MODERN LAYOUT

"CHALLENGING layouts made EASY"

ADVANCED METAL LAYOUT

USING THE HP-41 CALCULATOR

VOLUME 1

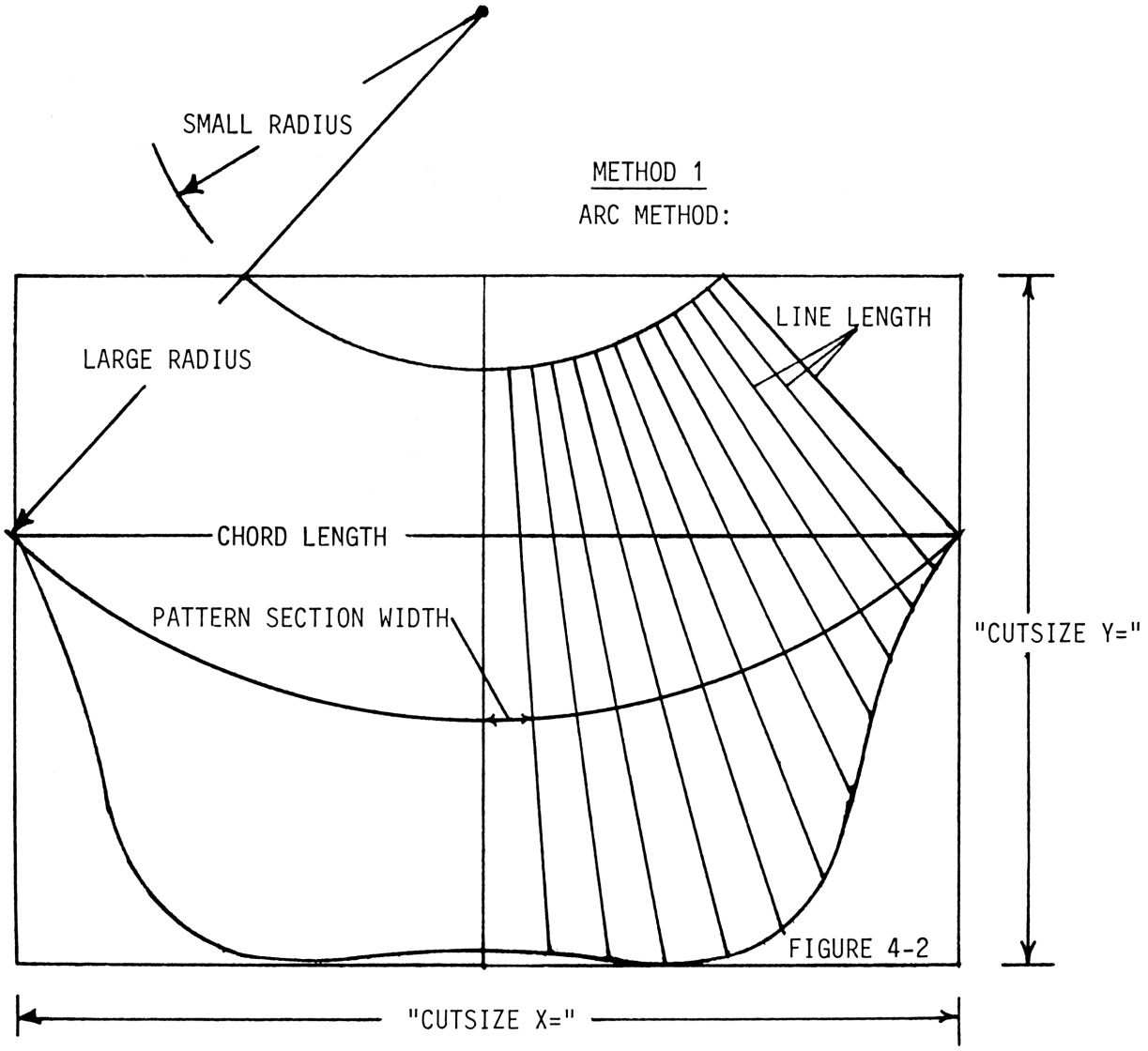


FIGURE 4-2

by John E. Hibbard

ACKNOWLEDGEMENTS!!

I wish to thank the following people who have helped me with this project.

Sheldon Hutchison; For his programming and technical writing.

Lollie Hutchison: For her typing.

Ivo Saul: For his consultation.

And my family for their support.

TABLE OF CONTENTS

PART I

THE SYSTEM

INTRODUCTION

Congratulations, you have purchased a system that can be a powerful tool in the sheetmetal and pipe-fitting trades. With this tool, some of the more difficult fittings encountered can be easily constructed by anyone with a minimal knowledge in the construction trades. This system was designed to increase the effectiveness and thus, the competitiveness of the American work force.

Your system consists of an HP-41 calculator, an HP infrared printer, and our plug-in software module. The Hewlett-Packard products are very useful to those who become familiar with them. Though the HP-41 is referred to as a calculator, it is really a powerful hand held computer. We suggest that you read the section in this manual....OPERATING THE HP-41....and that you take some time to study the HP-41 owners manual as well. The more you learn about all parts of your system, the more it will do for you.

The HP-82240A Infrared Printer is easy to operate. Read the section in this manual....OPERATING THE PRINTER....and the owners manual to familiarize yourself with the printer and it's operation.

All of the programs described in the manual are contained in the plug-in module that comes with this system. When you place the module into one of the calculator ports, you will have immediate access to the programs. All of the programs in this package have been designed to guide you through arc method layout. This method is based on using intersecting arcs and true lengths, which are the most common approaches to layout. Those with previous layout experience should find our arc method simple and easy to follow. Some of the programs, however, offer x-y coordinate layout. The x-y coordinate approach is a method even better suited to computer layout. Briefly, this method consists of making your cut size into a x-y coordinate system, plotting the given points, drawing the pattern by connecting the points, then cutting out and assembling your fitting. After using this method, we feel you will find it to be easier and faster then the arc method. Now, read on to the next section to see how to assemble your system.

ASSEMBLING THE SYSTEM

1) Install batteries in the printer and calculator if necessary.

2) IMPORTANT: THE CALCULATOR MUST BE TURNED OFF ANYTIME YOU INSTALL OR REMOVE MODULES.

Check to see if the HP 82242A printer module and the program module have been installed in the calculator. If not, put them in yourself.

3) If necessary place a roll of paper in the printer. Follow the instructions given in the HP operators manual.

4) Set up your system as follows:
The infrared sensor located on the bottom of the printer is "visible" to the top of the calculator.

5) Turn on your equipment and go on to the next section.

OPERATING THE HP-41

The following is intended to provide the minimum amount of knowledge required to operate your system. We recommend that, as time permits, you study the HP-41 owner's manual to become familiar with the total scope of its operation.

A) PREPARATION

1) Check to insure that the printer module and the program module are installed.
2) With the calculator and the printer turned on, do the following:

Press the XEQ button
Press the ALPHA button
Type KEY into the calculator display
Press the ALPHA button again

Your printer is ready to use.

B) PROGRAM EXECUTION

When you have selected a program to use, do the following:

Press the USER button
Press the START button
Press the program button for the fitting that you want. The button is below the program name.

The program will start executing. Answer each question you are asked, these are the inputs. Push the R/S button after each answer. ALL INPUTS MUST BE IN THE SAME UNITS, for example, in inches. After the outputs have all been printed, shut the calculator and printer off. OUTPUTS WILL BE IN THE SAME UNITS AS THE INPUTS. With the information given, construct the pattern according to the appropriate instructions.

OPERATING THE PRINTER

Your HP-82240A printer is very easy to use; there are only three buttons to control its operation. The left most button turns it on and off, the center button controls the darkness of the print, and the right most button advances the paper.

It's time to get on with familiarizing yourself with the programs. Go on to Part II THE PROGRAMS.

PART II

THE PROGRAMS

This section describes all of the programs and their operations. This is a very important section since operating the programs incorrectly will result in erroneous information for fitting construction. Each part of the instructions has been designed to make operation as simple as possible.

The following is a step by step explanation of the program instructions.

1) PROGRAM TITLE: is the program name that is on the overlay on the calculator.

2) PURPOSE: Gives a brief explanation of what the program does.

3) INPUTS: Describes the information you must feed into the program. The first line is capitalized and gives a description of the desired input.
The second line shows, in quotes, what the calculator displays when it is asking you for the information.
Following the quotes there is a paragraph that gives a more detailed description of the required input. NOTE! do not use "7" in PARTS PER. 1/4?

4) OUTPUTS: This follows the same format as the INPUTS. A brief statement of what the output is, followed by a quote of the actual display, and then a more detailed description.

5) CONSTRUCTION: Step by step instructions for constructing the pattern.

Familiarize yourself with program operation by running the CONE program. Get some construction paper and drawing equipment and make a scale model. When you can do the simple programs without problems you will be ready for many of the more advanced ones. CAUTION: The SQUARE TO ROUND PROGRAM is the most difficult program in the package, attempting it too early could result in considerable frustration. GOOD LUCK!

CHAPTER 1

CONE

The cone program has an important role in a number of the programs contained in this system, so that it is important to familiarize yourself with it's operation. Using this chapter as an introduction to operating all the programs in the package could prove to be helpful.

PROGRAM TITLE: "CONE"

PURPOSE: Gives the layout for a standard cone that is to be constructed in one piece.

INPUTS: Please refer to the figure 1-1 for an illustration of the inputs to this program.

1) DIAMETER OF TOP
   "DIA.OF TOP ?"
   Enter the inside diameter of the top of the cone.
   IMPORTANT: If 16 gauge or thicker material is used, enter the number equal to the inside diameter PLUS the material thickness.

2) DIAMETER OF BOTTOM
   "DIA.OF BOT.?"
   Enter the inside diameter of the bottom of the cone.
   IMPORTANT: If 16 gauge or thicker material is used, enter the number equal to the inside diameter PLUS the material thickness.

3) HEIGHT OF CONE
   "HEIGHT ?"
   Enter the perpendicular distance from the top diameter to the bottom diameter.

OUTPUTS: Refer to figure 1-2 for a better understanding of the outputs.

1) SMALL RADIUS

"SM.RAD.="

This is the radius of the arc that forms the top of the cone.

2) LARGE RADIUS

"LG.RAD.="

This is the radius of the arc that forms the bottom of the cone.

3) CORD LENGTH

"SM:PC:CORD="

"LG:PC:CORD="

This is the length of the cord that determines the diameter of the cone. You will notice from figure 1-2 that TWO possible situations occur. In either situation, the cord length is used to determine the arc length of the large radius.

4) CUT SIZE

"CUT SIZE="

"X="

"Y="

X is the width and Y is the height of the piece of material the cone is to be cut from.

CONSTRUCTION: Refer to figure 1-2 while following the steps below.

CONE

1) MARK THE CUT SIZE
It should be a rectangle X inches wide and Y inches high.

2) MAKE A PERPENDICULAR BISECTOR
Draw a line up through the middle of your cut size.

3) MAKE THE LARGE RADIUS
Set your compass for the large radius.
Set the marking end of your compass at the bottom of your cut size on the bisecting line.
Set the point of your compass on the bisecting line.
Swing as large an arc as your cut size will allow.

4) MAKE THE SMALL RADIUS
Set your compass for the small radius.
Set the point of your compass in the same spot used to make the large radius.
Swing as large an arc as your cut size will allow.

5) DRAW THE CORD DETERMINING THE ARC LENGTH OF THE LARGE RADIUS

GIVEN CORD LENGTH: "LG:PC:CORD=" REFER TO FIGURE 1-2
GIVEN CORD LENGTH: "SM:PC:CORD=" REFER TO FIGURE 1-3

Draw the cord, of the given length above, so that it is bisected by the line up through the cut size and spans the large radius. Refer to step #2 above.

6) CONNECT THE ENDS
Connect the end points of the large radius (the ends of the cord) to the small radius with straight lines that intersect the center point.

7) CUT OUT PATTERN ASSEMBLE
Cut out pattern, roll it and join the ends.

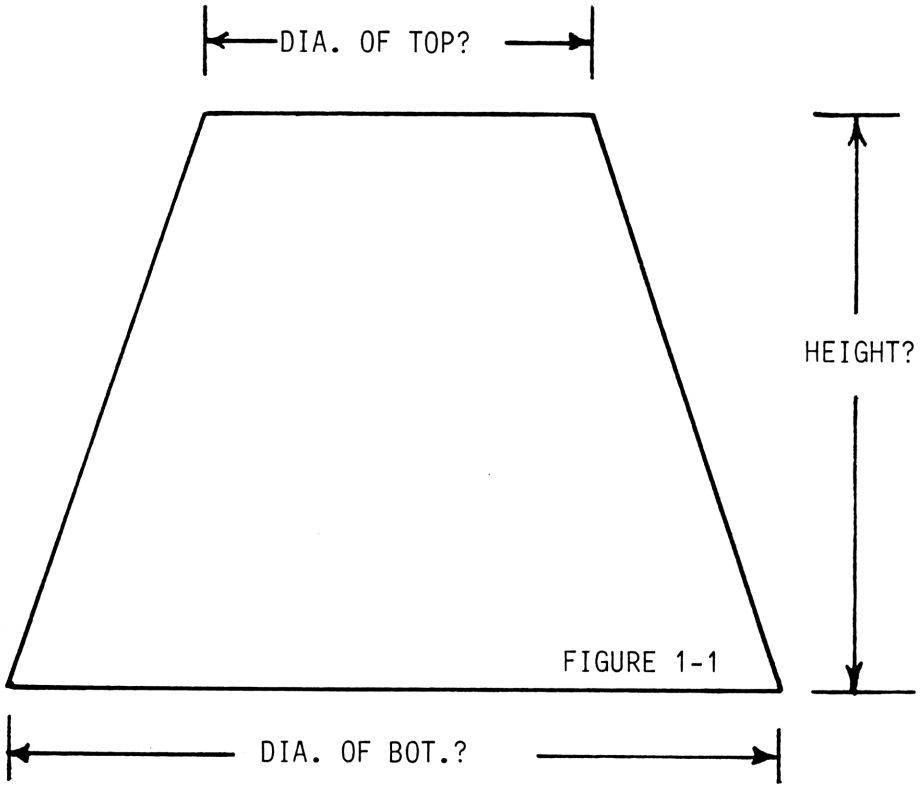


FIGURE 1-1

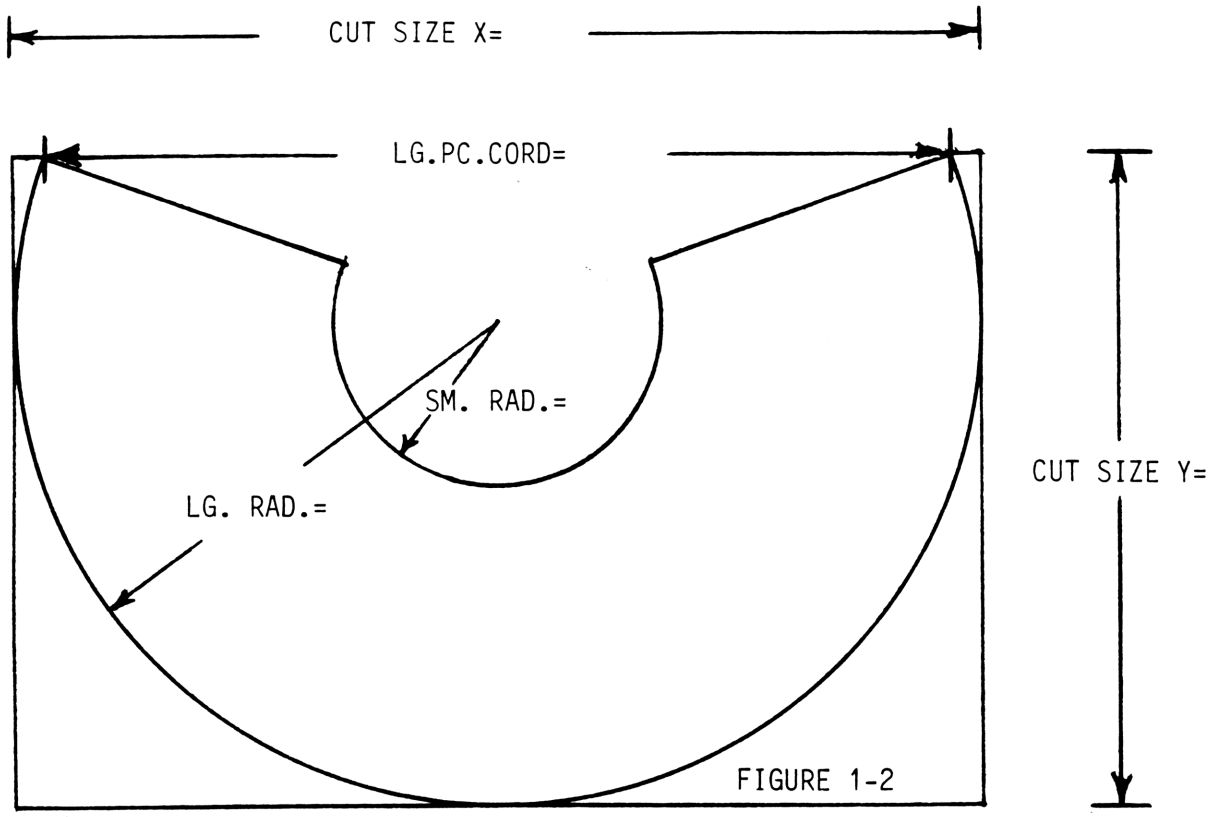


FIGURE 1-2

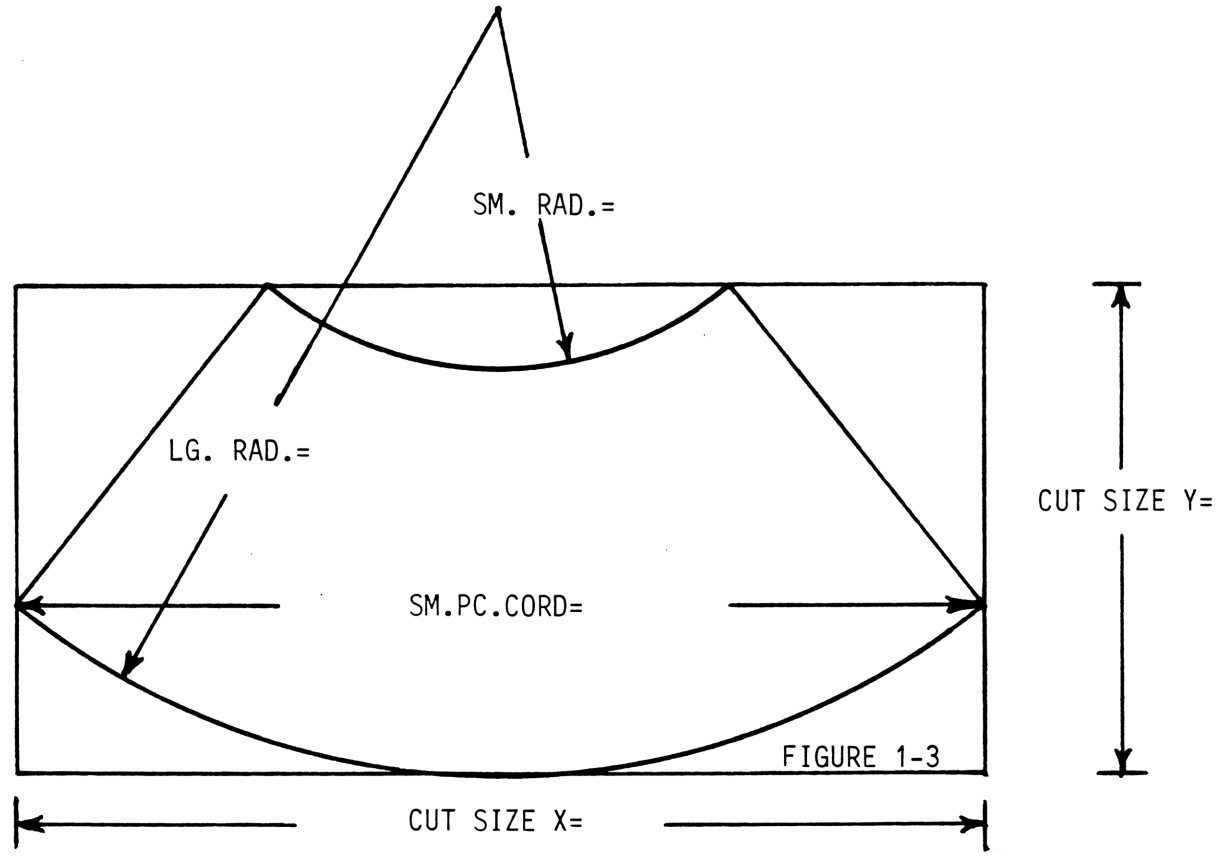


FIGURE 1-3

CHAPTER 2

CONE 2

PROGRAM TITLE: "CONE 2"

PURPOSE: Gives a multipiece cone construction.

INPUTS: Refer to figure 2-1.

1) DIAMETER OF THE TOP
   "DIA.OF TOP?"
   Enter the inside diameter of the top of the cone.

2) DIAMETER OF THE BOTTOM
   "DIA.OF BOT.?"
   Enter the inside diameter of the bottom cone.

3) HEIGHT OF THE CONE
   "HEIGHT ?"
   Enter the perpendicular distance from the top diameter to the bottom diameter.

4) NUMBER OF PIECES
   "NMBR. OF PC.?"
   Enter the number of sections you desire to make the cone.

5) PARTS PER PIECE
   "PARTS PER PC.?"
   Enter the number of segments you desire the pattern divided into. A typical number is 8. The higher the number, the greater the accuracy of your pattern. Refer to figure 2-3. You must, however, use only even numbers.

OUTPUTS: Refer to figure 2-2 and 2-3.

1) W LENGTH
   "W="
   Refer to figure 2-2.

2) Z LENGTH
   "Z="
   Refer to figure 2-2.

3) TOP POINTS
   "TOP POINT1="
   "X="
   "Y="
   Refer to figure 2-3.

4) BOTTOM POINTS
   "BOT.POINT1="
   "X="
   "Y="
   Refer to figure 2-3.

5) CUT SIZE
   "CUT SIZE="
   "X="
   "Y="
   Refer to figure 2-2.

CONSTRUCTION: Refer to figure 2-2.

CONE 2

1) Take a scrap piece of metal or cardboard, measuring half the X length by one Y length.

   Using the top of the metal for your X axis and using the LEFT side of the metal or cardboard as the Y axis.

   Plot all the top points and the bottom points and connect all points.

   Cut pattern out and place pattern on appropriate cut size.

   Refer to figure 2-2 for a clearer understanding.

2) Cut the pieces out of the cut size, then join the pieces together. Roll and join the seam.

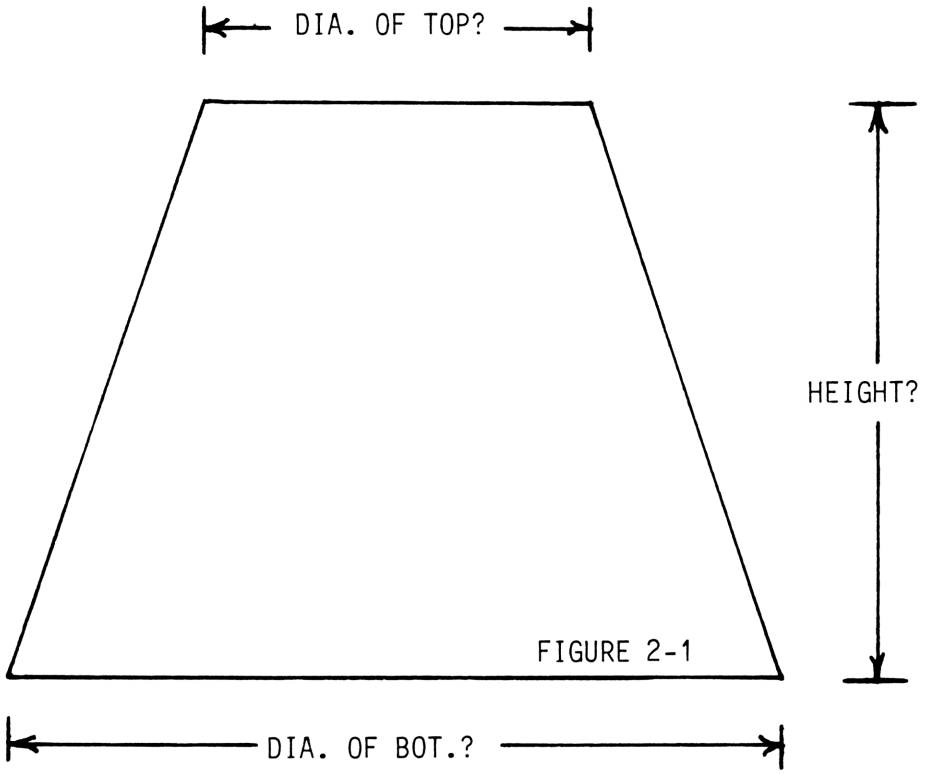


FIGURE 2-1

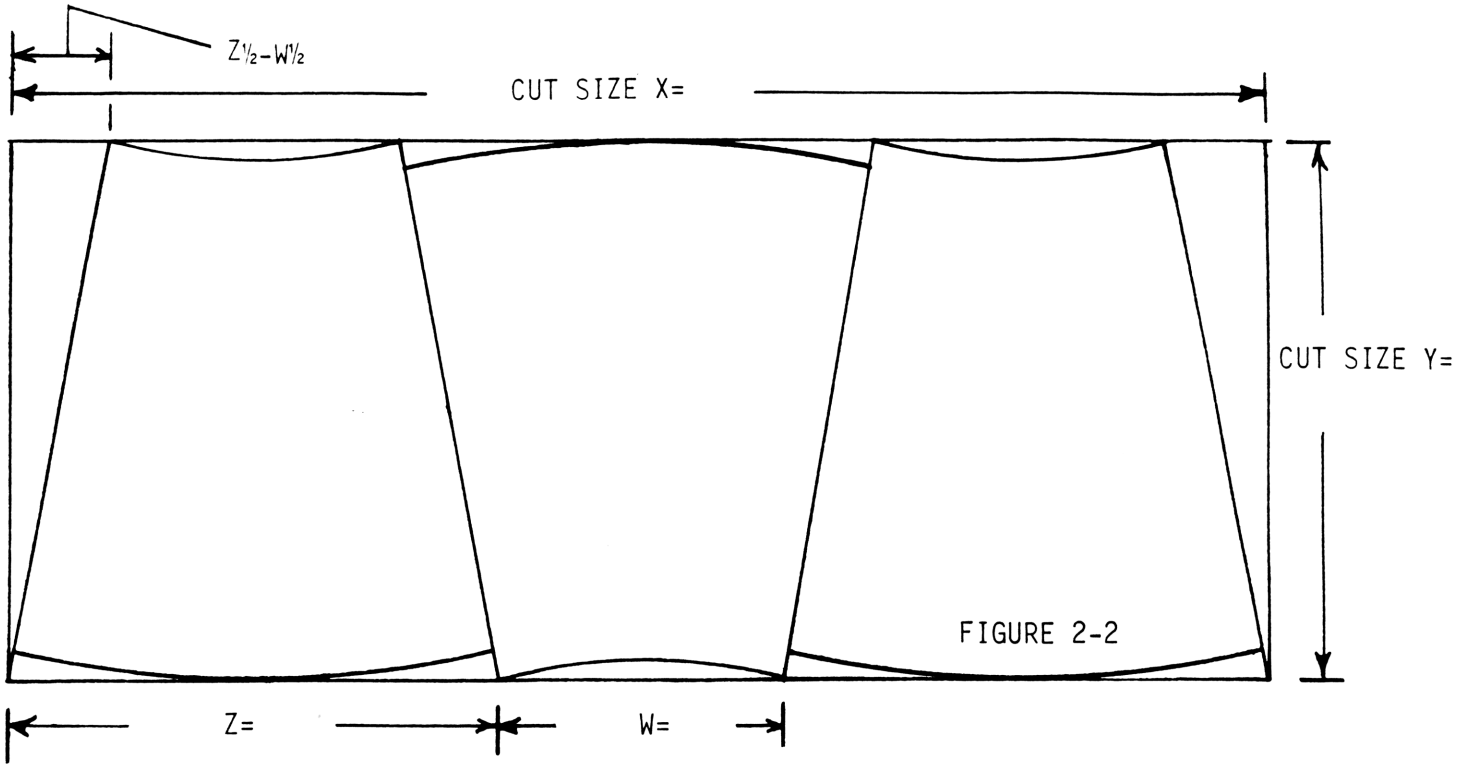


FIGURE 2-2

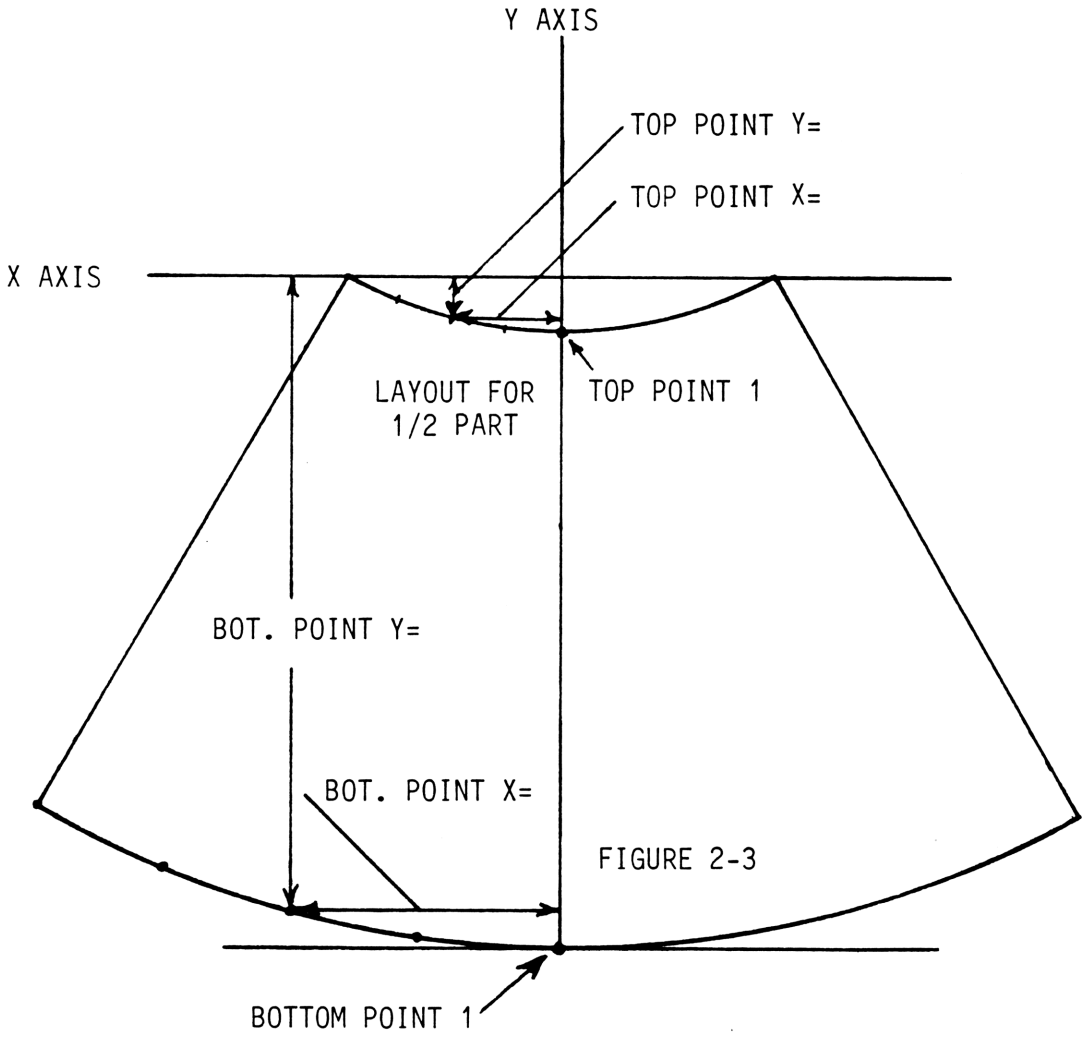


FIGURE 2-3

CHAPTER 3

ROOF CONE

PROGRAM TITLE: "RF CONE"

PURPOSE: Gives the layout for a cone on a flat angled surface.

INPUTS: Refer to figure 3-1.

1) DIAMETER OF THE TOP
   "DIA. OF TOP?"
   Enter the inside diameter.

   NOTE: If 16 gauge or thicker material is used, enter the inside diameter PLUS the material thickness.

2) DIAMETER OF THE BOTTOM
   "DIA. OF BOT.?"
   Enter the inside diameter. Please note, the inside diameter is the diameter of the cone where the cone and the roof first meet. Refer to figure 3-1.

   NOTE: If 16 gauge or thicker material is used, enter the inside diameter PLUS the material thickness.

3) HEIGHT OF THE CONE
   "HEIGHT?"
   Enter the vertical distance from the top diameter to the bottom diameter.

4) ANGLE OF THE FLAT SURFACE
   "ANGLE?"
   Enter the angle, in degrees, of the incline of the flat surface that the cone is to be mounted on.

INPUTS: Refer to figure 3-1

5) DO YOU WANT X,Y, COORDINATE SYSTEM?
"DO YOU WANT X,Y, COORD.?"
IF YES: TYPE IN "YES".....This gives all your points in a X,Y, coordinate measuring system.
IF NO: TYPE IN "NO".....This gives you the true length measurements.

6) PARTS PER QUARTER PATTERN
"PARTS PER.1/4?"
Enter the number of parts per quarter pattern you desire. The higher the number, the greater the accuracy.

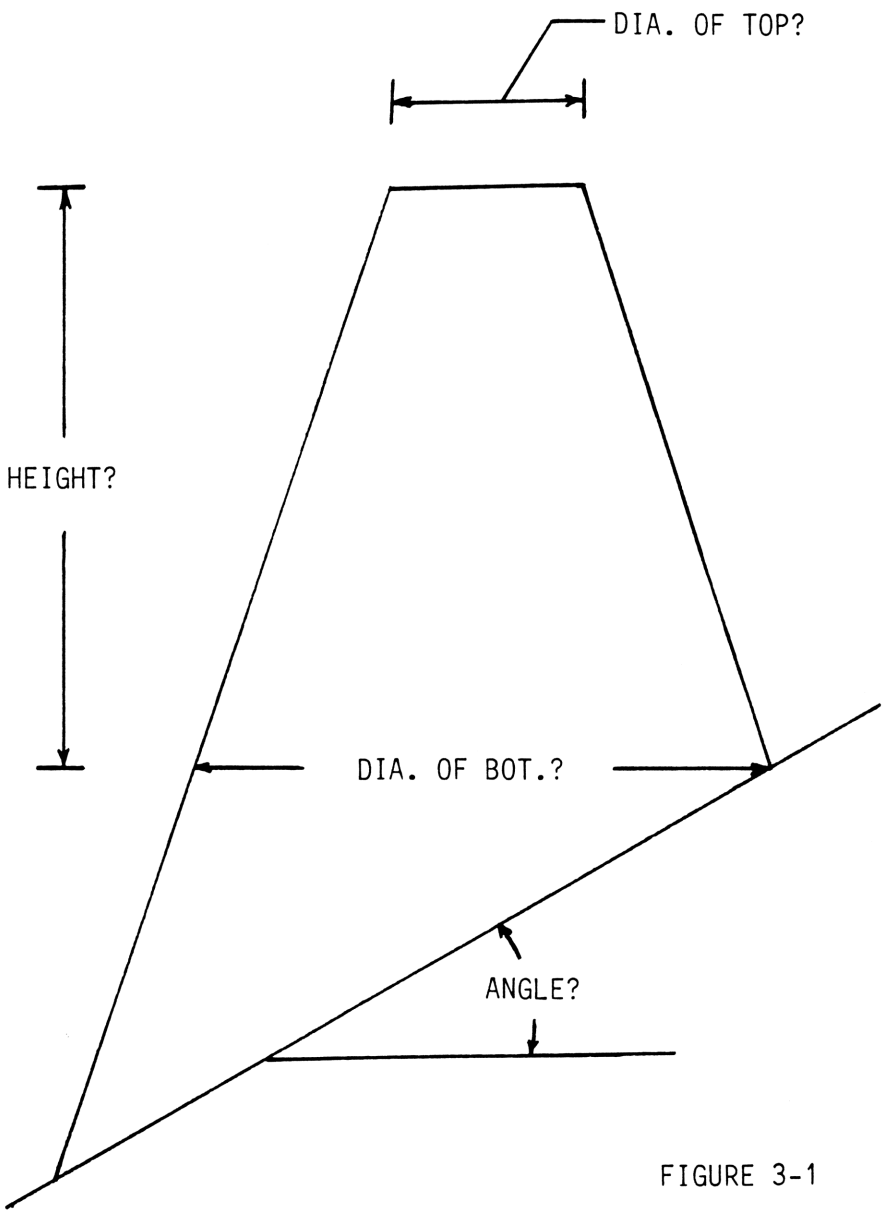


FIGURE 3-1

OUTPUTS: Refer to figure 3-2.

ARC METHOD 1

1) SMALL RADIUS

"SM.RAD.="

Radius of the arc that forms the top of the cone.

2) LARGE RADIUS

"LG.RAD.="

Radius of the arc that forms the bottom of the cone.

3) CORD LENGTH

"SM:PC:CORD="

"LG:PC:CORD="

This is the length of the cord that determines the diameter of the bottom of the cone.

4) PATTERN SECTION WIDTH

"BOT.DIA.="

"1/N.CIR.="

This number is the distance between the lines used to make the pattern as they pass through the large radius.
Where N is equal to four times the number of parts per quarter.

5) LINE LENGTH

"LINE:1.="

"LINE:2.="

ETC.

These are the length of the lines used to make the pattern.

6) CUT SIZE

"CUT SIZE="

"X="

"Y="

X is the width and Y is the height of the piece of material that the cone is to be cut from.

OUTPUTS
METHOD 2
X, Y,
SYSTEM:

Refer to figure 3-3

1) TOP POINTS
"TOP PT.1=X-Y,"
"TOP PT.2=X-Y,"
etc.
These are the coordinates for the points that form the top of the cone.

2) BOTTOM POINTS
"BOT.PT.1=X-Y,"
"BOT.PT.2=X-Y,"
etc.
These are the coordinates for the points that form the bottom of the cone.

3) CUT SIZE
"CUT SIZE="
"X="
"Y="
This is the width and the height of the piece of material the cone is to be cut from.

METHOD 1
CONSTRUCTION
ARC METHOD:

Refer to figure 3-2

1) MAKE THE SMALL RADIUS
Make a half circle with the radius equal to the "SMALL RADIUS" given above.

2) MAKE THE LARGE RADIUS
Using the same center point from Step 1 above, swing an arc with radius equal to "LARGE RADIUS". Make the arc as large as is possible.

3) MAKE A CENTER LINE
Starting at the center point of your radius, make a straight line down to bisect the small and large radius arcs.

4) DRAW THE CORD
Draw a cord, of length given above that is bisected by the center line and spans the large radius. Refer to OUTPUTS #3, method 1.

5) MARK THE INTERSECT POINTS
Starting on one of the points where the cord meets the large radius, divide the large radius into lengths equal to the PATTERN SECTION WIDTH calculated above. See OUTPUTS #4, method 1.

6) CONNECT THE ENDS
Connect the end points of the large radius (the ends of the cord) to the small radius with straight lines that pass through the center point.

7) DRAW THE PATTERN LINES
Starting with the first point, marked on the radius, in from the end points, lay a straight edge connecting this point to the center point. Now draw a line, equal in length to LINE:1, from the small radius through the large radius. Do this again with the next mark in on the large radius and make the line length equal to LINE:2. The last line length given is for the center line.

8) CONNECT THE LINES
Connect the ends of the lines you drew with a smooth curve.

CONSTRUCTION: Refer to figure 3-3.

ROOF CONE X,Y, COORDINATE SYSTEM

1) DRAW THE CUT SIZE
Draw a rectangle with the dimensions of your cut size.

2) DRAW THE Y AXIS
Draw a line down through the center of your rectangle,, this is your Y-axis. The top of the rectangle is your X-axis

3) LOCATE THE TOP POINTS
Locate the points that form the top of the cone by measuring the distance given in your outputs. Measure to the right of the Y-axis for the X distance and measure down from the top for the Y distance.

Do this step again, only now measure to the left of the Y-axis for the X distance.

4) CONNECT THE POINTS
Connect all of the top points with a smooth curve.

5) LOCATE THE BOTTOM POINTS
Locate the points that form the bottom of the cone by using the same process described in step #3.

6) CONNECT THE POINTS
Connect all of the bottom and the top points with a smooth curve.

7) CUTTING THE PATTERN OUT
Cut the pattern along its outer perimeter then roll and join the ends.

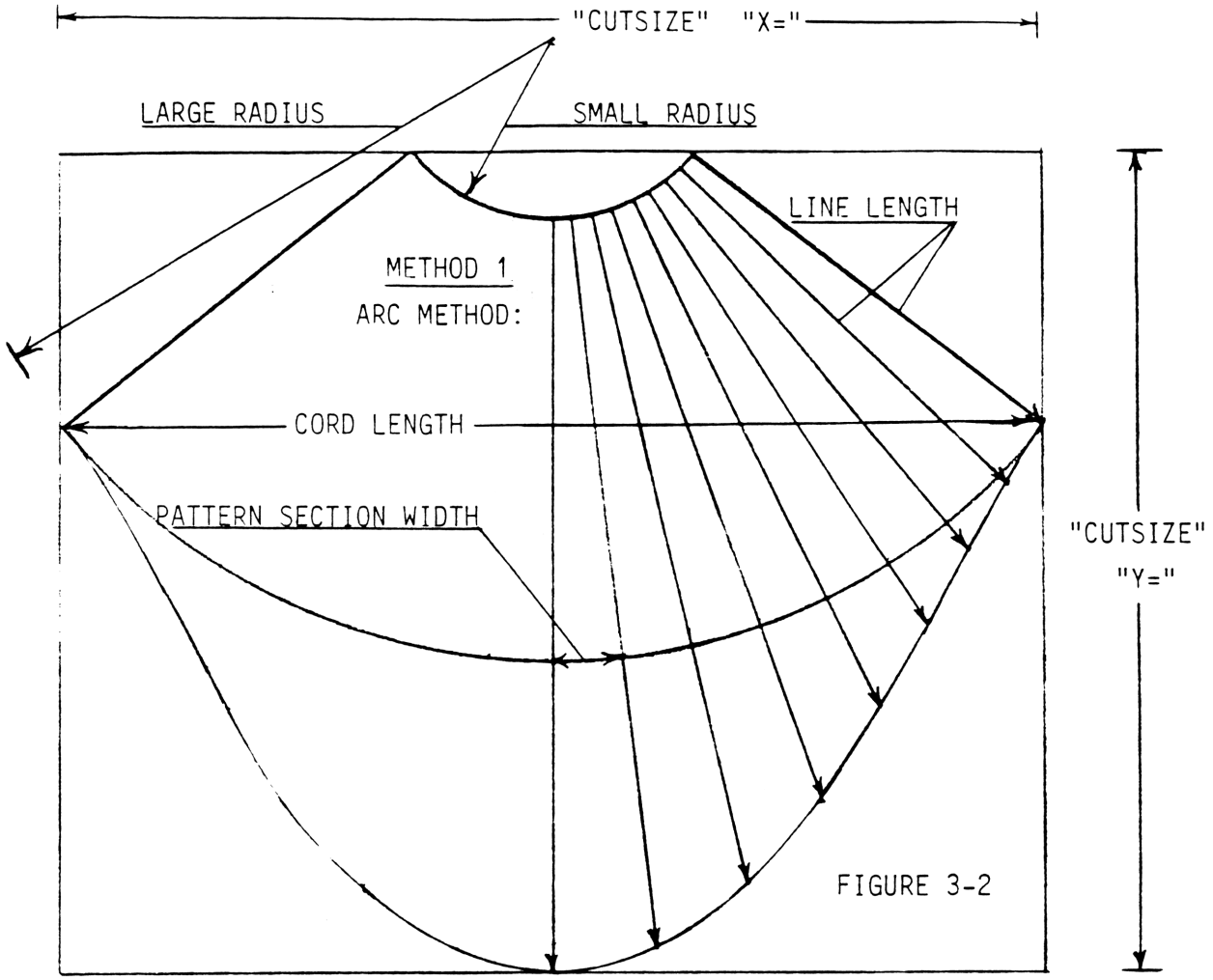


FIGURE 3-2

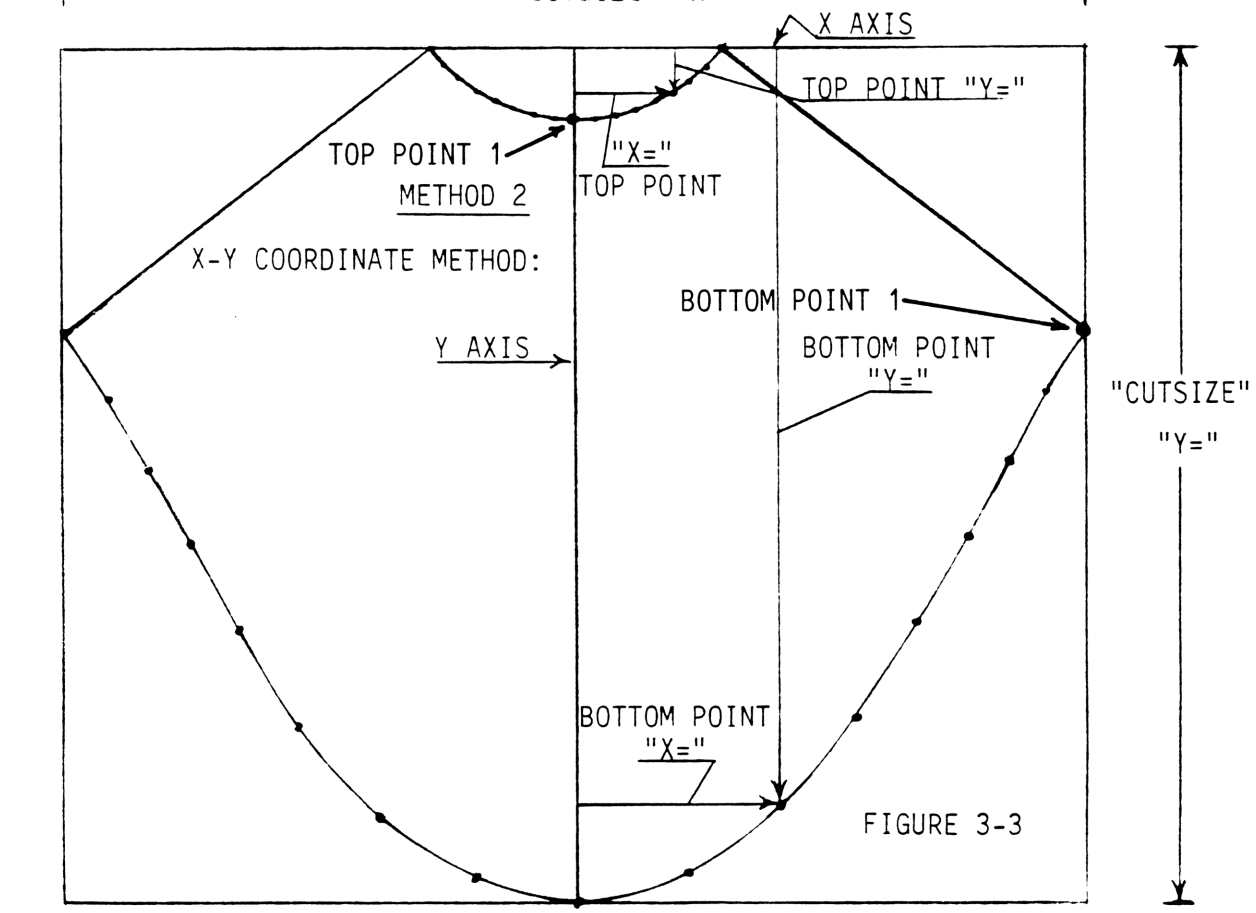


FIGURE 3-3

CHAPTER 4

CONE ON ROUND

PROGRAM TITLE: "C ON R"

PURPOSE: Gives the layout for a cone that is to be attached to a round pipe.

INPUTS: Refer to figure 4-1

1) DIAMETER OF THE TOP
"DIA. OF TOP?"
Enter the inside diameter of the opening at the top of the cone.
IMPORTANT: If 16 gauge or thicker material is used, enter the inside diameter PLUS the wall thickness.

2) DIAMETER OF THE BOTTOM
"DIA. OF BOT.?"
Enter the inside diameter of the bottom of the cone.
NOTE: The diameter here is the diameter at the highest cut point on the bottom of the cone.
IMPORTANT: If 16 gauge or thicker material is used, enter the inside diameter PLUS the wall thickness.

3) CONE HEIGHT
"HEIGHT?"
Enter the perpendicular distance between the top diameter and the bottom diameter.

4) DIAMETER OF THE PIPE
"DIA. OF PIPE?"
Enter the outside diameter of the pipe to which the cone is to be joined.

Refer to figure 4-1

5) ANGLE OF THE CONE

"ANGLE?"

Enter the angle, in degrees, between the pipe and the cone.

6) DO YOU WANT X,Y, COORDINATE SYSTEM?

"DO YOU WANT X,Y, COORD.?"

IF YES: TYPE IN "YES".....This gives all your points in a X,Y, coordinate measuring system.

IF NO: TYPE IN "NO".....This gives you the true length measurements.

7) PARTS PER QUARTER PATTERN

"PARTS PER.1/4?"

Enter the number of parts per quarter pattern you desire. The higher the number, the greater the accuracy.

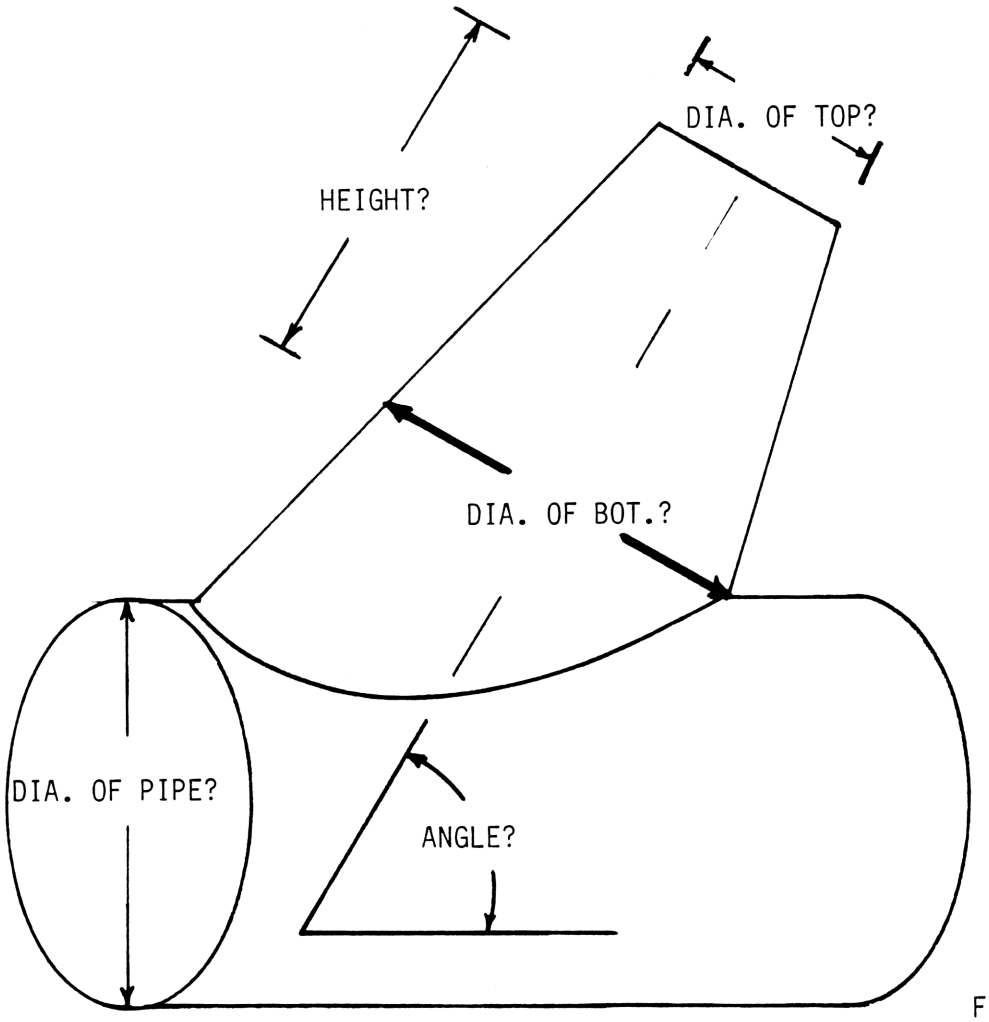


FIGURE 4-1

OUTPUTS: Refer to figure 4-2

ARC METHOD 1

1) SMALL RADIUS
"SM.RAD.="
Radius of the arc that forms the top of the cone.

2) LARGE RADIUS
"LG.RAD.="
Radius of the arc that forms the bottom of the cone.

3) CORD LENGTH
"SM:PC:CORD="
"LG:PC:CORD="
This is the lenght of the cord that determines the diameter of the bottom of the cone.

4) PATTERN SECTION WIDTH
"BOT.DIA.="
"1/N.CIR.="

This number is the distance between the lines used to make the pattern as they pass through the large radius.
Where N is equal to four times the number of parts per quarter.

5) LINE LENGTH
"LINE:1.="
"LINE:2.="
ETC.
These are the length of the lines used to make the pattern.

6) CUT SIZE
"CUT SIZE="
"X="
"Y="

X is the width and Y is the height of the piece of material that the cone is to be cut from.

OUTPUTS
METHOD 2
X, Y,
SYSTEM:

Refer to figure 4-3

1) TOP POINTS
"TOP PT.1=X-Y,"
"TOP PT.2=X-Y,"
etc.
These are the coordinates for the points that form the top of the cone.

2) BOTTOM POINTS
"BOT.PT.1=X-Y,"
"BOT.PT.2=X-Y,"
etc.
These are the coordinates for the points that form the bottom of the cone.

3) CUT SIZE
"CUT SIZE="
"X="
"Y="
This is the width and the height of the piece of material the cone is to be cut from.

IMPORTANT NOTE: IF YOU GET DATA ERROR AS AN OUTPUT THEN IT MEANS THAT ONE OF THE COORDINATES FOR THE SIDE OF THE CONE WILL NOT CONNECT WITH THE SIDE OF THE PIPE.

METHOD 1
CONSTRUCTION
ARC METHOD:

Refer to figure 4-2

1) MAKE THE SMALL RADIUS
Make a half circle with the radius equal to the "SMALL RADIUS" given above.

2) MAKE THE LARGE RADIUS
Using the same center point from Step 1 above, swing an arc with radius equal to "LARGE RADIUS". Make the arc as large as is possible.

3) MAKE A CENTER LINE
Starting at the center point of your radius, make a straight line down to bisect the small and large radius arcs.

4) DRAW THE CORD
Draw a cord, of length given above that is bisected by the center line and spans the large radius. Refer to OUTPUTS #3, method 1.

5) MARK THE INTERSECT POINTS
Starting on one of the points where the cord meets the large radius, divide the large radius into lengths equal to the PATTERN SECTION WIDTH calculated above. See OUTPUTS #4, method 1.

6) CONNECT THE ENDS
Connect the end points of the large radius (the ends of the cord) to the small radius with straight lines that pass through the center point.

7) DRAW THE PATTERN LINES
Starting with the first point, marked on the radius, in from the end points, lay a straight edge connecting this point to the center point. Now draw a line, equal in length to LINE:1, from the small radius through the large radius. Do this again with the next mark in on the large radius and make the line length equal to LINE:2. The last line length given is for the center line.

8) CONNECT THE LINES
Connect the ends of the lines you drew with a smooth curve.

CONSTRUCTION: Refer to figure 4-3

ROOF CONE X,Y, COORDINATE SYSTEM

1) DRAW THE CUT SIZE
Draw a rectangle with the dimensions of your cut size.

2) DRAW THE Y AXIS
Draw a line down through the center of your rectangle,, this is your Y-axis. The top of the rectangle is your X-axis

3) LOCATE THE TOP POINTS
Locate the points that form the top of the cone by measuring the distance given in your outputs. Measure to the right of the Y-axis for the X distance and measure down from the top for the Y distance.

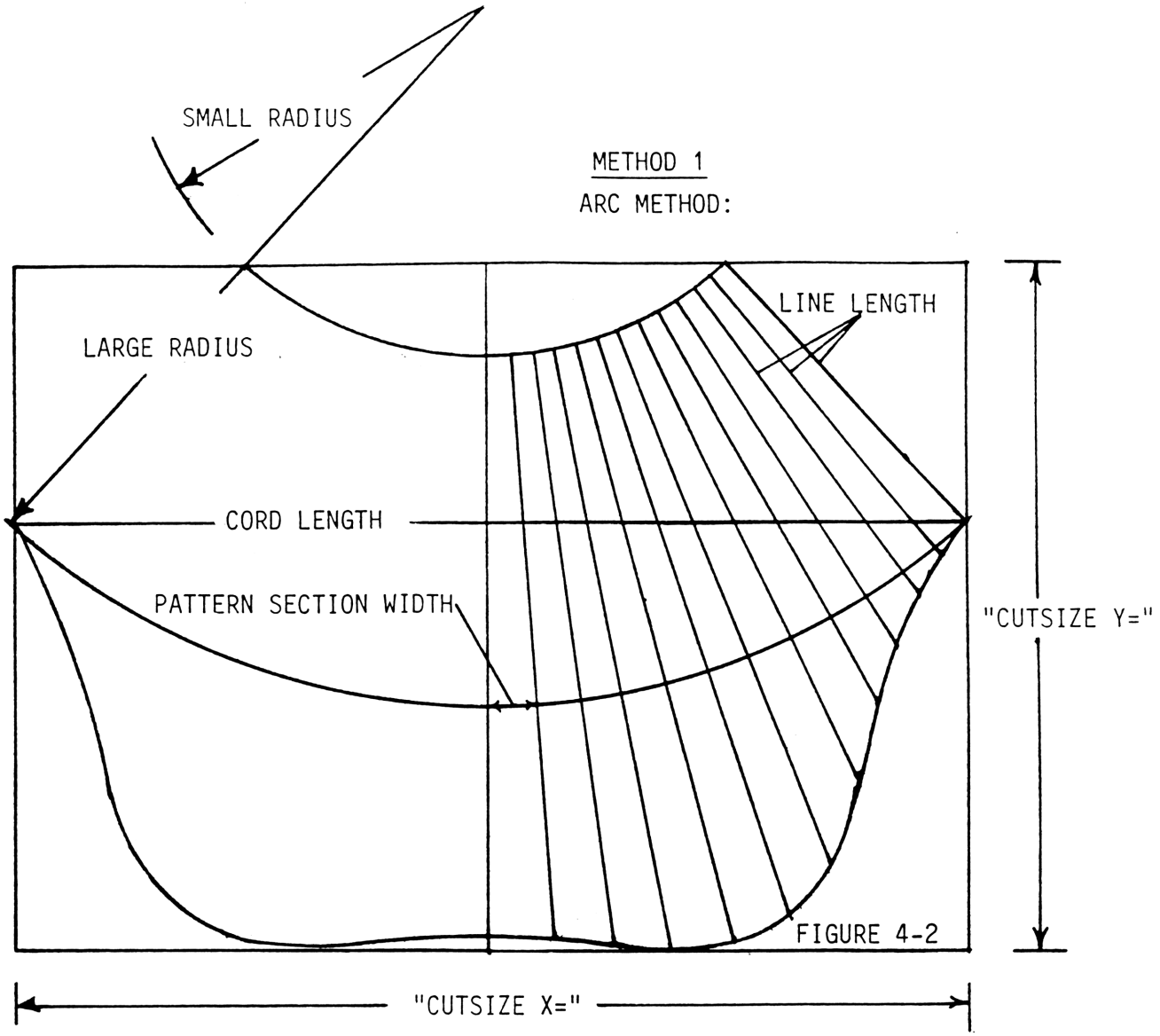
Do this step again, only now measure to the left of the Y-axis for the X distance.

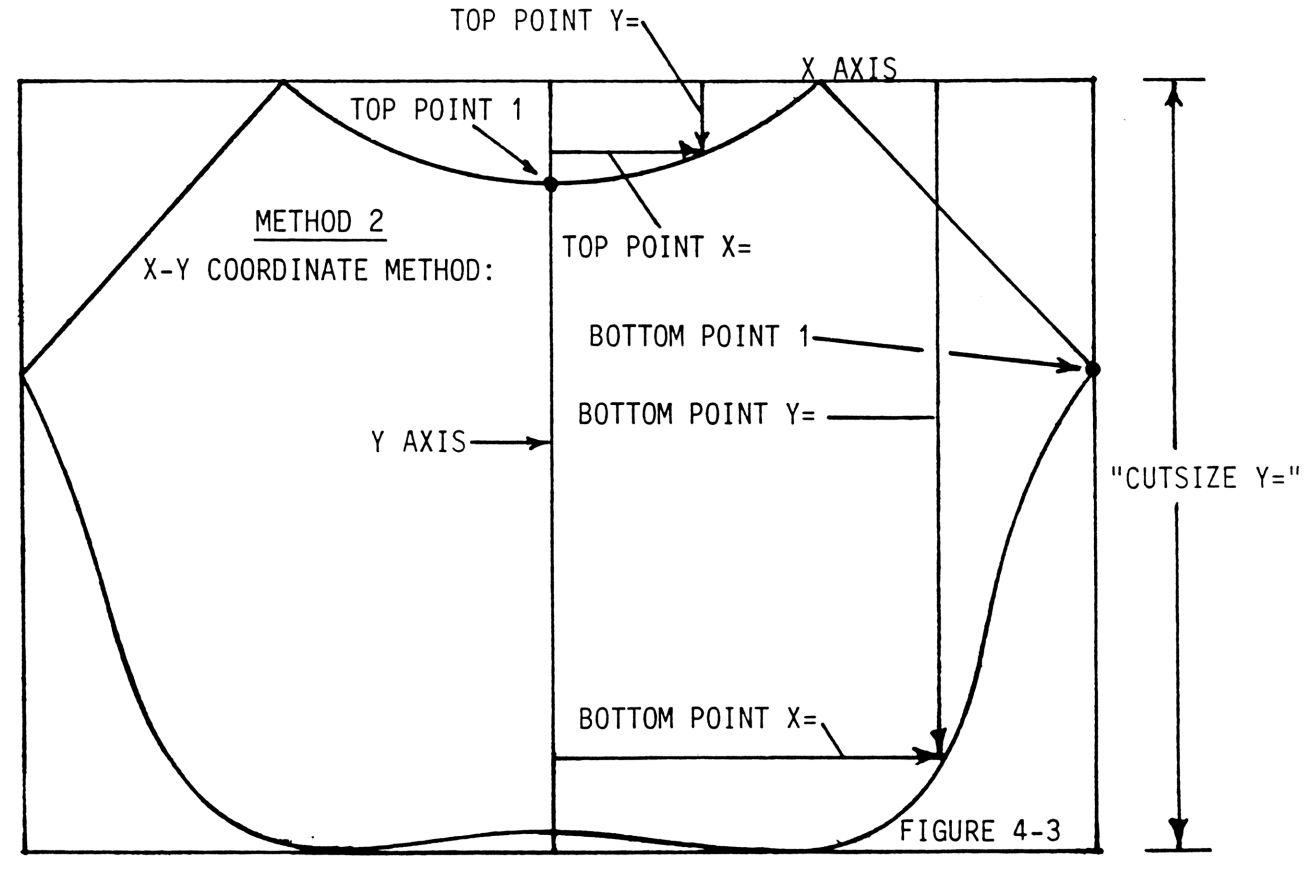
4) CONNECT THE POINTS
Connect all of the top points with a smooth curve.

5) LOCATE THE BOTTOM POINTS
Locate the points that form the bottom of the cone by using the same process described in step #3.

6) CONNECT THE POINTS
Connect all of the bottom and the top points with a smooth curve.

7) CUTTING THE PATTERN OUT
Cut the pattern along its outer perimeter then roll and join the ends.


SMALL RADIUS
METHOD 1
ARC METHOD:
LINE LENGTH
LARGE RADIUS
CORD LENGTH
PATTERN SECTION WIDTH
"CUTSIZE Y="
FIGURE 4-2
"CUTSIZE X="


TOP POINT Y=
X AXIS
TOP POINT 1
METHOD 2
X-Y COORDINATE METHOD:
TOP POINT X=
BOTTOM POINT 1
BOTTOM POINT Y=
Y AXIS
"CUTSIZE Y="
BOTTOM POINT X=
FIGURE 4-3

CHAPTER 5

CONE ON CONE

PROGRAM TITLE: "C ON C"

PURPOSE: Gives the layout for a cone on a conical surface.

INPUTS: Refer to figure 5-1.

1) TOP DIAMETER OF THE SMALL CONE
   "SM:DIA.OF TP.?"

2) BOTTOM DIAMETER OF THE SMALL CONE
   "SM:DIA.OF BT.?"

3) SMALL CONE HEIGHT
   "SM:HEIGHT?"

4) TOP DIAMETER OF THE LARGE CONE
   "LG:DIA.OF TP.?"

5) BOTTOM DIAMETER OF THE LARGE CONE
   "LG:DIA.OF BT.?"

6) HEIGHT OF THE LARGE CONE
   "LG:HEIGHT?"

7) ANGLE
   "ANGLE?"
   Enter the angle between the major axes of the two cones.

INPUTS: Refer to figure 5-1

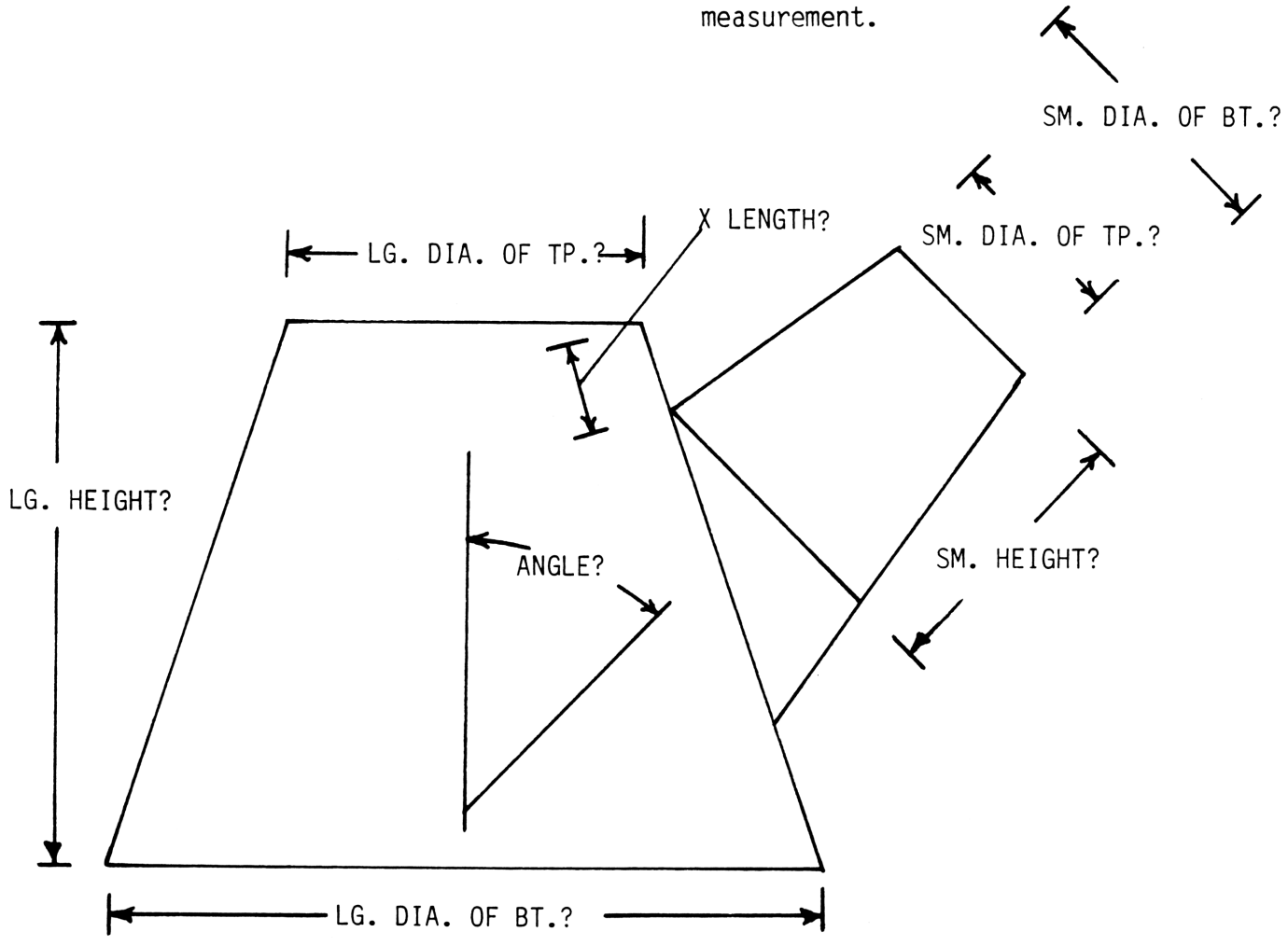
8) X LINE
"X LENGTH="
The distance the smaller cone is being placed from from the top of the larger cone.

9) PARTS PER QUARTER PATTERN
"PARTS PER.¼="
Enter the number of parts per quarter pattern you desire. The higher the number, the greater accuracy.

10) DO YOU WANT (X) or (Y) COORDINATE SYSTEM?
"DO YOU WANT X,Y, CORD="

IF YES: TYPE "YES". This gives all your points in an (X) or(Y) measuring system.

IF NO: TYPE "NO". The program gives you the true measurement.



OUTPUTS: Refer to figure 5-2

ARC METHOD 1

1) SMALL RADIUS
"SM.RAD.="
Radius of the arc that forms the top of the cone.

2) LARGE RADIUS
"LG.RAD.="
Radius of the arc that forms the bottom of the cone.

3) CORD LENGTH
"SM:PC:CORD="
"LG:PC:CORD="
This is the length of the cord that determines the diameter of the bottom of the cone.

4) PATTERN SECTION WIDTH
"BOT.DIA.="
"$^{1}/_{N}$.CIR.="

This number is the distance between the lines used to make the pattern as they pass through the large radius.
Where N is equal to four times the number of parts per quarter.

5) LINE LENGTH
"LINE:1.="
"LINE:2.="
ETC.
These are the length of the lines used to make the pattern.

6) CUT SIZE
"CUT SIZE="
"X="
"Y="

X is the width and Y is the height of the piece of material that the cone is to be cut from.

OUTPUTS
METHOD 2
X, Y,
SYSTEM:

Refer to figure 5-3

1) TOP POINTS
"TOP PT.1=X-Y,"
"TOP PT.2=X-Y,"
etc.
These are the coordinates for the points that form the top of the cone.

2) BOTTOM POINTS
"BOT.PT.1=X-Y,"
"BOT.PT.2=X-Y,"
etc.
These are the coordinates for the points that form the bottom of the cone.

3) CUT SIZE
"CUT SIZE="
"X="
"Y="
This is the width and the height of the piece of material the cone is to be cut from.

IMPORTANT NOTE: IF YOU GET DATA ERROR AS AN OUTPUT THEN IT MEANS THAT ONE OF THE COORDINATES FOR THE SIDE OF CONE WILL NOT CONNECT WITH THE SIDE OF THE OTHER CONE.

METHOD 1
CONSTRUCTION
ARC METHOD:

Refer to figure 5-2.

1) MAKE THE SMALL RADIUS
Make a half circle with the radius equal to the "SMALL RADIUS" given above.

2) MAKE THE LARGE RADIUS
Using the same center point from Step 1 above, swing an arc with radius equal to "LARGE RADIUS". Make the arc as large as is possible.

3) MAKE A CENTER LINE
Starting at the center point of your radius, make a straight line down to bisect the small and large radius arcs.

4) DRAW THE CORD
Draw a cord, of length given above that is bisected by the center line and spans the large radius. Refer to OUTPUTS #3, method 1.

5) MARK THE INTERSECT POINTS
Starting on one of the points where the cord meets the large radius, divide the large radius into lengths equal to the PATTERN SECTION WIDTH calculated above. See OUTPUTS #4, method 1.

6) CONNECT THE ENDS
Connect the end points of the large radius (the ends of the cord) to the small radius with straight lines that pass through the center point.

7) DRAW THE PATTERN LINES
Starting with the first point, marked on the radius, in from the end points, lay a straight edge connecting this point to the center point. Now draw a line, equal in length to LINE:1, from the small radius through the large radius. Do this again with the next mark in on the large radius and make the line length equal to LINE:2. The last line length given is for the center line.

8) CONNECT THE LINES
Connect the ends of the lines you drew with a smooth curve.

CONSTRUCTION: Refer to figure 5-3.

ROOF CONE X,Y, COORDINATE SYSTEM

1) DRAW THE CUT SIZE
Draw a rectangle with the dimensions of your cut size.

2) DRAW THE Y AXIS
Draw a line down through the center of your rectangle, this is your Y-axis. The top of the rectangle is your X-axis.

3) LOCATE THE TOP POINTS
Locate the points that form the top of the cone by measuring the distance given in your outputs. Measure to the right of the Y-axis for the X distance and measure down from the top for the Y distance.

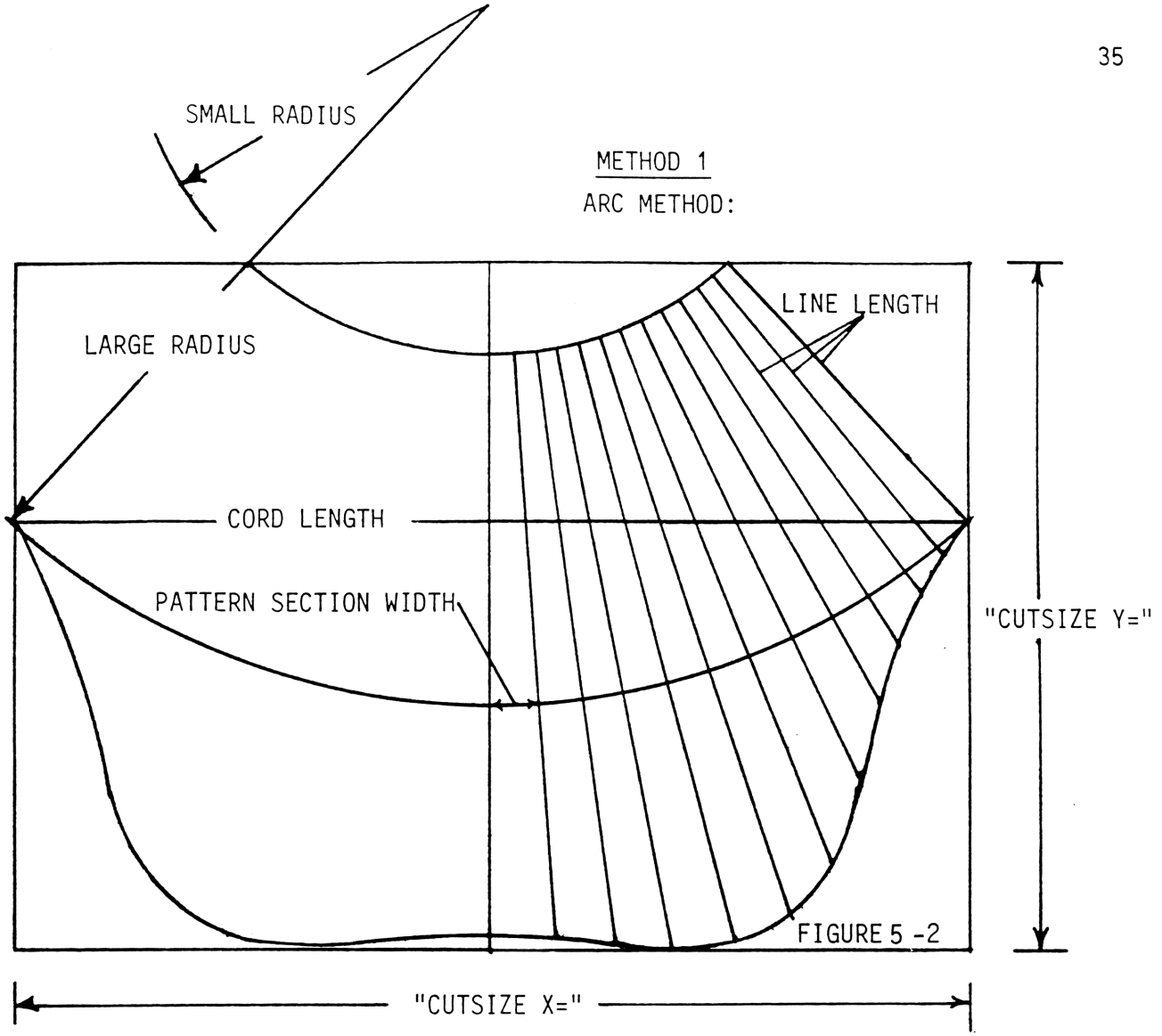
Do this step again, only now measure to the left of the Y-axis for the X distance.

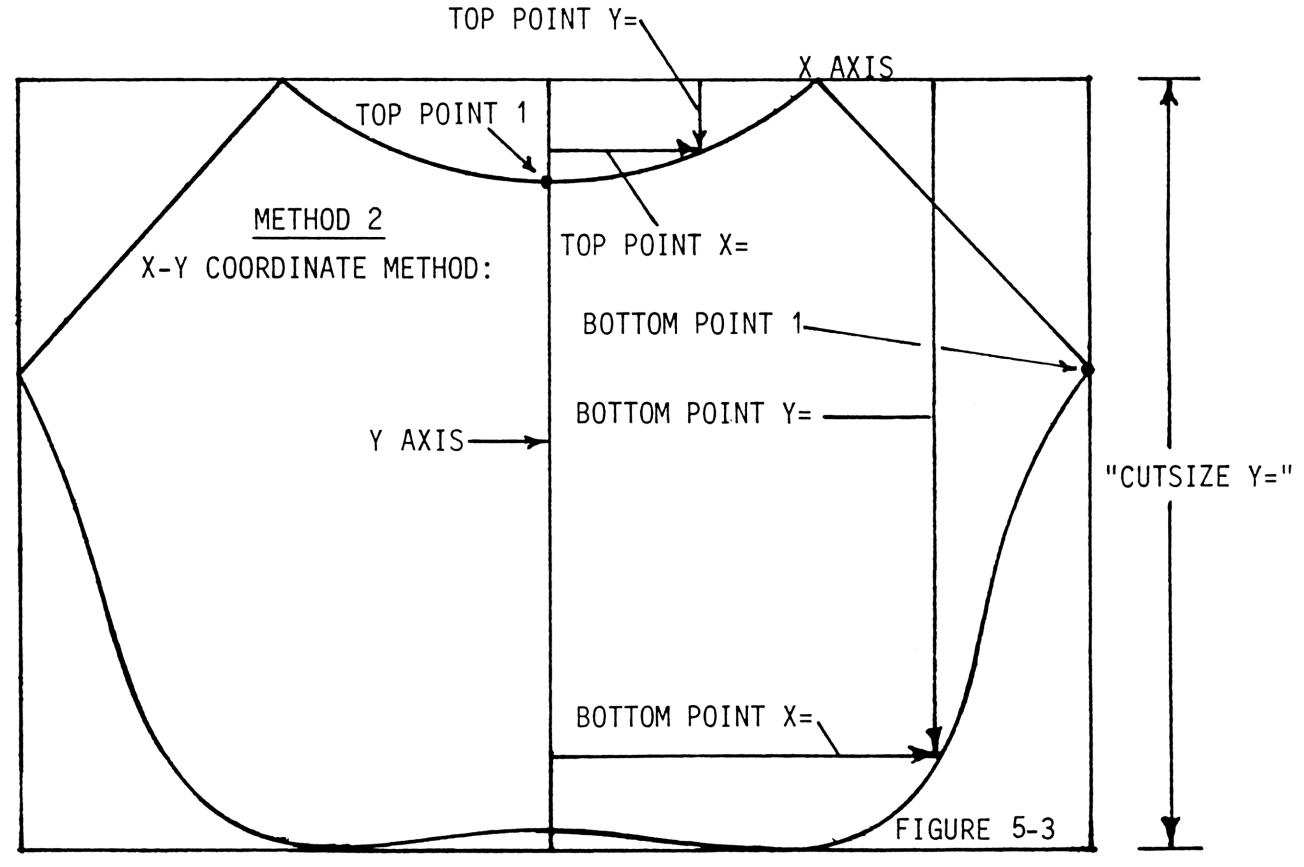
4) CONNECT THE POINTS
Connect all of the top points with a smooth curve.

5) LOCATE THE BOTTOM POINTS
Locate the points that form the bottom of the cone by using the same process described in step #3.

6) CONNECT THE POINTS
Connect all of the bottom and the top points with a smooth curve.

7) CUTTING THE PATTERN OUT
Cut the pattern along its outer perimeter then roll and join the ends.


SMALL RADIUS
METHOD 1
ARC METHOD:
LINE LENGTH
LARGE RADIUS
CORD LENGTH
PATTERN SECTION WIDTH
"CUTSIZE Y="
FIGURE 5 -2
"CUTSIZE X="


TOP POINT Y=
X AXIS
TOP POINT 1
METHOD 2
X-Y COORDINATE METHOD:
TOP POINT X=
BOTTOM POINT 1
BOTTOM POINT Y=
Y AXIS
"CUTSIZE Y="
BOTTOM POINT X=
FIGURE 5-3

CHAPTER 6

PIPE ON CONE

PROGRAM TITLE: "P ON C"

PURPOSE: Gives the layout for a pipe that joins a cone.

NOTE: This is an extension of the CONE ON CONE program, so some of the inputs are the same.

INPUTS: Refer to figure 6-1.

1) PIPE DIAMETER
   "PIPE DIA.?"

2) PIPE LENGTH
   "LENGTH?"

3) LARGE DIAMETER OF THE TOP
   "LG:DIA. OF TP.?"

4) LARGE DIAMETER OF THE BOTTOM
   "LG:DIA. OF BT.?"

5) HEIGHT OF THE CONE
   "LG:HEIGHT?"

6) ANGLE PIPE IS PLACED ON CONE
   "ANGLE?"
   The angle the pipe is being placed on the cone to each other's axis.

7) X-LINE

"X:LENGTH?"

The distance the pipe is being placed from the top of the cone.

8) PARTS PER QUARTER PATTERN

"PARTS PER.¼?"

Enter the number of parts per quarter pattern you desire. The higher the number, the greater the accuracy of the layout.

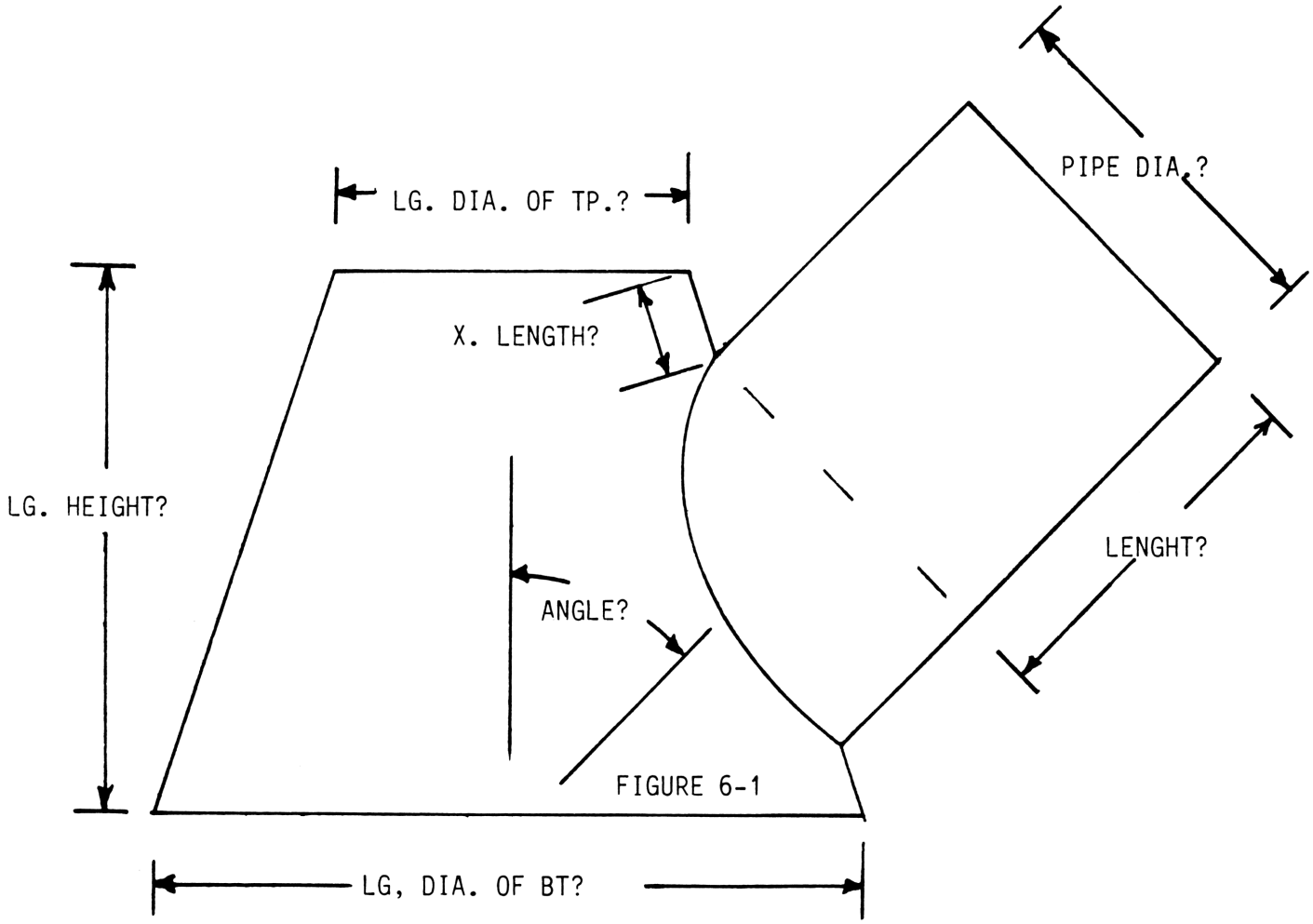


FIGURE 6-1

OUTPUTS: Refer to figure 6-2.

1) SEGMENT WIDTH
"1/X.CIR.="
Gives the distance between the lines used to construct the pattern.

2) LINE LENGTH
"LINE:N="
These are the true lengths of the lines used to construct the pattern.

3) CUT SIZE
"CUT SIZE="
"X="
"Y="

This is the width and the height of the piece of material required for your joint.

IMPORTANT NOTE: IF YOU GET DATA ERROR AS AN OUTPUT THEN IT MEANS THAT A SECTION OF THE DIAMETER OF THE PIPE WILL NOT CONNECT WITH THE SIDE OF THE CONE.

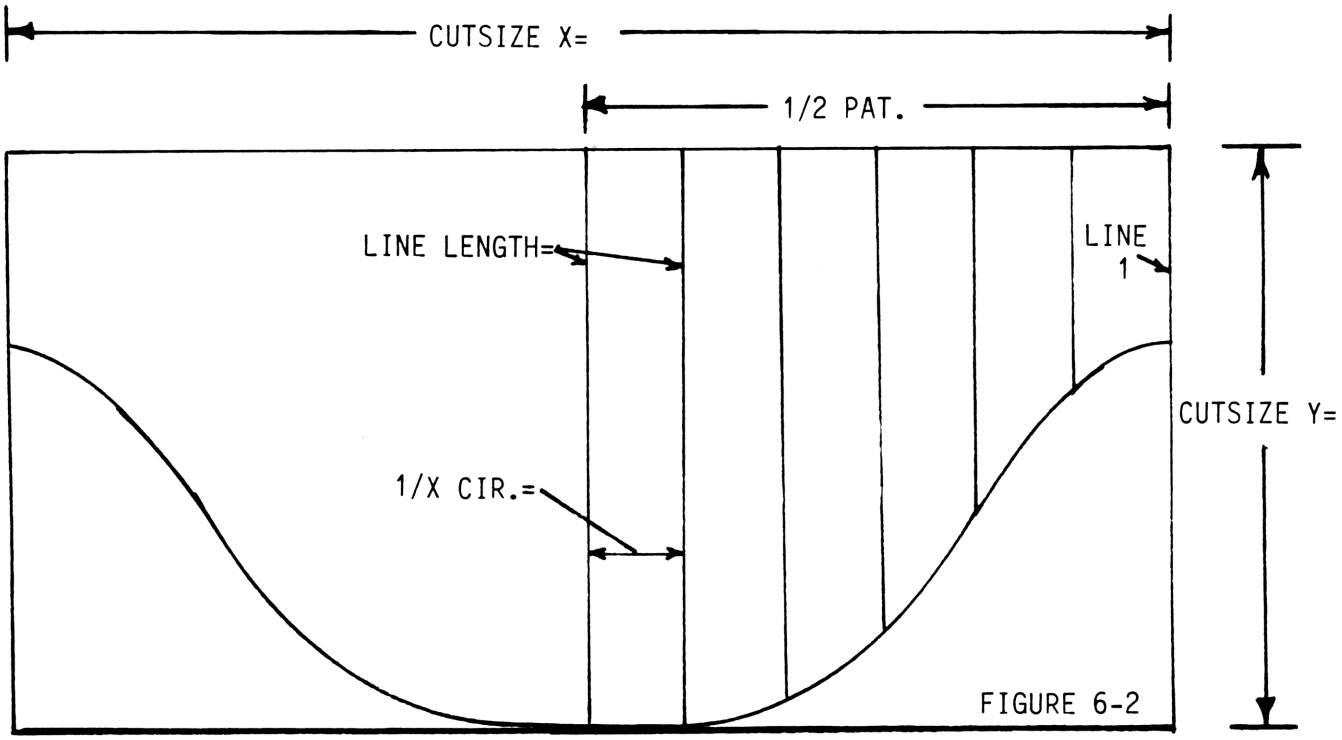


FIGURE 6-2

CONSTRUCTION Refer to figure 6-3.

PIPE ON CONE:

1) MEASURE THE CUT SIZE
Use the cut size measurements to layout a rectangle.

2) MARK THE DIVIDER
Make a vertical line all the way up through the middle of your cut size.

3) DRAW THE PATTERN LINES
Starting from both outside edges, measure line length 1 down from the top edge of the material. Now move inward, one segment width (on both sides), along the top edge. Measure down line length 2 and mark the spot. Repeat this pattern for all the lines.

4) CUT OUT THE PATTERN
Connect the dots with a smooth curve and cut out the pattern.

5) ROLL AND JOIN THE ENDS

CHAPTER 7

CONE OFFSET

PROGRAM TITLE: "R to R"

PURPOSE: Gives the layout for a cone that joins two pipes. Pipes joined may have an offset and different diameters.

INPUTS: Refer to figure 7-1

1) TOP DIAMETER
   "TOP DIA.?"
   Enter the diameter of top of cone.

2) BOTTOM DIAMETER
   "BOT.DIA.?"
   Enter the diameter of bottom of cone.

3) HEIGHT
   "HEIGHT?"
   Enter the height of cone.

4) CENTER LINE
   "CNT. LINE?"
   Enter the distance between the center line of the top cone and the center line of the bottom cone.

5) PARTS PER QUARTER
   "PARTS PER ¼.?"
   Enter the number of parts per quarter you desire. The higher the number, the greater accuracy.

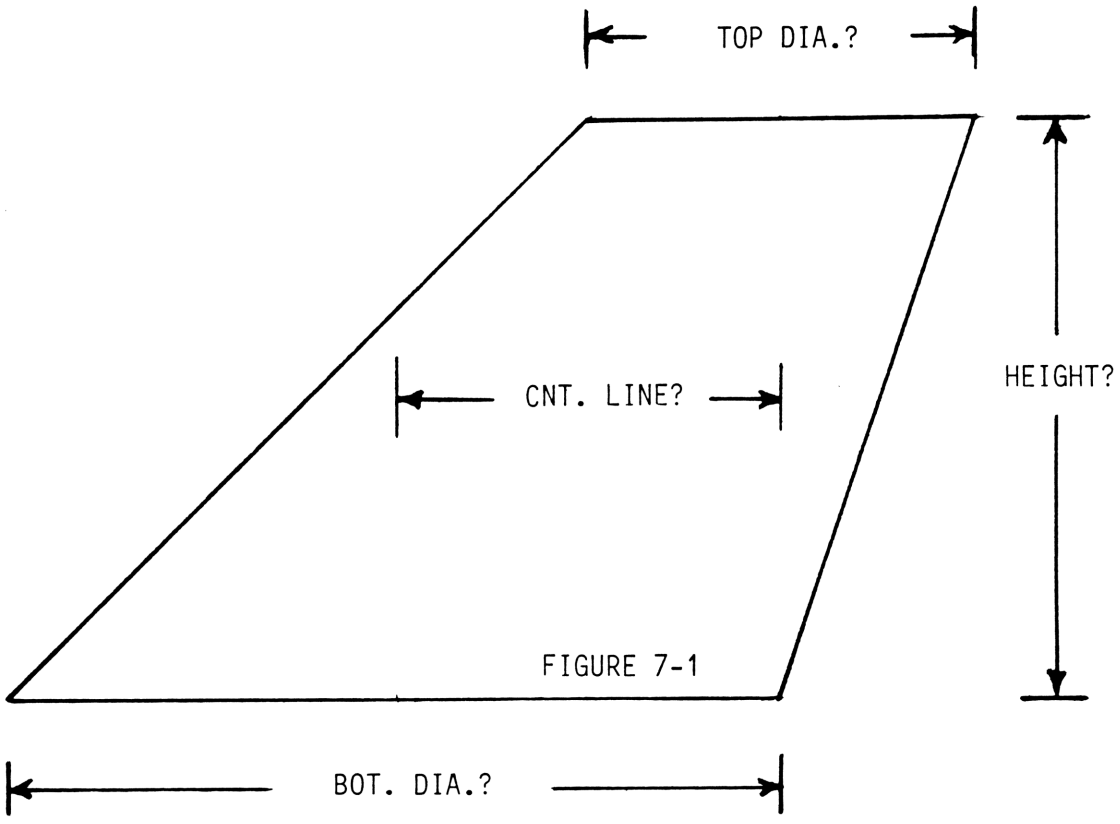


FIGURE 7-1

OUTPUTS: Refer to figure 7-2

1) TOP ARC DISTANCE
"TOP ARC.="
Distance between the points used to form the top of the pattern.

2) BOTTOM ARC DISTANCE
"BOT. ARC.="
Distance between the points used to form the bottom of the pattern.

3) Z-LINE LENGTH
"Z LINE="
This is the length of the pattern, from top to bottom, in the middle.

4) TOP DISTANCE LENGTHS
"TOP DIST.1.="
These are the heights of the points (that form the top of the pattern) from the Z-LINE.
The program lists the number of top distances needed for half the pattern (the other half is a mirror image).

5) BOTTOM DISTANCE LENGTHS
"BOT. DIST.1="
The distances to the bottom points from the bottom of the Z-LINE.

6) CUT SIZE
"CUT SIZE IS"
X is the width and Y is the height of the piece of metal required to cut the pattern from.

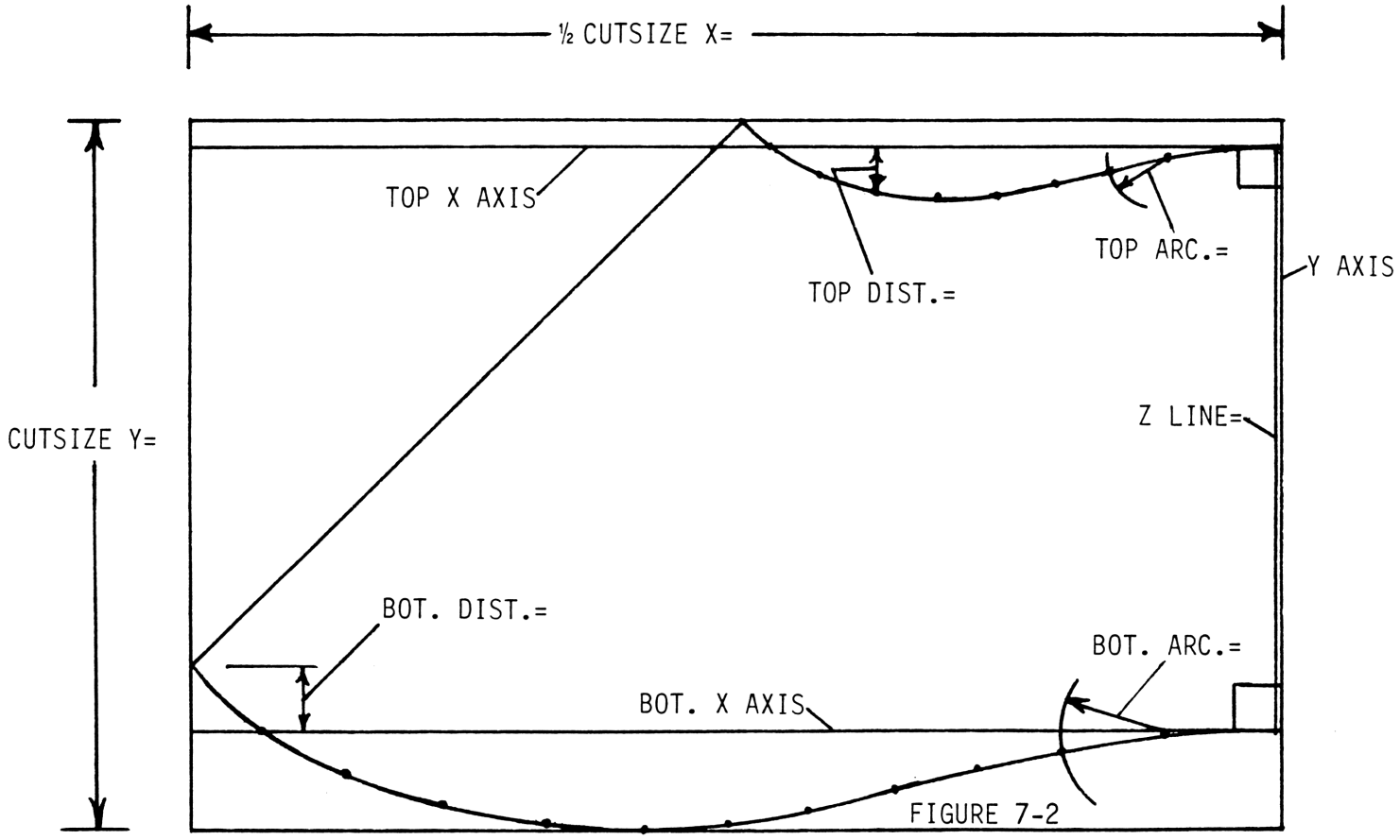

½ CUTSIZE X=
CUTSIZE Y=
TOP X AXIS
TOP DIST.=
TOP ARC.=
Y AXIS
Z LINE=
BOT. DIST.=
BOT. ARC.=
BOT. X AXIS

FIGURE 7-2

CONSTRUCTION CONE OFFSET: Refer to figure 7-2

1) MARK THE Z-LINE
Move along the top of the "CUT SIZE" to the center.
Now, move down a distance equal to the largest positive top distance listed.
This is the top of the Z-LINE.
From this point, mark the Z-LINE straight down.

2) MARK THE TOP POINTS
Starting at the top of the Z-LINE measure the distance listed as "TOP DIST.1=". NOTE: Measure up if positive. Measure down if negative.
Through this point, draw a horizontal line across the cut size piece that is parallel with the top.
Now, starting from the top of the Z-LINE, swing an arc with radius equal to "TOP ARC=".
Intersect the horizontal line you drew (top line 1) to the left of the Z-LINE and to the right of the Z-LINE.
These points of intersection locate the top of your pattern.
Measure the top distance Z from the top of the Z-LINE and draw another horizontal line.
Swing an arc (still equal to "TOP ARC LENGTH=") from the last two intersect points to continue the pattern.
Repeat this process until all the "TOP DIST.=" lengths are used.

3) MARK THE BOTTOM POINTS
The process for locating the bottom points is identical to locating the top points (Step 2 above) EXCEPT:
a) Start from the bottom of the Z-LINE.
b) Use the bottom arc length, and
c) Use the bottom distance.

CONSTRUCTION Refer to figure 7-2

CONE OFFSET:

4) CONNECT THE POINTS

First, connect the top outside points with their corresponding bottom outside points with a straight line.

Next, connect the top points together with a smooth curve.

Do the same for the bottom points and your pattern is complete.

5) CUT PATTERN AND ASSEMBLE

Cut along the outside of the pattern.

Roll up the pattern with the Z-LINE as the major axis for the finished cone.

CHAPTER 8
OG OFFSET

PROGRAM TITLE: "OG OFST"

PURPOSE: Gives the inside diameter of the top opening.

INPUTS: Refer to figure 8-1.

1) TOP LENGTH
   "TOP LNG.?"
Enter the inside diameter of the top opening.

NOTE: It is the smaller of the two ends.

2) TOP OFFSET
   "TOP OS.?"

3) BOTTOM LENGTH
   "BOT.LNG.?"
   Enter the inside diameter of the bottom opening.

4) HEIGHT OF THE FITTING
   "HEIGHT?"
   Enter the distance between the top and the bottom opening.

OUTPUTS: Refer to figure 8-2.

1) SMALL RADIUS
"SM.RAD.="

2) LARGE RADIUS
"LG.RAD.="

3) LARGE SIDE STRETCH-OUT
"LG.SIDE="

4) SMALL SIDE STRETCH-OUT
"SM.SIDE="

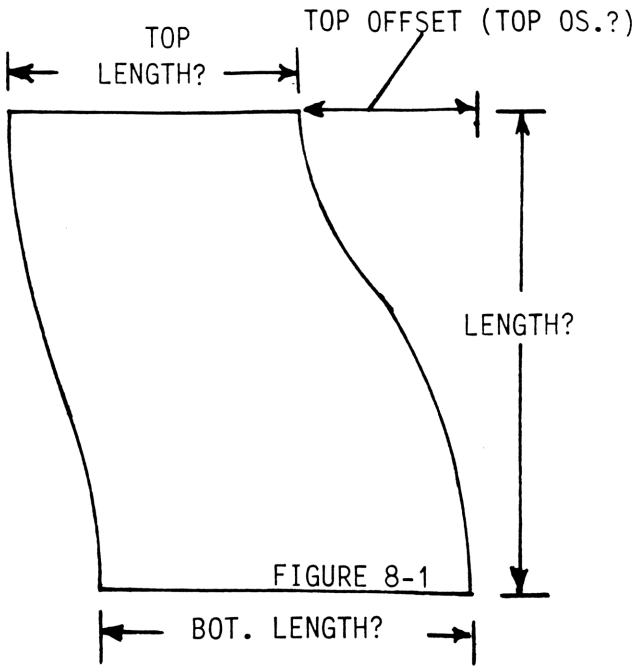


FIGURE 8-1

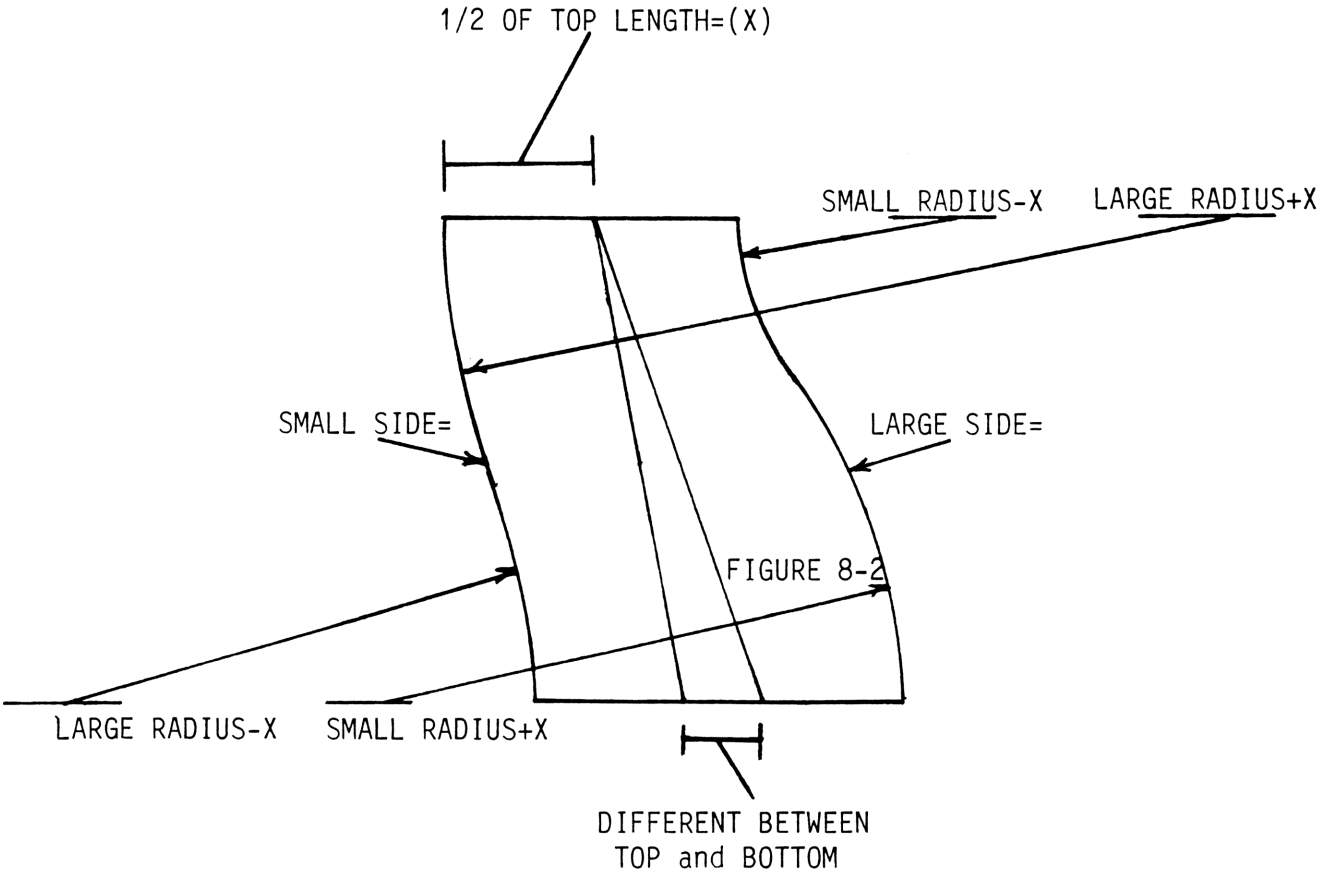


FIGURE 8-2

CONSTRUCTION: Refer to figure 8-2.

OG OFFSET

1) CONSTRUCTION OF THE CHEEKS
CONSTRUCTING THE RADIUS POINTS OF THE THROAT AND HEEL OF THE TOP

The small radius of the top of the fitting is given by, subtracting X from the small radius. X= ½ the top length.

2) CONSTRUCTING THE LARGE RADIUS OF THE TOP PORTION OF THE FITTING
Add X to the large radius.

3) CONSTRUCTING THE BOTTOM SMALL RADIUS
Take the small radius and add X to it.

4) CONSTRUCTING THE BOTTOM LARGE RADIUS
Take the large radius value and subtract X from it.
Please refer to figure

5) CONSTRUCT TWO PATTERNS LIKE THIS AND CUT OUT
NOTE: Adding extra metal to seams.....depending on method you are using to connect.

CHAPTER 9

OFFSET

PROGRAM TITLE: "OFFSET"

PURPOSE: To give the layout for constructing an offset for a round pipe in 3 or more pieces.

INPUTS: Refer to figure 9-1 and 9-2

1) NUMBER OF PIECES
   "NMBR. OF PC. ="
   Enter the number of sections that will be used to make the offset.

2) DIAMETER OF THE PIPE
   "DIA.PIPE="
   Enter the diameter of the pipe for which the offset is being made. See figure 9-1 or 9-2

3) OFFSET DISTANCE
   "OFFSET="
   Enter the amount of the offset required.

4) LENGTH OF THE JOINT
   "LENGTH="
   Enter the overall length of the joint.

   NOTE: FOR 3-PIECES ONLY: Enter the length of the centerpiece. See figure 9-1

5) NUMBER OF PARTS PER QUARTER PATTERN
   "PARTS PER.¼="
   Enter the number of segments you want the quarter pattern divided into; a typical number is 6. The higher the number, the greater the accuracy.

OUTPUTS: Refer to figure 9-3 or 9-4

1) SEGMENT HEIGHT

"CD.="

This is the height of one segment of the full pattern.

IMPORTANT: FOR 3 PIECE OFFSET ONLY (CCDD LAYOUT): Refer to figure 9-3

2) SEGMENT WIDTH

"1/X.CIR.="

This is the width of one segment of CD. See figure 9-4
Where X is equal to 4 times the number of pieces you desire.

3) THREE PIECE OFFSET

If using a 3 piece offset it will give you the MINIMUM fitting size. Refer to figure 9-1

4) LINE LENGTH

"LINE:N.="

These are the true lengths of the line segments used to construct the quarter pattern. Where N is equal to 1 through the number of parts per quarter pattern PLUS 1.

5) CUT SIZE

"CUT SIZE="

"X="

"Y="

X is the width and Y is the height of the piece of metal to cut the full pattern from.

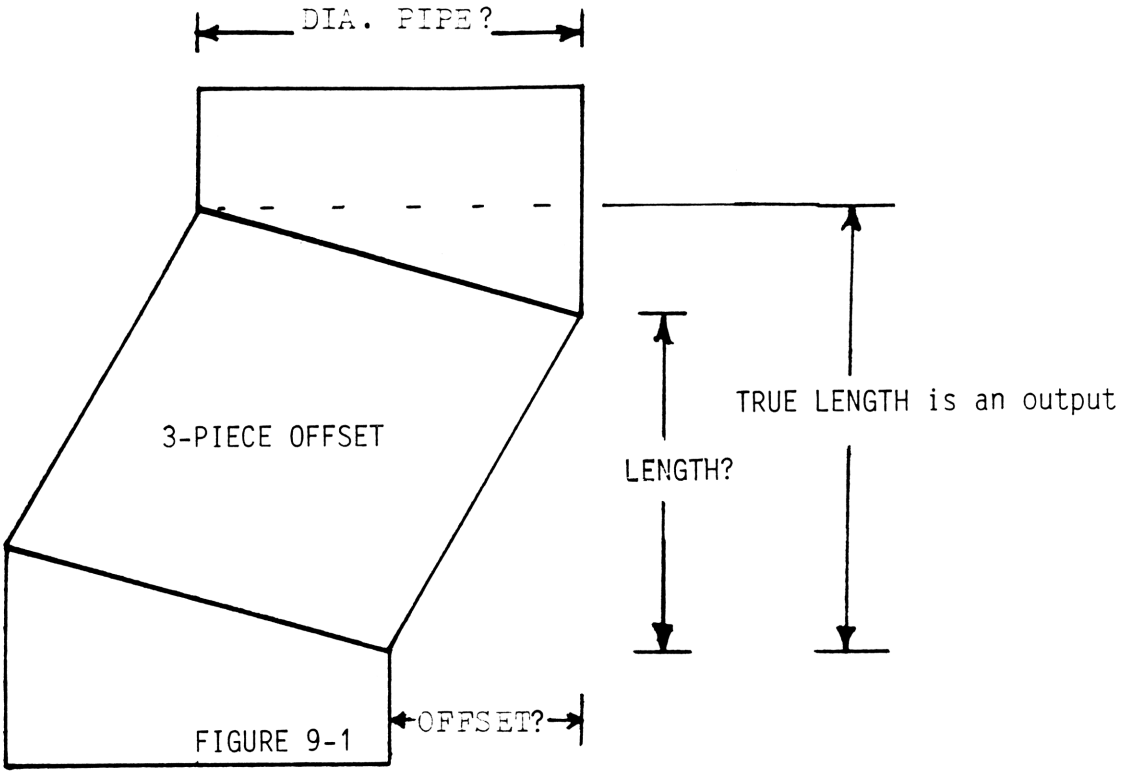


FIGURE 9-1

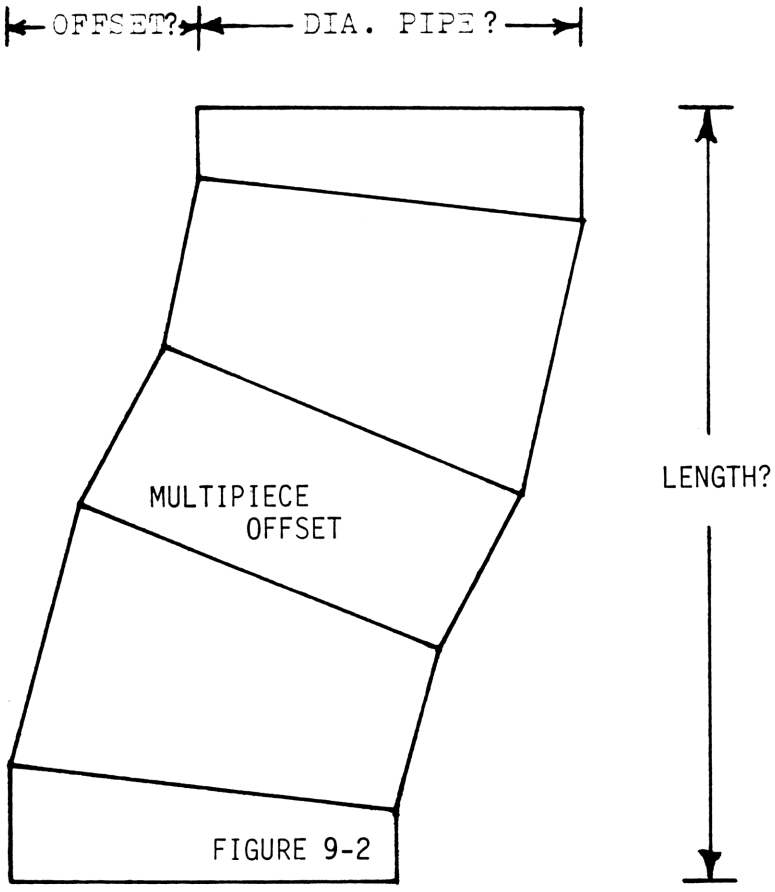


FIGURE 9-2

OUTPUTS: Refer to figure 9-3 or 9-4

6) CUT OUT THE JOINTS
Cut along the curves you have drawn. This separates the pattern into the offset segments.

7) FORM THE JOINTS
Roll the segments you cut into the correct diameter, the ends should match. Join the ends to form a continuous ring.

8) ASSEMBLE THE OFFSET
Use the quarter pattern marks to assist you in putting the offset together. See step #4 above.

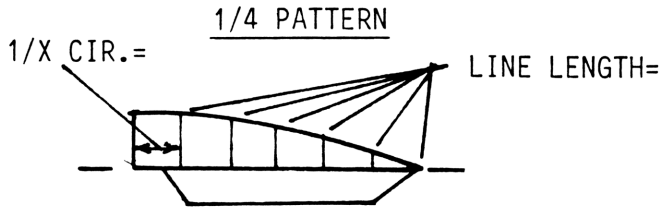
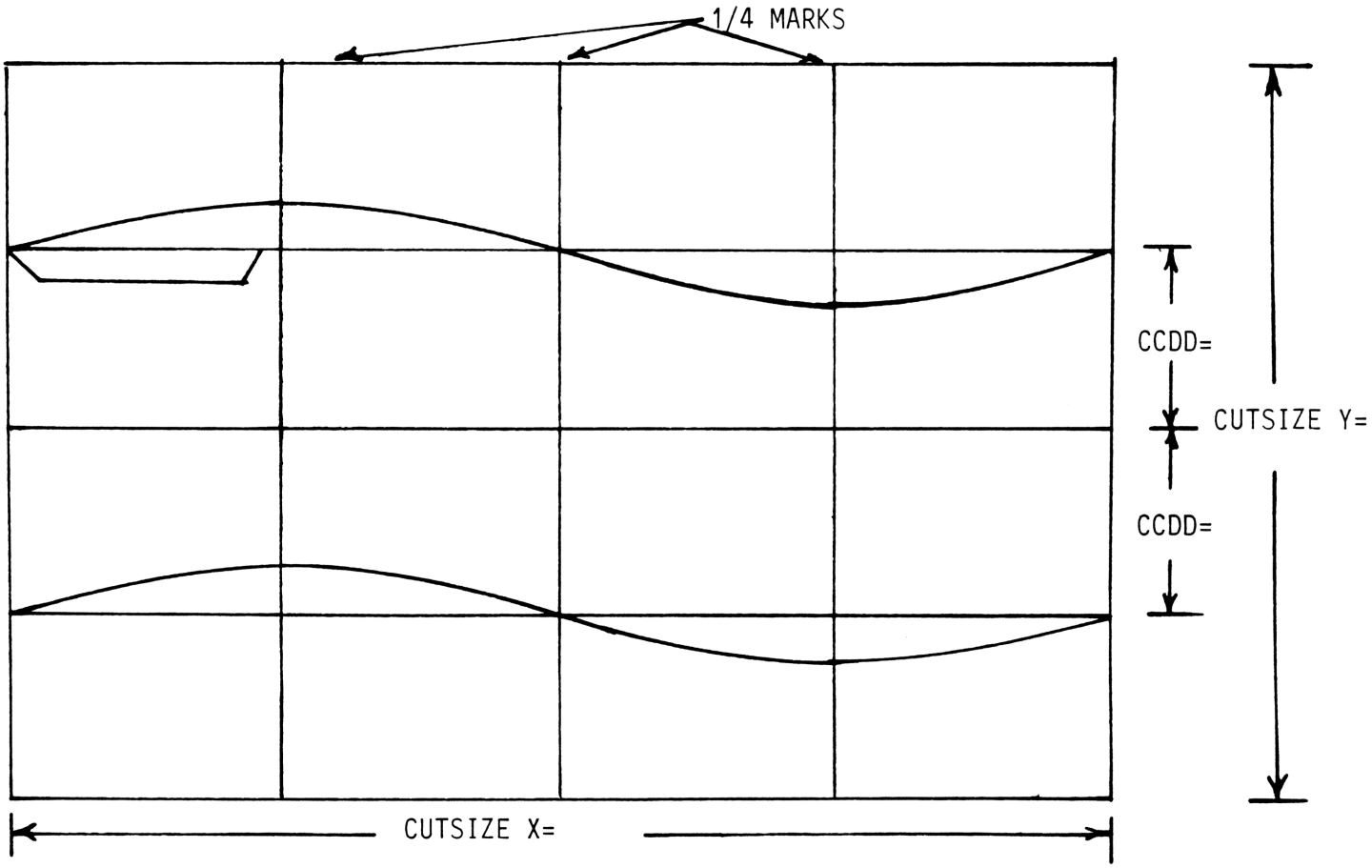


FIGURE 9-3



CONSTRUCTION Refer to figure 9-3 or 9-4

OFFSET:

1) MEASURE THE CUT SIZE

Use the cut size measurement to lay out a rectangle that is X inches wide and Y inches high.

2) MARK THE SEGMENTS

Divide the height (Y) into segments CD inches long.

If you subtract 1 from the number of pieces for the offset (input #1) and multiply the result by 2, that is how many CD lengths you will have.

For example, if you selected 5 pieces, then the height (Y) will divide into exactly (5-1)x2= 8CD segments.

Mark horizontal lines across the width of your pattern, spaced CD inches apart, as shown in figure 9-4

NOTE: FOR THREE PIECE LAYOUT ONLY

Divide the height (Y) in half and mark it. Measure the CCDD distance equally up and down from the center point. See figure 9-3

3) CONSTRUCT THE TEMPLATE

On your template material, lay out the quarter pattern as follows;

a) Start at the lower right corner of your material, make a mark. This point is line 1.
b) Move left one segment width (output #2 above) and make a mark. Now measure up (perpendicular to the bottom of your sheet) the amount given as line 2. Make a mark.
c) Repeat the process described in step (b) for the rest of the lines given for your quarter pattern.
d) Connect the points in a smooth curve.
e) Cut out the quarter pattern.

CONSTRUCTION Refer to figure 9-3 or 9-4

OFFSET:

4) LAYOUT OF THE PATTERN

Using the template, draw the curves for your full pattern. It is helpful to divide the length of material into four equal segments. Please see figures 9-3 or 9-4

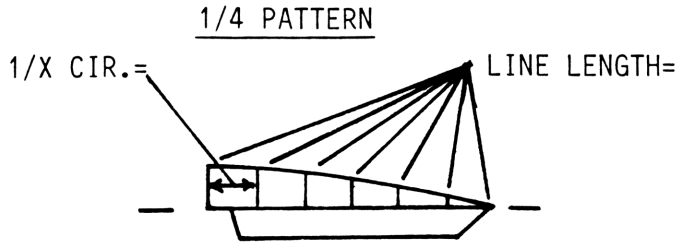
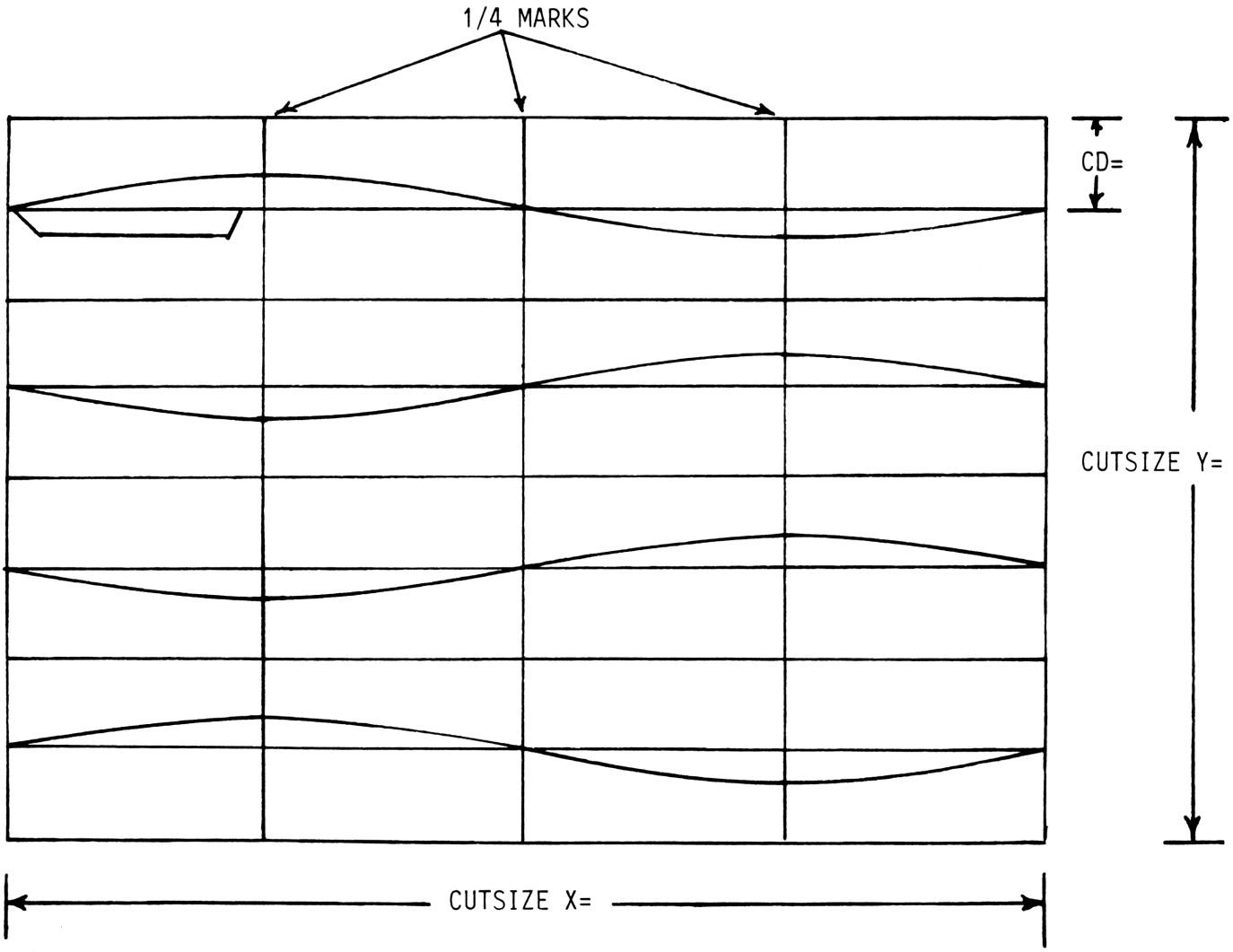


FIGURE 9-4



CHAPTER 10
ELBOW

PROGRAM TITLE: "ELBOW"

PURPOSE: To give the layout for constructing an elbow, for a round pipe, in two or more pieces.

Refer to figures 10-1 and 10-2

INPUTS:

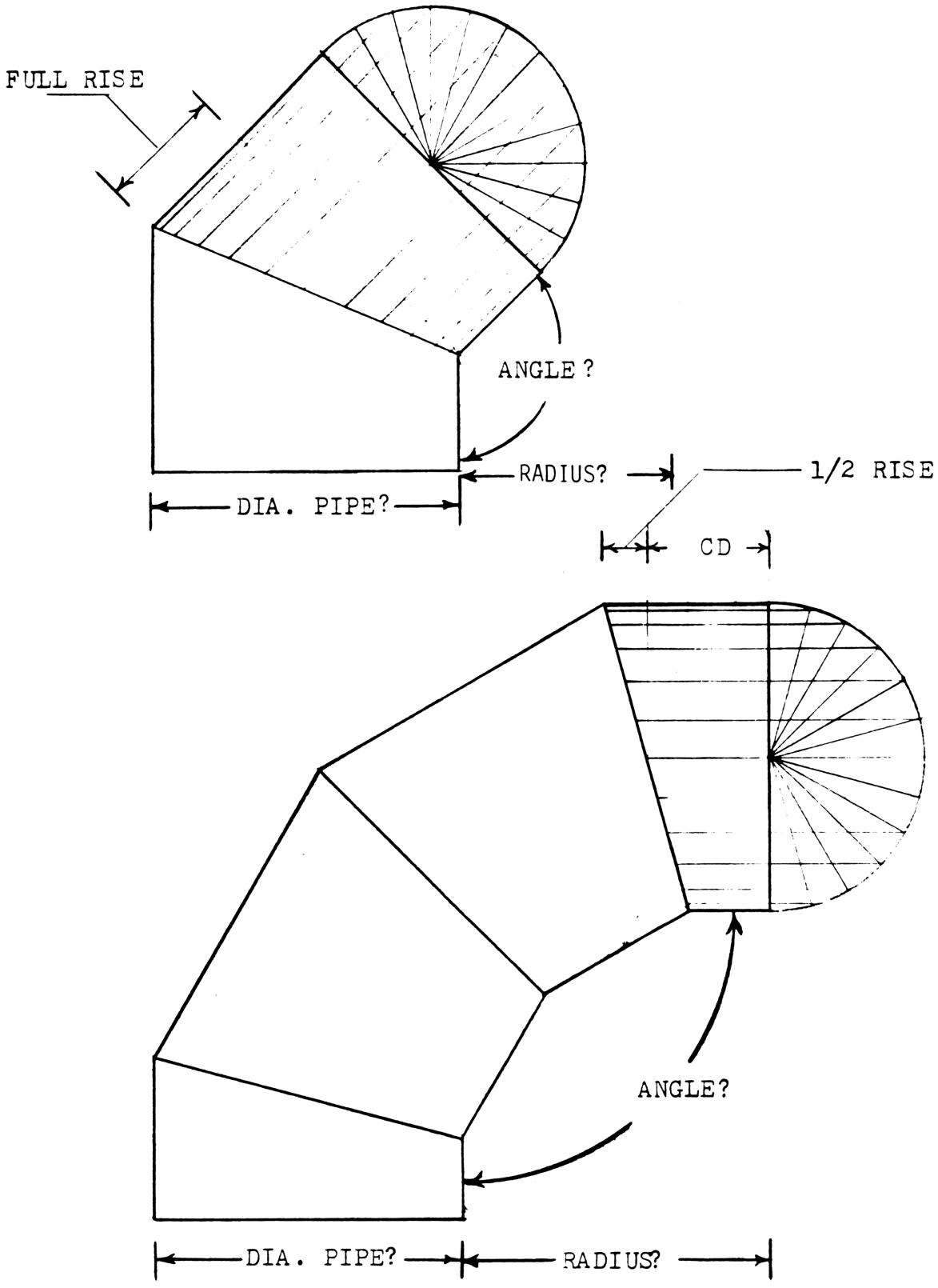
1) NUMBER OF PIECES
"NMBR. OF PC.="
Enter the number of sections that will be used to make an elbow.

2) DIAMETER OF PIPE
"DIA.PIPE="
Enter the diameter of the pipe for which the elbow is being made. (See figure 10-1). or figure 10-2

3) ANGLE OF ELBOW
"ANGLE="
Enter the number of degrees of bend required for the elbow.
For example, for a right angle, a full 90° bend, enter "90".

4) RADIUS OF ELBOW
"RADIUS="
Enter the perpendicular distance between the two pipe ends that are to be joined by the elbow.

5) NUMBER OF PARTS PER QUARTER PATTERN
"PARTS PER. ¼ ="
Enter the number of segments you want the quarter pattern divided into; a typical number is 6. The higher the number, the greater accuracy.


FULL RISE
ANGLE ?
RADIUS?
1/2 RISE
DIA. PIPE?
CD
ANGLE?
DIA. PIPE?
RADIUS?

OUTPUTS: Refer to figure 10-3

1) SEGMENT HEIGHT
"CD="
The height of one segment of the full pattern. See figure 10-3 for a better understanding.

2) SEGMENT WIDTH
"1/X. CIR.="
The width of one segment of CD (See figure 10-3)
Where X is equal to 4 times the number of pieces you desire.

3) LINE LENGTH
"LINE:N.="
The true lengths of the line segments used to construct the quarter pattern.
Where N is equal to 1 through (parts per.¼) + 1.

4) CUT SIZE
"CUTSIZE="
"X="
"Y="
The width and height of the piece of metal required to cut the full pattern from.

CONSTRUCTION ELBOW: Refer to figure 10-3.

1) MEASURE THE CUT SIZE
Use the cut size measurements to layout a rectangle that is X inches wide and Y inches high.

2) MARK THE CD SEGMENTS
Divide the height (Y) into segments CD inches long. If you subtract 1 from the number of pieces for the elbow (input #1) and multiply the result by 2, that is how many CD lengths you will have. (See example below.) Mark horizontal lines across the width of your pattern, spaced CD inches apart, as shown in the figure 10-3.
EXAMPLE: If you selected 5 pieces then the height (Y) will divide into exactly (5-1) x 2 = 8 CD segments.

3) CONSTRUCT THE TEMPLATE
On your template material lay out the quarter pattern as described below.

a) Start at the lower right corner of your material; make a mark. This point is line 1.
b) Move left one segment width (output #2) and make a mark. Now, measure up (perpendicular to the bottom of your sheet) the amount given on line 2. Make a mark.
c) Repeat the process described in step (b) for your quarter pattern.
d) Connect the points in a smooth curve.
e) Cut out the quarter pattern.

4) LAY OUT THE PATTERN
Using the template, draw the curves for your full pattern as shown in figure 10-3. It is helpful to make a mark at the end of each quarter pattern.

CONSTRUCTION ELBOW: Refer to figure 10-3

5) CUT OUT THE JOINTS

Cut along the curves you have drawn, this separates the pattern into the elbow segments.

6) FORM THE JOINTS

Roll the segments you cut into the correct diameter, the ends should match. Join the ends to form a continous ring.

7) ASSEMBLE THE ELBOW

Use the quarter pattern marks (Step 4) to assist in putting the elbow together.

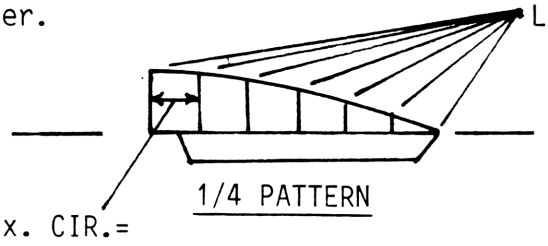
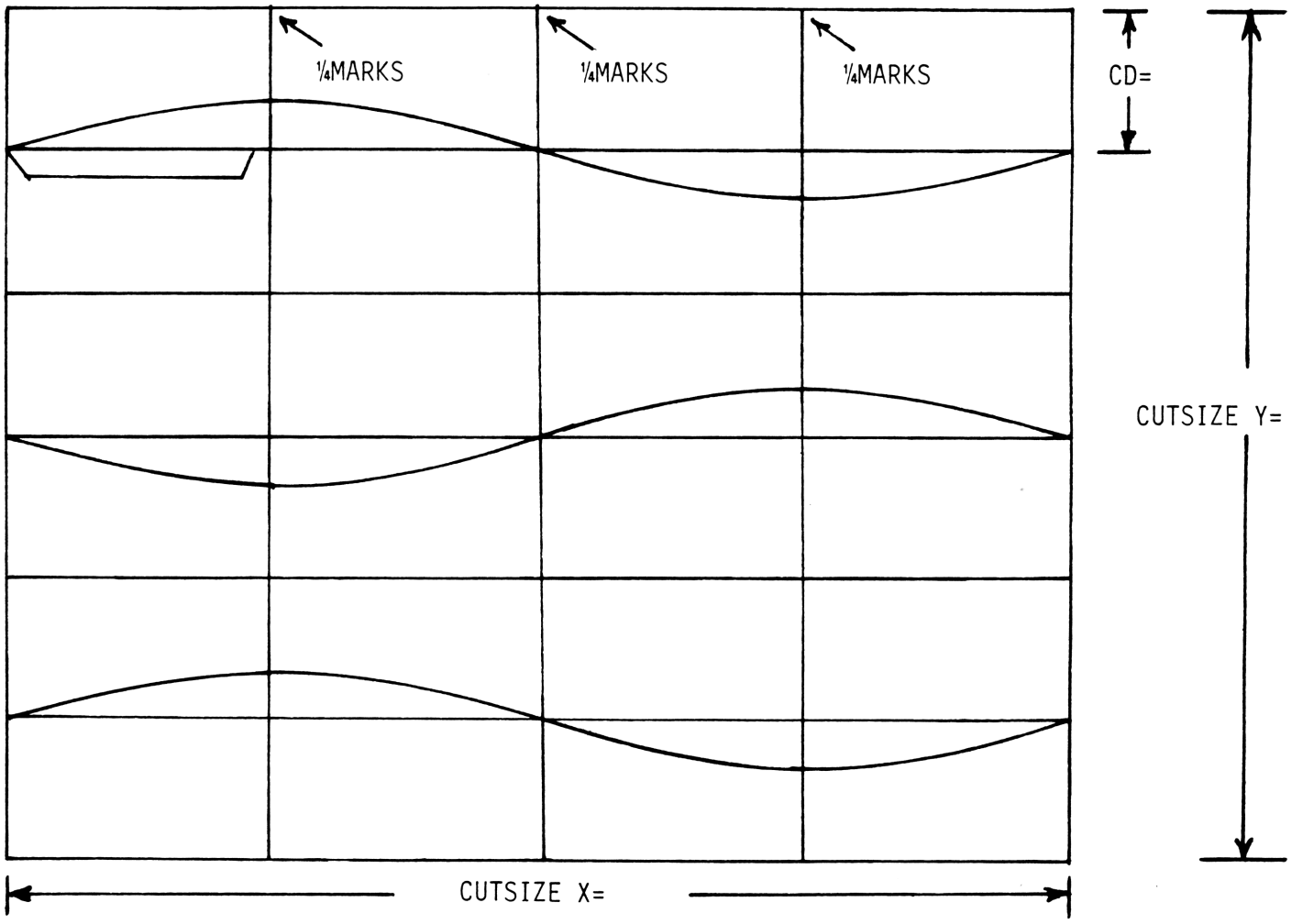


FIGURE 10-3



CHAPTER 11

Y BRANCH

PROGRAM TITLE: "Y BRCH"

PURPOSE: Connecting three pipes of the same diameter.

INPUTS: Refer to figure 11-1.

1) DIAMETER OF THE PIPE
   "DIA.PIPE?"
   Enter the inside diameter of the pipe.

   IMPORTANT: If 16 gauge or thicker material is used, enter the inside diameter PLUS the material thickness.

2) BRANCH ANGLE
   "ANGLE?"
   Enter the angle between the two branches.

3) PARTS PER QUARTER PATTERN
   "PARTS PER .¼.?"
   Enter the number of parts per quarter pattern you desire. The higher the number, the greater the accuracy.

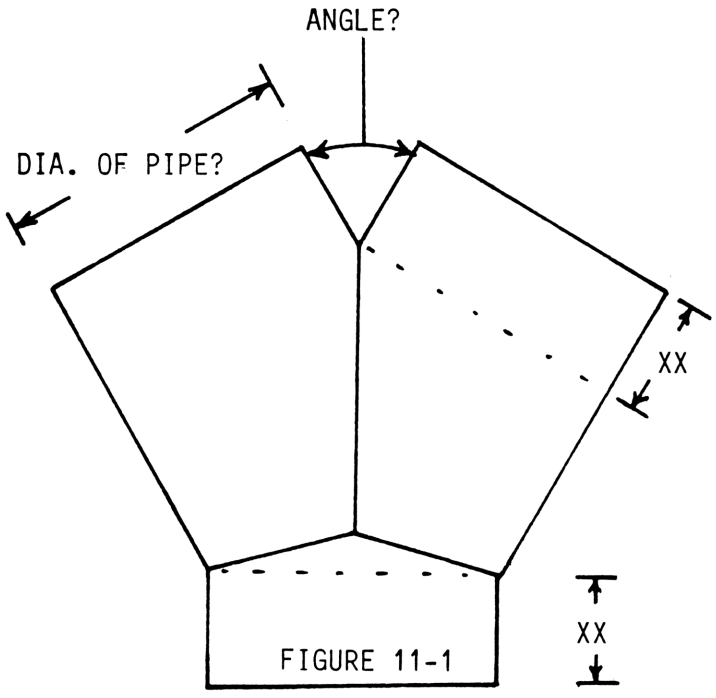


FIGURE 11-1

OUTPUTS: Refer to figure 11-2, 11-3.

1) SEGMENT WIDTH
"1/X.CIR.="
Gives the distance between the lines used to construct the pattern.

2) HALF-PATTERN LINES FOR THE TWO BRANCHES
"LINE:X.="

3) CUT SIZE FOR THE TWO BRANCHES
"CUT SIZE="
"X="
"Y="
This is the width and the height of the piece of material required for your branch.

4) QUARTER PATTERN LAYOUT FOR THE TRUNK
"LINE:X.="

5) CUT SIZE FOR THE TRUNK
"CUT SIZE="
"X="
"Y="
This is the width and the height of the piece of material required for your trunk.

CONSTRUCTION: Refer to figure 11-2.

TRUNK

1) MEASURE THE CUT SIZE
Use the cut size measurements to lay out a rectangle that is X inches wide and Y + XX inches high.

2) MARK THE BASELINE
Measure XX inches up from the bottom.

3) ESTABLISHING THE QUARTER PATTERN BOUNDARIES
Divide the material into four equal lengthwise segments.

4) ESTABLISHING A QUARTER PATTERN
Using a scrap piece of material or cardboard, make a baseline. Divide the baseline into "PARTS PER ¼.=" using the measurement "$^{1}/_{n}$.CIR.=" as your segment width. From the bottom of your material, measure your CD baseline. This line is the one the quarter pattern is flipped on.

5) FLIPPING YOUR QUARTER PATTERN
Flip the quarter pattern along the baseline. Please refer to figure 11-2

6) CUT OUT THE PATTERN AND ASSEMBLE
Roll up and join the ends.

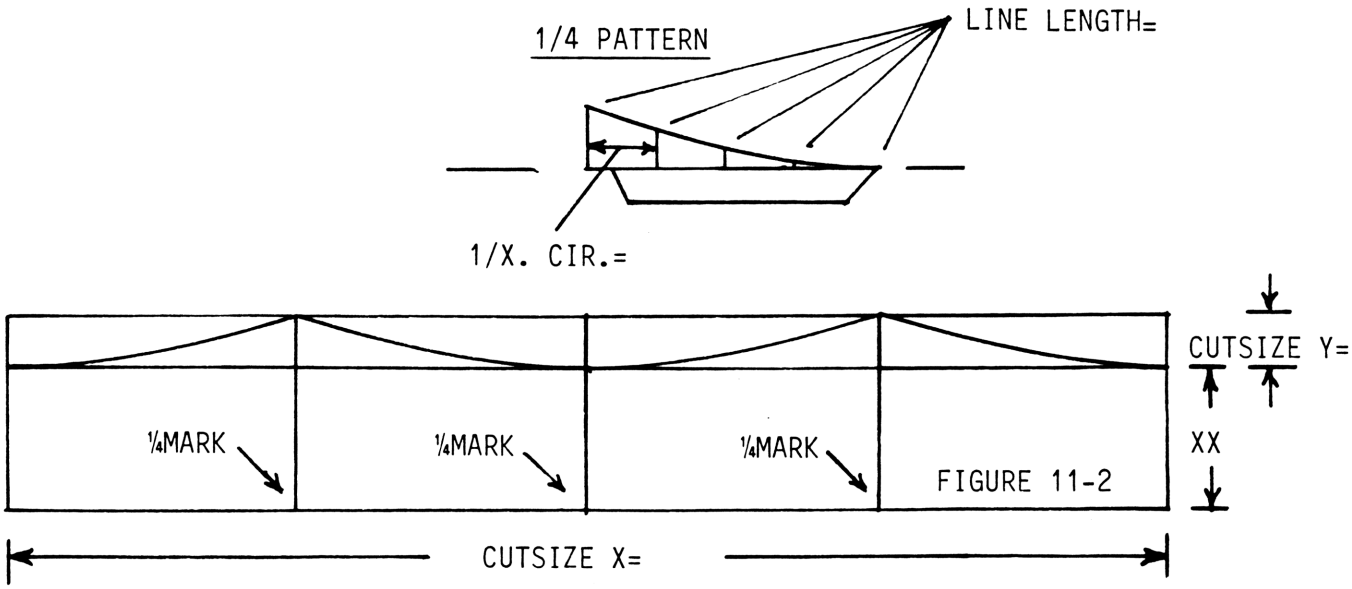


FIGURE 11-2

CONSTRUCTION: Refer to figure 11-3.

Y BRANCHES

1) MEASURE THE CUT SIZE
Use the cut size measurements to lay out a rectangle that is X inches wide and Y + XX inches high.

2) MARK THE BASELINE
Measure XX inches down from the top of your cut size and make a horizontal line all the way across.

3) MAKE A DIVIDER
Make a vertical line up through the middle of your cut size.

4) DRAW THE PATTERN LINES
Starting from both outside edges measure line length 1 down from the baseline. Line length 1 is always zero.

5) CUT OUT THE PATTERN
Connect the dots with a smooth curve and cut out the pattern.

6) CUT OUT THE PATTERN AND ASSEMBLE
Roll up and join the ends.

1/2 PATTERN

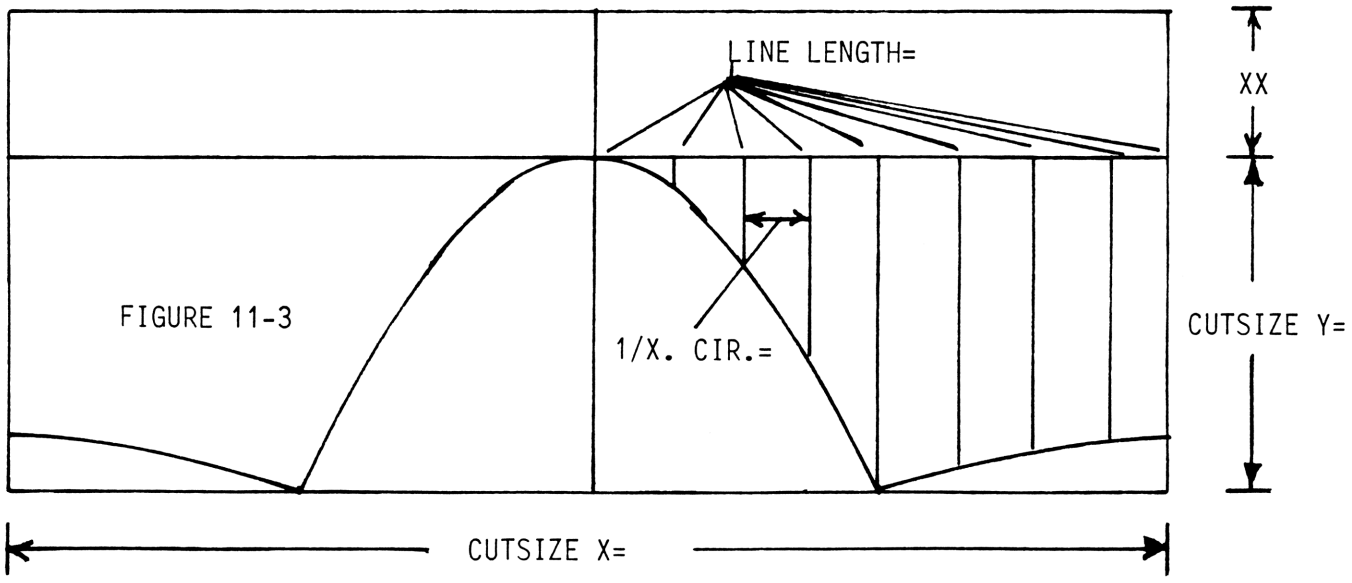


FIGURE 11-3

CHAPTER 12

ROOF PIPE

PROGRAM TITLE: "RF PIPE"

PURPOSE: Gives the layout for a pipe on a flat surface.

INPUTS: Refer to figure 12-1.

1) DIAMETER OF THE PIPE
   "DIA.PIPE?"
   Enter the inside diameter of the pipe.

   IMPORTANT: If 16 gauge or thicker material is used, enter the inside diameter PLUS the wall thickness.

2) ROOF ANGLE
   "ANGLE?"
   Enter the angle of the roof, in degrees.

3) PARTS PER QUARTER PATTERN
   "PARTS PER. ¼.?"
   Enter the number of segments you desire the quarter pattern divided into. A typical number is 6.
   The higher the number, the greater the accuracy of your pattern.

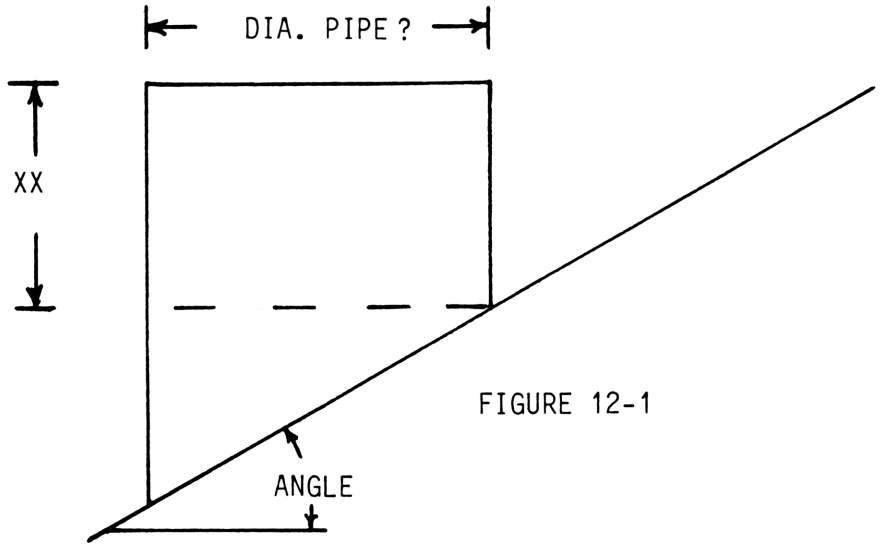


FIGURE 12-1

OUTPUTS: Refer to figure 12-2 for a better illustration of the outputs.

1) SEGMENT WIDTH
"1/X.CIR.="

The width of each segment of the quarter pattern.

2) LINE LENGTH
"LINE:X.="
These are the true lengths of the lines used to construct the quarter pattern.

3) HALF HEIGHT
"CD="
This is the height of the center line of the quarter pattern.

4) CUT SIZE
"CUT SIZE="
"X="
"Y="
Gives the dimensions for the cut size.

IMPORTANT: TO GET FULL PATTERN HEIGHT, ADD THE PIPE EXTENSION, XX, TO Y.

NOTE: You will now be asked if you want the layout for the corresponding ellipse.

"DO YOU WANT"
"ELLIPSE LAYOUT?"

If you answer "YES" then the X and Y coordinates are given to construct a quarter ellipse. You use this as a template to make the full pattern. Instructions for making the ellipse following the pipe construction section.

CONSTRUCTION: Refer to figure 12-2.

ROOF PIPE

1) MEASURE THE CUT SIZE

Measure the true cut size dimensions on your work piece.

IMPORTANT: The pipe extension, XX in the drawing, must be added to the Y dimension in order to get the true height of your cut size.

2) MARK THE CENTER LINE

Measure up from the bottom XX distance (the pipe extension) at each side of the cut size and mark the spot. From these points measure up CD units (one half height) and mark the spot. Draw a line across the work piece between the two higher points.

3) CONSTRUCT THE QUARTER PATTERN

Start from the lower left corner of your pattern material and measure up the height of line 1; mark the spot. Measure across the bottom, one segment width then up the height of line 2; mark the spot. Repeat this process for all the pattern lines. Connect the dots to form a smooth curve then cut out the quarter pattern.

4) MAKE THE FULL PATTERN

By placing the quarter pattern on the center line, make a curve like that shown in the drawing (figure 12-3).

5) CUT OUT AND ASSEMBLE

Cut along the curve and discard the excess. Roll your piece to the correct diameter and join along the seam.

CONSTRUCTION OF ELLIPSE: Refer to figure 12-3

1) MAKE COORDINATE AXES

On a piece of template material large enough for the quarter pattern, construct a X,Y, coordinate system. The origin should be at the lower left corner of the work piece.

2) PLOT THE POINTS

Make a mark at point X1-Y1, X2-Y2, etc.

3) CONNECT THE POINTS AND CUT OUT PATTERN

Connect the points with a smooth curve and cut out the quarter pattern.

4) CONSTRUCT FULL PATTERN

Use the quarter pattern template to layout the full pattern where you need it.

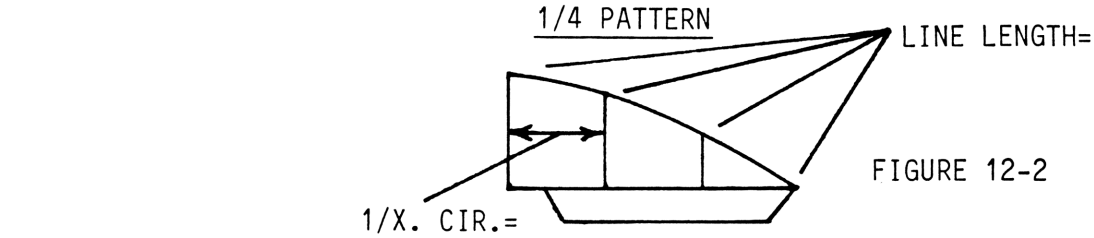
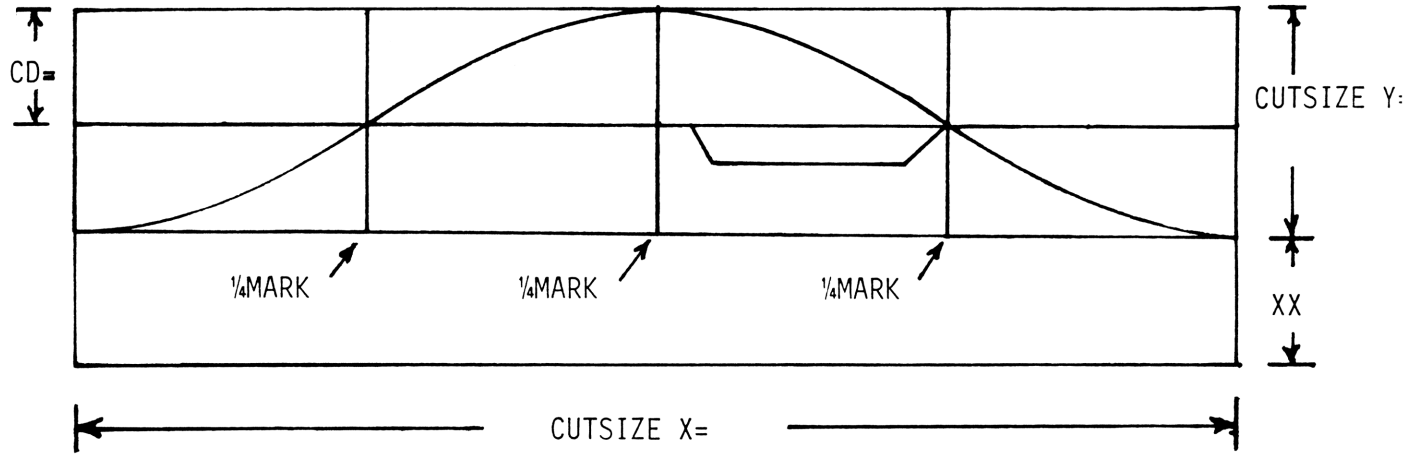


FIGURE 12-2



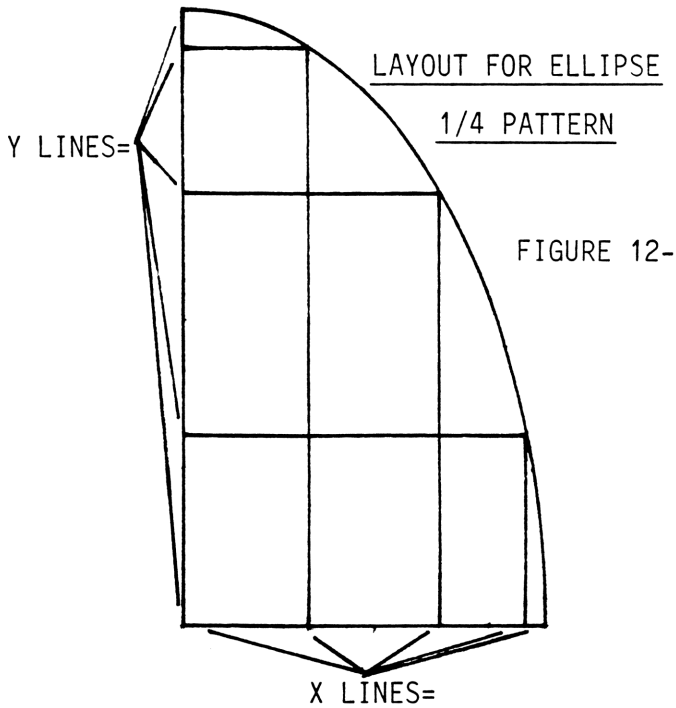


FIGURE 12-3

CHAPTER 13
PIPE ON PIPE

PROGRAM TITLE: "PIPE"

PURPOSE: Gives the layout for a round pipe joining another round pipe.

INPUTS: Refer to figure 13-1

1) SMALL PIPE DIAMETER
"SM.PIPE ?"
Enter the inside diameter of the smaller of the two pipes.

IMPORTANT: If 16 gauge or thicker material is used, enter the inside diameter PLUS the material thickness.

2) LARGE PIPE DIAMETER
"LG.PIPE ?"
Enter the inside diameter of the larger pipe.

IMPORTANT: If 16 gauge or thicker material is used, enter the inside diameter PLUS the material thickness.

3) JOINT ANGLE
"ANGLE ?"
Enter the angle, in degrees , formed by the two pipes.

4) NUMBER OF PARTS PER QUARTER PATTERN

"PARTS PER ¼ ?"

Enter the number of segments you want your quarter pattern constructed of; a typical number is 6.
NOTE: The higher the number, the greater the accuracy of your pattern.

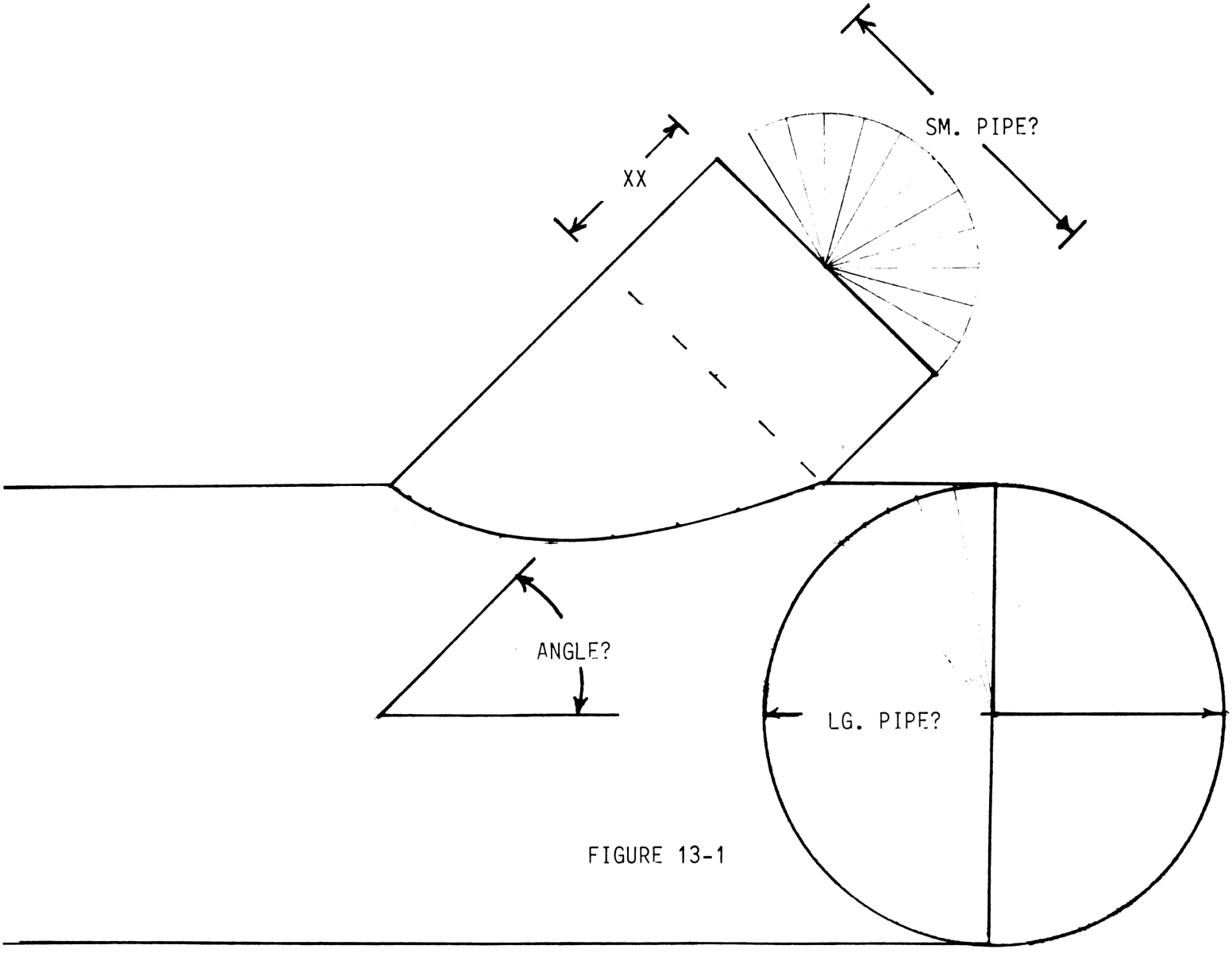


FIGURE 13-1

OUTPUTS: Refer to figure 13-2

1) SEGMENT WIDTH
   "1/X.CIR.="
   Gives the separation between the lines used to construct the pattern.

2) LINE LENGTH
   "LINE:N="

   These are the true lengths of the lines used to construct the pattern. (N) is equal to 1 through 2 times the parts per quarter PLUS 1.

3) CUT SIZE
   "CUT SIZE"
   "X="
   "Y="

   (X) is the width and (Y) is the height of the piece of material required for your joint.

   IMPORTANT: The extra length of pipe, (XX) in the drawing, MUST be added to the (Y) dimension (the height) to get the correct size.

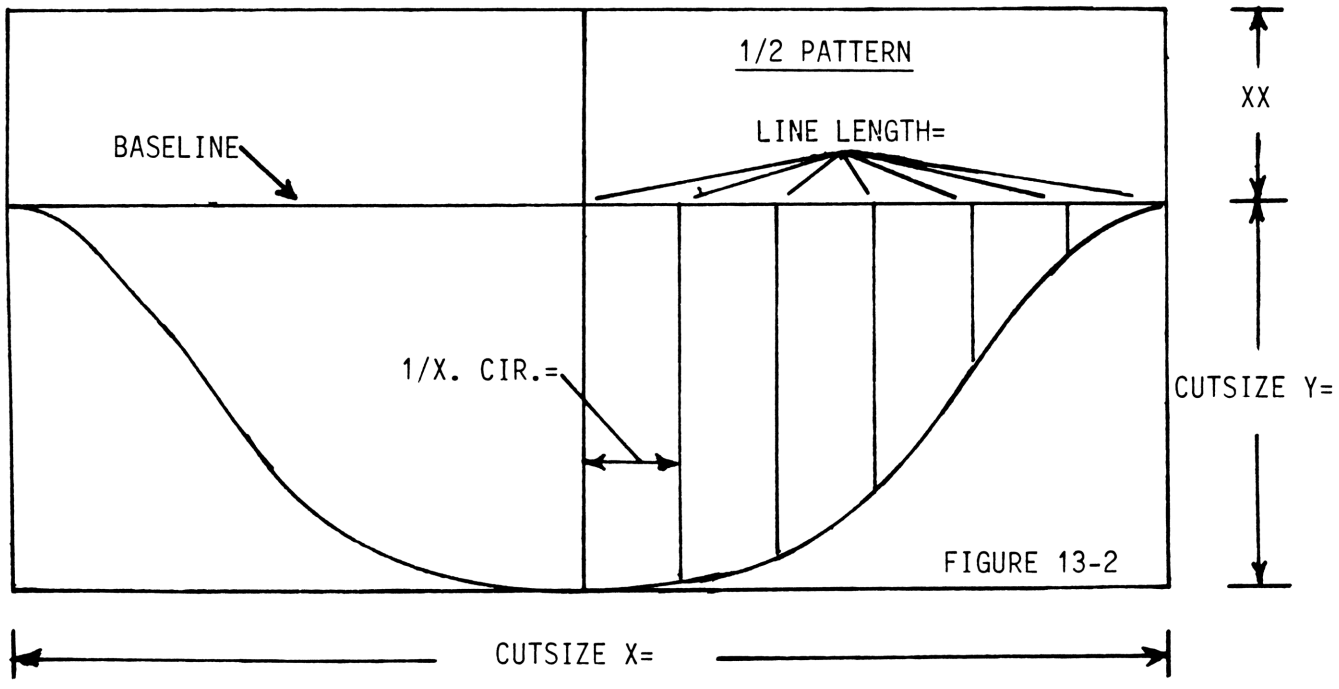


FIGURE 13-2

CONSTRUCTION PIPE ON PIPE: Refer to figure 13-2

1) MEASURE THE CUT SIZE
Use the cut size measurements to lay out a rectangle that is (X) inches wide and (Y) + (XX) inches high.

2) MARK THE BASELINE
Measure (XX) inches down from the top of your cut size and make a horizontal line all the way across.

3) MAKE THE DIVIDER
Make a vertical line up through the middle of your cut size.

4) DRAW THE PATTERN LINES

Starting from both outside edges measure line length 1 down from the baseline. (Line length 1 will always equal zero)

Now move inward one segment width (on both sides) along the baseline.

Measure down line length 2 and mark the spot.

Repeat this pattern for all the lines.

5) CUT OUT THE PATTERN
Connect the dots with a smooth curve and cut out the pattern.

6) ROLL AND JOIN THE ENDS

CHAPTER 14
SQUARE TO ROUND

PROGRAM TITLE: "S TO R"

PURPOSE: To give the layout for constructing the junction of a square (or rectangular) pipe to a round pipe.

DISCUSSION:

The square to round program is the most complex and should be studied thoroughly before you attempt to use it. Read carefully through the paragraphs that follow and study the joint you are to make so you can correctly classify it.

There are four square to round configurations that this program will handle. Each of those configurations has certain peculiarities so it is important that you correctly select the one that fits your situation. Your joint MUST fit the given categories, all possible options have been covered. Follow the guidelines below to classify your fitting.

CATEGORY 1. Square pipe to round pipe with the circle centered on the square. Figure 14-1a shows this situation. The square pipe must be a true square and the center of the square must be directly in line with the center of the circle, that is, no offset.

CATEGORY 2. Rectangular pipe to round pipe with the circle centered on the rectangle. Figure 14-2a shows this situation. It does not matter which dimension of the rectangle is largest; the most important aspect is that no offset is allowed.

CATEGORY 3. Either square or rectangular pipe to round pipe with offset allowed along the x-axis. See figure 14-3afor an illustration of this type. No up or down (i.e., y-axis) offset is allowed.

CATEGORY 4. Either square or rectangular pipe to round pipe with offset allowed on both axes. Please refer to figure 14-4a. Notice there is up-down and left-right offset.

INPUTS: Refer to figures 14-0a and 14-0b

NOTE: The layouts are shown as viewed from inside the fitting.

1)HEIGHT OF THE SQUARE

"SIDE :Y:?"

*Enter the length of the square or rectangle section of pipe.

2)WIDTH OF THE SQUARE

"SIDE :X:?"

*Enter the width of the square or rectangular section of pipe.

3)ROUND PIPE DIAMETER

"DIA. OF TOP?"

*Enter the diameter of the round pipe.

4)FITTING HEIGHT

"HEIGHT?"

*Enter the overall length of the fitting.

5)X COORDINATE OF THE CIRCLE

":X: LINE?"

*Enter the distance from the left side of the square to the center of the circle.

6)Y COORDIANTE OF THE CIRCLE

":Y: LINE?"

*Enter the distance from the bottom edge of the square to the center of the circle.

7)PARTS PER QUARTER PATTERN

"PARTS PER.¼?"

*Enter the number of parts you want in each quarter pattern. Larger numbers give more accurate fit but take longer to layout. Odd numbers cannot be used if quarter pattern selection is entered in step 11.

8)NUMBER OF PIECES TO ASSEMBLE

"DO YOU WANT"

"4 OR 2 PIECE?"

*Enter 4 if you want to construct the fitting in 4 pieces and enter

2 if you want to construct it in 2 pieces.

9)X-Y COORDINATE SELECTION

"DO YOU WANT"

"X Y CORD."

*Enter "YES" if you want to do an x-y coordinate layout. Enter "NO" if you want to do an arc method layout.

10)MIDSEAM SELECTION (2 PIECE ONLY)

"DO YOU WANT"

"MIDSEAM?"

*If you answer "YES", the layout is given for seams in the middle of the square pipe sides. If you answer "NO" then the seams lead to the corners of the square pipe.

11)PATTERN SELECTION

"DO YOU WANT"

"FULL,HALF,QUART"

*Enter the pattern you want-full, half, or quarter. If you entered 2 in step 8, then you can only enter half or full.

IMPORTANT

*CATEGORY 1-all combinations are possible.

*CATEGORY 2-the 4 piece quarter pattern is not possible.

*CATEGORY 3-The following are not possible: 4 piece quarter pattern, 4 piece half pattern, and the 2 piece half pattern with corner seams.

*CATEGORY 4-you must always use the full pattern.

OUTPUTS, ARC METHOD: Please refer to figure 14-1,14-2,14-3,or 14-4 as needed. Figure 14-0c applies to all fittings.

1)ARC LENGTH

"ARC="

*This is the length of the arc that separates the ends of the lines where they meet the round section of the pattern.

2)LINE LENGTHS

"QUAD,4 LINE5.="

etc.

*A list of line lengths is given. If you asked for 2 pieces then

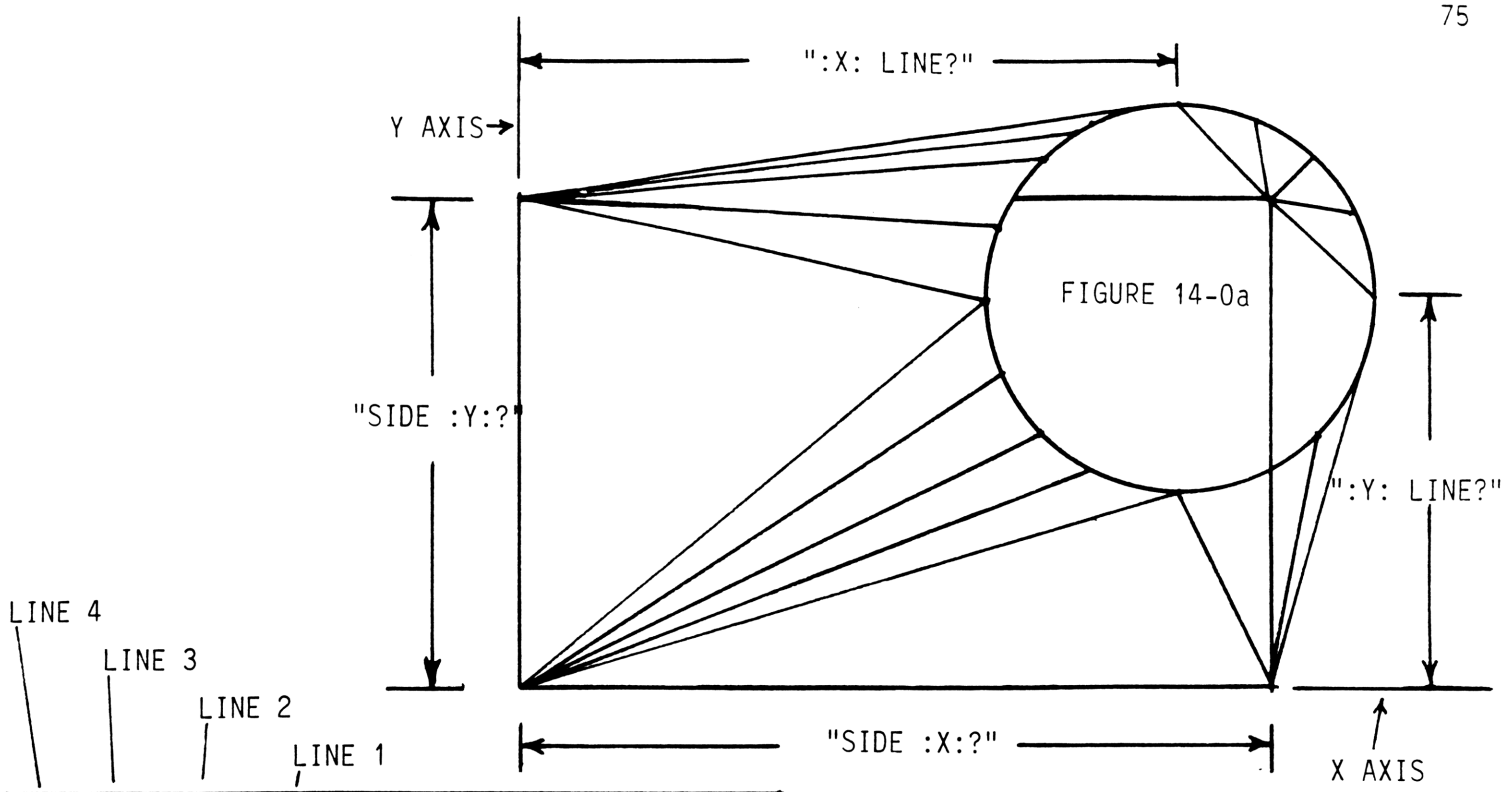


FIGURE 14-0a

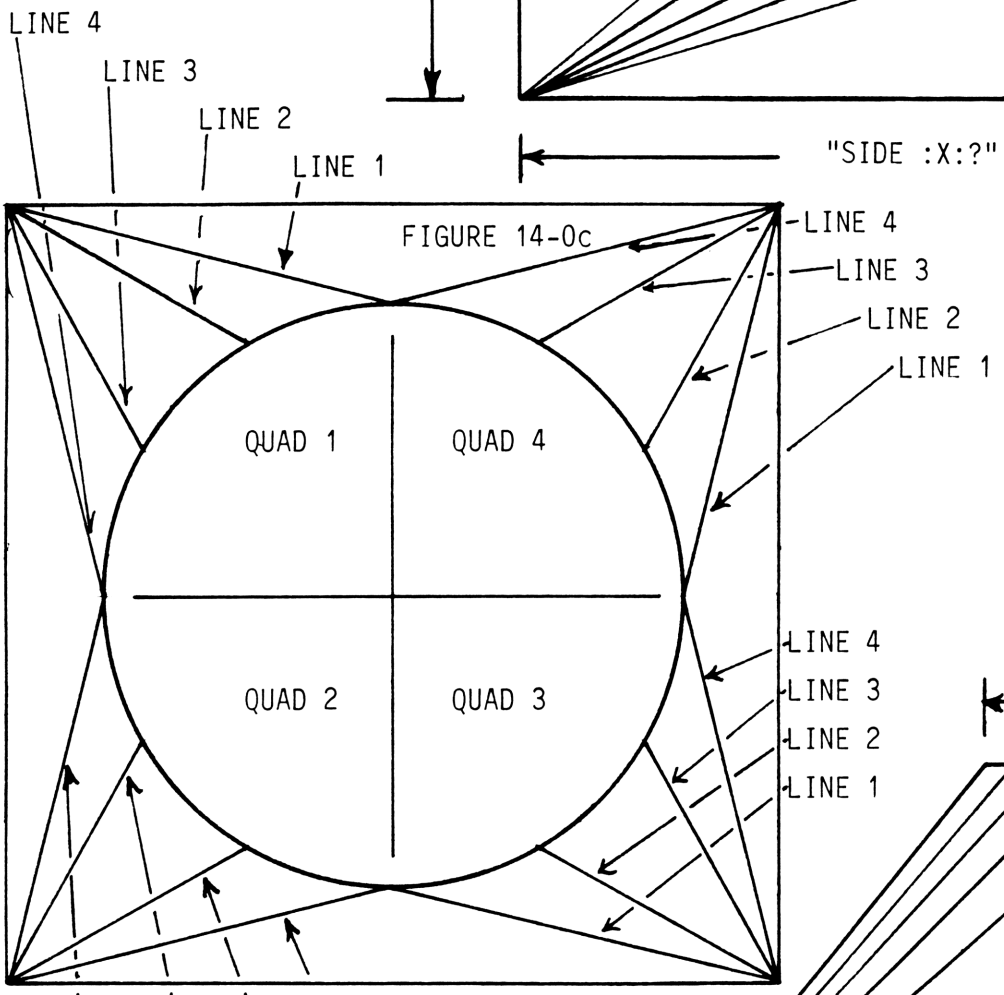


FIGURE 14-0c

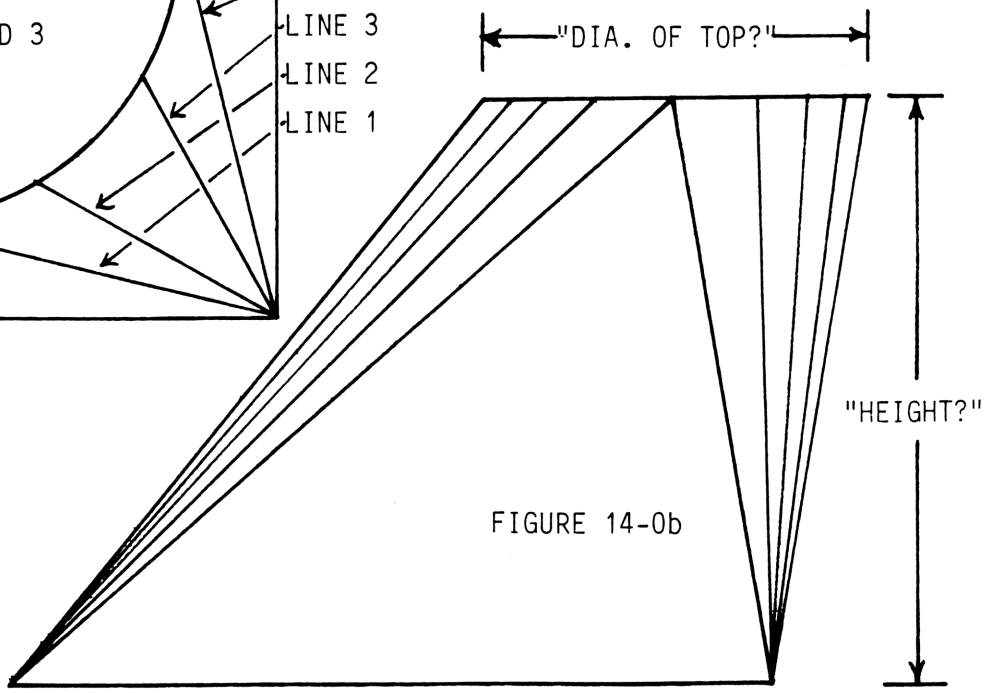
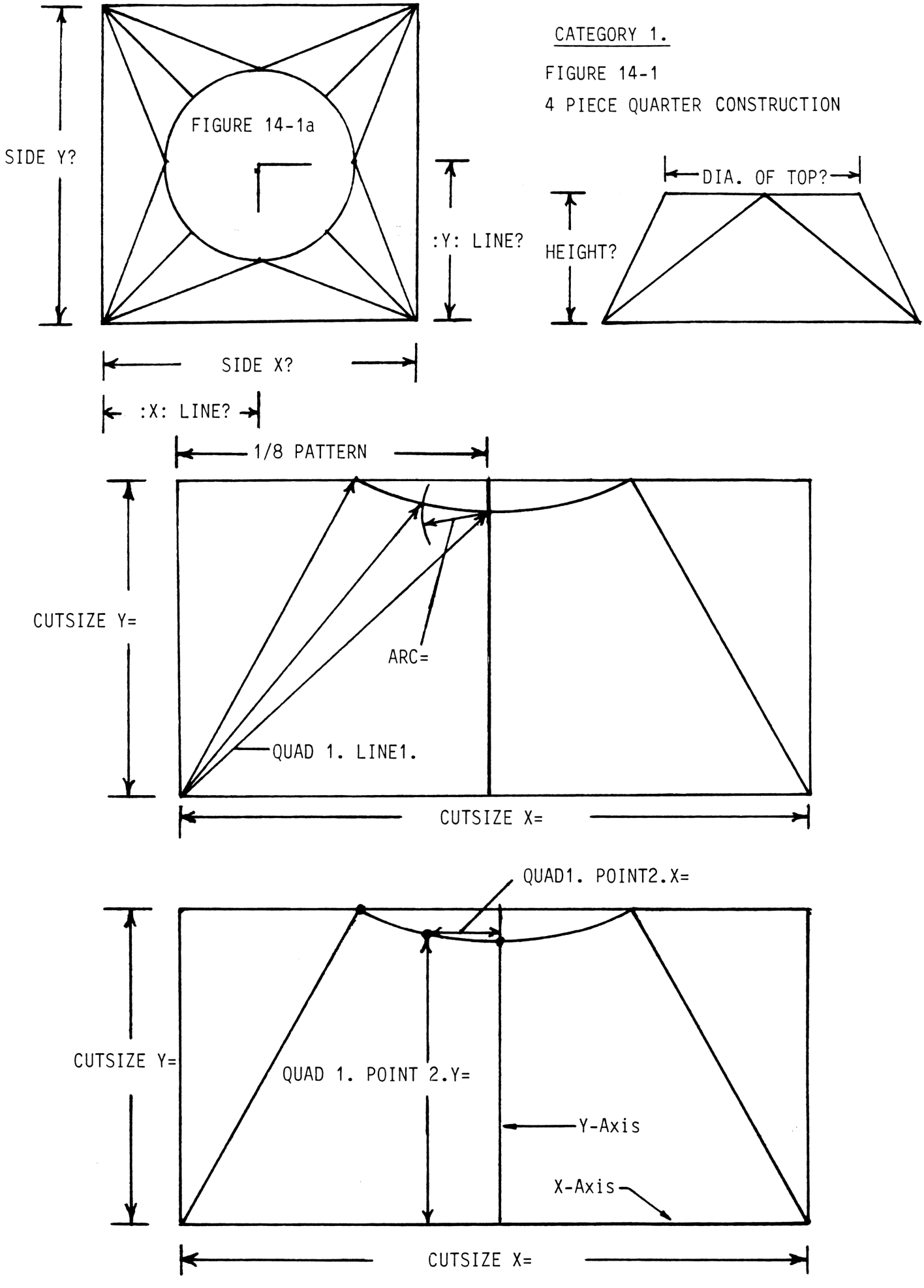


FIGURE 14-0b

CATEGORY 1.

FIGURE 14-1

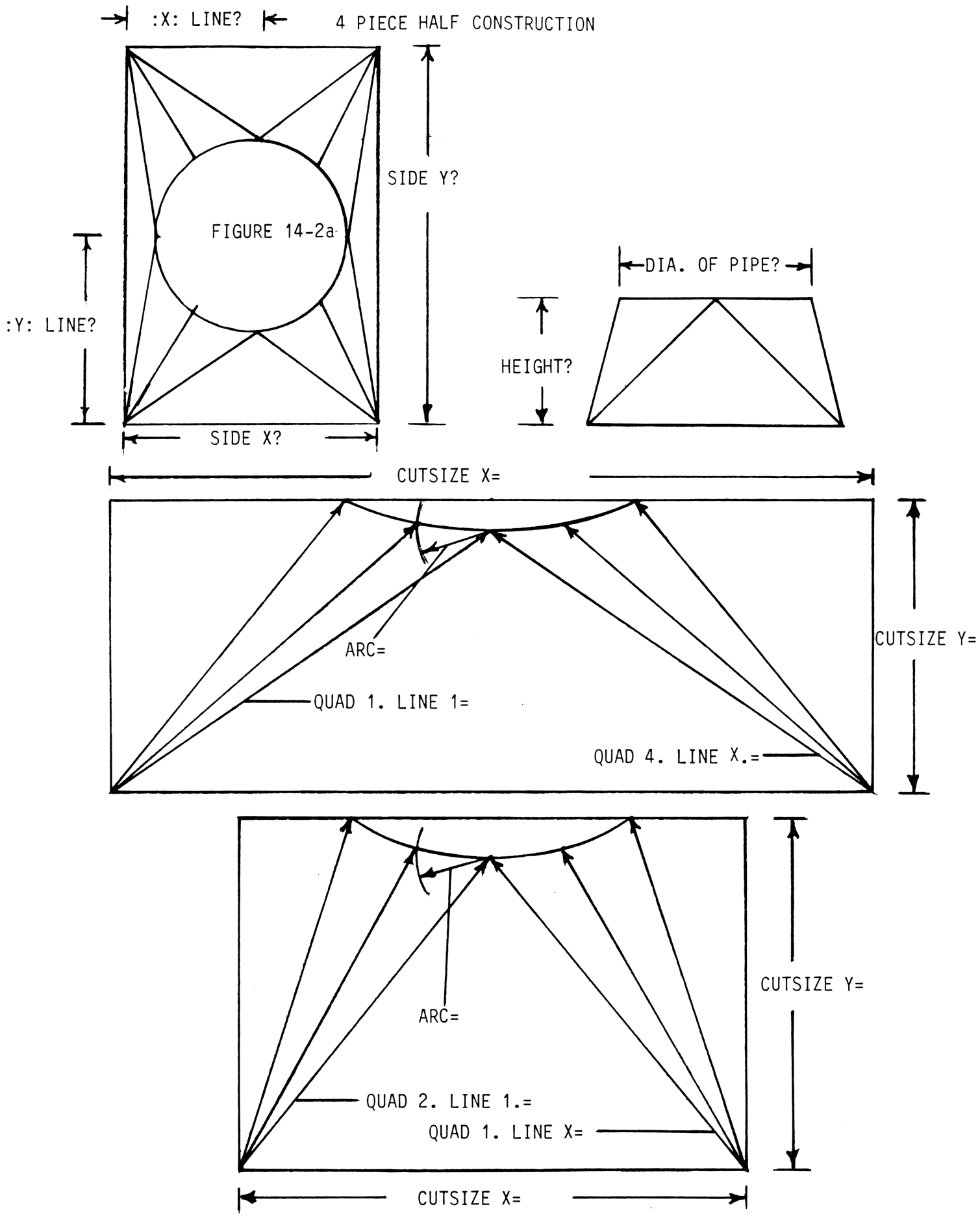
4 PIECE QUARTER CONSTRUCTION



CATEGORY 2.

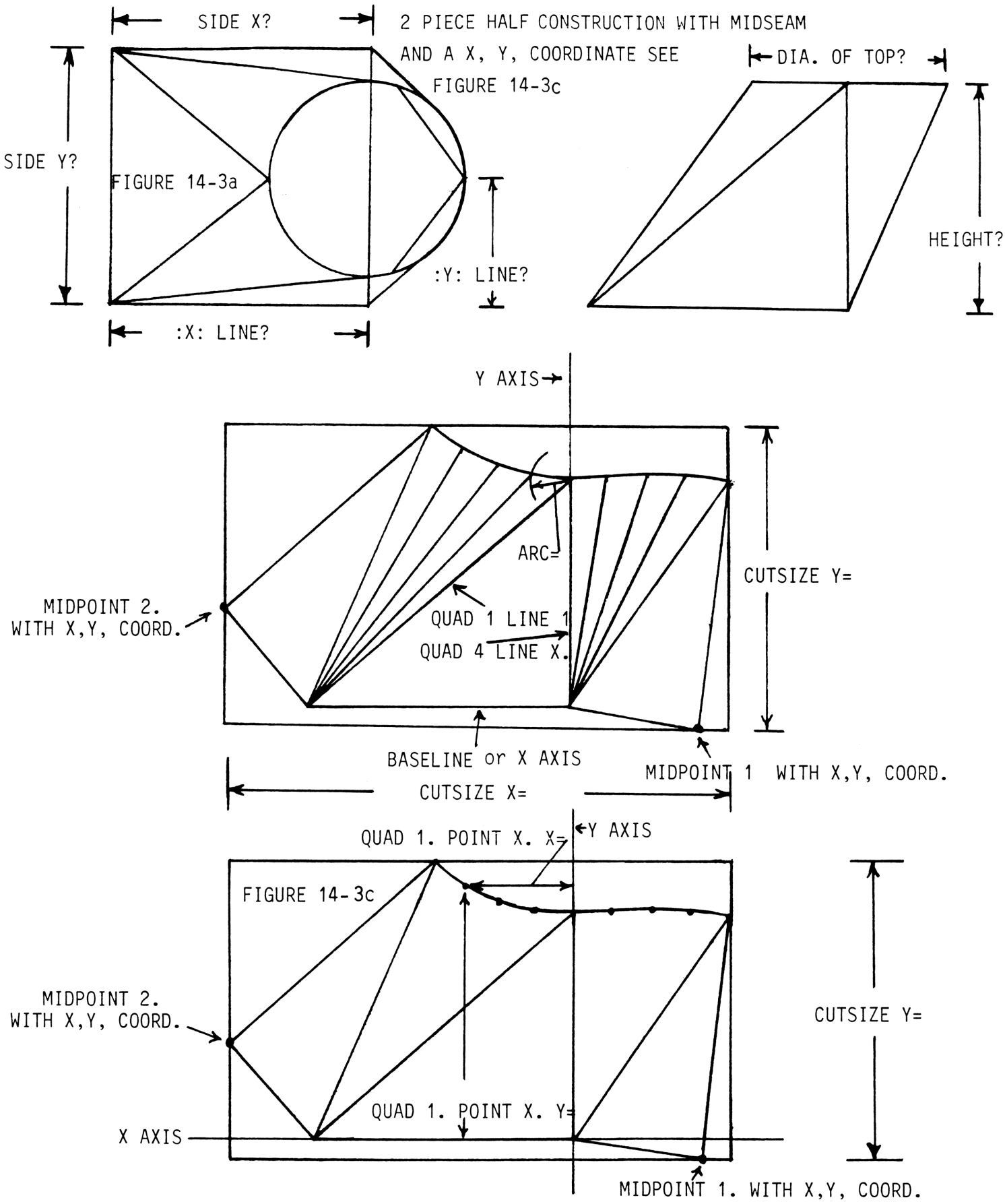
FIGURE 14-2

4 PIECE HALF CONSTRUCTION



CATEGORY 3.

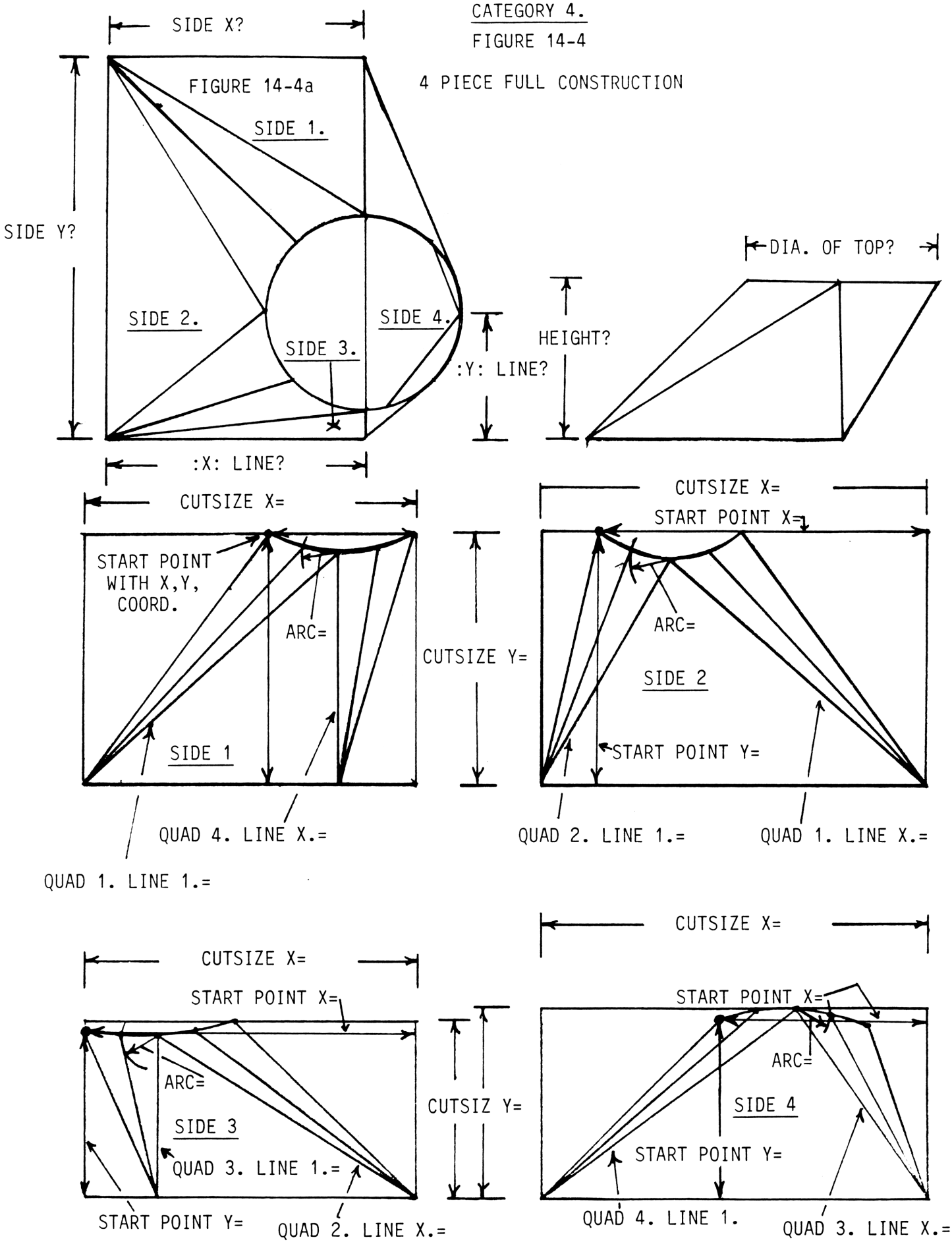
FIGURE 14-3



CATEGORY 4.

FIGURE 14-4

4 PIECE FULL CONSTRUCTION

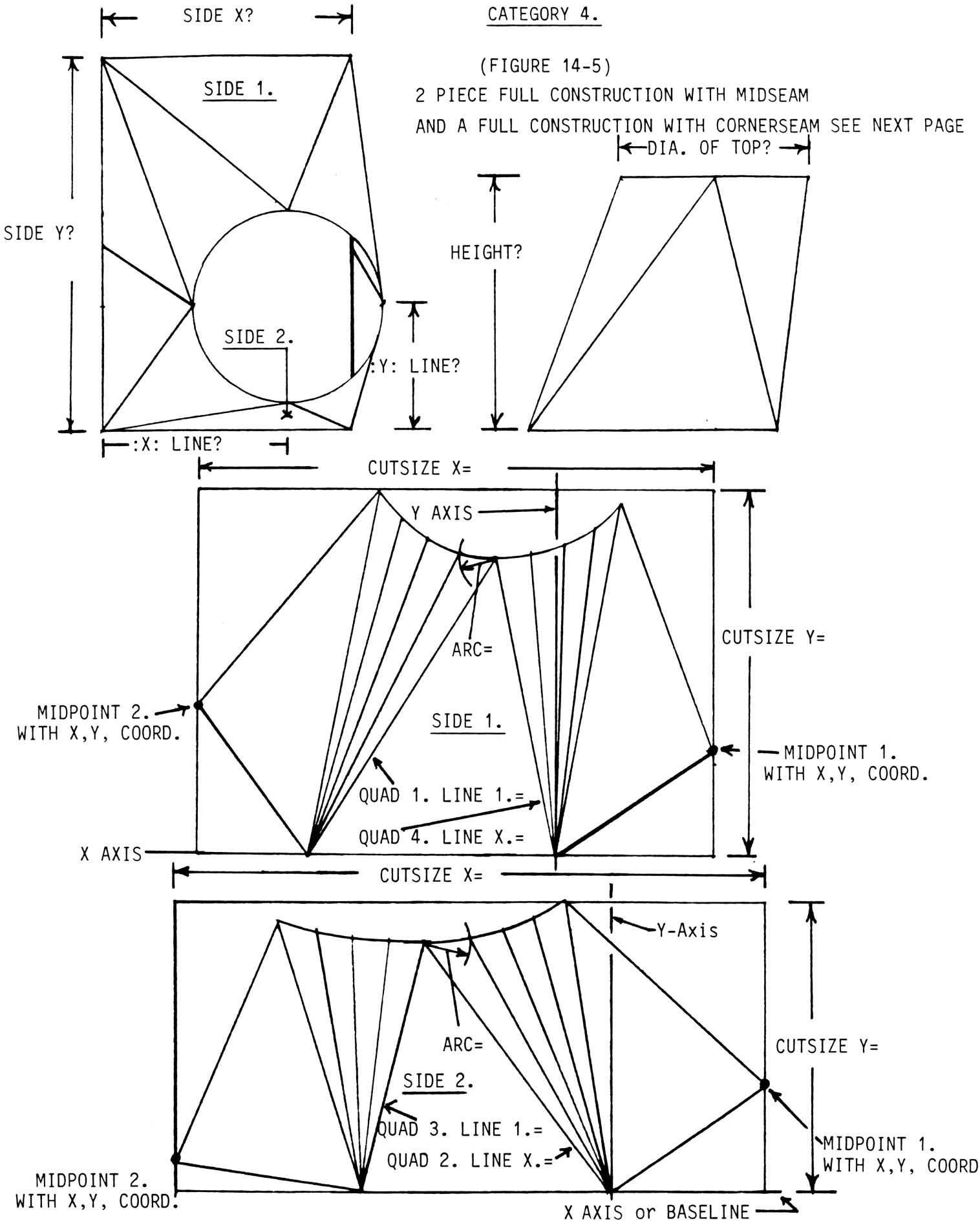


CATEGORY 4.

(FIGURE 14-5)

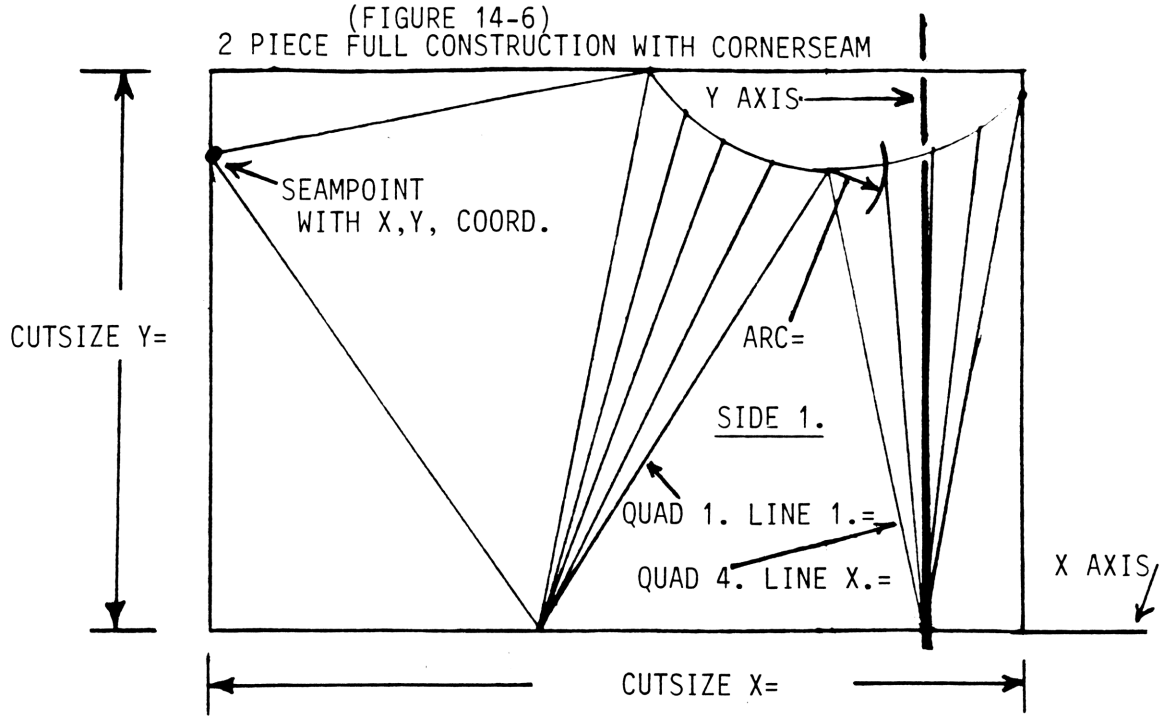
2 PIECE FULL CONSTRUCTION WITH MIDSEAM

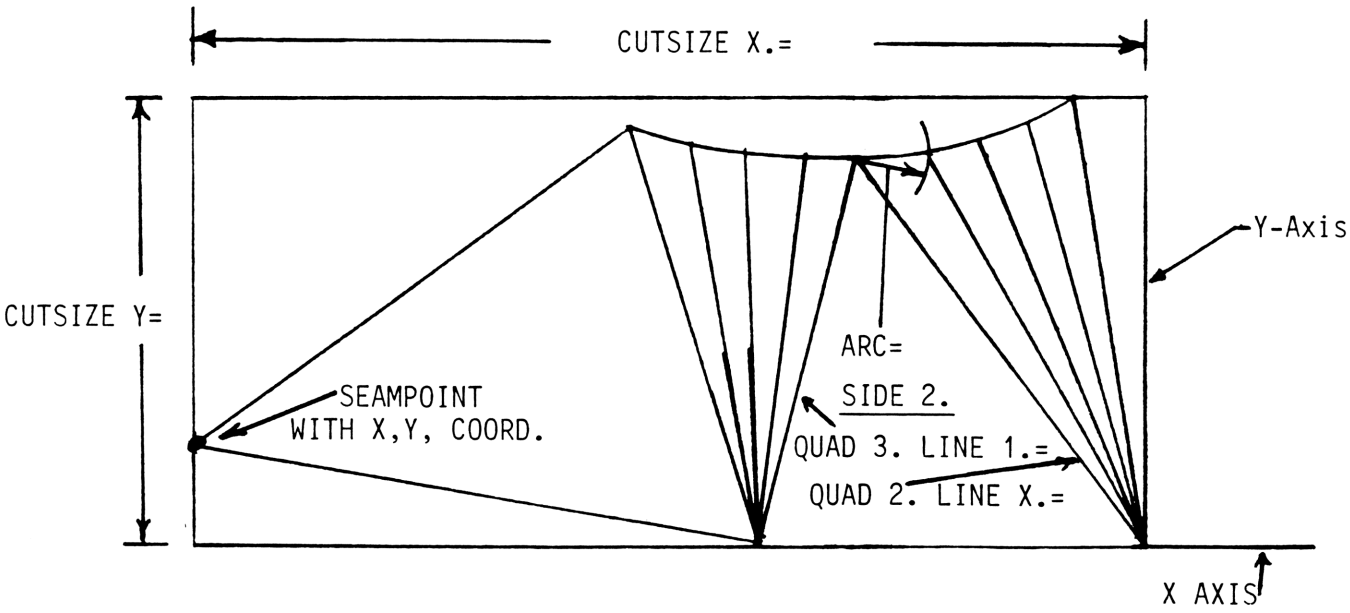
AND A FULL CONSTRUCTION WITH CORNERSEAM SEE NEXT PAGE



CATEGORY 4.

(FIGURE 14-6)
2 PIECE FULL CONSTRUCTION WITH CORNERSEAM





two sets of lines are given: quadrants 4 and 1. If you asked for 4 pieces then 4 sets of lines are given: quadrants 4,1,2,and3.

3)MIDPOINT COORDINATES
"MIDPOINT1"
"X="
"Y="
etc.
*These are the coordinates of the points that lie at the midpoints of the square. The midseams end at these points.

4)SEAM POINT LOCATION
"SEAMPOINT"
"X="
"Y="
*Gives the location of the corner of the square. This point is used as a start point for fittings joined at the corners.

5)CUT SIZE
"CUTSIZE"
"X="
"Y="
*These are the dimensions of the cut size.

CONSTRUCTION, ARC METHOD: SEE FIGURE 14-6 on page 81

A. 2 PIECE WITH CORNER SEAMS

1)MARK THE ORIGIN
*Using the X value from the seampoint, measure along the bottom of the cut size from the left side and mark the spot. Now, measure to the right of this point a distance equal to "SIDE : X:". Mark the spot; this is the origin.

2)FIND THE INTERCEPT
*Set your compass to the length of the highest numbered line in quadrant 4, place the point on the origin, and swing an arc between the origin and the first point. Now, set your compass for the length of line 1 quadrant 1, place the point at the first located (in step 1), and swing an arc that intercepts the first arc.

3)COMPLETE QUADRANT 1 LINES

*Set your small compass for the arc length given in output #1. Place the compass point on the intercept point and make an arc to the left. Set your large compass for quadrant 1 line 2. With the compass point on the base of quadrant 1 line 1, swing an arc that intercepts the small arc you made in the last step. This is the second intercept point. Repeat this process for the rest of the quadrant 1 lines.

4)COMPLETE QUADRANT 4 LINES

*Using the process desribed in step 3, complete the lines in quadrant 4. Be sure that you swing the small arcs to the right and place your large compass point at the base of the quadrant 4 line you constructed in step 2 (i.e., the origin). This completes one half of the pattern.

5)COMPLETE THE OTHER HALF

*If your fitting is symmetrical you use the pattern just made as a template to make the other half. If it is not symmetrical then you must construct the other half using the data given for quadrants 2 and 3. Notice another cut size is given for this half of the pattern. Use the same procedure desribed for making the first half.

6)SHAPE THE HALF PATTERNS

*After cutting them out, break up the half patterns to their correct shape.

7)JOIN THE HALVES TO FORM THE FITTING

B. 2 PIECE WITH MIDSEAMS-Midseams are allowed on 2 piece construction only. SEE FIGURE 14-5 on page 80

1)MAKE THE START POINT

*Using the midpoint 2(X value), measure along the bottom of the cut size from the left edge. Mark the point

2)MAKE THE BASELINE

*Look at the Y values of the two midpoints. If one of them

is negative then move up from the bottom a distance equal to the negative number. Now, construct a line across the cut size that is parallel to the bottom. This is the baseline. If there are no negative y values then the baseline is the bottom of the cut size. The point on the baseline directly above the start point is the ORIGIN.

3)MARK THE MIDPOINTS

*Measuring from the origin, locate and mark the two midpoints. Midpoint 1 is to the right of the origin and midpoint 2 is to the left.

4)FIND THE INTERCEPT

*Set your large compass for the length of the highest numbered line in quadrant 4. Place the compass point on the origin and swing an arc to the right. Now reset your large compass for the length of quadrant 1 line 1. Place the compass point on the baseline to the right of the origin a distance equal to the width of the square pipe. Swing an arc to the left that intercepts your last arc.

5)MARK ALL QUADRANT FOUR LINES

*Set your small compass for the arc length. Place the compass point on the intercept found in step 4 and swing an arc to the left . Set your large compass to the length of the next highest numbered line in quadrant 4. With the compass point at the origin, swing an arc that intercepts the last arc. Repeat this process for all of the quadrant 4 lines

6)MARK ALL QUADRANT ONE LINES

*With your small compass still set on the arc length, swing an arc to the right of the intercept point found in step 4. Set the large compass for the length of quadrant 1 line 2. Set the compass point at the base of quadrant 1 line1 and swing an arc that intercepts the last arc. Repeat this process for all of the quadrant 1 lines.

7)DRAW A LINE FROM THE TOP OF THE LAST QUADRANT 1 LINE TO MIDPOINT 1. DRAW A LINE FROM QUADRANT 4 LINE 1 TO MIDPOINT 2.

8)DRAW A LINE FROM MIDPOINT 2 TO THE BOTTOM OF THE QUADRANT 4 LINES. DRAW A LINE FROM MIDPOINT 1 TO THE BOTTOM OF THE QUADRANT 1 LINES.

9)CUT OUT THE PATTERN AND BREAK IT UP ACCORDING TO THE LAYOUT.

10)REPEAT FOR THE OTHER HALF PATTERN
Notice that quadrant 2 lines are the left half of the pattern.

C. 4 PIECE CONSTRUCTION

*Layout for 4 piece construction is accomplished in the same way as layout for 2 piece construction with corner seams (part A), except that the starting point is the left most point in the arc. Refer to that section and the following notes to construct 4 piece fittings.

NOTES:

1) An even number of parts per quarter must be selected for 4 piece construction.
2) Each quadrant constitutes a piece of the total pattern.
3) Midseams are not allowed for 4 piece work.
4) Full pattern must be selected for category 3 and 4 fittings.

OUTPUTS, X,Y COORDINATE METHOD: Please refer to figure 14-3c on page 78

1)ARC POINT LOCATIONS
"QUAD,4 POINT1"
"X="
"Y="
etc.
*These are the coordinates for the points used to form the arc of the circular opening. IMPORTANT- negative x-coordinates are marked to the right of the y-axis.

2)SEAMPOINT LOCATION
"SEAMPOINT="
"X="

"Y="

*Gives the location of the corner of the square. This point is used as a starting point for fittings that are seamed at the corners.

3)MIDPOINT COORDINATES-Applies only if you selected midseams.

"MIDPOINT1"

"X="

"Y="

etc.

*These are the coordinates of the points that lie at the midpoints of the square. The midseams end at these points.

CONSTRUCTION, X,Y COORDINATE METHOD:

1)MAKE THE Y-AXIS

*Measure from the left side of your cut size, along the bottom edge. The X value given for your seampoint is how far to measure, mark the spot. Now, construct a line at this point that is perpendicular to the base and extends up through your cut size. This is the Y-axis.

2)MAKE THE X-AXIS

*The x-axis is the same as the baseline described in the arc method construction section. The bottom edge of the cut size is the X-axis in all but one case. If you selected midseams and one of the Y coordinates is negative then then move up that negative distance to construct the axis.

3)LOCATE ALL POINTS

*Locate and mark the points given by using the coordinate system you just constructed. Remember an X value is positive to the left of the origin. Up is positive for Y values.

4)CONNECT THE DOTS

*Connect the points you have plotted to form the pattern.

5)CUT OUT, BREAK UP ACCORDING TO LAYOUT, AND ASSEMBLE

CHAPTER 15

BOOTTEE

PROGRAM TITLE: "BOOTTEE"

PURPOSE: Gives the layout for a boottee that joins a pipe.

INPUTS: Refer to figure 15-1.

1) DIAMETER OF BOOTTEE TOP
"BOTE.DIA.?"

2) HEIGHT OF THE FITTING
"HEIGHT?"

3) DIAMETER OF THE CONNECTING PIPE
"DIA.PIPE?"
Enter the diameter of the pipe that the boottee connects to.
HINT: If you want to layout a boottee for a flat surface, enter 999,999,999 for the diameter of the pipe. The higher the number, the closer it is to being flat.

4) PARTS PER QUARTER PATTERN
"PARTS PER.¼?"
Enter the number of parts per quarter pattern that you desire. The higher the number, the greater the accuracy.

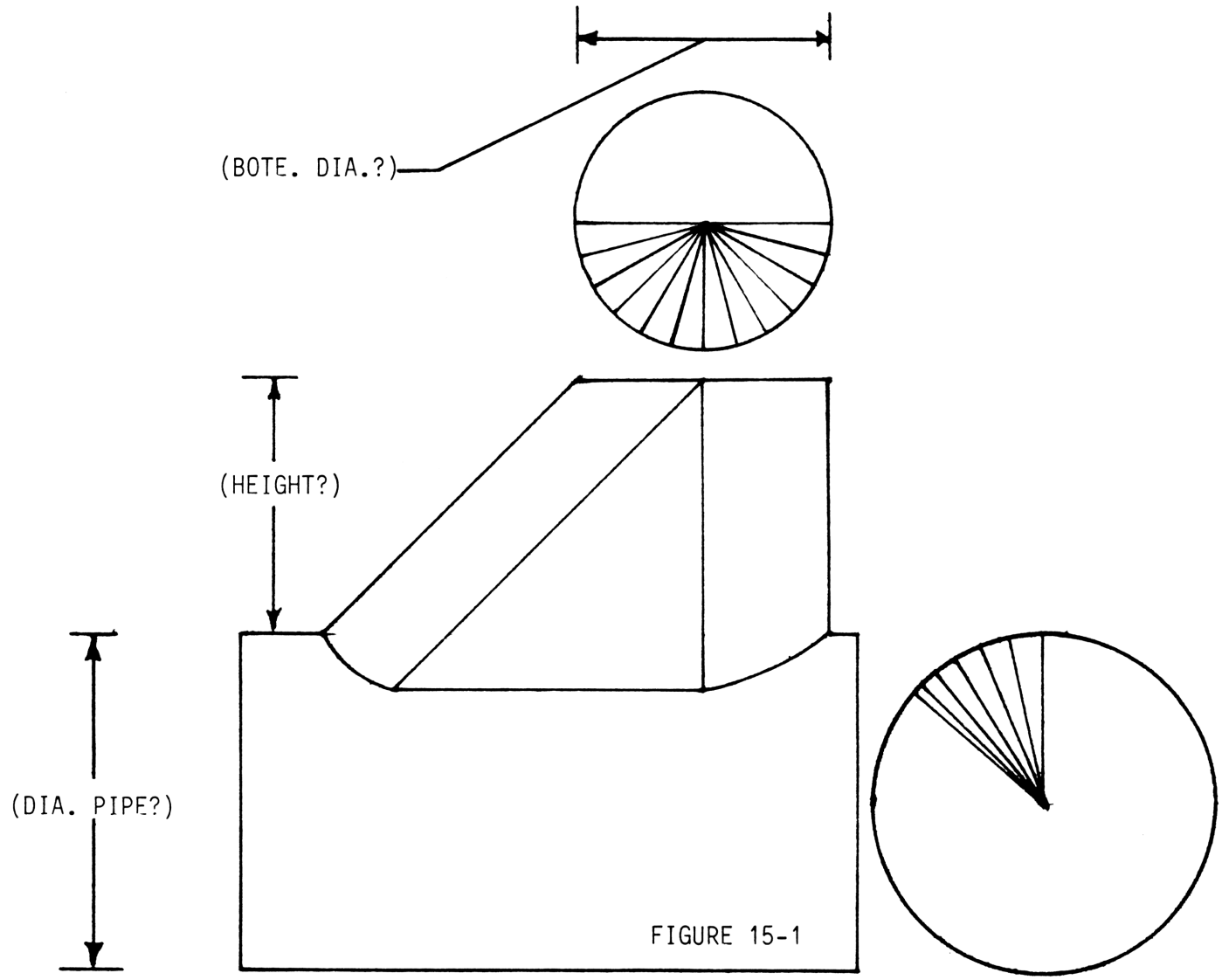


FIGURE 15-1

OUTPUTS: Refer to figure 15-2.

1) ARC LENGTHS OF THE QUARTER CIRCLE
"ARCS:1-X.="

2) ARC LENGTHS OF THE QUARTER ELLIPSE
"ARCS:X.="

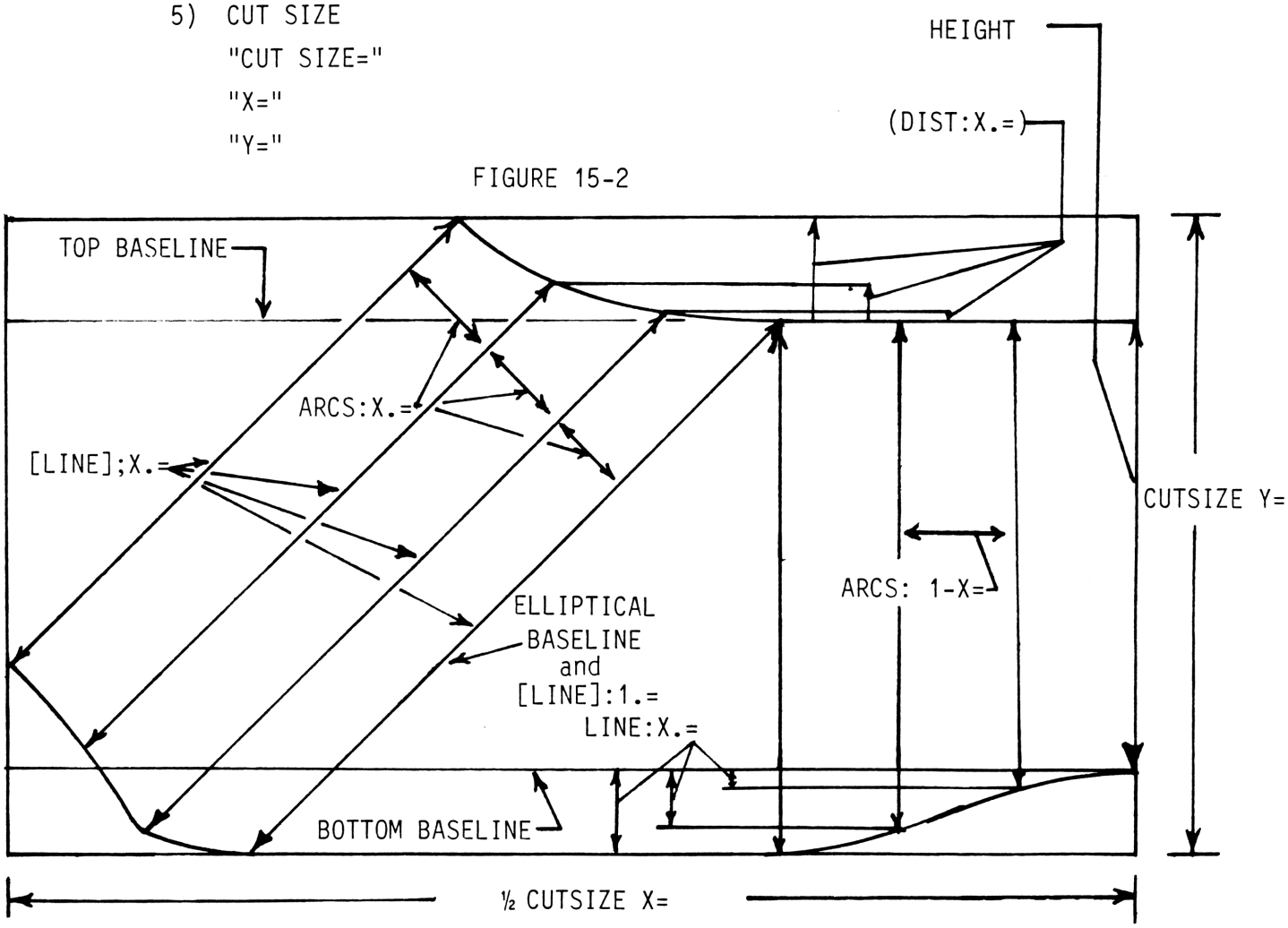
3) DIFFERENT ELLIPTICAL RADIUS LENGTHS
"DIST:X.="

4) FIRST SET OF LINE NUMBERS
"LINE:X.="
Forms the circle connection of the boottee.

SECOND SET OF LINE NUMBERS
"[LINE]:X.="
Forms the elliptical connection of the boottee.

5) CUT SIZE
"CUT SIZE="
"X="
"Y="

FIGURE 15-2



CONSTRUCTION: Refer to figure 15-2 for the illustration.

1)ESTABLISH A BOTTOM BASELINE

Take the last of the first series of the line numbers and measure UP from the bottom. This is the bottom baseline.

2)ESTABLISH A TOP BASELINE

From the bottom baseline, measure UP the height of the boottee. This is the top baseline.

3)ESTABLISH SEGMENTS FOR THE CIRCLE PORTION

Take the first set of arc numbers, and measure from the LEFT equal segments of the quarter pattern.

4)ESTABLISH THE BOTTOM CONNECTION OF THE CIRCLE TO THE PIPE

Take the first line number of the first series, connect it with the first arc number. This is the first point.
Take the second line number of the first series, connect it with the first arc number. This is the second point.
Take the next line number and repeat the same step.

5)ESTABLISH THE ELLIPTICAL BASELINE

Make a 45° angle line (this is line 1 and also point 1 of the top elliptical portion) from the top part of the boottee.
For a better understanding of this please refer to figure 15-2.

6)ESTABLISH THE TOP ELLIPTICAL PORTION OF THE BOOTTEE

Take the first arc number of the second series, and measure perpendicular to the elliptical baseline.
Take the first distance line at the intersecting point.
This is the second elliptical point.

Take the second arc number of the second series, and measure perpendicular to the elliptical baseline.
Take the second distance line at the intersecting point.
This is the third elliptical point.
Repeat this step until finished.

CONSTRUCTION:

7) ESTABLISH THE BOTTOM ELLIPTICAL PORTION OF THE BOOTTEE

GIVEN: The elliptical baseline is the first line number of the second series.

At the second point of the elliptical top pattern, measure DOWN line 2. of the second series, parallel to the elliptical baseline.

Repeat this step until finished.

8) CUT OUT PATTERN AND JOIN ENDS

You have finished the construction of a half pattern.

Make another half pattern and cut out and connect.