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(54) METHOD OF FABRICATING AN ANGLED DUCTWORK FITTING

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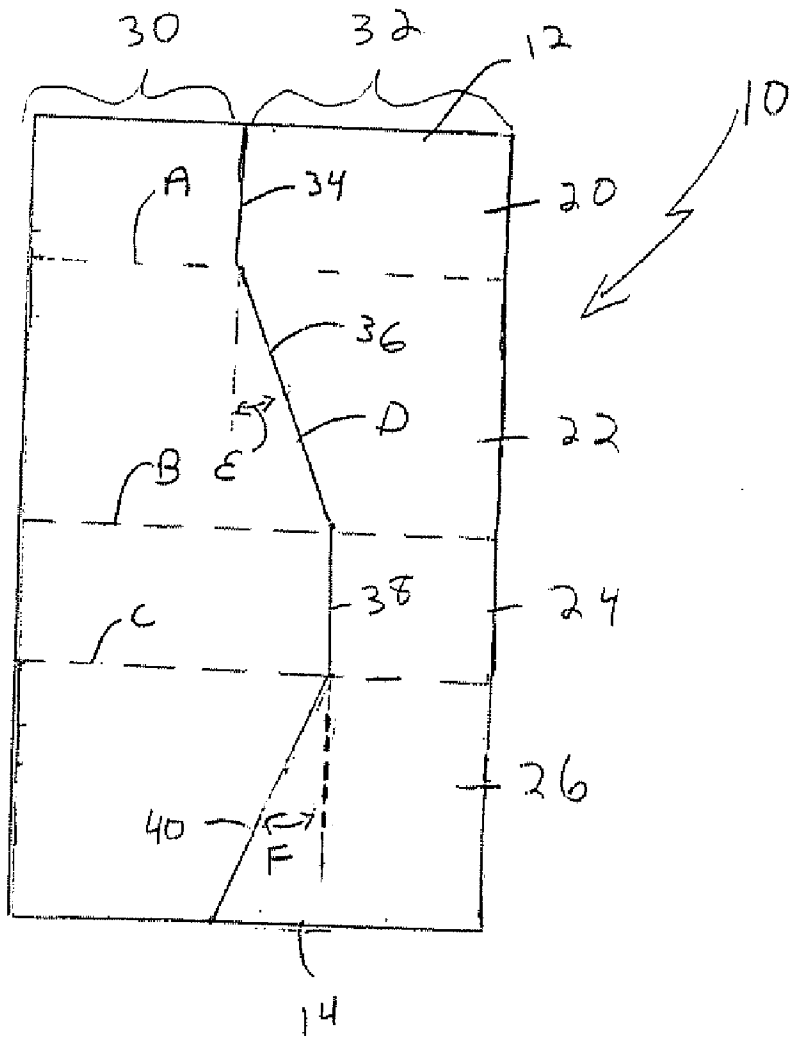
(57) ABSTRACT

Substantially scrapless methods for fabricating angled ductwork fittings. The methods include cutting a pre-determined pattern into a blank comprised of sheet metal material to separate the blank into two or more portions. Bending each of the portions of the blank so that each portion forms a rectangular section of ductwork pipe and joining the sections of ductwork pipe together to form an angled fitting. A transition fitting comprising a transition plate including a first panel and a second panel. The first panel is sized and shaped to be positioned in and to blank-off a gap between a first pipe and a second pipe. The second panel is positionable within the first pipe to direct fluid traveling through the first pipe into the second pipe.



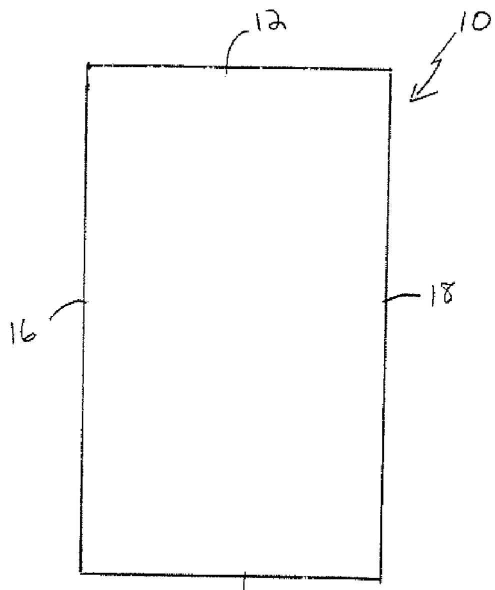


Fig. 1

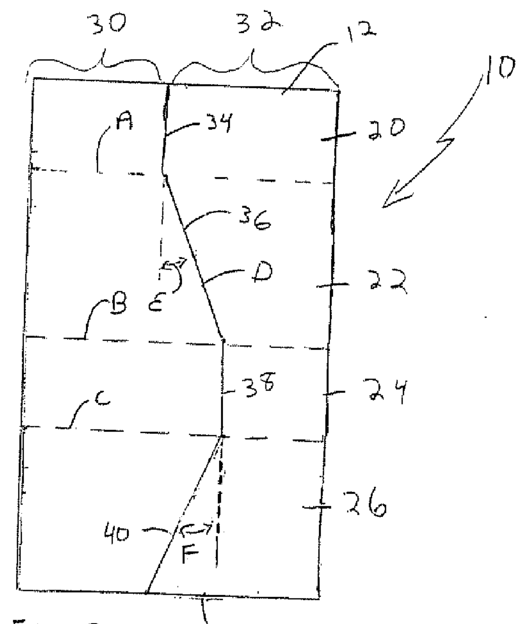


Fig. 2

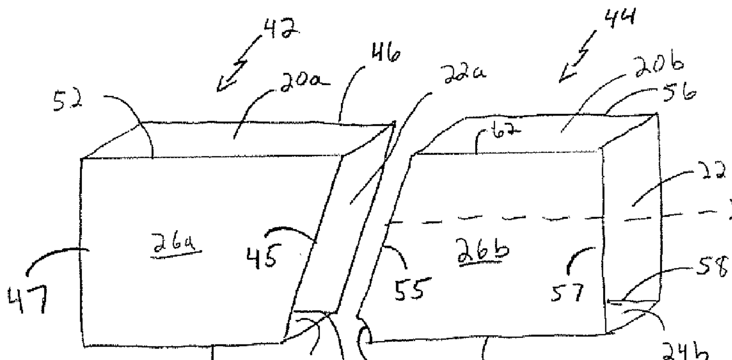


Fig. 3

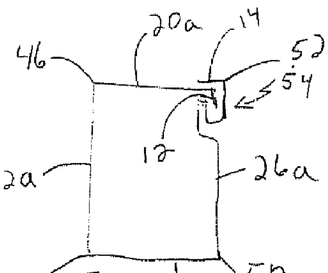


Fig. 4

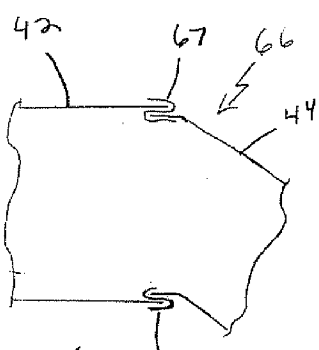


Fig. 6

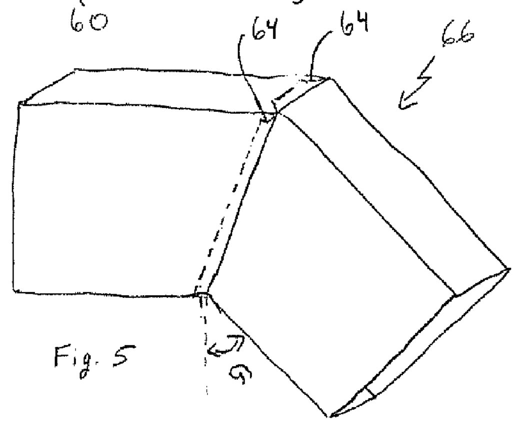


Fig. 5

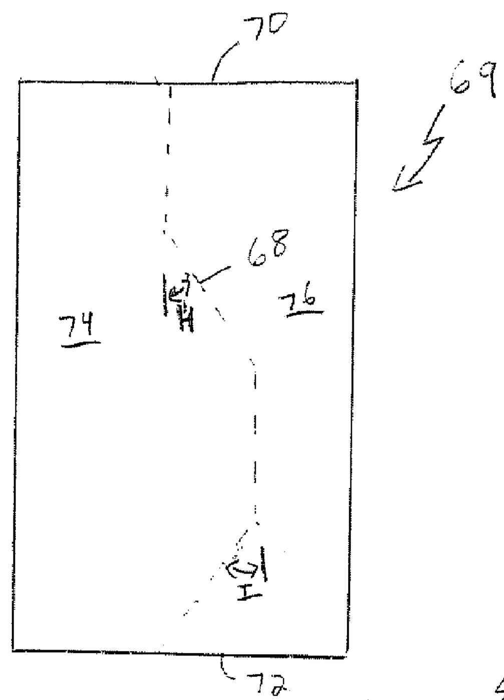


Fig. 7

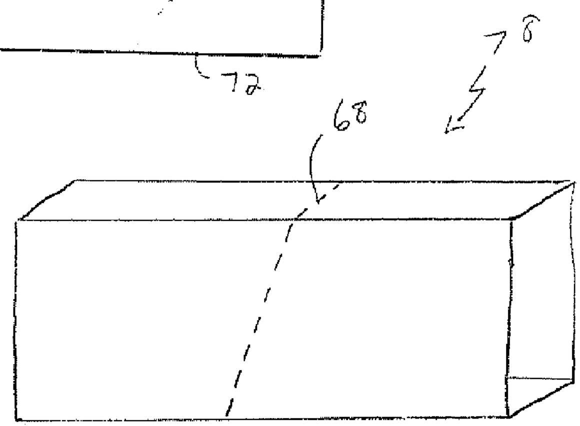


Fig. 8

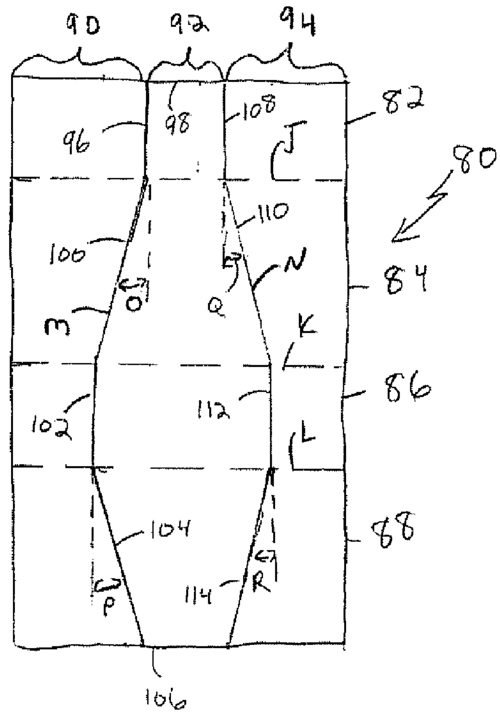
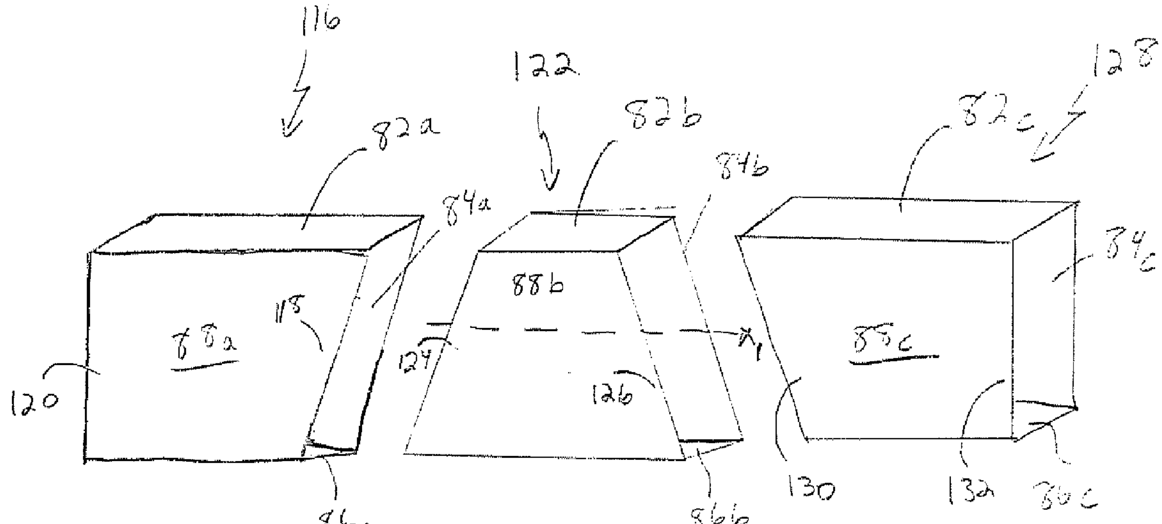


Fig. 9


116
122
128
82a
82b
82c
84a
84b
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88b
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118
120
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126
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130
132
86a
86b
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Fig. 10

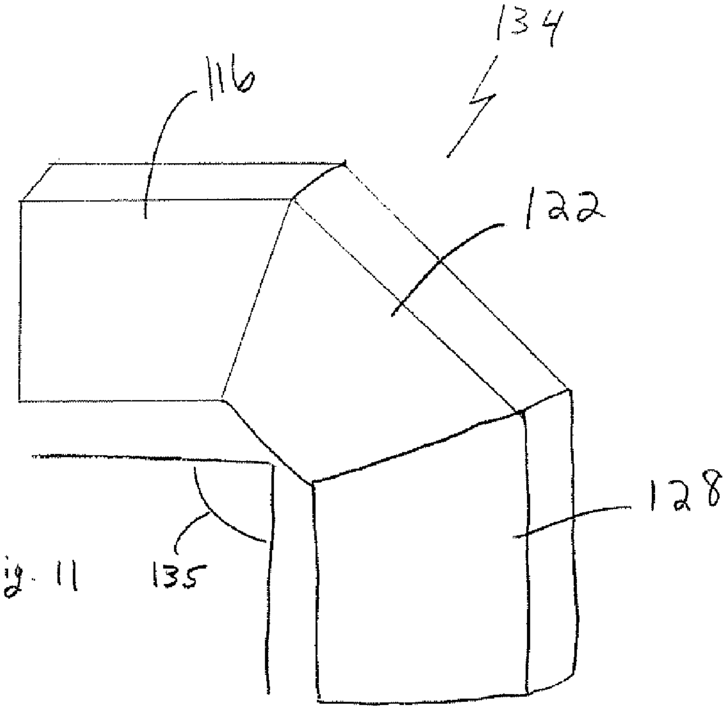
134
116
122
128
135

Fig. 11

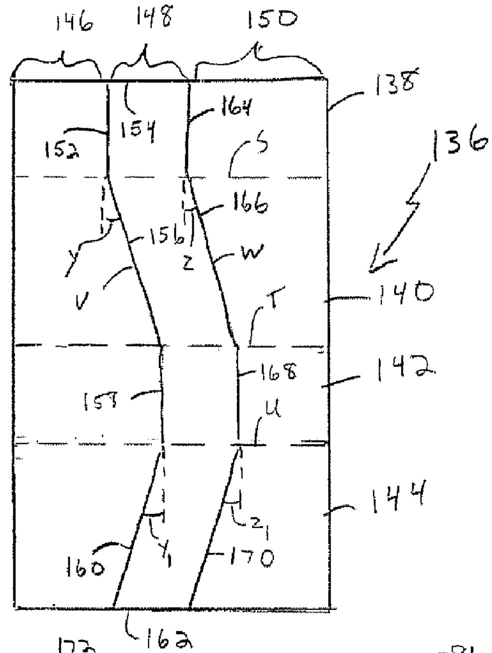

Fig. 12

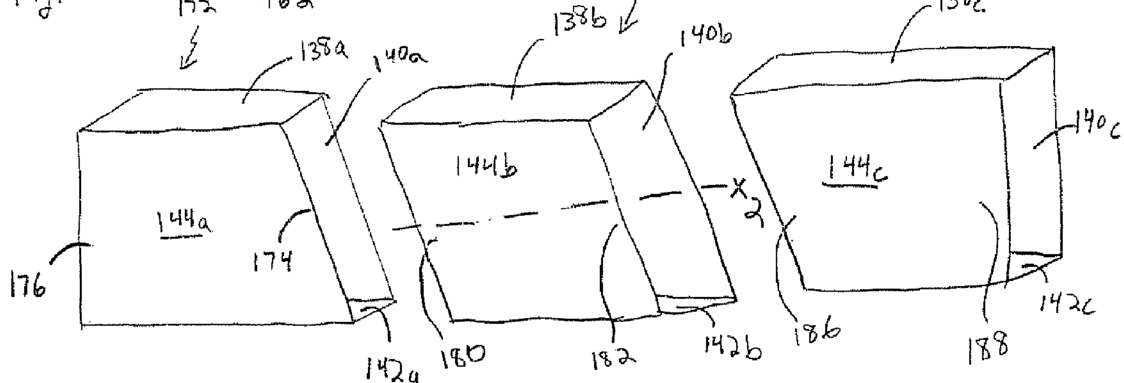

Fig. 13

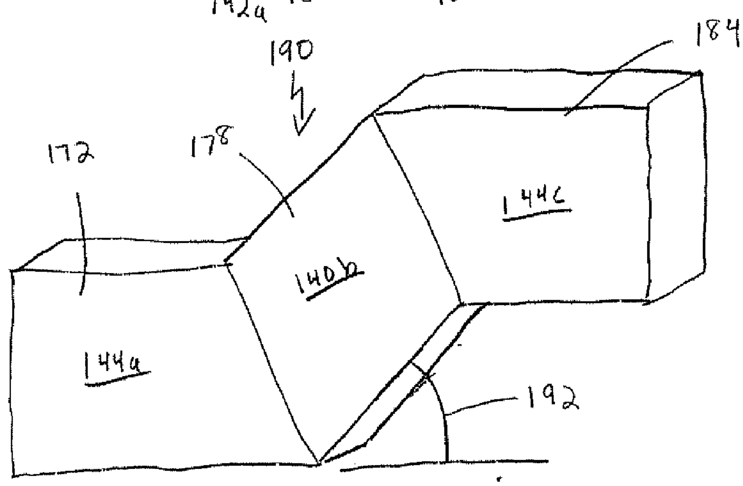

Fig. 14

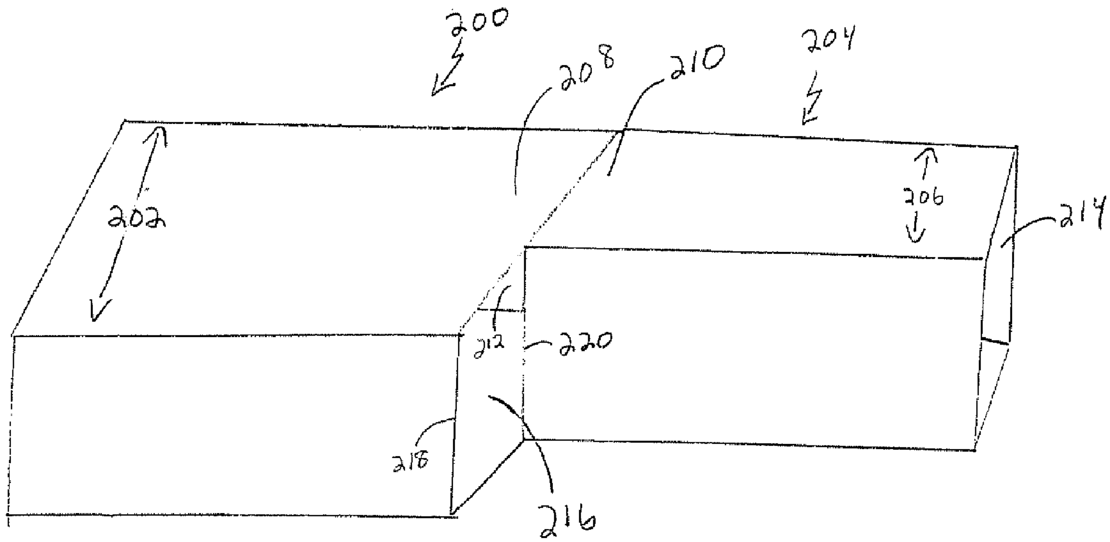

Fig 15

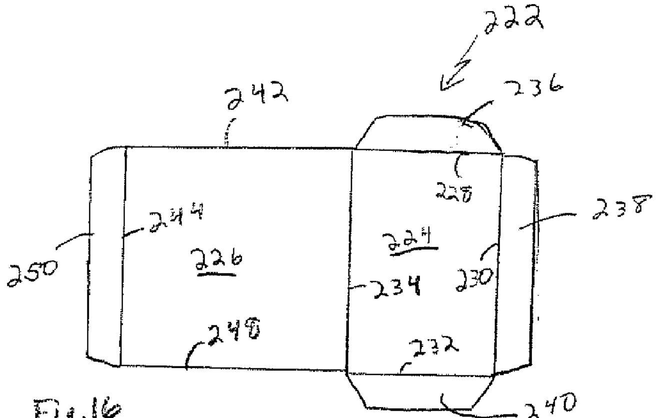

Fig.16

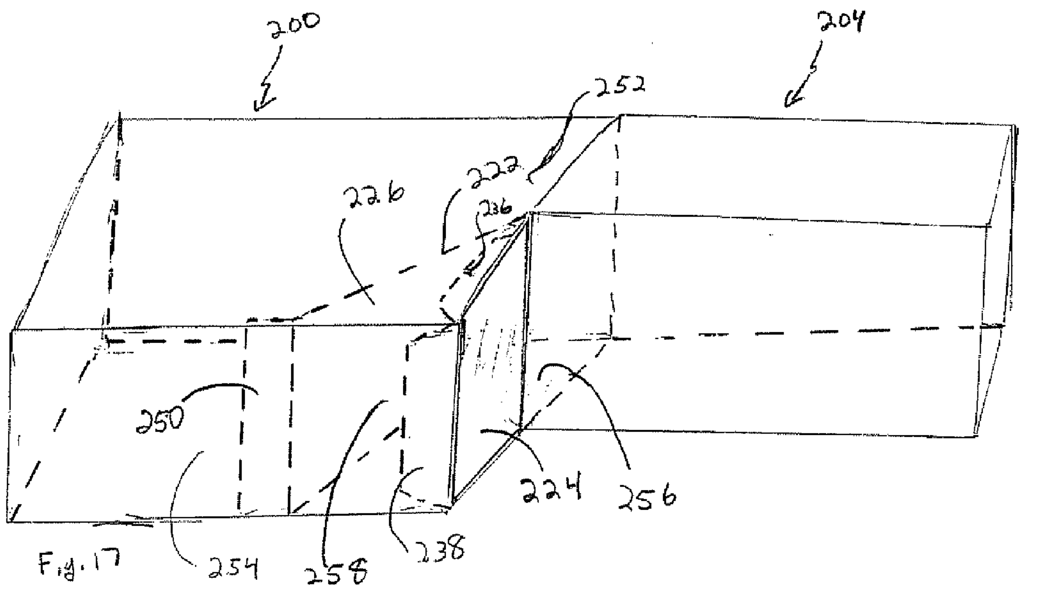

Fig.17

METHOD OF FABRICATING AN ANGLED DUCTWORK FITTING

FIELD OF THE INVENTION

[0001] The present invention is generally related to heating, ventilation and air conditioning (HVAC) ductwork systems, and more particularly to methods of fabricating angled rectangular ductwork fittings from a sheet of sheet metal material, or continuous sheet from a coil of sheet metal material in a substantially scrapless manner that greatly reduces waste or scrap.

BACKGROUND OF THE INVENTION

[0002] In general, ductwork is used in forced air heating and air conditioning ventilation systems to circulate air therethrough. Typically, the ductwork is fabricated from sheet metal, such as sheets of galvanized steel, carbon-steel, stainless steel and aluminum. One common type of ductwork is rectangular or box-shaped ductwork, which has four sides and a square or rectangular cross-section.

[0003] Rectangular ductwork can be fabricated using a variety of methods, and the method of fabrication typically depends on the size of the ductwork. For example, for ductwork used in residential or light commercial buildings, relatively small rectangular ductwork can be formed by what is sometimes referred to as the wrap-around method wherein a sheet of metal is bent along three bend lines to form the four-sided ductwork having a rectangular cross-section. In industrial or large-scale commercial use, which requires relatively large sections of ductwork, the ductwork can be formed from multiple pieces of sheet metal. For example, the ductwork can be formed by securing two L-shaped pieces of sheet metal together or by securing four pieces of sheet metal together wherein each sheet forms one of the four walls of the ductwork.

[0004] Installation of a ductwork system into a building requires both a series of straight runs and angled fittings. The angled fittings typically include elbows, offsets and transition, or change, fittings of varying degrees. Currently, such angled fittings for rectangular ductwork systems fabricated from sheet metal are created by methods which produce a substantial amount of waste. In such methods, each wall of the rectangular angled fitting is cut or stamped out of a flat sheet of sheet metal. The cut-out pieces or walls are then assembled together to form the angled fitting. For example, to fabricate a 90 degree elbow fitting, a top wall, bottom wall and two sidewalls are cut or stamped out of one or more sheets of metal. The top wall and the bottom wall are basically mirror images of each other and typically have arcuate portions that create the 90 degree bend in the fitting. The sidewalls are bent to conform to the top and bottom walls and then, the top wall, bottom wall and sidewalls are assembled together by a mechanical seam connection or welding. The only pieces of the original sheet metal material that are used to form the angled fitting are the cutout pieces, and the rest of the sheet metal material is waste or scrap.

[0005] Due to environmental concerns, there has been increasing pressure on builders to develop ways to reduce the amount of waste material created during a construction project. One environmental organization that provides guidelines and standards to builders is the U.S. Green Building Council (USGBC). The USGBC provides a rating system called Leadership in Energy and Environmental Design [LEED] Green Building Rating System. One of the categories that the LEEDs rating system takes into account is the amount of construction material waste created from a project.

[0006] Therefore, there remains a need for a fabrication process for creating angled rectangular ductwork fittings from sheet metal material that substantially reduces the amount of scrap or waste material and increases the overall efficiency of the fitting fabrication process.

SUMMARY OF INVENTION

[0007] The present invention generally related to substantially scrapless methods of fabricating angled rectangular metal ductwork fittings, such as elbows and offsets having various angles. The method generally comprises providing a generally flat piece of sheet metal material. For example, a piece of sheet metal that has been flattened after being unwound from a coil. The sheet metal material can be comprised of galvanized steel, carbon-steel, stainless steel, aluminum or any other suitable metal. A pre-determined pattern, which corresponds to a desired elbow or offset having a desired angle, is then cut through the sheet metal to divide the sheet metal into two or more sections, depending on the number of sections needed to construct the desired elbow or offset. Each of the sections is then bent to form a rectangular or boxed-shaped section of ductwork pipe having a mitered end. The sections of ductwork pipe are then orientated and the mitered ends of the ductwork pipe are secured together.

[0008] Another aspect of the present invention generally relates to a method of fabricating an angled fitting for a rectangular ductwork system comprising cutting a pre-determined continuous circumferential pattern through the walls of a rectangular ductwork pipe to separate the ductwork pipe into two or more sections of ductwork pipe. Orienting the sections of ductwork pipe into a desired orientation and mechanically joining the sections of ductwork pipe together to form an angled ductwork fitting.

[0009] Yet another aspect of the present invention is generally related to a blank for fabricating a rectangular angled ductwork fitting that comprises a substantially flat sheet of sheet metal material having a top edge and a bottom edge and at least one indicator forming a predetermined cutting patterning substantially extending from the top edge to the bottom edge. The blank can be cut along the indicator to form two or more portions of the blank that can be bent into rectangular sections of ductwork pipe. The rectangular sections of pipe can be assembled to form an angled ductwork fitting.

[0010] A further aspect of the present invention is generally related to a ductwork pipe for fabricating an angled ductwork fitting that comprises a rectangular metal pipe including a top wall, a bottom wall and opposed sidewalls. The pipe also includes at least one indicator forming a pre-determined cutting pattern extending circumferentially around the pipe. The pipe can be cut along the cutting pattern to form segments of ductwork pipe that can be connected together to form an angled ductwork fitting.

[0011] Another aspect of the present invention is generally related to a transition fitting for a ductwork system that comprises a transition plate that can be installed in a transition fitting connecting a first pipe having a width and a second pipe having a width that is less than the width of the first pipe. The transition plate includes a first panel and a second panel wherein the first panel is sized and shaped to be positioned in and to blank-off a gap between the first pipe and the second pipe. The second panel is positioned within the first pipe so as to direct fluid traveling through the first pipe into the second pipe.

[0012] Other aspects, objects and advantages of the present invention will be understood from the following description according to the preferred embodiments of the present invention, specifically including stated and unstated combinations of the various features which are described herein, relevant information concerning which is shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] In describing the preferred embodiments of the present invention, reference will be made to the accompanying drawings, wherein:

[0014] FIG. **1** is a top view of a sheet metal blank that can be used in the fabrication process of the present invention;

[0015] FIG. **2** is a top view of the sheet metal blank of FIG. **1** including a cutting pattern represented by a solid line and bend lines represented by dashed lines;

[0016] FIG. **3** is a perspective view of two segments of rectangular ductwork pipe that can be formed by cutting and bending the blank of FIG. **2**;

[0017] FIG. **4** is a cross-sectional view of one of the segments of ductwork pipe of FIG. **3**, showing one method of securing the ends of the blank to form the rectangular ductwork pipe;

[0018] FIG. **5** is a perspective view of an angled ductwork fitting that can be fabricated from the sections of ductwork pipe of FIG. **3**;

[0019] FIG. **6** is a cross-sectional view of the angled fitting of FIG. **5** shown with an s-slip to assist in securing the first and second sections of ductwork pipe together;

[0020] FIG. **7** is a top view of another embodiment of a sheet metal blank of the present invention;

[0021] FIG. **8** is a perspective view of one embodiment of a ductwork pipe of the present invention;

[0022] FIG. **9** is a top view of another embodiment of a sheet metal blank of the present invention shown with cutting patterns represented by solid lines and bend lines represented by dashed lines;

[0023] FIG. **10** is a perspective view of the three sections of ductwork pipe that can be fabricated from the blank of FIG. **9**;

[0024] FIG. **11** is a perspective view of one embodiment of an angled fitting that can be fabricated from the sections of ductwork pipe of FIG. **10**;

[0025] FIG. **12** is a top view of another embodiment of a sheet metal blank of the present invention shown with cutting patterns represented by solid lines and bend lines represented by dashed lines;

[0026] FIG. **13** is a perspective view of the three sections of ductwork pipe that can be fabricated from the blank of FIG. **12**;

[0027] FIG. **14** is a perspective view of an angled fitting that can be fabricated from the sections of ductwork pipe of FIG. **13**;

[0028] FIG. **15** is a perspective view of a first ductwork pipe adjoined to a second smaller ductwork pipe;

[0029] FIG. **16** is a top view of one embodiment of a transition plate of the present invention; and

[0030] FIG. **17** is a perspective view of a transition fitting of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0031] As required, detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention, which may be embodied in various forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, but merely as a basis for the claims and as a representative basis for teaching one skilled in the art to variously employ the present invention in virtually any appropriate manner.

[0032] The methods of fabricating angled metal ductwork fittings and the related devices described herein can be used to substantially reduce or eliminate the amount of scrap metal material that is typically created by conventional methods of forming such fittings. Thus, it will be apparent from the following description that in the methods described herein all or substantially all of the sheet metal material is utilized in the creation of an angled fitting. Such reduction in waste material will aid builders in building structures that conform to the LEED rating system.

[0033] As used herein, the term "angled fitting" or "angled ductwork fitting" is meant to include pieces of ductwork, such as elbows, offsets and transition fittings of varying degrees, that when fitted together, provide a non-linear path through the assembled ductwork.

[0034] FIG. **1** generally illustrates one embodiment of a blank **10** of sheet metal material that can be used in the methods of the present invention to fabricate an angled ductwork fitting. The blank **10** is preferably a substantially flat rectangular sheet of metal having a top marginal edge **12**, a bottom marginal edge **14** and first and second opposed side marginal edges **16**, **18**. The blank **10** of sheet metal can be comprised of galvanized steel, carbon steel, stainless steel, aluminum or any other metal or metal alloy that is suitable for ductwork.

[0035] The blank **10** can vary in size depending on the desired size of the finished angled ductwork fitting. For example, for small ductwork sizes, typically used in residential and light commercial ductwork systems, the blank can have a length up to 70-inches long for a one-piece, three-bend, wrap-up ductwork configuration. For larger industrial and commercial ductwork systems, the blank length is up to 120-inches long for a two-piece configuration of ductwork comprised of two "L"-shaped sections of formed sheet metal. For even larger ductwork sizes where the sum of two adjacent sides exceeds 120-inches, the blank can be comprised of four or more panels of sheet metal material that are used to form the ductwork. This multi-panel fabrication process can be used to fabricate ductwork of unlimited sizes. Thus, it should be understood that the blank **10** can be one continuous piece of sheet metal material or the blank **10** can be multiple pieces of sheet metal material that are adjoined together before or during the fabrication of the angled ductwork fitting.

[0036] FIG. **2** through FIG. **6** generally illustrate one method of the present invention for fabricating a two-sectioned elbow fitting. In general, the method comprises cutting and bending the blank **10** to form two or more sections of ductwork pipe that are then assembled together to form the angled fitting. Referring to FIG. **2**, the blank **10** is first divided into four sections **20**, **22**, **24** and **26**. The division of the blank

10 into such sections is represented in FIG. **2** by dashed lines A, B and C. In one embodiment of the method, the dashed lines A, B and C can be physical indicia located on the blank **10** that indicates where the blank is to be bent. As will be explained below, each of the sections **20**, **22**, **24** and **26** corresponds to and forms one of the walls of the rectangular ductwork pipes shown in FIG. **3**.

[0037] A cutting pattern D is cut through the blank **10** to divide the blank into a first portion **30** and a second portion **32**. For example, the blank is cut continuously along cutting pattern D from the top marginal edge **12** to the bottom marginal edge **14** to divide the blank. In the illustrated embodiment, the cutting pattern D includes a perpendicular cut line **34** through section **20** extending from the top marginal edge **12** to the dashed line A. An angled cut line **36** through section **22** extends from the end of cut line **34** to the dashed lined B. The angled cut line **36** extends at an angle E relative to cut line **34**. The value of angle E of cut line **36** can vary and depends on the desired angle of the finished joint fitting. For example, in the illustrated embodiment, angle E is 22.5 degrees, which will result in a finished joint fitting having an angle of 45 degrees. In general, angle E of cut line **36** will have a value of about half of the desired value of the angle of the joint fitting. For instance, if the desired angle of the finished joint fitting is 90 degrees, angle E of cut line **36** will be 45 degrees, and if the desired angle of the finished joint fitting is 60 degrees, angle E of cut line **36** will be about 30 degrees.

[0038] The cutting pattern D also includes cut line **38** through section **24** extending from cut line **36** to dashed line C. The cut **38** is generally parallel to cut line **34** and extends perpendicular to dashed lines B and C. A second angled cut line **40** through section **26** extends from cut line **38** to bottom marginal edge **14**. Angled cut line **40** is made at an angle F relative to cut line **38**. The value of angle F is substantially equal to the value of angle E of cut line **36**. The blank can be cut with the use of any suitable type of cutting instrument, such as a plasma cutter, laser cutter, high pressure water cutter or circular saw.

[0039] After the blank **10** has been cut into a first portion **30** and a second portion **32**, each portion **30**, **32** is bent along dashed lines A, B and C to form a first section of rectangular ductwork pipe **42** and a second section of rectangular ductwork pipe **44**, shown in FIG. **3**. The first section of rectangular ductwork pipe **42**, which is formed from portion **30** of blank **10**, includes a top wall **20***a*, a bottom wall **24***a* and opposed sidewalls **22***a*, **26***a* that respectively correspond with sections **20**, **22**, **24** and **26** of blank **10**. The section of pipe **42** includes a mitered end portion **45** and a planar end portion **47**.

[0040] Additionally, the first section of ductwork pipe **42** includes corners **46**, **48**, **50** and **52**. Corners **46**, **48** and **50** correspond to the locations of bending of the blank **10** represented by dashed lines A, B and C, respectively. Corner **52** is formed by the joining of the top marginal edge **12** and the bottom marginal edge **14**. In one embodiment, as illustrated in FIG. **4**, the top marginal edge **12** and the bottom marginal edge **14** can be mechanically joined together, such as by what is sometimes referred to as a Pittsburg lock **54**. Alternatively, the top marginal edge **12** and bottom marginal edge **14** can be joined together by any other suitable means, mechanical or otherwise, such as by welding.

[0041] The second section of rectangular ductwork pipe **44** is formed by bending portion **32** of blank **10** along bend lines A, B and C. The pipe **44** includes a mitered end **55** and a planar end **57**. The second portion of ductwork pipe **44** also includes a top wall **20***b*, a bottom wall **24***b* and opposed sidewalls **26***b*, **22***b* that correspond with sections **20**, **24**, **26** and **22** of blank **10**, respectively. Furthermore, the locations of dashed lines A, B and C of blank **10** form corners **56**, **58** and **60** respectfully, and corner **62** is formed by joining top marginal edge **12** and bottom marginal edge **14** using any of the methods described above.

[0042] After the two sections of ductwork pipe **42**, **44** have been formed, they are oriented and assembled together to form an angled ductwork fitting **66** (FIG. **5**). For instance, the second section of ductwork pipe **44** is rotated 180 degrees along the longitudinal axis X from the position illustrated in FIG. **3**. The mitered end **55** of the second pipe **44** is inserted into the mitered end **45** of the first pipe **42** so that the mitered end **55** of the second pipe **44** overlaps the mitered end **45** of the first pipe **42**. To assist in inserting the mitered end **55** of the second pipe **44** into the mitered end **45** of the first pipe **42**, the ends of corners **64** of the mitered end portion **55** of the second pipe can be removed or notched out. The notched out corners **64** allow the walls of the second section of pipe **44** to slightly flex inward so that the mitered end **55** of the pipe **44** fits within the mitered end **45** of the first pipe **42**. After the mitered end **55** of the second pipe is positioned inside the mitered end **45** of the first pipe **42**, fasteners such as sheet metal screws can be used to fasten together the overlapped portions of the mitered ends **45**, **55** of the first and second section of ductwork pipe **42**, **44**. The value of the angle G of the ductwork fitting **66** is about twice the value of angle E.

[0043] The first and second sections of ductwork pipe **42**, **44** can also be assembled using other methods. For example, referring to FIG. **6**, s-slip connectors **67** can be used to connect the first and second sections of pipe **42**, **44**. Alternatively, the mitered ends **45**, **55** can be butted up against each other and self adhesive strips of galvanized metal material or heavy metal foil tape can be used to join the first and second sections of pipe **42**, **44** together or a double s-cleat having a slight angle could be used. Additionally, the first and second sections of pipe **42**, **44** can be welded together or can be adjoined together by a flange type connection.

[0044] FIG. **7** illustrates another embodiment of a sheet metal blank **69** that can be used in the methods of the present invention to fabricate an angled ductwork fitting. The blank **69** is generally similar to blank **10**. However, in this embodiment, the blank **69** includes a physical indicator **68** that extends from the top marginal edge **70** to the bottom marginal edge **72** and separates the blank **69** into a first portion **74** and a second portion **76**. The physical indicator **68** can be used as a guide to cut the blank **66** and divide it into the first and second portions **74** and **76**. Additionally, the physical indicator **68** can be physical indicia or marking, such as a solid or dashed pattern, printed on or etched into the blank or can be an intermittent cut or perforation through the sheet metal.

[0045] In the embodiment shown in FIG. **7**, the pattern of the indicator **68** is substantially similar to the cutting pattern D shown in FIG. **2**. It will also be understood that similar to the cutting pattern of FIG. **2**, angles H and I of the indicator **68** can vary depending on the desired angle of the finished joint fitting. Furthermore, the shape and design of the pattern of the indicator **68** is not limited to that shown in FIG. **7** and can comprise any number of the shapes and designs, such as the cutting patterns shown in FIGS. **9** and **12** and discussed in more detail below.

[0046] Blanks having physical indicators can be employed in a variety of different fashions to fabricate an angled fitting.

For example, in one method, a ductwork installer could determine the type of angled ductwork fitting that is needed during the installation of a ductwork system. The installer can then choose a blank that has a physical indicator that when cut will produce sections of ductwork pipe that could be assembled to create the desired fitting. After the installer chooses the desired blank, the installer can cut along the physical indicator to divide the blank into portions that can be bent into rectangular sections of pipe similar to those shown in FIG. **3**. For example, in the blank **69** shown in FIG. **7**, the installer would cut along physical indicator **68** to separate the first portion **74** from the second portion **76**. After the blank **69** is divided, the portions **74**, **76** are bent to form rectangular sections of ductwork pipe similar to those shown in FIG. **3**. The rectangular pipes are then assembled in a generally similar fashion as described above to form the angled ductwork fitting shown in FIG. **5**.

[0047] In an alternative method, the blank **69** is first bent to form a ductwork pipe, such as the ductwork pipe **78** shown in FIG. **8**. After the ductwork pipe **78** is formed, the ductwork pipe is cut along the physical indicator **68** to divide the ductwork pipe into a first section and a second section, similar to those shown in FIG. **3**. The first and second sections of ductwork pipe are then assembled in a generally similar fashion as described above to form the finished angled ductwork fitting shown in FIG. **5**. It will be understood that the blank having the desired pattern could be bent into the ductwork pipe in the factory prior to being obtained by the installer. In such a case, the installer would determine the type of angled ductwork fitting needed and then choose the appropriate ductwork pipe having a physical indicator of a desired pattern. Furthermore, it should also be understood that a blank could be bent to form the pipe shown in FIG. **8**, and then the physical indicator could be placed on the pipe.

[0048] FIG. **9** illustrates another embodiment of a blank **80** that can be used in the methods of the present invention to fabricate an angled ductwork fitting. The blank **80** can be divided into four sections **82**, **84**, **86** and **88** as indicated by lines J, K and L. A first pattern M and a second pattern N can be cut through the blank **80** to separate the blank into a first portion **90**, a second portion **92** and third portion **94**.

[0049] The first pattern M includes a cut line **96** through section **82** extending from the top marginal edge **98** to dashed line J. An angled cut line **100** through section **84** extends from the cut line **96** to dashed bend line K. The angled cut line **100** extends at an angle O relative to cut line **96**. The value of angle O can vary, depending on the desired angle of the finished joint fitting, and is generally about one fourth the value of the angle of the desired joint fitting. In the illustrated embodiment, the angle O is about 22.5 degrees, which will result in an angled fitting of about 90 degrees (FIG. **11**).

[0050] The cutting pattern M also includes a cut line **102** through section **86** extending from cut line **100** to dashed line L. The cut line **102** is generally parallel to cut line **96** and perpendicular to dashed lines K and L. A second angled cut line **104** through section **88** extends from cut line **102** to marginal bottom edge **106**. The second angled cut line **104** extends at an angle P relative to cut line **102** wherein angle P is substantially equal to angle O.

[0051] The second cutting pattern N is preferably a mirror image of cutting pattern M and includes a cut line **108** through section **82**, an angled cut line **110** through section **84** at angle Q from cut line **108**, a cut line **112** through section **86** that is parallel to cut line **108** and an angled cut line **114** through section **88** at an angle R from cut line **112**. The values of angles Q and R are preferably substantially the same as the value of angle O. However, the values of angles Q and R could also be a different value from the value of O.

[0052] After the blank **80** has been cut and divided into the three portions, the first portion **90** can then be bent along dashed lines J, K and L to form a first section of rectangular ductwork pipe **116**, as illustrate in FIG. **10**. The ductwork pipe **116** is comprised of a top wall **82***a*, a bottom wall **86***a*, and a pair of opposed sidewalls **84***a*, **88***a* that respectively correspond with sections **82**, **86**, **84** and **88** of blank **80**. The section of pipe **116** also includes a mitered end portion **118** and a planar end portion **120**.

[0053] The second portion **92** of the blank **80** is bent along dashed lines J, K and L to form a second section of rectangular ductwork pipe **122**. The ductwork pipe **122** is comprised of a top wall **82***b*, a bottom wall **86***b* and a pair of opposed sidewalls **84***b*, **88***b* that respectfully correspond with sections **82**, **86**, **84** and **88** of blank **80**. The second section of ductwork pipe **122** also includes a first mitered end portion **124** and a second mitered end portion **126**.

[0054] The third portion **94** of the blank **80** is bent along dashed lines J, K and L to form a third section of ductwork pipe **128**. The ductwork pipe **128** is comprised of a top wall **82***c*, a bottom wall **86***c* and a pair of opposed sidewalls **84***c*, **88***c* that correspond with sections **82**, **86**, **84** and **88** of blank **80**. The third section of ductwork pipe **128** also includes a mitered end portion **130** and a planar end portion **132**.

[0055] After the three sections of ductwork pipe **116**, **122** and **128** have been formed, the second piece of ductwork pipe **122** is rotated 180 degrees about the longitudinal axis X_1 and the sections of ductwork are assembled together to form the ductwork fitting **134** shown in FIG. **11**. To assemble the ductwork fitting **134**, the mitered end portion **124** of pipe **122** is connected to the mitered end portion **118** of pipe **116** and the mitered end portion **126** of pipe **122** is connected to mitered end portion **130** of pipe **128**. The mitered end portions of the pipe can be connected by any of the methods of connection described above. As mentioned above, the value of angle **135** of the elbow joint fitting is about four times the value of angle O. Accordingly, in the embodiment illustrated in FIG. **11**, the angle **135** of the elbow joint fitting is 90 degrees.

[0056] FIG. **12** illustrates another embodiment of a blank **136** that can be used in the methods of the present invention to fabricate an angled ductwork fitting. The blank **136** can be divided into four sections **138**, **140**, **142** and **144** as indicated by dashed lines S, T and U. A first pattern V and a second pattern W can be cut through the blank **136** to separate the blank into a first portion **146**, a second portion **148** and third portion **150**.

[0057] The first pattern V includes a cut line **152** through section **138** extending from the top marginal edge **154** to dashed line S. An angled cut line **156** through section **140** extends from the cut line **152** to dashed line T. The angled cut line **156** extends at an angle Y relative to cut line **152**. The value of angle Y can vary, depending on the desired angle of the finished joint fitting, and is generally about half the value of the angle of the desired joint fitting. In the illustrated embodiment, the angle Y is about 22.5 degrees, which will result in an angled off set fitting of about 45 degrees (FIG. **14**).

[0058] The cutting pattern V also includes a cut line **158** through section **142** extending from cut line **156** to dashed line U. The cut line **142** is generally parallel to cut line **152**

and perpendicular to dashed lines T and U. A second angled cut line **160** through section **144** extends from cut line **158** to marginal bottom edge **162**. The second angled cut line **160** extends at an angle Y_1 relative to cut line **158** wherein the value of angle Y_1 is substantially equal the value of angle Y.

[0059] The second cutting pattern W preferably has substantially the same shape of cutting pattern V and includes a cut line **164** through section **138**, an angled cut line **166** through section **140** at an angle Z from cut line **164**, a cut line **168** through section **142** that is parallel to cut line **164** and an angled cut line **170** through section **144** at an angle Z_1 from cut line **168**. The values of angles Z and Z_1 are preferably substantially the same as the value of angle Y. However, the values of angles Z and Z_1 could also be of a different value than Y.

[0060] After the blank **136** has been cut and divided into the three portions, the first portion **146** can then be bent along dashed lines S, T and U to form a first section of rectangular ductwork pipe **172**, as illustrated in FIG. **13**. The ductwork pipe **172** is comprised of a top wall **138***a*, a bottom wall **142***a*, and a pair of opposed sidewalls **140***a*, **144***a* that respectively correspond with sections **138**, **142**, **140** and **144** of blank **136**. The section of pipe **172** also includes a mitered end portion **174** and a planar end portion **176**.

[0061] The second portion **148** of the blank **136** is bent along bend dashed lines S, T and U to form a second section of rectangular ductwork pipe **178**. The ductwork pipe **178** is comprised of a top wall **138***b*, a bottom wall **142***b* and a pair of opposed sidewalls **140***b*, **144***b* that respectfully correspond with sections **138**, **142**, **140** and **144** of blank **136**. The second section of ductwork pipe **178** also includes a first mitered end portion **180** and a second mitered end portion **182**.

[0062] The third portion **150** of the blank **136** is bent along dashed lines S, T and U to form a third section of rectangular ductwork pipe **184**. The ductwork pipe **184** is comprised of a top wall **138***c*, a bottom wall **142***c* and a pair of opposed sidewalls **140***c*, **144***c* that correspond with sections **138**, **142**, **140** and **144** of blank **136**. The third section of ductwork pipe **184** also includes a mitered end portion **186** and a planar end portion **188**.

[0063] After the three sections of ductwork pipe **172**, **178** and **184** have been formed, the second piece of ductwork pipe **178** is rotated 180 degrees about the longitudinal axis X_2 and the sections of ductwork are assembled together to form the offset ductwork fitting **190** shown in FIG. **14**. To assemble the ductwork fitting **190**, the mitered end portion **180** of pipe **178** is connected to the mitered end portion **174** of pipe **172** and the mitered end portion **182** of pipe **178** is connected to mitered end portion **186** of pipe **184**. The mitered end portions of the each pipe can be connected by any of the methods of connection described above. As mentioned above, the value of angle **192** of the offset joint fitting is twice the value of angle Y. Accordingly, in the embodiment illustrated in FIG. **14**, the angle **192** of the offset joint fitting is 45 degrees.

[0064] Another aspect of the present invention relates to transition fittings and methods of using the same for connecting different sized pipe of ductwork together. In conventional methods of joining pipes of different widths together, transition fitting having complex angles are used to join the pipes together. Typically, these conventional transition fittings are fabricated from cutting out individual pieces from sheet metal material and assembling the pieces together to form the fitting.

[0065] As will be appreciated from the following description, the transition fittings and methods described herein eliminate the need for a complex transition fitting, reduce the amount of material needed for the transition fitting and reduce the amount of scrap or waste material.

[0066] In one embodiment of a method of the present invention, referring to FIG. **15**, a first rectangular ductwork pipe **200**, having a width **202**, is joined to a second rectangular ductwork pipe **204**, having width **206** that is smaller than width **202** of the first ductwork pipe **200**. The first and second ductwork pipes **200**, **204** are connected by joining an end portion **208** of the first ductwork pipe **200** to an end portion **210** of the second ductwork pipe **204**. The end portions **208**, **210** of the ductwork pipes can be adjoined by any suitable type of connection, such as a drive slip connection, an s-slip connection, a flanged connection or welding. The first and second ductwork pipes **200**, **204** are connected so that wall **212** of the first ductwork pipe **200** and wall **214** of the second ductwork pipe **204** are generally aligned and a gap or opening **216** exists between the edge **218** of the end portion **208** of the first ductwork pipe **200** and the edge **220** of end portion **210** of the second ductwork pipe **204**. Additionally, the first and second pipes are preferably substantially the same depth so that the top and bottom walls of the pipes generally align.

[0067] The gap **216** between the edge **218** of the first ductwork pipe **200** and the edge **220** of the second ductwork pipe **204** can be blanked or closed off by a transition plate **222** (FIG. **16**). The transition plate **222** is preferably comprised of a sheet metal material which has been cut out or stamped out of a sheet of sheet metal material. The transition plate **222** can include a first or blanking panel **224** and a second or fluid directing panel **226**. The first panel **224** is substantially the same size and shape as gap **216**. In the illustrated embodiment, the first panel **224** is a rectangular panel defined by edges **228**, **230**, **232** and **234**. The first panel **226** includes a first securing flap **236** extending from edge **228**, a second securing flap **238** extending from edge **230** and a third securing flap **240** extending from edge **232**. The transition plate **222** can be bent along edges **228**, **230**, **232** so that the securing flaps **236**, **238**, **240** extend at an angle from panel **224**.

[0068] In the illustrated embodiment, second panel **226** also has a generally rectangular shape defined by edges **234**, **242**, **246** and **248**. The second panel **226** also can have shapes other than rectangular. The transition plate **222** may be bent along edge **234** to create an angle between the first panel **224** and the second panel **226**. The second panel **226** also includes a securing flap **250** extending from the edge **244** of the second panel. The securing flap **250** can be bent to extend from the second panel **226** at a desired angle and is employed to secure the transition plate to the first ductwork pipe.

[0069] Referring to FIG. **17**, the transition plate **222** is bent along edge **234** so as to create an angle between the first panel **224** and the second panel **226**. The plate **222** is also bent along edges **228**, **230** and **232** so that the securing flaps **236**, **238**, **240** extend at right angles to the first panel **224**. The transition plate **222** is then positioned within the first ductwork pipe **200** so that the first plate **224** is located within gap **216**, thereby blanking or closing off gap **216**, and the second plate **226** is located within the interior of the first pipe **200**. The first securing flap **236** of the first panel **224** is then secured to the top wall **252** of the pipe **200**, the second securing flap **238** is secured to the sidewall **254** of pipe **200** and the third securing flap **240** is secured to the bottom wall **256** of pipe **200**. Furthermore, the securing flap **256** of the second plate **226** is bent back and secured to sidewall **254** of the pipe **200**. The securing flaps can be secured to the ductwork by the use of sheet metal screws.

[0070] When the transition plate **222** is installed, the second panel **226** is at an angle relative to the first and second ductwork pipes **200**, **204** and blocks off the dead space **258** defined by the wall **254**, the first panel **224** and the second panel **226**. As fluid flows through the first pipe **200** toward the second pipe **206**, the second panel **226** prevents fluid from flowing into the dead space **258** and directs fluid into the second pipe **204**.

[0071] It will be understood that the embodiments of the present invention which have been described are illustrative of some of the applications of the principles of the present invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention, including those combinations of features that are individually disclosed or claimed herein.

1. A method of fabricating an angled fitting for a rectangular ductwork system, comprising:
- providing a substantially flat blank of sheet metal material having a top edge and a bottom edge;
- cutting a pre-determined pattern in the blank from the top edge to the bottom edge to separate the blank into two or more portions;
- bending each of the portions of the blank so that each portion forms a discrete section of rectangular ductwork pipe; and
- joining the sections of rectangular ductwork pipe together to form an angled ductwork fitting.

2. The method of claim **1** in which the cutting a pre-determined pattern in the blank comprises separating the blank into two portions.

3. The method of claim **1** in which the cutting a pre-determined pattern in the blank comprises separating the blank into three portions.

4. The method of claim **1** in which the angled ductwork fitting formed by joining the sections of rectangular ductwork pipe is an elbow fitting.

5. The method of claim **1** in which the angled ductwork fitting formed by joining the sections of rectangular ductwork pipe is an offset fitting.

6. A method of fabricating an angled fitting for a rectangular ductwork system, comprising:
- providing a rectangular metal ductwork pipe having a top wall, a bottom wall and first and second opposed sidewalls;
- cutting a pre-determined continuous circumferential pattern through the top wall, bottom wall and first and second opposed sidewalls to separate the pipe into two or more sections of ductwork pipe;
- orienting the sections of ductwork pipe into a desired orientation; and
- mechanically joining the sections of ductwork pipe together to form an angled ductwork fitting.

7. The method of claim **6** in which the cutting a pre-determined continuous circumferential pattern in the ductwork pipe comprises separating the ductwork pipe into two sections.

8. The method of claim **6** in which the cutting a pre-determined continuous circumferential pattern in the ductwork pipe comprises separating the ductwork pipe into three sections.

9. The method of claim **6** in which the angled ductwork fitting formed by joining the sections of ductwork pipe is an elbow fitting.

10. The method of claim **6** in which the angled ductwork fitting formed by joining the sections of ductwork pipe is an offset fitting.

11. A blank for fabricating a rectangular angled ductwork fitting, comprising:
- a substantially flat sheet of sheet metal material having a top edge and a bottom edge; and
- at least one indicator forming a predetermined cutting patterning substantially extending from the top edge to the bottom edge, said blank adapted to being cut along said indicator to form two or more portions of the blank, each of said portions being adapted to being bent into a rectangular section of ductwork pipe, wherein the rectangular sections of pipe can be assembled to form an angled ductwork fitting.

12. The blank of claim **11** in which the flat sheet of metal comprises galvanized steel.

13. The blank of claim **11** in which the indicator comprises perforations in the blank.

14. The blank of claim **11** furthering including a second indicator forming a cutting pattern extending from the top edge to the bottom edge of the blank.

15. The blank of claim **11** in which the flat sheet of metal material comprises a plurality of metal pieces.

16. A ductwork pipe for fabricating an angled ductwork fitting, comprising:
- a rectangular metal pipe including a top wall, a bottom wall and opposed sidewalls, and at least one indicator forming a pre-determined cutting pattern extending circumferentially around the pipe, said pipe adapted to being cut along the cutting pattern to form segments of ductwork pipe that connect together to form the angled ductwork fitting.

17. The ductwork pipe of claim **16** in which the indicator comprises perforations through the ductwork pipe.

18. A transition fitting for a ductwork system, comprising:
- a transition plate adapted for being installed in a transition fitting connecting a first pipe having a width and a second pipe having a width that is less than the width of the first pipe, said transition plate comprising a first panel and a second panel, said first panel sized and shaped to be positioned in and to blank-off a gap between the first pipe and the second pipe, said second panel positioned within the first pipe so as to direct fluid traveling through the first pipe into the second pipe.

19. The transition fitting of claim **18** in which the first panel includes at least on securing flap extending from an edge of the first panel, said securing flap adapted to assist in securing the transition plate to the first pipe.

20. The transition fitting of claim **18** in which the second panel includes at least one securing flap extending form an edge of the first panel, said securing flap adapted to assist in securing the transition plate to the first pipe.

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