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PRACTICAL SHEET METAL LAYOUT

Round Fittings Used Today including
Methods and Techniques of Fabricating Round Work

RICHARD S. BUDZIK



4TH EDITION

PRACTICAL SHEET METAL LAYOUT

Round Fittings Used Today

including
Methods and Techniques of Fabricating Round Work

4TH EDITION

RICHARD S. BUDZIK

Instructor, Vocational Sheet Metal
Prosser Vocational High School
Chicago, IL

May Practical Sheet Metal Layout fulfill its purpose.

For its purpose is to provide you with a practical and logical approach to Sheet Metal Layout Work, along with providing you with very necessary and useful trade information — and something more — to give you confidence in yourself as you use the handbook.

Write us, please, when Practical Sheet Metal Layout has:

1. Helped you help yourself to become a better sheet metal worker
2. Helped you gain confidence in your own abilities



Richard S. Budzik

PRACTICAL PUBLICATIONS

DIVISION OF PRACTICAL PRODUCTS

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PRACTICAL SHEET METAL LAYOUT
Round Fittings Used Today including
Methods and Techniques of Fabricating Round Work

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FOREWORD

In November 1969, a sheet metal book titled "Today's 40 Most Frequently Used Fittings" was introduced to the industry and schools offering sheet metal instruction. In 1972, two more sheet metal books were introduced, and one more was completed in 1981. It is titled "Specialty Items Used Today including Methods of Design, Fabrication and Important Trade Topics."

From November 1969 till today, industry response and acceptance of the books has met with overwhelming approval. School adoptions of the books and quantity orders have come from all over the United States and Canada from schools, unions, and trade associations and in plant company training programs that are responsible for training their members in sheet metal work.

Due to students and apprentices starting at different times of the year as well as the different levels of students within the program, it is often very difficult to explain or demonstrate certain details to all of our students and apprentices. Doing this individually is almost impossible for any instructor due to the lack of time.

These books were organized and written with the primary purpose to help solve much of the problem. The step-by-step instructions reduce questions to a minimum. Equally important, the trade information explains and illustrates the necessary details for layout and fabrication.

In essence, the features of these handbooks have been the reasons that many instructors have chosen to adopt these books either as supplementary material to augment their present program or use them as a permanent course of study, and using other books as supplementary material.

These features include:

- Fittings numbered in order of difficulty
- Written in trade language
- Helpful notes about each fitting
- Special sizes for sheet metal pattern drafting and slightly larger for shop practice
- Isometric drawing with each fitting for clarity
- Visual Table of Contents
- Important information concerning methods and techniques of fabricating round work
- Much trade information never published before
- Well illustrated with many drawings
- Duct systems in each book show how the fittings are used
- Short-cut methods where appropriate
- 5 1/2" x 11" for easy storage in tool box
- Metal spiral binding allows books to lay open flat
- Sturdy covers and heavy paper for durability
- Instructions for making each pattern are labeled separately
- All patterns shown in sequence as they would be laid out in the shop
- All patterns for each fitting are shown including collars, etc.
- Full working views are shown for clarity with special note indicating portion needed - quarter, half, or full working view
- Readily understood with enumerated instructions in step-by-step order rather than in paragraph form
- No flipping of pages or referring to another fitting while making a fitting
- Working drawings are drawn, dimensioned and marked to conform to current industry standards
- All forming information is correct and consistent
- Time-saving valuable charts
- Working drawings of round work have direction of air flow. L.E., and S.E. marked
- Patterns for round work have L.E. and S.E. marked appropriately
- These books contain miscellaneous trade information that explains and illustrates the methods and techniques used for layout and fabrication
- Oblong (flat oval) fittings appropriately placed after the regular fittings
- Author is sheet metal journeyman and instructor

You will not find any other book or series of books that incorporate all of these important features. Also glance through the Table of Contents of each handbook. No other set of books contain all of the miscellaneous trade topics for use in training programs.

- Practical Publications

P R E F A C E

Many of the complicated round fittings that were used years ago are seldomly used today. Due to better engineering and planning, fittings of a simpler nature are used. Since the architects and engineers knew that almost any shape of fitting could be made, they did not adapt themselves as much to considering efficiencies for the sheet metal contractor or workers when planning the systems.

Due to the high cost of labor today, the number of different round fittings used has been reduced to the simplest, most practical fittings that will do the job efficiently.

Due to the increasing costs of labor and materials in recent years, space limitations in modern buildings have restricted or limited the size of ductwork. Therefore, to convey the necessary volume of air within limited space, high pressure ductwork is needed. High pressure ductwork can be made in round, rectangular, or flat oval (oblong) shapes. For high pressure applications, round duct has become the lowest in cost to fabricate and the easiest to erect. This is due to the development of the spiral machine which first appeared on the market in the middle 1950's. This machine has made it economical for the contractor to use more round work. The impact of using spiral duct has become comparable to the impact on the sheet metal industry of machine-made pittsburgh lock seams back in the late 1930's and early 1940's.

The advantages of spiral duct over longitudinal seams on round or flat oval duct provide overall economy since the longer lengths require fewer field connections and the spiral pipe is stronger and more rigid, requiring less duct stiffeners. Consequently, the amount of round work has increased and will continue to increase at an ever-growing rate. Round pipe and oblong pipe that once had to be made by the contractor are now able to be purchased at reasonable prices (much less than it would cost to make in his shop).

Due to the cost of these spiral machines, many shops purchase their round or flat oval duct from a supplier or manufacturer that can provide a variety of sizes. Although there is a trend followed by contractors to purchase as much of a complete ductrun system as possible, they still have to make a majority of their own fittings because of limited sizes, types and gauges of materials available as well as the factor of ordering time. However, much of the pipe can be purchased which comprises a majority of the entire system.

For these reasons, the sheet metal worker should be able to make the round fittings that are most-frequently needed in today's heating, ventilating, and air conditioning systems, which are the round fittings featured in this book.

Flat oval (oblong) duct is also classified as round work and is also currently increasing in use due to the spiral machine. A separate section, appropriately placed after the round fittings, contains the most frequently-used fittings of this type.

Quite often sheet metal workers are not as confident when doing round work as they are when working with rectangular fittings and ducts. This is primarily due to a lack of necessary knowledge about the methods and techniques of laying out, fabricating, and assembling round work. The second part of this book contains the specific trade information on the methods and techniques of fabricating and assembling round work presented in a step-by-step sequence to insure success when learning to do round work.

Many otherwise good sheet metal workers have difficulty with round work--not in doing the layout work, but primarily with fabricating and assembling the pieces. This is mainly due to the fact that they were never exposed to some of the helpful suggestions and aids that are so important when fabricating round work efficiently.

If you follow the specific principles outlined in this section, you will soon begin to have more success which will give you confidence in yourself when doing round work. Round fittings that require triangulation are covered in the book titled *Fittings Used Today that Require Triangulation*.

FEATURES OF THIS BOOK

The second part of this book contains the specific trade information on the methods and techniques of fabricating and assembling round work, presented in a step-by-step sequence to insure success when learning to do round work. Diagrams and drawings are appropriately-placed throughout the pages of trade information to clearly illustrate what is being explained.

An important feature of this book is the proper sequence so necessary for success in sheet metal layout. The instructions for some of the fittings contain many steps. This was done so that it is easy to follow, so there will be no confusion, doubts or questions when first learning and so that it is not necessary to refer to any other fitting for part of the instructions. When you are using the book merely as a reference, you will find that you probably just need to glance at the patterns, not the step-by-step instructions.

These step-by-step instructions are particularly helpful when there is not an instructor available.

This book is a convenient reference for the experienced sheet metal worker who occasionally has some difficulty with a particular fitting or pattern. The instructions for making each specific pattern can be found at a glance without reading through the other instructions. The person who is referring to the book as a reference frequently needs only to look at the drawings of the patterns and not go through the step-by-step instructions. He already is familiar with the basic layout procedures but might not remember how a specific pattern is developed or point is obtained.

This book also has another special feature which is extremely helpful to the beginner as well as the experienced sheet metal worker who uses the book as a reference. Each projection and development line is designated with an arrowhead to show the direction in which it is drawn.

Most of the full working views in this book are only drawn for illustrative learning and instructional purposes. The instructions for each fitting include what portion of the working view or views must be drawn such as quarter, half, or full working view or views.

The Visual Table of Contents which is opposite the regular Table of Contents is similar to the cover of the book, but it indicates the page on which to find the instructions for the fittings. It is especially helpful because it eliminates the necessity of looking through the entire book to find the required fitting. This is also helpful due to the fact that the names of the fittings are not standardized--people refer to the same fitting by different names.

Pages 189-193 contain practical charts and formulas along with helpful descriptive diagrams when doing round work. The time it takes to familiarize yourself with these charts and formulas so you feel comfortable using them will be well worthwhile due to the time and labor saved when doing the layout work, if you will be doing a lot of round work.

The book lays open flat with all the instructions and patterns across from each other and in the order that the patterns are laid out. Due to its size, it can be easily kept in the tool box. On each fitting there is a note that explains the variations that might be required when making the fitting. All working drawings and patterns in this book conform to current trade practices. This means that no unnecessary lines have been drawn; this saves time when laying out the patterns. All layout lines, marking and forming instructions are consistently placed on the inside of each fitting. In this way, they will be on the inside of the assembled fitting and are easier to understand.

With the instructions for each fitting, both a working drawing and an isometric sketch (perspective drawing) are shown for clarity.

The special oblong fitting section includes the most frequently-used fittings appropriately placed after the round fittings--as a separate section.

It is the purpose of this book to provide the sheet metal industry with a practical approach to laying out today's most frequently-used round fittings. It eliminates the fear or mystery which often accompanies the term "round work."

Richard S. Budzik

-Sheet Metal Apprentice and Journeyman

-Sheet Metal Instructor

Prosser Vocational High School, Chicago

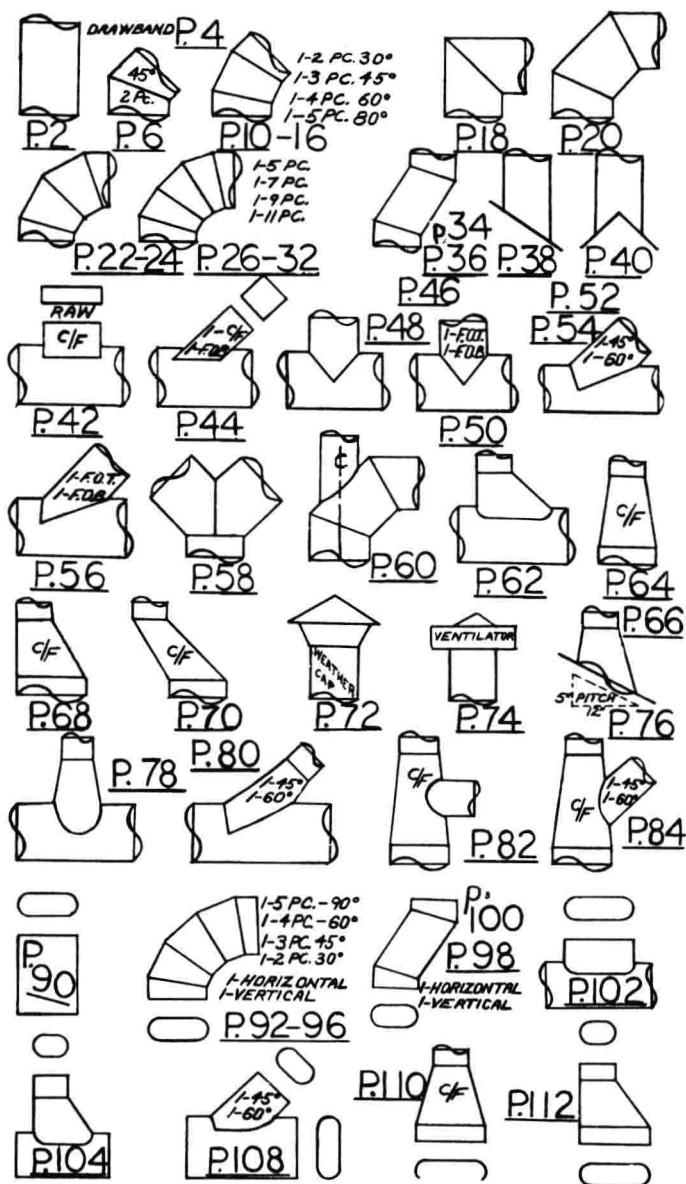
PREFACE TO THE THIRD EDITION . . .

- A Supplemental Section has been added.
- In the step-by-step instructions, words have been underlined so the reader will readily see and understand how they relate to the developed patterns.
- All isometric drawings on instruction pages have been shaded.
- Developed patterns that require more steps and time to complete have arrowheads inserted in order to see the direction the line was drawn.

PREFACE TO FOURTH EDITION

Several items have been added to the Supplemental Section.

Visual Table of Contents



SUGGESTIONS FOR MAKING PRACTICE FITTINGS

1. Make the fitting using the dimensions given on the working drawing of the instructions for each fitting.
2. Make the fitting using the dimensions given on the practice fittings at the back of the book.
3. Make the fitting using the dimensions given on the blueprint or drawing of the ductrun system at the back of the book.

Sketch the fitting on a sheet of paper, insert the dimensions, and place this paper above the instructions for that particular fitting.

This ductrun system gives you the following learning experiences:

- a. Learning how to take the necessary dimensions off a drawing. This is often referred to as listing a fitting.
- b. Help in sketching the shape of the required fitting, properly labeling direction of air flow, and labeling Large End (L.E.) and Small End (S.E.).
- c. Make each fitting.
- d. Connecting the fittings into a run of ductwork.

SUGGESTIONS FOR MAKING PRACTICE FITTINGS ON PAPER

1. For practice purposes, it is helpful to layout the patterns on paper using drafting instruments and equipment. You would need a drafting board, T-square, 45° angle, 30°-60° angle, compass, dividers, 12" ruler, pencils, eraser and tape for securing the paper to the board.
2. Extreme perfection and neatness are not necessary but be sure you are accurate.
3. Use the abbreviations listed in "Suggestions for Marking Patterns" on the next page. In this way, you will already be in the habit of using them when working in the shop.
4. Label the dimensions on each pattern rather than using the labels in the book such as pipe diameter, tee diameter, length, circumference. Do not label circumference on a pattern. Simply label the diameter and whether it is S.E. (Small End) or L.E. (Large End).
5. Due to many different allowances used for seams and edges, dimensions for these have been purposely omitted in this book. When making practice fittings on paper, get into the habit of using the allowance you use in the shop where you work.

SUGGESTIONS FOR MARKING PATTERNS AND SEAM ALLOWANCES

Before laying out or fabricating any fitting, be sure to familiarize yourself with the necessary miscellaneous trade information. The time it takes to read this will be well worth while.

When doing round work or layout work with a considerable number of development points, it is a good habit to number the points as you are developing the pattern or patterns. It is also a good practice to mark the ends L.E. (Large End) and S.E. (Small End), and to mark the diameter of the end, for example: 5" dia. S.E.

Always mark forming information on the inside so that when the patterns are formed, it will be to the inside of the fitting.

If the fitting you are to make is numbered, place the same number on each pattern of the fitting.

If you are given a sketch or drawing of a ductrun which contains several fittings that will be attached to one another, it is helpful to number the fittings consecutively so there is no confusion when they are put together.

A.F. - Air Flow Direction

C/F - Center flare or E.T. equal taper

F.O.T. - Flat on top or S.O.T. straight on top or T.F. top flat

F.O.B. - Flat on bottom or S.O.B. straight on bottom or B.F. bottom flat

PATT. - Pattern

STR. - Straight

DN - Down

K - Kink

R - Roll

REQ. - Required

L.E. - Large end

S.E. - Small end

DIA. - Diameter

R - Radius

PC. - Piece



- round work symbol



- symbol for horizontal oblong
(flat oval)



- symbol for vertical oblong
(flat oval)



- symbol for centering a tee on
pipe, etc.

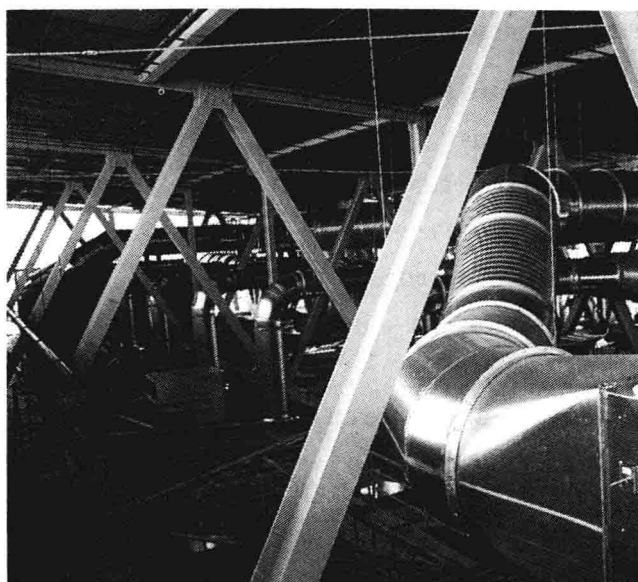
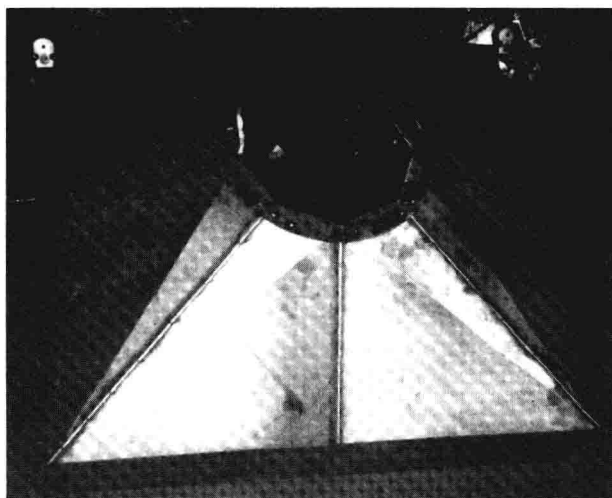
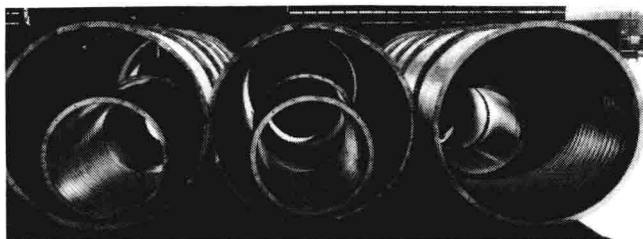
The following suggestions should be noted when making the fittings in this handbook:

1. When making a riveted elbow, angle or offset or any other fitting that requires flanging (stretching or shrinking), use 24 gauge or heavier metal.
2. If you want to avoid flanging on elbows, angles, or offsets, collars to square-to-rounds or tapers, use an elbow edge lock seam. Make the fitting out of 26 gauge or lighter metal.
3. To avoid flanging the tee when making a tee joint, simply use tabs on opposite ends, as shown on Fitting 14A rather than a complete flange as shown in Fitting 14. This method is much easier and faster.
4. When laying out and fabricating tee joints, do not place the rivet holes on the pipe pattern for attaching the tee joint, due to forming the flanges and the factor of metal thickness. It is often very difficult to get the holes to line up perfectly.
5. Remember when doing any flanging, it is easier to flange a small allowance than a large one. For riveted elbows, angles, or offsets, use 1/4" riveted lap seams. This also applies to collars of tapers and square-to-rounds or any other round tapering fittings.

Seam allowances vary from shop to shop due to the various methods and techniques used to fabricate round work, as well as the variety of machinery available. When drawing these fittings on paper, use the seam allowance you normally would use in your shop. When making these fittings, due to the smallness in size, use these suggested dimensions for seam allowances:

Seam	Allowance
Riveted lap seams	1/4"
Crimped end or beaded end	1"
Elbow edge (single edge)	3/16"
Elbow edge (double edge)	3/8"
Flange allowance on T-joints	1/2"
Rivet line	1/4"
Notched flange allowance on pipe pattern for tee opening	1/4" or 3/8"
Tabs on T-joints	1/2" x 1/2"

HVAC Sheet Metal Work



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