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### Method and apparatus for plastic duct bank manufacture

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#### Abstract

A method and apparatus for manufacturing a duct bank comprising the steps of loading a frame with a series of templates, positioning the frame adjacent a pipe extruder, aligning a set of a plurality of holes with a die of the pipe extruder, extruding a pipe of a first length into the set of holes, repeating the steps of aligning and extruding for each set of holes, thereby forming the duct bank, banding the duct bank, and removing the duct bank from the frame.

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**References Cited**

**U.S. PATENT DOCUMENTS**

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
1525087	12/1924	Murray	N/A	N/A
1821234	12/1930	Parker	138/112	H02G 3/0481
2161570	12/1938	Harris	N/A	N/A
3422648	12/1968	Lemelson	N/A	N/A
3606395	12/1970	Salerno et al.	N/A	N/A
3711127	12/1972	Raffa	285/55	F16L 37/56
3856246	12/1973	Sinko	N/A	N/A
3891733	12/1974	Maroschak	N/A	N/A
3962766	12/1975	Pompidor et al.	N/A	N/A
4099617	12/1977	Nist, Jr.	206/83.5	B65D 61/00
4199009	12/1979	Ballone	138/112	F16L 3/2235
4440712	12/1983	Imgram	N/A	N/A
4565289	12/1985	Lesueur	N/A	N/A
4601447	12/1985	McFarland	248/68.1	F16L 3/222
5167138	12/1991	Sinha et al.	N/A	N/A
RE34332	12/1992	Adams et al.	N/A	N/A
5240663	12/1992	Stringaro et al.	N/A	N/A
5605419	12/1996	Reinert, Sr.	405/184.5	F16L 3/22
5735412	12/1997	Sheckells	206/443	B65D 57/003
7806629	12/2009	McCoy	405/184	H02G 9/06
7942371	12/2010	McCoy	N/A	N/A
9909692	12/2017	Dean	N/A	F16L 3/1211
10816109	12/2019	Gross	N/A	B29C 48/147
10876661	12/2019	Pearson	N/A	H02G 3/0406
2009/0057497	12/2008	Bradbury	N/A	N/A
2011/0204202	12/2010	Masters	248/512	F16L 3/22

**FOREIGN PATENT DOCUMENTS**

Patent No.	Application Date	Country	CPC
2057852	12/1991	CA	N/A
21092	12/2009	CZ	N/A
2427580	12/1974	DE	N/A
0804662	12/1996	EP	N/A
2798719	12/2000	FR	N/A

## Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS (1) This application is a continuation-in-part of U.S. patent application Ser. No. 15/663,069, filed on Jul. 28, 2017, issued as U.S. Pat. No. 10,816,109 on Oct. 27, 2020, which is a continuation of U.S. patent application Ser. No. 14/993,545, filed on Jan. 12, 2016, issued as U.S. Pat. No. 9,719,612 on Aug. 1, 2017, which is a continuation of U.S. patent application Ser. No. 13/486,953, filed on Jun. 1, 2012, issued as U.S. Pat. No. 9,410,642 on Aug. 9, 2016. The patent applications identified above are incorporated herein by reference in their entirety to provide continuity of disclosure.

## FIELD OF THE INVENTION

(1) The field of the invention relates to the manufacture of plastic pipe. In particular, the field of the invention relates to a method and apparatus for the prefabrication of plastic duct bank.

## BACKGROUND OF THE INVENTION

(2) The transmission of electrical power, data, and telephone communications beneath buildings is carried out through wires and cables installed inside conduit pipes. The pipes are often assembled into bundles known as “duct banks.” Duct banks consist of multiple sections of ducting arranged in a rectangular pattern and held in position by “templates.” The templates are generally flat rectangular spacers each having a pattern of holes through which the pipes are inserted.

(3) Duct banks are typically assembled on site or transported to a construction site where they are installed. During installation each duct bank is loaded into a trench along a predetermined route. Each duct bank is then joined with other similar duct banks with couplings, sealed and encased in concrete.

(4) In the prior art, duct banks are assembled on the job site either in the trench or above ground near the trench. Typically, a first set of workers holds a set of templates at a predetermined angle and at the correct spacing to position and hold the ducts in place. A second set of workers positions each pipe in a set of corresponding holes in the templates by sliding it through the holes. The process is labor-intensive, dangerous, and subject to frequent interruption during assembly in order to provide realignment of the templates and undo jamming of the pipes.

(5) The prior art has attempted to solve some of these problems. For example, U.S. Pat. No. 3,606,395 to Salerno, et al. discloses a method and apparatus of laying underground cables using preformed conduit sections. The preformed conduit sections are rectangular blocks having four longitudinal holes forming conduit pipes. The preformed conduit sections are aligned end to end to form four continuous ducts. However, the block conduit sections in Salerno require excess material to surround each conduit in order to form the conduit section. This excess material requires additional raw materials, which increases manufacturing costs.

(6) U.S. Pat. No. 3,711,127 to Raffa discloses a closure to arrange conduit members into a duct bank. The closure includes a horizontal base, upright side walls formed integrally with the base, longitudinal side walls, and upright members attached to the base having a generally rectangular shape adapted to align and support conduit members. The upright side walls have tapered sleeves sized to align and support the conduit members. The closure is sealed and filled with an inert gas to improve insulation and heat dissipation. However, Raffa requires the use of a housing to encase the duct bank and inert gas to fill the housing, thereby making the arrangement expensive to manufacture and assemble.

(7) U.S. Pat. No. 5,605,419 to Reinert discloses a method for assembling and installing duct banks.

The duct banks are assembled with upright plastic grids having apertures sized to axially receive conduits. The grids are spaced apart along the length of the conduits. Spacers are installed in groups of four, onto conduit members, one on each corner of the cross section of the duct bank. Wooden supports are placed across the conduits to support the duct bank. However, the method requires the duct bank to be assembled at the jobsite, which requires additional workers and exposes the workers to unnecessary dangers, thereby increasing installation costs.

(8) The prior art fails to disclose or suggest a method and apparatus for prefabricating duct banks at the point of pipe extrusion. The prior art also fails to disclose an automated method of assembly of duct banks. Therefore, there is a need in the prior art for a method and apparatus for manufacturing and preassembling a duct bank that reduces time and labor costs and increases worker safety.

#### SUMMARY OF THE INVENTION

(9) In a preferred embodiment, a method for manufacturing a duct bank comprising the steps of providing a set of rigid templates, each of the templates comprising a set of patterned holes; providing a frame having a set of supports for the templates loading the set of supports with the set of templates; positioning the templates to align a set of holes; positioning the frame adjacent an extrusion machine, the extrusion machine having a coaxial extrusion die, a cooling section, and a cutter; aligning the set of holes with the extrusion die; extruding a pipe of a first predetermined length into the set of holes; repeating the steps of aligning and extruding until a pipe is extruded into each set of holes, thereby forming the duct bank; banding the duct bank; and removing the duct bank from the frame.

(10) In a preferred embodiment, the step of extruding a pipe of a first predetermined length into the set of holes includes the steps of cooling the pipe and cutting the pipe at the first predetermined length.

(11) In a preferred embodiment, the step of extruding at least one pipe of the second predetermined length includes the steps of cooling the at least one pipe and cutting the at least one pipe at the second predetermined length.

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## Description

#### BRIEF DESCRIPTION OF THE DRAWINGS

(1) The disclosed embodiments will be described with reference to the accompanying drawings. Like pieces in different drawings carry the same number.

(2) FIG. 1 is a flow chart of a preferred embodiment.

(3) FIG. 2A is a side view of a template of a preferred embodiment.

(4) FIG. 2B is a side view of a template of a preferred embodiment.

(5) FIG. 2C is a side view of a template of a preferred embodiment.

(6) FIG. 3A is a top view of a frame of a preferred embodiment.

(7) FIG. 3B is a side view of a frame of a preferred embodiment.

(8) FIG. 4 is a side view of a preferred embodiment.

(9) FIG. 5A is a side view of a preferred embodiment.

(10) FIG. 5B is an end view of a preferred embodiment.

(11) FIG. 5C is a plan view of a preferred embodiment.

(12) FIG. 6A is a side view of a preferred embodiment.

(13) FIG. 6B is an end view of a preferred embodiment.

(14) FIG. 6C is a plan view of a preferred embodiment.

(15) FIG. 7A is an isometric view of a duct bank of a preferred embodiment.

(16) FIG. 7B is a partial section view taken along line I-I of FIG. 7A of a duct bank of a preferred embodiment.

(17) FIG. 8A is a computer architecture schematic of a controller system of a preferred

embodiment.

(18) FIG. 8B is a flowchart of a method executed by the controller system.

## DETAILED DESCRIPTION OF THE INVENTION

(19) Referring to FIG. 1, a method for manufacturing a duct bank is described. In a preferred embodiment, in step 1, a movable frame is provided having a set of regularly spaced template supports. In step 2, a set of templates is provided, each including a set of holes in a pattern. In step 3, the set of templates are loaded into the template supports. In step 4, the set of templates are positioned so that each of the sets of holes is aligned to form a set of coaxially aligned holes or “receivers” for the duct pipes. In step 5, the frame and the set of adjusted templates is positioned adjacent a pipe extrusion machine, the pipe extrusion machine having an extrusion die, a cooling section, and a cutter. In an optional step 6, a chosen receiver is positioned relative to an x-y plane to be coaxial with the extrusion die. In step 7, a pipe of a first predetermined length is extruded into the receiver. Step 7 includes the optional step of cooling the pipe. In step 8, the pipe is cut to a first predetermined length. In step 9, steps 6, 7 and 8 are repeated until all receivers are full, thereby forming a duct bank. The duct bank is banded in step 10 and removed from the frame in step 11.

(20) Referring to FIGS. 2A, 2B, and 2C, examples of preferred embodiments of the templates are shown. Templates 101, 102, and 103 each have generally rectangular hole pattern 104, 105, and 106, arranged in x-y plane 99. Each hole has a larger diameter than the diameter of the pipe to be received. In a preferred embodiment, the holes have a diameter about 15-20% larger than that of the pipe. The diameter of the pipe and the number of holes, including the number of rows and columns, vary according to the desired duct bank to be assembled. Other geometrical patterns, besides rectangular, may be employed.

(21) In a preferred embodiment, the templates are generally flat having a thickness of approximately  $\frac{3}{4}$  inch. Other shapes and thicknesses may be employed. In a preferred embodiment, templates 101, 102, and 103 are made of plastic, such as HDPE, Delrin, or Teflon. Other durable materials known in the art may be employed.

(22) Referring to FIG. 3A, frame 200 includes rails 201 and 202. Angled member 203 has first end 234 and second end 235. Angled member 204 has first end 232 and second end 233. First end 234 of angled member 203 attaches to rail 201. First end 232 of angled member 204 attaches to rail 202. Second end 233 of angled member 204 attaches to second end 235 of angled member 203. Cross members 205, 206, 207, 208, and 209 connect to rails 201 and 202. Hitch 231 attaches to angled members 203 and 204 at second ends 233 and 235. Wheels 227 and 228 attach to rail 202. Wheels 229 and 230 attach to rail 201. Post 225 attaches to rail 202 and angled member 204 adjacent first end 232 of angled member 204 and rail 202. Post 226 attaches to rail 201 and angled member 203 adjacent first end 234 of angled member 203 and rail 201.

(23) Referring to FIG. 3B, supports 210 and 211 attach to cross member 205. Supports 210 and 211 form slot 212. Slot 212 receives, supports, and orients template 130 generally perpendicularly with respect to rails 201 and 202. Supports 213 and 214 attach to cross member 206. Supports 213 and 214 form slot 215. Slot 215 receives, supports, and orients template 131 generally perpendicularly with respect to rails 201 and 202. Supports 216 and 217 attach to cross member 207. Supports 216 and 217 form slot 218. Slot 218 receives, supports, and orients template 132 generally perpendicularly with respect to rails 201 and 202. Supports 219 and 220 attach to cross member 208. Supports 219 and 220 form slot 221. Slot 221 receives, supports, and orients template 133 generally perpendicularly with respect to rails 201 and 202. Supports 222 and 223 attach to cross member 209. Supports 222 and 223 form slot 224. Slot 224 receives, supports, and orients template 134 generally perpendicularly with respect to rails 201 and 202.

(24) The distance between cross members 205, 206, 207, 208, and 209, and thereby the distance between loaded templates 130, 131, 132, 133, and 134, is dependent upon the strength, the length, and the diameter of the desired pipe to be used in the duct bank. In one preferred embodiment, the cross members are spaced evenly to support 40' sections of pipe. In another embodiment, the cross

members are spaced evenly to support **20'** sections of pipe.

(25) In a preferred embodiment, rails **201** and **202**, angled members **203** and **204**, cross members **205**, **206**, **207**, **208**, and **209**, and supports **225** and **226** are made of steel. Other rigid and durable materials known in the art may be employed.

(26) In a preferred embodiment, supports **210**, **211**, **213**, **214**, **216**, **217**, **219**, **220**, **222**, and **223** are made of steel angle iron. Other rigid and durable materials known in the art may be employed. In other embodiments, the cross members can have different cross sections, such as box channel and/or triangular supports.

(27) In a preferred embodiment, wheels **227**, **228**, **229**, and **230** are castor wheels. Other wheel types known in the art may be employed.

(28) Referring to FIG. **4**, in one embodiment, proximal end **251** of frame **200** is positioned adjacent extrusion system **300**. Extrusion system **300** includes extruder **304**, extrusion die **301** attached to extruder **304**, cooling section **302**, aligned with extrusion die **301**, and cutter **303**, aligned with cooling section **302**. Each of templates **130**, **131**, **132**, **133**, and **134** is identical, and includes a set of holes arranged in the same pattern. The sets of holes are aligned by adjusting the templates, one to another, until the holes match the sets of aligned holes for receivers for the pipes.

(29) Pipes **450** and **451** are shown positioned in the set of holes of templates **130**, **131**, **132**, **133**, and **134**. Each pipe is cut to a predetermined length. The pipes can have different predetermined lengths. In one preferred embodiment, workers **801** and **811** manually transport pipe **452** from cutter **303** and insert it into one of the set of coaxially aligned holes of the templates. Workers **801** and **811** repeatedly transport and insert each pipe into the set of holes until each of the set of coaxially aligned holes contains a pipe.

(30) The duct bank is then banded for transport. Banding includes the steps of inserting blocks at chosen intervals between the pipes and between the templates. Steel straps, as known in the art, are then positioned around the duct bank and secured in order to prevent the templates and pipes from changing position during transport. The duct bank is then lifted from the frame and transported to the jobsite for installation.

(31) Referring to FIGS. **5A-5C**, in another embodiment, proximal end **251** of frame **200** is positioned adjacent extrusion system **300**. Distal end **252** of frame **200** includes hitch **231**. Extrusion system **300** includes extruder **304**, extrusion die **301** attached to extruder **304**, cooling section **302** collinearly aligned with extrusion die **301**, and cutter **303** collinearly aligned with cooling section **302**. The holes of templates **130**, **131**, **132**, **133**, and **134**. The position of the frame in the x-y plane is adjusted so as to coaxially align with extrusion die **301**, cooling section **302**, and cutter **303** with a set of collinear holes in the templates.

(32) In this embodiment, frame **200** is horizontally and vertically positioned with respect to extrusion system **300** by position system **700**. Position system **700** includes indexing tracks **701** and **702**, winches **703**, **704**, **715** and **750** connected to the frame by cables. The winches are typically supported overhead by attachment to beams **752** and **754**. In a preferred embodiment, winches **703**, **704**, **715**, and **750** are electric winches capable of lifting about 2,000 pounds. In one preferred embodiment, each winch is locally controlled with a drop switch (not shown). In another preferred embodiment each winch is connected to a programmable controller.

(33) Winches **703**, **704**, **715** and **750** are attached to the frame by a series of cables or wire ropes. Winches **703**, **704**, **715** and **750** are movably attached to indexing track **701** and **702** through a rolling suspension system including a set of carriages **797**, **799**, **795**, and **793** operatively attached to wheels **740**, **741**, **762**, **764**, **738**, **739**, **766** and **768**, respectively.

(34) Winch **703** is attached to indexing track **701**. Winch **703** is also attached to main cable **705**. Secondary cables **707** and **708** attach to main cable **705**. Hook **711** attaches to secondary cable **707**. Hook **711** connects to eye hook **253**. Eye hook **253** attaches to rail **202** of frame **200**. Hook **712** attaches to secondary cable **708**. Hook **712** connects to eye hook **254**. Eye hook **254** attaches to rail **202** of frame **200**.

(35) Winch **704** is attached to indexing track **702**. Winch **704** is also attached to main cable **706**. Secondary cables **709** and **710** attach to main cable **706**. Hook **713** attaches to secondary cable **709**. Hook **713** connects to eye hook **255**. Eye hook **255** attaches to rail **202** of frame **200**. Hook **714** attaches to secondary cable **710**. Hook **714** connects to eye hook **256**. Eye hook **256** attaches to rail **202** of frame **200**.

(36) Winch **715** is attached to indexing track **701**. Winch **715** is also attached to main cable **759**. Secondary cables **716** and **756** attach to main cable **759**. Hook **770** attaches to secondary cable **716**. Hook **770** connects to eye hook **774** attached to the frame. Hook **772** attaches to secondary cable **756**. Hook **772** connects to eye hook **776** connected to the frame.

(37) Winch **750** is attached to indexing track **702**. Winch **750** is also attached to main cable **778**. Secondary cables **758** and **760** attach to main cable **778**. Hook **780** attaches to secondary cable **758**. Hook **780** connects to eye hook **784**. Eye hook **784** is attached to the frame. Hook **782** attaches to secondary cable **760**. Hook **782** connects to eye hook **786**. Eye hook **786** is connected to the frame.

(38) Winches **703**, **704**, **715** and **750** enable movement of frame **200** along y-axis **743**, thereby enabling positioning system **700** to position each hole of geometrical pattern **106** at a set of predetermined positions along y-axis **743**.

(39) Linear motivators **790** and **794** are positioned at the respective ends of indexing track **701**. Linear motivator **790** is connected to a threaded receiver incorporated into carriage **797** by threaded rod **798**. Linear motivator **794** is connected to a threaded receiver incorporated into carriage **799** by threaded rod **796**. A similar set of motivators **788** and **792**, threaded rods **789** and **791**, and carriages are included in indexing track **702** which is connected to winches **704** and **750**. Wheels **738**, **739**, **740**, and **741** roll within indexing track **701**, and wheels **762**, **764**, **766** and **768** roll within indexing track **702**, thereby enabling movement of frame **200** along x-axis **742** and enabling position system **700** to position each hole of geometrical pattern **106** at a set of predetermined positions along x-axis **742**. When activated, the linear motivators rotate the threaded rods to move the carriages and the winches along an x-axis. In a preferred embodiment, linear motivators **790** and **794** are electric motors with the appropriate transmissions to rotate the threaded rods at a desirable slow speed. In one preferred embodiment, the motivators are controlled locally by a drop switch. In another preferred embodiment, the motivators are connected to and controlled by a programmable controller which positions the frame.

(40) Referring to FIGS. **6A-6C**, in another embodiment, proximal end **251** of frame **200** is positioned collinearly adjacent extrusion system **300**. Extrusion system **300** includes extruder **304**, extrusion die **301**, having an extrusion axis **305**, attached to extruder **304**, cooling section **302** collinearly aligned with extrusion die **301**, and cutter **303** collinearly aligned with cooling section **302**. The holes of templates **130**, **131**, **132**, **133**, and **134** coaxially align with extrusion die **301**, cooling section **302**, and cutter **303**.

(41) In this embodiment, frame **200** is horizontally and vertically positioned with respect to extrusion system **300** by position system **950**. Position system **950** includes indexing tracks **923** and **925** connected to a series of hydraulic lifting pistons. Indexing tracks **923** and **925** support frame **200**. Indexing track **923** slidably engages with inside track **922**. Inside track **922** attaches to piston rods **920** and **936**. Piston rod **920** attaches to piston **951**. Piston **951** slidably engages with cylinder **918**. Piston rod **936** attaches to piston **957**. Piston **957** slidably engages cylinder **935**.

(42) Indexing track **925** slidably engages with inside track **924**. Inside track **924** attaches to piston rods **921** and **812**. Piston rod **921** attaches to piston **952**. Piston **952** slidably engages with cylinder **919**. Piston rod **812** attaches to piston **808**. Piston **808** slidably engages with cylinder **809**. Position system **950** further includes piston rod **936** connected to inside track **922**. Piston rod **936** further connects to piston **957**. Piston **957** slidably engages with cylinder **935**.

(43) Each of the cylinders is connected to hydraulic fluid line **930**. Hydraulic fluid line **930** connects to pump **931**. In one embodiment, pump **931** is manually controlled by a foot switch. In another embodiment, pump **931** connects to controller **933** with communication line **932**.

Controller **933** connects to monitor **934** and keyboard **735** for data management and entry by an operator.

(44) Linear motivator **802** is attached to outside track **923**. Linear motivator **802** includes pinion **806**. Pinion **806** engages rack **1000** attached to inside track **922**. Linear motivator **800** is attached to indexing track **925**. Linear motivator **800** includes pinion **804** which engages rack **1002** of inside track **924**. In a preferred embodiment, the linear motivators include electric motors which rotate the pinions which thereby move the racks along the x-axis. In one preferred embodiment, the motivators are controlled locally using a drop switch. In another preferred embodiment, the motivators are connected to and controlled by a programmable controller which positions the frame.

(45) The sliding engagement between inside track **922** and indexing track **923** enables movement of frame **200** along the x-axis and moves the frame to position the templates to predetermined positions along the x-axis.

(46) Pressure from the hydraulic fluid against the pistons enables movement of frame **200** along the y-axis and moves the frame to position the templates to predetermined positions along the y-axis.

(47) Referring to FIG. **8A**, control system **1150** is described. Controller **1152**, in a preferred embodiment, includes a programmable microcontroller or a computer work station programmed with suitable programming to carry out method steps necessary to move the x motivators and the y motivators to predetermined positions in order to move the frame to a predetermined location in the x-y plane. Controller **1152** is connected to x position motivators **1154**, y position motivators **1156** and stop sensor **1158**.

(48) In a preferred embodiment, stop sensor **1158** is a simple mechanical limit switch, fixed in a position of axial alignment with the extruder and in a position to sense contact with the end of the pipe as it is completely inserted in the axially aligned holes or receivers. In another embodiment, the limit switch can be an optical sensor and transmitter pair connected to the controller.

(49) Referring to FIG. **8B**, the method **850** is described that is executed by the program resident on controller **1152**.

(50) At step **852**, the program starts. At step **854**, input is received from the operator regarding a maximum number columns in the template ("MAXx") and the maximum number of rows in the template ("MAXy"). At step **855**, input is received which identifies each unique location in the x-y plane of an axis corresponding to the center of a particular receiver. The locators are numbered in a sequence of rows and columns each having an x-y address.

(51) At step **856**, the program then initiates and sets a variable x to 1, and initiates and sets a variable y to 1.

(52) At step **857**, the controller sends signals to the x position motivators **1154** and y position motivators **1156** sufficient to locate the frame and associated templates to the x=1, y=1 position corresponding to the first axis physical location.

(53) At step **858**, the controller waits for a signal from stop sensor **1158** indicating that a pipe has been inserted. At step **860**, the controller compares the x location to the variable MAXx. If the variables are not equal, the program moves to step **862** and increments the x value by 1 and then proceeds to step **863**. At step **863** the controller sends signals to the x and y motivators sufficient to physically move the frame to its x position. The new position coaxially locates the next receiver in order with the extruder and extrusion die. The program then returns to step **858**. If the variables are equal, then the program proceeds to step **864** and resets the value of x to 1. At step **865**, the controller send signals to the x motivators sufficient to return them to their original x position thereby aligning the original receiver with the extruder.

(54) At step **866**, the value of y is incremented by 1. At step **868**, the program compares the value of y to MAXy. If the position of y is not greater than MAXy, then the program returns to step **869** where the controller sends signals to the y position motivators sufficient to advance the frame to the next y position. The next y position corresponds to the row of empty receivers above the first row.



The program then returns to step **858**. If the value of *y* is greater than MAX<sub>y</sub>, then the program proceeds to step **870** and ends.

(55) In a preferred embodiment the receivers are filled in order from left to right and bottom to top in order to increase duct bank stability. However, other orders of x-y positions can be used with success.

(56) The program in a preferred embodiment is written in a basic interpretive language such as Basic or FORTRAN. However, other languages may be employed. In a preferred embodiment, the program is stored in physical memory at the controller. However, in other embodiments the program may be stored on a computer network connected to the controller on a removable permanent memory accessed by the controller.

(57) Referring to FIG. 7A, by way of example, after assembly, duct bank **400** comprises pipes **401**, **402**, **403**, **404**, **405**, **406**, **407**, **408**, and **409** inserted through templates **130**, **131**, **132**, **133**, and **134**.

(58) In a preferred embodiment, pipes **401**, **402**, **403**, **404**, **405**, **406**, **407**, **408**, and **409** are made of polyvinyl chloride (PVC). Other materials known in the art may be employed.

(59) Band **475** surrounds pipes **402**, **405**, and **408**. Blocks **417** and **418** position within duct bank **400** and held in position with band **475**. Block **417** is held adjacent pipes **402**, **405**, and **408** by band **475**. Block **418** is held adjacent pipes **402**, **405**, and **408**, opposite block **417** by band **475**. Band **410** surrounds pipes **401**, **402**, **403**, **404**, **406**, **407**, **408**, and **409**. Blocks **415** and **416** position on the outer sides of duct bank **400** and maintained in position by band **410**. Block **415** is held adjacent pipes **403**, **406**, and **409** by band **410**. Block **416** is held adjacent pipes **401**, **404**, and **407** by band **410**.

(60) Referring to FIGS. 7A and 7B, by way of example, band **412** surrounds pipes **402**, **405**, and **408**. Blocks **419** and **420** position within duct bank **400** and held in position with band **412**. Block **419** is held adjacent pipes **402**, **405**, and **408** by band **412**. Block **420** is held adjacent pipes **402**, **405**, and **408**, opposite block **419** by band **412**. Band **411** surrounds pipes **401**, **402**, **403**, **404**, **406**, **407**, **408**, and **409**. Blocks **413** and **414** position on the outer sides of duct bank **400** and maintained in position by band **411**. Block **413** is held adjacent pipes **403**, **406**, and **409**. Block **414** is held adjacent pipes **401**, **404**, and **407** by band **411**.

(61) The position of bands **410**, **411**, **412** and **475** and the distance between each band is dependent upon the length, the strength, and the diameter of pipe to be used in duct bank **400**, and the height and the width of duct bank **400**. Further, the number of bands and blocks employed varies and is dependent upon the length, the strength, and the diameter of pipe to be used in duct bank **400**, and the height and the width of duct bank **400**.

(62) In a preferred embodiment, bands **410**, **411**, **412** and **475** are made of polyester. Other materials known in the art may be employed.

(63) In a preferred embodiment, blocks **413**, **414**, **415**, **416**, **417**, **418**, **419**, and **420** are made of wood. Other durable materials known in the art may be employed.

(64) In FIG. 7A, the blocks are oblong and are positioned vertically. In another embodiment, the blocks may be positioned horizontally, but yet retain the same relative positions with respect to the pipes and bands.

(65) It will be appreciated by those skilled in the art that modifications can be made to the embodiments disclosed and remain within the inventive concept. Therefore, this invention is not limited to the specific embodiments disclosed, but is intended to cover changes within the scope and spirit of the claims.

## Claims

1. A method of forming a duct bank comprising: providing a set of rectangular templates; providing an array of circular holes in each rectangular template of the set of rectangular templates, arranged in a rectangular pattern; arranging a set of pipes, in the array of circular holes, in a first plurality of

columns; arranging a set of blocks in a second plurality of columns; wherein each column of the first plurality of columns is positioned between at least two columns of the second plurality of columns; securing the set of pipes and the set of blocks, in the set of rectangular templates, with a set of bands arranged in a concentric pattern with a first band of the set of bands inside a second band of the set of bands; and positioning each block of the set of blocks vertically.

2. The method of claim 1: wherein the set of blocks comprises: a first block, a second block, a third block, a fourth block, a fifth block, a sixth block, a seventh block, and an eighth block; wherein the set of bands comprises: the first band, the second band, a third band, and a fourth band; and wherein the set of pipes comprises: a first pipe, a second pipe, a third pipe, a fourth pipe, a fifth pipe, a sixth pipe, a seventh pipe, an eighth pipe, and a ninth pipe; and, wherein the set of rectangular templates comprises: a first template, spaced apart from a second template.

3. The method of claim 1 further comprising: providing each pipe of the set of pipes made of polyvinyl chloride.

4. The method of claim 2 further comprising: providing the first band, the second band, the third band, and the fourth band each made of polyester.

5. The method of claim 2 further comprising: providing the first block, the second block, the third block, the fourth block, the fifth block, the sixth block, the seventh block, and the eighth block made of wood.

6. A method of forming a duct bank comprising: providing a set of rectangular templates; providing an array of circular holes in each rectangular template of the set of rectangular templates, arranged in a rectangular pattern; arranging a set of pipes, in the array of circular holes, in a first plurality of columns; arranging a set of blocks in a second plurality of columns; wherein each column of the first plurality of columns is positioned between at least two columns of the second plurality of columns; securing the set of pipes and the set of blocks, in the set of rectangular templates, with a set of bands arranged in a concentric pattern with a first band of the set of bands inside a second band of the set of bands; wherein the set of blocks comprises: a first block, a second block, a third block, a fourth block, a fifth block, a sixth block, a seventh block, and an eighth block; wherein the set of bands comprises: the first band, the second band, a third band, and a fourth band; wherein the set of pipes comprises: a first pipe, a second pipe, a third pipe, a fourth pipe, a fifth pipe, a sixth pipe, a seventh pipe, an eighth pipe, and a ninth pipe; wherein the set of rectangular templates comprises: a first template, spaced apart from a second template; providing the first block, the second block, the third block, the fourth block, the fifth block, the sixth block, the seventh block, and the eighth block made of wood; retaining the second pipe, the fifth pipe, and the eighth pipe, of the set of pipes, with the first band; retaining the first block and the second block, with the first band; retaining the first block adjacent the second pipe, the fifth pipe, and the eighth pipe; and, retaining the second block adjacent the second pipe, the fifth pipe, and the eighth pipe, opposite the first block.

7. The method of claim 6 further comprising: retaining the first pipe, the second pipe, the third pipe, the fourth pipe, the sixth pipe, the seventh pipe, the eighth pipe, and the ninth pipe, with the second band; retaining the third block and the fourth block, with the second band; retaining the third block, adjacent the third pipe, the sixth pipe, and the ninth pipe; and, retaining the fourth block, adjacent the first pipe, the fourth pipe, and the seventh pipe.

8. The method of claim 7 further comprising: retaining the second pipe, the fifth pipe, and the eighth pipe, with the third band; retaining the fifth block and the sixth block, with the third band; retaining the fifth block, adjacent the second pipe, the fifth pipe, and the eighth pipe; and, retaining the sixth block, adjacent the second pipe, the fifth pipe, and the eighth pipe, opposite the fifth block.

9. The method of claim 8 further comprising: retaining the first pipe, the second pipe, the third pipe, the fourth pipe, the sixth pipe, the seventh pipe, the eighth pipe, and the ninth pipe, with the fourth band; retaining the seventh block and the eighth block, with the fourth band; retaining the

seventh block, adjacent the third pipe, the sixth pipe, and the ninth pipe; and, retaining the eighth block, adjacent the first pipe, the fourth pipe, and the seventh pipe.

10. The method of claim 9 wherein each pipe, of the set of pipes, has a length, a strength, and a diameter and wherein each rectangular template, of the set of rectangular templates, has a height and a width, the method further comprising: positioning the first band and the second band, relative to a first rectangular template of the set of rectangular templates, based on the length, the strength, and the diameter of each said pipe of the set of pipes and based on the height and the width of each said rectangular template of the set of rectangular templates; positioning the third band and the fourth band, relative to a second rectangular template of the set of rectangular templates, based on the length, the strength, and the diameter of each said pipe of the set of pipes and based on the height and the width of each said rectangular template of the set of rectangular templates; and, positioning the first band and the second band, at a set of distances from the third band and the fourth band, based on the length, the strength, and the diameter of each said pipe of the set of pipes and based on the height and the width of each said rectangular template of the set of rectangular templates.

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