seams shall lap at least 3" on vertical surfaces or built-in flashings, or 4" elsewhere.

3—Standing seams shall finish at least 1" high unless otherwise specified. Soldered seams shall only be used for inserting gutter pieces, making special caps, and for other special conditions, and in no case shall be used to join roofing or flashing sheets to make continuous runs of roofing or flashing greater than 8'0".

CLEATS

(a) Cleats shall be 16 oz. copper, except that if any part is exposed, 3 lb hard lead shall be used. Cleats, except where otherwise specified, shall be at least 2" wide and 4" long, secured by two nails. Continuous cleats shall be in lengths not exceeding 8'0" and a space of at least ¼" wide shall be left between ends. They shall be nailed at least every 8". All cleats shall have sufficient metal on the nailed end to turn back over the nail heads to protect the lead lying over the nails.

FASTENING

(a) Cleats shall be used to secure sheet lead to supporting surfaces in such manner as to permit free expansion and contraction of the lead. Nails or screws shall never be driven through sheet lead unless particularly specified, except that pieces of lead not larger than 12" square may be nailed along one edge only if next beads are covered.

BENDS

(a) All bends shall be made with an easy radius. Where metal turns up on a wall, curve, or batten, or other surface, provide a clearance between bend in metal and such surface of at least ½" for expansion.

VERTICAL SURFACES

(a) Sheathing for vertical surfaces shall be installed by the standing seam method (or) flat seam method. At the bottom it shall be loose locked to base flashing and at the top to through wall flashing or lead coping.

1—Standing seams shall run vertically. Sheets shall be not more than 3'0" wide, with this dimension horizontal. They shall not exceed 4'0" in height and, if the wall is higher than this, the sheathing shall be executed in more than one sheet vertically, with loose locks between sheets. Continuous cleats broken only at standing seams shall support the sheathing at these horizontal joints. Cleats 2" wide shall be folded into the standing seams at 12" intervals.

2—Flat seam sheathing shall be installed in sheets not exceeding 4'0" long and 18" high with long dimension horizontal. It shall be supported by continuous cleats, broken only at vertical seams in all horizontal seams. Cleats 2" wide shall also be folded into the lock at the end of each sheet.

FLASHING

(a) Where flashing is built into a wall and emerges more than 3" into the open, it shall be loose locked where it emerges to a separate piece.

(b) Flashing called into a reglet shall have separate flashing piece loose locked to the called piece.

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BH 1.65 (20M) Printed in USA