DOCUMENT RESUME

ED 183 872 CE 024 381

TITLE Military Curricula for Vocational & Technical Education. Light Frame Construction II.

INSTITUTION Naval Construction Training Center, Port Hueneme, Calif.; Ohio State Univ., Columbus. National Center for Research in Vocational Education.

SPONS AGENCY Bureau of Occupational and Adult Education (DHEW/OE), Washington, D.C.

PUB DATE Jan 76

NOTE 289p.; Not available in paper copy due to light and broken type. For a related document see CE 024 380.

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DESCRIPTORS Behavioral Objectives; *Building Trades; *Construction (Process); Course Descriptions; Criterion Referenced Tests; Curriculum Guides; *Equipment Maintenance; *Equipment Utilization; High Schools; Learning Activities; Lesson Plans; Machine Repairers; Postsecondary Education; Repair; Secondary Education; Teaching Guides; *Trade and Industrial Education; *Woodworking

IDENTIFIERS Military Curriulum Project

ABSTRACT

This training manual for a secondary-postsecondary level course in light frame construction II is one of a number of military-developed curriculum packages selected for adaptation to vocational instruction and curriculum development in a civilian setting. Purpose stated for the fifty-five hour course is for students to interpret construction drawings for the layout of wood frame members for service-type stairs and all types of rafters and to set up, operate, and perform operator's maintenance on trailer-mounted saws. Course prerequisites are Applied Builder Mathematics and Light Frame Construction I (see Note). The outline of instruction, which suggests number of hours of classroom instruction and shop devoted to each course objective, is based on the following outline: trailer mounted saws, roof framing plan, common rafters, hip and valley rafters, hip and valley jacks, roof truss construction, stair construction, and course summarization. The instructor guide lists objectives, texts, references, tools, equipment, materials, training aids, and training aid equipment. Lesson plans for each section contain instructional materials, objectives, criterion tests, homework, and instructor and student activities. Job sheets for use as student handouts include references, tools and equipment, and procedures for performing the tasks. Required chapters from a recommended text are provided. A second text, commercial references, films, and transparencies are suggested. (YLB)

Military Curricula for Vocational & Technical Education

LIGHT FRAME CONSTRUCTION

II

THE NATIONAL CENTER
FOR RESEARCH IN VOCATIONAL EDUCATION
THE OHIO STATE UNIVERSITY

This military technical training course has been selected and adapted by The Center for Vocational Education for "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education," a project sponsored by the Bureau of Occupational and Adult Education, U.S. Department of Health, Education, and Welfare.

BUILDERS SCHOOL, LIGHT FRAME CONSTRUCTION II

Table of Contents

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

Agriculture	Food Service
Aviation	Health
Building & Construction Trades	Heating & Air Conditioning
Clerical Occupations	Machine Shop
Communications	Management & Supervision
Drafting	Meteorology & Navigation
Electronics	Photography
Engine Mechanics	Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

Developed by
United States Navy

Development and Review Dates
January 1976

Occupational Area:
Building and Construction

Target Audiences:
Grades 10-adult

Print Pages
225

Cost:
$4.50

Availability:
Military Curriculum Project, The Center for Vocational Education, 1960 Kenny Rd., Columbus, OH 43210

Contents	Type of Materials: Lesson Plans	Programmed Text	Student Workbook	Handouts	Text Materials	Audio Visuals	Instructional Design: Performance Objectives	Tests	Review Exercises	Additional Materials Required	Type of Instruction: Group Instruction	Individualized
Unit 1.1—Introduction												
1.1.2 Safety	•					*	•	•			•	
Unit 1.2—Advance Light Frame Structures												
1.2.1 Trailer Mounted Saws	•		•				•	•		*	•	•
1.2.2 Roof Framing Plan	•		•	•			•	•		*	•	•
1.2.3 Common Rafters	•		•	•	*		•	•		*	•	•
1.2.4 Hip and Valley Rafters	•		•	•	*		•	•		*	•	•
1.2.5 Hip and Valley Jacks	•		•	•	*		•	•		*	•	•
1.2.6 Roof Truss Construction	•		•	•			•	•		*	•	•
1.2.7 Stair Construction	•		•	•	*		•	•		*	•	•
1.2.8 Course Summarization	•		•	•			•	•		*	•	•

* Materials are recommended but not provided.

Course Description

Students completing this short course will be able to interpret construction drawings for the layout of wood frame members for service-type stairs and all types of rafters. They will also learn to set up, operate, and perform operator's maintenance on trailer-mounted saws. The course prerequisites are Applied Building Mathematics and Light Frame Construction I (3-11). Course materials are provided for both classroom and shop use. The course is divided into two units. The first section of Unit 1.1 was deleted because it deals with the military chain of command and specific military procedures. The remaining sections are suitable for vocational program use.

Unit 1.1 – **Introduction** contains a thirty minute lesson on safety procedures.

Unit 1.2 – **Advance Light Frame Structures** contains eight sections covering fifteen hours of classroom instruction and forty-two hours of shop instruction.

- 1.2.1 – Trailer Mounted Saws (1 hour classroom, 2 hours shop)
- 1.2.2 – Roof Framing Plan (1 hour classroom, 3 hours shop)
- 1.2.3 – Common Rafters (2 hours classroom, 2 hours shop)
- 1.2.4 – Hip and Valley Rafters (2 hours classroom, 8 hours shop)
- 1.2.5 – Hip and Valley Jacks (2 hours classroom, 8 hours shop)
- 1.2.6 – Roof Truss Construction (2 hours classroom, 11 hours shop)
- 1.2.7 – Stair Construction (2 hours classroom, 4 hours shop)
- 1.2.8 – Course Summarization (1 hour classroom, 4 hours shop)

The course training manual contains both teacher and student materials. The teacher materials include instructions on how to use instructor guide sections and the outline of instruction. It also contains training objectives, texts, references, tools, equipment, materials, training aids and training aid equipment, and the outline of instruction. The outline of instruction contains the lesson plans for each section with an outline of activities for the instructor and the students. Job sheets are provided as student handouts and include references, tools and equipment, and procedures for performing the tasks.

The text recommended is a Navy training manual, *Builder 3 & 2 NAVPERS 10648-F*. The required chapers are provided. A second text is produced commercially, and is not provided. Two commercial references are also given. The following films are suggested for use but not provided.

- GIF 001 – The Gift of Life
- MN 6710C – Building Technique—Framing, Rafter Principles and Common Rafters
- MN 6719D – Building Technique—Framing, Hip and Valley Rafters
- MN 6719F – Building Technique—Fundamentals of Stair Layout

A list of suggested transparencies is also included.

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SPECIAL CONSTRUCTION BATTALION TRAINING

BUILDERS SCHOOL

150.2 Light Frame Construction II

3-12

JANUARY 1976

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TABLE OF CONTENTS

4

TITLE PAGE

TITLE: SPECIAL CONSTRUCTION BATTALION TRAINING COURSE 150.2
LIGHT FRAME CONSTRUCTION II

COURSE NUMBER: SCBT 150.2

COURSE LENGTH: 55 Hours

TAUGHT AT: Naval Construction Training Center, Port Hueneme, California 93043

Naval Construction Training Center, Gulfport, Mississippi 39502

CLASS CAPACITY: Maximum - 16
Minimum - 8

INSTRUCTOR REQUIREMENTS PER CLASS: Class: 16/1
Pract: 8/1

COURSE CURRICULUM MODEL MANAGER: Naval Construction Training Center, Port Hueneme, California 93043

CURRICULUM CONTROL: Chief of Naval Technical Training

QUOTA MANAGEMENT AUTHORITY: School at which taught

APPROVAL/IMPLEMENTATION DATE: Chief of Technical Training letter dated 21 January 1976

The pages that follow the "Information" and "Outline of Instruction" pages are the body of the instruction guide. The pages are divided into three columns; the column on the left includes the outline of instruction required by the objectives of the lesson; the center column is for listing instructor activity that corresponds to the particular portion of the lesson; and the right hand column contains student activity that corresponds to the particular portion of the lesson. Instructor creativity in designing learning exercises, techniques and training aids to meet course objectives can enhance the lesson and should be utilized and noted in the appropriate column. In addition, student comments pertaining to updating, additions, deletions, etc., to the lesson should be encouraged and noted for continual revision of the lesson.

HOW TO USE THE INSTRUCTOR GUIDE

Instructor guides (I.G.'s) are provided for each topic. They include supporting instructional material and aids identified by the topic number and a letter-code designation. The latter codes used in I.G.'s are as follows:

AS - Assignment Sheet	PE - Performance Evaluation
CN - Class Notes	PI - Programmed Instruction
DS - Diagram Sheet	PS - Problem Sheet
EG - Evaluation Guide	PT - Pretest
FT - Final Test	T - Test
IS - Information Sheet	TR - Transparency
JS - Job Sheet	WS - Work Sheet
OS - Operation Sheet	

The instructor guides are intended to be used as master lesson plans, but subject however, to personalization by the individual instructor. The instructor should study and refer to the listing of references, materials and aids given in the appropriate enclosed annex when annotating the instructor guides.

The first page of each instructor guide contains the following functional information.

1. Topic of lesson.
2. Average time in periods (class and practical).
3. Instructional materials such as texts, references, equipment, tools, training aids, etc.
4. Instructional aids such as job sheets, handouts, etc.
5. Enabling objectives (see section "Outline of Training Objectives" that follows).
6. Criterion Test.
7. Homework assignment.

The second page is the "Outline of Instruction" page whereby each instructor will develop an appropriate introduction for each topic that will: (1) create interest; (2) show the value of the topic to the student; (3) relate the topic to previous and future topics in the course; and (4) communicate the learning objectives to the student. Well prepared lesson introductions can provide direction for student motivation and establish readiness for learning.

OUTLINE OF INSTRUCTION

TOPIC	Unit 1.1	CLASS	PRACT	TOTAL	PAGE
	Introduction				
1.1.1	Orientation	1.5	0	1.5	
1.1.2	Safety	0.5	0	0.5	
		2	0	2	
	Unit 1.2				
	Advance Light Frame Structures				
1.2.1	Trailer Mounted Saws	1	2	3	
1.2.2	Roof Framing Plan	1	3	4	
1.2.3	Common Rafters	2	2	4	
1.2.4	Hip and Valley Rafters	2	8	10	
1.2.5	Hip and Valley Jacks	2	8	10	
1.2.6	Roof Truss Construction	2	11	13	
1.2.7	Stair Construction	2	4	6	
1.2.8	Course Summarization	1	4	5	
		13	42	55	

* Total periods classroom: 15
* Total periods practical: 42
Total hours for course: 57
Total weeks for course: 1.9 weeks

* All periods represent 60 minutes of actual instruction.

COURSE DATA PAGE

COURSE MISSION: To train selected Builders in interpreting construction drawings; developing a roof framing plan; laying out, preparing and erecting of stairs, and a hip and valley roof frame; and in operating and performing operator's maintenance on a trailer mounted saw.

PERSONNEL AND RATING ELIGIBLE: E4 thru E7.

OBLIGATED SERVICE: None

NEC EARNED: None

PHYSICAL REQUIREMENTS: None

SECURITY CLEARANCE REQUIRED: None

PREREQUISITE TRAINING AND/OR BASIC BATTERY SCORE REQUIRED: 100.2 Applied Builder Mathematics and 150.1 Light Frame Construction. I.

RELATED TRAINING: None

FOLLOW-UP TRAINING: None

GRADING WEIGHT FACTORS: Performance of tasks throughout the course will be strictly on a go/no go basis.

Topic 1.2.2 ROOF FRAMING PLAN Contact Hours: 4

Enabling Objectives: Upon completion of this topic the student will be able to interpret construction drawings such as floor plans, elevation drawings and sectional drawing in developing a roof framing plan for an intersecting roof by following the procedures outlined in Job Sheet SCBT 150.2 BU JS 1.2.2.1, "Roof Framing Plan". The roof framing plan will be drawn to scale and will show the types and quantity of roof framing members needed for the completion of the roof framing project. The outline of the building will be drawn to within ± 1/16", all rafters and ridge lines will be darkened, and all corners of the building will be alphabetically designated.

Topic 1.2.3 COMMON Contact Hours: 4

Enabling Objectives: Upon completion of this topic the student will be able to interpret the roof framing plan and construction drawing for laying out, preparing and erecting common rafters by following procedures as outlined in Job Sheet SCBT 150.2 BU JS 1.2.3.1, "Laying Out Common Rafters". The prepared rafters will be within ± 1/8" of the specified length, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16", and the rafter will be set with the crown up. A job sheet will be provided to the student.

Topic 1.2.4 HIP AND VALLEY RAFTERS Contact Hours: 10

Enabling Objectives: Upon completion of this topic the student will be able to interpret the roof framing plan and construction drawings for laying out, preparing and erecting hip and valley rafters by following procedures as outlined in Job Sheet SCBT 150.2 BU JS 1.2.4.1, "Laying Out Hip and Valley Rafters". The prepared rafters will be within ± 1/8" of the specified length, the side cut will be within ± 1/16" of the specified angle, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16" at the corner of the building, and the rafters will be laid with the crown up. A job sheet will be provided to the student.

Topic 1.2.5 HIP, VALLEY AND CRIPPLE JACKS Contact Hours: 10

Enabling Objectives: Upon completion of this topic the student will be able to interpret the roof framing plan and construction drawings for laying out, preparing and erecting hip, valley and cripple jacks by following procedures as outlined in Job Sheet SCBT 150.2 BU JS 1.2.5.1, "Laying Out Hip, Valley and Cripple Jacks". A job sheet will be furnished to each student. The hip, valley and cripple jacks will be within ± 1/8" of the specified length, the side cut(s) will be within ± 1/16" of the specified angle cut, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16", and the rafters will be laid with the crown up.

OUTLINE OF TRAINING OBJECTIVES

Unit 1.1 INTRODUCTION — Contact Hours:

Terminal Objectives: Upon completion of this unit the student will have reported to the Builder School and received the school orientation and safety procedures required to complete the assigned course of instruction as a SCBT student.

Topic 1.1.1 ORIENTATION — Contact Hours:

Enabling Objectives: Upon completion of this topic the student will have reported for the course, and answered questions pertaining to kep points on the organization, mission and regulations of NAVCONSTRACEN.

Topic 1.1.2 SAFETY — Contact Hours:

Enabling Objectives: Upon completion of this topic the student will be able to report accidents or fires and state the safety practices that eill be enforced in the school.

Unit 1.2 ADVANCE LIGHT FRAME STRUCTURES — Contact Hours:

Terminal Objectives: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program, skill level 150.2, "Light Frame Construction II", involving: interpreting construction drawings for the layout of wood frame members for service-type stairs, and all types of rafters, and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheet.

Topic 1.2.1 TRAILER MOUNTED SAW — Contact Hours: 3

Enabling Objectives: Upon completion of this topic the student will be able to set up, operate and perform operator's maintenance on the trailer mounted saw, including the prime mover by following the procedures outlined in Job Sheet SCBT 150.2 BU JS 1.2.1.1, "Setting up a Trailer Mounted Saw". A job sheet will be set-up stable and reasonably level, a prestart check, i.e., checking oil, water, fuel, etc., will be conducted, and the generator will be started and stopped. The machine will be secured with its master switch and load switch in the off position, the machine and work area around the machine will be swept clean, all door panels will be closed and if saw covering is available, the saw will be covered.

ANNEX I

TEXTS

1. Builder 3 & 2, NAVPERS 10648-F.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc.

Topic 1.2.6 ROOF TRUSS CONSTRUCTION

Contact Hours:

Enabling Objectives: Upon completion of this topic the student will be able to interpret construction drawings for laying out and setting up a template for roof trusses as outlined in Job Sheet 150.2 BU JS 1.2.6.1, "Roof Truss Construction". A job sheet will be furnished to the student. The completed template and manufactured roof truss will have the length upper chords to within ± 1/4" of the specified length and with the angle cut to within 1/16" of the specified angle; the lower chord to within ± 1/8" of the span and the angle cut to within 1/8" of the specified angle, the king post to within 1/16" of a snug fit, the angle cut(s) of all web members to within ± 1/16" of the specified angle; and the crown of the chords up.

Topic 1.2.7 STAIR CONSTRUCTION

Contact Hours:

Enabling Objectives: Upon completion of this topic the student will be able to calculate the number of steps needed for the flight of stairs and the height of each riser; and be able to layout a pair of stringers for the stairs by following the procedures outlined in Job Sheet SCBT 150.2 BU JS 1.2.7.1, "Laying out Stair Stringers". The calculation for the height of the riser must be within ± 1/32" of an inch, the total height marked off on the story pole must be within ± 1/8 of an inch to the desired height, the layout work on the stringer must show tread allowance less the thickness of the finish floor materials and the stringers must be laid with the crown up.

Topic 1.2.8 COURSE SUMMARIZATION

Contact Hours: 5

Enabling Objectives: Upon completion of this topic the student will have reinforced his ability to identify by naming all the framing members in accordance with the texts as the members are pointed out by the instructor. The student will also have reviewed the methods used in the erection of the light frame structures as each structure is torn down. The dismantled framing members will be clear of all nails and be neatly stacked.

ANNEX III

TOOLS, EQUIPMENT AND MATERIALS

TOOLS:

FSN MFG NO.	ITEM	QUANT	COST	EXT. COST
9QG 5120-00-892-5485	Hammer Hand Carp 16 oz. Claw Fbr. Gls.	16 ea	3.71	59.36
70L 5210-00-545-5615	Tape Measure Flexible 3M Metric 10 ft. English	16 ea	2.37	37.92
9QG 5210-00-241-3599	Square Comb Mach 12	16 ea	3.45	55.20
9QG 5210-00-246-2576	Square Carp 16 x 24 Stn Stl	16 ea	6.49	103.84
9QG 5110-00-827-2079	Saw Crosscut 8 Pt 26 Lg Stn Stl	8 ea	10.22	81.76
9QG 5210-00-244-7561	Bevel Sliding T 10	8 ea	1.49	11.92
9QG 5210-00-273-9793	Chalk Line-Reel	4 ea	.84	3.36
9QL 7510-00-283-0619	Chalk Line Marking Powder White	12 oz	.08	.96
9DL 8415-00-178-7527	Apron Nail 2-pocket Leather w/ Web Belt	16 ea	11.00	176.00
9QG 5210-00-926-5430	Level 2 Plum 28" Alum	4 ea	4.00	16.00
9QL 6675-00-190-5864	Triangle 45 D 12	16 ea	.69	11.04
9QG 7510-00-161-5675	Crayon Lumber Blue Pencil	1 doz.	.67	.67
82016	Saw Circ Port Elec 7 in.	2 ea	113.60	227.20

EQUIPMENT:

1. Sawhorses
2. Trailer mounted saw including prime mover.

MATERIALS:

1. 18" x 24" paper.

ANNEX II

REFERENCES

1. Fundamentals of Carpentry, Volume 2, W.E. Durbahn/E.W. Sundberg.

2. Framing Guide and Steel Square, D.L. Sigmon.

ANNEX IV

TRAINING AIDS

FILMS

1. GIF 001 "The Gift of Life" (18 min.), Creative Communications Inc,
2. MN 6719C "Building Technique - Framing, Rafter Principles and Common Rafters" (15 min.).
3. MN 6719D "Building Technique - Framing, Hip and Valley Rafters.
3. MN 6719F "Building Technique - Fundamentals of Stair Layout (11 min.).

TRANSPARENCIES

1. 11CS 10321.101T-6 [illegible]er Framing Table".
2. 11CS 10321.101T-1 "Rafter Measurement".
3. 11CS 10321.101T-2 "Rafter Cuts".
4. 11CS 7400064-T "Common Rafter Layout".

CHARTS

1. Typical Roof Plan.
2. Roof Trusses.
   a. King Post.
   b. Pitched.
3. Common Rafter.
4. Sectional Drawing of a Building.
5. Types of Stairs.
6. Stairway showing layout terms.
7. Stairways showing the parts of a stairway.

LOCALLY PREPARED MATERIALS

JOB SHEETS

1. SCBT 150.2 BU JS 1.2.1.1, "Trailer Mounted Saw with Primer Mover".

MATERIALS (Cont'd)

2. Masking tape.
3. 2 x 4's.
4. 3/4 " plywood.
5. 2 x 10's.
6. 2 x 12's.
7. 2 x 6's
8. 16d box nails.
9. 8 d box nails.

ANNEX V

TRAINING AIDS EQUIPMENT

1. 16mm movie projector.
2. Overhead projector.

JOB SHEETS (Cont'd)

2. SCBT 150.2 BU JS 1.2.2.1, "Roof Framing Plan".

3. SCBT 150.2 BU JS 1.2.3.1, "Laying Out Common Rafters".

4. SCBT 150.2 BU JS 1.2.4.1, "Laying Out Hip and Valley Rafters".

5. SCBT 150.2 BU JS 1.2.5.1, "Laying Out Hip, Valley and Cripple Jacks".

6. SCBT 150.2 BU JS 1.2.6.1, "Roof Truss Construction".

7. SCBT 150.2 BU JS 1.2.7.1, "Laying Out Stair Stringer".

MODEL

1. Platform Frame Building.

SAMPLES

1. Common Rafter.

2. Hip Rafter.

3. Valley Rafter.

4. Hip Jack.

5. Valley Jack.

6. Connectors.

   a. Tooth Ring.

   b. Split Ring.

DRAWING

1. Construction drawing of a 22' 0" x 24' 0" double car garage.

   a. Floor plan.

   b. Sectional drawings.

   c. Elevation drawings.

SECOND WEEK

TOPIC NO.	TYPE	PERIOD	TITLE	RATIO
FIRST DAY				
1.2.5	P	1	Hip and Valley Jacks	8/1
		2		
		3		
1.2.6	C	4	Roof Truss Construction	16/1
		5		
	P	6		8/1
		7		
SECOND DAY				
1.2.6	P	8	Roof Truss Construction	8/1
		9		
		10		
		11		
		12		
		13		
		14		
THIRD DAY				
1.2.6	P	15	Roof Truss Construction	8/1
		16		
1.2.7	C	17	Stair Construction	16/1
		18		
	P	19		8/1
		20		
		21		
FOURTH DAY				
1.2.7	P	22	Stair Construction	8/1
1.2.8	C	23	Course Summarization	16/1
	P	24		16/1
		25		
		26		
		27		

ANNEX VI

MASTER SCHEDULE

FIRST WEEK

TOPIC NO	TYPE	PERIOD	TITLE	RATIO
FIRST DAY				
1.1.1	C	1	Orientation	16/1
		2		
1.1.2	C	2.5	Safety	16/1
1.2.1	C	3	Trailer Mounted Saw	16/1
	P	4		16/1
		5		
1.2.2	C	6	Roof Framing Plan	16/1
	P	7		8/1
SECOND DAY				
1.2.2	P	8	Roof Framing Plan	8/1
		9		
1.2.3	C	10	Common Rafters	16/1
		11		
	P	12		8/1
		13		
1.2.4	C	14	Hip and Valley Rafters	16/1
THIRD DAY				
1.2.4	C	15	Hip and Valley Rafters	16/1
	P	16		8/1
		17		
		18		
		19		
		20		
		21		
FOURTH DAY				
1.2.4	P	22	Hip and Valley Rafters	8/1
		23		
1.2.5	C	24	Hip and Valley Jacks	16/1
		25		
	P	26		8/1
		27		
		28		
FIFTH DAY				
1.2.5	P	29	Hip and Valley Jacks	8,
		30		

MODIFICATIONS

Instructor Guide
1.1.1 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 100-190

Classification: Unclassified

Topic: Safety

Average Time: 0.5 Period (Class)

Instructional Materials:

A. Texts: None.

B. References:

1. NAVCONSTRACEN Instruction 5400.4 (Current Series), Organization Manual of NAVCONSTRACEN.

2. "Safety Practices for Shore Activities", NAVMAT P-5100, (Jan 73).

C. Tools and Equipment: None.

D. Training Aids and Devices:

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1. Film.

a. GIF 001 "The Gift of Life (18 min)", Creative Communications Inc.

E. Training Aids Equipment.

1. 16mm movie projector.

Terminal Objectives: Upon completion of this unit the student will have reported to Builder School and will have received the school's orientation and safety procedures required to complete the assigned course of instruction as a SCBT student.

Enabling Objectives: Upon completion of this topic the student will be able to report accidents or fire and state the safety practices that will be enforced in the school,

Criterion Test: The student will answer orally specific questions pertaining to the method of reporting and fighting fires as established by NAVCONSTRACEN and CBC regulations and will conform to the safety policies for the duration of his assignment to Builder School.

Homework: None.

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OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name:		
2. Topic: Safety.		
B. Establish readiness.	I.B. Motivate student.	
1. Purpose.		
2. Assignment.		
C. Establish effect.	I.C. Bring out need and value of material being presented.	
1. Value.		
a. Pass course.		
b. Perform better on the job.		
D. Overview.	I.D. State learning objectives.	
1. You will be able to answer orally specific questions related to the methods of reporting and fighting fires as established by NAVCONSTRACEN and CBC regulations and conform to the safety practices that will be enforced in this school.	a. State information and materials necessary to guide student.	
2. Ask questions.		
3. Take notes.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. Presentation.		
A. Safety.		
1. Reporting accidents.		
a. Class safety man.	II.A.1.a. Pick safety man and explain job.	
b. Instructor.		
c. School director.		
d. First aid when appropriate.		
2. Fire safety.		
a. Evacuation routes.		
b. Reporting fires.		
c. Fighting fires.		
(1) Location of extinguishers.		
3. Field safety.		
a. Show film.	II.A.3.a. Introduce film and discuss key points to look for.	
(1) GIF 001 "The Gift Of Life"		
b. Discuss film highlights.	II.A.3.b. Lead discussion, ask questions and stress safety.	II.A.3.b. Participate in discussion - ask questions as necessary.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
III. Application.		
A. Discussion.	III.A. Questions to be developed by the instructor.	III.A. Answer and ask questions.
IV. Summary.		
A. Safety.		
1. Reporting accidents.		
2. Fire safety.		
3. Field safety.		
V. Test: None.		

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Trailer Mounted Saws.

Average Time: 1 Period (Class), 2 Periods (Pract)

Instructional Materials:

A. Texts: None.

B. References:

1. Ross Hydraulic Power Steering Trouble Shooting Manual, Lafayette, Indiana 47902

C. Tools, Equipment and Materials:

1. Hammer.

2. Hand level.

3. Adjustable wrench.

4. Broom.

5. Shovel, flat nose.

6. Trailer mounted saw.

D. Training Aids and Devices:

1. Locally Prepared Material:

a. Job Sheet.

Terminal Objective: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program, skill level 150.2, Light Frame Construction II, involving: interpreting construction drawings for the layout of wood frame members for service-type stairs, and all types of rafters, and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to set up, operate and perform operator's maintenance on the trailer mounted saw, including the prime mover by following the procedures outlined in Job Sheet SCBT 150.2 BU JS 1.2.1.1, "Setting up a Trailer Mounted Saw". A job sheet will be furnished to each student. The saw assembly will be set up stable and reasonably level, a prestart check, i.e. checking oil, water, fuel, etc. will be conducted, and the generator will be started and stopped. The machine will be secured with its master switch and load switch in the off position, the machine and work area around the machine will be swept clean, all door panels will be closed and if saw covering is available, the saw will be covered.

(1) SCBT 150.2 BU JS 1.2.1.1, "Trailer Mounted Saw with Prime Mover".

E. Training Aids Equipment.

1. None.

Criterion Test: The student will set up, operate and secure the trailer mounted saw with prime mover. The saw will be set up stable and reasonably level, a prestart check on oil, water, fuel, etc., will be conducted, the generator will be started and stopped. The machine will be secured with its master switch and load switch in the off position, the machine and work area around the machine will be swept clean, all door panels will be secured and if a saw cover is available, the saw will be covered.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name:		
2. Topic: Trailer Mounted Saws		
B. Establish readiness.	I.B. Motivate student by reading the statement on trailer mounted saws.	
1. The trailer mounted saw with prime mover is used extensively in the battalion. It is essential that you become familiar with this equipment.		
2. Assignment.		
a. Study job sheet SCBT 150.2 BU JS 1.2.1.1.		
C. Establish effect.	I.C. State learning objectives.	
1. Value.	1. Upon completion of this topic you will be able to perform operator's maintenance, set up equipment, start and stop equipment.	
a. Pass course.		
b. Perform better on the job.		
c. Get advanced.		
d. Be a better builder.		
D. Overview.		
1. Ask questions.		
2. Job sheets are to be used as a guide and are to be returned at the completion of [illegible]		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Job sheet may be requested for personal reference.		
4. Stress that the builder is limited to operator's maintenance only.		
II. Presentation.		
A. Introduce job sheet.	II.A. Hand out job sheet, take class out to the field and give a lecture/demonstration on the trailer mounted saw.	
1. SCBT 150.2 BU JS 1.2.1.1, "Trailer Mounted Trailer Saw with Prime Mover".		
B. Introduce equipment.		
1. Trailer mounted saw with primer mover.		
C. Procedures.		
1. Pre-start check.		
a. Check water in radiator.		
(1) Full.		
b. Check oil in engine.		
(1) Oil gauge to register full.		
c. Check fuel.		
(1) Full tank.		
(a) For diesel engine, use diesel oil only.		
(b) For gasoline engine, use gasoline only.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Check fuel line for leakage.		
(1) Report leakage immediately to instructor.		
e. Check fan belt for proper tension.		
f. Check battery water in battery.		
g. Check tire for ample air pressure.		
h. Check safety chain.		
(1) Necessary only if equipment is to be moved.		
i. Check running lights.		
(1) Necessary only if equipment is to be moved.		
2. Setting up equipment.		
a. H. l equipment to job site.		
b. Select placement site.		
(1) Ground should be fairly level.		
c. Unhook equipment on selected site.		
d. Stabilize equipment.		
(1) Level table saw is desireable.		
e. Set conveyor table rollers nearest the table 1/16" above table top - on each extension.		

f. Set conveyor table rollers on the far end 1/16" below table top - on each extension.

g. Locate and clamp a block parallel with table guide strip at the extreme right of roller conveyor approximately 8 feet from infeed sprocket.

5. Start generator.

a. Secure ground.

(1) Drive ground rod.

(2) Hook up ground cable.

b. Lift and secure switch panel door to stay open.

c. Set all switches to OFF position.

d. Lift and secure instrument panel door to stay open.

e. Set load switch to OFF position.

f. Set volt meter switch to OFF position.

g. Set ammeter switch to OFF position.

h. Set synchronizing switch to single phase.

i. Pull out on the throttle knob about 1/3 way.

j. Set switch and start generator.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
k. Check engine oil pressure gauge to assure oil is circulating in engine.		
l. Check battery charge gauge to assure that battery charger is working.		
m. Adjust throttle knob after temperature gauge reads normal.		
n. Check and adjust throttle knob such that the frequency gauge registers 60 cycles.		
o. Adjust voltage adjuster such that the volt meter registers 220.		
p. Set load switch to ON position.		
q. Set master switches (2) on switch panel to ON positions.		
r. The field saw is now ready for use.		
4. Stop generator.		
a. Set master switches (2) to OFF position.		
b. Set load switch to OFF position.		
c. Pull throttle knob out to decrease speed of generator to idle.		
(1) Run generator for 5 minutes for cool down period.		
d. Set engine control switch to OFF position.		
5. Clean up and secure.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Broom all saw dust from machine.		
b. Pick up debris and clean up work area.		
c. Lower and secure all panel doors.		
d. If cover is available, cover the saw.		
III. Application.		
A. Student practice individually in conducting operator's maintenance, starting and stopping of prime mover.	III.A. Be available to assist and show.	III.A. Student practice with the trailer mounted saw.
IV. Summary.		
A. Prestart check.		
B. Setting up of equipment.		
C. Start generator.		
D. Stop generator.		
E. Secure and clean up.		
V. Test:		
A. Student will perform criterion test as stated.		

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

JOB SHEET

TITLE: Trailer Mounted Saw with Prime Mover

INTRODUCTION: This job sheet is to guide you in conducting operator's maintenance, setting up, starting and securing of the portable field saw.

REFERENCE:

1. Ross Hydraulic Power Steering Trouble Shooting Manual, Lafayette, Indiana 47902.

TOOLS, EQUIPMENT AND MATERIALS:

1. Hammer
2. Hand level.
3. Adjustable wrench.
4. Trailer mounted saw
5. Broom
6. Shovel, flat nose.

PROCEDURES:

1. Pre-start check.
   a. Check water in radiator.
      (1) Full.
   b. Check oil in engine.
      (1) Oil gauge to register full.
   c. Check fuel.
      (1) Full tank.
         (a) For diesel engine use diesel oil only.
         (b) For gasoline engine use gasoline only.
   d. Check fuel line for leakage.
      (1) Report leakage immediately to instructor

e. Check fan belt for proper tension.

f. Check battery water in battery.

g. Check tire for ample air pressure.

h. Check safety chain.

(1) Necessary only if equipment is to be moved.

i. Check running lights.

(1) Necessary only if equipment is to be moved.

2. Setting up equipment.

a. Haul equipment to job site.

b. Select placement site.

(1) Ground should be fairly level.

c. Unhook equipment on selected site.

d. Stablize equipment.

(1) Level table saw is desirable.

e. Set conveyor table rollers nearest the table 1/16" above table top - on each extension.

f. Set conveyor table rollers on the far end 1/16" below table top - on each extension.

g. Locate and clamp a block parallel with table guide strip at the extreme right of roller conveyor approximately 8 feet from infeed sprocket.

3. Start generator.

a. Secure ground

(1) Drive ground rod.

(2) Hook up ground cable.

b. Lift and secure switch panel door to stay open.

c. Set all switches to OFF position

d. Lift and secure instrument panel door to stay open

e. Set load switch to OFF position.

f. Set volt meter switch to OFF position.

g. Set ammeter switch to OFF position.

h. Set synchronizing switch to single phase.

i. Pull out on the throttle knob about 1/3 way.

j. Set switch and start generator.

k. Check engine oil pressure gauge to assure oil is circulating in engine.

l. Check battery charge gauge to assire that battery charger is working.

m. Adjust throttle knob after temperature gauge reads normal.

n. Check and adjust throttle knob such that the frequency gauge registers 60 cycles.

o. Adjust voltage adjuster such that the volt meter registers 220.

p. Set load switch to ON position.

q. Set master switches (2) on switch to ON position.

r. The field saw is now ready to use.

4. Stop generator.

a. Set master switches (2) to OFF position.

b. Set load switch to OFF position.

c. Pull throttle knob to decrease speed of generator to idle.

(1) Run generator for 5 minutes for cool down period.

d. Set engine control switch to OFF position.

5. Clean up and secure.

a. Broom all saw dust from machine.

b. Pick up debris and clean up work area.

c. Lower and secure all panel doors.

d. If cover is available, cover the saw.

6. Check work with the instructor.

   a. The saw assembly must be stabilized.

   b. Prestart check on the trailer mounted saw must be conducted.

      (1) Fuel

      (2) Oil

      (3) Water

NOTE: Instructor visually must observe prestart checking by student.

   c. The saw assembly when secured must

      (1) Be clean

      (2) Have panel doors secured.

      (3) Have saw covered - if cover is available.

   d. Master switch must be in off position.

   e. Load switch must be in OFF position.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Roof Framing Plan

Instructional Materials:

A. Texts:

1. Builder 1 & 2, NAVPERS 10648-F, page 324.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc., page 127.

B. References:

1. Fundamentals of Carpentry, Volume 2, W.E. Durban/E.W. Sundberg.

2. A Framing Guide and Steel Square, D.L. Sigmon.

C. Tools, Equipment and Materails:

1. Combination square.

2. Framing square.

3. Measuring tape.

4. 24 inch ruler.

5. Pencil.

Terminal Objective: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, "Light Frame Construction II", involving: interpreting construction drawings for the layout of wood frame members for service-type stairs and all types of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to intrepret construction drawings such as floor plans, elevation drawings and sectional drawings in developing a roof framing plan for an intersecting roof by following the procedures outlined in Job Sheet SCBT 150.2 BU JS 1.2.2.1, "Roof Framing Plan". The roof framing plan will be drawn to scale and will show the types and quantity of roof framing members needed for the completion of the roof framing project. The outline of the building will be drawn to within ± 1/16", all rafters and ridge lines will be darkened, and all corners of the building will be alphabetically designated.

6. 18" paper.

7. 24" paper

D. Training Aids and Devices:

1. Locally Prepared Materails:

a. Models.

(1) Platform frame building.

(2) Types of roof.

b. Chart.

(1) Typical roof plan.

c. Job sheets.

(1) SCBT 150.2 BU JS 1.2.2.1, "Roof Framing Plan".

E. Training Aids Equipment:

1. None

Criterion Test: The student will complete a roof framing plan for an intersecting roof that will be drawn to scale. The outline of the building on the plan will be drawn to within ± 1/16", all rafters and ridge lines will be darkened, and all corners of the building will be alphabetically designated.

Homework: Read:

1. Builder 3 & 2, NAVPERS 10648-F, page 324.

2. Framing, Sheathing and Insulation, page 127.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY / STUDENT ACTIVITY
I. Introduction to the Lesson.	
A. Establish contact.	I.A. Introduce self and topic.
1. Name:	
2. Topic: Roof Framing Plan	
B. Establish readiness.	I.B. Motivate student by stating that this knowledge is essential in organizing a group of men to work as a team in the preparation and erection of a roof framing project.
1. Roof framing plan is used to control the preparation of rafters, identification of the rafters and the placing of the rafters in the proximity of their actual placement site.	
2. Assignment:	
a. Read:	
(1) Builder 3 & 2, NAVPERS 10648-F, page 324.	
(2) Framing, Sheathing and Insulation, page 127.	
C. Establish Effect.	I.C. State learning objectives.
1. Value.	a. Upon completion of this topic, you will be able to interpret construction drawings in planning, laying out and drawing of a roof framing plan.
a. Pass course.	
b. Perform better on the job.	
c. Get advanced.	
d. Be a better builder.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview.		
1. Ask questions anytime, raise your hand and be recognized.		
2. Job sheets are to be used as a guide and are to be returned at the completion of this topic.		
3. Job sheets may be requested for personal references.		
4. Stress need of accuracy.		
II. Presentation.		
A. Introduce job sheet.	II.A. Hand out job sheet.	
1. SCBT 150.2 BU JG 1.2.2.1, "Roof Framing Plan".		
B. Roof types.	II.B. Give brief lecture on the types of roof. Use model on the types of roofs to reinforce lecture.	
1. Gable.		
2. hip.		
3. Intersecting.		
a. Hip and valley.		
b. Gable and valley.		
4. Flat.		
5. Lean to.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Roof frame members. 1. Ridge board. 2. Common rafter. 3. Hip rafter. 4. Valley rafter. 5. Hip jack. 6. Valley jack. 7. Cripple. 8. Barge rafter. 9. Collar ties.	II.C. Give brief lecture on the various roof framing members. Use model on platform frame building to reinforce lecture.	
D. Roof framing plan. 1. Used for checking off purpose, X-ing rafter lines as rafters are prepared. 2. Used to guide in the application of rafter (alphabet) designator and in the distribution of prepared rafter to the proximity of placement site.	II.D. Give brief lecture on how and why a roof framing plan. Use chart to illustrate a roof framing plan to reinforce lecture.	
E. Procedure in drawing of a roof framing plan. 1. Sketch building outline. a. Shape. b. Dimensions.	II.E. Call students attention to job sheets as lecture is given on procedures.	II.E. Turn to job sheets and follow lecture.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Make scaled drawing of building.		
a. Front of the building at the bottom of the sheet.		
b. Use scale 1/4" = 1' 0".		
c. Darken outline of the building.		
3. Draw hip roof lines.		
a. Locate and draw center lines.		
b. Locate intersecting points for hip lines.		
c. Run lines from outside corners of building to center lines.		
4. Draw valley roof lines.		
a. Locate points equal to the length of the wing(s) on the center lines in the wing(s) from where the hip lines intersect the center line.		
b. Run a line from the inner corners of the building to the center line.		
5. Draw cripple hip roof lines.		
a. Run a line from the intersecting point of hip and ridge on the main building to the point of intersecting of valley and ridge on the wing(s).		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
6. Darken outline of ridge, hip, valley and cripple lines.		
7. Draw common rafters, hip jacks, valley jacks and cripple lines.		
a. From the middle of the building or 8 inches from the middle, layout for rafters at 16 inches on center on all walls of the building always working outward.		
b. Run lines through corresponding points on the building outline to the ridge line for common rafter.		
c. Run lines in line with corresponding points from building outline to the hip lines for the hip jacks.		
d. Run lines in line with corresponding points from ridge lines to valley lines for valley jacks.		
e. Run lines in line with corresponding points from the hip lines to valley lines for cripples.		
8. Darken all rafter lines.		
9. Designate corners of building, alphabetically.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Start at any corner and work clockwise.		
III. Application.		
A. Student practice individually in drawing a roof framing plan.	III.A. Be available to show and assist.	III.A. Student practice on their drawing.
IV. Summary.		
A. Roof types.		
1. Gable.		
2. Hip.		
3. Intersecting.		
a. Hip and valley.		
b. Gable and valley.		
4. Flat.		
5. Lean to.		
B. Roof frame members.		
1. Ridge board.		
2. Common rafter.		
3. Hip rafter.		
4. Valley rafter.		
5. Hip jack.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
6. Valley jack.		
7. Cripple.		
8. Barge rafter.		
9. Collar ties.		
C. Roof framing plan.		
1. Used for check off purpose.		
2. In distribution of rafters.		
V. Test:		
A. Student will perform criterion test as stated.		

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

JOB SHEET

Title: Roof Framing Plan

Introduction: This job sheet is to guide you in the development of a roof framing plan.

Tools and Equipment:

1. Measuring tape.
2. Framing square.
3. Pencil.
4. 45° triangle.

Materials:

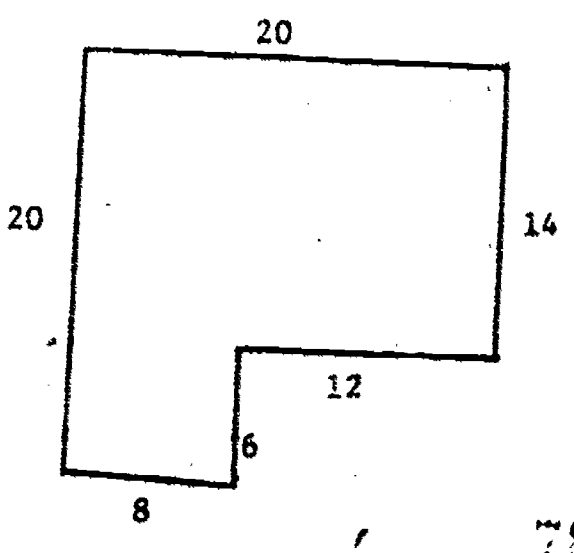
1. Paper, 18" x 24".
2. Masking tape.

References:

1. Builder 3 & 2, NAVPERS 10648-F, chapter 11.
2. Fundamentals of Carpentry, Durbahn and Sundberg.

Procedures:

1. Sketch shape of building.
   a. Refer to the floor plan for size and shape.
   b. Put dimensions on the corresponding sides of sketch.



2. Make a scaled drawing of the building.

   a. Lay sheet of paper on the desk and secure temporarily with masking tape.

   b. Plan layout of building such that the front of the building will be at the bottom of the sheet.

   c. Draw outline of building with a light pencil - use 1/4" = 1' 0" scale.

   d. Darken outline of building.

3. Draw hip roof lines for the building.

   a. With a light pencil draw center line through the main portion of the building.

NOTE: In some instances the ridge line will not fall in the center of the building.

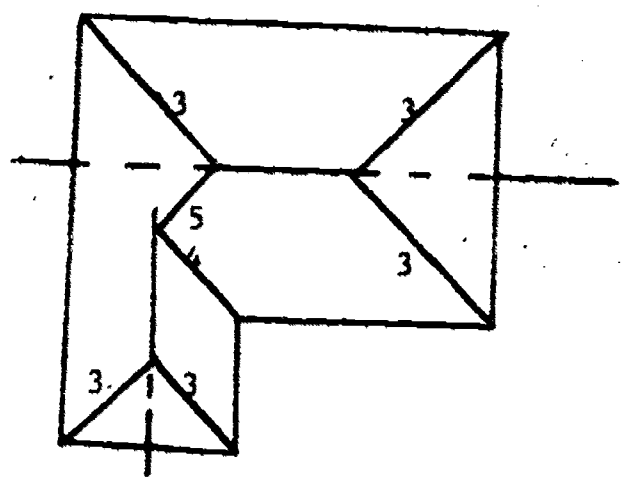
   b. Draw center line(s) through all wing(s) until line(s) intersect the main center line.

   c. From outline of building locate points on the main center line that is on half the span of building.

   d. Run a line from these points to the outside corners at each respective end of building for hip lines.

   e. Repeat procedures 3.c. and 3.d. for hip line(s) at the wing(s).

NOTE: Hip lines are marked with the number 3, valley line with 4 and cripple hip with 5.



4. Draw valley roof lines for the building.

   a. From the point where the hip lines intersect the center line in the wing(s), measure in the distance equal to the length of the wing(s).

   b. Run a line from this point to the inner corner for valley line(s).

5. Draw cripple hip roof lines.

   a. Run a line from the intersecting point of hip and ridge on the main building to the point of intersection of valley and ridge on the wing(s) for cripple hip rafter.

   See sketch .. step 3.

6. Darken outline of ridge, hip, valley and cripple lines.

7. Draw common rafters, hip jacks, valley jacks and cripple lines.

   a. Layout for rafters at 16 inches on center from the middle of the building outward or offset 8 inches from the middle and work outward.

   b. Run lines through corresponding points on the building outline to the ridge line for common rafters. Use light pencil.

   c. Run lines from building outline to hip rafter lines for hip jacks.

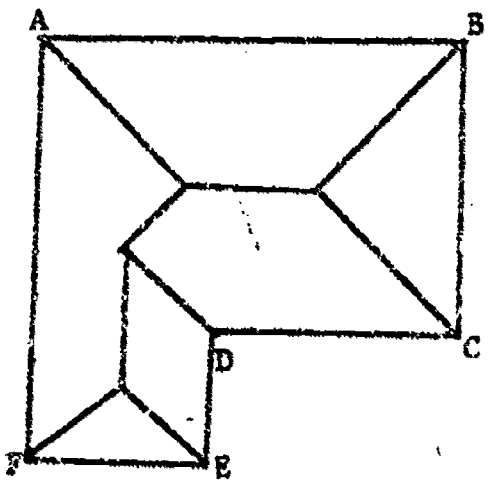
   d. Run lines from ridge to valley rafter lines for valley jacks.

   e. Run lines from cripple hip or hip rafter to valley rafter for cripples.

8. Darken all rafter lines.

9. Designate corners of building.

   a. Starting at any corner of the building marking it with "A", working clockwise designate the next corner "B" and so on until all corners are designated. These designators will be used in designating each rafter and where the rafter is to be placed.



10. Check work with the instructor.

    a. Call instructor to have your drawing checked.

b. The outline of the building must be within ± 1/16", all rafter and ridge lines must be darkened and all corners of the building must be designated with an alphabet.

NOTE: Roof framing plans are used in preparing of rafters and in placing of the prepared rafters in the proximity of their placement in the erection of the roof frame.

Questions:

1. Rafters that run from the ridge to the outside corners of the building are called _____ rafters.

2. Rafters that run from the ridge to the inside corners of the building are called _____ rafters.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Common Rafters

Average Time: 2 Periods (Class), 2 Periods (Pract)

Instructional Materails:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 11.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc., Units 14 and 15.

B. References:

1. Fundamentals of Carpentry, Volume 2, W.E. Durbahn/E.W. Sandberg.

2. A Framing Gufde and Steel Square, O.L. Sigmon.

C. Tools, Equipment and Materials:

1. Trailer mounted saw including prime mover.

2. Portable electric circular saw.

3. Crosscut saw.

4. Combination square.

5. Measuring tape.

Terminal Objective: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, "Light Frame Sonstruction II", involving: interpreting construction drawings for the layout of wood frame members for service-type stairs and all type of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to interpret the roof framing plan and construction drawing for laying out, preparing and erecting common rafters by following procedures as outlined in Job Sheet SCBT 150.2 BU JS 1.2.3.1, "Laying Out Common Rafters". The prepared rafters will be within ± 1/8" of the specified length, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16", and the rafter will be set with the crown up. A job sheet will be provided to the student.

Criterion Test: The student will prepare and install a common rafter which will be within ± 1/8" of the specified length, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16", and the rafter will be set with the crown up.

6. Framing square.

7. Sliding T-bevel square

8. Nail apron.

9. Sawhorses

10. Pencil

11. Hammer, 16 oz.

D. Training Aids and Devices:

1. Film:

   a. MN-6719C "Building Technique - Framing, Rafter Principles and Common Rafters" (15 min.)

2. Transparencies:

   a. 11CS 10321.101T-2 "Rafter Cuts".

   b. 11CS 10321.101T-1 "Rafter Measurements".

   c. 11CS 7400064T "Common Rafter Layout".

   d. 11CS 10321.101T-6 "Rafter Table".

3. Charts:

   a. Common Rafter.

   b. Sectional Drawing of a Building.

4. Model:

   a. Platform Frame Building.

5. Sample:

Homework: Read

1. Builder 3 ' 2, NAVFERS 1064[illegible] T, C[illegible]ote 11

2.

a. Common rafter.

c. Locally Prepared Material:

a. Job sheet.

(1) SCBT 150.1 BU JS 1.2.3.1, "Laying Out Common Rafters".

. Materials:

a. 2 x 4's.

b. 16d box nails.

c. 8d box nails.

NOTE: Recommend 2 x 4's secured on sill plate of practice building to simulate top plate of building.

E. Training Aids Equipment:

. . 16mm projector.

. . Overhead projector.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name:		
2. Topic: Common Rafter.		
B. Establish readiness.	I.B. Motivate student by stating that this knowledge is essential in order to understand roof framing principles.	
1. Common rafters are roof frame members that extend at right angles from the plate line to the ridge whose purpose is to support roof sheathing and roofing.		
2. Assignment:		
a. Read:		
(1) Builder 3 & 2, NAVPERS 16048-F, chapter 11, pages 318-323.		
(2) Framing, Sheathing and Insulation pages 104-111 and 115-124.		
C. Establish effect.	I.C. State learning objectives.	
1. Value.	a. Upon completion of this topic you will be able to interpret construction drawings in laying out common rafter and use trailer mounted saw, portable electric circular saw and carpenter hand tools in preparing common rafters.	
a. Pass course.		
b. Perform better on the job.		
c. Get advanced.		
d. Be a better builder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
D. Overview.		
1. Ask questions anytime, raise your hand and be recognized.		
2. Job sheets/information sheets are to be used as guides.		
3. Job sheets and information sheets may be requested for personal references.		
4. Stress accuracy.		
II. Presentation.		
A. Introduce job sheet.	II.A. Hand out job sheet.	
1. SCBT 150.2 BU JS 1.2.3.1, "Laying Out Common Rafters".		
B. Parts of a rafter.	II.B. Give a brief lecture on the parts of a rafter. Reinforce lecture with the aid of sample of common rafter and transparency no. 11CS 10321.101T-2.	
1. Plumb cut.		
2. Birds mouth.		
3. Body of a rafter.		
4. Overhang or tail.		
5. Facia cut or tail cut.		
C. Rafter layout terms.	II.C. Give a brief lecture on rafter layout terms. Reinforce lecture with transparencies 11CS 10321.101T-1, 11CS 74000 64-T and 11CS 10321.14T-6.	
1. Unit of run.		
2. Unit of rise.		
3. Total run.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Total rise.		
5. Span of building.		
6. Projection.		
7. Shortening.		
8. Line length.		
9. Bridge measure.		
10. Rafter table.		
11. Pitch.	II.c.11. Show how to determine the unit of rise if pitch of roof is given. EXAMPLE: 1/4 pitch 1/4 x 24/1 = 6 Unit of rise = 6"	
D. Common rafter layout procedure.	II.D. Give a brief lecture on common rafter layout techniques. Demonstration in layout method is to be given in the field at the completion of this topic.	
1. Step off method.		
2. Bridge measure method.		
a. Pythagorean Theory.	II.D.2.a. Demonstrate working mechanics of theory by working a problem on the chalk board. Have students work out a couple of problems.	II.D.2.a. Work out assigned problems. Ask questions to clarify any doubtful area.

a: (Cont'd)

$a^2 + b^2 = c^2$
$(6 \times 6) + (12 \times 12) = c^2$
$36 + 144 = c^2$
$180 = c^2$

```
      13.416
    √180.00,00,00
      1
   23/80
      69
  264/1100
      1056
 2681/  4400
        2681
26826/  171900
        160956
```

c = 13.416
or
13.42

b. Rafter table.

(1) 'Length common rafter per foot run' is on the first line.

(2) If unit of rise is 6", locate bridge measure on the first line under number 6. Should read 13.42.

II.D.2.b. Pass out framing square. Use transparency 11CS 10321.101T-6 to point out key information to look for on the table.

II.D.2.b. Follow directions in the use of the table.

c. Line length is determined by multiplying bridge measure and total run

II.D.2.c. Demonstrate line length calculating technique.

EXAMPLE:

```
  13.416
x     11
 13.416
13.416
146.576
```

147.576 inches
or
12 ft. 3 7/16 inches.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
d. Length of overhang is determined by multiplying bridge measure and projection (in feet).	II.D.2.d. Demonstrate calculating for overhang.	
EXAMPLE: Projection = 18 inches = 1 1/2 ft. 13.416 x 1 1/2 6708 13416 20.124 inches or 1 ft. 8 1/8 inches.		
3. Introduce film.	II.D.3. Introduce film.	
a. MN-6719-C, "Building Technique - Framing Rafter Principles and Common Rafter".		
4. Discuss key points to look for.	II.D.4. Discuss key points.	
5. Show film.	II.D.5. Show film.	
. Discuss film.	II.D.6. Lead discussion on film.	II.D.6. Participate in discussion.
a. Highlights.	a. Ask questions.	
b. Accuracy.		
E. Steps of procedure.	II.E. Take class out in the field to demonstrate common rafter layout techniques.	II.E. Follow demonstration procedures.
1. Layout common rafter (step off method).		
a. Select and set 2 x 4 on saw horses.		
b. Determine crown.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Mark plumb cut at one end and step off 11 times. Use 12 and 6 on framing square.		
NOTE: In lecture, 1/4 pitch and span of 22 feet were used.		
d. Mark plumb cut for line length and compare this distance with line length calculated using bridge measure method.	II.E.1.d. Show inaccuracy of step off method.	
NOTE: Calculation was 12 ft. 3 9/16 inches.		
2. Lay out common rafter (bridge measure method).		
a. Select and set 2 x 4 on saw horse.		
b. Determine crown.		
c. Mark plumb cut at one end.		
d. Measure 12 ft. 3 9/16 inchs from long point of this mark.		
e. Square this mark at the top.		
f. Run a plumb line down the side.		
g. From the top, measure down 2 1/2 inches and mark.		
h. Run a level line at this mark.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
i. From the squared line length, mark at the top measure length of overhang (1 ft. 8 1/8 inches).		
j. Square this mark at the top and run a plumb line down the side.		
k. Shorten rafter for ridge board.		
III. Application.		
A. Student practice individually in laying out of common rafter for the practice building using the bridge measure method. Have layout work checked by instructor, then utilize tools and equipment and cut the rafters.	III.A. Be available to show, assist and supervise the student.	III.A. Student practice individually - seek instructor's assistance as needed.
IV. Summary.		
A. Parts of a rafter.		
1. Plumb cut.		
2. Body of rafter.		
3. Birds mouth.		
4. Overhang or tail.		
5. Facia cut or tail cut.		
B. Rafter layout terms.		
1. Unit of run.		
2. Unit of rise.		
3. Total run.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Total rise.		
5. Span of a building.		
6. Projection.		
7. Shortening.		
8. Line length.		
9. Bridge measure.		
10. Rafter table.		
11. Pitch.		
C. Layout methods.		
1. Step off method.		
2. Bridge measure method.		
V. Test:		
A. Student will perform criterion test as stated.		

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

JOB SHEET

Title: Laying Out Common Rafter

Introduction: This job sheet is to guide you in the laying out of common rafter.

Tools, Equipment and Materials:

1. Measuring tape.
2. Framing square.
3. Combination square.
4. Crosscut saw.
5. Portable electric circular saw.
6. Sawhorses
7. Pencil.
8. Trailer mounted saw including prime mover.
9. Sliding T-bevel square
10. Hammer.
11. Nail apron.

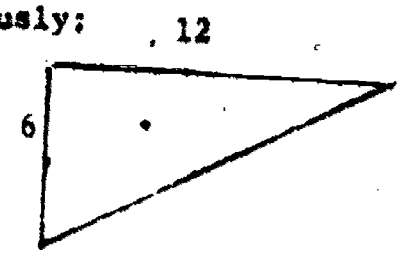
Materials:

1. 2 x 4's.

Procedures:

1. Determine the span of the building.
   a. By refering to the floor plan.
2. Determine the unit of rise.
   a. By refering to the elevation plan or/and the sectional drawing.

b. Will be shown thusly:



3. Determine bridge measure using pythagorean theory.

a. Use Pythagorean Theory equation:

$a^2 + b^2 = c^2$

Given: a = 12
b = 6

Step 1: $(12 \times 12) + (6 \times 6) = c^2$
$144 = 36 = c^2$
$180 = c^2$

Step 2:

```
          13.416
        180.00,00,00
          1
       23/80
          69
      264 /1100
          1056
    26810 /  4400
             2681
    26826 /  171900
             160956
               9944 - R
```

The bridge measure is 13.416 inches.

4. Determine bridge measure using the rafter schedule.

a. From the rafter schedule on your framing square, read the numbers given on the first line under the number 6. The number should read 13.42

5. Determine line length of common rafter.

a. Multiply the bridge measure and the total run (in feet) equation.

Step 1:

```
  13.416
  x   11
  13416
 13416
147.576 inches
```

Step 2:

```
        12
12/147.576
        12
         27
         24
          3
```

12 Feet 3.576 inches

b. The total run is one half the span, equate:

span = 22 feet.

22 - 2 = 11 feet.

total run = 11 feet

Step 3:

```
 .576
x 16
 3456
576
9.216
```

The line length is 12 ft. 3 9/16 inch.

6. Determine length of projection and the length of tail.

a. By refering to the elevation plan and/or sectional drawing.

b. Multiply the bridge measurement and length of the projection (in feet). equate:

projection = 18"

18" = 1 1/2 feet

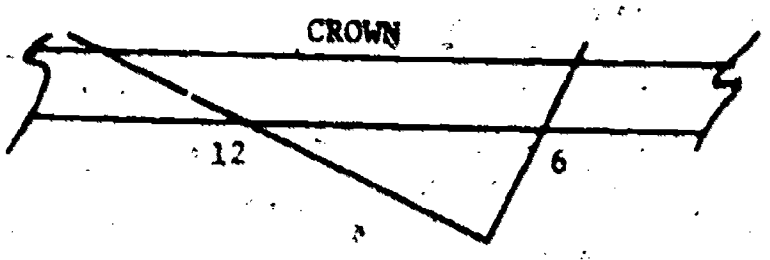
```
13.416
x  1.5
 67080
13416
20.1240
```

Tail length is 20 1/8" or ;' 8 1/8"

7. Layout common rafter line length.

a. Select a straight 2 x 4 and place it on a pair of saw horses.

b. As in previous tasks, determine the crown.



c. By holding the framing square with the body on 12 and the tongue on 6. Strike a plumb mark on the tongue at the end of the 2 x 4 such that the crown will be up.

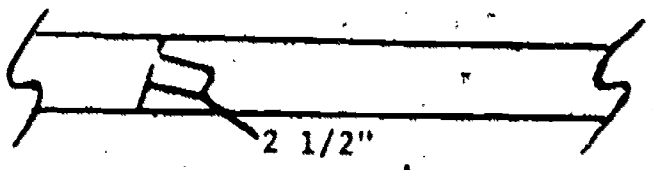
d. From the long point of the mark, measure out the line length determined in step 5 (12' 3 9/16").

8. Lay out for birds mouth.

a. Square the top of the 2 x 4 at the mark.

b. Using the framing square run a plumb line down the side of the 2 x 4.

c. From the top edge, measure down and mark 2 1/2".



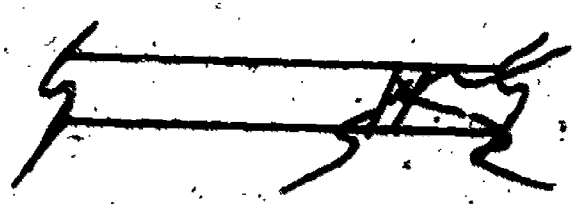
d. Using a framing square, run a level line at this mark. This level line is called seat cut.

9. Lay out for tail.

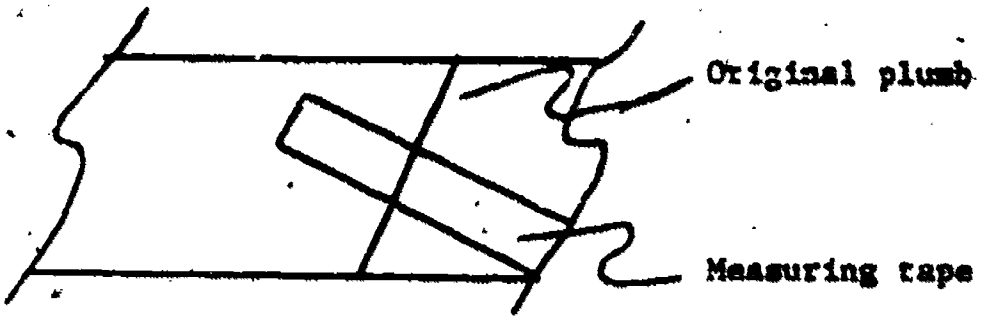
a. Refer to step 6 for length of tail.

b. Utilizing skills gained from previous tasks, mark for tail.

10. Lay out for ridge shortening allowance.



a. From the plumb line marked in step 7, measure back one half the thickness of the ridge board. This half thickness must be taken perpendicular from the original plumb line.



b. Mark new plumb line and scratch out the original mark.

c. Scratch out old marking to eliminate cutting on the wrong mark.

11. Check work with instructor.

a. Raise your hand or call instructor.

b. The layout work must show the total rafter length to be within ± 1/8" of the correct length. The lumber to be left after cutting the birds mouth must be within 2 7/16" - 2 9/16" and the rafter must be laid out with the crown up.

12. Cut your rafter.

a. Using the tools and equipment assigned.

Questions:

1. The pitch is equal to the _____ over the _____.

2. Line length of a rafter is determined by multiplying the _____, _____, and the _____ of the building.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Hip and Valley Rafter

Average Time: 2 Periods (Class), 8 Periods (Pract)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 11.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc., Unit 16.

B. References:

1. Fundamentals of Carpentry, Volume 2, W.E. Durbahn/E.W. Sundberg.

2. A Framing Guide and Steel Square, D.L. Sigmon.

C. Tools and Equipment:

1. Combination square.

2. Framing square.

3. Measuring tape.

4. Sliding T-bevel square.

Terminal Objectives: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, "Light Frame Construction II", involving: interpreting construction drawings for the layout of wood frame members for service-type stairs and all types of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to interpret the roof framing plan and construction drawings for alying out, preparing and erecting hip and valley rafters by following procedures as outlined in Job Sheet SCBT 150.2 BU JS 1.2.4.1, "Laying Out Hip and Valley Rafters". The prepared rafters will be within ± 1/8" of the specified length, the side cut will be within ± 1/16" of the specified angle, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16" at the corner of the building, and the rafters will be laid with the crown up. A job sheet will be provided to the student.

Criterion Test: The student will prepare and install a hip rafter and a valley rafter. The prepared rafters will be within ± 1/8" of specified length, the side cut will be within ±, 1/16" of the specified angle, the lumber above the bird's mouth will be within 2 6/16" to 2 9/16" at the corner of the building, and the rafters will be laid with the crown up.

5. Sawhorses.

6. Crosscut saw.

7. Pencil.

8. Portable electric circular saw.

9. Hammer.

10. Nail apron.

11. Trailer mounted saw including prime mover.

D. Training Aids and Devices:

1. Film.

   a. MN-6719D "Building Technique - Framing Hip, Valley and Cripple Rafters" (25 min.)

2. Transparencies.

   a. 11CS 10321.101T-6, "Rafter Table".

3. Locally Prepared Materials:

   a. Samples.

      (1) Hip rafter.

      (2) Valley rafter.

   b. Model.

      (1) Platform frame building.

c. Job Sheet.

(1) SCBT 150.2 BU JS 1.2.4.1, "Laying Out Hip, Valley and Cripple Rafters".

4. Materials.

a. 2 x 4's.

b. 16d box nails.

c. 8d box nails.

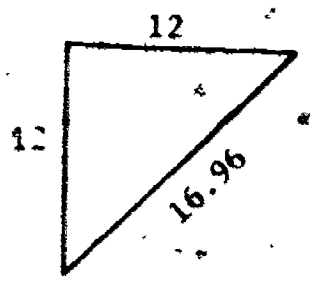
E. Training Aids Equipment:

1. 16mm projector

2. Overhead projector.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name.		
2. Topic: Hip and Valley Rafters.		
B. Establish readiness.	I.B. Motivate student by stating that this knowledge is essential in advance roof framing.	
1. Hip rafters are roof members that extend at 45° from the plate lines forming an outside corner to the ridge, whose purpose is to support hip jacks, roof sheathing and roofing.		
2. Valley rafters are roof frame members that extend at 135° from the plate lines forming an inside corner to the ridge, whose purpose is to support valley jacks, roof sheathing and roofing.		
3. Assignment:		
a. Read:		
(1) Builder 3 & 2, NAVPERS 16048-F, Chapter 11, pages 324-327.		
(2) Framing, Sheathing and Insulation, Unit 16.		
C. Establish effect.	I.C. State learning objectives.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY / STUDENT ACTIVITY
1. Value.	a. Upon completion of this topic you will be able to interpret construction drawings in laying out, preparing and erecting hip and valley rafters.
a. Pass course.	
b. Perform better on the job.	
c. Get advanced.	
d. Be a better builder.	
D. Overview.	
1. Ask questions any time.	
2. Job sheets are to be used as guide.	
3. Job sheets may be requested for personal references.	
II. Presentation.	
A. Introduce job sheet.	II.A. Hand out job sheet.
1. SCBT 150.2 BU JS 1.2.4.1, "Laying Out Hip and Valley Rafters".	
B. Hip rafter.	II.B. Explain why the unit of run has changed.
1. Unit of run for hip and valley rafter.	



Unit of run for hip or valley rafter = 16.96 or 17 inches.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Unit of rise.		
a. 6 inches.		
3. Bridge measure.	II.B.3. Pass out framing square. Use transparency 11CS 10321.101T-6 to point out key information to look for.	
a. Rafter table.		
(1) Length hip or valley per foot run is on the second line.		
(2) If unit of rise is 6", locate bridge measure on the second line under number 6, should read 18.		
4. Line length is determined by multiplying bridge measure and total run.	II.B.4. Demonstrate line length calculating technique.	
EXAMPLE:		
18 x11 18 18 198	198 inches or 16 ft. 6 in.	
5. Length of overhang is determined by multiplying bridge measure and projection (in feet).	II.B.5. Demonstrate calculating technique for overhang.	
EXAMPLE: Projection = 18" = 1 1/2 ft.		
18 x 1 1/2 9 18 27	27 inches or 2 ft. 3 in.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
6. Introduce film.	II.B.6. Introduce film.	
a. MN-6719D "Building Technique - Framing Hip and Valley Rafters".		
7. Discuss key points to look for.	II.B.7. Discuss key points.	
8. Show film.	II.B.7. Show film.	
9. Discuss film.	II.B.9. Lead discussion of film.	II.B.9. Participate in discussion.
a. Highlights.	II.B.9.a. Ask questions.	
b. Accuracy.		
C. Steps of procedure.	II.C. Take class out in the field to demonstrate hip and valley rafter layout technique.	
1. Layout hip rafter line length.		
a. Select and set 2 x 4 on saw horse.		
b. Determine crown.		
c. Strike a square mark on the edge approximately 2 inches from the end and locate midpoint of the squared mark.		
d. From this mark, measure out line length.		
e. Square this new mark and locate midpoint of squared line.		
2. Mark for side cut for the top of the rafter.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Layout for birds mouth. a. Mark opposite side cuts intersecting the center mark of step II.G.1.d. b. Run a plumb line down from the shorter end of side cut markings. c. Run a plumb line down from the squared mark used in step a. d. From the top of the edge, measure and mark 2 1/2" down on plumb line in step c. e. Mark a level line through this mark and scratch out any marking beyond the plumb line marked in step b.	II.C.3. Stress the importance in this portion of layout work.	
4. Layout tail for hip rafter. a. From the line length marking of step II.G.1.d., measure out 2 ft. 3 in. b. Square this mark and locate midpoint of squared line. c. Mark opposite side cuts intersecting the center point. d. Run a plumb line from the shorter end of side cut marking on face of 2 x 4.	II.C.4. Stress importance in this portion of layout work, use simple sketch to clarify this cut.	
5. Shorten rafter at the ridge.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. Holding a measuring tape perpendicular to the side cut markings made in step II.G.2., locate points on half the thickness of the ridge board.		
b. Run side cut markings through these points and cross out old markings.		
c. Run plumb cut markings from the short end of the side cut marks.		
D. Valley rafter.		
1. In laying out for the birds mouth for a valley rafter, use same procedures as in laying out for the hip rafter except the running of plumb line down from the long end of the side cut marking in step II.G.3.b. and the not scratching out of any markings as in step II.G.3.e.		
2. In laying for the tail cut for a valley rafter, use same procedures as in laying out for the hip rafter except the running of plumb lines down from the long end of the side cut marking in step II.G.4.c.		
III. Application.		
A. Student practice individually in laying out a hip rafter and a valley rafter for the practice building using bridge measure method. Have layout work checked then and erect rafters.	III.A. Be available to show, assist and supervise the student.	III.A. Student practice individually - seek instructors assistance if help is needed.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. Summary.		
A. Hip and valley rafters.		
1. Unit of run.		
2. Bridge measure.		
a. Line length.		
b. Tail.		
3. Birds mouth length.		
a. Hip.		
b. Valley.		
4. Tail cut.		
a. Hip.		
b. Valley.		
5. Shortening.		
V. Test		
A. Student will perform criterion test as stated.		

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

JOB SHEET

TITLE: Laying Out Hip and Valley Rafters.

INTRODUCTION: This job sheet is to guide you in laying out of hip and valley rafters.

Tools, Equipment and Materials:

1. Measuring tape
2. Framing square
3. Combination square
4. Sliding T-bevel square
5. Sawhorses
6. Pencil
7. Crosscut saw
8. Portable electric circular saw
9. Hammer
10. Nail apron
11. Trailer mounted saw including prime mover.
12. 2 x 4's

Questions:

1. What is the unit of run in laying out for a hip rafter?

PROCEDURES:

1. Determine the span of the building.

   a. By referring to the floor plan.

2. Determine the unit of rise.

   a. By referring to the elevation plan and or the sectional drawing.

   b. Will be shown thusly:

NOTE: 16.96 or 17 is used as the unit of run when working on a hip or valley rafter.

3. Determine bridge measure using Pythagorean Theory.

   a. Use Pythagorean Theory eg. $a^2 + b^2 = c^2$.

      given: a = 16.96
             b = 6

      $(16.96 \times 16.96) + 6 \times 6) = c^2$
      $287.6416 + 36 = c^2$
      $324.6416 = c^2$

```
        18.02
      √324.6416
        11
   28 | 224
        224
3602     | 6416
```

      The bridge measure is 18 inches.

      NOTE: 16.96 or 17 is used as the unit of run when working on a hip or valley rafter.

4. Determine bridge measure using the rafter schedule.

   a. From the rafter schedule on framing square, read the number given on the second line under the number 6. The number should read 18.

5. Determine line length of hip (or valley) rafter.

   a. Multiply the bridge measure and the total run (in feet) eg.

```
Step 1:  18          Step 2:      16
         11                  12 198
         18                      12
        18                        78
        198                       72
                                   6
```

      Line length of the rafter is 16 feet 6 inches.

      (1) Total run is one half the span of the building, eg.

      Span = 22 feet.

      22 ÷ 2 = 11 feet.

      Total run = 11 feet.

6. Determine line length of the tail.

   a. By referring to the elevation plan and or sectional drawing

   b. Multiply the bridge measure and the length of projection (in feet), e.g.

      projection = 18 inches

      18" = 1 1/2 feet.

      $$\begin{array}{r} 18 \\ \times\ 1\ 1/2 \\ \hline 9 \\ 18 \\ \hline 27 \end{array}$$ inches.

      Tail length is 27 inches or 2 feet 3 inches.

7. Layout hip (or valley) rafter line length.

   a. Select a straight piece of 2 x 4 and set it on a pair of saw horses.

   b. Determine the crown.

   c. Strike a square mark on the edge approximately 2 inches from the end of the 2 x 4 and find the center of the squared mark.

      (1) In layout work for hip and valley rafters, work from the center line

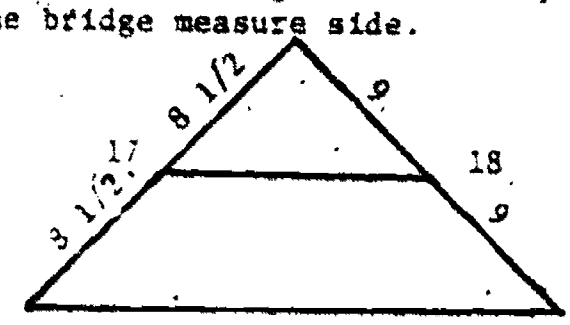
   d. From this mark, measure out the line length determined in Step 6.

      (1) This mark will be exactly on the corner of the Building.

8. Mark for side cut for the top of the rafter, this marking must pass through the center mark.

   a. Depending on whether a single or a double side cut is needed mark for side cut, by holding 8 1/2" and 9" on your framing square and marking on the 9" side.

   b. Side cut of a hip or valley rafter is made by using the unit of run and the bridge measure on your framing square. Mark on the bridge measure side.



9. Determine side angle cut using the rafter schedule.

   a. From the rafter schedule on your framing square, read the number given on the last line under number 6. The number should read 11 5/16.

   b Using this number (11 5/16) and 12 on the framing square, mark on the 12 side for the proper angle.

      (1) You will find that the angle formed by this mark is the same angle as that in step 7.

10. Layout birds-mouth for hip rafter.

   a. Mark a square at the marking for line length.

   b. Find the center of the squared mark.

   c. Using the numbers 8 1/2 and 9 on your framing square, mark opposite side cuts intersecting at the center mark.

   d. From the shorter end of the side cuts markings run a plumb line across the face of the 2 X 4.

   e. Run a plumb line across the face from the squared line length mark.

   f. From the top measure down and mark the amount of wood equal to the wood left on the common rafter.

   g. Mark a level line through this mark.

   h. Scratch out the marking beyond the plumb line marked in step 10d.

11. In laying out birds-mouth for a valley rafter.

   a. Run a plumb line from the longer end of the side cut marking in step 10c.

   b. Run the level line to this plumb marking through marking in step 10e.

12. Layout tail for hip rafter.

   a. Determine length of projection from sectional drawing.

b. Multiply bridge measure (18) and length of projection (in feet) eg.

Projection = 18 inches = 1 1/2 feet.

$$\begin{array}{r} 18 \\ \times\ 1\ 1/2 \\ \hline 9 \\ 18 \\ \hline 27 \end{array}$$ inches or 2 feet 3 inches.

c. From the line length marking measure out 2 feet 3 inches, square this mark and locate center.

d. Using 8 1/2 and 9 on your framing square, mark opposite side cuts intersecting at the center point.

e. Using 6 and 17 on your framing square run a plumb line from the shorter end of the side cut marking.

13. Layout tail for valley rafter.

a. Same procedures as in step 12 except the running of plumb line from the long end of side cut markings.

14. Shortening rafter at the ridge.

a. Run side cut markings through midpoint of squared mark in step 7c.

b. Holding a measuring tape perpendicular to the side cut marking, locate points one half the thickness of the ridge board.

c. Run new side cut marking through these new markings and cross out the old side cut markings.

d. Run plumb cut markings from the short end of side cut markings.

15. Check work with instructor.

a. Call for instructor - have a framing square handy.

b. The total length of the rafter must be within ± 1/8" of being correct, the side cut from one end of the angle to the other be within ± 1/16", the lumber left after cutting out the birdsmouth must be such that the portion that will be directly over the building corner be within 2 7/16" - 2 9/16", and the rafter must be laid with the crown up.

16. Cut your rafter.

a. Using tool and equipment assigned.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Hip, Valley and Cripple Jacks

Average Time: 2 Periods (Class) 8 Periods (Pract)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 11, pages 332 - 336.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc., pages 132 - 135.

B. References:

1. Fundamentals of Carpentry, Volume 2, W.E. Durbahn/E.W. Sundberg.

2. A Framing Guide and Steel Square, D.L. Sigmon.

C. Tools, Equipment and Materials:

1. Trailer mounted saw including prime mover.

2. Portable electric circular saw.

3. Crosscut saw.

4. Combination square.

Terminal Objectives: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, "Light Frame Construction II", involving: interpreting construction drawings for the layout of wood frame members for service-type stairs and all types of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to interpret the roof framing plan and construction drawings for laying out, preparing and erecting hip, valley and cripple jacks by following procedures as outlined in Job Sheet SCBT 150.2 BU JS 1.2.5. "Laying Out Hip, Valley and Cripple Jacks". A job sheet will be furnished to each student. The hip, valley and cripple jacks will be within ± 1/8" of the specified length, the side cut(s) will be within ± 1/16" of the specified angle cut, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16", and the rafters will be laid with the crown up.

Criterion Test: The student will prepare and install a hip jack, valley jack, and a cripple jack. The prepared rafters will be within ± 1/8" of specified length, the side cuts will be within ± 1/16" of the specified angle cut, the lumber left above the bird's mouth will be within 2 7/16" to 2 9/16", and the rafters will have the crown up.

5. Measuring tape.

6. Framing square.

7. Sliding T-bevel square.

8. Nail apron.

9. Sawhorses.

10. Hammer, 16 oz.

11. 2 x 4's.

12. 16d box nails.

13. 8d box nails.

D. Training Aids & Devices:

1. Transparencies.

   a. 11CS 10321.101T-6, "Rafter Table".

2. Locally Prepared Materials.

   a. Model.

      (1) Platform frame building.

   b. Samples.

      (1) Hip jack.

      (2) Valley jack.

      (3) Cripple jack.

Homework: Read:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 11, pages 332 - 336.

2. Framing, Sheathing and Insulation, pages 132 - 135.

c. Job Sheets.

(1) SCBT 150.2 BU JS 1.2.5.1, "Laying Out Hip, Valley and Cripple Jacks".

E. Training Aide Equipment:

1. Overhead projector.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name		
2. Topic: Hip, Valley and Cripple Jacks.		
B. Establish readiness.	I.B. Motivate student by stating that this information is essential in advance roof framing - define and state purpose of hip, valley and cripple jacks.	
1. Hip jacks are roof frame members that extend at right angles from the plate line to the hip rafter whose purpose is to support roof sheathing and roofing.		
2. Valley jacks are roof frame members that extend at right angles from the ridge board to the valley rafter whose purpose is to support roof sheathing and roofing.		
3. Cripple jacks are roof frame members that extends from the hip rafter to the valley rafter whose purpose is to support roof sheathing and roofing.		
4. Assignment.		
a. Read		
(1) Builder 3 & 2, NAVPERS 10648-F, pages 332 - 336.		
(2) Framing, Sheathing & Insulation, pages 132 - 135.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
C. Establish effect.	I.C. State learning objectives.	
1. Value.		
a. Pass course.	I.C.1.a. Upon completion of this topic you will be able to intreprat construction drawing in laying out, cutting and erecting hip, valley and cripple jacks.	
b. Perform better on the job.		
c. Get advanced.		
d. Be a better builder.		
D. Overview.		
1. Ask questions any time.		
2. Job sheets are to be used as guides.		
3. Job sheets may be requested for personal references.		
4. Stress accuracy.		
II. Presentation.		
A. Introduce job sheets.		
1. SCBT 150.2 BU JS 1.2.5.1, "Laying Out Hip, Valley and Cripple Jacks".		
B. Hip, valley and cripple jacks.		
1. Unit run is 12 inches.		
2. Unit of rise is 6 inches.		

3. Bridge measure is 13.42 inches.

4. Length of overhang is 2 feet 3 inches.

5. Common difference of jack at 16 inches on center is determined by using ratio and proportion.

   EXAMPLE: c = common difference in length.

   $$16/12: \frac{C}{13.42} = 4/3 \times \frac{C}{13.42}$$

   3C = 53.68

   C = 17.893 17 7/8 inches.

   Common difference of jacks is 17 7/8 inches or 1 foot 5 7/8 in.

6. Side cuts of jacks.

   a. 12 and 13 7/16 on the framing square, mark on the 13 7/16 side.

   b. If using rafter table, the fifth line is for the side cut of jacks. Under 6 locate number of fifth line, the number should read; 10 3/4, this means use 12 and 10 3/4 on framing square, marking on the 12 side.

II.B.5. Demonstrate common difference calculating technique on C/B.

Have student work at similar type of problem.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
4. Shortening allowance. a. Run side cut of jacks through midpoint. b. Allow deduction for one half thickness of hip rafter. c. Mark new side and cut marking through this new mark. d. Square the long point at the top. e. From this squared line, measure down 17 7/8 inches as necessary. f. Square these markings. NOTE: The squared lines will be the long points of hip jacks.	II.C.4. Emphasize shortening technique.	
5. Layout a pair of hip jacks. a. Place 2 x 4's, one on each side of template. b. Transpose marking from template to the 2 x 4's for long point, birds mouth and tail length. c. Mark for side cut.	II.C.5. Show students laying out of the jacks in pairs will help eliminate error in side cutting of jacks.	

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
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d. Mark for plumb cut.

e. Mark for birds mouth.

f. Mark for facia cut.

PART II Valley Jacks

6. Determine total run of longest valley jack.

a. Inner corner of building to the center of the first common rafter.

b. Subtract this dimension from the spacing on center of rafter.

7. Determine line length for this valley jacks.

8. Layout line length for valley jacks.

a. Select and set a straight common rafter on saw horses.

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b. From the long point of the measure down of line length for longest valley jack calculated in step II.B.7.

c. From this mark measure length of common difference back up to the top end of rafter.

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d. Square these marks.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
NOTE: These marks will be the long points of valley jacks.		
9. Shortening allowance.	11.C.9. Explain how this will allow shortening for one half the thickness of the ridge board and one half the thickness of the valley rafter.	
a. From the plumb cut on the common rafter, deduct the full thickness of the ridge board.		
10. Layout a pair of valley jacks.		
a. Place 2 x 4's, one on each side of template.		
b. Transpose marking from template to the 2 x 4's for plumb cut at the top and the long point of the side cut.		
c. Mark for side cut.		
d. Mark for plumb cut.		
Part III. Cripple Jack		
11. Determine total run of longest cripple jack.		
a. Center of the shortest valley rafter at the ridge to the point of intersection of the center lines of hip rafter and the ridge.		
b. Add this dimension to the total run of the shortest valley jack for theoratical dimension.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Subtract two time [illegible]fter spacing from theoratical dimension.	II.C.11.c. Explain this portion of deducting of two rafter spacing.	
12. Determine line length of this cripple jack.		
a. Multiply bridge measure by total run of longest cripple jack.		
13. Layout line length for cripple jack.		
a. Select and set a scrap of 2 x 4, long enough for this jack on a pair of sawhorses.		
b. Square a line on the edge, approximately 2" from one end.		
c. Measure and mark for length of cripple jack.		
d. Square a line on this mark.		
e. Locate center on the square mark.		
f. Mark for side cut through these centers.		
14. Shortening allowance.		
a. Deduct for full thickness of a 2x		
b. Mark for new side cut.		
15. Mark for plumb cut		

16. Determine common difference of cripple jacks.

III. Application.

A. Student practice.

1. Laying out of templates for hip jacks and for valley jacks, individually.

2. Laying out of a pair of hip jacks and a pair of valley jacks, individually.

3. Laying out a cripple jack, individually.

IV. Summary

A. Hip, valley and cripple jacks.

1. Unit of run.

2. Unit of rise.

3. Bridge measure.

a. Line length.

b. Tail length for hip jacks.

4. Birds mouth for hip jacks.

5. Tail cut for hip jacks.

6. Shortening.

   a. Hip jack one half thickness of hip rafter.

   b. Valley jack - a full thickness of the ridge board.

   c. Cripple jack - a full thickness of a 2x.

V. Test:

A. Student will perform criterion test as stated.

NAVAL CONSTRUCTION TRAINING CENTER
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SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

JOB SHEET

Title: Laying Out Hip, Valley and Cripple Jacks.

Introduction: This job sheet is to guide you in the laying out of hip valley and cripple jacks.

Tools, Equipment and Materials:

1. Measuring tape.
2. Framing square.
3. Combination square
4. Crosscut saw.
5. Portable electric circular saw.
6. Sliding T-bevel square.
7. Sawhorses.
8. Pencil.
9. 2 x 4's.
10. Trailer mounted saw including prime mover.
11. Hammer.
12. Nail apron.

Procedures:

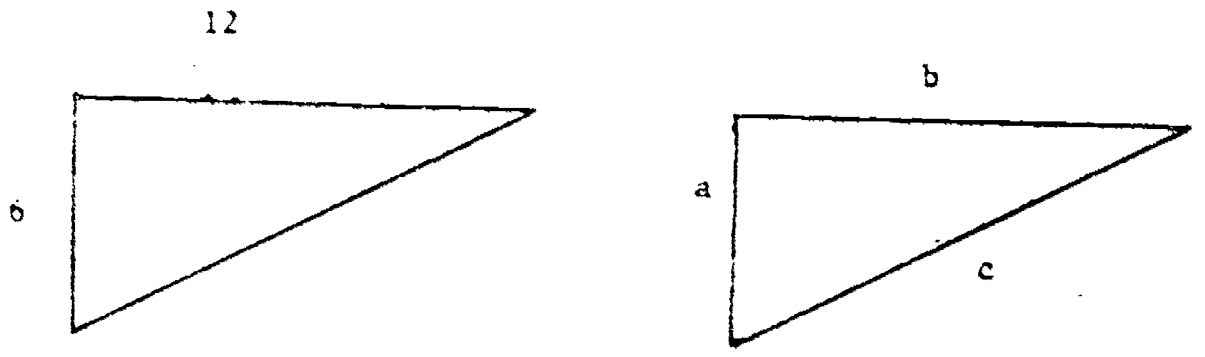
1. Determine the span of the building.

   a. By referring to the floor plan.

2. Determine the unit of rise.

   a. By referring to the elevation plan and/or the sectional drawing.

   b. Will be shown thusly:



3. Determine the bridge measure using pythogorean theory.

   a. Use pythagorean theory, example:

$a^2 + b^2 = c^2$ Given: $a = 12$
$b = 6$

$(12 \times 12) + (6 \times 6) = c^2$

$144 + 36 = c^2$

$180 = c^2$

```
      13.416
√ 180.00,00,00
    1
23/ 80
     69
264/ 1100
      1056
2681/ 4400
       2681
26826/171900
      160956
```

The bridge measure is 13.42 or 13 7/16"

4. Determine bridge measure using rafter schedule.

   a. From the rafter schedule on your framing square, read the number given on the first line under the number 6. The number should read 13.42.

5. Determine the common difference between jacks.

   a. Depending on rafter spacing the common difference will vary, example.

      (1) Rafters at 2' 0" on center.

```
  13.42
x     2
26.84 or 2'   2 13/16"
```

Common difference in this case is 2' - 2 13/16".

(2) Rafters at 16" on center.

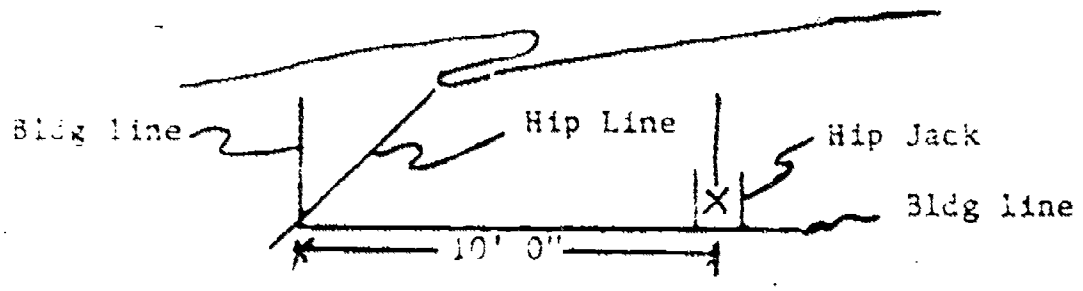
16" = 1 1/3 foot.

13.42
x 1 1/3
447
1342
17.89 or 1' 5 7/8" Common difference is 1' 5 7/8"

Part II Hip Jacks

6. Determine the total run of the longest hip jack.

a. By measuring the distance from the outside corner of the building to the center of the longest hip jack placement marked on the top plate.



7. Determine line length of the hip jack.

a. by multiplying bridge measure (13.42) and total run (10' 0") in feet, example:

13.42
x 10
134.20 or 11' 2 3/16"

8. Select a straight common rafter.

a. By looking through your commons.

b. Pick a good straight piece, this member is to be used as template for all your hip jacks.

9. Lay out line length for hip jacks.

a. Set your selected common on a pair of saw horses.

b. Run a plumb line from the birds mouth to the top of the common.

c. Square at the top.

d. From this mark measure out the line length of the longest hip jack determined in step 7.

e. Square this mark and locate center of the squared line.

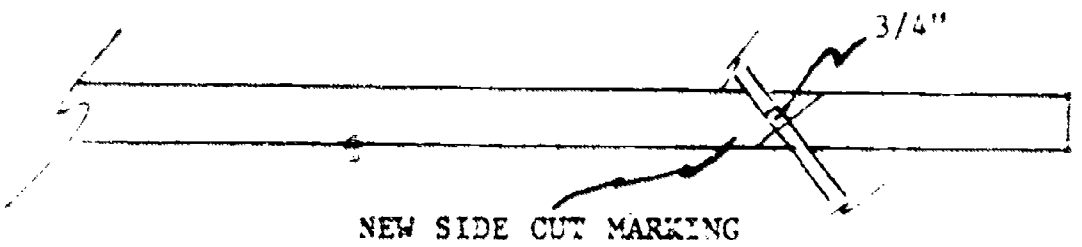
10. Determine shortening allowance.

a. Using 12" and 13 7/16" on your framing square, mark a line through the center mark in step 9.e. Mark on the 13 7/16" side of the square.

b. By holding your tape perpendicular to the side cut marking, deduct for one half the thickness of the hip rafter.

c. Mark new side cut marking through this new mark and cross out the old marking.

d. Given: 1/2 thickness of hip rafter = 3/4".



11. Determine long points of hip jacks.

a. Square the long point of the side cut marking in step 10.

b. From this squared line measure out common difference of jacks determined in step 5 (11' - 5 7/8") as many times as necessary.

c. Square the markings.

d. These squared lines are the long points of hip jacks.

12. Lay out a pair of hip jacks.

a. Place two 2 x 4's, one on each side of template.

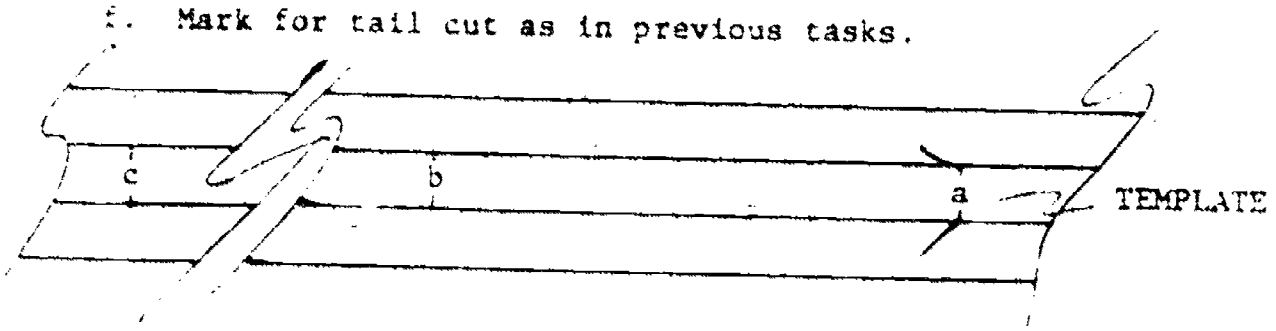
b. Transpose markings on template to the 2 x 4's for bird's mouth, tail lengths and long point of hip jacks.

c. Use 12" and 13 7/16" on framing square to mark for cut.

d. Use 12" and 6" to mark for plumb cut.

e. Mark for bird's mouth as in previous tasks.

f. Mark for tail cut as in previous tasks.



NOTE: Place marks "a" as shown to designate side cut of each rafter, "b" for bird's mouth and "c" for end cut of tail. Working jacks in pairs will help eliminate cutting jacks with the same side cuts.

13. Check work with the instructor.

a. Call instructor - have a framing square handy.

b. The total length of the hip jacks must be within ± 1/8" of being correct, the side cut to within ± 1/16" of being correct from one end of the angle to the other, the lumber left after the cutting out the bird's mouth must be within 2 7/16" - 2 9/16", and the rafter must be laid with the crown up.

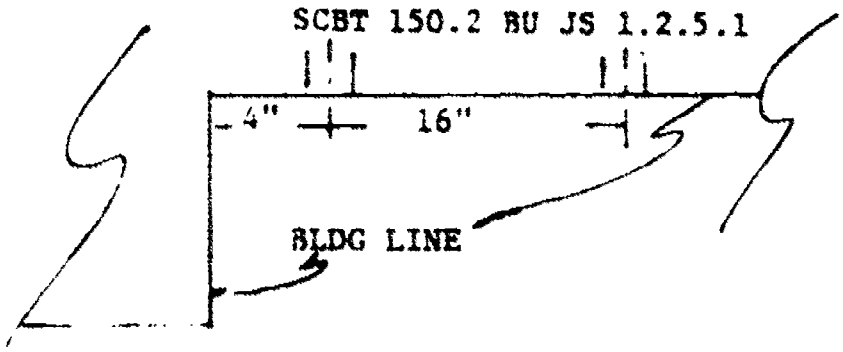
Part II: Valley Jacks.

6. Determine the total run of the longest valley jack.

a. By measuring the distance from the inner corner of the building to the center of the first common rafter and find the difference of this dimension from the rafter spacing. dimension from the total run of the common rafter.

Given: Rafter spacing = 16" on center
Distance from first common rafter to inner corner = 12"
Span of building = 22' - 0"
Total run - 22/2 = 11' - 0"

a. Con't.




```
  11' - 0"
-  1' - 0"
  10' - 0"
```

The total run of the longest valley = 10' -

7. Determine line length of this valley jack.

   a. By multiplying bridge measure (13.42) and total run (10' - 0") in feet, example:

```
    13.42
X      10
  134.20   or   11' - 2 3/16"
```

8. Select a straight common rafter.

   a. As in previous task.

9. Lay out line length for valley jack.

   a. Set your selected common on a pair of saw horses.

   b. From the long point at the top of your rafter measure out line length of the longest valley jack (11' 2 3/16").

   c. Square the mark at the top and locate center of the squared line.

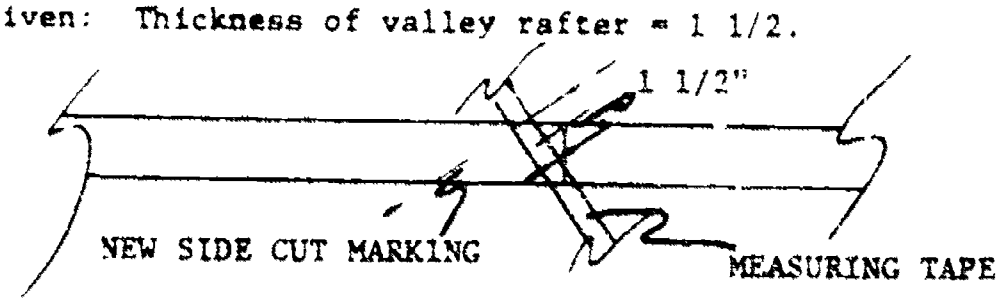
10. Determine shortening allowance.

   a. Using 12 and 13 7/16 on your framing square, mark a line through the center mark in step 9.c. Mark on the 13 7/16" side of the square.

   b. By holding your tape perpendicular to the side cut marking, deduct for one full thickness of a 2 x 4.

   c. Mark new side cut marking through this new mark and cross out the old side cut marking.

   d. Given: Thickness of valley rafter = 1 1/2.



NOTE: One full allowance of the 2X will compensate for 1/2 thickness of valley rafter and the ridge board (the ridge board must be a 2X).

11. Determine long points of valley jacks.

    a. Square the long point of the side cut marking in step 10.c.

    b. From this squared line measure out common difference of jacks determined in step 5 (1' - 5 7/8").

    c. Square the markings.

    d. These squared markings are the long points of other valley jacks.

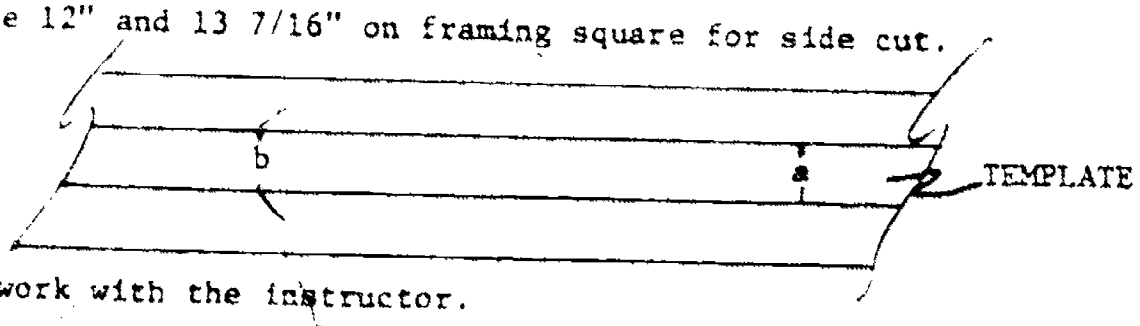
12. Lay out a pair of valley jack.

    a. Place two 2 x 4's, one on each side of template.

    b. Transpose marking on template to the 2 x 4's for ridge cut and the long point at the top side of the valley jacks.

    c. Use 12" and 6" on framing square to mark for plumb cut.

    d. Use 12" and 13 7/16" on framing square for side cut.



13. Check work with the instructor.

    a. Call instructor - have a framing square handy.

    b. The total length of the valley jacks must be within ± 1/8" of being correct, the side cut to within ± 1/16" of being correct from one end of the angle to the other, and the rafter must be laid with the crown up.

Part III: Cripple Jack.

6. Determine the total run of the longest cripple jack.

   a. Measure the distance of run the center of the shortest valley jack at the ridge to the point of intersection of the center lines of the hip rafter and the ridge e.g. 4".

   b. Add this dimension to the total run of the shortest valley jack e.g. 7' - 4" total run of the shortest valley jack.

      4"
      7' - 8" Theoratical dimension of the shortest valley jack for calculating of cripple jack.

   c. Subtract two times rafter spacing (2 x 16") = 2' - 8" or 32" from the theoratical dimension acquired in step b. e.g.

      7' - 8"
      -2' - 8"
      5' - 0" = total run of the longest cripple jack.

7. Determine line length of this cripple jack

   a. By multiplying bridge measure (13.42) and total run (5' - 0") in feet, e.g.

      13.42
      x 5
      67.10 or 67 1/8"

8. Select a scrap of rafter material (2 x 4) long enough for this rafter and set it on a pair of sawhorses.

9. Layout line length for cripple jack.

   a. Square a line on the edge approximately 2" from one end.

   b. Measure and mark for length (67 1/8") for cripple jack.

   c. Square this mark.

   d. Locate center of squared lines.

   e. Use 12 and 13 7/10 on framing square and mark through the c centers made in step 9d. Mark on the 13 7/16 side of the square.

   NOTE: Side cut markings must not be parallel to each other.

10. Determine shortening allowance

a. Hold your tape perpindicular to the side cut marking at one end, and deduct for one full thickness of the 2x

b. Mark new side cut marking through this new mark and cross out the old side cut marking.

NOTE: One full thickness of the 2x will compensate for 1/2 thickness of the valley rafter and 1/2 thickness of the hip rafter.

11. Layout for plum cut.

a. Plumb cuts must be parallel.

12. Determine common difference of cripple jacks. e.g.

32" = 2.66 ft.

```
 13.42
  2.66
 ------
  8052
 8052
2684
------
35.6972  or 35 5/8"
```

13. Determine long points of succeeding cripple jacks.

a. Mark off the common difference of the cripple jacks (35 5/8") as necessary on the laid out cripple jack.

14. Check work with the instructor.

a. Call instructor - have framing square handy.

b. The total length of the cripple jacks must be within ± 1/8" of being correct, the side cut and the plumb cut must be within ± 1/16" of being in correct angle cut and the rafters must be laid with the crown up.

Questions:

1. Rafters that are tied to the hip rafter and top plate are called _____jacks.

2. Rafters that are tied to the valley rafter and the ridge board are called _____jacks.

3. Rafters that are tied to the hip and valley rafters are called _____jacks.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Roof Truss Construction

Average Time: 2 Periods (Class) 11 Periods (Pract)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, pages 343 - 345.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc., pages 109 - 165.

B. References:

1. Fundamentals of Carpentry, Volume 2, W.E. Durbahn/E.W. Sundberg.

2. A Framing Guide and Steel Square, D.L. Sigmon.

3. Architectural Graphic Standards, 6th Edition Ramsey & Sleeper.

C. Tools and Equipment:

1. Trailer mounted saw including prime mover.

2. Portable electric circular saw.

Terminal Objectives: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, "Light Frame Construciton II", involving: interpreting construction drawings for the layout of wood frame members for the service-type stairs and all types of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saw. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to interpret construction drawings for laying out and setting up a template for roof trusses as outlined in Job Sheet SCBT 150.2 BU JS 1.2.6.1, "Roof Truss Construction". A job sheet will be furnished to the student. The completed template and manufactured roof truss will have the length upper chords to within ± 1/4" of the specified lwngth and with the angle cut to within 1/16" of the specified angle; the lower chord to within ± 1/8" of the span and the angle cut to within 1/8" of the specified angle, the king post to within 1/16 of a snug fit, the angle cut(s) of all web members to within ± 1/16" of the specified angle; and the crown of the chords up.

3. Crosscut saw.

4. Combination square.

5. Measuring tape.

6. Framing square.

7. Sliding T-bevel square.

8. Chalkline

9. Tool apron.

10. Sawhorses.

11. Hammer, 16 oz.

12. Pencil

D. Training Aids and Devices:

1. Charts.

a. Roof trusses.

(1) King post.

(2) Pitched.

2. Construction drawing of a 22'0" x 24'0" double car garage.

a. Floor paln.

b. Sectional drawings

Criterion Test: The student will set up roof trusses and manufacture roof trusses which will have the length of the upper chords to within ± 1/4" of the specified length and with the angle cut to within 1/16" of the specified angle; the lower chord to within ± 1/8" of the span and the angle cut to within ± 1/8" of the specified angle, the king post to within 1/16" of a snug fit; the angle cut(s) of all web members to within ± 1/16" of the specified angle; and the crown of the chords up.

Homework: Read

1. Builder 1 & 2. NAVPERS 10648-F, pages 343 - 4..

2. Framing, Sheathing and Insulation, pages 109 - 1..

c. Elevation drawings.

NOTE: Use trusses, 1/4 pitch.

3. Samples.

a. Tooth ring connector.

b. Split ring connector.

4. Locally Prepared Materails:

a. Job Sheet.

(1) SCBT 150.2 BU JS 1.2.6.1, "Roof Truss Construction".

5. Materials:

a. 2 x 10's or 2 x 12's.

b. 2 x 4's.

c. 3/4 inch plywood.

d. 16d box nails.

e. 8d box nails.

E. Training Aids Equipment:

1. None

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.	I.A. Introduce self and topic	
1. Name:		
2. Topic: Roof Truss Construction.		
B. Establish readiness.	I.B. Motivate student by stating that this knowledge is essential in order to layout and fabricate roof trusses	
1. Roof trusses are [illegible] that [illegible] open large space [illegible] roof and ceiling		
2. [illegible]		
a. Read		
(1) Builder 1 & 2, NAVFAC [illegible], pages [illegible]		
(2) Framing, Sheathing, and [illegible]		
II. Lesson Content.	II.A. State learning objectives.	
1. Value.	a. Upon completion of this topic you will be able to set up a jig for the assembling of roof trusses and layout, cut and assemble roof trusses.	
a. Pass course.		
b. Perform better on the job.		
c. Get advanced.		
d. Be a better builder.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Overview.		
1. Ask questions any time.		
2. Job sheets are to be used as guides.		
3. Job sheets may be requested for personal references.		
II. Presentation.		
A. Introduce job sheet.	II.A. Hand out job sheet.	
1. SCBT 150.2 BU JS 1.2.6.1, "Roof Truss Construction".		
B. Common light frame roof trusses.	II.B. Give a brief lecture on light frame trusses. Use chart(s) illustrating the types of trusses to reinforce lecture.	
1. Pitched and king post - These are roof frame structures designed to carry the roof load and transmit the load to the bearing walls.		
C. Parts of a truss.	II.C. Give a brief lecture on the parts of a roof truss - point out the parts on the chart(s) to reinforce lecture.	
1. Upper chord - same as a common rafter except that no shortening allowances are made and there in no birds mouth.		
2. Lower chord - same as a ceiling joist.		
3. King post - upright member that ties the upper chord at the ridge to the lower chord.		
4. Web members - diagonal members that tie upper chord to the lower chord.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
5. Gussets and/or splice plates are members inserted or added to give greater strength in joining structural members at stress points.		
D. Connectors and fastening methods.	II.D. Give a brief lecture on connectors and fastening methods.	
1. Nailing method.		
a. Gussets and/or splicing plates of 1/2" - 3/4" plywood, glued (water proof) and nailed with 8d common galvanized or cement coated) nails on each side.		
2. Bolt and washer method.		
a. Bolts of 1/2" diameter or larger, long enough to pass through the thickness of timber with a washer on each side and with a full nut of thread.		
3. Timber connectors.	II.D.3. Use samples of connectors to reinforce lecture.	
a. Tooth ring connectors are made in standard sized of 2", 2 5/8", 3 3/8" and 4". All ring connectors will be 15/16" deep between the points of the teeth.		
b. Split ring connectors are made in sizes of 2 1/2" I.D., 3/4" deep; 4" I.D., 3/4" deep; and 6" I.D., 1 1/4" deep.		

OUTLINE OF INSTRUCTON	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
E. Steps of procedures.	II.E. Call students attention to job sheet and go over items step by step - use construction drawing on the double car garage to reinforce lecture.	II.E. Turn to the job sheet and follow instruction being given - take notes for these dimensions will be used in the field exercise.
1. Determine the span of the building.		
a. As shown on the floor plan (22' 0").		
2. Determine unit of rise.		
a. As shown on the drawing (6").		
3. Determine bridge measure using rafter schedule.	II.E.3. Hand out framing square and call students attention to the rafter schedule to reinforce rafter schedule reading technique.	II.E.3. Turn to rafter table on framing square.
a. First line is for length of common rafter per foot run.		
b. Under 6 read number 13.42 on the first line.		
4. Determine line length of rafter or upper chord of truss.	II.E.4. Demonstrate line length calculating technique on chalkboard.	
5. Determine length of projection.	II.E.5. Call students attention to construction drawing.	
a. Elevation plan and or sectional drawings.		
6. Determine length of tail.	II.E.6. Demonstrate tail length calculating technique.	
7. Determine total rise.	II.E.7. Demonstrate total rise calculating technique on chalkboard.	
a. Total run = 11' 0".		
b. Unit of rise = 6".		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
8. Set up work bench.		
a. Secure 2" x 4" x 6' 0" on saw horses.		
b. Align saw horses on flat ground.		
c. Lay 2 x 10's and/or 2 x 12's and secure sparingly to 2 x 4's.		
9. Lay out roof truss outline.	II.E.9. Demonstrate roof truss laying out technique on chalk-board.	
a. Snap chalkline and locate points for lower chord		
b. Locate midpoint of lower chord and construct a perpendicular line to the line at that point.		
c. Locate point for total rise on the perpendicular line.		
d. Snap chalkline from this point to the points on lower chord for upper chord.		
e. Locate midpoints on upper chords.		
f. From these midpoints, strike chalk-line to midpoint of lower chord.		
g. Offset center perpendicular line one half the width of a 2 x 4.		
h. Strategically place 2 x 4 blocks for placement of truss member.		
i. Prepare gussets and splice plates.		
III. Application.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
A. Student practice as a team member in the setting up of truss template and in the preparation and manufacturing of a roof truss.	III.A. Take the class to the field, assign student to team of four men and be available to show, assist and supervise.	III.A. Student practic as a team member.

IV. Summary.

A. Common light frame roof trusses.

1. Pitched.

2. King post.

B. Parts of a truss.

1. Upper chord.

2. Lower chord.

3. King post.

4. Web members.

5. Gusset and/or splice plate.

C. Connectors and fastening methods.

1. Nail - recommend glue.

2. Bolt.

a. Washer.

b. Full thread on nut.

3. Timber connectors.

a. Tooth ring.

b. Split ring.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

JOB SHEET

Title: Roof Truss Construction

Introduction: This job sheet is to guide you in laying out, preparing and making of roof trusses.

Tools, Equipment and Materials:

1. Measuring tape.
2. Framing square.
3. Combination square.
4. Sliding T-bevel square.
5. Sawhorses.
6. Pencil.
7. Trailer mounted saw including prime mover.
8. Portable electric circular saw.
9. Crosscut saw.
10. Chalk line
11. Nail apron.
12. Hammer
13. 2 x 4's.
14. 1 x 6's

Procedures:

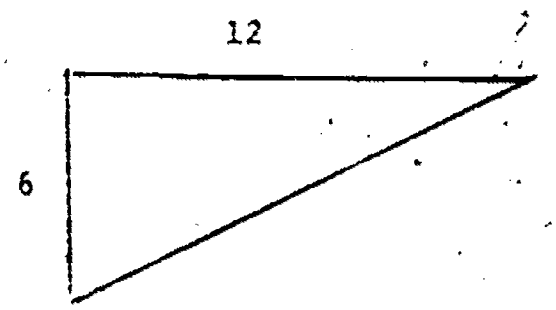
1. Determine the span of the building.

   a. By referring to the floor plan.

2. Determine the unit of rise.

   a. By referring to the elevation plan and/or the sectional drawing.

   b. Will be shown thusly:



3. Determine bridge measure using the rafter schedule.

   a. From the rafter schedule on framing square read the number on the first line given under number G. The number should read 13.42.

4. Determine line length of rafter.

   a. Multiply the bridge measure and the total run (in feet), example:

Step 1:

```
   13.416
x     11
 13416
13416
147.576
```

NOTE: Total run is 1/2 the span, example:
span = 22 feet
22 ÷ 2 = 11 feet
total run = 11 feet

Step 2:

```
        12.
12/ 147.576
    12
     27
     24
      3 - R
```

Step 3:

```
   .576
x    16
  3456
  576
 9.216
```

The line length is 12 feet, 3 9/16 inches.

5. Determine the length of projection and the length of tail.

   a. By referring to the elevation plan and/or sectional drawing.

   b. Multiply the bridge measure and length of projection (in feet), example:

projection = 18 inches
18" = 1 1/2 feet

```
   13.416
x     1.5
 67080
13416
20.1240
```

Tail length is 20 1/8" or 1 foot, 8 1/8 inches.

6. Set up work bench.

a. Align four saw horses with 2 x 4 x 6' - 0 extention nailed on top of the saw horses.

b. Lay 2 x 10's or 2 x 12's for bench top and temporarily secure them.

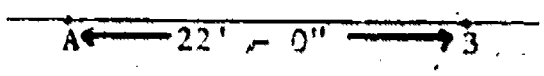
7. Lay out roof truss outline on work bench.

a. Snap a chalk line 8 inches inward from the edge of the nearest 2x on top of bench.

b. This line is the bottom of the lower cord.

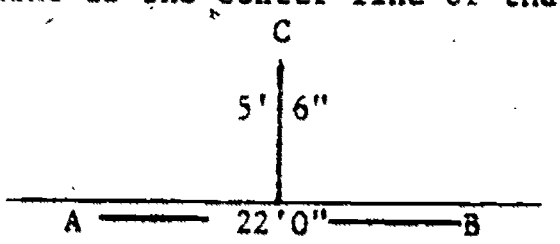
c. Locate two points (A and B) on this line that are 22 feet apart.

d. Span of building is 22' - 0".



e. Locate midpoint of this line and run a perpendicular line across the top of the bench.

f. This line is the center line of the king-post.



g. Locate a point (c) on this line that is the total rise of the bottom of the truss work.

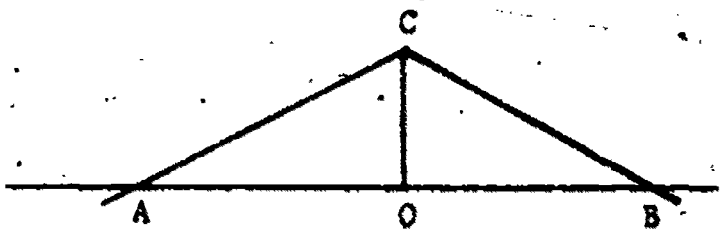
total run = 11 feet.
unit of rise = 6 inches

total rise = 5' 6"

$$\begin{array}{r} 11 \\ \times\ 6 \\ \hline 66 \end{array}$$ inches or 5' 6"

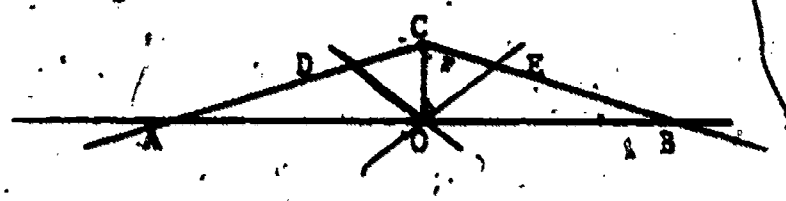
h. Snap a chalk line from this point through the points located in step 7c.

i. These lines are the bottom of the upper chord.



j. Snap chalk lines DO and EO.

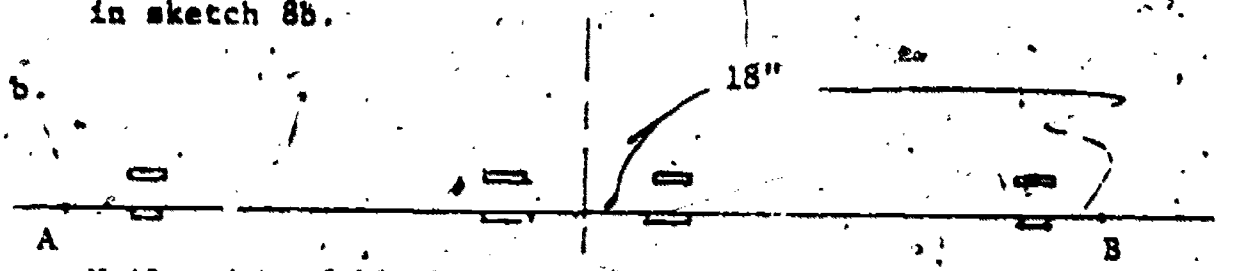
k. These lines are the bottom lines of the web.



8. Secure template blocks, blocks of 2" x 4" x 12".

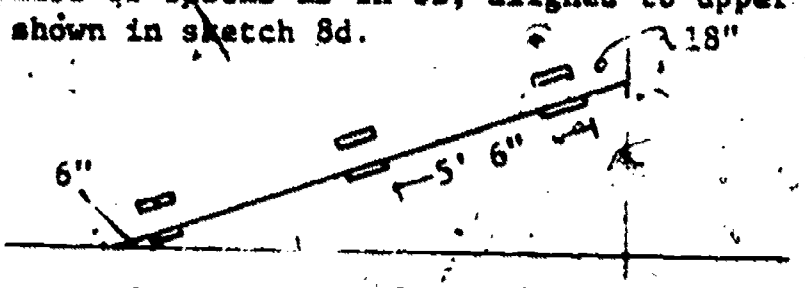
a. Nail pairs of blocks that are a width of a 2 x 4 away from each other, align with line AB and located as shown in sketch 8b.

b.



c. Nail pairs of blocks as in 8b, aligned to upper chord line AC as shown in sketch 8d.

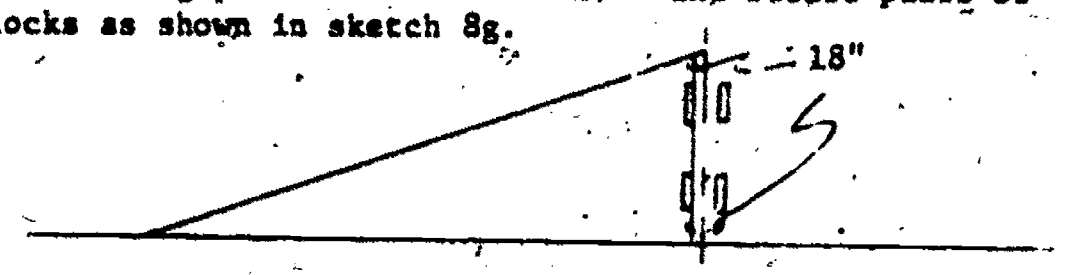
d.



e. Follow procedures in step 8c and secure blocks to upper chord line BC.

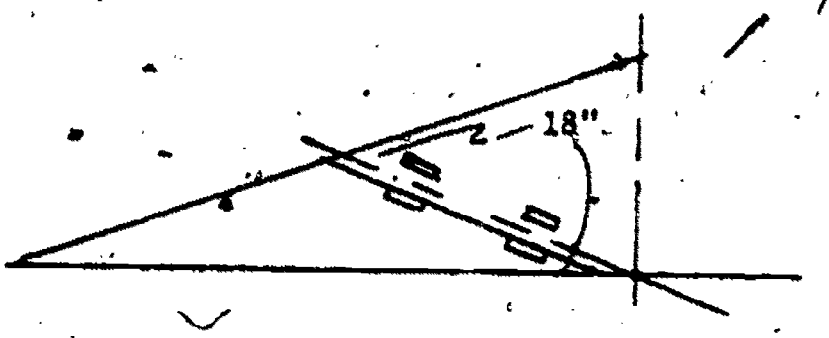
f. Off-set king post center line 1 3/4" and secure pairs of blocks as shown in sketch 8g.

g.



h. Secure pairs of blocks as shown in sketch 8i.

i.



j. Follow procedures as in step 8.h. and secure blocks to web line EO.

19. Determine total length of upper chord.

a. By adding the line length (Step 5) and tail length (Step 6):

Line length	12' - 3 9/16"
Tail length	+ 1' - 8 1/8"
	13' - 11 11/16"

10. Lay out and cut pair of upper chords and place in template.

a. Determine crown of 2 x 4.

b. Use 12 and 6 on the framing square and lay out plumb line such that the corwn is up. Mark on the 6 side of square.

c. From the long point measure out 13' - 11 11/16" on the edge of 2 x 4.

d. Square this mark and plumb as in step 10b.

e. Cut the 2 x 4 at these plumb markings.

f. Cut another similar upper chord member.

g. Place upper chords in template.

11. Lay out and cut lower chord and place in template.

a. Use 12 and 6 on the framing square and lay out roof slope line such that the crown is up. Mark on the 12 side of the square.

b. From the long point measure out 22' - 0" on the edge of the 2 x 4, square this mark and place another slope line running opposite of slop in step 11a.

b. Cut the 2 x 4 at these slope markings and place it in template.

12. Determine length of king post.

a. Measure distance from meeting point of upper chord and top of upper chord and top of lower chord should read 62 1/2".

13. Lay out, cut and place king post in template.

a. Cut one end of 2 x 4 square, measure out 62 1/2" and square the mark.

b. Locate midpoint of squared mark.

c. Use 12 and 6 of the framing square, mark for the top of post, from both edges. Mark on the 12 side, intersecting midpoint marking.

d. Cut the top of post and place in template.

14. Layout, cut and place web members in template.

a. Use combination square to square the bottom line of web members up to the faces of the upper chord and the lower chord.

b. Measure the distance of the mark on the lower chord to the side of 2 x 4 king post.

c. Use 12 and 6 on framing square and mark one end of 2 x 4. Mark on the 12 side.

d. Cut this marking and from the short end of the angle cut. Measure out distance acquired in step 14b. Measure on the face.

e. Square this mark the angle cut and cut.

f. Place the end cut piece snuggly against the lower chord and king post, and scribe the bottom of the upper chord on web member.

g. Cut this piece.

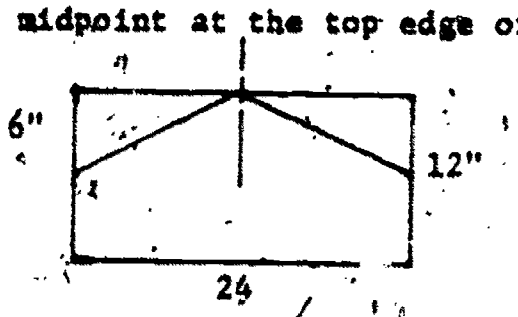
h. Cut another piece exactly the same and place both pieces in template.

15. Lay out and prepare gosset for the top of truss work.

a. 3/4" x 12" x 24" plywood.

b. Locate and mark midpoint at the top edge of the long side.

c.



d. Locate and mark 6" at both ends.

e. Run a line from these points to the midpoint.

f. [illegible]

g. Cut along these lines for upp chord and king post gusset.

16. Use 3/4" x 12" x 24" gusset for lower chord and king post.

17. Lay out and parepare gusset for lower chord and upper chord.

a. Use 3/4" x 12" x 12" plywood.

b. Locate and mark 6" at one end.

c. Run a line from this point to corner at opposite end.

d. Cut along these lines for bottom and gussets.

18. Check work with the instructor.

a. Call instructor - have framing square handy.

b. The total length of the uppor chord must be within ± 1/4" and the angle cut must be within ± 1/16" from one end to the other; the lower chord must be within ± 1/8" of the span of the building and the angle cut within ± 1/8"; the king post must fit such that there will not have a play of more than 1/16"; the angle cut of the web members must be within ± 1/16" and the crown must be up in both upper and lower chords.

NOTE: Recommend gussets be placed on both sides.

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified

Topic: Stair Construction

Average Time: 2 Periods (Class), 4 Periods (Pract)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 13, pages 364 - 368.

2. Framing, Sheathing and Insulation, Delmar Publishers Inc., Unit 23, pages 196 - 208.

B. Reference:

1. Fundamentals of Carpentry, Volume 2, W.E. Durbahn/E.W. Sundberg.

C. Tools and Equipment:

1. Measuring tape.

2. Framing square.

3. Combination square.

4. Cross cut saw.

5. Portable electric circular saw.

6. Saw horses

Terminal Objective: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, Light Frame Construction II, involving: interpreting construction drawings for the layout of wood frame members for service-type stairs and all types of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the tasks involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will be able to calculate: the number of steps needed for the flight of stairs and the height of each riser; and be able to layout a pair of stringers for the stairs by following the procedures outlined in Job Sheet SCBT 150.2 BU JS 1.2.7.1, "Laying Out Stair Stringers". The calculation for the height of the riser must be within ± 1/32 of an inch, the total height marked off on the story pole must be within ± 1/8 of an inch to the desired height, the layout work on the stringer must show tread allowance less the thickness of the finish floor materials and the stringers must be laid with the crown up.

7. Story pole.

8. Hammer.

9. Nail apron.

10. Pencil.

11. Hand level.

12. Stair gage.

D. Training Aids and Devices:

1. Film:

   a. MN-6719-F, "Building Technique - Fundamentals of Stair Layout". (11 min.)

2. Charts.
   a. Parts of a stairway.

   b. Types of stairs.

   c. Stairway layout terms.

3. Models.

   a. Stairway.

   b. Stair stringer.

4. Sample.

   a. Story pole.

Criterion Test: The student will calculate and lay out a pair of stringers whose risers will be within ± 1/32" of the correct height, with tread allowance less the thickness of the finished floor materials, and with the crown up. The total height marked off on the story pole will be within ± 1/8" to the desired height.

Homework: Read:

1. Builder 3 & 2, NAVPERS 10648-F, pages 364 - 368.

2. Framing, Sheathing and Insulation, pages 196 - 208.

5. Locally Prepared Material:

a. Job Sheet.

(1) SCBT 105.2 BU JS 1.2.7.1, "Laying Out Stair Stringer".

E. Training Aids Equipment:

1. 16mm projector.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name.		
2. Topic: Stair Construction.		
B. Establish readiness.	I.B. Motivate the student by statement on stair construction.	
1. Stair construction requires more care and knowledge in planning and more skilled workmanship in its construction. It is the most difficult work about a building and could be considered as a trade in itself. In this topic we will be involved in a straight flight of stairs only.		
2. Assignment.		I.B.2. Very important that you read your assignments.
a. Read:		
(1) Builder 3 & 2, NAVPERS 10648-F, pages 364 - 368.		
(2) Framing, Sheathing and Insulation, Unit 23, pages 196 - 208.		
C. Establish effect.	I.C. Bring out value of material being presented - state learning objectives.	
1. Value.		
a. Pass course.	a. Upon completion of this topic you will be able to layout, cut and install stairways.	
b. Perform better on the job.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Advance in rate.		
d. Be a better builder.		
D. Overview.		
1. Job sheet.		
a. SCBT 150.2 BU JS 1.2,7.1, "Laying Out Stair Stringer".		
2. Pay close attention to demonstration by the instructor.		
3. Take notes.		
4. Ask questions.		
II. Presentation.		
A. Introduce job sheet.	II.A. Hand out job sheet.	
1. SCBT 150.2 BU JS 1.2.7.1, "Laying Out Stair Stringer".		
B. Materials:		
1. 2 x 12's.		
C. Types of stairs.	II.C. Give a brief lecture on the types of stairs, use chart(s) illustrating the various types of stairs to reinforce lecture.	
1. Straight - one flight of stairs.		
2. Platform - resting place on a long flight of stairs or in changing direction of the stairs.		

3. Winding - changing direction of stairs by the use of steps that are not parallel to each other.

4. Closed - a flight of stairs built between two walls.

5. Open - a flight of stairs with one or both sides open. The open side or sides are usually equipped with balustrade or bannister.

D. Stair layout terms.

II.D. Give brief lecture on stair layout terms. Use charts to illustrate stair layout terms to reinforce lecture.

1. Total rise.

   a. The vertical distance from one finish floor to another.

2. Tread rise.

   a. The vertical distance from top of one tread to the top of the next tread.

3. Total run.

   a. The overall horizontal distance covered by the stairway.

4. Tread run.

   a. The horizontal distance from the face of one riser to the face of the next riser.

5. Stair carriage length.

   a. The length of the stair stringer.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
6. Head room.		
a. The minimum vertical clearance between the tread nosing in a stairway to overhead.		
E. Parts of a stair.	II.E. Give brief lecture on parts of a stairway. Use charts illustrating parts of a stairway to reinforce lecture.	
1. Tread.		
a. The part of the stairway that is stepped on.		
2. Riser.		
a. The piece of material placed vertically between two treads to close the space.		
3. Tread projection.		
a. The portion of the tread that projects beyond the face of the riser.		
4. Nosing.		
a. The molded front edge of a tread.		
5. Newel post.		
a. The post or posts located at the bottom tread, top tread or on platforms.		
6. Baluster.		

OUTLINE INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
a. The small column or post forming an enclosure that support the hand rail between newel posts.		
7. Hand rail.		
a. The top member of the guard placed on stairway.		
8. Balustrade or bannister.		
a. The complete guard made up of newel post, baluster and hand rail.		
F. Film - MN-6719-F, "Building Technique Fundamentals of Stair Layout".	II.F. Give brief introduction to the film, pointing out key points to look for and then show the film.	
1. Introduce film.		
2. Discuss key points to look for.		
3. Show film.		
4. Discuss film.	II.F.4. Lead discussion by asking and answering questions on the film.	II.F.4. Participate in the discussion.
a. Highlights.		
G. Procedures.	II.G. Call students attention to job sheets, having the student follow lecture on stair layout.	II.G. Turn to job sheet and follow lecture.
1. Determine total rise.		
a. Vertical distance from top of one floor to the next, EXAMPLE: 8' 6" or 102".		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
2. Determine number of risers. a. Seven (7) inches is the means of a riser. EXAMPLE: 15 risers are needed.	II.G.2. Demonstrate technique in calculating for the number of risers on chalkboard.	
3. Determine exact height of each riser. a. To the 32nd of an inch. EXAMPLE: 6 13/16".	II.G.3. Demonstrate technique in calculating for exact height of a riser on chalkboard.	
4. Check with story pole.	II.G.4. Demonstrate technique in marking off story pole.	
5. Determine width of the tread run. a. Subtract height of riser from 17 1/2 inches. EXAMPLE: 10 11/16".	II.G.5. Demonstrate technique in claculating for tread width on chalkboard.	
6. Determine total run of stairway. a. Multiply the number of tread and the width of a tread. EXAMPLE: 10 11/16 x 14 = 149 5/8 or 12 ft. 5 5/8 inches.	II.G.6. Demonstrate calculating technique for total run on chaldboard.	
7. Determine length of stringer. a. Use Pythagorean Theory. b. Simplify mathematical calculation by changing dimension to the next larger inch. EXAMPLE: a = 150" b = 102" $a^2 + b^2 = c^2$ C = 182 in. or 15 ft. 2 in.	II.G.7. Demonstrate technique in calculating for length of stringer on chalkboard.	

OUTLINE INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
c. Another technique that could be used is by measuring the hypothenuse or diagonal on the framing square, measuring from:	II.G.7.c. Demonstrate technique in calculating for stringer using framing square. Simulate condition on chalkboard.	
(1) 8 1/2 (8' 6") on one side of square to 12 1/2 (12' 6") on the other side. Distance should read 15 1/8 or approximately 15 ft. 1 1/2 in.		
8. Stringer layout.	II.G.8. Take class out to the field in demonstrating layout technique.	
a. Select straight stock.		
b. Determine crown.		
c. Use 6 13/16 and 1 11/15 on the framing square and layout for 14 steps.		
d. Mark top tread so that it may be fastened to the platform. Mark this as step #1.		
e. Mark other treads to #14.		
f. Mark bottom tread with line that is parallel to landing.		
g. Deduct for tread thickness.		
NOTE: Stair gage is helpful in laying out of stringers.		

III. Application.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
A. Student practice stair layout calculating technique on hypothetical problem.	III.A. Take class back to the classroom to work out hypothetical problem. Use dimensions that the student will use in the field exercise. a. Be available to show, assist and supervise.	III.A. Student practic individually in calculating. Call instructo to clarify any doubtful areas.
B. Student practice stair layout technique.	III.B. Take class out to the field to practice stair layout.	III.B. Student practic individually in laying out of stair stringer.
C. Student practice as team member in cutting out of stringer and in the erecting of a stairway.		III.C. Student practic as a team member in the construction of a stairway.
IV. Summary.	IV. Use charts as necessary to reinforce summary.	
A. Types of stairs. 1. Straight. 2. Platform. 3. Winding. 4. Closed. 5. Open.		
B. Stair layout terms. 1. Total rise. 2. Tread rise.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
3. Total run.		
4. Tread run.		
5. Stair carriage length.		
C. Parts of stairs.		
1. Tread.		
2. Riser.		
3. Tread projection.		
4. Nosing.		
5. Newel post.		
6. Baluster.		
7. Hand rail.		
8. Balustrate or bannister.		
V. Test		
A. Student will perform criterion test as stated.		

NAVAL CONSTRUCTION TRAINING CENTER
PORT HUENEME, CALIFORNIA 93043
SPECIAL BATTALION CONSTRUCTION TRAINING (SCBT) 150.2

JOB SHEET

Title: Laying Out Stair Stringer.

Introduction: This job sheet is to guide you in laying out stairway stringers.

Tools, Equipment and Materials:

1. Measuring tape.
2. Framing square.
3. Combination square.
4. Crosscut saw.
5. Portable electric circular saw.
6. Sawhorses.
7. Story pole.
8. Pencil.
9. Hammer.
10. Nail apron.
11. Hand level.
12. 2 x 12's

Procedures:

1. Determine total rise.

   a. By measuring the vertical distance from the top of one floor to the top of the next floor, example: 8'6" or 102".

      (1) Allowance must be made for the thickness of the finish floor for when working on stairway framing the finish floors are ususlly not yet laid on both upper and lower decks.

2. Determine number of risers that will be needed for the stairway.

   a. By dividing the total rise by seven (7) to the nearest full number, example:

2.a. (cont'd)

```
      14.5
7 /102.      or 15 riser
    7
    32
    28
     40
     35
      5
```

3. Determine exact height of each riser.

   a. By dividing the number of risers into the total rise.

   b. Work problem out to three decimals and determine to the nearest 32nd of an inch, example:

```
      6.8
15/ 102.
     90
      120
      120

.8
32
25.6
```

or $\frac{26}{32} = \frac{13}{16}$

Exact height of each riser = 6 13/16"

4. Check calculation using story pole.

   a. Locate a strip of wood approximately 1" x 1" to 2" and slightly longer than the total rise.

   b. From one end of the strip of wood measure out and work exact height of riser for the number of risers needed.

   c. Place this against the upper deck such that the bottom portion of the story pole is at the same height as the top of the lower deck.

   d. Check marking on story pole with the top of the finish floor on the upper deck to insure correct calculation on riser.

      (1) The top marking on the story pole must be within ± 1/4" of the desired height.

5. Determine width of the tread or the run of the tread.

   a. Subtracting the height of a rise from 17 1/2" will give width of the tread, example:

5.a. (cont'd)

```
  17 1/2
   6 13/16
 ---------
  10 11/16
```

width of tread 10 11/16"

6. Determine total run of stairway.

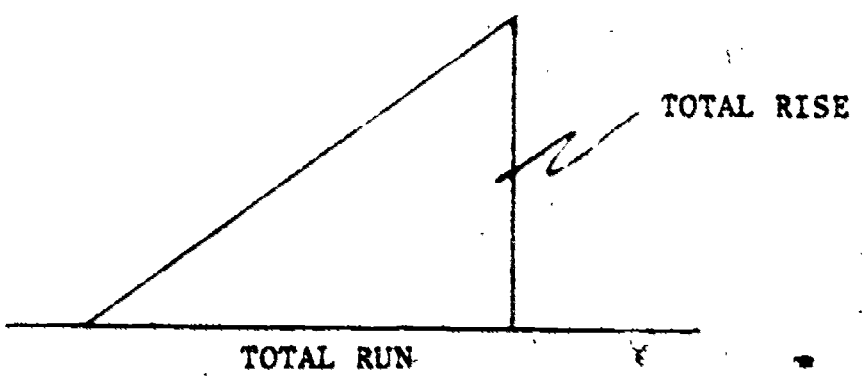
   a. By multiplying the number of tread (one less tread than riser) and the width of a tread. example:

```
     10 11/16
   X 14
   ---------
     90 10/16
    40
   100
   ---------
   149 10/16
```

= 149 5/8# = total run: 12 ft. 5 5/8 In.

7. Determine length of stringer

   a. By using the Pythagorean Theory, the total run is the base and the total rise the altitude.



   b. To simplify the problem, change dimensions to the next larger inch and work the problem.

   Given: a = 12' - 6" or 150"
   b = 8' - 6" or 102"
   $a^2 + b^2 = c^2$
   $(150 \times 150) + (102 \times 102) = c^2$
   $22500 + 10404 = c^2$
   $32904 = c^2$

```
        181 or approximately 182" or 15 ft. 2 in.
   √32904
     1
  28/229
     224
   361/504
     361
     133
```

Approximate length of string = 15 ft. 2 inches.

8. Select stock for stringer.

   a. Selecting a straight piece of 2 x 12, slightly longer than 15 ft. 2 in.

   b. Determine crown and set on a pair of saw horses.

9. Layout for steps.

   a. By holding square at 6 13/16" and 10 11/16", layout for 14 steps.

   b. On the top tread mark on the stringer, run a squared line that is parallel to the riser.

      (1) This squared line is to be the back end cut that is to be fastened to the platform.

   c. Mark top tread as #1, and mark other treads numerically to #14.

   d. On the bottom of riser marked for step #14, run a squared line parallel to the tread.

      (1) This squared line is to be the bottom end cut that is parallel to the landing.

10. Deduct for tread thickness.

   a. From riser #14, deduct for tread thickness and run line for bottom of stringer.

   b. Cross out old squared bottom line.

11. Check with the instructor.

   a. The stringer must have 14 treads for a 15 riser stringer, the riser and the treads must be laid out to within ± 1/16" of the calculated dimensions, the bottom riser must be a tread thickness less in height and the stringer must be laid with the crown up.

12. Cut stringer.

   a. Utilizing tools and equipment provided.

Questions:

1. _____ inches is the height of a riser.

2. The run of a riser and a tread is _____ inches.

NAVAL CONSTRUCTION TRAINING CENTER
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SPECIAL CONSTRUCTION BATTALION TRAINING (SCBT) 150.2

Classification: Unclassified.

Topic: Course Summarization

Average Time: 1 Period (Class) 4 Periods (Pract)

Instructional Materials:

A. Texts:

1. Builder 3 & 2, NAVPERS 10648-F, Chapter 10

2. Framing, Sheathing and Insulation, Delmar Publishers, Inc.

B. References:

1. Fundamentals of Carpentry, American Technical Society.

C. Tools, Equipment and Materials:

1. Hammer.

2. Adjustable wrench

3. Wrecking bar.

4. Sawhorses.

5. Stepladder.

6. Nail apron.

Terminal Objectives: Upon completion of this unit the student will have met all the requirements of Personnel Readiness Capability Program skill level 150.2, "Light Frame Construction II", involving: interpreting construction drawings for the layout of wood frame members for service-type stairs and all types of rafters; and setting up, operating and performing operator's maintenance on the trailer mounted saws. The light frame structures to be erected and the task involved with the trailer mounted saws are to be done by following the procedures and meeting the specifications as stated on the job sheets.

Enabling Objectives: Upon completion of this topic the student will have reinforced his ability to identify by naming all the framing members in accordance with the texts as the members are pointed out by the instructor. The student will also have reviewed the methods used in the erection of the light frame structures as each structure is torn down. The dismantled framing member will be clear of all nails and will be neatly stacked.

Criterion Test: In dismantling the frame structure the student will identify all framing members in accordance with the texts and will review the methods used in the erection of the structure. The dismantled framing members will be clear of all nails and will be neatly stacked.

D. Training Aids and Devices:

1. None.

E. Training Aids Equipment:

1. None

Homework:

1. None

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
I. Introduction to the Lesson.		
A. Establish contact.	I.A. Introduce self and topic.	
1. Name:		
2. Topic: Course Summarization.		
B. Establish readiness.	I.B. Motivate student by saying that this task will help the student in recalling the procedures used to erect this structure.	
1. Purpose of this topic is to review what we have learned in this course and to clean up our work area.		
2. Assignment: None.		
C. Establish effect.		
1. Value.		
a. Perform better on the job.		
b. Be a better builder.		
D. Overview.	I.D. State learning objectives.	
1. Stress safety.	a. Upon completion of this topic you will have reinforced your ability to identify the parts of framing members by naming all framing members and you will have reviewed the methods used in the erection of the light frame structures.	
2. Ask questions.		

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
II. Presentation.		
A. Framing members and methods of layout and installation.	II.A. Point to each framing member and ask appropriate questions pertaining to that member.	II.A. Be alert and answer the questions.
1. Ridge board.		
2. Common rafter.		
3. Hip rafter.		
4. Valley rafter.		
5. Hip jack.		
6. Valley jack.		
7. Cripple jack		
8. Roof truss.		
a. King post.		
b. Pitched.		
c. Web members.		
d. Gussetts.		
9. Stair stringer.		
a. Riser.		
b. Tread		
III. Application.		
A. Student dismantle framed structure and clean up work area.	III.A. Supervise work - stress safety.	III.A. Work as a team member.

OUTLINE OF INSTRUCTION	INSTRUCTOR ACTIVITY	STUDENT ACTIVITY
IV. Summary.		
A. Ridge board.		
B. Common rafter.		
C. Hip rafter.		
D. Valley rafter.		
E. Hip jack.		
F. Valley jack.		
G. Cripple jack.		
H. Roof truss.		
I. Stair stringer.		
V. Test:		
A. Student will perform criterion test as stated.		

CHAPTER 11
ROOF FRAMING

The use of concrete walls in Navy-built structures has increased in recent years, and the use of frame walls has decreased to a certain degree. The use of frame roofs has not decreased nearly as much, however. Many Navy-built concrete-walled structures are still being covered with wood-frame roofs.

ROOFS

The primary object of a roof in any climate is to keep out the rain and the cold. The roof must be sloped so as to shed water. Where heavy snows cover the roofs for long periods of time, roofs must be constructed more rigidly to bear the extra weight. They must also be strong enough to withstand high winds. The most commonly used types of roof construction include the gable, the lean-to shed, the hip, and the gable and valley.

The GABLE roof (fig. 11-1) has two roof slopes meeting at the center, or ridge, to form a gable. This form of roof is the one most commonly used by the Navy, since it is simple in design, economical to construct, and may be used on any type structure.

LEAN-TO or SHED ROOF (fig. 11-1), is a near-flat roof and is used where large buildings are framed under one roof, where hasty or temporary construction is needed, and where sheds or additions to buildings are erected. The pitch of the roof is in one direction only. The roof is held up by the walls or posts on four sides; one wall or the posts on one side are at a higher level than those on the opposite side.

The HIP roof (fig. 11-1) consists of four sides or slopes running toward the center of the building. Rafters at the corners extend diagonally to meet at the center, or ridge. Into these rafters, other rafters are framed.

GABLE and VALLEY roof is a combination of two gable roofs intersecting each other. The valley is that part where the two roofs meet, each roof slanting in a different direction. This type of roof is slightly complicated and requires much time and labor to construct.

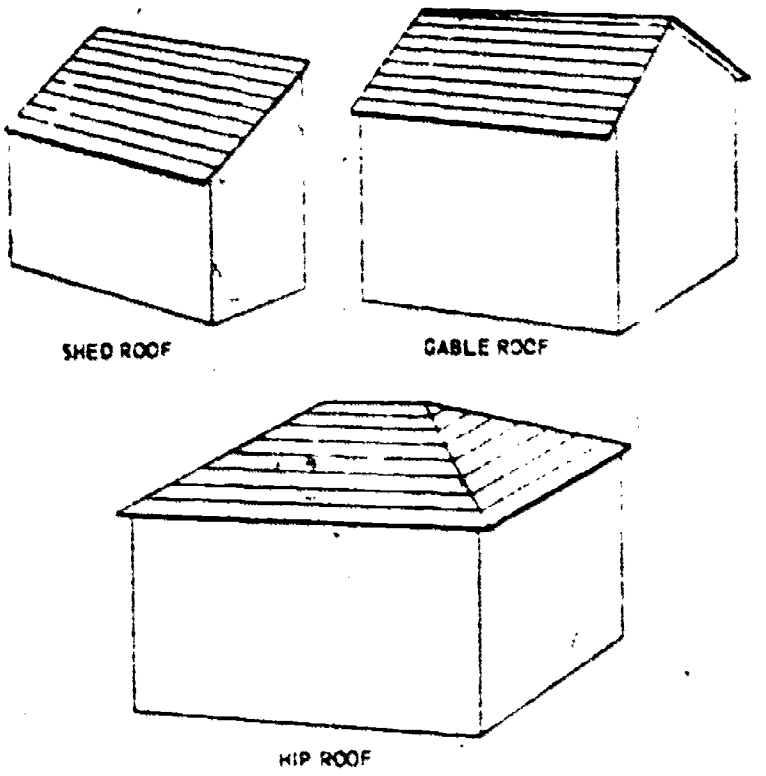


Figure 11-1.—Most common types of pitched roofs.

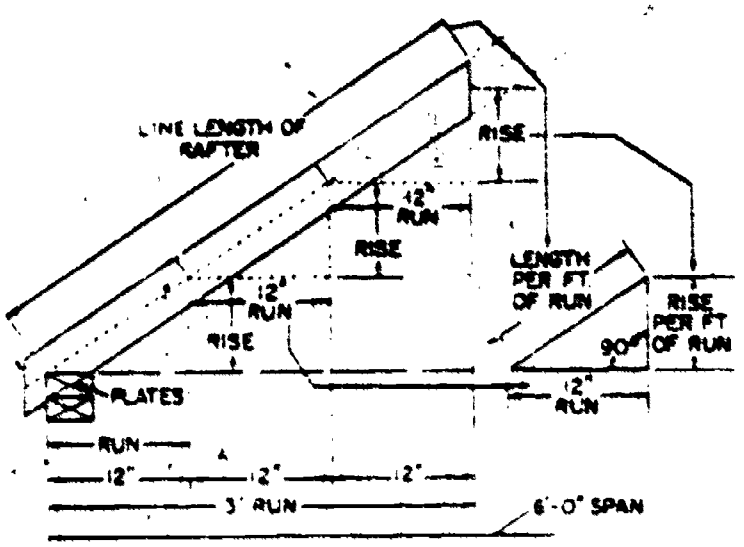
TERMS USED IN ROOF CONSTRUCTION

The PITCH or "slope" of a roof is the angle which the roof surface makes with a horizontal plane. The surface may vary from absolutely flat to a steep slope. The usual way to express roof pitch is by means of numbers; for example, 8 and 12, 8 being the rise and 12 the run. On drawings, roof pitch is shown in figure 11-2.

The SPAN (part 1, fig. 11-3) of any roof is the shortest distance between the two opposite rafter seats. Seated in another way, it is the measurement between the outside plates, measured at right angles to the direction of the ridge of the building.

The TOTAL RISE (part 1, fig. 11-3) is the vertical distance from the plate to the top of the ridge.

The term "TOTAL RUN" (part 1, fig. 11-3) always refers to the level distance over which



133.362

Figure 11-2.—Roof pitch.

any rafter passes. For the ordinary rafter, this would be one-half the span distance.

The unit of measurement or unit of run, 1 foot or 12 inches is the same for the roof as for any other part of the building. By the use of this common unit of measurement, the framing square is employed in laying out large roofs (parts 1 and 2, fig. 11-3).

The rise in inches is the number of inches that a roof rises for every foot of run.

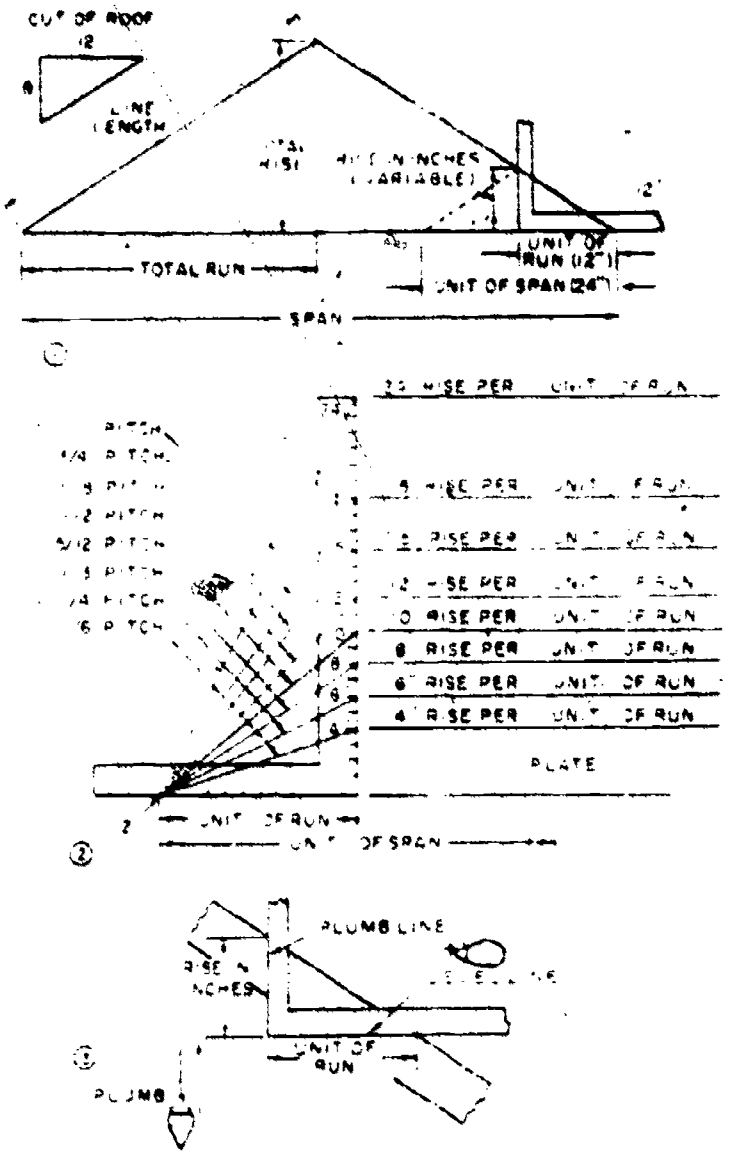
The cut of a roof is the rise in inches and the unit of run (12 inches) (part 2, fig. 11-3).

The "line length" as applied to roof framing is the hypotenuse of a triangle whose base is the total run and whose altitude is the total rise (part 1, fig. 11-3).

PLUMB and LEVEL LINES refer to the direction of a line on a rafter and not to any particular rafter cut. Any line that is vertical when the rafter is in its proper position is called a plumbline. Any line that is level when the rafter is in its proper position is called a level line (part 3, fig. 11-3).

RAFTERS

The pieces which make up the main body of the framework of all roofs are called rafters. They do for the roof what the joists do for the floor and what the studs do for the wall. Rafters are inclined members spaced from 16 to 48 inches apart which vary in size, depending on their length and the distance at which they are spaced. The tops of the inclined rafters are fastened in one of the various common ways



133.114

Figure 11-3.—Roof terms.

determined by the type of roof. The bottoms of the rafters rest on the plate member which provides a connecting link between wall and roof and is really a functional part of both. The structural relationship between rafters and wall is the same in all types of roofs. The rafters are not framed into the plate but are simply nailed to it, some being cut to fit the plate while others, in hasty construction, are merely laid on top of the plate and nailed in place. Rafters may extend a short distance beyond the wall to form the eaves and protect the sides of the building.

TERMS USED IN CONNECTION WITH RAFTERS

Since rafters, with ridgeboards and plates, are the principal members of roof framing, it

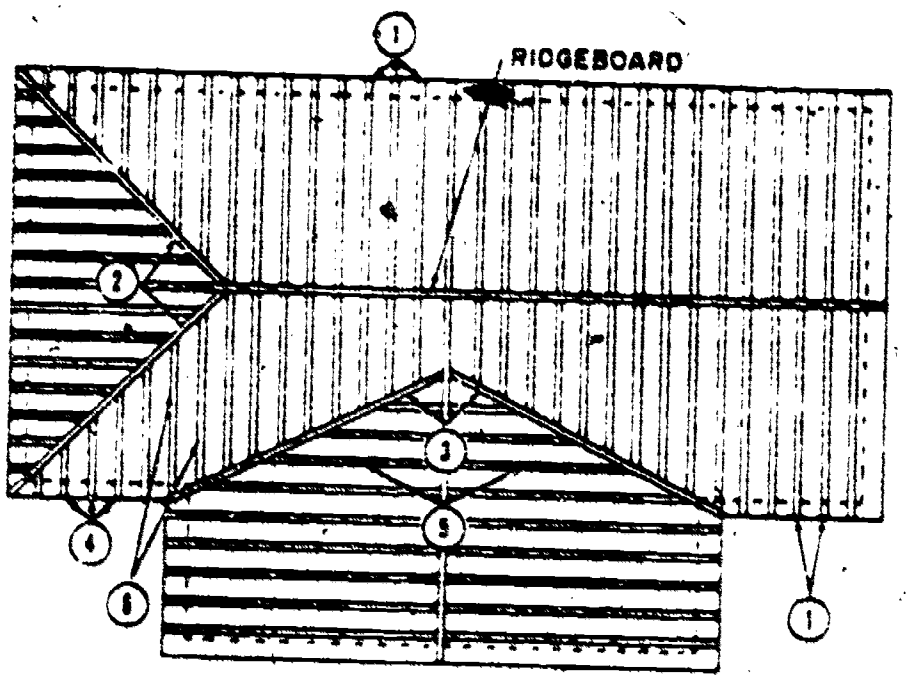
is important to understand the following terms that apply to them.

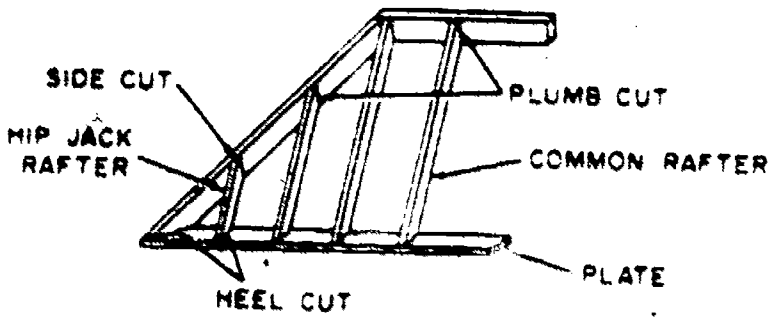
The COMMON rafters (part 1, fig. 11-4), extend from plate to ridgeboard at right angles to both.

HIP rafters (part 2, fig. 11-4), extend diagonally from the outside corners formed by perpendicular plates to the ridgeboard.

VALLEY rafters (part 3, fig. 11-4), extend from the plates to the ridgeboard along the lines where two roofs intersect.

JACK rafters never extend the full distance from plate to ridgeboard. Jack rafters are subdivided into the hip jacks (part 4, fig. 11-4), the lower ends of which rest on the plate and the upper ends against the hip rafter; valley





1 Common rafters
2 Hip rafters
3 Valley rafters
4 Hip jacks
5 Valley jacks
6 Cripple jacks

133.333

Figure 11-4.—Rafter terms.

jacks (part 5, fig. 11-4), the lower ends of which rest against the valley rafters and the upper ends against the ridgeboard; and cripple jacks (part 6, fig. 11-4), which are nailed between hip and valley rafters.

TOP or PLUMB CUT is the cut made at the end of the rafter to be placed against the ridgeboard or, if the ridgeboard is omitted, against the opposite rafters.

SEAT, BOTTOM, or HEEL CUT is the cut made at the end of the rafter which is to rest on the plate.

SIDE or CHEEK CUT is a bevel cut on the side of a rafter to fit it against another frame member.

RAFTER LENGTH is the shortest distance between the outer edge of the plate and the center of the ridge line.

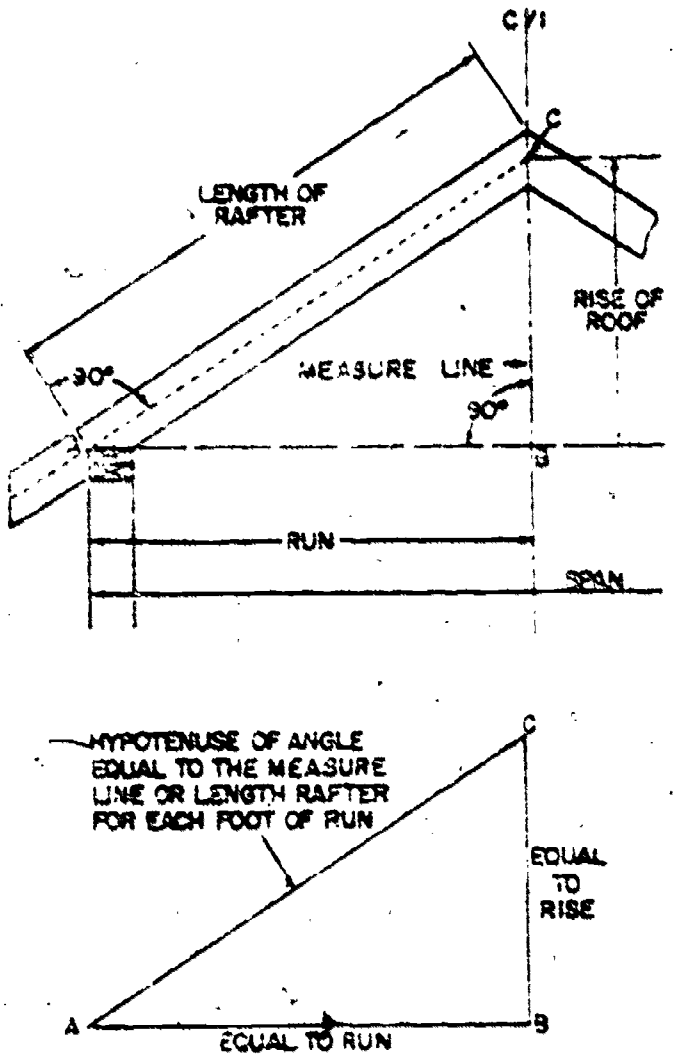
EAVE or TAIL is the portion of the rafter extending beyond the outer edge of the plate.

MEASURE LINE is an imaginary reference line laid out down the middle of the face of a rafter. If a portion of a roof is represented by a right triangle (fig. 11-5), the measure line will correspond to the hypotenuse, the rise to the leg, and the run to the base.

COMMON RAFTER LAYOUT

Rafters must be laid out and cut with slope, length, and overhang exactly right so that they will fit when placed in the position they are to occupy in the finished roof.

The Builder first determines the length of the rafter and the length of the piece of lumber from which the rafter may be cut. If he is working from a set of plans which includes a roof plan, the rafter lengths and the width of the building may be obtained from this plan. If no plans are available, the width of the building may be measured with a tape. To determine the rafter length, first find one-half of the distance between the outside plates. This distance is the horizontal distance which the rafter will cover. The amount of rise per foot has yet to be considered. If the building to be roofed is 20 feet wide, half the span will be 10 feet. For example, the rise per foot is to be 8 inches. To determine the approximate overall length of a rafter, measure on the steel carpenter square the distance between 8 on the tongue and 12 on the blade, because 8 is the rise and 12 is the unit of run. This distance is 14 5/12 inches, and represents the line length of a rafter with a total run of 1 foot and a rise of 8 inches. Since



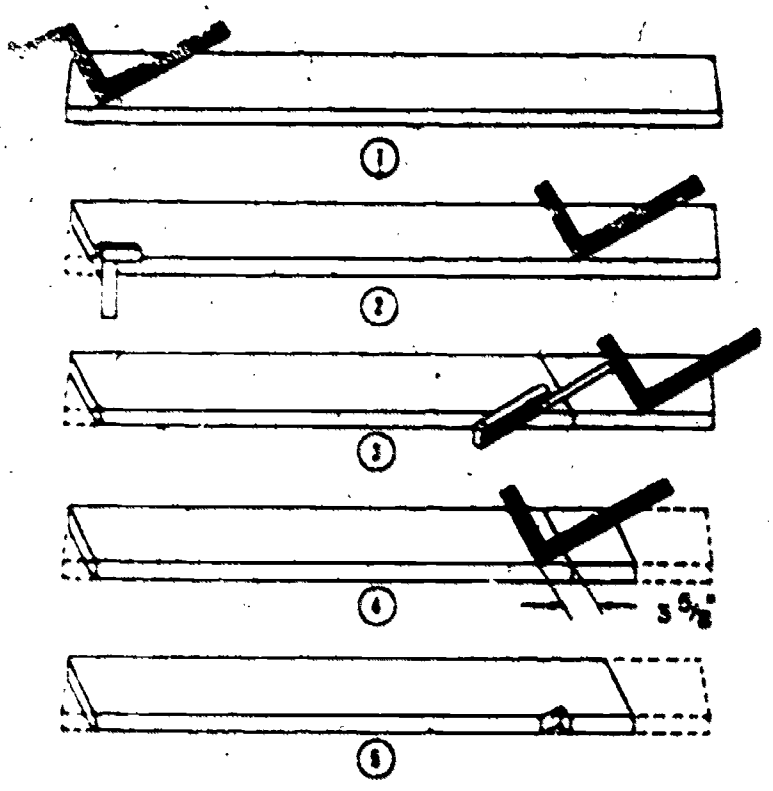
133.364

Figure 11-5.—Measure line.

the run of the rafter is 10 feet, multiply 10 by the line length for 1 foot. The answer is 144 2/12 inches, or 12 feet and 1/6 inch. The amount of overhang, normally 1 foot, must be added if an overhang is to be used. This makes a total of 13 feet for the length of the rafter, but since 13 feet is an odd length for timber, a 14-foot timber is used.

After the length has been determined, the timber is laid on sawhorses, sometimes called "saw benches," with the crown or bow (if any) as the top side of the rafter. If possible, select a straight piece for the pattern rafter. If a straight piece is not available, have the crown toward the person laying off the rafter. Hold the square with the tongue in the right hand, the blade in the left, the heel away from the body, and place the square as near the upper end of

the rafter as possible. In this case, the figure 8 on the tongue and 12 on the blade are placed along the edge of timber which is to be the top edge of the rafter as shown in view 1, figure 11-6. Mark along the tongue edge of the square, which will be the plumb cut at the ridge. Since the length of the rafter is known to be 12 feet and 1 6 inch, measure the distance from the top of the plumb cut and mark it on the timber. Hold the square in the same manner with the 8 mark on the tongue directly over the 12-foot and 1 6 inch mark. Mark along the tongue of the square to give the plumb cut for the seat (view 2, fig. 11-6). Next measure off, perpendicular to this mark, the length of overhang along the timber and make a plumb cut mark in the same manner, keeping the square on the same edge of the timber (view 3, fig. 11-6). This will be the tail cut of the rafter; often the tail cut is made square across the timber.



133.365

Figure 11-6.—Rafter layout—scale or measurement method.

The level cut or width of the seat is the width of the plate, measured perpendicular to the plumb cut, as shown in view 4, figure 11-6. Using the try square, square lines down on the sides from all level and plumb cut lines. Now the rafter is ready to be cut.

If a building is 20 feet 8 inches wide, the run of the rafter would be 10 feet 4 inches, or half the span. Instead of using the above method, the rafter length may be determined by "stepping it off" by successive steps with the square as shown in figure 11-7. Stake the same number of steps as there are feet in the run, which leaves 4 inches over a foot. This 4 inches is taken care of in the same manner as the full foot run; that is, with the square at the last step position, make a mark on the rafters at the 4-inch mark on the blade, then move the square along the rafter until the tongue rests at the 4-inch mark. With the square held for the same cut as before, make a mark along the tongue. This is the line length of the rafter. The seat-cut and hangover are made as described above. When laying off rafters by any method, be sure to recheck the work carefully. When two rafters have been cut, it is best to put them in place to see if they fit. Minor adjustments may be made at this time without serious damage or waste of material.

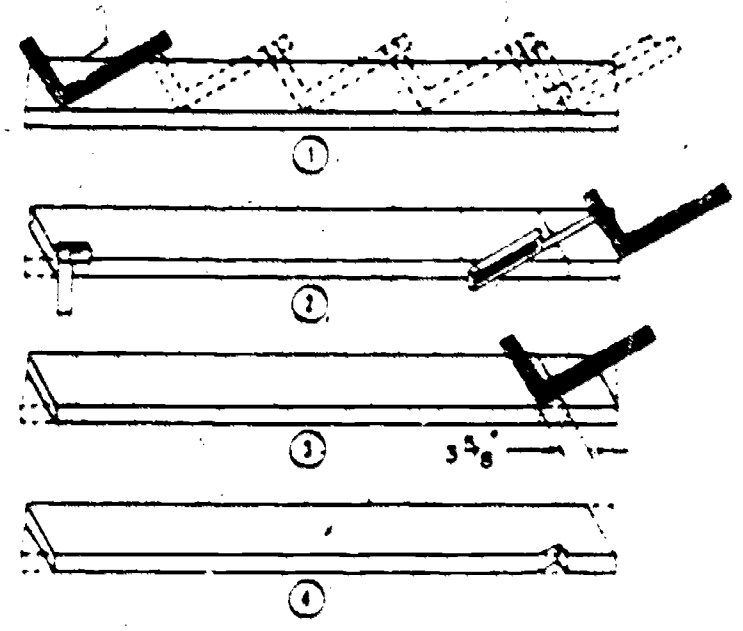


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Figure 11-7.—Rafter layout—step-off method.

TABLE METHOD, USING RAFTER TABLE ON FRAMING SQUARE

The rafter table which is located on the blade gives both the line length of any pitch or rafter per foot of run and the line length of any hip or valley rafter per foot of run. The difference in length of the jack rafter spaced 16 or 24 inches (on center) is also shown in the

table. Where the jack rafter, hip, or valley rafter requires side cuts, the cut is given in the table.

The table (fig. 11-8) appears on the face of the blade. It is used to determine the length of the common, valley, hip, and jack rafters, and the angles at which they must be cut to fit at the ridge and plate. To use the table, the Builder first must become familiar with it and know what each figure represents. The row of figures in the first line represents the length of common rafters per foot of run, as the title indicates at the lefthand end of the blade. Each set of figures under each inch division mark represents the length of rafter per foot of run with a rise corresponding to the number of inches over the number. For example, under the 16-inch mark appears the number 20.00 inches. This number equals the length of a rafter with a run of 12 inches and a rise of 16 inches, or, under the 13-inch mark appears the number 17.69 inches which is the rafter length for a 12-inch run and a 13-inch rise. The other five lines of figures in the table will not be discussed as they are seldom used.

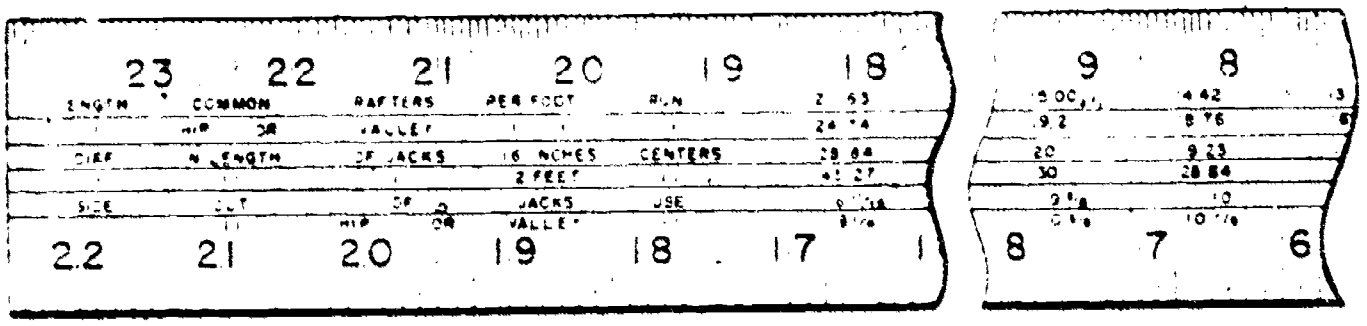
out the rafters after the length has been determined was described above.

When the roof has an overhang the rafter is usually cut square to save time. When the roof has no overhang, the rafter cut is plumb, but no notch is cut in the rafter for a seat. The level cut is made long enough to extend across the plate and the wall sheathing. This type of rafter saves material, although little protection is given to the side wall.

BIRD'S MOUTH

A rafter with a projection has a notch in it called a BIRD'S MOUTH, as shown in figure 11-9. The plumb cut of the bird's mouth, which bears against the side of the rafter plate is called the HEEL cut; the level cut, which bears on the top of the rafter plate, is called the SEAT cut.

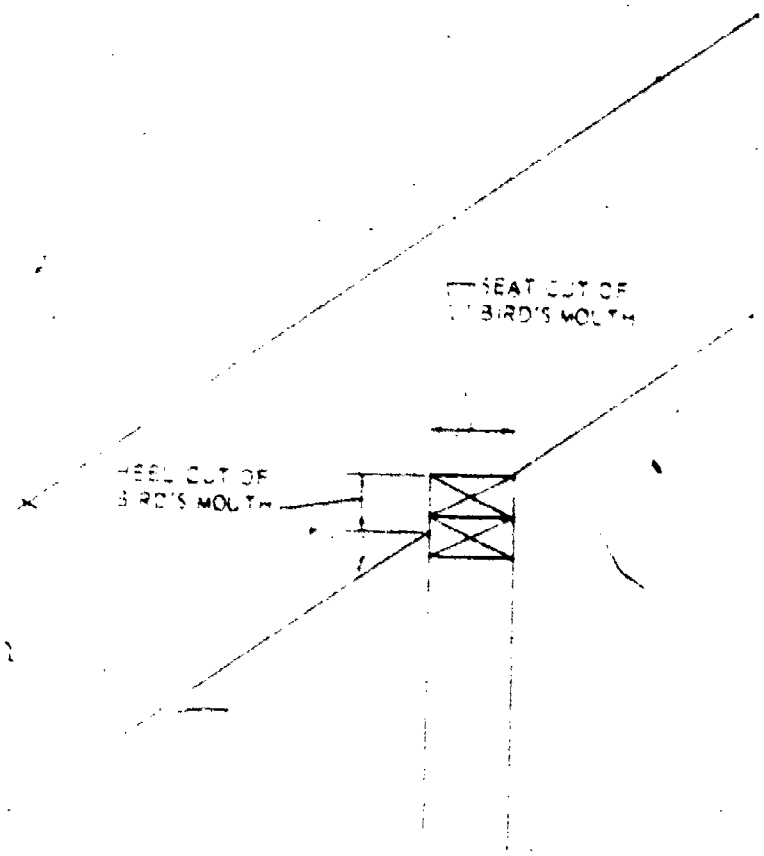
The size of the bird's mouth is usually stated in terms of the depth of the heel cut rather than in terms of the width of the seat cut. You lay out the bird's mouth in about the same way you lay out the seat on a rafter without a projection.



133.367

Figure 11-8.—Rafter table method.

To use the table for laying out rafters, the width of the building must first be known. Suppose the building is 20 feet 8 inches wide and the rise of the rafters is to be 8 inches per foot of run. The total run of the rafter will be 10 feet 4 inches. Look in the first line of figures, under the 8-inch mark appears the number 14.42, which is the length in inches of a rafter with a run of 1 foot and a rise of 8 inches. To find the line length of a rafter with a total run of 10 feet 4 inches, multiply 14.42 inches by 10 1/3 and divide by 12 so as to get the answer in feet. The 14.42 inches by 10 1/3 equals 149.007 inches, which is divided by 12 to equal 12 5/12 feet. Therefore 12 feet 5 inches is the line length of the rafter. The remaining procedure for laying Measure off the depth of the heel on the heel plumb line, set the square as shown in figure 11-10, and draw the seat line along the blade. For the roof surface, ALL RAFTERS should be exact, therefore, the amount above the seat cut, rather than the bottom edge of the rafters, is the most important measurement. Suppose that on a hip roof, or an intersecting roof, the hips or valley rafters are 2 x 6 and the common rafters 2 x 4. The amount above the seat cut should be such as to adequately support the overhang of the roof, plus personnel working on the roof. The width of the seat cut is important as a bearing surface. The maximum width of the common rafter should not exceed the width of the plate.



133.119
Figure 11-9.—Bird's mouth on a rafter with projection.

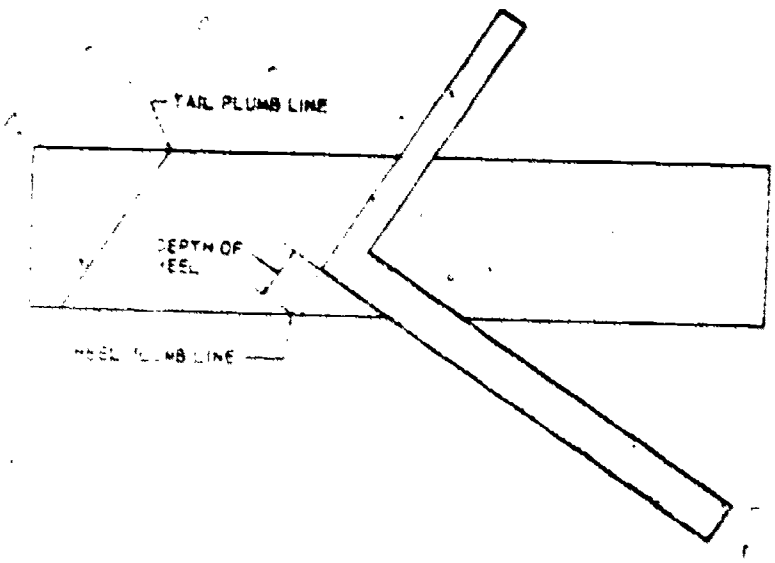


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Figure 11-10.—Laying out a bird's mouth.

HIP RAFTER LAYOUT

Most hip roofs are EQUAL-PITCH hip roofs, in which the angle of slope on the roof end or ends is the same as the angle of slope on the sides. Unequal-pitch hip roofs do exist, but they are quite rare, and they require special layout methods. The UNIT LENGTH RAFTER TABLE on the framing square applies only to equal-pitch hip roofs.

In the following discussion of hip roof framing it will be assumed that in every case the roof is an equal-pitch hip roof.

The length of a hip rafter, like the length of a common rafter, is calculated on the basis of bridge measure times the unit of run. Any of the methods previously described for a common rafter may be used. Some of the basic data for a hip rafter, however, are different.

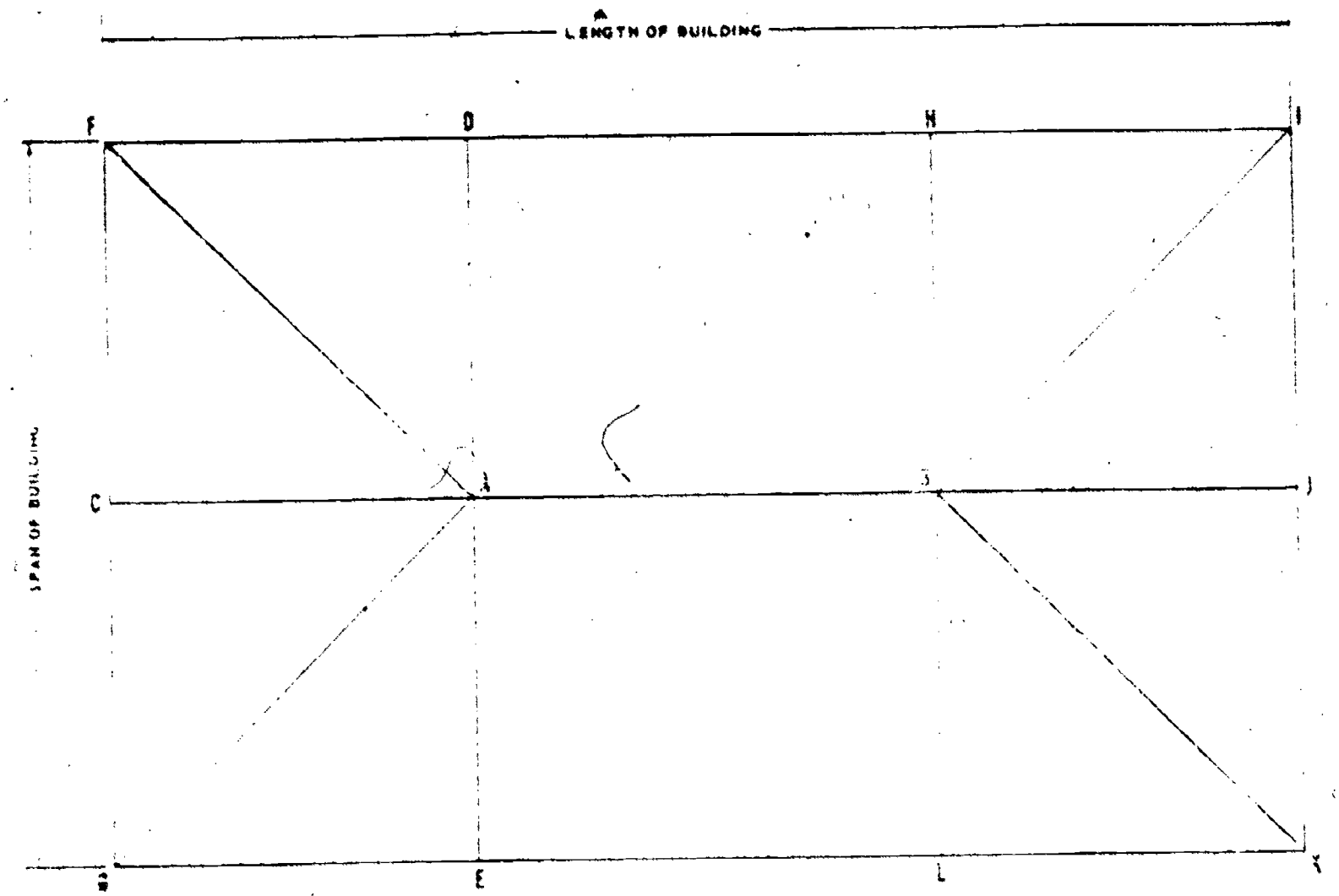
Take a look at figure 11-11, which shows part of a ROOF FRAMING DIAGRAM for an EQUAL-PITCH hip roof. A roof framing diagram may be included among the working drawings; if it is not, you should lay one out for yourself. Lay the building lines out to scale first; you can find the span and the length of the building on the working drawings. Then draw a horizontal line along the center of the span.

In an equal-pitch hip roof framing diagram the lines which indicate the hip rafters (FA, GA, IB, and KB in fig. 11-11) forms 45° angles with the building lines. Draw these lines in at 45°, as shown. The points where they meet the center line are the THEORETICAL ends of the ridge piece. The ridge-end common rafters CA, DA, EA, HB, JB, and LB join the ridge at the same points.

A line which indicates a rafter in the roof framing diagram is equal in length (to scale, of course) to the TOTAL RUN of the rafter it represents. You can see from the diagram that the total run of a hip rafter (represented by lines FA, GA, IB, and KB) is the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter. You know the total run of a common rafter: it is one-half the span, or one-half the width of the building. Knowing this, you can find the total run of a hip rafter by applying the Pythagorean theorem.

Let us suppose, for example, that the span of the building is 30 ft. Then one-half the span, which is the same as the total run of a common rafter, is 15 ft. By the Pythagorean theorem, the total run of a hip rafter is the square root of $(15^2 + 15^2)$, or 21.21 ft.

What is the total rise? Since a hip rafter joins the ridge at the same height as a common rafter, the total rise for a hip rafter is the same as the total rise for a common rafter.



133.121

Figure 11-11.—Equal pitch hip roof framing diagram.

You know how to figure the total rise of a common rafter. Let us support that this roof has a unit run of 12 and a unit rise of 8. Since the total run of a common rafter in the roof is 15 ft, the total rise of a common rafter is the value of x in the proportional equation 12:8::15:x, or 10 ft.

Knowing the total run of the hip rafter (21.21 ft) and the total rise (10 ft), you can figure the line length by applying the Pythagorean theorem. The line length is the square root of $(21.21^2 + 10^2)$, or 23.44 ft, or about 23 ft 5 1/4 in.

To find the length of a hip rafter on the basis of bridge measure, you must first determine the bridge measure. As with a common rafter, the bridge measure of a hip rafter is the length of the hypotenuse of a triangle with shorter sides equal to the unit run and unit rise of the rafter. The unit rise of a hip rafter is always the same as that of a common rafter, but THE UNIT RUN OF A HIP RAFTER IS DIFFERENT.

The unit run of a hip rafter in an equal-pitch hip roof is the hypotenuse of a right triangle with shorter sides each equal to the unit run of a common rafter. Since the unit run of a common rafter is 12, the unit run of a hip rafter is the square root of $(12^2 + 12^2)$, or 16.97.

If the unit run of the hip rafter is 16.97 and the unit rise (in this particular case) is 8, the unit length of the hip rafter must be the square root of $(16.97^2 + 8^2)$, or 18.76. This means that for every 16.97 units of run the rafter has 18.76 units of length. Since the total run of the rafter is 21.21 ft, the length of the rafter must be the value of x in the proportional equation 16.97:18.76::21.21:x, or 23.44 ft.

Like the unit length of a common rafter, the bridge measure of a hip rafter may be obtained

from the unit length rafter table on the framing square. If you turn back to figure 11-8, you will see that the second line in the table is headed "Length hip or valley rafters per foot run." This means "per foot run of A COMMON RAFTER IN THE SAME ROOF." Actually, the unit length given in the tables is the unit length for every 16.97 units of run OF THE HIP RAFTER ITSELF. If you run across to the unit length given under 3, you will find the same figure, 18.76 units, that you calculated above.

An easy way to calculate the length of an equal-pitch hip roof rafter is to multiply the bridge measure by the number of feet in the total run of a common rafter, which is the same as the number of feet in one-half of the span of the building. One-half of the span of the building in this case is 15 ft; the length of the hip rafter is therefore 18.76 x 15, or 281.40 in., which is 281.40 ÷ 12, or 23.45 ft. Note that when you use this method you get a result in inches, which you must convert to feet. The slight difference of 0.01 ft between this result and the one previously obtained amounts to less than 1/8 in., and may be ignored.

You step off the length of an equal-pitch hip roof rafter just as you do the length of a common rafter, except for the fact that you set the square to a unit of run of 16.97 in. instead of to a unit of run of 12 in. Since 16.97 inches is the same as 16 in. and 15.52 sixteenths of an inch, setting the square to a unit of run of 17 in. is close enough for most practical purposes. Bear in mind that for any plumb cut line on an equal-pitch hip roof rafter you set the square to the unit rise of a common rafter and to a unit run of 17.

You step off the same number of times as there are feet in the total run of a common rafter in the same roof; only the size of each step is different. For every 12-in. step in a common rafter a hip rafter has a 17-in. step. In the roof on which we are working, the total run of a common rafter is exactly 15 ft; this means that you would step off the hip-rafter cut (17 in. and 8 in.) exactly 15 times.

Suppose, however, that there was an ODD UNIT in the common rafter total run. Assume, for example, that the total run of a common rafter is 15 ft 10 1/2 in. How would you make the odd fraction of a step on the hip rafter?

You remember that the unit run of a hip rafter is the hypotenuse of a right triangle with other sides each equal to the unit run of a common rafter. This being the case, the run of the odd unit on the hip rafter must be the hypotenuse of a right triangle with other sides each equal to the odd unit of run of the common rafter, which in this case is 10 1/2 in. You can figure this by the Pythagorean theorem (square root of $(10.5^2 + 10.5^2)$), or you can set the square on a true edge to 10 1/2 in. on the tongue and 10 1/2 in. on the blade and measure the distance between the marks. It comes to 14.84 in., which rounded off to the nearest 1/16 in. equals 14 13/16 in.

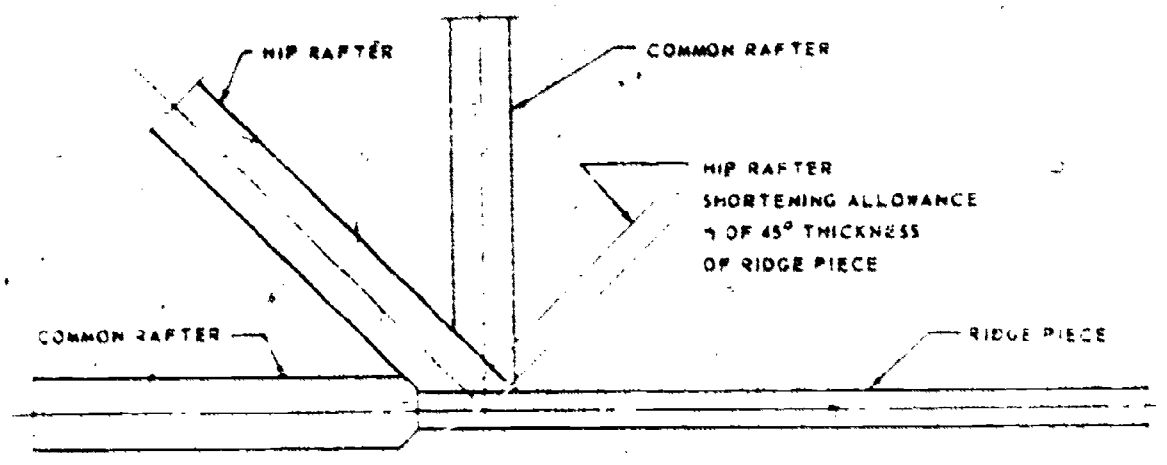
To lay off the odd unit, set the tongue of the framing square to the plumb line for the last full step made and measure off 14 13/16 in. along the blade. Place the tongue of the square at the mark, set the square to the hip rafter plumb cut of 8 in. on the tongue and 17 in. on the blade, and draw the line length cut line.

Hip Rafter Shortening Allowance

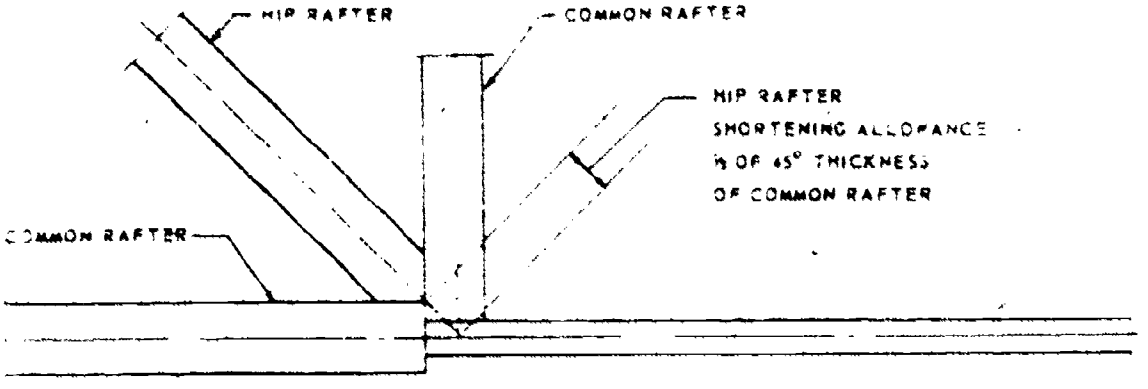
As is the case with a common rafter, the line length of a hip rafter does not take into account the thickness of the ridge piece. The size of the ridge-end shortening allowance for a hip rafter depends upon the manner in which the ridge end of the hip rafter is joined to the other structural members. As shown in figure 11-12, the ridge end of the hip rafter may be framed against the ridge piece (view A, fig. 11-12) or against the ridge-end common rafters (view B, fig. 11-12). If the hip rafter is framed against the ridge piece, the shortening allowance is one-half of the 45° thickness of the ridge piece. The 45° thickness of stock is the length of a line laid at 45° across the thickness dimension of the stock. If the hip rafter is framed against the common rafters, the shortening allowance is one-half of the 45° thickness of a common rafter. To lay off the shortening allowance, set the tongue of the framing square to the line length ridge cut line, measure off the shortening allowance along the blade, set the square at the mark to the cut of the rafter (8 in. and 17 in.), and draw the actual ridge plumb cut line.

Hip Rafter Projection

A hip rafter projection, like a common rafter, is figured as a separate problem. The run of a hip rafter projection, however, is not the same as the run of a common rafter projection in the same roof. Figure 11-13 shows you why. The run of the hip rafter projection,



(A)



(B)

133.122

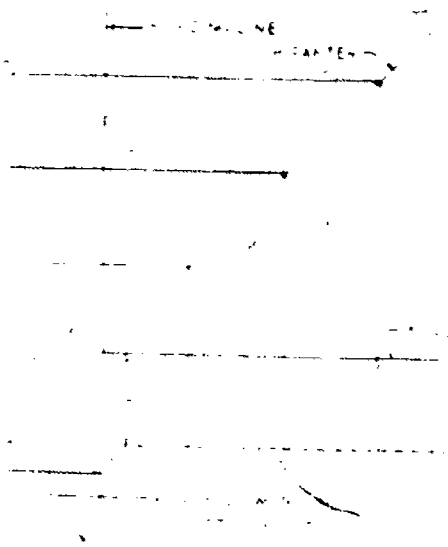
Figure 11-12.—Hip rafter shortening allowance

as you can see, the hypotenuse of a right triangle with shorter sides each equal to the run of a common rafter projection. If the run of the common rafter overhang is 18 in., the run of the hip rafter is the square root of ($18^2 + 18^2$), or 25.45 in. Since the rafter rises 8 units for every 17 units of run, the total rise of the projection is the value of x in the proportional equation 17:8::25.45:x, or 11.9 in. If the total run is 25.45 in. and the total rise 11.9 in., the length of the projection is the square root of ($25.45^2 + 11.9^2$), or about 28 in.

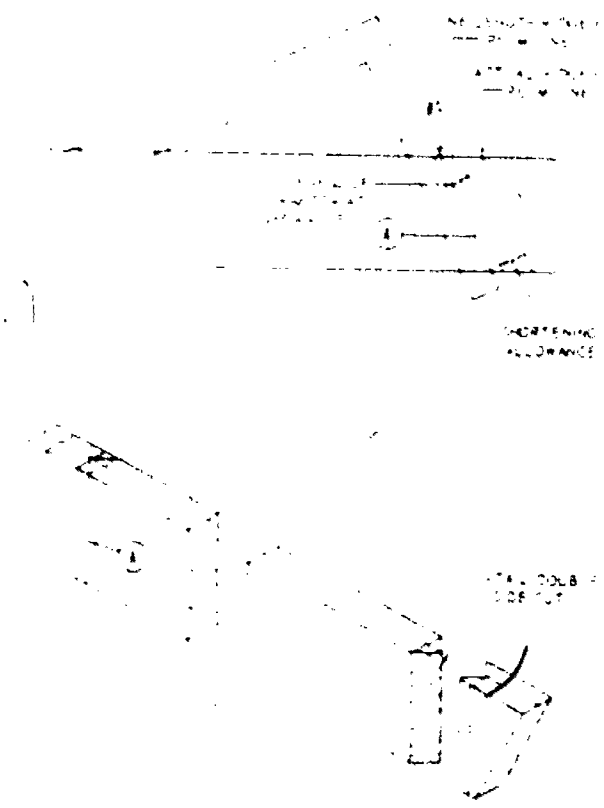
Hip Rafter Side Cuts

Since a common rafter runs at 90° to the ridge, the ridge end of a common rafter is cut square, or at 90° to the lengthwise line of the rafter. A hip rafter, however, joins the ridge, or the ridge ends of the common rafters, at an angle, and the ridge end of a hip rafter must therefore be cut to a corresponding angle, called a SIDE CUT. The angle of the side cut is more acute for a high unit rise than it is for a low one.

The angle of the side cut is laid out as shown in figure 11-14. Place the tongue of the framing square along the ridge cut line, as shown, and measure off one-half the thickness of the hip rafter along the blade. Shift the tongue to the mark, set the square to the cut of the rafter (17 in. and 8 in.), and draw the plumb line marked A in the figure. Then turn the rafter edge-up, draw an edge center line, and draw in the angle of the side cut as indicated in the lower view of figure 11-14. For a hip rafter



133.123
Figure 11-13.—Run of hip rafter projection.

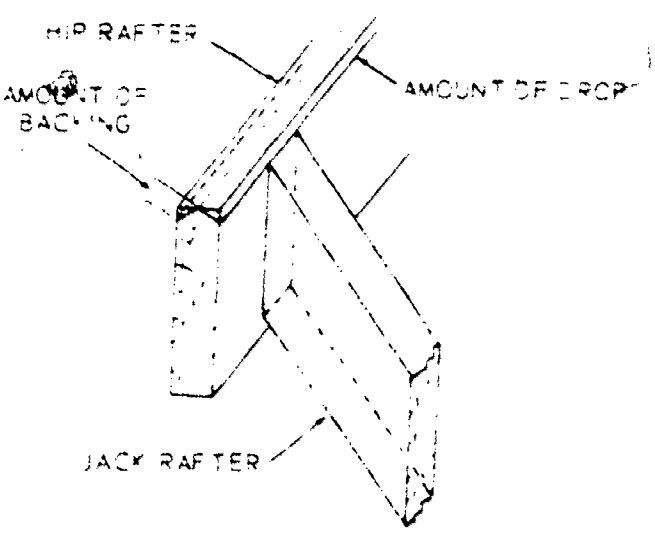


133.124
Figure 11-14.—Laying out hip rafter side cut.

which is to be framed against the ridge there will be only a single side cut, as indicated by the dotted line; for one which is to be framed against the ridge ends of the common rafters there will be a double side cut, as shown. The tail of the rafter must have a double side cut at the same angle, but in the reverse direction.

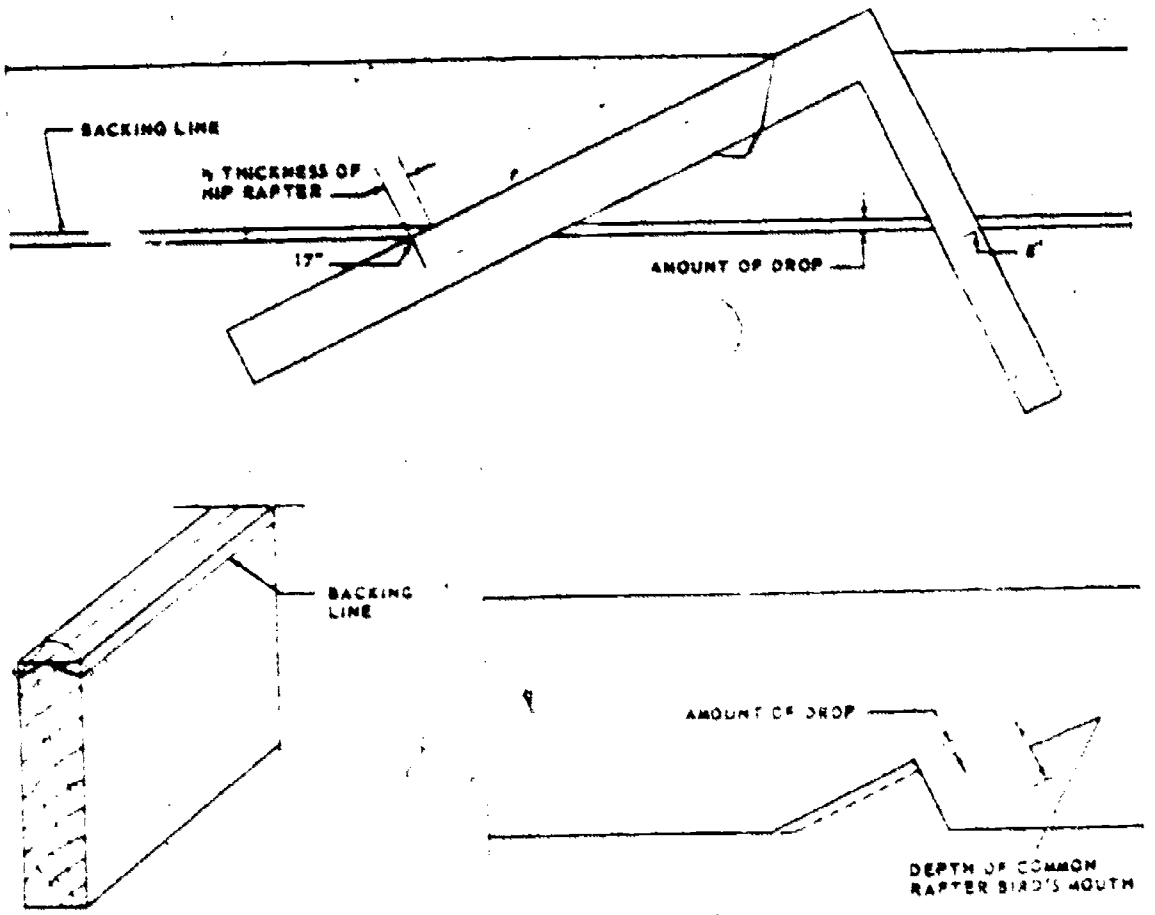
The angle of the side cut on a hip rafter may also be laid out by referring to the unit length rafter table on the framing square. If you turn back to figure 11-8, you will see that the bottom line in the table is headed "Side cut hip or valley use." If you follow this line over to the column headed by the figure 8 (for a unit rise of 8), you will find the figure 10 7/8. If you place the framing square face-up on the rafter edge, with the tongue on the ridge-end cut line, and set the square to a cut of 10 7/8 in. on the blade and 12 in. on the tongue, you can draw the correct side-cut angle along the tongue.

If the bird's mouth on a hip rafter had the same depth as the bird's mouth on a common rafter, the edges of the hip rafter would extend above the upper ends of the jack rafters as shown in figure 11-15. This can be corrected by either BACKING or DROPPING the hip rafter. Backing means to bevel the upper edge of the hip rafter. As shown in figure 11-15, the amount of backing is taken at the right angle to the roof surface, or the top edge of the hip rafter. Dropping means to deepen the bird's mouth so as to bring the top edge of the hip rafter down to the upper ends of the jacks. The amount of drop is taken on the heel plumb line.



133.125
Figure 11-15.—Backing or dropping a hip rafter.

The amount of backing or drop required is calculated as shown in figure 11-16. Set the framing square to the cut of the rafter (8 in. and 17 in.) on the upper edge, and measure off one-half the thickness of the rafter from the edge along the blade. A line drawn through this



133.126

Figure 11-16.—Determining required amount of backing or drop.

mark, parallel to the edge, will indicate the bevel angle, as shown, if the rafter is to be backed. The perpendicular distance between the line and the edge of the rafter will be the amount of drop—meaning the amount that the depth of the hip rafter bird's mouth should exceed the depth of the common rafter bird's mouth.

VALLEY RAFTER LAYOUT

A valley rafter follows the line of intersection between a main roof surface and a gable-roof addition or a gable-roof dormer surface. Most roofs which contain valley rafters are EQUAL-PITCH roofs, in which the pitch of the addition or dormer roof is the same as the pitch of the main roof. There are UNEQUAL-PITCH valley-rafter roofs, but they are quite rare, and they require special framing methods. In the discussion of valley rafter layout it will be assumed that the roof is in every case an equal pitch roof, in which the unit of run and unit of rise of an addition or dormer common rafter is the same as the unit of run and unit of rise of a main roof common rafter. In an equal-pitch roof the valley rafters always run at 45° to the building lines and the ridge pieces.

Figure 11-17 shows an EQUAL-SPAN framing situation, in which the span of the addition is the same as the span of the main roof. Since the pitch of the addition roof is the same as the pitch of the main roof, equal spans bring the ridge pieces to equal heights.

If you look at the roof framing diagram in the figure, you will see that the total run of a valley rafter (indicated by AB and AD in the diagram) is the hypotenuse of a right triangle with shorter sides equal to the total run of a common rafter in the main roof. The unit run of a valley rafter is therefore 16.97, the same as the unit run for a hip rafter. It follows that figuring the length of an equal-span valley rafter is the same as figuring the length of an equal-pitch hip roof hip rafter.

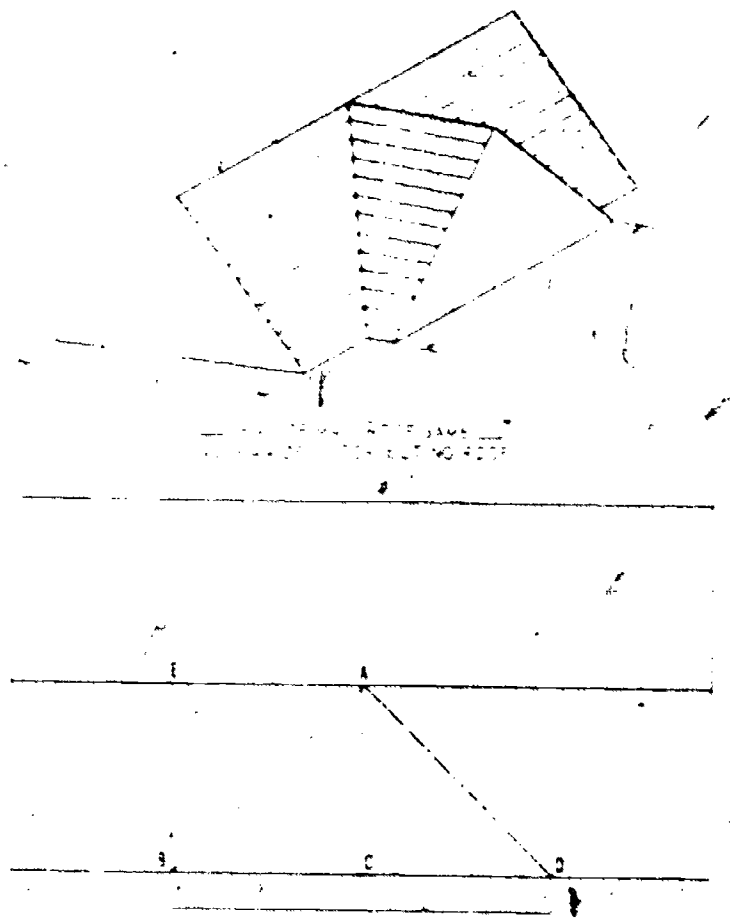


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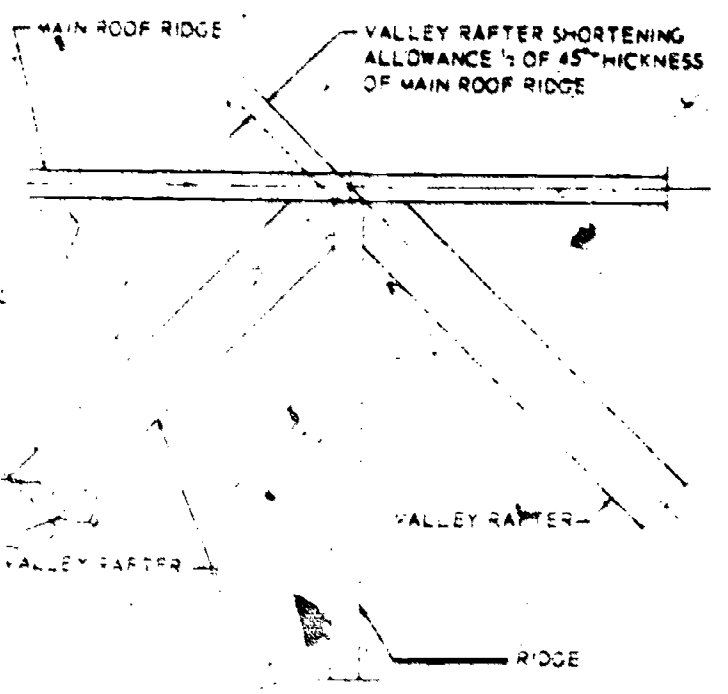
Figure 11-17.—Equal span main roof and intersection roof.



133.128

Figure 11-18.—Ridge-end shortening allowance for equal span intersection valley rafter.

A valley rafter, however, does not require backing or dropping. The projection, if any, is figured just as it is for a hip rafter. Side cuts are laid out as they are for a hip rafter; the valley-rafter tail has a double side cut, like the hip-rafter tail, but in the reverse direction, since the tail cut on a valley rafter must form an inside rather than an outside corner. As indicated in figure 11-18 the ridge-end shortening allowance in this framing situation amounts to one-half of the 45° thickness of the ridge.

Figure 11-19 shows a framing situation in which the span of the addition is shorter than the span of the main roof. Since the pitch of the addition roof is the same as the pitch of the main roof, the shorter span of the addition brings the addition ridge down to a lower level than that of the main roof ridge.

There are two ways of framing an intersection of this type. By the method shown in figure 11-19, a full-length valley rafter (AD in the figure) is framed between the rafter plate and the ridge piece, and a shorter valley rafter (CB in the figure) is then framed to the longer one. If you study the framing diagram you will see that the total run of the longer valley rafter is the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter IN THE MAIN ROOF. The total run of the shorter valley rafter, on the other hand, is the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter IN THE ADDITION. The total run of a common rafter in the main roof is equal to one-half the span of the main roof; the total run of a common rafter in the addition is equal to one-half the span OF THE ADDITION.

Knowing the total run of a valley rafter (or of any rafter, for that matter), you can always find the line length by applying the bridge measure times the total run. Suppose, for example, that the span of the addition in figure 11-19 is 30 ft, and that the unit rise of a common rafter in the addition is 9. The total run of the shorter valley rafter is the square root of ($15^2 + 15^2$), or 21.21 ft. If you refer back to the unit length rafter table in figure 11-8, you will see that the bridge measure for a valley rafter in a roof with a common-rafter unit rise of 9 is 19.21. Since the unit run of a valley rafter is 16.97 and the total run of this rafter is 21.21 ft, the line length must be

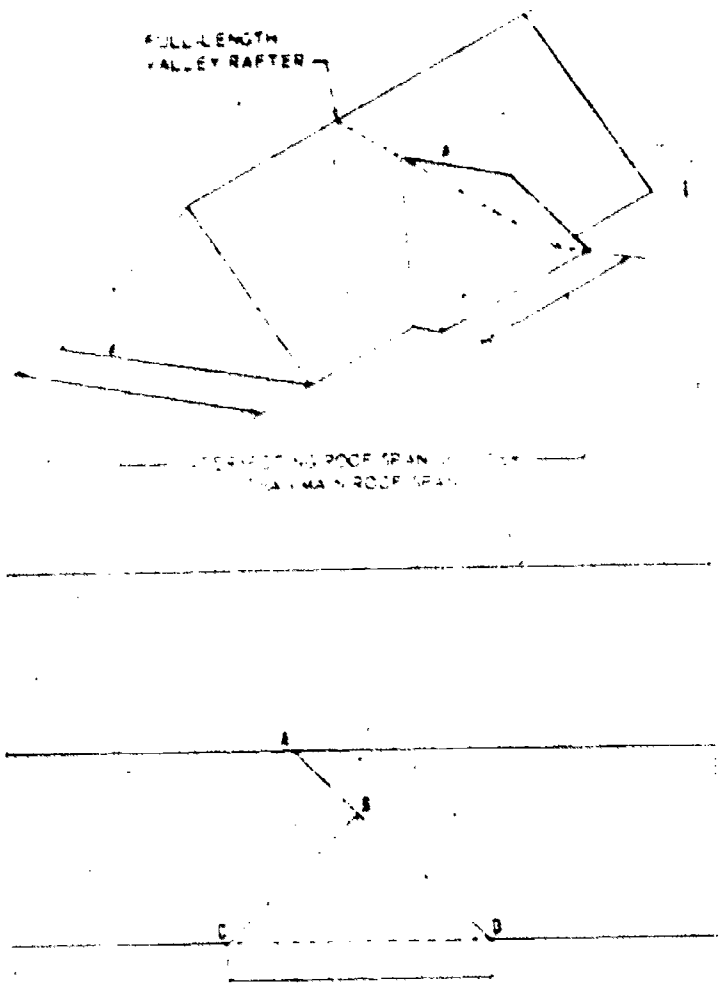


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Figure 11-19.—Equal-pitch but unequal span framing situation.

the value of x in the proportional equation 16.97:19.21::21.21:x, or 24.01 ft.

An easier way to find the length of a valley rafter is to simply multiply the bridge measure by the number of feet in one-half the span OF THE ROOF TO WHICH THE VALLEY RAFTER BELONGS. The length of the longer valley rafter in figure 11-19, for example, would be 19.21 times one-half the span OF THE MAIN ROOF. The length of the shorter valley rafter is 19.21 times one-half the span OF THE ADDITION. Since one-half the span of the addition is 15 ft, the length of the shorter valley rafter is 15 x 19.21, or 288.15 in., which is 288.15 ÷ 12, or 24.01 ft. Note again that when you use this method you get a result in inches, which you must change to feet.

Figure 11-20 shows the long and short valley rafter shortening allowances. Note that the long valley rafter has a single side cut for framing to the main roof ridge piece, while the

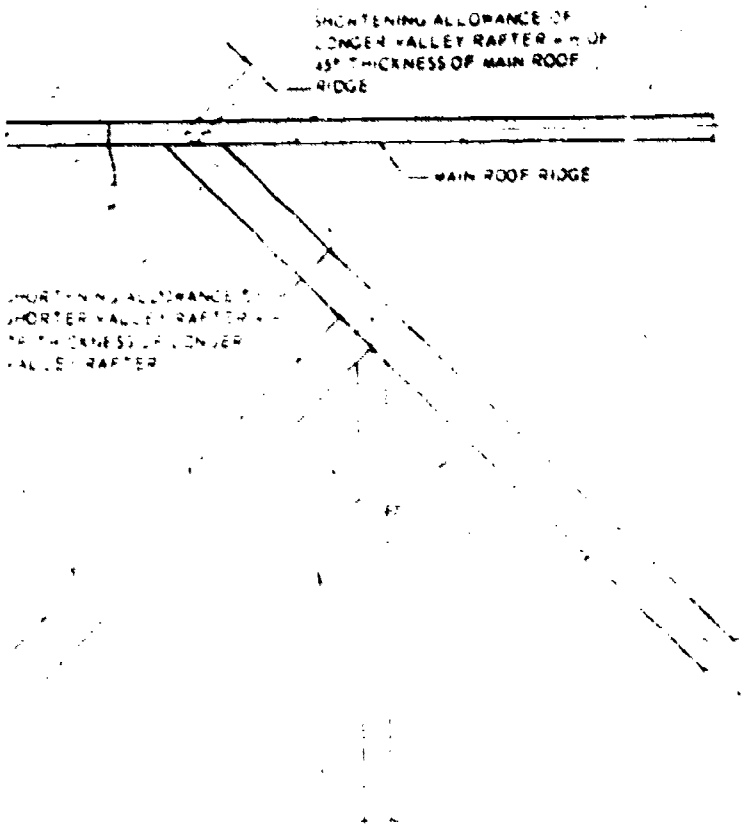

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Figure 11-20.—Long and short valley rafter shortening allowances.

short valley rafter is cut square for framing to the addition ridge.

Figure 11-21 shows another method of framing an equal-pitch unequal-span addition. In this method the inboard end of the addition ridge is nailed to a piece which hangs from the main roof ridge. As shown in the framing diagram, this method calls for two short valley rafters, each of which extends from the rafter plate to the addition ridge. The framing diagram shows that the total run of each of these valley rafters is the hypotenuse of a right triangle with shorter sides, each equal to the total run of a common rafter IN THE ADDITION.

As indicated in figure 11-22, the shortening allowance of each of the short valley rafters is one-half of the 45° thickness of the addition ridge. Each rafter is framed to the addition ridge with a single side cut.

Figure 11-23 shows a method of framing a gable dormer without side walls. The dormer ridge is framed to a header set between a couple of doubled main-roof common rafters. The valley rafters are framed between this header and a lower header. As indicated in the framing diagram, the total run of a valley rafter is

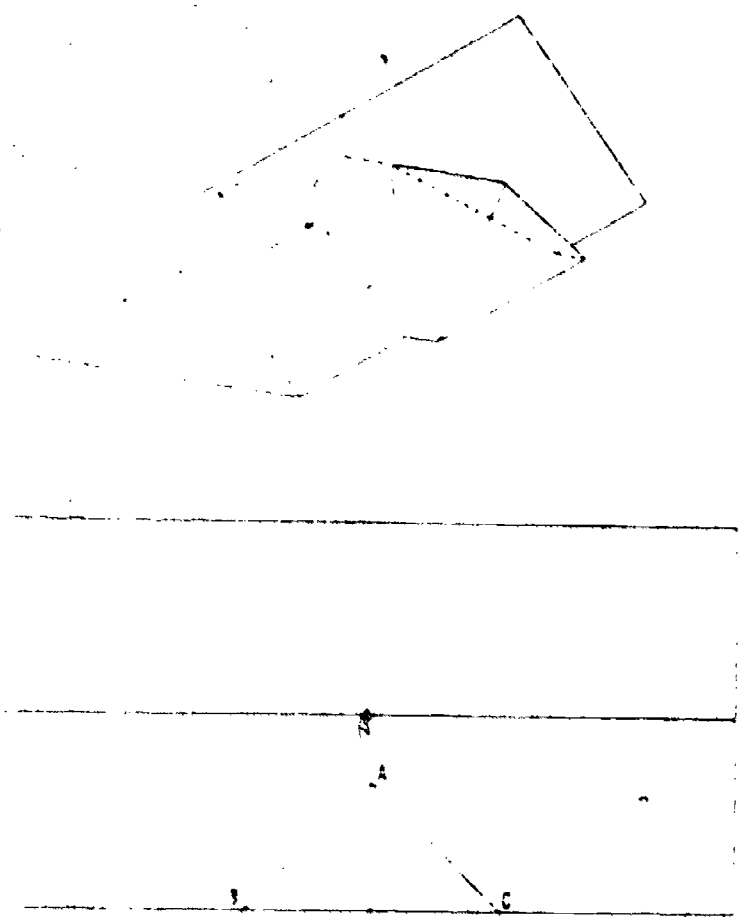

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Figure 11-21.—Another method of framing equal-pitch unequal span intersection.

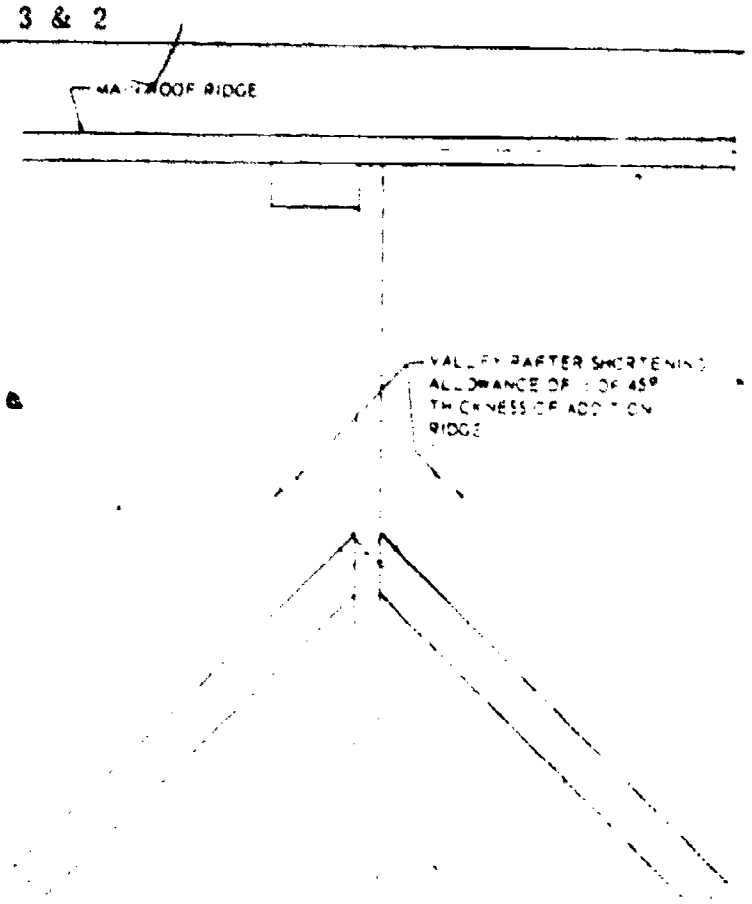

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Figure 11-22.—Shortening allowance of valley rafters in suspended ridge method of intersection roof framing.

the hypotenuse of a right triangle with shorter sides each equal to the total run of a common rafter IN THE DORMER.

Figure 11-24 shows the arrangement and names of framing members in this type of dormer framing.

Figure 11-24 also shows that the upper edges of the headers must be beveled to the cut of the main roof. Figure 11-25 shows that in this method of framing the shortening allowance for the upper end of a valley rafter is one-half of the 45° thickness of the inside member in the upper doubled header. There is also a shortening allowance for the lower end, consisting of one-half of the 45° thickness of the inside member of the doubled common rafter. The figure also shows that each valley rafter has a double side cut at the upper end and a double side cut at the lower end.

Figure 11-26 shows a method of framing a gable dormer with side walls. As indicated in the framing diagram, the total run of a valley rafter is again the hypotenuse of a right triangle with shorter sides each equal to the run of a common rafter IN THE DORMER. You figure the lengths of the dormer corner posts and side studs just as you do the lengths of gable-end studs, and you lay off the lower-end cut-off angle by setting the square to the cut of the main roof.

Figure 11-27 shows the valley rafter shortening allowances for this method of framing a dormer with side walls.

JACK RAFTER LAYOUT

A jack rafter is a part of a common rafter, shortened for framing to a hip rafter, a valley rafter, or both. This means that in an equal-pitch framing situation the unit rise of a jack rafter is always the same as the unit rise of a common rafter.

A HIP JACK rafter is one which extends from a hip rafter to a rafter plate. A VALLEY

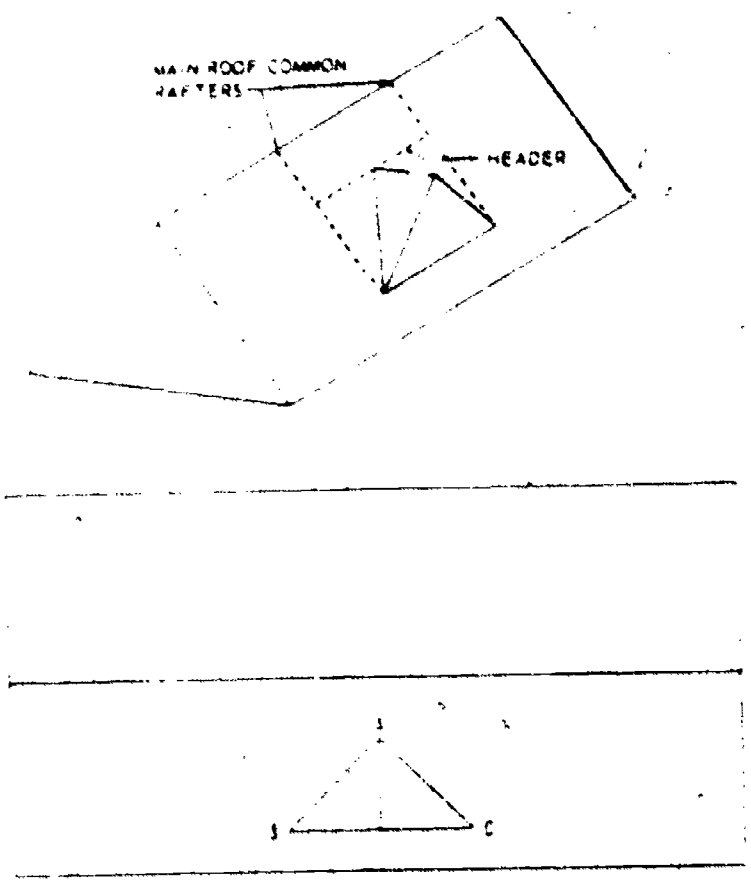

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Figure 11-23.—Method of framing dormer without sidewalls.

JACK rafter is one which extends from a valley rafter to a ridge. A CRIPPLE JACK rafter is one which does not contact either a rafter plate or a ridge. A VALLEY CRIPPLE JACK is one which extends between two valley rafters in the long-and-short-valley-rafter method of addition framing. A HIP-VALLEY CRIPPLE JACK is one which extends from a hip rafter to a valley rafter. All types of jacks except cripple jacks are shown in figure 11-28. A valley cripple jack and a couple of hip-valley cripple jacks are shown in figure 11-29.

Lengths of Hip Jack Rafters

Figure 11-30 shows a roof framing diagram for a series of hip jack rafters. The jacks are always on the same spacing O.C. as the common rafters. Suppose that the spacing in this instance is 16 in O.C. You can see that the total run of the shortest jack is the hypotenuse of a right triangle with shorter sides each 16 in. long. The total run of the shortest jack is therefore the square root of $(16^2 + 16^2)$, or 22.62 in.

Suppose that a common rafter in this roof has a unit rise of 8. The jacks, as you know, have the same unit rise as a common rafter. The unit length of a jack in this roof, then, is the square root of $(12^2 + 8^2)$, or 14.42. This means that a jack is 14.42 units long or every 12 units of run. The length of the shortest hip jack in this roof is therefore the value of x in the proportional equation 12:14.42::16:x, or 19.23 in.

This is always the length of the shortest hip jack when the jacks are spaced 16 in O.C. and the common rafter in the roof has a unit rise of 8. It is also the COMMON DIFFERENCE OF JACKS, meaning that the next hip jack will be 2(19.23 in.) long, the next 3(19.23 in.) long, and so on.

The common difference for hip jacks spaced 16 in. O.C., and also for hip jacks spaced 24 in. O.C., is given in the unit length rafter table on the framing square for unit rises ranging from 2 to 18 inclusive. Turn back to figure 11-8, which shows a segment of the unit length rafter table. Note the third line in the table, which reads "Diff. in length of jacks 16 inches centers." If you follow this line over to the figure under 8 (for a unit rise of 8), you will find the same unit length (19.23 in.) that you worked out above.

The best way to figure the length of a valley jack or a cripple jack is to apply the bridge measure to the total run. The bridge measure of any jack is the same as the bridge measure of a common rafter having the same unit of rise as the jack. Suppose, for example, that the jack has a unit rise of 8. In figure 11-8, look along the line on the unit length rafter tables headed "Length common rafters per foot run" for the figure in the column under 8, and you will find a unit length of 14.42. You should know by this time how to apply this to the total run of a jack to get the line length.

The best way to figure the total runs of valley jacks and cripple jacks is to lay out a framing diagram and study it to determine what these runs must be. Figure 11-31 shows part of a framing diagram for a main hip roof with a long-and-short-valley-rafter gable addition. By studying the diagram you can figure the total runs of the valley jacks and cripple jacks as follows:

The run of valley jack No. 1 is obviously the same as the run of hip jack No. 8, which is the run of the shortest hip jack. The length of

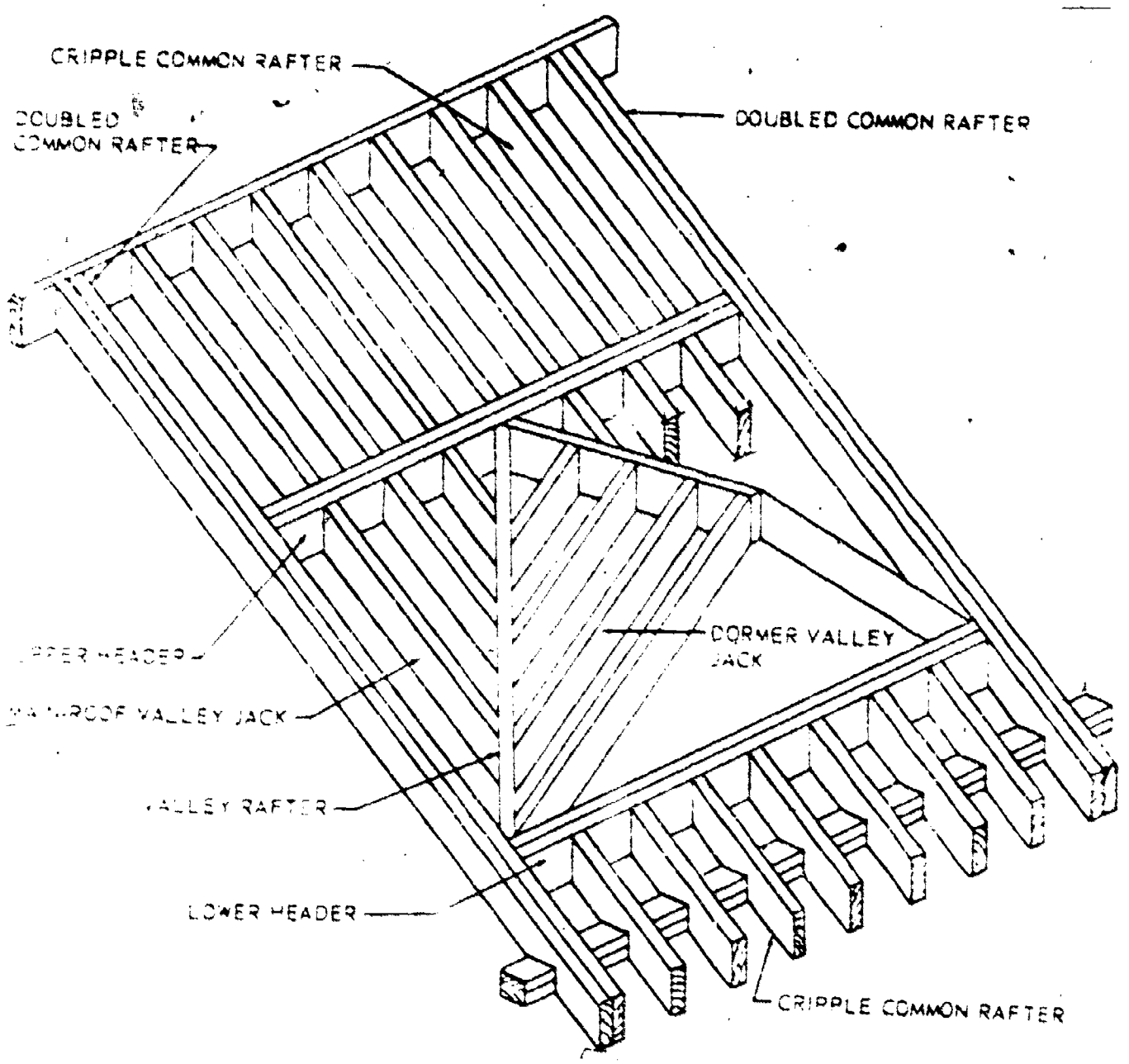

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Figure 11-24.—Arrangement and names of framing members for dormer without sidewall.

valley jack No. 1 is therefore equal to the common difference of jacks.

The run of valley jack No. 2 is the same as the run of hip jack No. 7, and the length is therefore twice the common difference of jacks.

The run of valley jack No. 3 is the same as the run of hip jack No. 6, and the length is therefore three times the common difference of jacks.

The run of hip-valley cripple No. 4, and also of hip-valley cripple No. 5, is the same as the run of valley jack No. 3.

The run of valley jack No. 9, and also of valley jack No. 10, is equal to the spacing of jacks O.C. Therefore, the length of one of these jacks is equal to the common difference of jacks.

The run of valley jacks Nos. 11 and 12 is twice the run of valley jacks Nos. 9 and 10, and the length of one of these jacks is therefore twice the common difference of jacks.

The run of valley cripple No. 13 is twice the spacing of jacks O.C., and the length is therefore twice the common difference of jacks.

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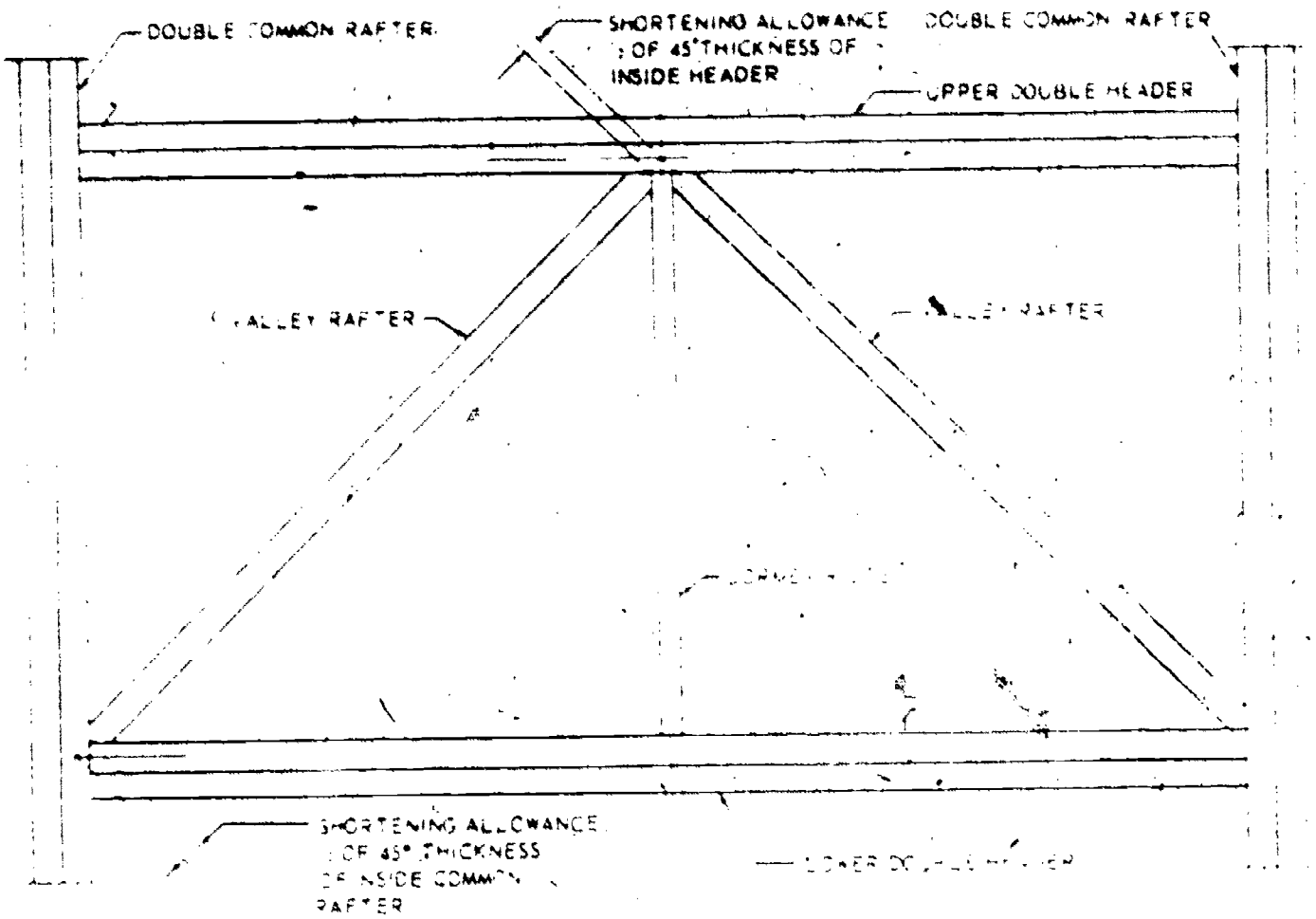

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Figure 11-25.—Valley rafter shortening allowances for dormer without sidewall.

The run of valley cripple No. 14 is twice the run of valley cripple No. 13, and the length is therefore times the common difference of jacks.

Jack Rafter Shortening Allowances

A hip jack rafter has a shortening allowance at the upper end consisting of one-half of the 45° thickness of the hip rafter. A valley jack rafter has a shortening allowance at the upper end, consisting of one-half of the thickness of the ridge, and another at the lower end, consisting of one-half of the 45° thickness of the valley rafter. A hip-valley cripple has a shortening allowance at the upper end, consisting of one-half of the 45° thickness of the hip rafter, and another at the lower end, consisting of one-half of the 45° thickness of the valley rafter. A valley cripple has a shortening allowance at the upper end, consisting of one-half of the 45° thickness of the long valley rafter, and another at the lower end, consisting of one-half the 45° thickness of the short valley rafter.

Jack Rafter Side Cuts

The side cut on a jack rafter can be laid out by the method illustrated in figure 11-14 for laying out the side cut on a hip rafter. Another method is to use the fifth line of the unit length rafter table, which is headed "Side cut of jacks use" (fig. 11-8). If you follow that line over to the figure under 8 for a unit rise of 8, you will see that the figure given is 10. To lay out the side cut on a jack, set the square face-up on the edge of the rafter to 12 in. on the tongue and 10 in. on the blade, and draw the side-cut line along the tongue.

Jack Rafter Bird's Mouth and Projection

A jack rafter is a shortened common rafter; consequently, the bird's mouth and projection

45.458

Figure 11-26.—Method of framing gable dormer with sidewalls.

on a hip rafter are laid out just as they are on a common rafter.

RIDGE LAYOUT

Laying out the ridge for a gable roof presents no particular problem, since the line length of the ridge is equal to the length of the building. The actual length would include any overhang. For a hip main roof, however, the ridge layout requires a certain amount of calculation.

As previously mentioned, in an equal-pitch hip roof the line length of the ridge amounts to the length of the building minus twice the total run of a main roof common rafter. The ACTUAL length, however, depends upon the way in which the hip rafters are framed to the ridge.

As indicated in figure 11-32, the line length ends of the ridge are at the points where the ridge center line and the hip rafter center lines cross. In figure 11-32 the hip rafter is framed against the ridge; in this method of framing the actual length of the ridge exceeds the line length, at each end, by one-half of the thickness of the ridge, plus one-half of the 45° thickness of the hip rafter. In figure 11-32 the hip rafter is framed between the common rafters; in this method of framing the actual length of the ridge exceeds the line length, at each end, by one-half of the thickness of a common rafter.

Figure 11-33 shows that the length of the ridge for an equal-span addition is equal to the length of the addition rafter plate, plus one-half the span of the building, minus the shortening allowance at the main roof ridge; the shortening allowance amounts to one-half of the thickness of the main roof ridge. Figure 11-33 shows that the length of the ridge for an unequal-span addition varies with the method of framing the ridge. If the addition ridge is suspended from the main roof ridge, the length is equal to the length of the addition rafter plate plus one-half the span of the building. If the addition ridge is framed by the long-and-short valley rafter method, the length is equal to the length of the addition rafter plate, plus one-half of the span of the addition, minus a shortening allowance consisting of one-half of the 45° thickness of the long valley rafter. If the addition ridge is framed to a double header set between a couple of double main roof common rafters, the length of the ridge is equal to the length of the addition side-wall rafter plate, plus one-half the span of the addition, minus a shortening allowance consisting of one-half the thickness of the inside member of the double header.

Figure 11-34 shows that the length of the ridge on a dormer without side walls is equal to one-half of the span of the dormer, less a shortening allowance consisting of one-half the thickness of the inside member of the upper double header. Figure 11-34 shows that the length of the ridge on a dormer with side walls amounts to the length of the dormer rafter plate, plus one-half the span of the dormer, minus a shortening allowance consisting of one-half the thickness of the inside member of the upper double header.

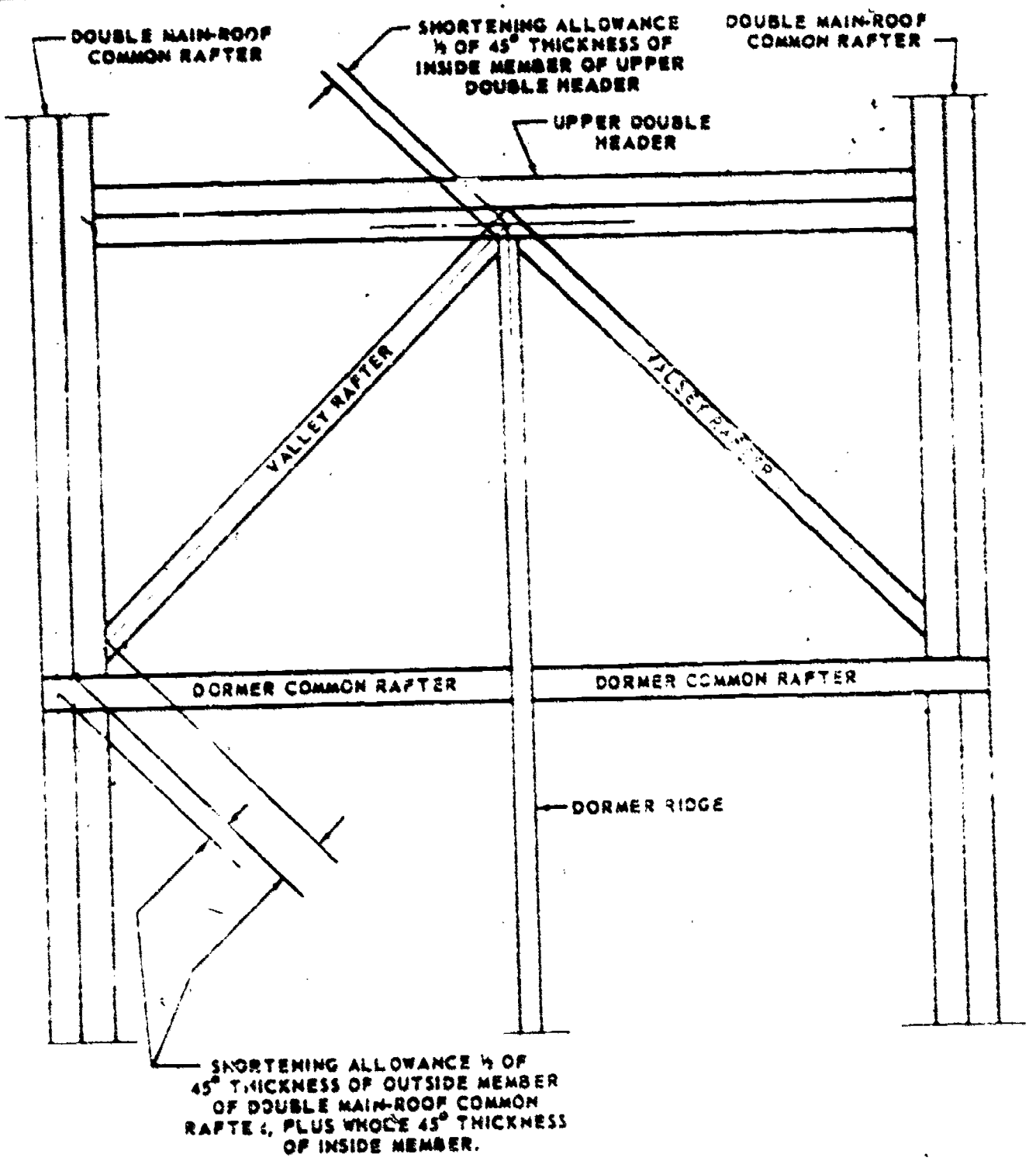

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Figure 11-27.—Valley rafter shortening allowances for dormer with sidewall.

SHED ROOF FRAMING

As previously mentioned, a SHED or SINGLE-PITCH roof is essentially one-half of a gable or double-pitch roof. Like the full-length rafters in a gable roof, the full-length rafters in a shed roof are COMMON rafters. Note, however, that as shown in figure 11-35, the total run of a shed roof common rafter is equal to the span of the building MINUS THE WIDTH OF THE RAFTER PLATE ON THE HIGHER RAFTER-END WALL. Note also, that the run of the projection on the higher wall is measured from the INNER EDGE of the rafter plate. To this must be added the width of the plate and the length of the overhang at the top. Shed-roof common rafters are laid out like gable-roof common rafters. A shed-roof common rafter

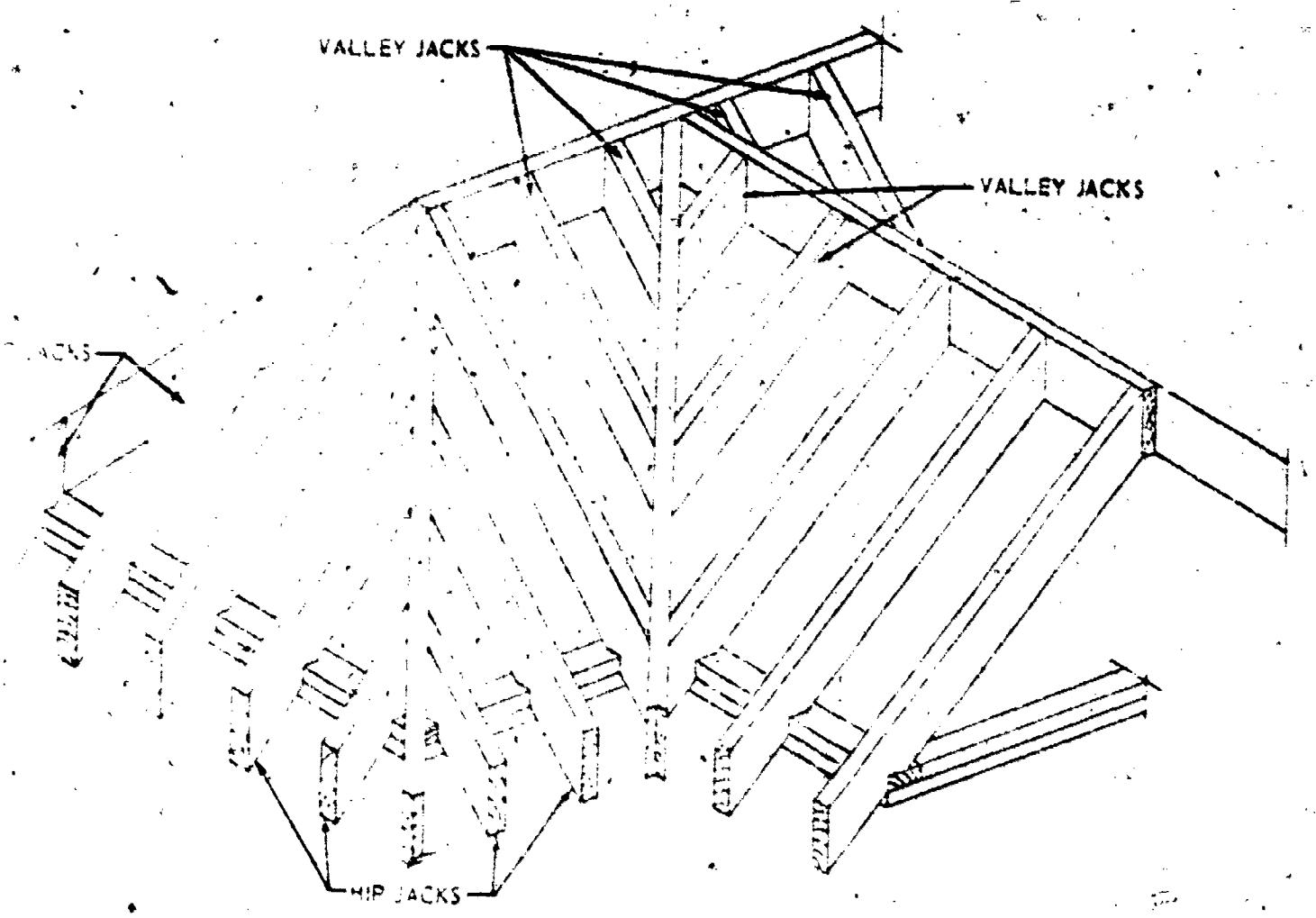

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Figure 11-28.—Types of jack rafters.

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Figure 11-29.—Valley cripple jack and hip-valley cripple jacks.

has two bird's mouths but they are laid out just like the bird's mouth on a gable-roof common rafter.

Figure 11-35 also shows that the height of the higher rafter-end wall must exceed the height of the lower by an amount equal to the total rise of a common rafter.

Figure 11-36 shows a method of framing a shed dormer. There are 3 layout problems to be solved here, as follows: (1) determining the total run of a dormer rafter, (2) determining the angle of cut on the inboard ends of the dormer rafters, and (3) determining the lengths of the dormer side-wall studs.

To determine the total run of a dormer rafter you divide the height of the dormer end wall, in inches, by the difference between the unit rise of the dormer roof and the unit rise of the main roof. Take the dormer shown in figure 11-37, for example. The height of the

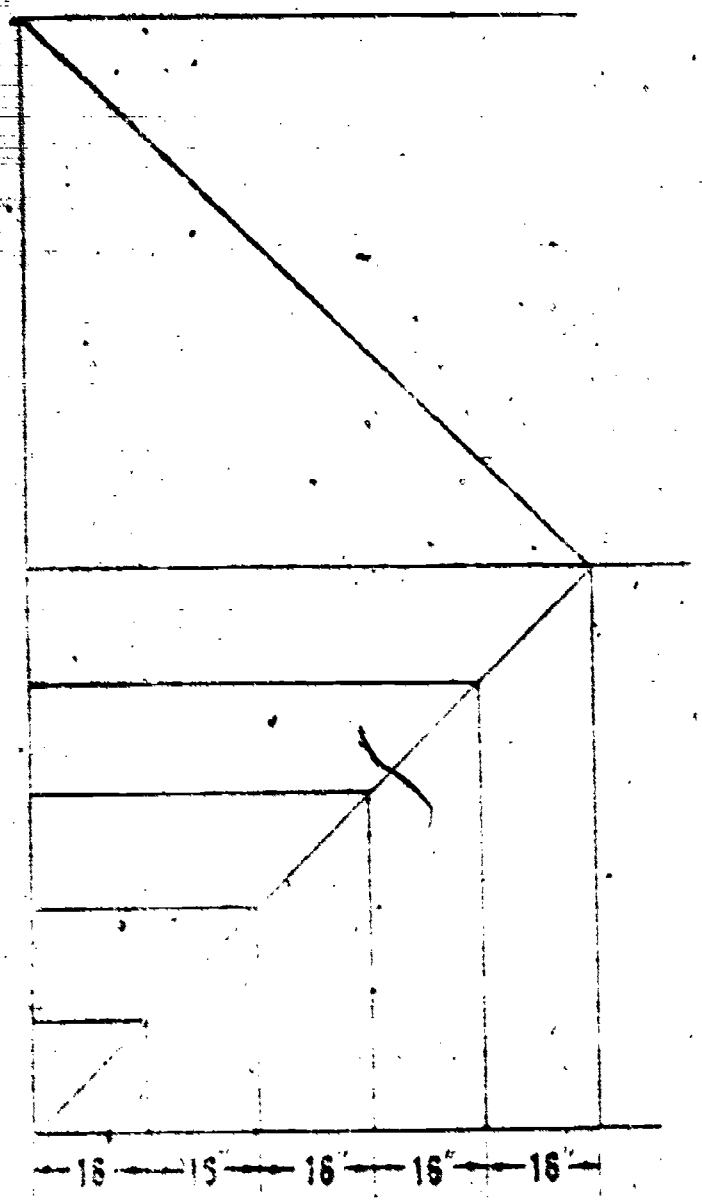

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Figure 11-30.—Hip jack framing diagram.

dormer end-wall is 9 ft, or 108 in. The unit rise of the main roof is 8; the unit rise of the dormer roof is 2 1/2; the difference between them is 5 1/2. The total run of a dormer rafter is therefore 108 divided by 5 1/2, or 19.63 ft. Knowing the total run and the unit rise, you can figure the length of a dormer rafter by any of the methods already described.

As, indicated in figure 11-37 the inboard ends of the dormer rafters must be cut to fit the slope of the main roof. To get the angle of this cut, set the square on the rafter to the cut of the main roof, as shown in the third view of figure 11-37; measure off the unit size of the dormer roof from the heel of the square along

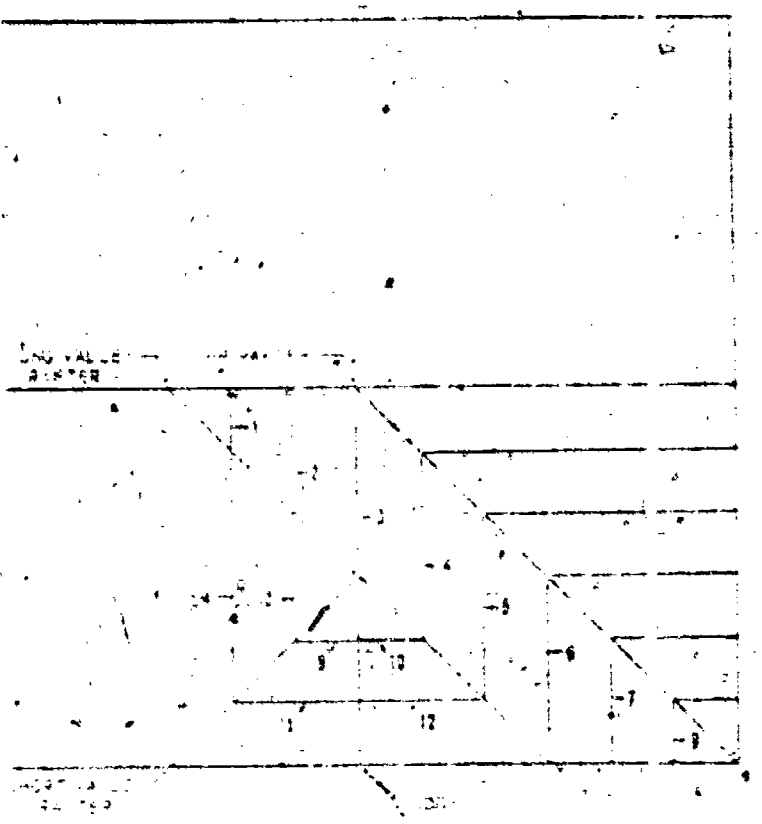

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Figure 11-31.—Jack rafter framing diagram.

the tongue as indicated; make a mark at this point; and draw the cut-off line through this mark from the 12-in. mark.

You figure the lengths of the side-wall studs on a shed dormer as follows: In the roof shown in figure 11-37, a dormer rafter raises 2 1/2 units for every 12 units of run, and a main roof common rafter rises 8 units for every 12 units of run. If the studs were spaced 12 in. O.C., the length of the shortest stud (which is also the COMMON DIFFERENCE of studs) would be the difference between 8 and 2 1/2 in., or 5 1/2 in. This being the case, if the stud spacing is 16 in., the length of the shortest stud is the value of x in the proportional equation 12:5 1/2::16:x, or 7 5/16 in. The shortest stud, then, will be 7 5/16 in. long; the next stud will be 2(7 5/16)in. long, and so on. To get the lower-end cut-off angle for studs you set the square on the stud to the cut of the main roof; to get the upper-end cut-off angle you set it to the cut of the dormer roof.

RAFTER LOCATION LAYOUT

Rafter locations are laid out on plates, ridge and other rafters with the same lines and X's used to lay out stud and joist locations.

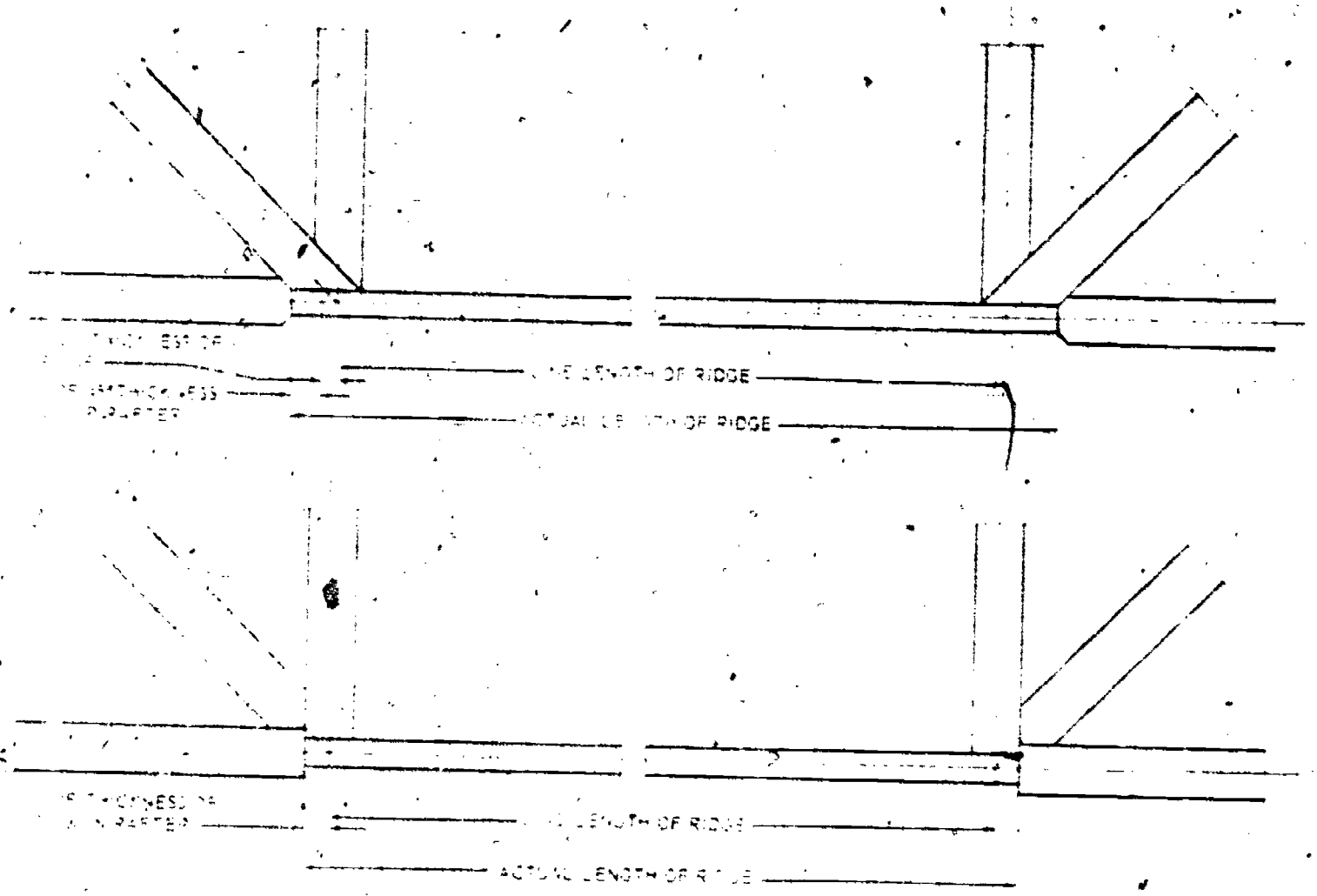

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Figure 11-32.—Line and actual lengths of hip roof ridge.

For a gable roof the rafter locations are laid out on the rafter plates first, and the locations are then transferred to the ridge by matching the ridge against a rafter plate.

The rafter-plate locations of the ridge-end common rafters in an equal-pitch hip roof measure one-half of the span (or the run of a main-roof common rafter) away from the building corners. These locations, plus the rafter-plate locations of the rafters lying between the ridge-end-common rafters, can be transferred to the ridge by matching the ridge against the rafter plates.

The locations of addition ridge and valley rafters can be determined as indicated in figure 11-38. In an equal-span situation (illustrated in parts 1 and 2, fig. 11-38) the valley rafter locations on the main roof ridge lie alongside the addition ridge location. In part 1 of figure 11-38 the distance between the end of the main roof ridge and the addition ridge location is equal to distance A plus distance B, distance B being one-half the span of the addition. In part 2 of figure 11-38 the distance between the line length end of the main roof ridge and the addition ridge location is the same as distance A. In both cases the line length of the addition ridge is equal to one-half the span of the addition plus the length of the addition side-wall rafter plate.

Part 3 of figure 11-38 shows an unequal-span situation. If framing is by the long-and-short valley rafter method, the distance from the end of the main roof ridge to the upper end of the longer valley rafter is equal to distance A plus distance B, distance B being one-half of the span of the main roof. The location of the inboard end of the shorter valley rafter on the longer valley rafter can be determined as follows: first calculate the unit length of the longer valley rafter, or obtain it from the unit-length rafter tables. Let us suppose that

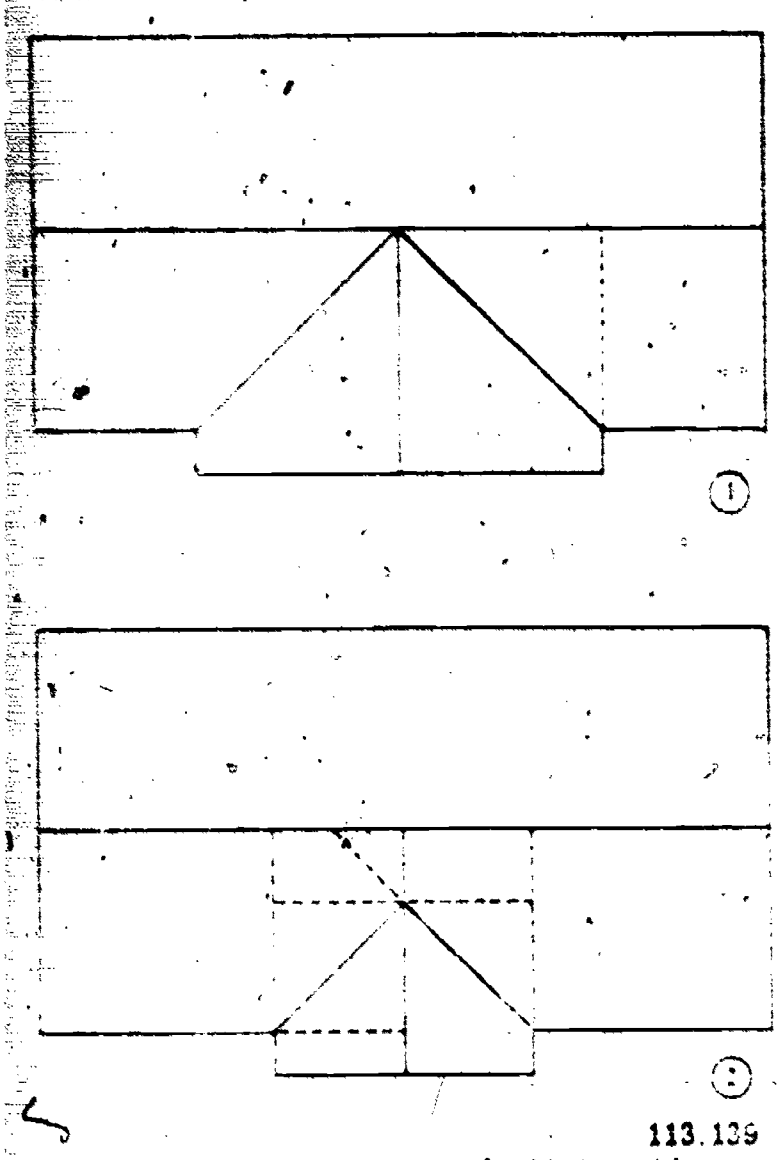

Figure 11-33.—Lengths of addition ridge.

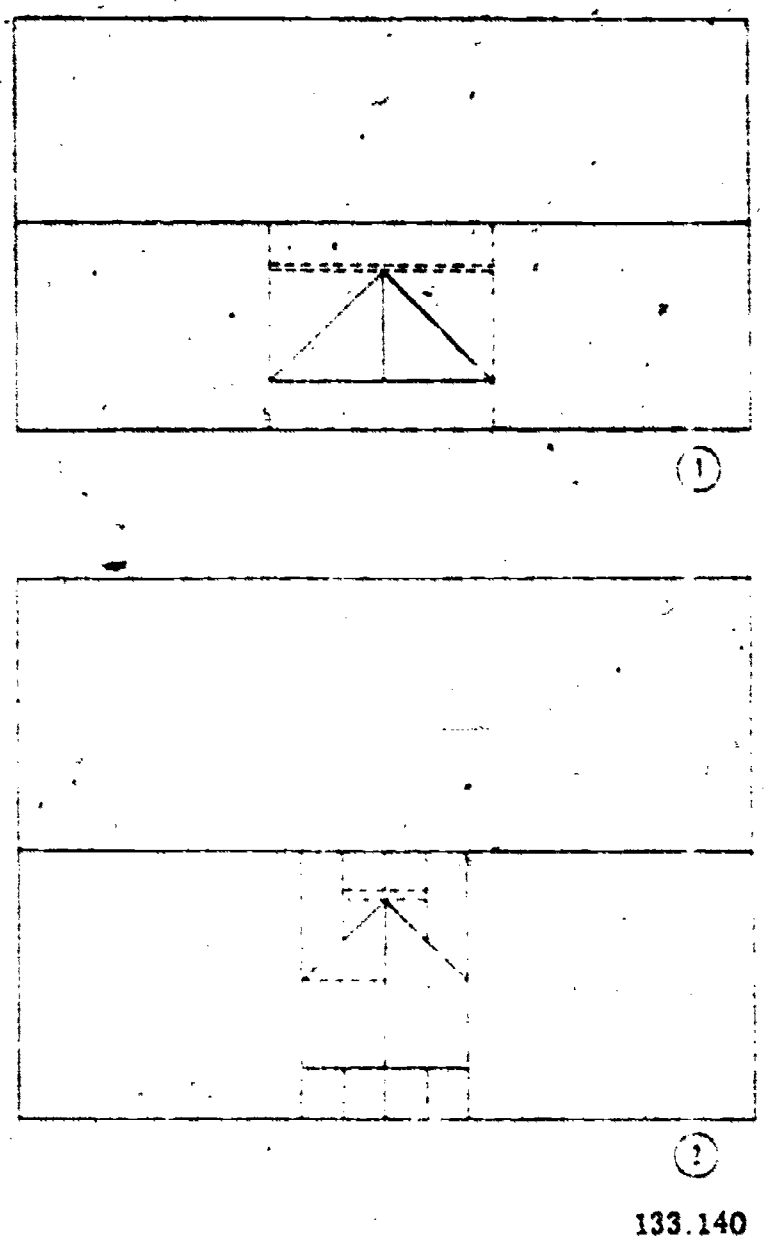

Figure 11-34.—Lengths of dormer ridge.

the common-rafter unit rise is 8; in that case the unit length of a valley rafter is 18.76.

The total run of the longer valley rafter between the point where the shorter rafter ties in and the rafter plate is the hypotenuse of a right triangle with other sides each equal to one-half of the span of the addition. Suppose the addition is 20 ft wide; then the total run in question is the square root of $(10^2 + 10^2)$, or 14.14 ft.

You know that the valley rafter is 18.76 units long for every 16.97 units of run. The length of rafter for 14.14 ft of run must therefore be the value of x in the proportional equation 16.97:18.76::14.14:x, or 15.63 ft. The location mark for the inboard end of the shorter valley rafter on the longer valley rafter, then, will be 15.63 ft, or 15 ft 7 9/16 in., from the heel plumb cut line on the longer valley rafter. The length of the addition ridge will be equal to one-half the span of the addition, plus the length of the addition side-wall rafter plate, minus a shortening allowance equal to one half of the 45° thickness of the longer valley rafter.

If framing is by the suspended-ridge method, the distance between the suspension point on the main roof ridge and the end of the main roof ridge is equal to distance A plus distance C; distance C is one-half of the span of the addition. The distance between the point where the inboard ends of the valley rafters (both short in this method of framing) tie into the addition ridge and the out-board end of the ridge is equal to one-half the span of the addition plus the length of the addition side-wall rafter plate. The length of the addition ridge is equal to one-half of the span of the main roof

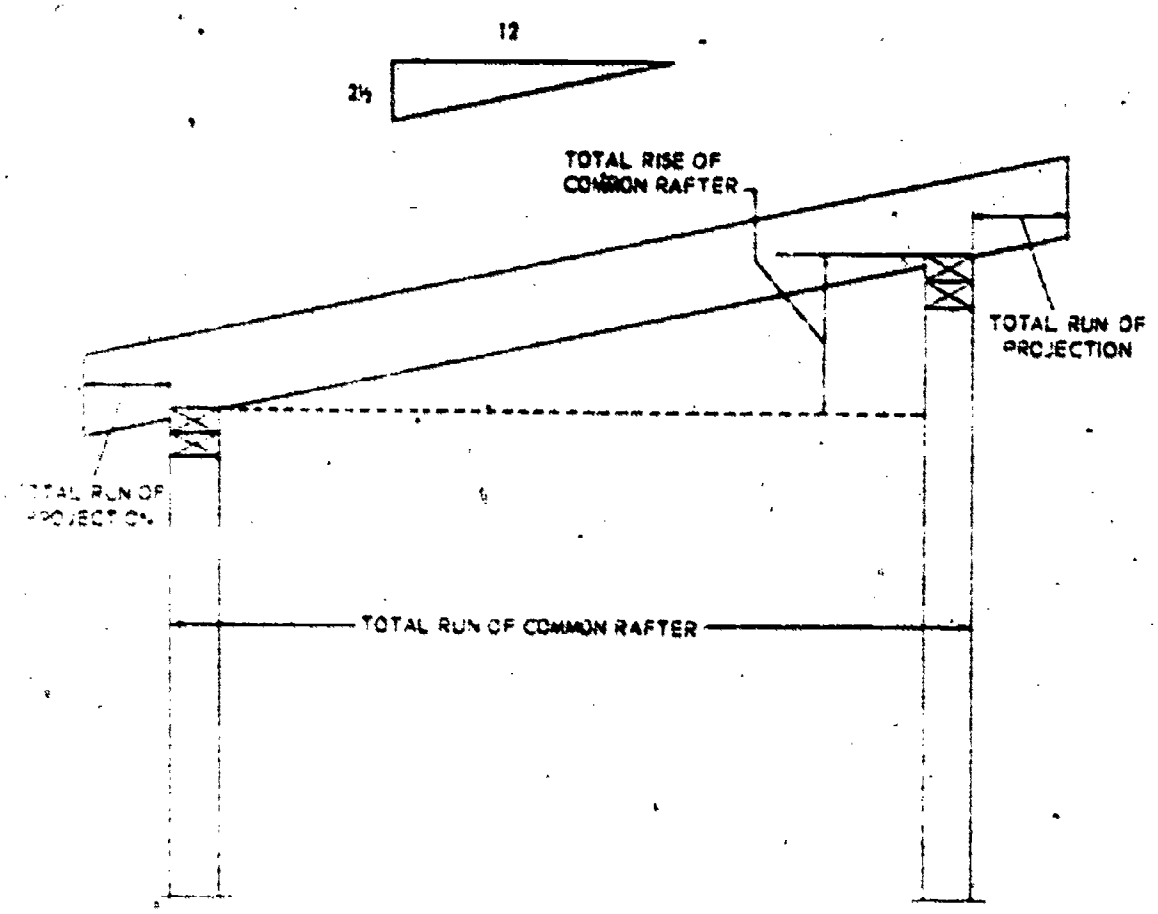

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Figure 11-35.—Shed roof framing.

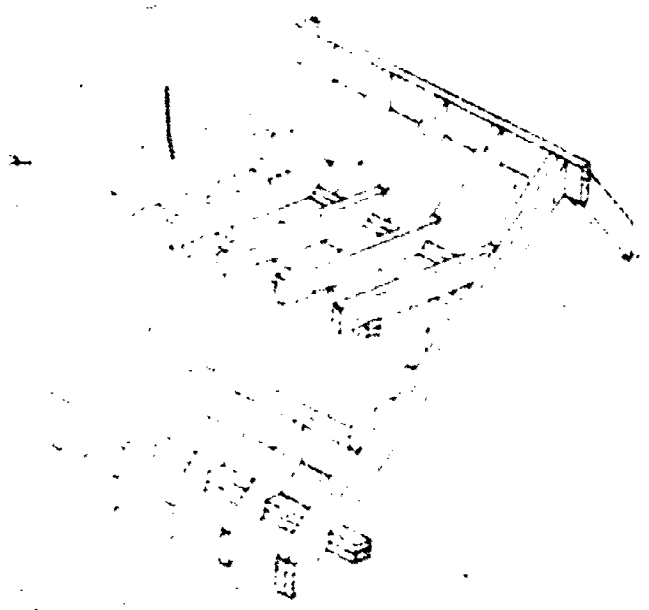

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Figure 11-36.—Method of framing a shed dormer.

plus the length of the addition side wall rafter plate.

COLLAR TIE

Gable or double-pitch roof rafters are often reinforced by horizontal members called collar ties (fig. 11-39). In a finished attic the ties may also function as ceiling joists.

To find the line length of a collar tie divide the amount of drop of the tie in inches by the unit of rise of the common rafter. This will equal one-half the length of the tie in feet. Double the result for actual length. The formula is: Drop in inches x 2 over unit of rise, equals the length in feet.

The length of the collar tie depends on whether the drop is measured to the top edge or bottom edge of the collar tie (fig. 11-39). The tie must fit the slope of the roof. To obtain this angle, use the framing square. Hold

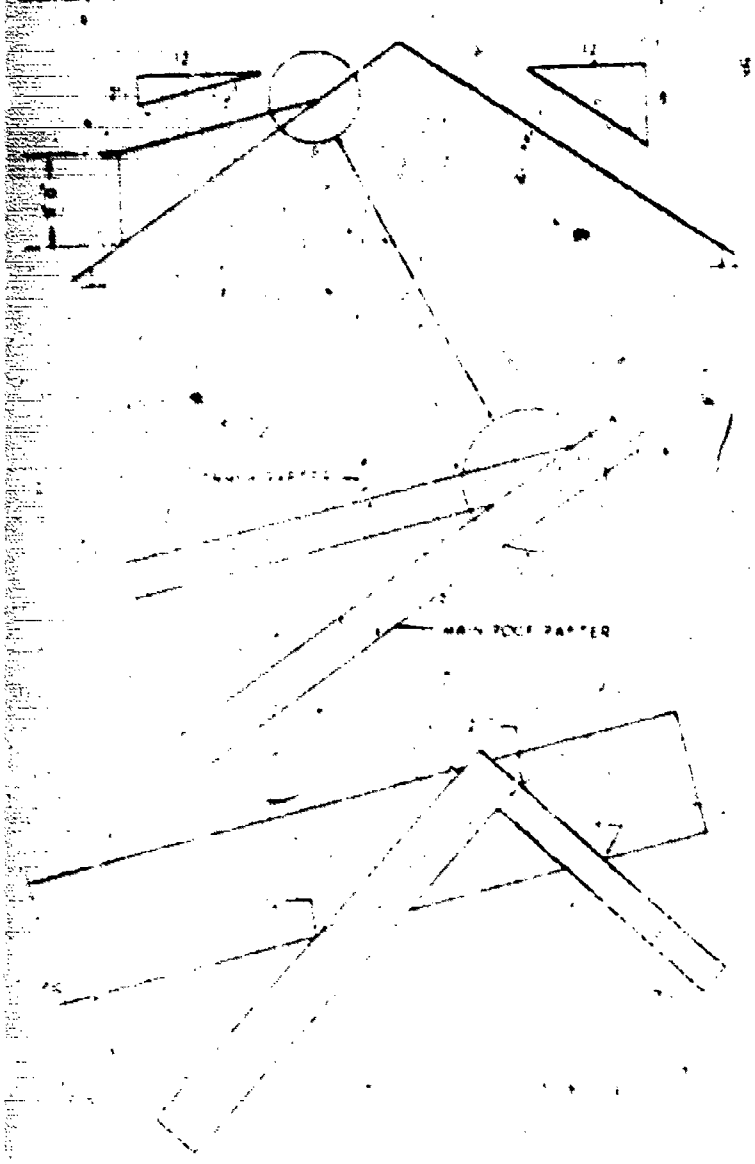

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Figure 11-37.—Shed former framing calculations.

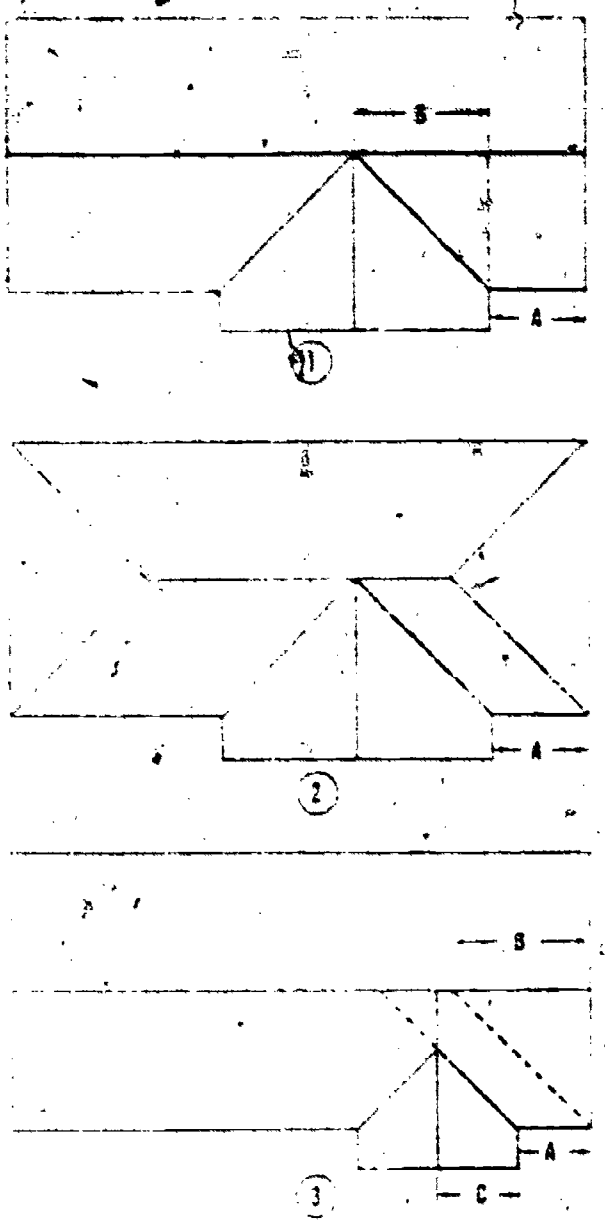

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Figure 11-38.—Intersection ridge and valley rafter location layout.

unit of run and unit of rise of the common rafter. Mark and cut on unit of run side (fig. 11-40).

ROOF TRUSSES

Much modern roof framing is done with ROOF TRUSSES like the one shown in figure 11-41. The principal parts of a truss are the UPPER CHORD (consisting of the rafters), the LOWER CHORD (corresponding to a ceiling joist), and various diagonal and/or vertical bracing and connecting members which are known collectively as the WEB MEMBERS.

The truss shown in figure 11-41 is joined at the corners with plywood GUSSETS. Other methods of corner joining are by metal gussets or by various types of notched joints, reinforced with bolts. Construction information on trusses is usually given in detail drawings.

ROOF FRAMING ERECTION

Roof framing should be done from a scaffold with planking not less than 4 ft below the level of the main roof ridge. The usual type of roof scaffold consists of diagonally braced 2-legged horses, spaced about 10 ft apart and extending the full length of the ridge.

If the building has an addition, as much as possible of the main roof is framed before the addition framing is started. Cripples and jack

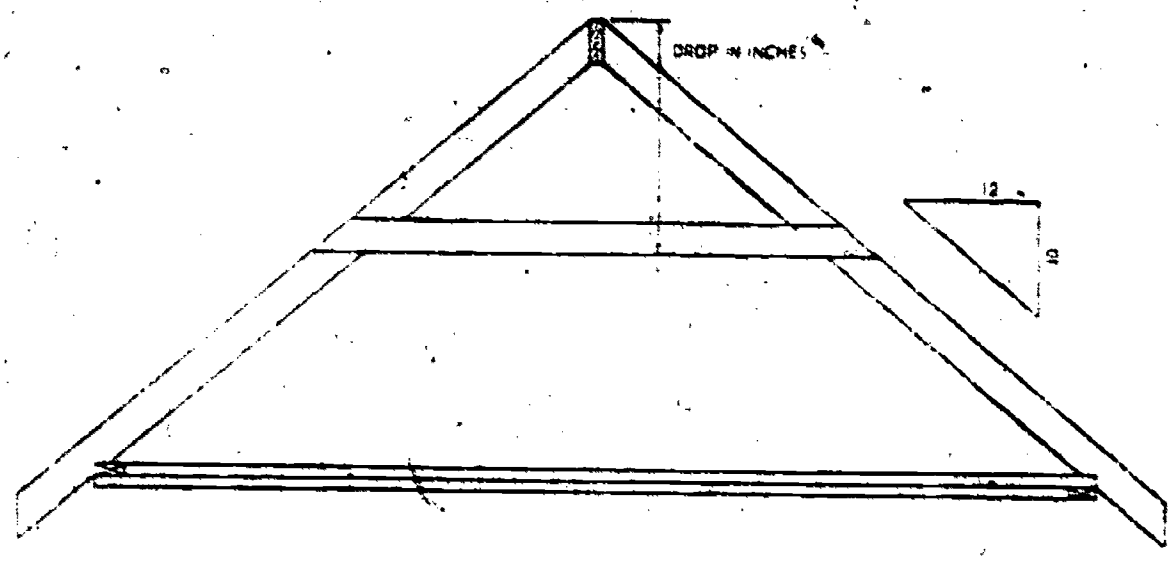

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Figure 11-39.—Calculation for a collar tie.

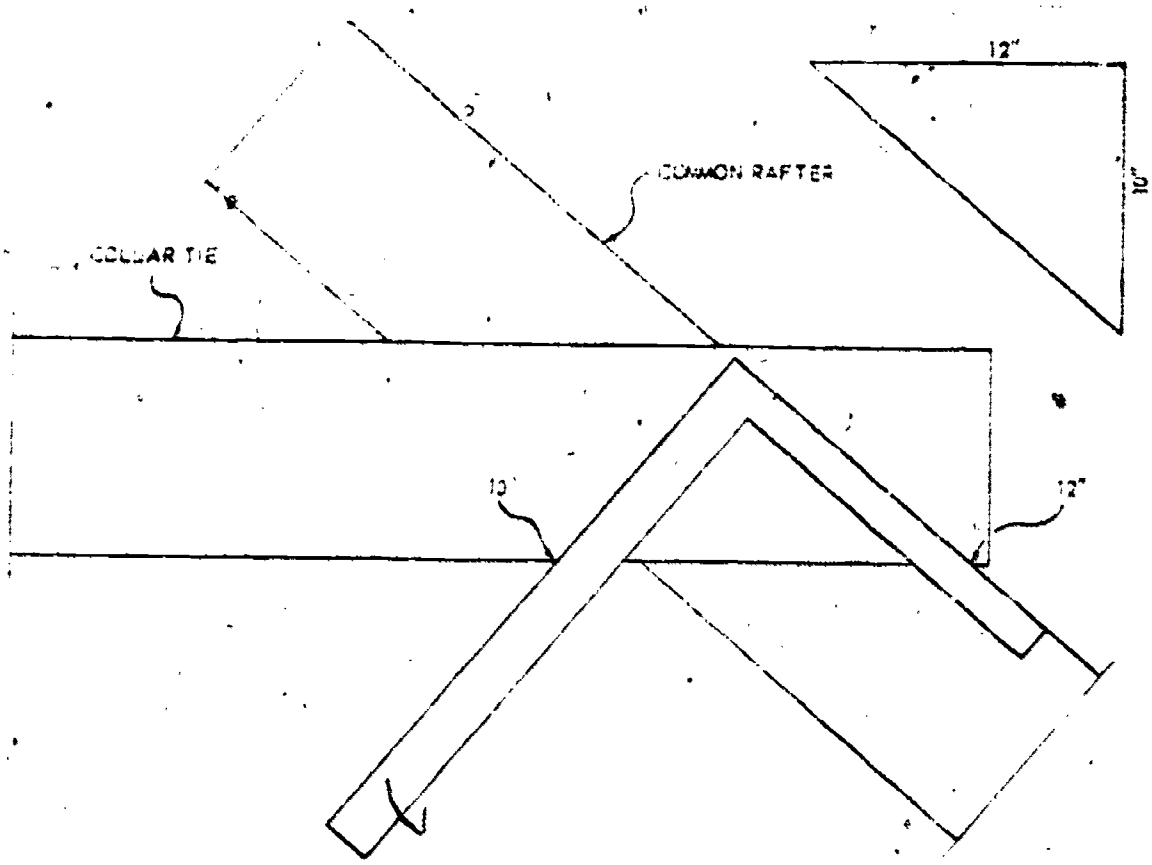

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Figure 11-40.—Laying out end cut on a collar tie.

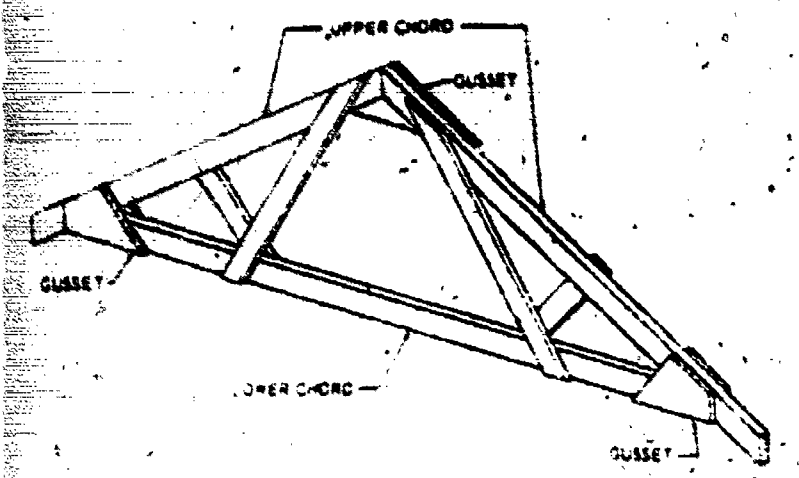

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Figure 11-41.—Typical lightweight roof truss.

rafters are usually left out until after the headers, hip rafters, valley rafters, and ridges to which they will be framed have been installed.

For a gable roof the two pairs of gable-end rafters and the ridge are usually erected first. Two men, one at each end of the scaffold, hold the ridge in position, while a third man sets the gable-end rafters in place and toenails them at the rafter plate with 8-penny nails, one to each side of a rafter. Each man on the scaffold then end-nails the ridge to one of his rafters with two 10-penny nails, driven through the ridge into the end of the rafter; and toenails the other rafter to the ridge and to the first rafter with two 10-penny nails, one on each side of the rafter. Temporary braces like those for a wall should be set up at the ridge ends to hold the rafters approximately plumb, after which the rafters between the end-rafters should be erected. The braces should then be released, and the pair of rafters at one end should be plumbed with a plumb line, fastened to a stick extended from the end of the ridge. The braces should then be reset, and they should be left in place until enough sheathing has been installed to hold the rafters plumb. Collar ties, if any, are nailed to common rafters with 8-penny nails, 2 to each end of a tie. Ceiling-joist ends are nailed to adjacent rafters with 10-penny nails, 2 to each end.

On a hip roof the ridge-end common rafters and ridges are erected first, in about the same manner as for a gable roof, and the intermediate common rafters are then filled in. After that, the ridge-end common rafters extending from the ridge ends to the mid-points on the end walls are erected. The hip rafters and hip jacks are installed next. The common rafters in a hip roof do not require plumbing; if the hip rafters are correctly cut, installing the hip rafters will bring the common rafters plumb. Hip rafters are toenailed to plate corners with 16-penny nails, 2 to each side. Hip jacks are toenailed to hip rafters with 10-penny nails, 3 to each jack.

For an addition or dormer the valley rafters are usually erected first. Valley rafters are toenailed to plates with 16-penny nails, 2 to each side, and to ridge pieces and headers with three 10-penny nails. Ridges and ridge-end common rafters are erected next, other addition common rafters next, and valley and cripple jacks last. A valley jack should be held in position for nailing as shown in figure 11-42. When properly nailed, the end of a straightedge laid along the top edge of the jack should contact the center line of the valley rafter as shown.

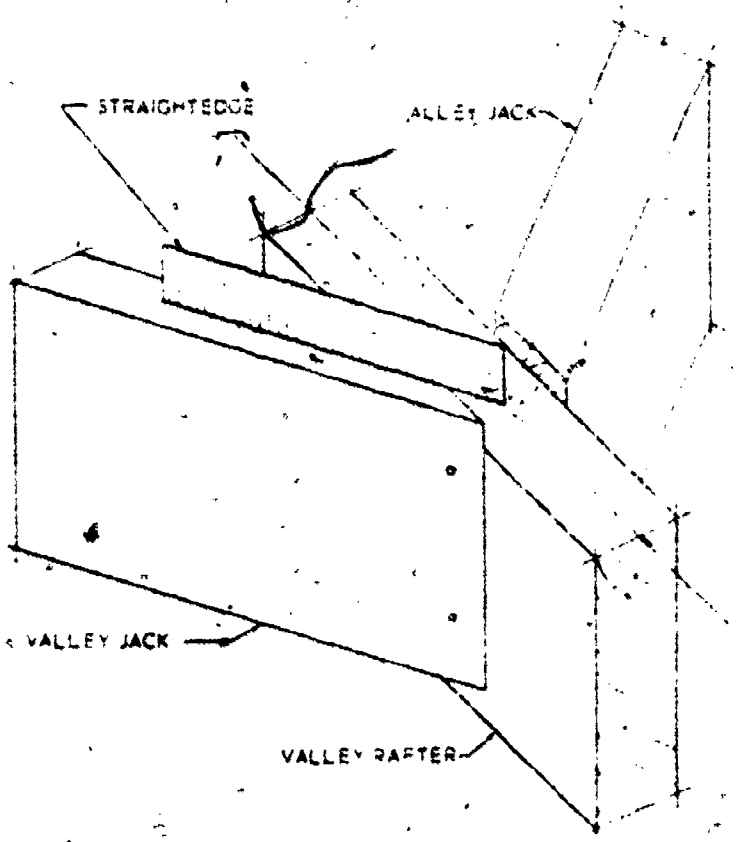

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Figure 11-42.—Correct position for nailing a valley jack rafter.

ROOF SHEATHING

The lower layer of roof covering is called the ROOF SHEATHING; the upper layer is called the ROOF COVERING or the ROOFING. The roof sheathing, like the wall sheathing and the subflooring, is a structural element and therefore a part of the framing. The roof covering or roofing is a part of the exterior finish. Roof sheathing, like wall sheathing and subflooring, may be laid either horizontally or diagonally. Horizontal sheathing may be either CLOSED sheathing (laid with no spaces between courses) or OPEN sheathing (laid with spaces between courses). Open sheathing is used for the most part only when the roof covering is to consist of wooden shingles. Closed sheathing is usually nominal 8-in. in width; it may consist of square-edged boards but may be dressed-and-matched or shiplap. Open sheathing usually consists of 1 x 3 or 1 x 4 strips, with spacing O.C. equal to the specified exposure of shingles TO THE WEATHER. An 18-in. shingle which is lapped 12 in. by the shingle above it is said to be laid 6 in. to the weather.

Sheathing should be nailed with two 8-penny nails to each rafter crossing. End-joint requirements are the same as those previously described for wall sheathing. The sheathing ends should be sawed flush with the outer face of the end-wall sheathing, unless a projection of the roof sheathing over the end-walls is called for. If such a projection is needed, projecting sheathing boards must be long enough to span at least 3 rafter spaces.

Plywood, usually in 8-ft x 4-ft sheets, laid horizontally, is frequently used for roof sheathing. Nailing requirements are the same as those previously described for 8-ft x 4-ft sheets of plywood wall sheathing.

CHAPTER 13

INTERIOR FINISH

The interior finish consists mainly of the finish covering applied to the rough walls, ceilings, and floors. Other major interior finish items are the inside door frames, the doors, the window sash, and the stairs.

Interior-finish items whose function is principally ornamental are classified under the general heading of INTERIOR TRIM. Interior trim includes inside door and window casings, window stools and aprons, baseboards, and molding trim.

The usual order of construction for the interior finish is as follows:

1. Ceiling covering
2. Wall covering
3. Stairs
4. Window sash
5. Window inside casings, stools, and aprons
6. Finish flooring
7. Inside door frames and casings
8. Baseboards
9. Molding trim.

WALL AND CEILING COVERING

The two major types of wall and ceiling covering are PLASTER and DRY-WALL COVERING. Dry-wall covering is a general term applied to sheets or panels of wood, plywood, fiberboard, and the like.

PLASTER

A PLASTER wall and/or ceiling covering requires the construction of a PLASTER BASE, or surface on which the plaster can be spread and to which it will adhere. A surface of this kind was formerly constructed by nailing wooden LATHS (thin, narrow strips usually 48 in. long) to the edges of studs and joists, or to wooden FURRING STRIPS anchored to concrete or masonry walls. In modern construction, wooden lath has been almost entirely superseded by GYPSUM lath, FIBERBOARD lath and METAL lath.

Gypsum lath usually consists of 16 in. by 48 in. sheets of GYPSUM BOARD, either solid or perforated and usually squared-edged. It is applied horizontally to studs and at right angles to joists, and nailed to studs, joists, or furring strips, with 1 1/8-in. flat-headed GYPSUM-LATH NAILS, 5 to each stud, joist or strip crossing.

Fiberboard lath consists of sheets of fiberboard, also usually 16 in. by 48 in. in size. It may be either square-edged or shiplap edged. It is applied in much the same manner as gypsum lath, except that 1 1/4-in. blued FIBERBOARD-LATH NAILS are used.

Metal lath consists of screen-like sheets of MESHED or RIBBED metal, usually 27 in. by 96 in. in size. To walls it is applied horizontally; to ceilings with the long dimension perpendicular to the line of the joists. It may be nailed to studs or to furring strips with regular metal-lath STAPLES, or with 8-penny nails driven part-way in and then hammered over. It may be similarly nailed to ceiling joists, or it may be tied up with wire ties to nails driven through the joists about 2 in. above the lower edges.

Before lath is applied to walls and ceilings, PLASTER GROUNDS are installed as called for in the working drawings. Plaster grounds are wood strips of the same thickness as the combined thickness of the lath and plaster. They are nailed to the framing members around doors and windows and to the studs along floor lines. They serve as a guide to the plasterers, to ensure that the plaster behind door casings, window casings, and baseboards will be of uniform and correct thickness. They also serve as nailing bases for the trim members mentioned.

Plastering is usually done in three coats, which form a combined thickness of about 5/8 in. The first coat is called the SCRATCH coat, because it is usually scored when partially set to improve the adhesion of the second coat. The second coat is called the BROWN coat, and the third the WHITE (also the SKIM or FINISH) coat. As gypsum or fiberboard lath provides the equivalent of a scratch coat, only the brown and finish coats of plaster are applied when these types of lath are used.

The basic ingredients for scratch-coat and brown-coat plaster are lime and sand. Proportions vary, but a scratch coat usually has about 1 part of lime to 2 parts of sand, by volume. The proportion of lime to sand in a brown coat is slightly smaller.

Plaster for an ordinary white coat usually consists of lime putty mixed with plaster-of-paris; a little marble dust may be included. Plaster for a high grade finish coat contains calcium sulphate instead of lime. KEENE'S CEMENT is a well-known variety of calcium sulphate finish plaster. A very superior hard-finish coat can be obtained by mixing 4 parts of Keene's cement with 1 part of lime putty.

Manufacturers of plaster usually furnish instruction sheets which set forth the recommended ingredient proportions and methods of application for their products. Follow these instructions closely. The actual application of plaster, especially to ceilings, is a skill which can be acquired only through practice. Additional information on plaster work may be found in chapter 14.

DRY-WALL FINISH

DRY-WALL FINISH is a general term applied to sheets or panels of various materials used for inside-wall and ceiling covering. The most common dry-wall finishes are GYPSUM-BOARD, PLYWOOD, FIBERBOARD, and WOOD.

Gypsum Board

Gypsum board usually comes in a standard size of 4' by 8'. However, on notice it can be obtained in any length up to 16 ft. It can be applied to walls, either vertically or horizontally. A 4-ft wide sheet applied vertically to studs 16 in. O.C. will cover 3 stud spaces. Fivepenny cement-coated nails should be used with 1/2-in.-thick gypsum, 4-penny nails with 3/8-in.-thick gypsum. Nails should be spaced 6 to 8 in. O.C. for walls and 5 to 7 in. O.C. for ceilings.

Nail heads should be driven about one-sixteenth inch below the face of the board; this set can be obtained by using a crowned hammer. The indentations around nails away from edges are concealed by applying JOINT CEMENT. The nail indentations along edges are concealed with a perforated fiber JOINT TAPE set in joint cement. Edges are slightly recessed to bring the tape flush with the faces. Besides concealing the nail indentations, the tape also conceals the joint.

The procedure for taping a joint is as follows:

1. Spread the joint cement along the joint with a 4- to 6-in. putty knife. Joint cement comes in powder form; the powder is mixed with water to about the consistency of putty.
2. Lay the tape against the joint and press it into the recess with the putty knife. Press until some of the joint cement is forced out through the holes in the tape.
3. Spread joint cement over the tape, and FEATHER (taper off) the outer edges.
4. Allow the cement to dry, then sand lightly. Apply a second coat, and again feather the edges.
5. Allow the cement to dry, and then sand the joint smooth.

For nail indentations away from edges, fill the indentations with cement, allow the cement to dry, and sand lightly. Apply another coat, allow to dry, and sand smooth.

Plywood

Plywood finish comes in sheets of various sizes which can be applied either vertically or horizontally. With horizontal application, lengths of stud stock called NAILERS are framed between the studs along the lines of horizontal joints. Panels can be nailed directly to studs and nailers, but a better method is to nail 2-in. furring strips to the studs and nailers and then glue and nail the panels to the strips. This method reduces joint movements caused by swelling or shrinking of the studs and nailers.

Joints between plywood panels can be finished in a variety of ways. For a tight butt joint, spread enough glue on the furring strip, stud, or nailer to provide a SQUEEZE of glue between the edges, allow the glue to dry, and then block-sand the joint smooth. Another smooth joint can be obtained by rabbeting the edges for shiplap.

Edges of panels can be smoothed and the joints left open for ornamental effect; or the edges can be beveled to form a V-groove joint when brought together; or joints can be left open and then filled with glued-in wooden splines. Outside corners between panels can be miter-joined, or the right angle between square edges at outside corners can be filled with quarter-round molding. Inside corners can be butted or mitered.

One-half inch plywood finish is nailed on with 1 1/4 in. finish nails spaced 6 in. O.C.

Fiberboard

Fiberboard wall finish comes in 2 ft by 8 ft sheets which are applied horizontally. The long edges are usually rabbeted or tongue-and-grooved for joining. Fiberboard is nailed in place with finish nails, brads, or cadmium plated fiberboard nails. Use 1 1/2-nails for 1/2-inch thick boards and 2-inch nails for 1-inch thick boards.

Fiberboard in small squares or rectangles is called TILEBOARD and each piece of tileboard is called a TILE. Common sizes are 12 inches by 12 inches, 12 inches by 24 inches, 16 inches by 16 inches, and 16 inches by 32 inches. Tiles can be nailed to studs, joists, and furring strips; usually, however, they are glued to a continuous surface of wood or plasterboard with a special type of adhesive.

STAIRS

There are many different kinds of stairs, but all have two main parts in common: the TREADS people walk on, and the STRINGERS (also called STRINGS, HORSES, and CARRIAGES) which support the treads. A very simple type of stairway, consisting only of stringers and treads, is shown in the left-hand view of figure 13-1. Treads of the type shown here are called PLANK treads, and this simple type of stairway is called a CLEAT stairway, because of the cleats attached to the stringers to support the treads.

A more finished type of stairway has the treads mounted on two or more sawtooth-edged stringers, and includes RISERS, as shown in the right-hand view of figure 13-1. The stringers

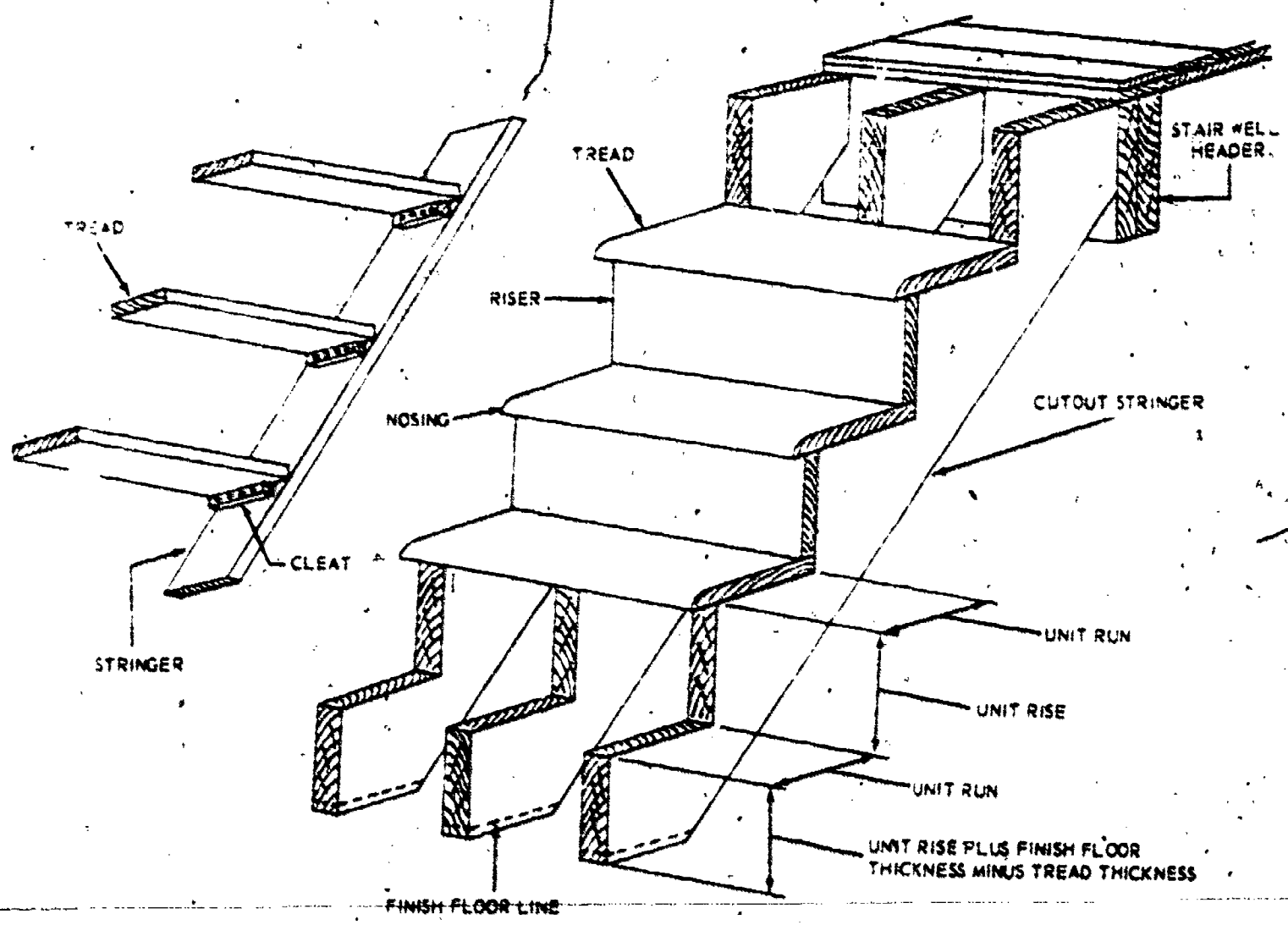

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Figure 13-1.—Stairway nomenclature.

shown here are cut out of solid pieces of dimension lumber (usually 2 x 12), and are therefore called CUTOUT or SAWED stringers.

STAIRWAY LAYOUT

The first step in stairway layout is to determine the UNIT RISE and UNIT RUN shown in figure 13-1. The unit rise is calculated on the basis of the TOTAL RISE of the stairway, and the fact that the customary permissible unit rise for stairs is in the vicinity of 7 inches.

The total rise is the vertical distance between the lower finish floor level and the upper finish floor level. This may be shown in the elevations; however, since the actual vertical distance as constructed may vary slightly from what it should have been, and since it is the actual distance you are dealing with, the distance should be measured.

At the time the stairs are to be laid out, the subflooring is laid but the finish flooring isn't. If both the lower and the upper floor are to be covered with finish flooring of the same thickness, the measured vertical distance from lower subfloor surface to the upper subfloor surface will be the same as the eventual distance between the finish floor surfaces, and therefore equal to the total rise of the stairway. But if you are measuring up from a finish floor (such as a concrete basement floor, for instance), then you must add to the measured distance the thickness of the upper finish flooring to get the total rise of the stairway. If the upper and lower finish floors will be of different thicknesses, then you must add the difference in thickness to the measured distance between subfloor surfaces to get the total rise of the stairway. Use a straight piece of lumber plumbed in the stair opening with a spirit level, or a plumb bob and cord, to measure the vertical distance.

Assume that the total rise measures 8 ft 11 in., as shown in figure 13-2. Knowing this, you can determine the unit rise as follows. First, reduce the total rise to inches—in this case it comes to 107 in. Next, divide the total rise in inches by the average permissible unit rise, which is 7 in. The result, disregarding any fraction, is the number of RISERS the stairway will have—in this case it is 107/7, or 15. Now divide the total rise in inches by the number of risers—in this case, this is 107/15, which comes to 7.13 in., or, rounded off to the nearest 1/16 in., 7 1/8 in. This, then, is the unit rise, as shown in figure 13-2.

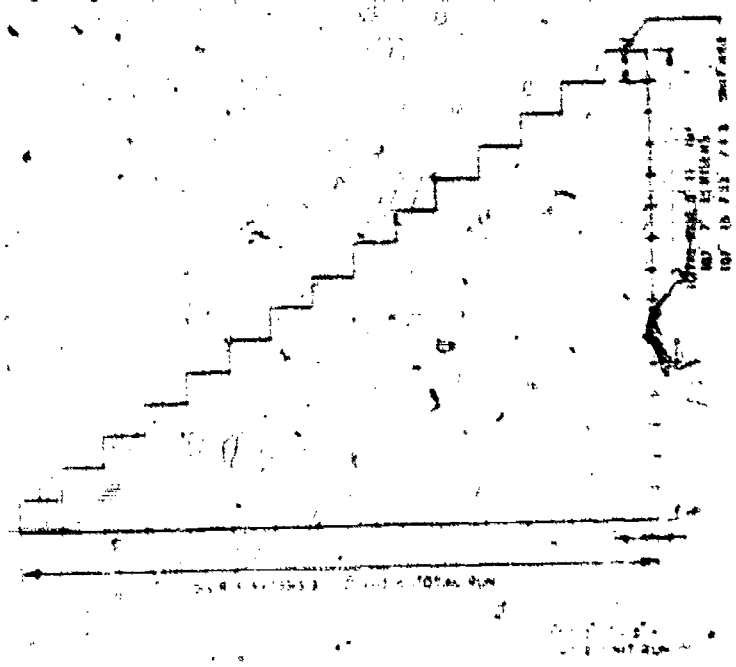

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Figure 13-2.—Stairway layout computations.

The unit run is calculated on the basis of (1) the unit rise, and (2) a general architects' rule that the sum of the unit run and unit rise should be 17 1/2 in. In view of (2), if the unit rise is 7 1/8 in., the unit run is 17 1/2 in. minus 7 1/8 in., or 10 3/8 in.

You can now calculate the TOTAL RUN of the stairway. The total run is obviously equal to the product of the unit run times the total number of treads in the stairway. However, the total number of treads depends upon the manner in which the upper end of the stairway will be anchored to the header.

In figure 13-3, three methods of anchoring the upper end of a stairway are shown. In the first view there is a complete tread at the top of the stairway. This means that the number of complete treads will be the same as the number of risers. For the stairway shown in figure 13-1, there are 15 risers and 15 complete treads. Therefore, the total run of the stairway will be the product of the unit run times 15, or 10 3/8 in. x 15, or 155 5/8", or 12 ft 11 5/8 in., as shown.

In figure 13-3, second view, there is only part of a tread at the top of the stairway. If this method were used for the stairway shown in figure 13-2, the number of complete treads would be ONE LESS than the number of risers, or 14. The total run of the stairway would be the product of 14 x 10 3/8, PLUS THE RUN OF

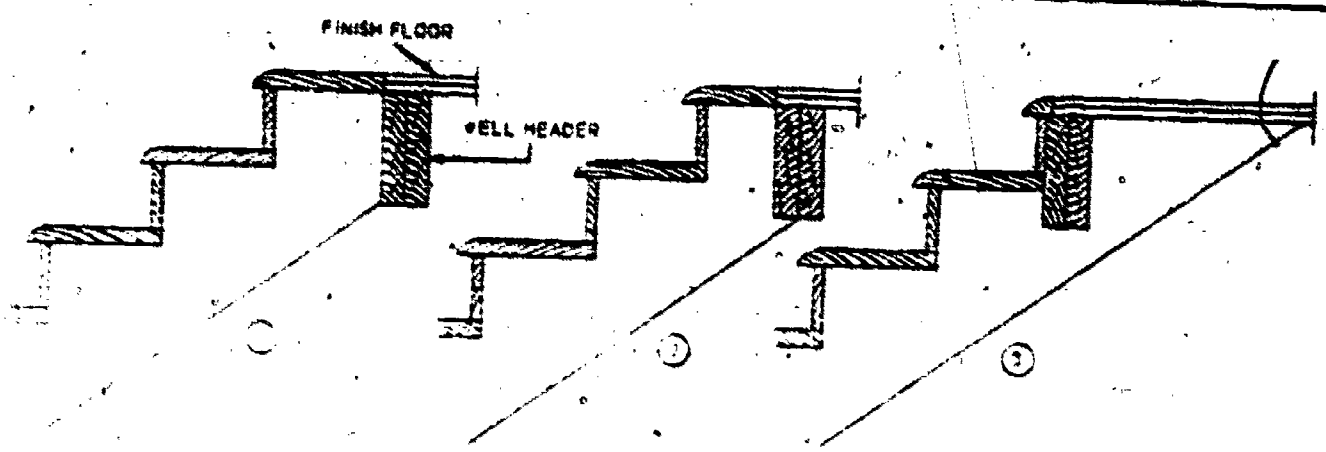

Figure 13-3.—Three methods of anchoring upper end of a stairway. 45.508

THE PARTIAL TREAD AT THE TOP. Suppose this run were 7 inches. Then the total run would be 14 x 10 3/8 + 7, or 152 1/4 in., or 12 ft 8 1/4 in.

In figure 13-3, third view, there is no tread at all at the top of the stairway; the upper finish flooring serves as the top tread. In this case the total number of complete treads is again 14, but since there is no additional partial tread, the total run of the stairway is 14 x 10 3/8, or 145 1/4 in., or 12 ft 1 1/4 in.

When you have calculated the total run of the stairway, drop a plumb bob from the well head to the floor below and measure off the total run from the plumb bob. This locates the anchoring point for the lower end of the stairway.

Cutout stringers for main stairways are usually made from 2 x 12 stock. The first question is: About how long a piece of stock will you need? Let's assume that you are to use the method of upper-end anchorage shown in the first view of figure 13-3 to lay out a stringer for the stairway shown in figure 13-2. This stairway has a total rise of 8 ft 11 in. and a total run of 12 ft 11 5/8 in. The stringer must be long enough to form the hypotenuse of a triangle with sides of those two lengths. For an approximate length estimate, call the sides 9 and 13 ft long. The length of the hypotenuse, then, will equal the square root of $9^2 + 13^2$, or the square root of 250, or about 15.8 ft, or about 15 ft 9 1/2 in.

Figure 13-4 shows the layout at the lower end of the stringer. Set the framing square to the unit run on the tongue and the unit rise on the blade, and draw the line AB. This line represents the bottom tread. Then draw AD perpendicular to AB, in length equal to the unit rise. This line represents the bottom riser in the stairway. Now, you've probably noticed that, up to this point, the thickness of a tread in the stairway has been ignored. This thickness is now about to be accounted for, by making an allowance in the height of this first riser, a process which is called DROPPING THE STRINGER.

As you can see in figure 13-1, the unit rise is measured from the top of one tread to the top of the next for ALL RISERS EXCEPT THE BOTTOM ONE. For this one, the unit rise is measured FROM THE FINISHED FLOOR SURFACE TO THE SURFACE OF THE FIRST TREAD. If AD were cut to the unit rise, the actual rise of the first step would be the sum of the unit rise plus the thickness of a tread. Therefore, the length of AD is shortened by the thickness of a tread, as shown in figure 13-4—or by the thickness of a tread less the thickness of the finish flooring. The first is done if the stringer will rest on a finish floor, such as concrete basement floor. The second is done if the stringer will rest on subflooring.

When you have shortened AD to AE, as shown, draw EF parallel to AB. This line represents the bottom horizontal anchor-edge of the stringer. Then proceed to lay off the remaining risers and treads to the unit rise and unit run, until you have laid off 15 risers and 15 treads. Figure 13-5 shows the layout at the upper end of the stringer. The line AB represents the top—that is, the 15th—tread. BC, drawn perpendicular to AB, represents the upper vertical anchor-edge of the stringer, which will butt against the stairwell header.

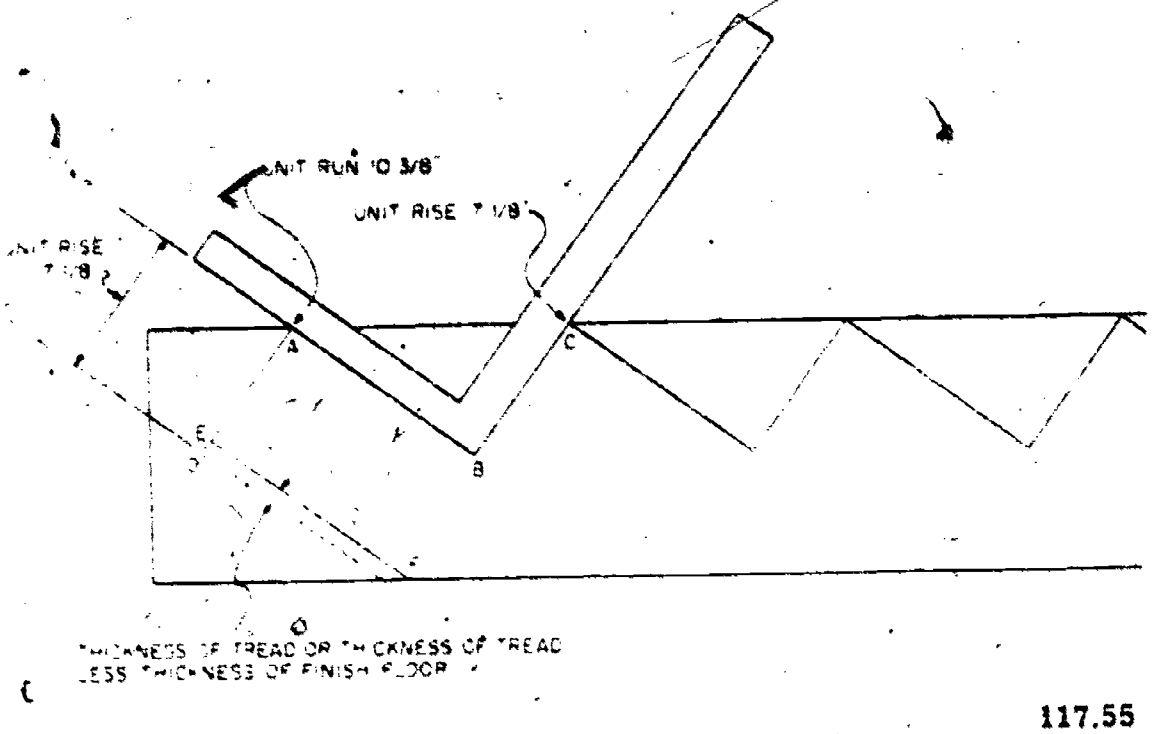

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Figure 13-4.—Layout of lower end of cutout stringer.

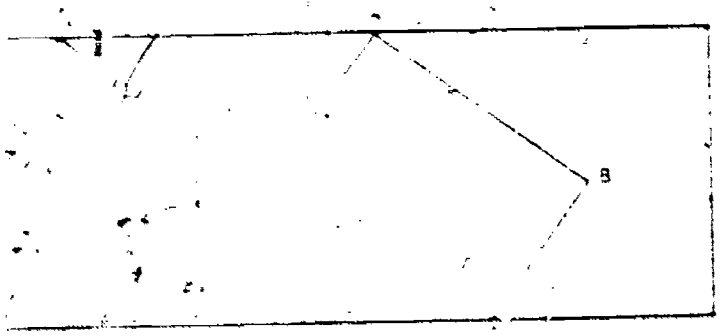

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Figure 13-5.—Layout at upper end of cutout stringer.

STAIRWAY CONSTRUCTION

We have been dealing with a common STRAIGHT-FLIGHT stairway, meaning one which follows the same direction throughout. When floor space is not extensive enough to permit construction of a straight-flight stairway, a CHANGE stairway is installed—meaning, one which changes direction one or more times. The most common types of these are 90-DEGREE change and 180-DEGREE change. These are usually PLATFORM stairways—that is, successive straight-flight lengths, connecting platforms at which the direction changes 90 degrees, or doubles back 180 degrees. Such a stairway is laid out simply as a succession of straight-flight stairways.

The stairs in a structure are broadly divided into PRINCIPAL stairs and SERVICE stairs. Service stairs are porch, basement, and attic stairs. Some of these may be simple cleat stairways; others may be OPEN-RISER stairways. An open-riser stairway has treads anchored on cut-out stringers or stair-block stringers, but no risers. The lower ends of the stringers on porch, basement, and other stairs anchored on concrete are fastened with a KICK-PLATE like the one shown in figure 13-6.

A principal stairway is usually more finished in appearance. Rough cutout stringers are concealed by FINISH stringers like the one shown in figure 13-7. Treads and risers are often rabbet-joined as shown in figure 13-8. To prevent squeaking, triangular blocks may be glued into the joints as shown in the same figure.

The vertical members which support a stairway handrail are called BALUSTERS. Figure 13-9 shows a method of joining balusters to treads. For this method, dowels shaped on the lower ends of the balusters are glued into holes bored in the treads.

Stringers should be toenailed to well headers with 10-penny nails, three to each side of the stringer. Those which face against trimmer joists should be nailed to the joist with at least three 16-penny nails apiece. At the bottom a

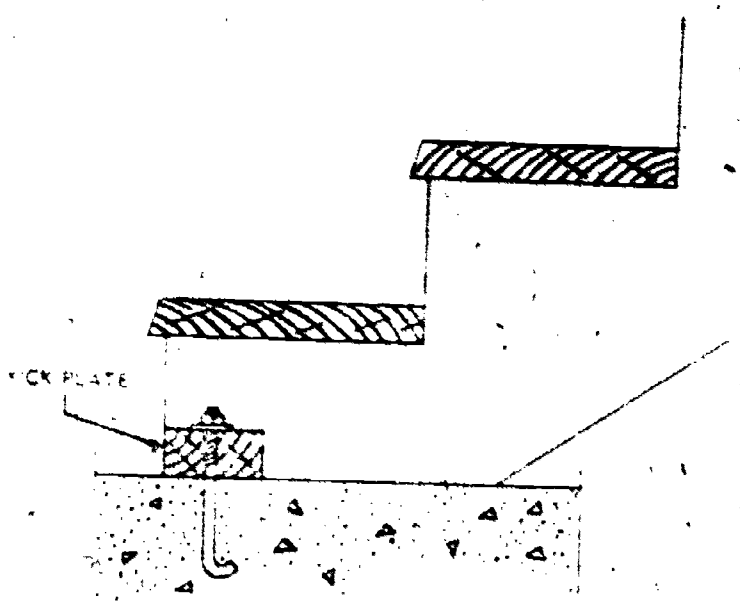

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Figure 13-6.—Kick-plate for anchoring stairs to concrete.

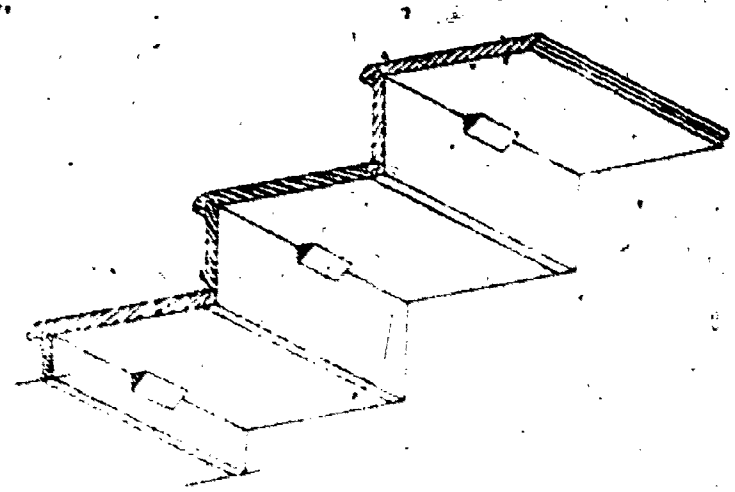

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Figure 13-8.—Rabbet-joined treads and risers.

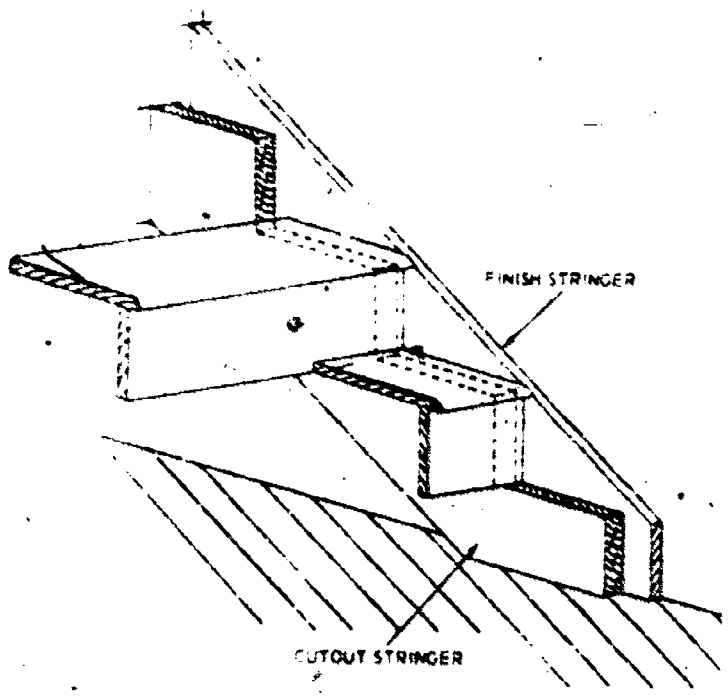

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Figure 13-7.—Finish stringer.

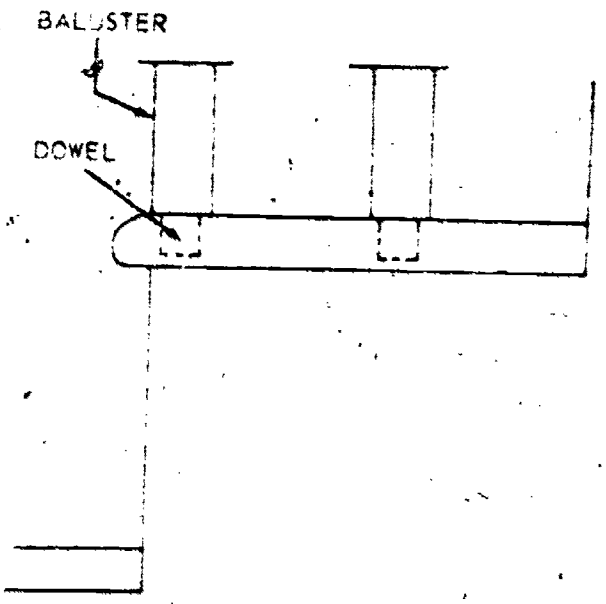

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Figure 13-9.—One method of joining a baluster to the tread.

stringer should be toenailed with 10-penny nails, 4 to each side, driven into the subflooring and if possible into a joist below.

Treads and risers should be nailed to stringers with 6-penny, 8-penny, or 10-penny finish nails, depending on the thickness of the stock.

WINDOW SASH

A window frame is built to the dimensions of the window, as given on the window schedule. To prevent the sash from binding in the frame, it is necessary to apply a CLEARANCE ALLOWANCE when laying out the sash. Sash for a double-hung window is made 1/8 in. narrower and 1/16 in. shorter than the finished opening size; sash for wooden casements is made 1/8 in. narrower and 1/32 in. shorter than the opening size. Wooden sash is usually made from 1 3/8-in.-thick stock.

INSTALLING WINDOW SASH

Casement sash is hung in about the same manner that a door is hung.

Double-hung sash consists of an upper and a lower sash, each of which can be slid up and down in a separate vertical runway. The upper sash slides in the outer runway, the lower sash in the inner runway. The inner side of the outer runway is formed by the parting stop, the outer side by the blind stop, or by a SIDE STOP nailed to the faces of the jambs. The outer side of the inner runway is formed by the parting stop, the inner side by a side stop nailed to the faces of the side jambs. All this is shown in figures 13-10 and 13-11.

The weight of a double-hung sash may be counterbalanced by a couple of SASH WEIGHTS,

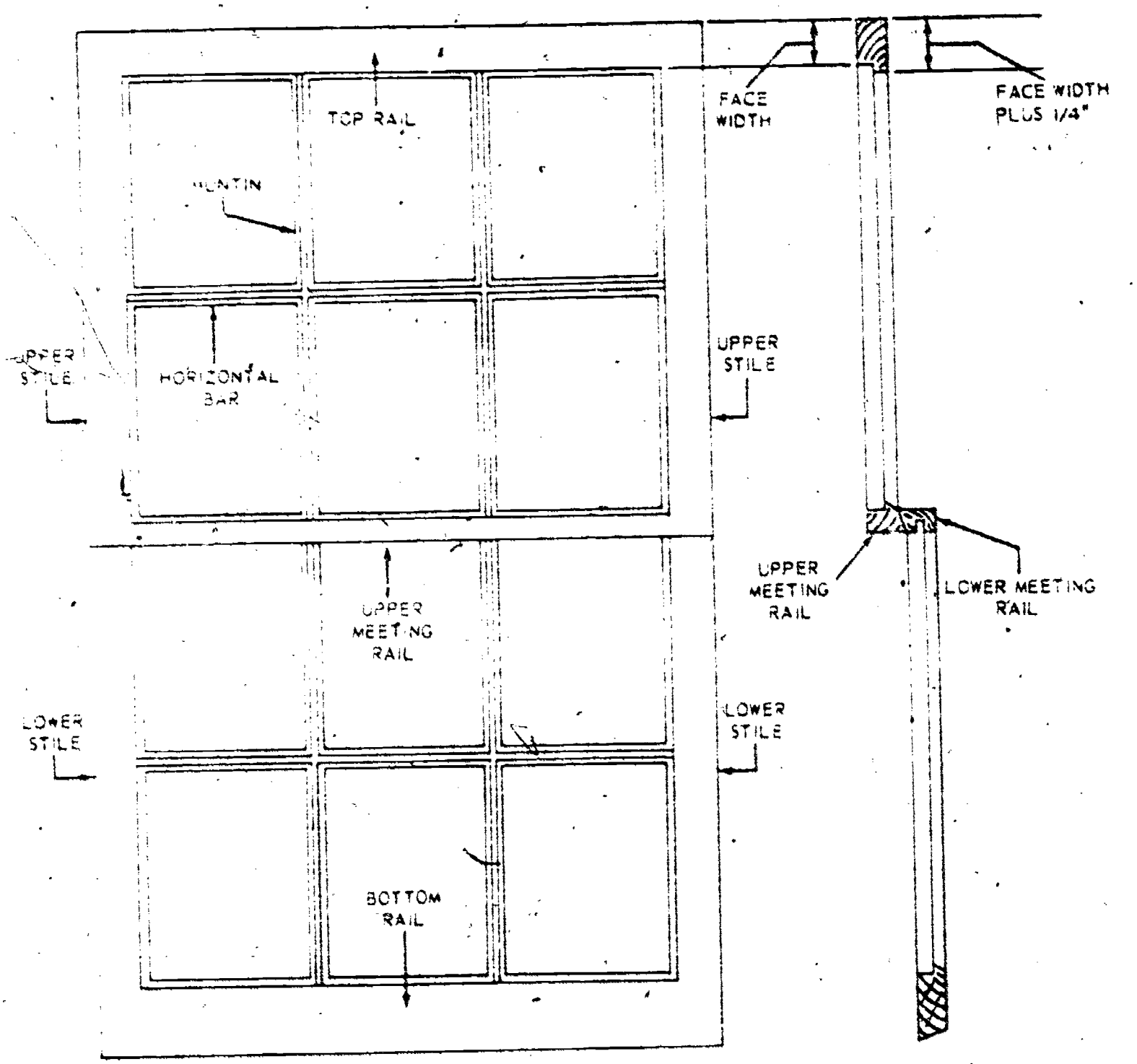

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Figure 13-10.—Parts of a double-hung window sash.

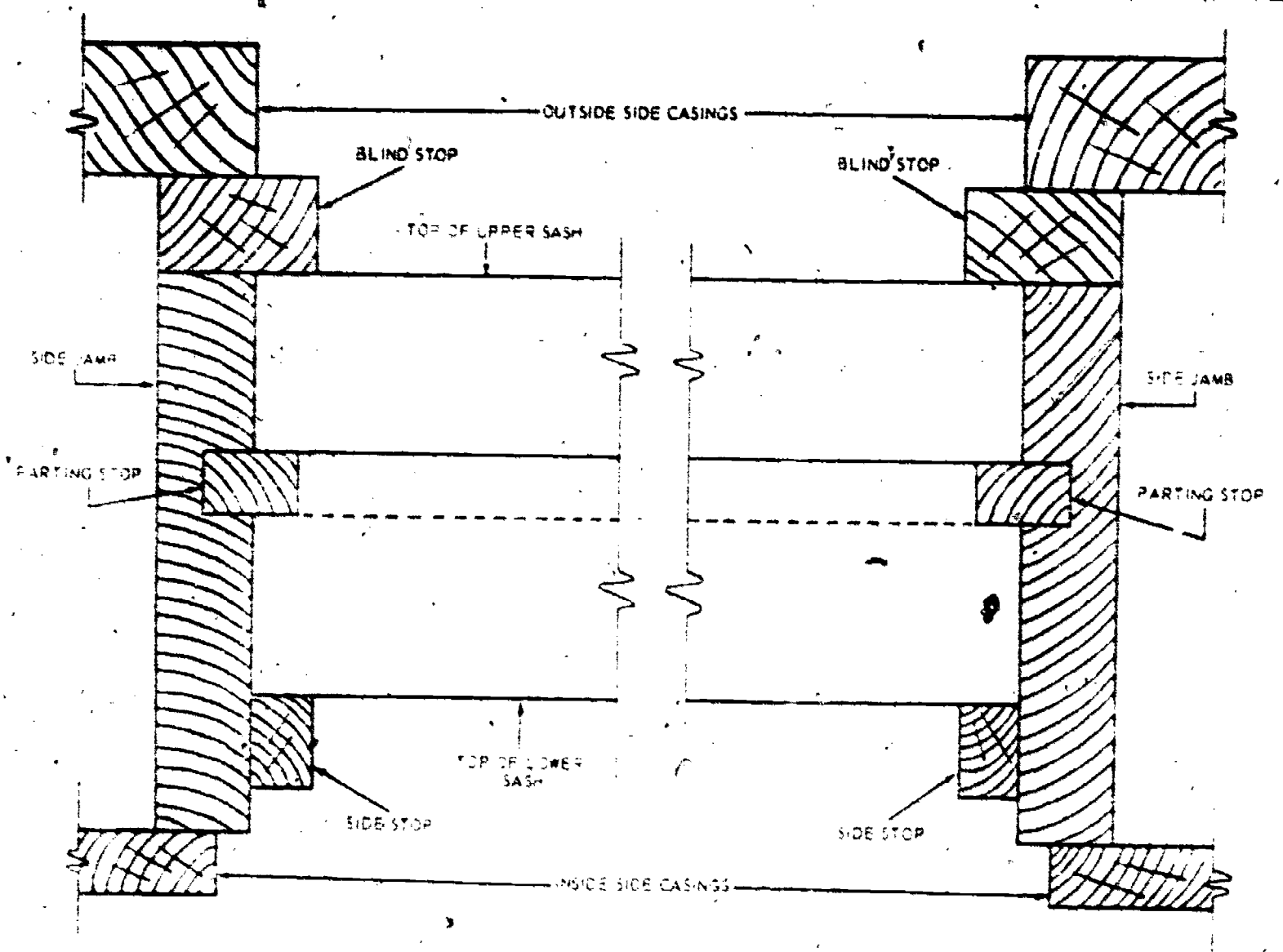

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Figure 13-11.—Double-hung sash installed.

which hang in PULLEY POCKETS on either side of the frame, and which are connected to the tops of the upper and lower sash by lengths of SASH CORD running up and over pulleys at the top of the frame. SASH WEIGHTS HAVE BEEN LARGELY REPLACED, HOWEVER, BY VARIOUS SPRING DEVICES WHICH LIE INSIDE THE JAMBS AND DO NOT REQUIRE PULLEY POCKETS. For sash cord the outer edges of the stiles must be grooved about one-third of the way down from the top, and a hole must be cut at the end of each groove to contain a knot in the end of the cord. For some types of spring balances the stiles are not grooved; other types require a groove the full length of the stile.

Steps in fitting and hanging double-hung sash are as follows:

1. Try the upper sash in the frame for a fit; if necessary, plane down the stiles to get a clearance of 1/8 in.

2. Notch the ends of the meeting rails so the rails will fit around the parting stop as shown in figure 13-12. The depth of the notch is equal to the thickness of the parting stop, plus a 1/16-in. allowance for clearance. The width of the notch is the width of the parting stop, less the depth of the parting stop groove, plus a 1/16-in. allowance for clearance.

3. Remove the parting stop from the jambs, set the upper sash in its runway, and replace the parting stop. Run the upper sash all the way up and fasten it there with a nail tacked into each of the side jambs.

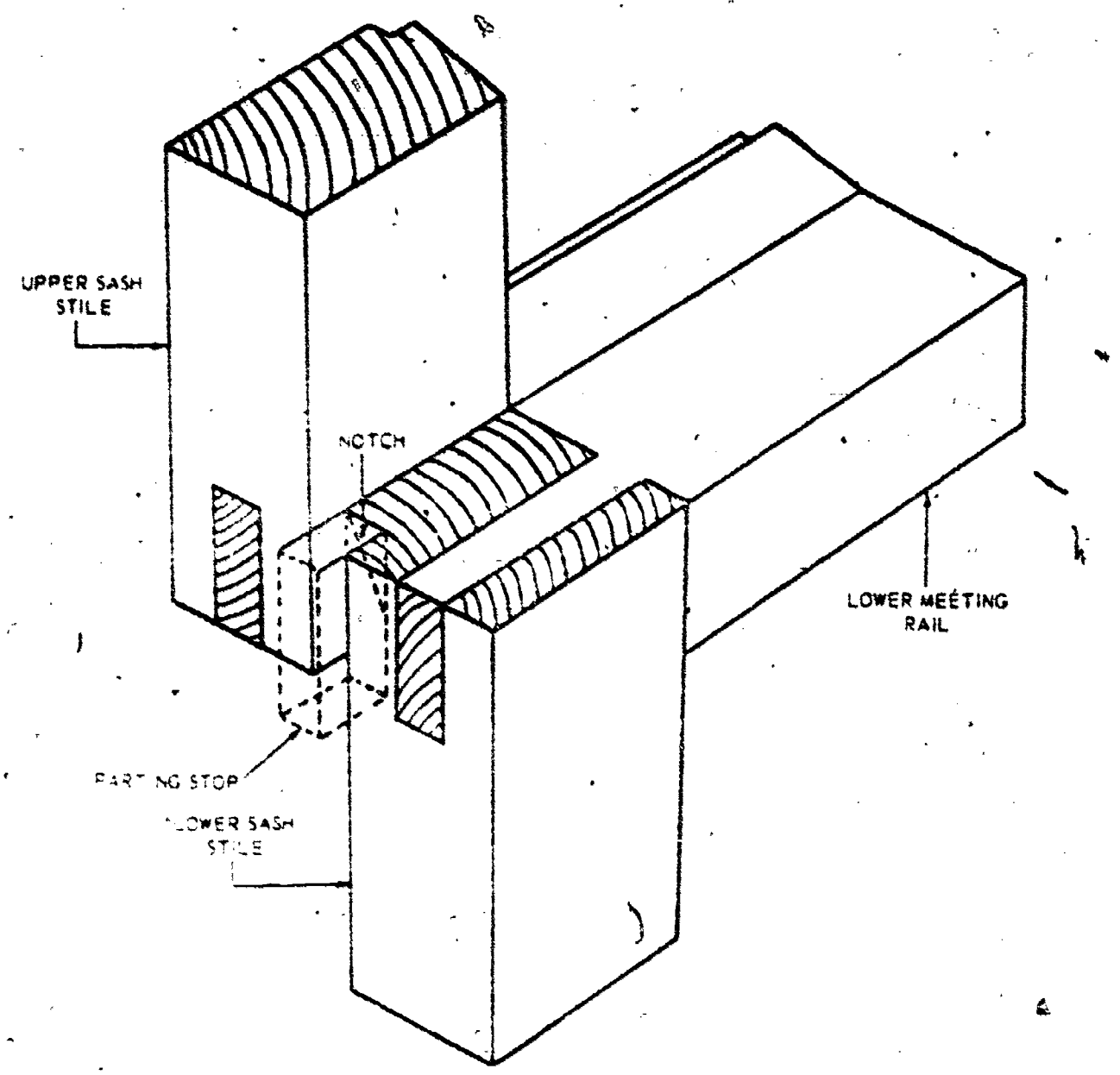

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Figure 13-12.—Notching meeting rails for parting stop.

4. Try the lower sash for a fit, planing down the stiles as necessary.

5. Set the angle of the sill on the T-bevel by lining the handle of the bevel up with the parting stop and the blade with the sill. Lay off this angle on the bottom of the bottom rail and bevel the bottom of the rail to the angle.

6. Set the lower sash in its runway, all the way down, and measure the amount that the tops of the meeting rails are out of flush with each other. This is the amount that must be planed off the bottom rail to ensure that the meeting rails will be exactly flush when the window is closed. Plane down the bottom rail until the meeting rails come flush.

7. Remove the sash and the parting stop, and install or attach the counterbalance for the upper sash. Manufacturer's instructions for installing are usually included with SPRING BALANCES. To attach a sash weight, first run the end of the sash cord over the pulley into the sashweight pocket. Place the weight in the pocket and bend the cord to it with a round turn and two half-hitches through the eye of the weight. Set the sash in its runway, all the way down, and haul down on the sash cord until the weight is up to the pulley. Bring the cord against the stile, and cut it off about 4 in. below the hole at the end of the groove in the stile. This 4 in. is about the amount required to tie a figure-of-eight knot to set in the hole at the end of the groove.

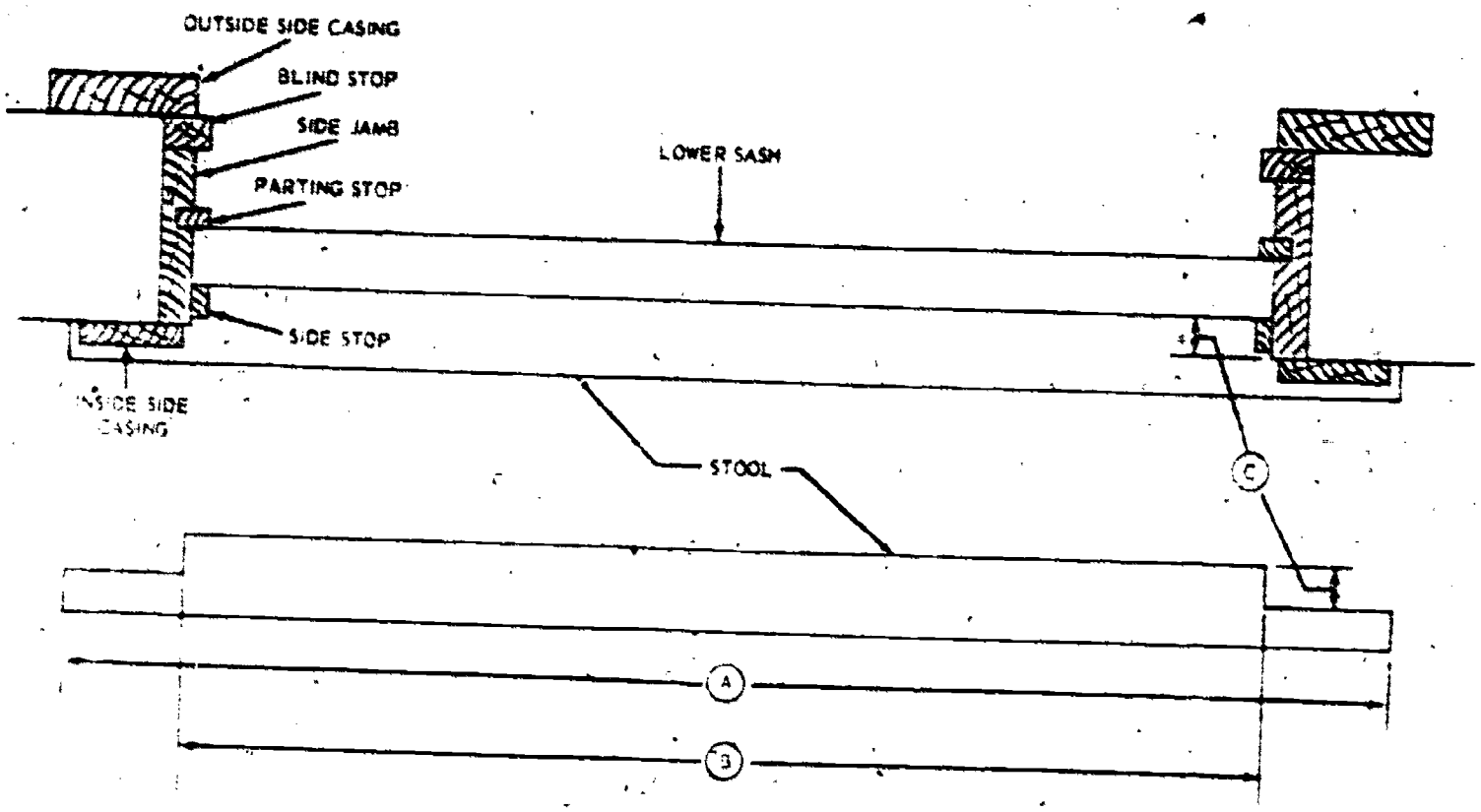

Figure 13-13.—Window stool layout.

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When the counterbalances have all been prepared, set the upper sash in its runway, all the way up, and nail the parting stop into its groove with 8-penny finish nails spaced 12 in. O.C.

The side stop and the inside casings cannot be installed until after the STOOL and APRON have been installed. Figure 13-13 shows the general layout of a window stool; whereas figure 13-14 shows the assembled window stool and apron.

METAL WINDOWS

Either aluminum or steel windows will most likely be installed in a permanent type of building. Information on construction requirements and pointers on installing metal windows are given below.

Regardless of the type of window used, it should be of the size, combination, and type indicated or specified. Windows should be constructed to produce the results specified and to assure a neat appearance. Permanent joints should be formed by welding or by mechanical fastenings, as specified for each type window.

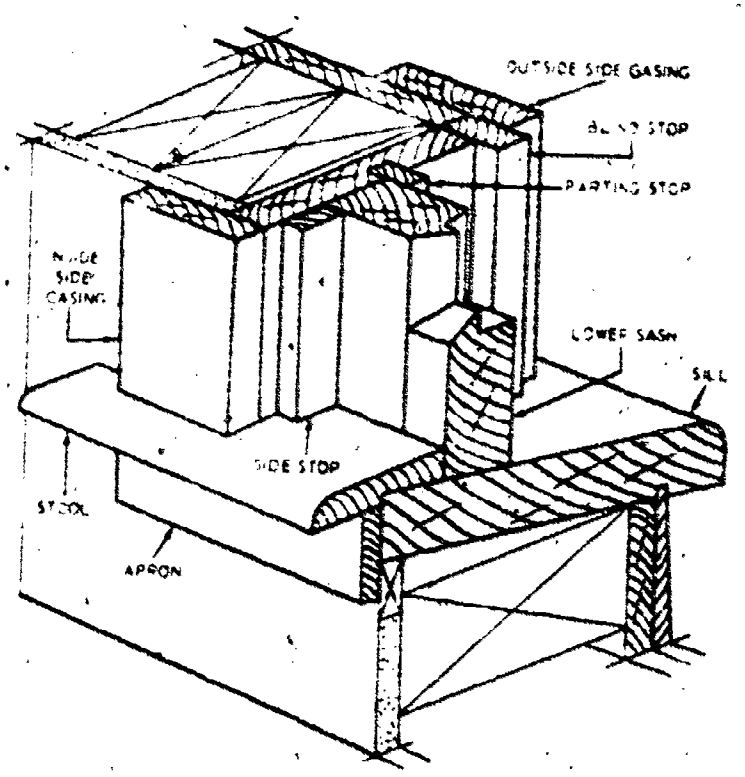

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Figure 13-14.—Window stool and apron.

Joints should be of sufficient strength to maintain the structural value of members connected. Welded joints should be solid, have excess metal removed, and be dressed smooth on exposed and contact surfaces. The dressing should be done so that no discoloration or roughness will show after finishing. Joints formed with mechanical fastenings should be closely fitted and made permanently watertight. Frames and sash, including ventilators, come assembled as a unit with hardware unattached.

Hardware should be of suitable design and should have sufficient strength to perform the function for which it is used. It should be attached securely to the windows with noncorrosive bolts or machine screws; sheet metal screws should not be used. Where fixed screens are specified, the hardware should be especially adapted to permit satisfactory operation of ventilators.

Make sure you exercise care in handling windows to avoid dropping them. In addition, store windows upright on pieces of lumber to keep them off the ground, and cover them thoroughly to protect them from the elements.

Windows should be installed and adjusted by experienced and qualified Builders. Aluminum windows in concrete or masonry walls should be set in prepared openings. Unless indicated or specified otherwise, all other windows should be built-in as the work progresses, or they should be installed without forcing into prepared openings. Windows should be set at the proper elevation, location, and reveal. They should be set plumb, square, level, and in alignment. They should also be braced, strutted, and stayed properly to prevent distortion and misalignment. Ventilators and operating parts should be protected against accumulation of cement, lime, and other building materials, by keeping ventilators tightly closed and wired fast to the frame. Screws or bolts in sill members, joints at mullions, and contacts of windows with sills, built-in fins, or subframes should be bedded in mastic sealant of a type recommended by the window manufacturer. Windows should be installed in a manner that will prevent entrance of water.

Ample provision should be made for securing units to each other, to masonry, or to other adjoining or adjacent construction. Windows that are to be installed in direct contact with masonry must have head and jamb members designed to enter into masonry not less than 7/16 inch. Where windows are set in prepared masonry openings, the necessary anchorage or fins should be placed during progress of wall construction. Anchors and fastenings should be built into, anchored, or bolted to the jambs of openings, and should be fastened securely to the windows or frames and to the adjoining construction. Unless indicated otherwise, anchors should be spaced not more than 18 inches apart on jambs and sills. Anchors and fastenings should have sufficient strength to hold the member firmly in position.

After windows have been installed and upon completion of glazing and painting, all ventilators and hardware should be adjusted to operate smoothly and to be weathertight when ventilators are closed and locked. Hardware and parts should be lubricated as necessary. Adjustments and tests should be as follows:

(a) Double-hung windows should have balances adjusted to proper tension, and guides waxed or lubricated.

(b) Casements equipped with rotary operators should be adjusted so that the top of the ventilator makes contact with the frame approximately 1/4 inch in advance of the bottom.

(c) Casements equipped with friction hinges, or friction holders, should be adjusted to proper tension.

(d) Projected sash should have arms or slides lubricated and adjusted to proper tension.

(e) Awning windows should have arms to ventilators adjusted so that the bottom edge of each ventilator makes continuous initial contact with frames when closed.

(f) Where windows are weatherstripped, the weatherstripping should make weathertight contact with frames when ventilators are closed and locked. The weatherstripping should not cause binding of sash, or prevent closing and locking of the ventilator.

After adjustment, all non-weatherstripped steel and aluminum windows, except security and commercial projected steel windows, should comply with prescribed feeler gage tests. Windows failing to comply with the tests should be removed and replaced with new windows, or should be corrected and restored to approved condition meeting the required tests. When ventilators are closed and locked, the metal-to-metal contacts between ventilators and their frames should conform to the following requirements:

Whenever conducting the feeler gage test on SIDE-HUNG VENTILATORS, the Builder should remember that it should not be possible to freely insert a steel feeler gage, 2 inches wide by 0.031 inch thick, at any point between the outside contacts of ventilator and frame; nor to freely insert a similar feeler gage, 0.020 inch thick, between more than 40 percent of such contacts.

Remember that for PROJECTED-OUT HORIZONTAL VENTILATORS, it should not be possible to freely insert a steel feeler gage, 2 inches wide by 0.031 inch thick, between the top rail inside contacts, or between the bottom and side rail outside contacts; nor to freely insert a similar feeler gage, 0.020 inch thick, between more than 40 percent of such contacts.

For PROJECTED-IN HORIZONTAL VENTILATORS, it should not be possible to freely insert a steel feeler gage, 2 inches wide by 0.031 inch thick, between the bottom rail outside contacts, or between the top and side rail inside contacts; nor to freely insert a similar feeler gage, 0.020 inch thick, between more than 40 percent of such contacts.

GLAZING

Glazing wood and metal sashes and doors consists of sash conditioning and placement of glass. Maintenance often involves only replacement of loose, deteriorated, or missing putty. When replacing glazing items in buildings and structures, use the same type materials as were used in the original work. Use replacement materials of improved quality only when justified by obvious inadequacy of the materials that have failed or by planned future utilization of the building or structure.

Wood sash may be glazed at the factory or on the job. In some instances it will reduce breakage and labor costs to have glazing done at the job site after sash is fitted. When a large number of stock-size wood sash are used, it is generally cheaper to have glazing done at the factory.

Steel sash are generally furnished open and glazing is performed on the job.

Cost of material varies with the size and kind of glass and whether glass is bedded in putty and face puttied, face puttied only, or set with wood or metal beads.

TYPES OF GLASS

Single strength glass is approximately 1/10 inch thick and used for small areas, never to exceed 400 square inches. Double strength glass is approximately .133 thick and is used where high wind resistance is necessary. Window glass comes in three grades, (AA) or superior grade, (A) or very good, and (B) for general or utility grade.

Heavy sheet glass comes in various thicknesses from 3/16 inch to 1/4 inch and in sheet sizes up to 76 inches x 120 inches. Sheet glass is sometimes used for windows but is usually used for greenhouses. It is slightly wavy and may cause a slight distortion of images viewed through it.

Plate glass is manufactured in a continuous ribbon and cut into large sheets. Plate glass is ground and polished for high quality. It comes in thicknesses from 1/8 inch to 1 1/4 inches and is usually used for large windows, such as store fronts.

Tempered glass is glass that has been reheated to just below its melting point and suddenly cooled by oil bath method.

By cooling against metallic surface. Tempered glass cannot be cut or drilled after tempering and must be ordered to exact size. It will withstand heavy impacts and great pressures but if tapped near edge, will disintegrate into small pieces.

Heat strengthened glass is made of polished plate or patterned glass and is reheated and cooled to strengthen it.

It is used in curtain wall design as spandrel glazing of multistoried buildings.

Patterned glass is a rolled flat glass with an impressioned design on one or both sides.

Wire glass is a regular rolled flat glass with either a hexagonal twisted or a diamond shaped welded continuous wire mesh as near as possible in the center of the sheet. The surface may be either patterned, figured or polished.

Heat absorbing glass is usually a heavy sheet glass, 1/8 inch or 1/4 inch thick, either a bluish or greenish color, has the ability to absorb the infra-red rays from the sun. More than 35 percent of the heat is excluded.

Insulating glass units are comprised of two or more sheets of glass separated by either 3/16 inch, 1/4 inch, or 1/2 inch air space. These units are factory sealed and the captive air is hydrated at atmospheric pressure. They are made of either window glass or polished plate glass. Special units may be obtained of varying combinations of heat absorbing, laminated patterned or tempered glass.

Glare reducing glass is available in double strength, in panes up to 60 inches x 80 inches,

and 3/16 inch, 7/32 inch and 1/4 inch in panes up to 72 inches x 120 inches in size. It is light gray in color, gives clear vision and is also slightly heat absorbent. One-fourth inch glass will exclude about 21 percent of the sun's heat rays.

Laminated glass is comprised of two or more sheets of glass with one or more layers of transparent vinyl plastic sandwiched between the glass. An adhesive applied with heat and pressure cements the layers into one unit. The elasticity of the plastic cushions any blow against the glass, preventing sharp pieces from flying. There is also laminated glare reducing glass where the pigment in the vinyl plastic laminated provides the glare control quality.

SASH PREPARATION

Attach the sash to structure so it will withstand the design load and to comply with the specifications. Adjust, plumb and square the sash to within 1/8 inch of nominal dimensions on shop drawings. Remove all rivet, screw, bolt or nail heads, welding fillets and other projections from specified clearances. Seal all sash corners and fabrication intersections to make the sash watertight. Primer paint all sealing surfaces of wood sash and carbon steel sash. Use appropriate solvents to remove grease, lacquers and other organic protecting finishes from sealing surfaces of aluminum sash.

GLASS CUTTING

Insofar as possible, glass should be purchased and stocked in sizes that can be used without cutting. Glass of special sizes is cut in the shop. For glass sizes, measure all four sides of the sash and deduct 1/16 to 1/8 inch in the light size for irregularities in the sash. Minimum equipment required for glass cutting consists of a table, a common wood or metal T-square, and a glass cutter. The table should be about 4 feet square, with front and left-hand edges square. Mark off the surface of the table vertically and horizontally in inches. A thin coating of turpentine or kerosene on the glass line to be cut is helpful in lubricating the action of the cutter wheel. A sharp cutter must be carefully drawn only ONCE along the line of the desired cut. Additional strokes of the cutter may result in breakage.

Check dimensions related to sash openings to be sure that adequate clearances are maintained on all four sides of the perimeter. No attempt should be made to change the size of heat strengthened, tempered or doubled glazed units since any such effort will result in permanent damage. All heat absorbing glass must be clean cut. Nipping to remove flares or to reduce oversized dimensions of heat-absorbing glass is not permitted.

PREPARATION BEFORE GLAZING

Old wood sash. Clean all putty runs of broken glass fragments and glazier's points. Remove loose paint and putty by scraping. Wipe the surface clean with cloth saturated in mineral spirits or turpentine, prime the putty runs, and allow them to dry.

New wood sash. Remove dust, prime the putty runs, and allow them to dry. All new wood sash should be pressure treated for decay protection in accordance with Federal Specification TT-W-571.

Old metal sash. Remove loose paint or putty by scraping. Use steel wool or sandpaper to remove rust. Clean the surfaces thoroughly with a cloth saturated in mineral spirits or turpentine. Prime bare metal and allow it to dry thoroughly.

New metal sash. Wipe the sash thoroughly with a cloth saturated in mineral spirits or turpentine to remove dust, dirt, oil, or grease. Remove rust with steel wool or sandpaper. If the sash is not already factory primed, prime it with rust-inhibitive paint and allow it to dry thoroughly.

SETTING GLASS IN WOOD AND METAL SASH

Do not glaze or reglaze exterior sash when the temperature is 40 degrees F or lower unless absolutely necessary. Sash and door members must be thoroughly cleaned of dust with a brush or cloth dampened with turpentine or mineral spirits. Lay a continuous 1/6-inch-thick bed of putty or compound in the putty run (fig. 13-15). The glazed face can be recognized as the size on which the glass was cut. If the glass has a bowed surface, it should be set with the concave side in. Wire glass is set with the twist vertical. Press the glass firmly into place so that the bed putty will fill all irregularities.

When glazing wood sash, insert two glazier's points per side for small lights and about 8 inches apart on all sides for large lights. When glazing metal sash, use the wire clips or metal glazing beads.

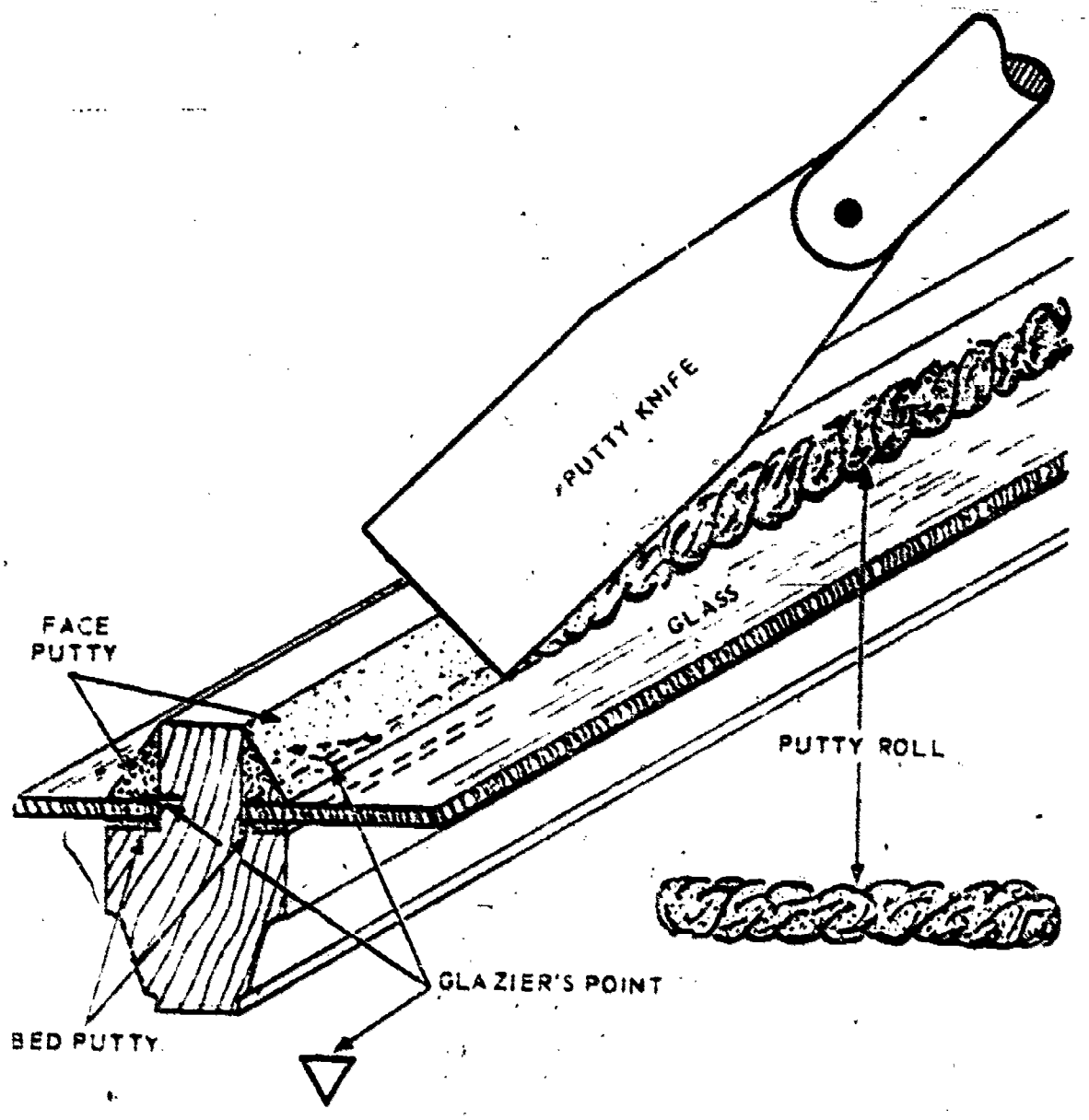

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Figure 13-15.—Setting glass with glazier's points and putty.

After the glass has been bedded, lay a continuous bead of putty against the perimeter of the glass-face putty run. Press the putty with a putty knife or glazing tool with sufficient pressure to ensure its complete adhesion to the glass and sash. Finish with full, smooth, accurately formed bevels with clean cut miters. Trim up the bed putty on the reverse side of the glass. When glazing or reglazing interior sash and transoms, whether fixed or movable, and interior doors, use wood or metal glazing beads. Exterior doors and hinged transoms should have glass secured in place with inside wood or metal glazing beads bedded in putty. When setting wire glass for security purposes, set wood or metal glazing beads, secured with screws, on the side facing the area to be protected. Wood sash putty should be painted as soon as it has surface-hardened. Do not wait longer than 2 months after glazing. Metal sash, Type I, elastic compound, should be painted immediately after a firm skin forms on the surface. Depending on weather conditions, the time for skinning over may be 2 to 10 days. Type II, metal sash putty, can usually be painted within 2 weeks after placing. This putty should not be painted before it has hardened because early painting may retard the set.

Clean the glass on both sides after painting. A cloth moistened with mineral spirits will remove putty stains. Ammonia, acid solutions, or water containing caustic soaps must not be used.

When scrapers are used, care should be exercised to avoid breaking the paint seal at the putty edge.

Handling and cutting glass creates a serious cutting hazard. Appropriate gloves and other personal protective equipment must be provided and adequate procedures for the disposal of cuttings and broken glass established.

FINISH FLOORING

Before any finish flooring is laid the rough floor must be thoroughly cleaned. All plaster droppings must be removed, all protruding nail-heads driven flush, and all irregularities planed down or otherwise smoothed. The rough floor should then be carefully inspected for any loose boards or other imperfections.

WOOD-STRIP FINISH FLOORING

Most wood-strip finish flooring is SIDE-MATCHED (tongue-and-grooved on the edges), and some is END-MATCHED (tongue-and-grooved on the ends) as well. Softwood flooring comes in face widths ranging from 2 1/4 to 5 in. The most widely used standard pattern of hardwood flooring has a face width of 2 1/4 in. Most wood-strip flooring is recessed on the lower face as shown in figures 13-16 and 13-17.

Wood subfloors are covered with building paper or with a layer of heavy felt before wood-strip finish flooring is applied. If the specifications call for furring strips between the subflooring and the finish flooring, the strips are nailed on top of the paper or felt. Furring strips are laid at right angles to the line of the finish flooring; they are usually spaced 12 or 16 in. O.C.

Wood-strip flooring is laid at right angles to the line of direction of the joists under the largest room on the floor. The first strip laid (which is called the STARTER strip) is laid parallel to and 5/8 in. away from the outer joist-end wall in the key room. This strip is placed with the side groove toward the wall, and face-nailed down with nails placed where they will be concealed by the SHOE MOLDING (molding placed in the angle between the baseboard and the floor) as shown in figure 13-16.

Subsequent strips are cut, fitted, and laid ahead of the nailing, about 6 or 8 courses (continuous wall-to-wall strips) at a time. A 3-man crew is convenient for wood-strip flooring, with one man cutting, the second fitting, and the third nailing. The cutter cuts strips of random

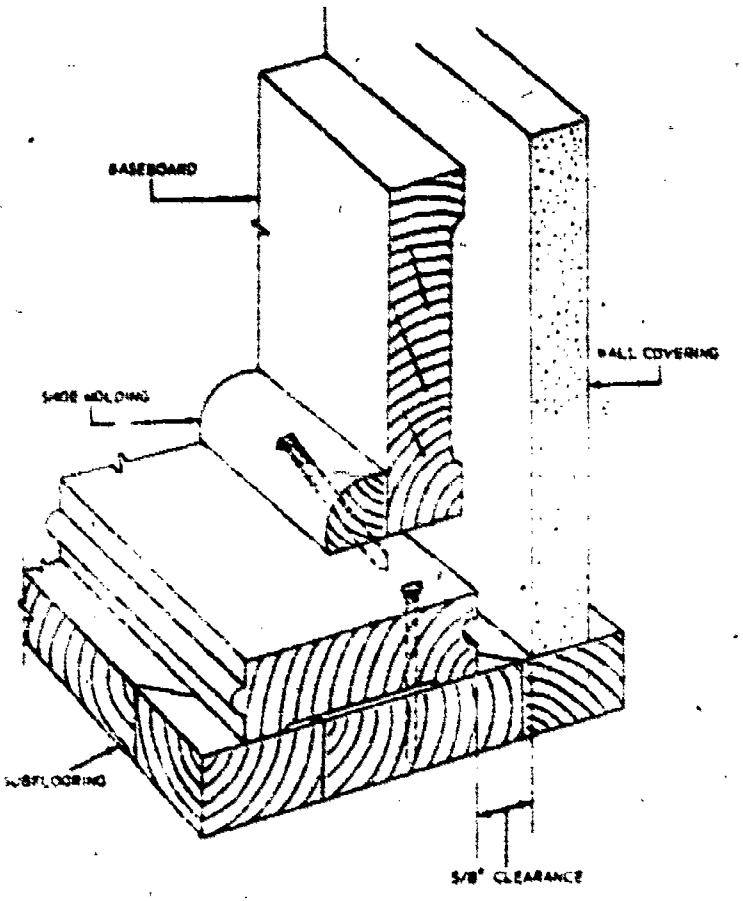

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Figure 13-16.—Blind-nailing starter strip of wood finish flooring.

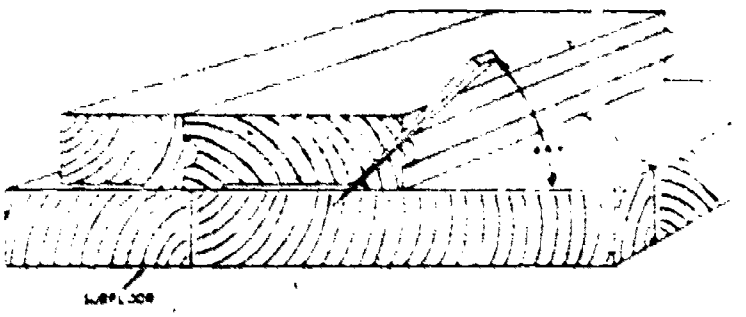

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Figure 13-17.—Toenailing wood-strip flooring.

(various) lengths. The fitter lays out wall-to-wall strips, taking care to stagger end-joints in as uniform a manner as possible. The nailer drives strips up hard against previously nailed strips, using a piece of scrap flooring for the purpose, and then nails the strips down.

Courses which follow the starter course are toenailed down as shown in figure 13-17. Nails should be driven into joists, and it is a good idea to chalk-mark the lines of the joists on the

building paper before the floor-laying is started. For 25/32-in.-thick flooring use 8-penny cut flooring nails; for 1/2-in.-thick flooring use 6-penny wire casing nails; for 3/8-in.-thick flooring use 4-penny wire casing nails. Drive each nail down to the point where another blow or two might cause the hammer to damage the edge of the strip: then use a nail set to drive the nail the rest of the way home. Best nailing procedure is to stand on the strip, with toes in line with the outer edge, and strike the nail from a stooping position which will bring the hammer head square against the nail.

Sanding

Power-operated sanding machines are the most satisfactory means of preparing wood floors for finishing. The operator should wear an approved respirator or dust mask while sanding. Abrasive paper, commonly called sandpaper, is made with paper of fabric backing. For machine use, a fabric-backed or fabric-reinforced paper backing is recommended. The mineral cutting agent glued to the face of the paper may be flint (Federal Specification P-P-135), garnet (Federal Specification P-P-121, waterproof), or silicon carbide (Federal Specification P-P-101, waterproof). Cutting surfaces are designated close coat (cutting grits covering the entire face) or open coat (grits covering about half the cutting surface). Opencoat paper is recommended for sanding over materials, such as paint and varnish, that tend to clog spaces between the grits. Flint papers are made in at least 12 grades: 5/0 (very fine), 4/0, 3/0, 2/0, 0, 1/2, 1, 1 1/2, 2, 2 1/2, 3, 3 1/2 (very coarse). Flint (sand) papers having glue binders must not be stored where they will be subject to oil, moisture, or extreme heat and cold. Brittle paper can be softened by dampening the backing. The following table is a guide to sandpaper selection for floor furnishing.

Grade	Type	Use
3 1/2	Open	Preliminary roughing off of stubborn varnish, shellac, floor oil, wax, and deep penetrating filler compounds. Not to be used for cutting into wood surfaces.
3	Open	Used in place of No. 3 1/2 for surfaces of less resistance; is preferred if it does the required work.
2 1/2	Open	Preliminary roughing off of floor finishes such as shellac, wax, floor oils, alcohol stains, and lacquered surfaces. Use as followup paper for floors roughed off with No. 3 1/2.
2	Close	Use instead of No. 2 and No. 2 1/2 open coat where surface permits cutting without gumming. Closed coat should be used in preference to open coat whenever practicable.
1 1/2	Close	Use as a first paper on all new floors.
1	Open	Use as a followup for No. 2 and No. 2 1/2 in all cases.
1	Close	Use the same as No. 1 open coat to provide a smooth floor finish.
1/2	Close	Use a final finish on most floor work.
1/0 & 2/0	Close	Use as a final finish on best hardwood floor work.
3/0 & 4/0	Close	Use for finishing fine woodwork, such as furniture, and for rubbing down paint and varnish finishes.

In exceptional cases, when old floor finishes cannot be removed by sanding or scraping with an abrasive, highly volatile liquids may be used. These liquids, as well as those used in floor finishing, include paint and varnish remover, varnish, liquid paint, and shellac, which have flashpoints as low as 40 degrees F. Finishing should be done only under expert supervision.

Sealing

Seal wood floor by sealing and waxing them in the following manner: Apply liberally a sealer of light varnish that conforms to Federal Specification TT-S-176. Spread or spray it along the grain of the wood. After the sealer has dried completely, buff the floor with a floor-polishing machine, using No. 1 steelwool pads. If portions of the floor look lusterless, dry, or dead after the buffing, continue sealing and polishing until the floor surface has a uniform appearance. Apply two thin coats of water emulsion wax that conforms to Federal Specification P-W-155. Buff the wax after each application has thoroughly dried.

RESILIENT FLOORING

In Navy construction, wood-strip flooring has been largely replaced by various types of RESILIENT flooring, most of which is applied in the form of 6 x 6-, 9 x 9-, or 12 x 12-in. squares called TILES. The types most frequently used are ASPHALT, VINYL, LINOLEUM, CORK, and RUBBER.

Manufacturers recommend that wood subfloors have an underlayment for resilient flooring, or that sheets of synthetic wood, such as plywood or tempered hardboard, be nailed over single subfloors. The subsurface must be carefully cleaned, smoothed, and inspected, and any cracks wider than 1/8 in. or holes larger than 1/4 in. must be filled. The subsurface is then covered with a felt backing, cemented down with adhesive. The tile is then laid on the felt.

Asphalt and vinyl tile is set in an asphalt tile EMULSION, linoleum and cork tile in linoleum cement, and rubber tile in waterproof rubber cement. The manufacturer's instructions on proper methods of applying adhesive and laying tile are provided and should be carefully followed. All floors subjected to excessive moisture should be applied with a waterproof adhesive.

ASPHALT AND VINYL TILES

Asphalt tile is a blended composition of asphaltic and/or resinous binders, asbestos fibers, and inert fillers or pigments. It can be installed satisfactorily over concrete floors in direct contact with the ground without the need to completely waterproof the concrete slab. It is quiet and safe to walk on, durable, and resistant to abrasion from foot traffic and common abuses such as scuffing and cigarette burns. The tile is low in maintenance cost. Tiles are available in sizes of 4 by 4 inches, 9 by 9 inches, and 12 by 12 inches, in thicknesses of 1/8 and 3/16 inch. Tiles 9 by 9 inches are most commonly used in military construction.

Vinyl tiles are available in two types: vinyl asbestos tile, Federal Specification L-T-345, and flexible vinyl, Federal Specification L-F-450. Tiles are available in sizes of 6 by 6 inches, 9 by 9 inches, and 12 by 12 inches, and in thicknesses of 1/8 and 3/32 inch. Vinyl is also available in 54-inch sheets. Vinyl tile may be laid on a concrete floor in direct contact with the ground only if the slab is membrane-waterproofed. Vinyl tiles are durable and easy to keep clean. Vinyl plastic floorings have good resistance to abrasion, are impervious to water, and are outstanding in resistance to grease, oils, and alkalies.

Asphalt and vinyl tiles should be laid according to the manufacturer's recommendations, with or without lining felt as suitable for the application. Before the tile is laid, the floor area should be squared and the best method of laying the tile determined, depending on the shape of the room, location of fixed furnishings and equipment, and doorways. Tile should always be laid from the center of the room toward the walls so that border widths can be adjusted accordingly. Tiles should be stored for 24 hours before installation in a room heated to at least 70 degrees. Cold tiles may cause condensation on the underside and break down the cement bond. Cement should be spread at a uniform consistency ahead of the work and allowed to dry to a tacky state before tile is laid in it.

CERAMIC AND QUARRY FLOOR TILE

Ceramic floor tile is glazed or unglazed, manufactured in small square, hexagonal, rectangular, and circular shapes about 1/4 inch thick, and often arranged in mosaic patterns. The pieces are usually factory-assembled (face side up) on paper sheets in the required pattern, laid on a mortar setting bed, pressed firmly on the mortar, and tamped true and even with the finished floor line. Grout is then forced into the joints, filling them completely, and is finished flush and level with the floor line.

Quarry tile is usually unglazed and manufactured in square and rectangular shapes, ranging from 2 3/4 inches to 9 inches in width, from 2 3/4 inches to 12 inches in length, and of

varying thicknesses. Tiles are laid individually on a mortar setting bed with joints about 1/2 inch wide.

In locations such as galleys and food preparation areas, where the floor is directly exposed to the effects of corrosion agents, use acid-resistant joint material to fill the joints. The acid-resistant mortars are proprietary products and should be mixed in accordance with the manufacturer's recommendations. They should be composed of powdered resin and liquid resin cement and be resistant to the effects of oils, fats, greases, organic and inorganic acids, salts, alkalies, and mineral solvents.

DOORS

Inside door frames are constructed in several ways. The interior type is constructed like the outside type except that no casing is used on inside door frames. Hinge blocks are nailed to the inside wall finish, where the hinges are to be placed, to provide a nailing surface for the hinge flush with the door. Both the outside and inside door frames may be modified to suit a climatic condition.

DOOR JAMBS

Door jambs (fig. 13-18) are the linings of the framing of door openings. Casings and stops are nailed to the door jambs and the door is hung from them. Inside jambs are made of 3/4-inch stock and outside jambs of 1 3/8-inch stock. The width of the stock will vary in accordance with the thickness of the walls. Inside jambs are built up with 3/8- by 1 3/8-inch stops nailed to the jamb, while outside jambs are usually rabbeted out to receive the door. Jambs are made and set in the following manner:

Regardless of how carefully rough openings are made, be sure to plumb the jambs and level the heads, when jambs are set.

Rough openings are usually made 2 1/2 inches larger in width and height than the size of the door to be hung. For example, a 2-foot 8-inch by 6-foot 8-inch door would need a rough opening of 2 feet 10 1/2 inches by 6 feet 10 1/2 inches. This extra space allows for the jambs, the wedging, and the clearance space for the door to swing.

Level the floor across the opening to determine any variation in floor heights at the point where the jambs rest on the floor.

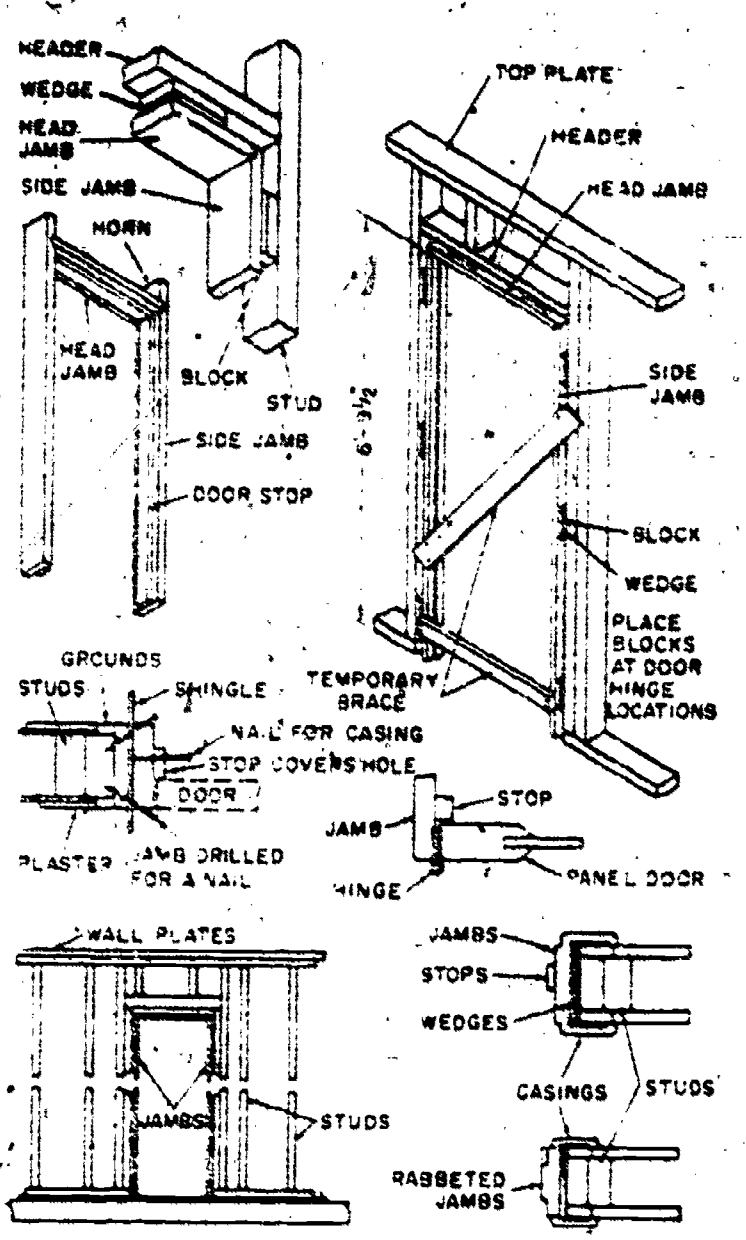

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Figure 13-18.—Door jamb and door trim.

Now cut the head jamb with both ends square, having allowed width of the door plus the depth of both dadoes and a full 3/16 inch for door clearance.

From the lower edge of the dado, measure a distance equal to the height of the door plus the clearance wanted under it. Mark and cut square.

On the opposite jamb do the same, only make additions or subtractions for the variation in the floor, if any.

Now nail the jambs and jamb heads together with 8-penny common nails through the dado into the head jamb.

Set the jambs into the opening and place small blocks under each jamb on the subfloor just as

thick as the finish floor will be. This is to allow the finish floor to go under.

Plumb the jambs and level the jamb head.

Wedge the sides with shingles between the jambs and the studs, to align, and then nail securely in place.

Take care not to wedge the jamb unevenly.

Use a straightedge 5 or 6 feet long inside the jambs to help prevent uneven wedging.

Check jambs and head carefully, because jambs placed out of plumb will have a tendency to swing the door open or shut, depending on the direction in which the jamb is out of plumb.

DOOR TRIM

Door trim material is nailed onto the jambs to provide a finish between the jambs and the plastered wall. It is frequently called "casing" (fig. 13-18). Sizes vary from 1/2 to 3/4 inches in thickness, and from 2 1/2 to 6 inches in width. Most trim has a concave back, to fit over uneven plaster. In mitered work, care must be taken to make all joints clean, square, neat, and well fitted. (If the trim is to be mitered at the top corners, a miter box, miter square, hammer nail set and block plane will be needed.) Door openings are cased up in the following manner:

Leave a margin of 1/4-inch from the edge of the jamb to the casing all around.

Cut one of the side casings square and even at the bottom, with the bottom of the jamb.

Cut the top or mitered end next, allowing 1/4-inch extra length for the margin at the top.

Nail the casing onto the jamb and even with the 1/4-inch margin line, starting at the top and working toward the bottom.

Use 4-penny finish nails along the jamb side and 6-penny or 8-penny case nails along the outer edge of the casings.

The nails along the outer edge will need to be long enough to go through the casing and plaster and into the studs.

Set all nailheads about 1/8 inch below the surface of the wood with a nail set.

Now apply the casing for the other side and then the head casing.

FITTING A DOOR

If a number of doors are to be fitted and hung, a DOOR JACK like the one shown in figure 13-19 should be constructed, to hold doors upright for the planing of edges and the installation of HARDWARE (hinges, locks, knobs, and other metal fittings on a door or window).

NOTE: The edge of the door can be beveled to prevent binding and to give a tighter fit.

The first step in fitting a door is to determine from the floor plan which stile is the hinge stile and which the lock stile, and to mark both the stiles and the corresponding jambs accordingly. Next, carefully measure the height of the finished opening ON BOTH SIDE JAMBS and the width of the opening AT BOTH TOP AND BOTTOM. The finished opening should be perfectly rectangular; but IT MAY NOT BE. Your job now is to fit the door accurately to the opening, regardless of the shape of the opening.

A well-fitted door, when hung, should conform to the shape of the finished opening, less a clearance allowance of 1/16 in. at the sides and on top. For an interior door without sill or threshold there should be a bottom clearance above the finished floor of from 3/8 to 1/2 in. This clearance is required to ensure that the door will swing clear of carpeting; if the carpeting is to be extra-thick, the bottom clearance will have to be greater than 1/2 in. For a door with a sill and no threshold, the bottom clearance should be 1/16 in. above the sill. For a door with a threshold, the bottom clearance should be 1/16 above the threshold. The sill and threshold, if any, should be set in place before the door is hung.

Lay off the measured dimensions of the finished opening, less allowances, on the door. Check the door jambs for trueness, and if you find any irregularities, transfer them to the door lines. Place the door in the jack and plane the edges to the lines, setting the door in the opening frequently to check the fit.

HANGING A DOOR

You will be dealing mainly with doors equipped with SIDE hinges (hinges located on the edges of one stile or the other). There are various types of side hinges, but yours will be mostly LOOSE-PIN BUTT MORTISE hinges like the one shown in figure 13-20. A loose-pin butt hinge consists of two rectangular LEAVES, pivoted on a PIN which is called a LOOSE PIN because it can be removed by simple extraction. The hinge is called a MORTISE hinge because the leaves are MORTISED into gains cut in the hinge stile of the door and the hinge jamb of the door frame.

The first step in hanging a door is to lay out the locations of the hinges on the hinge stile and the hinge jamb. Set the door in the frame, and

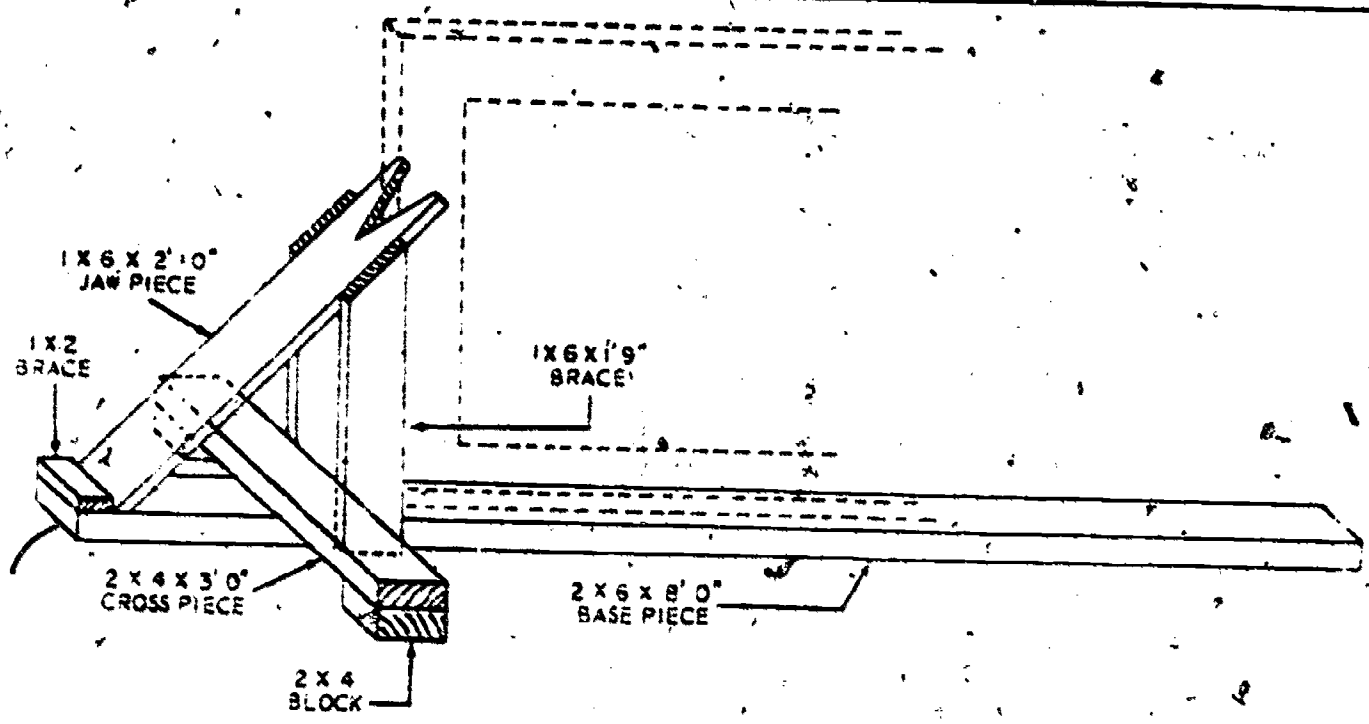

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Figure 13-19.—Door jack.

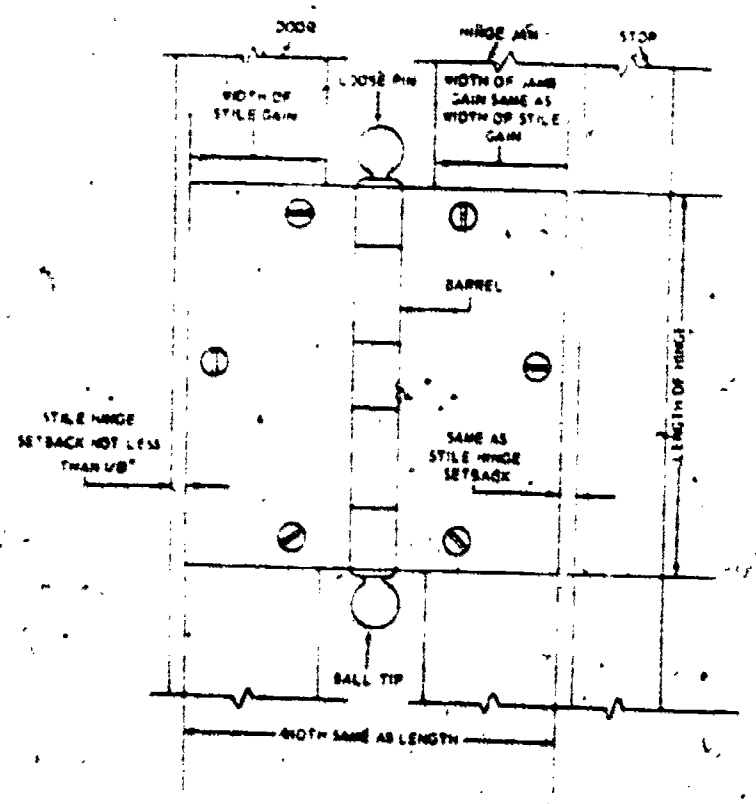

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Figure 13-20.—Loose-pin butt mortise hinge.

force the hinge stile against the hinge jamb with the wedge marked A in figure 13-21. Then insert a 4-penny finish nail between the top rail and the head jamb, and force the top rail up against the nail with the wedge marked B in the figure. Since a 4-penny finish nail has a diameter of 1/16 in. (which is the standard top clearance for a door), the door is now at the correct height.

Exterior doors usually have 3 hinges, interior doors, as a rule, only 2. The vertical distance between the top of the door and the top of the top hinge, and between the top of the finish floor and the bottom of the bottom hinge, may be specified. If not, the distances customarily used are those shown in figure 13-21. The middle hinge, if there is one, is usually located midway between the other two.

The size of a loose-pin butt mortise hinge is designated by the length (height) and by the combined width of the leaves in inches (height is always given first). The width varies with the requirements of setback, clearance, door thickness, etc., and is calculated individually for each door. Doors 1 1/8 to 1 3/8 in. thick and up to 32-in. wide take a 3 1/2-in. hinge. Doors 1 1/8 to 1 3/8 in. thick and from 32 to 37-in. wide take a 4-in. hinge. Doors more than 1 3/8 in. but not more than 1 7/8 in. thick and up to 32-in. wide take a 4 1/2 in. hinge; if more than 32 but not more than 37-in. wide they take a 5-in. hinge; if from 37 to 43-in. wide they take a 5-in. EXTRA HEAVY hinge. Doors thicker than 1 7/8

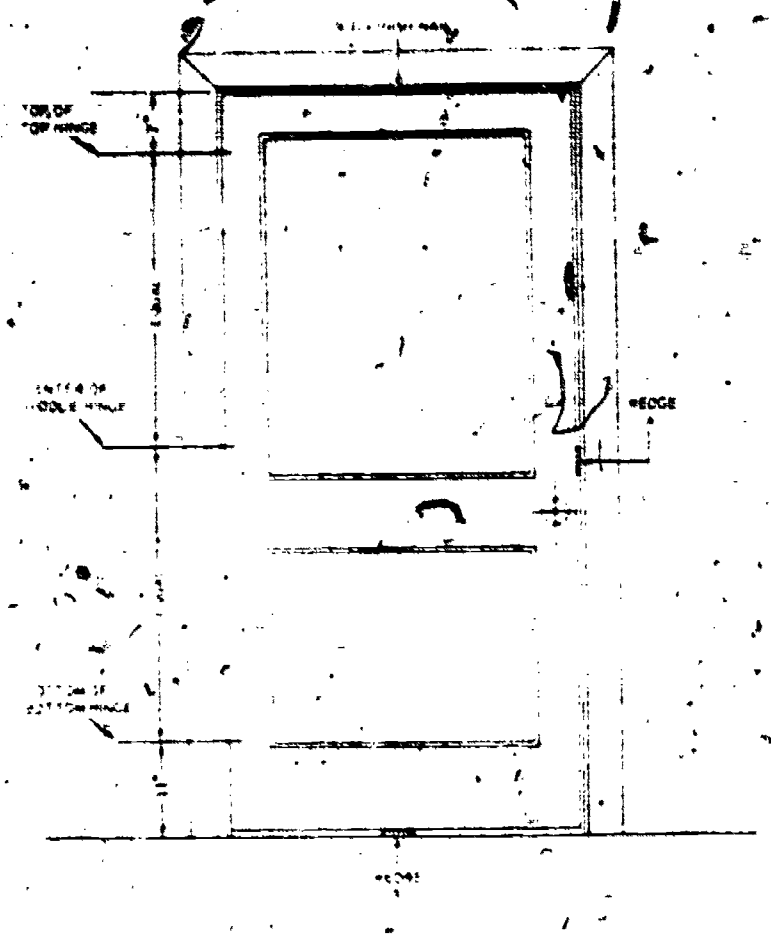

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Figure 13-21.—Laying out hinge locations on a door.

in. and up to 43-in. wide take a 5-in. extra heavy hinge. Doors thicker than 1 7/8 in. and wider than 43-in. take a 6-in. extra heavy hinge.

Place the door in the door jack and lay off the outlines of the gains on the edge of the hinge stile, using a hinge leaf as a marker. The STILE HINGE SETBACK (shown in fig. 13-20) should be not less than 1/8-in. and is usually made about 1/4-in. Lay out gains of exactly the same size on the hinge jamb, and then chisel out the gains to a depth exactly equal to the thickness of a leaf.

Separate the leaves on the hinges by extracting the loose pins, and screw the leaves into the gains, taking care to ensure that the loose pin will be up when the door is hung in place. Hang the door in place, insert the loose pins, and check the clearances at the side jambs. If the clearance along the hinge jamb is too large (more than 1/16-in.) and that along the lock jamb too small (less than 1/16), remove the door, remove the hinge leaves from the gains, and slightly deepen the gains. If the clearance along the hinge jamb is too small and that along the lock jamb too large, the gains are too deep. This can be corrected by shimming up the leaves with strips of cardboard placed in the gains.

INSTALLING A CYLINDER LOCK

The parts of an ordinary cylinder LOCK for a door are shown in figure 13-22. The procedure for installing a lock of this type is as follows:

Open the door to a convenient working position and check it in place with wedges under the bottom near the outer edge.

Measure up 36 in. from the floor (the usual knob height), and square a line across the face and edge of the lock stile.

Use the template that is usually supplied with cylinder lock; place the template on the face of the door (at proper height and alignment with layout lines) and mark the centers of holes to be drilled. (See fig. 13-23.)

Drill the holes through the face of the door and then the one through the edge to receive the latch bolt. It should be slightly deeper than the length of the bolt.

Cut a gain for the latch-bolt mounting plate, and install the latch unit.

Install interior and exterior knobs.

Find the position of the strike plate and install it in the jamb.

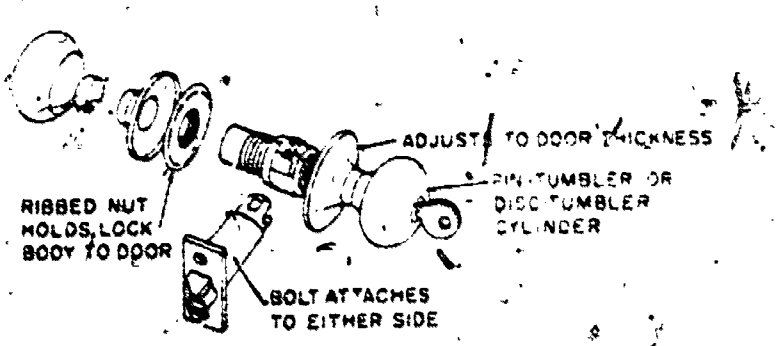

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Figure 13-22.—Parts of a cylinder lock.

INTERIOR TRIM

The casing around the doors and windows, the baseboard with its base mold and shoe mold, the picture mold, chair rail, cornice mold, and panel mold are the various trim members used in finishing the interior of a building.

Various types of wood can be used for interior trim, such as birch, oak, mahogany, walnut, white and yellow pine, and other available woods.

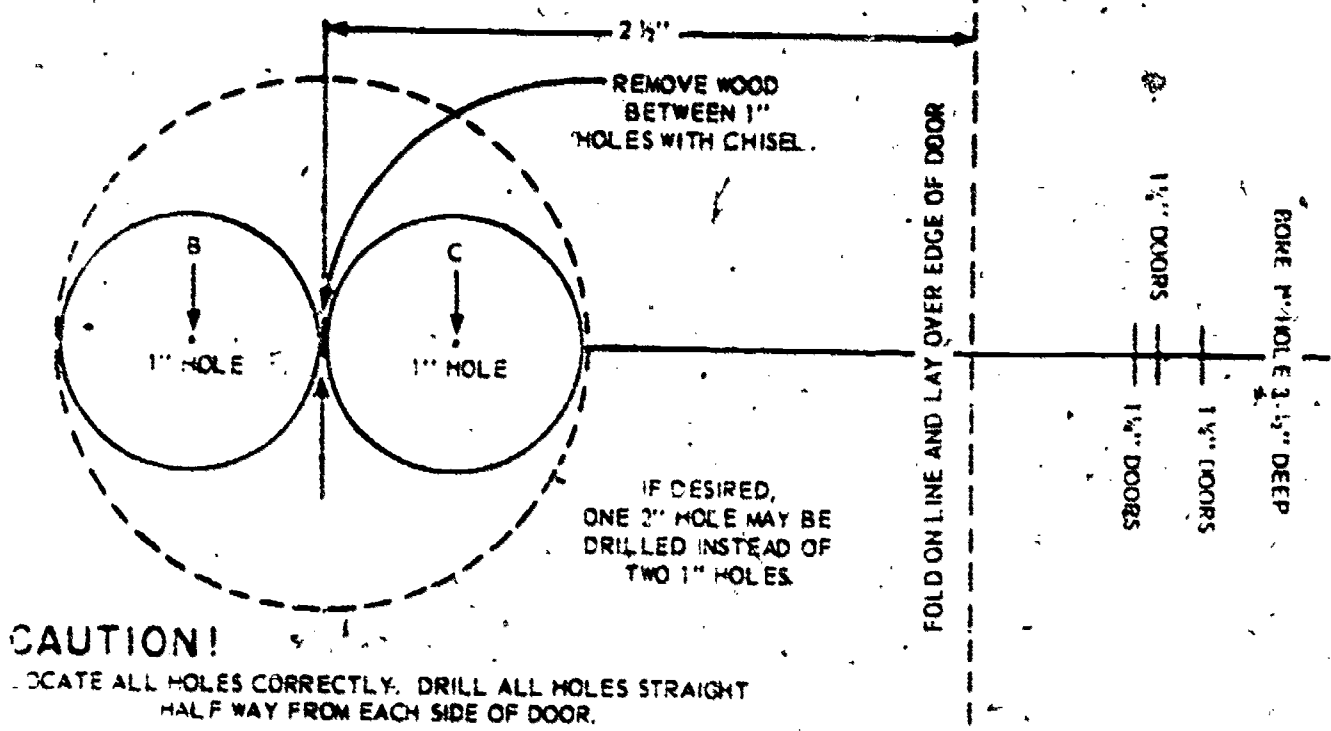

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Figure 13-23.—One type of template.

A close-grain wood should be used when the trim is to be painted. However, harder woods free from pitch will provide a better paint surface.

BASEBOARDS

A trim member called a BASEBOARD is usually installed on the line along which the walls join the floors. Baseboard is nailed to the studs with two 6-penny finish nails at each stud crossing. The first step in installing baseboard, therefore, is to locate all the studs in the wall and mark the locations on the floor with light pencil marks.

Baseboard is miter-joined at outside corners and butt-joined at inside corners. Where baseboards cannot be miter-joined or butt-joined at corners, they should be capped. Since the walls at corner baseboard locations may not be perfectly vertical, inside and outside corners should be joined as follows:

To butt-join a piece of baseboard to another piece already in place at an inside corner, set the piece to be joined in position on the floor, bring the end against or near the face of the other piece, and take off the line of the face with a scriber as shown in figure 13-24. Use the same procedure when butting ends of baseboard against the side casings of doors.

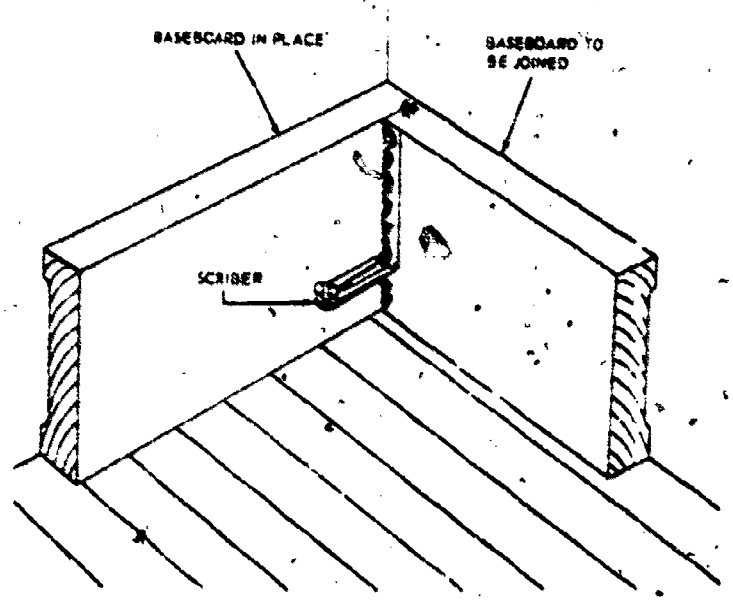

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Figure 13-24.—Butt-joining baseboard at an inside corner.

For miter-joining at an outside corner, proceed as shown in figure 13-25. First set a

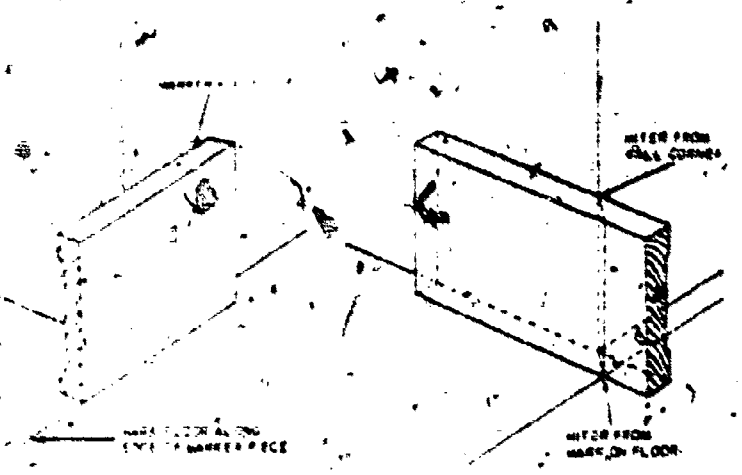

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Figure 13-25.—Miter-joining baseboard at an outside corner.

MARKER PIECE of baseboard across the wall corner, as shown in the left-hand view and mark the floor along the edge of the piece. Then set the piece to be mitered in place, and mark the point where the wall corner intersects the top edge and the point where the mark on the floor intersects the bottom edge. Lay 45 degree lines across the edge from these points (for a 90-degree corner), connect these lines with a line across the face, and miter to the lines as indicated.

The line along which the baseboard joins the floor is usually covered by a strip of quarter-round molding called a SHOE molding. The shoe molding should be nailed to the floor, as shown in figure 13-16, and not to the baseboard. If it is nailed to the baseboard and the floor should happen to settle, a space will appear between the bottom of the shoe molding and the floor surface.

The upper edges of baseboards are sometimes trimmed with a strip of molding called a BASE CAP.

MISCELLANEOUS TRIM MEMBERS

The PICTURE MOLD is usually placed against the wall near the ceiling; however, at times you may prefer to lower it to 12 or 16 inches below the ceiling. CORNICE MOLD is usually a large cove mold fitted and nailed against both the wall and ceiling. The cornice mold of a room is sometimes ornamental and made up of several members. The CHAIR RAIL may be placed at various heights on the wall, usually around 48 inches up from the floor. The chair rail can be used to fasten fixtures. The PANEL MOLD is used to divide wall spaces into panels; this mold may be used horizontal or vertical. SHELF CLEATS make removal of shelves easier and they are very convenient for closets.

CASINGS and STOPS for doors and windows as well as STOOLS and APRONS, usually come in rough lengths. When this happens, it is a good plan to assort, select, and place the various members at each opening. When they come in random lengths, cut them to the rough lengths, and then assort them. Most base members and other moldings come in random lengths. Remember that the longest pieces should be reserved for the longest distances to be trimmed to avoid unsightly patching and piecing of trim.