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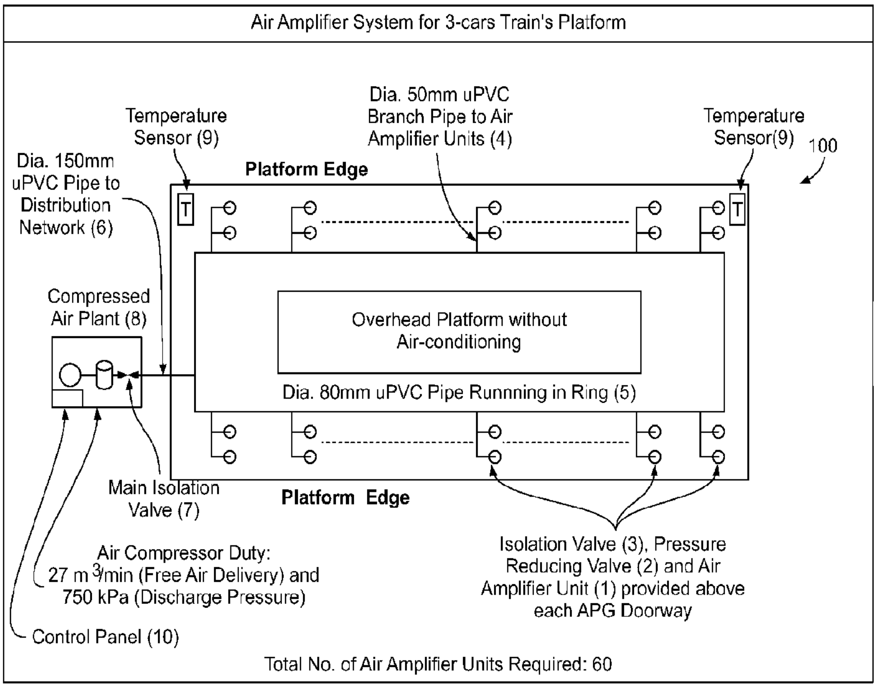

FIG. 1A

(57) **Abstract:** An air amplifier ventilation system for providing efficient spot cooling in multiple locations for various applications, such as railway station platforms, includes compressed air plants (8) at remote locations, which may be located at one or both ends of the railway station platform, and air amplifier units (1) located at various cooling locations, such as automatic platform gateway doorways located on a railway station platform. Compressed air generated by the plants (8) is provided to the air amplifier units (1) through delivery pipes and respective pressure reducing valves (2). The air amplifier units (1) generate an amplified and evenly distributed air stream via air induction principles and Coanda effect to provide spot cooling based on compressed air, and without the use of conventional bladed fans or physical air movers.

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AIR AMPLIFIER VENTILATION (AAV) SYSTEM

TECHNICAL FIELD

[0001] The present invention relates to an air amplifier ventilation system which makes use of compressed air and air amplifier units for providing localized air delivery at one or more spot cooling locations.

BACKGROUND OF THE INVENTION

SUMMARY OF THE INVENTION

[0002] Disclosed herein is an air amplifier ventilation (AAV) system for enhancing the thermal comfort of personnel at areas without air-conditioning. The air amplifier ventilation system may be used in at-grade or above-ground railway station platforms and concourses to provide spot cooling at specific locations such as automatic platform gate (APG) doorways. The air amplifier ventilation system makes use of compressed air and air amplifier units (AAUs) to generate an amplified air stream, instead of using conventional bladed fans or physical air movers.

[0003] In the air amplifier ventilation system disclosed herein, compressed air generated by remote compressed air plants is delivered to platform areas through pipes. The compressed air is then released through a pressure reducing valve connected to an air amplifier unit from the pipes and the air stream is then amplified for spot cooling at APG doorways locations. Each pressure reducing valve can individually govern the output air pressure for its respective air amplifier unit. Groups of pressure reducing valves may be operated in tandem with one another. The use of the air amplifier ventilation system to provide spot cooling through the use of a remote compressed air generation system provided to air amplifier units through compressed air delivery pipes has several advantages from existing air ventilation systems that rely on conventional fans. One advantage that the air amplifier ventilation system has over conventional spot cooling systems is that it can be deployed in a greater variety of locations and applications. The air amplifier ventilation system alleviates the need for powered components and cables in the spot cooling location, thereby eliminating electrical and other constraints, which expands the scope of potential installations and uses for the system. Another advantage is the relatively small pipe size when compared with ventilation air ducts, which also eliminates physical constraints and expands the scope of possible installations, while reducing installation complexity.

[0004] Another advantage is decreased maintenance complexity resulting from the lack of moving parts at delivery locations. Because air compressor plants may be housed at remote locations, such as inside plant rooms at either or both ends of a platform, and because there are no moving or mechanical parts at the delivery locations (which are normally public locations within a station), the air amplifier ventilation system is relatively simple to maintain as compared with that of systems that rely upon the use of ventilation fans for spot cooling at locations. Moreover, the appearance of the air amplifier units can be designed to match with the architectural design of the platforms or locations served.

[0005] The air amplifier ventilation system and the air amplifier units provide for total air flow amplification which is obtained when air is emitted downward at high velocity from slots contained in each air amplifier unit, creating a low pressure region that draws in air from above. Air stream flows from an upper level near the air amplifier unit to a lower passenger level through the air amplifier unit, thereby creating a localized air circulation for enhancing passenger comfort. Furthermore, since the air emitted from the air amplifier units has low relative humidity (as described in greater detail in later sections), the evaporation rate of sweat on passengers will be increased, which further enhances passenger comfort.

[0006] In this regard, the air amplifier units of the system disclosed herein also have several advantages over conventional induction air systems. The air amplifier units utilize the induction principle and Coanda effect to create high velocity and large volume air streams from compressed air provided through pressure reducing valves. The use of compressed air has significant advantages over conventional induction air systems that utilize built-in or localized fans to create high velocity air streams, including the ability to avoid the need for electrical service at the air amplifier unit location, and to avoid the need for complex maintenance and upkeep associated with fan components at the air amplifier unit location. The use of compressed air and the lack of localized fans also makes it easier to provide air amplifier units at any desired location provided only that compressed air can be delivered via a pipe distribution network to such location, as further described below.

[0007] These and other aspects and advantages will become apparent to those of ordinary skill in the art by reading the following detailed description, with reference where appropriate to the accompanying drawings. Further, it should be understood that the foregoing summary is merely illustrative and is not intended to limit in any manner the scope or range of equivalents to which the appended claims are lawfully entitled.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The invention is described below in connection with the following illustrative figures, wherein:

[0009] Fig. 1(a) is a general schematic of an air amplifier system, according to an embodiment of the invention;

[0010] Fig. 1(b) is a general schematic of an air amplifier system, according to another embodiment of the invention;

[0011] Fig. 2 is a schematic showing the control and operation of the air amplifier system, according to an embodiment of the invention;

[0012] Fig. 3 is an illustration of an air amplifier unit and associated electric isolation valve and pressure reducing valve, and the operating principles thereof, according to one embodiment of the invention;

[0013] Fig. 4(a) is a top-level drawing of an air amplifier unit, according to one embodiment of the invention;

[0014] Fig. 4(b) is a cross-sectional view of the section labeled "A - A" in the air amplifier unit depicted in Fig. 4(a);

[0015] Fig. 4(c) is a cross-sectional view of the section labeled "B - B" in the air amplifier unit depicted in Fig. 4(a);

[0016] Fig. 4(d) is a cross-sectional view of the section labeled "C - C" in the air amplifier unit depicted in Fig. 4(a);

[0017] Fig. 4(e) is a side-level drawing of an air amplifier unit, according to one embodiment of the invention;

[0018] Fig. 4(f) is a bottom-level drawing showing and sectional view of the section labeled "D – D" in the air amplifier unit depicted in Fig. 3(e);

[0019] Fig. 4(g) is a detailed cross-sectional view of the section labeled "R" in the air amplifier unit depicted in Fig. 4(f);

[0020] Fig. 4(h) is a detailed cross-sectional view of the section labeled "S" in the air amplifier unit depicted in Fig. 4(f);

[0021] Fig. 4(i) is a detailed view of the section labeled "T" in the air amplifier unit depicted in Fig. 4(f);

[0022] Fig. 4(j) is a cross-sectional view of the section labeled "E – E" in the air amplifier unit depicted in Fig. 4(e);

DETAILED DESCRIPTION

[0023] While the present invention is capable of being embodied in various forms, for simplicity and illustrative purposes the principles of the invention are described by referring to several embodiments thereof. It is understood, however, that the present disclosure is to be considered as an illustrative example of the claimed subject matter and is not intended to limit the appended claims to the specific embodiments illustrated. It will be apparent to one of ordinary skill in the art that the invention may be practiced without limitation to these specific embodiments or details. In other instances, well-known methods and structures have not been described in detail so as not to unnecessarily obscure the invention.

[0024] The air amplifier ventilation (AAV) system may be used at grade or above ground railway station platforms and concourses to provide spot cooling at specific locations such as automatic platform gate (APG) doorways. It makes use of the compressed air and air amplifier units (AAUs) to generate the amplified air stream.

[0025] The air amplifier ventilation system includes one or more air amplifier units and associated pressure reducing valves, one or more air compressors and receivers, air dryers, and compressed air distribution pipework. The details regarding the structure and operation of the overall system, as well as the structure and operation of each component, is described further below.

[0026] **Air Amplifier Ventilation System**

[0027] Fig. 1(a) provides a detailed overview the air amplifier ventilation system 100 according to an embodiment for a train platform application, for use in, for example, railway stations that serve 3-car trains. Compressed air is generated at the compressed air plant 8, which may be remotely located in an area separate from the air delivery areas. The compressed air generated by the compressors and receivers in the plant 8 is delivered to the platform areas through a pipe distribution network, and is then released through pressure reducing valves 2 connected to air amplifier units 1 above the automatic platform gate doorways. Using the air discharged from the pressure reducing valve 2, the air amplifier unit creates high velocity and large volume air streams which cause overall air to be emitted downward to passenger body level, thereby increasing localized air circulation to enhance passenger comfort.

[0028] In the system shown in Fig. 1(a), the compressed air plant 8 is housed in a location that is remote from the train platform. Each compressed air plant 8 contains optional air dryers, at least one air compressor, and an air receiver. The air dryer has a capacity no less than that of the air compressor. The air dryer works in conjunction with the air compressor to keep water vapor out of the compressed air expelled by the air compressor. In one embodiment, the air dryer is a refrigeration type dryer and has a pre-filter and after-filter for each air compressor installation. In operation, the refrigerated compressor dryer draws in the hot air from the compressor and cools it down, lowering the dew point and ultimately reducing the overall moisture level in the air.

[0029] The air compressor takes in ambient air and generates high-pressure compressed air. In general, the air compressor is able to deliver sufficient volume flow rate at a working pressure between about 600kPa and about 900kPa, in order to support the maximum consumption of air flow rate at the station, which occurs when all air amplifier units are in operation simultaneously. In one embodiment, the air compressor is electric motor driven and has one or more of the following features: a finned air cooled inter-cooler, an automatic unloader, a heavy duty disposable cartridge type inlet paper filter, and automatic start-stop control based on a predefined cut-in and cut-out pressure at the air receiver. In system 100, the air compressor for the 3-car system with 60 air amplifier units is rated to provide around 27 m^3/min (+/- 5 m^3/min) of free air delivery at around 750kPa (+/- 250kPa), i.e. 500 to 1,000kPa discharge pressure. As discussed in greater detail below with respect to the system of Fig. 1(b), the free air delivery of the air compressor may be greater for systems with more air amplifier units, such as platforms for 8-car trains.

[0030] The air receiver stores the high-pressure air from the compressor units to maintain a steady pressure range under various load situations. In a preferred embodiment, the air receiver is of welded steel plate construction and is able to operate safely at the maximum pressure output from the compressor unit.

[0031] The compressed air plant 8 also includes a control panel 10 for operating the air compressor and related components, such as the air receivers and air dryers. The compressed air generated by the air compressor and related components at the compressed air plant 8 is distributed to air amplifier units in the platform area via piping in a pipe distribution network . The pipe distribution network is generally in the form of large-diameter network uPVC pipe segments in a ring arrangement 5 for even compressed air distribution. The ring arrangement 5 is located at the ceiling level of the station platform. The ring segment is coupled to the compressed air plant 8 via an air plant connection segment 6, and is further coupled to multiple air amplifier unit segments 4 branching off the ring, with each air amplifier unit segment connected to one or more air amplifiers. An electrically actuated main isolation valve 7 is provided at the compressed air plant 8 and selectively couples the air compressor outlet to the pipe distribution network via the large-diameter air plant connection segment 6. The electrically actuated main isolation valve 7 can be used to open or close the compressed air supply to the pipe distribution network in order to selectively isolate the compressed air plant from the remainder of the air amplifier system to facilitate inspection and maintenance of different components. The electrically actuated main isolation valve 7 is also used to control operation of the system by selectively supplying compressed air to the air amplifier units, as further described below.

[0032] The air amplifier unit segments 4 of the pipe distribution network branching off of the main loop have a smaller diameter than the segments of the main ring 5. The sizing and diameter of the piping in the pipe distribution network components (including the air plant connection segment, main ring segment, and branch segments) are such that they allows sufficient delivery of air to support the simultaneous operation of all air amplifier units in the system. In system 100, the uPVC pipe of the air plant connection segment 6 has a diameter of 150 mm and the uPVC pipe of the main loop segments 5 has a diameter of 80 mm, whereas the uPVC pipe of the air amplifier unit branch segments 4 has a diameter of 50 mm. As discussed in greater detail below with respect to the system of Fig. 1(b), the diameter of the piping of the air plant connection segments and the ring segments may be larger to accommodate higher pressures and greater air delivery volumes for systems with more air amplifier units, such as platforms for 8-car trains.

[0033] Each branch segment 4 is connected to one or more air amplifier units 1, with each air amplifier unit having a corresponding pressure reducing valve 2 and isolation valve 3. Each pressure reducing valve and isolation valve unit governs the air pressure provided to its respective air amplifier unit, and therefore affects the strength of the air stream output by the air amplifier unit. In addition, the pressure reducing valves and isolation valves are used to balance the amount of airflow through the branch segments 4 along the main distribution ring 4, and then to the air amplifier units for even air distribution. If required, a silencer can be added at the outlet of the pressure reducing valve to attenuate the noise.

[0034] Fig. 1(b) provides a detailed overview an air amplifier ventilation system 200 according to another embodiment that is adapted for a train platform application for an 8-car train platform having 160 individual air amplifier units. Because the system 200 services more air amplifier units, there are two compressed air plants 8 located at the two ends of a platform. For system 200, the air compressor for the 8-car system with 160 air amplifier units is rated to provide around 36 m^3/min (+/- 5 m^3/min) of free air delivery at around 750kPa (+/- 250kPa), i.e. 500 to 1,000kPa discharge pressure.

[0035] Both compressed air plants 8 of system 200 are coupled to the ring pipework 5 via a respective main isolation valve 7 in order to isolate it from the system for inspection and maintenance. Because the number of air amplifier units in system 200 is larger than that of system 100, the diameter of the pipework for the distribution network is larger in order to allow for sufficient delivery of air to support the simultaneous operation of all 160 air amplifier units in the system. In system 200, the uPVC pipe of the air plant connection segment 6 has a diameter of 200 mm and the uPVC pipe of the main loop segments 5 has a diameter of 100 mm. The uPVC pipe of the air amplifier unit branch segments has a diameter of 50 mm. The relative sizing of the segments of the distribution network may be adjusted as required in order to permit sufficient air delivery to the air amplifier units and to provide the necessary air speed for those units in order to provide the desired cooling effect.

[0036] As with other embodiments, the isolation valves 3 are provided upstream of the pressure reducing valves and the air amplifier units to facilitate air balancing and to isolate the pressure reducing valves or air amplifier units from the main distribution ring when required for inspection and maintenance.

[0037] It will be readily appreciated by those of ordinary skill in the art that other platform systems are possible and the invention is not limited to 3-car or 8-car train platform systems. For example, more compressed air plants may be added, or compressed air plants with greater air capacity may be used, along with additional air amplifier units and respective components and larger pipe distribution networks in order to support systems for larger train car platforms or larger cooling service areas. Similarly, compressed air plants with lesser air capacity may be used in connection with fewer air amplifier units and respective components and smaller pipe distribution networks for systems with smaller train car platforms or air cooling service areas.

[0038] System Control and Automation

[0039] The air amplifier ventilation system is automated based on ambient factors, such as air temperature at the areas served; input signal information, such as train station state; and other factors and variables relating to conditions outside of the system, as further described below. Fig. 2 is a schematic showing the control and operation components 300 of the air amplifier system, including sensors, input signals, output control signals, and controlled devices, according to an embodiment of the invention.

[0040] The control system includes one or more temperature sensors 9 at the platform (as shown in the figures relating to the overall arrangement of systems 100 and 200) in order to provide a generalized indication of the temperature conditions of the platform to the system controller via ambient temperature signals 31. When the ambient temperature at the served areas is detected to be above an upper threshold, such as 30 degrees Celsius or another adjustable upper set point, the air amplifier ventilation system is configured to turn on automatically. In this state, controller generates control signals 33 to open the main isolation valves 7 allowing the compressed air to be distributed to the air amplifier units. When the ambient temperature at the served areas is detected to be below a lower threshold, such as 26 degrees Celsius or another adjustable lower set point, the air amplifier ventilation system is configured to turn off automatically. In this "off" state controller 30 generates control signals 33 to close main isolation valves 7, thereby cutting off the compressed air from the air amplifier units.

[0041] In certain embodiments, the controller for the air amplifier ventilation system is configured to interface with a train signaling system 32 to obtain train or train station state information 35 to achieve various operational goals. The operation or activation of the air amplifier units may be synchronized with the train operation in order to save electrical energy. For example, the operation of the system may depend on the state of trains entering or leaving a train station, such that the system will cease operation when a train stalls at the platform and resume operation when a train leaves as to provide thermal comfort to the queuing passengers. When a train arrives or nears arrival, the train signaling system 32 indicates via the train station state information 35 a train arrival signal that de-activates the system. When the train departs, the train signaling system 35 indicates via the train state information 35 a train departure signal that re-activates the system.

[0042] The system may also be activated or deactivated manually by the station operator or another responsible party whenever required. In this regard, an input/output (I/O) interface 34 is provided that allows a user to interact with the system controller 30 via input and output signals over a bi-directional communication link. The I/O interface may take the form of a computer terminal or control panel, and may include displays that provide to the user information provided by the temperature sensors 9, ambient temperature signals 31, train signaling system 32, train and train station state information 35, and other sensors and signals. The I/O interface may further include input devices, such as touch screens, keyboards, optical mice, physical control inputs, and the like in order to receive from the user various control signals relating to the overall operation of the system and to the electric isolation valves, as well as other outputs and output signals.

[0043] Air Amplifier Units

[0044] As described above, the system provides spot cooling at various locations through a plurality of air amplifier units. Fig. 3 provides an illustration of an air amplifier unit according to an embodiment, along with the associated components of the air amplifier unit including the isolation valve 3, pressure reducing valve 2, and the portion of compressed air pipe segment 5 that delivers highly compressed air to the air amplifier unit for operation of the device.

[0045] The principles of the air amplifier unit are also illustrated in Fig. 3. In general, the air amplifier unit 1 amplifies the total air flow as the air is emitted downward from the air amplifier unit at high velocity, through the use of the induction principle. Pressurized air is delivered to the air amplifier unit from the highly pressurized air in compressed air pipe segment 5 through the isolation valve 3 and the pressure reducing valve 2. This pressurized air is emitted from the unit through narrow slots in the form of high velocity air. As described in greater detail below, the size and spacing of these slots may vary around the perimeter of the air amplifier unit to provide for an even distribution of pressurized air or for a relatively uniform speed of high velocity air emitted from the slots. This high velocity air induces the movement of other surrounding air to create a strengthened overall air stream in the direction of the high velocity air. In the systems shown, the high velocity air and thus the strengthened air stream are directed towards the passenger area. In this way, air stream flows down from the air amplifier units to passenger level, thereby creating localized air circulation to enhance passenger comfort. Although the air amplifier unit shown in Fig. 3 is in the form of a ring with high velocity air slots, other air amplifier unit designs and geographies can be used in connection with the overall system. As further discussed below, just before the distribution ring, a flow separator, is created by the flow channels 20a, 20b and 22a as indicated in Fig. 4(j) to allow the incoming air flow distributed evenly over the ring. In the narrower channel 22a, the air is still distributed through the Coanda effect.

[0046] In one embodiment, the air amplifier units are designed with a profile that promotes smooth airflow with low air flow resistance and noise generated, as shown in Figs. 4(a)-4(j). As shown, the air amplifier unit has an air inlet 12 that couples to and receives air from the pressure reducing valve 2. The air amplifier unit 1 further has an air outlet portion 16 that outputs the air at a high velocity. As shown the top-view of the air amplifier unit 1 provided in Fig. 4(a), the air outlet portion 16 is in the form of a ring, and is connected to the air inlet 12 via connecting segment 14. Although the air amplifier unit shown in Figs. 4(a)-4(j) has an outlet portion with a ring shape, other geometries may be used, such as a square or rectangular outlet portion.

[0047] As shown in the side-view provided in Fig. 4(e), the air amplifier unit 1 has an upper portion 18 and a lower portion 20. The upper portion 18 allows for distribution of the air from an air inlet channel 30 in air inlet 12 to the air outlet portion 16. Between the air inlet 12 and the ring, the upper portion 18 within connecting segment 14 includes air delivery channels 20a and 20b separated by a flow separator 36 that evenly distribute the air to a channel 22 within the ring portion of the outlet portion, as shown in the cross-sectional view of the upper portion provided in Fig. 4(j). The channel 22 has a narrower portion 22a at the segment located closest to the inlet 12. Air is distributed to the narrower channel 22a through the Coanda effect. The air in channel 22 is ejected downward at high velocity from the lower portion 20 of the air outlet portion 16 of air amplifier unit via narrow slots 24. These narrow slots are formed between two elongated air delivery guides, an inner air delivery guide 26 and an outer air delivery guide 28, which are arranged concentrically around the inner perimeter of the ring of the outlet portion 16. As shown in cross-sectional views provided in Figs. 4(b) and 4(d), the outer air delivery guide 28 is longer than the inner air delivery guide 26, and serves to direct the high velocity air within the general geography defined by the shape of the ring, and to thereby increase the induction of air within the ring to create the strengthened downward air stream and provide the air amplifier effect. As described below, in certain areas along the perimeter of the ring of the outlet portion 16, no gap is provided between the inner and outer delivery guides, as illustrated in the cross-sectional view in Fig. 4(c), in order to create breaks 34 between the narrow slots 24 and thus create regions through which air does not escape.

[0048] The design and arrangement of air discharge slots 24 between the air delivery guides varies around the perimeter of the ring in order to ensure a more even velocity of air output. The slots furthest from the air inlet 12 are generally longer and include fewer breaks between slots than the slots located nearer the air inlet 12, which are generally shorter and include more breaks between slots. As shown in the cross-sectional view of the air amplifier unit provided in Fig. 4(f), the design of the slots 24 differs between a near segment 32a (corresponding to radial segment "R"), the side segments 32b (corresponding to radial segments "S" in the figure), and the far segment 32c (corresponding to radial segment "T" in the figure). As shown in the detail of a portion of radial segment "R" provided in Fig. 4(g), the length of slots is 10 mm with 1 mm breaks in between in the near segment 32a. As shown in the detail of a portion of radial segment "S" provided in Fig. 4(h), the length of slots in the side segments 32b is double that of segment 32a, with a length of 20 mm with 1 mm breaks in between. And as shown in the detail of a portion of radial segment "T" provided in Fig. 4(i), the length of slots in the side segments 32c is triple that of segment 32c, with a length of 30 mm with 1 mm breaks in between. Although the air amplifier unit shown in Figs. 4(a)-4(j) has slots of three different lengths, other arrangements and designs can be provided in order to ensure a more even flow of air around the perimeter of the outlet portion.

[0049] Multiple embodiments of the inventive system have been described herein. Of these, variations of the disclosed embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing disclosure. The inventors expect skilled artisans to employ such variations as appropriate (*e.g.*, altering or combining features or embodiments), and the inventors intend for the invention to be practiced otherwise than as specifically described herein. In addition, in many of the embodiments disclosed herein, it will be readily appreciated that the methods and processes described for selecting the optimal contribution of air distribution to achieve a certain criteria can be used to determine the number of compressors and air amplifier units to include in the system, including based on factors relating to the performance and efficiencies of the compressors, and while controlling for other factors such as cost, size, and other characteristics of compressors.

[0050] Accordingly, this invention includes all modifications and equivalents of the subject matter recited in the claims appended hereto as permitted by applicable law. Moreover, any combination of the above described elements in all possible variations thereof is encompassed by the invention unless otherwise indicated herein or otherwise clearly contradicted by context.

[0051] For the avoidance of doubt, the use of the terms "a" and "an" and "the" and similar references in the context of this disclosure (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (*e.g.*, such as, preferred, preferably) provided herein, is intended merely to further illustrate the content of the disclosure and does not pose a limitation on the scope of the claims. No language in the specification should be construed as indicating any non-claimed element as essential to the practice of the present disclosure.

CLAIMS

We claim:

1. An air amplifier ventilation system for providing localized air delivery at one or more spot cooling locations, the system comprising:

one or more compressed air plants for generating compressed air;

a pipe distribution network that selectively receives compressed air from the one or more compressed air plants through one or more associated main isolation valves;

one or more air amplifier units that receive highly pressurized air from the pipe distribution network through pressure reducing valves, wherein each air amplifier unit emits air through one or more slots in a manner that induces the flow of additional air in order to create an amplified air stream; and

a controller that generates control signals to operate the main isolation valves, wherein by opening the main isolation valves compressed air is delivered through the pipe distribution network to activate the one or more air amplifier units, and wherein by closing the main isolation valves the air amplifier units are deactivated.

2. The air amplifier ventilation system of claim 1, wherein the compressed air plants comprise one or more air compressor; and one or more air receiver for storing highly pressurized air from the air compressor.

3. The air amplifier ventilation system of claim 2, wherein the compressed air plants comprise one or more air dryer.

4. The air amplifier ventilation system of claim 3, wherein the air dryer is refrigeration type dryer.

5. The air amplifier ventilation system of any one of claims 2 to 4, wherein the controller generates control signals to operate the air compressor, the air receiver and the air dryer.

6. The air amplifier ventilation system of any one of claims 1 to 5, wherein the air amplifier unit has an air inlet that couples to and receives air from the pressure reducing valves; a connecting segment connected to the air inlet; and an air outlet portion where the air amplifier unit emits air.

7. The air amplifier ventilation system of claim 6, wherein the air outlet portion has a ring shape.

8. The air amplifier ventilation system of claim 6 or 7, wherein the connecting segment includes two air delivery channels separated by a flow separator that evenly distributes air in the air outlet portion.

9. The air amplifier ventilation system of any one of claims 1 to 8, wherein the main isolation valve is electrically actuated.

10. The air amplifier ventilation system of claim 8, wherein the air amplifier unit comprises an upper portion and a lower portion; the air delivery channels are located in the upper portion; and the air amplifier unit emits air through the lower portion via the slots; and wherein the slots furthest from the air inlet are longer and include fewer breaks between the slots than the slots located nearer the air inlet.

11. The air amplifier ventilation system of any one of claims 1 to 10, wherein outlet of the pressure reducing valve is connected to a silencer which attenuates noise.

12. The air amplifier ventilation system of any one of claims 1 to 11, wherein the one or more compressed air plants provide free air delivery in the range between 500kPa to 1,000kPa.

13. The air amplifier ventilation system of any one of claims 1 to 7, wherein the system further comprising one or more temperature sensor that are installed at the one or more spot cooling locations for detecting the temperature conditions at the one or more spot cooling locations; wherein the temperature sensor sends signals to the controller.

14. The air amplifier ventilation system of claim 13, wherein the air amplifier ventilation system is synchronized with a train signaling system through the controller; wherein the train signaling system sends train arrival and departure signals to the controller that deactivates and activates the air amplifier ventilation system respectively.

15. A method for enhancing the thermal comfort of personnel at one or more spot cooling locations, comprising installing the air amplifier ventilation system of any one of claims 1 to 14 at the one or more spot cooling locations.

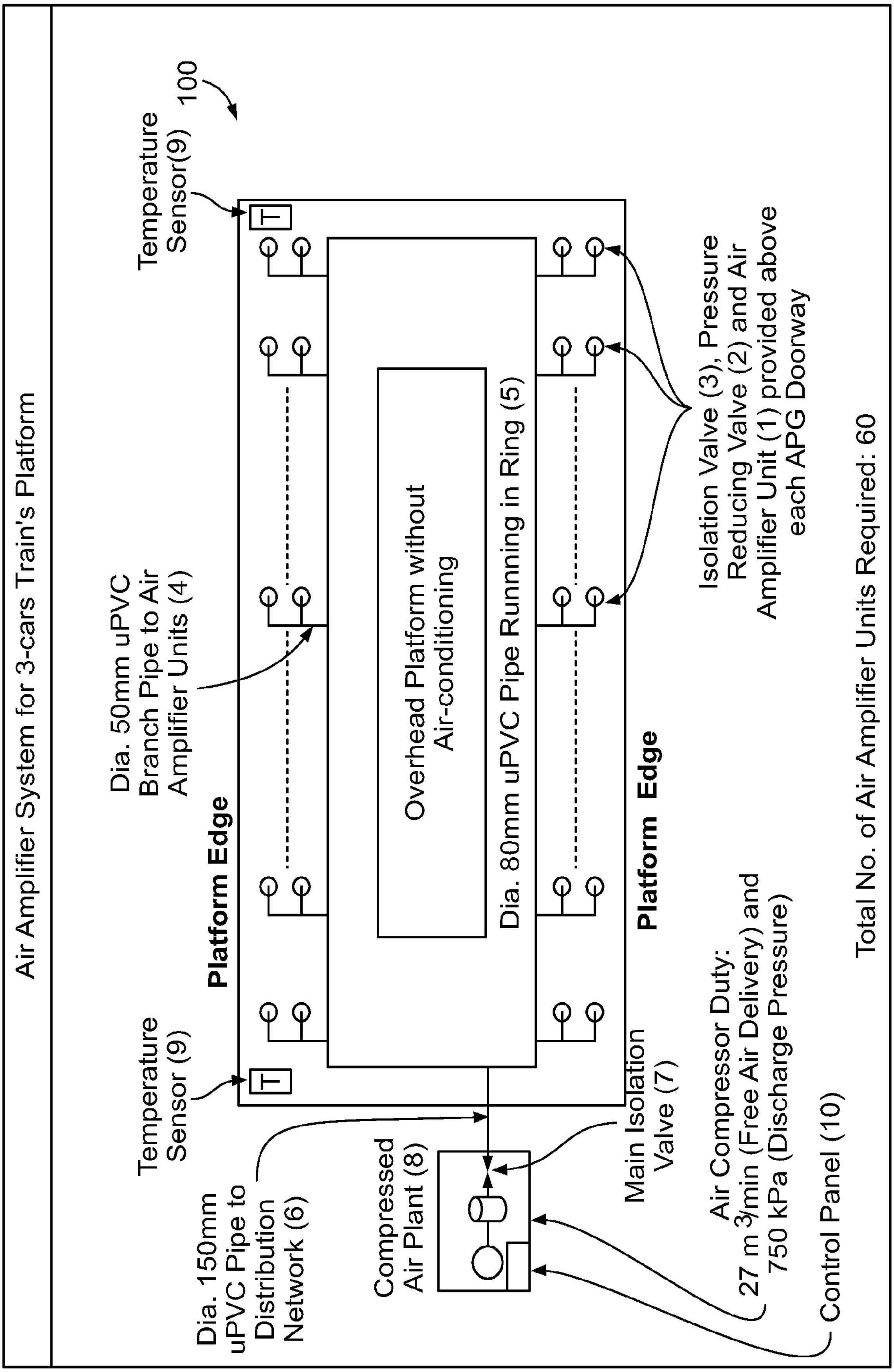

Air Amplifier System for 3-cars Train's Platform
100
Temperature Sensor(9)
Temperature Sensor (9)
Dia. 50mm uPVC Branch Pipe to Air Amplifier Units (4)
Platform Edge
Overhead Platform without Air-conditioning
Dia. 80mm uPVC Pipe Running in Ring (5)
Platform Edge
Isolation Valve (3), Pressure Reducing Valve (2) and Air Amplifier Unit (1) provided above each APG Doorway
Total No. of Air Amplifier Units Required: 60
Dia. 150mm uPVC Pipe to Distribution Network (6)
Compressed Air Plant (8)
Main Isolation Valve (7)
Air Compressor Duty: 27 m3/min (Free Air Delivery) and 750 kPa (Discharge Pressure)
Control Panel (10)
T
T

FIG. 1A

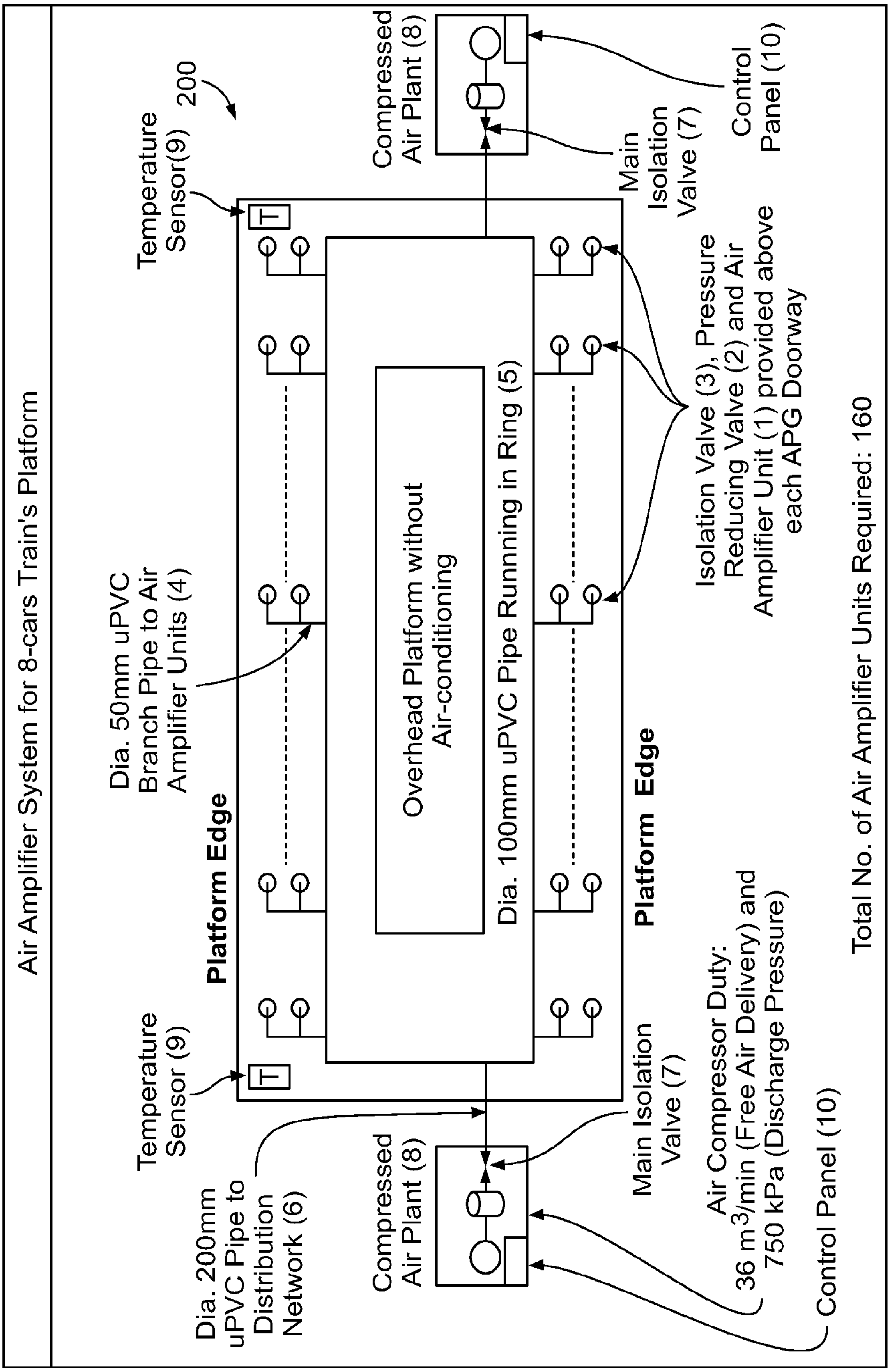

Air Amplifier System for 8-cars Train's Platform
200
Temperature Sensor(9)
Temperature Sensor (9)
Compressed Air Plant (8)
Main Isolation Valve (7)
Control Panel (10)
Platform Edge
Platform Edge
Dia. 50mm uPVC Branch Pipe to Air Amplifier Units (4)
Overhead Platform without Air-conditioning
Dia. 100mm uPVC Pipe Running in Ring (5)
Isolation Valve (3), Pressure Reducing Valve (2) and Air Amplifier Unit (1) provided above each APG Doorway
Dia. 200mm uPVC Pipe to Distribution Network (6)
Compressed Air Plant (8)
Main Isolation Valve (7)
Air Compressor Duty: 36 m3/min (Free Air Delivery) and 750 kPa (Discharge Pressure)
Control Panel (10)
Total No. of Air Amplifier Units Required: 160

FIG. 1B

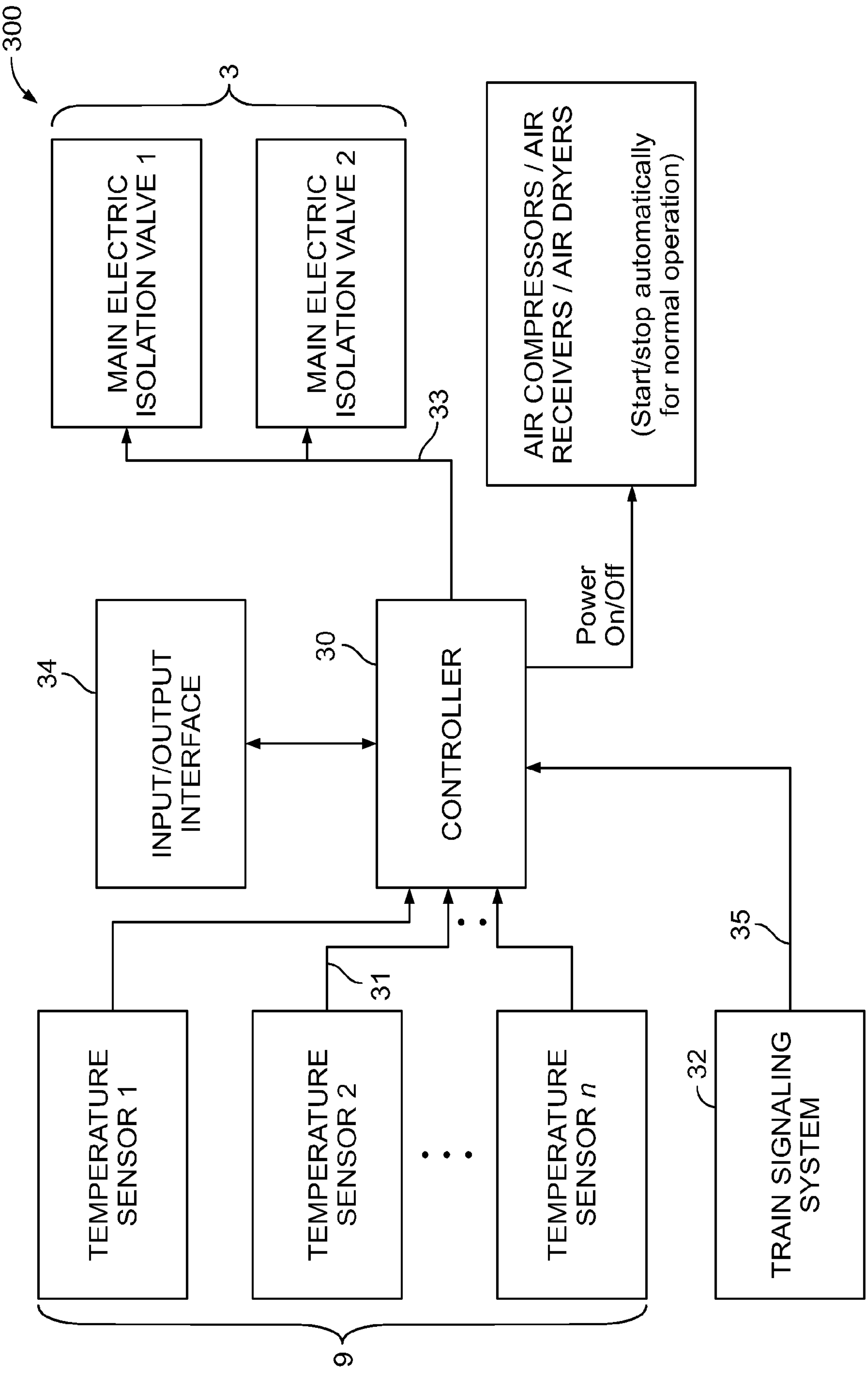

300
3
MAIN ELECTRIC ISOLATION VALVE 1
MAIN ELECTRIC ISOLATION VALVE 2
33
AIR COMPRESSORS / AIR RECEIVERS / AIR DRYERS
(Start/stop automatically for normal operation)
34
INPUT/OUTPUT INTERFACE
30
CONTROLLER
Power On/Off
31
35
TEMPERATURE SENSOR 1
TEMPERATURE SENSOR 2
TEMPERATURE SENSOR n
32
TRAIN SIGNALING SYSTEM
9

FIG. 2

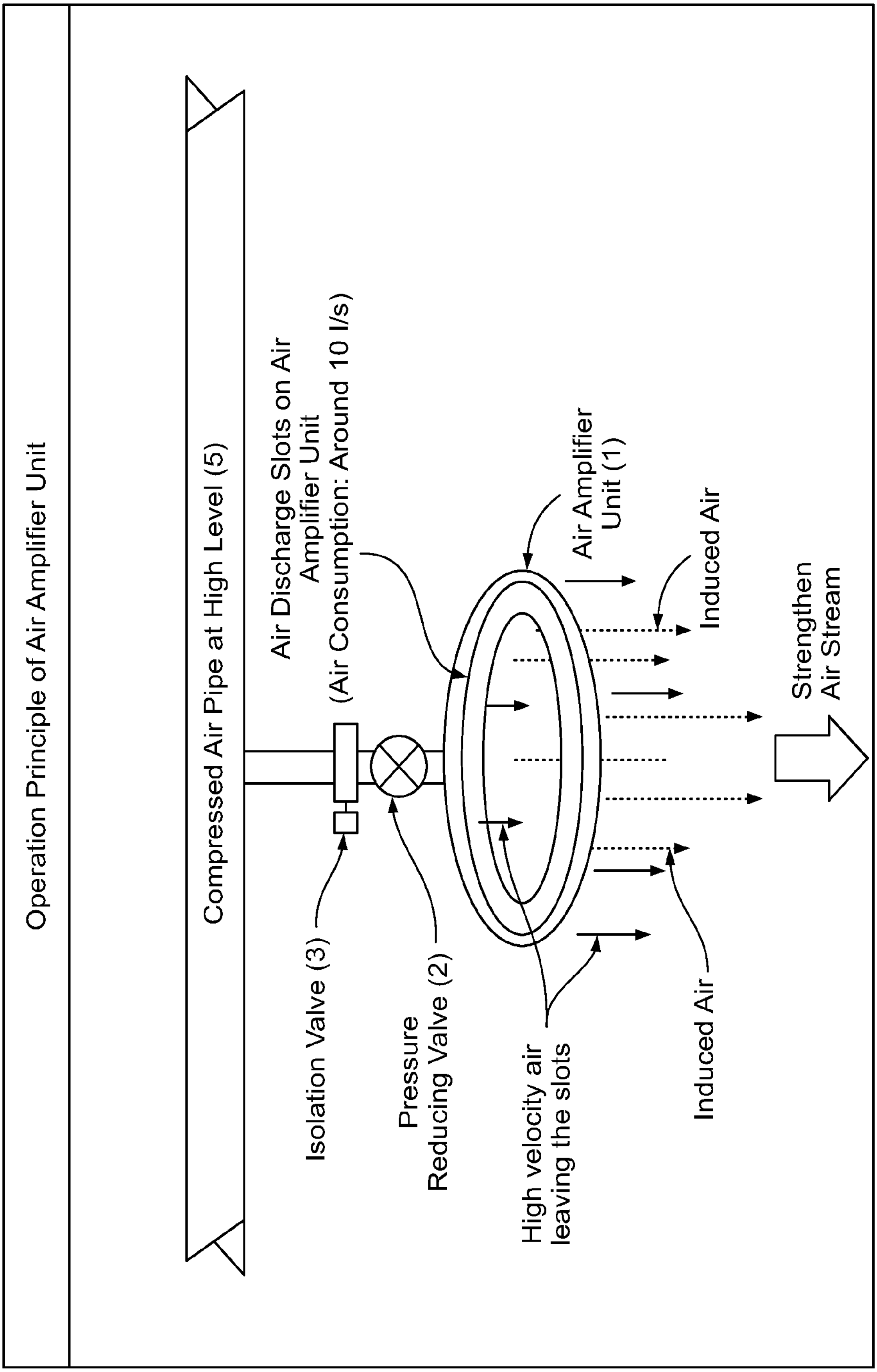
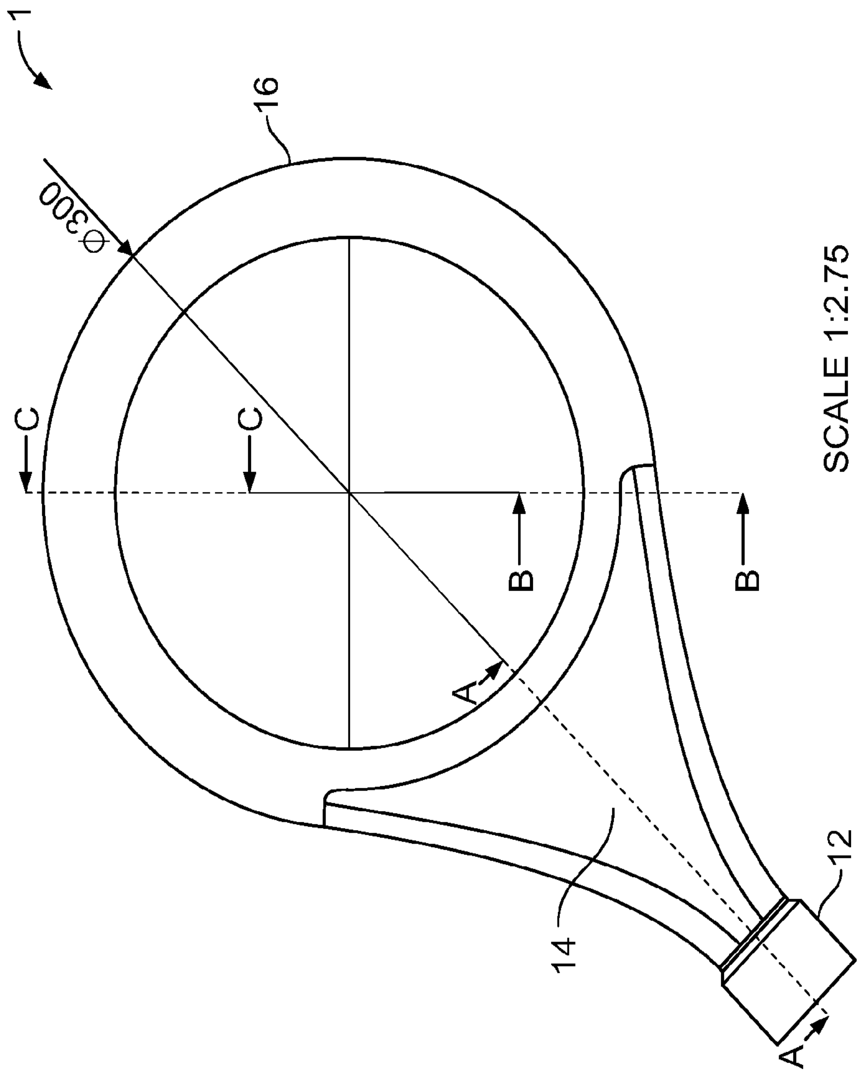
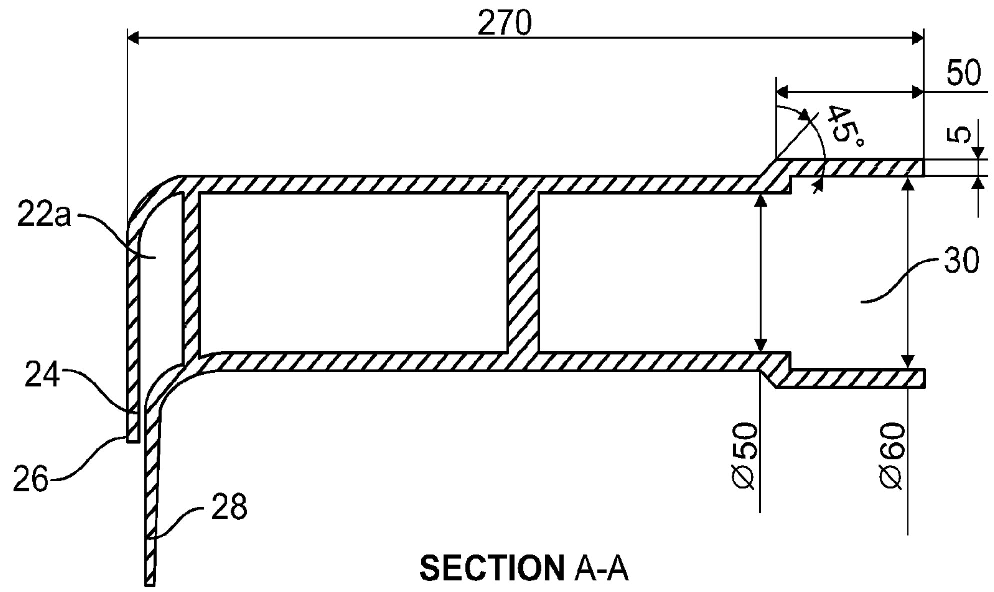

Operation Principle of Air Amplifier Unit
Compressed Air Pipe at High Level (5)
Air Discharge Slots on Air Amplifier Unit (Air Consumption: Around 10 l/s)
Air Amplifier Unit (1)
Induced Air
Strengthen Air Stream
Isolation Valve (3)
Pressure Reducing Valve (2)
High velocity air leaving the slots
Induced Air

FIG. 3



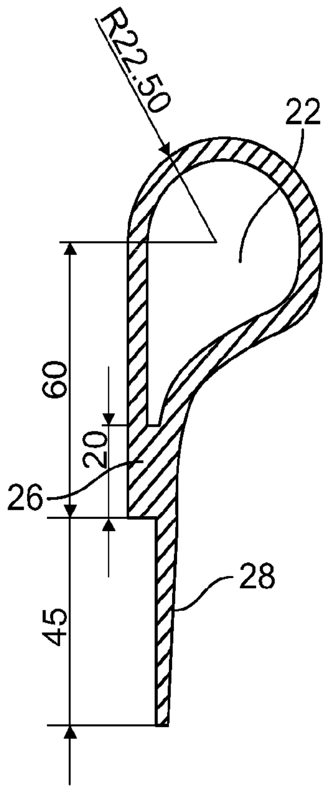
SCALE 1:2.75

FIG. 4A



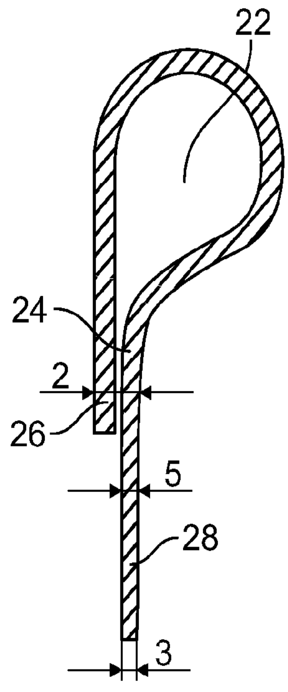
SECTION A-A
SCALE 1 : 2.5

FIG. 4B



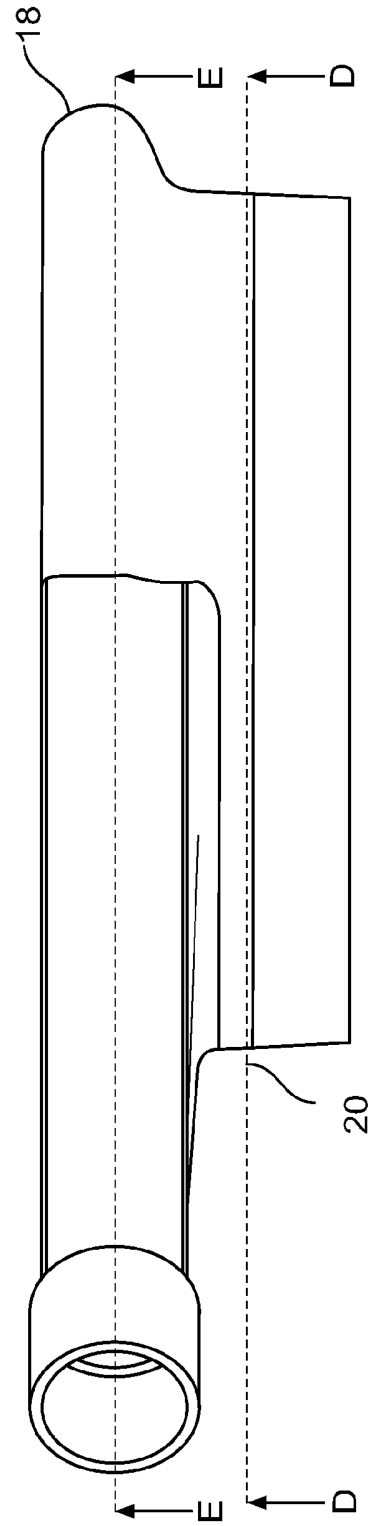
SECTION B-B
SCALE 1 : 2.5

FIG. 4C



SECTION C-C
SCALE 1 : 2.5

FIG. 4D



SCALE 1 : 2.75

FIG. 4E

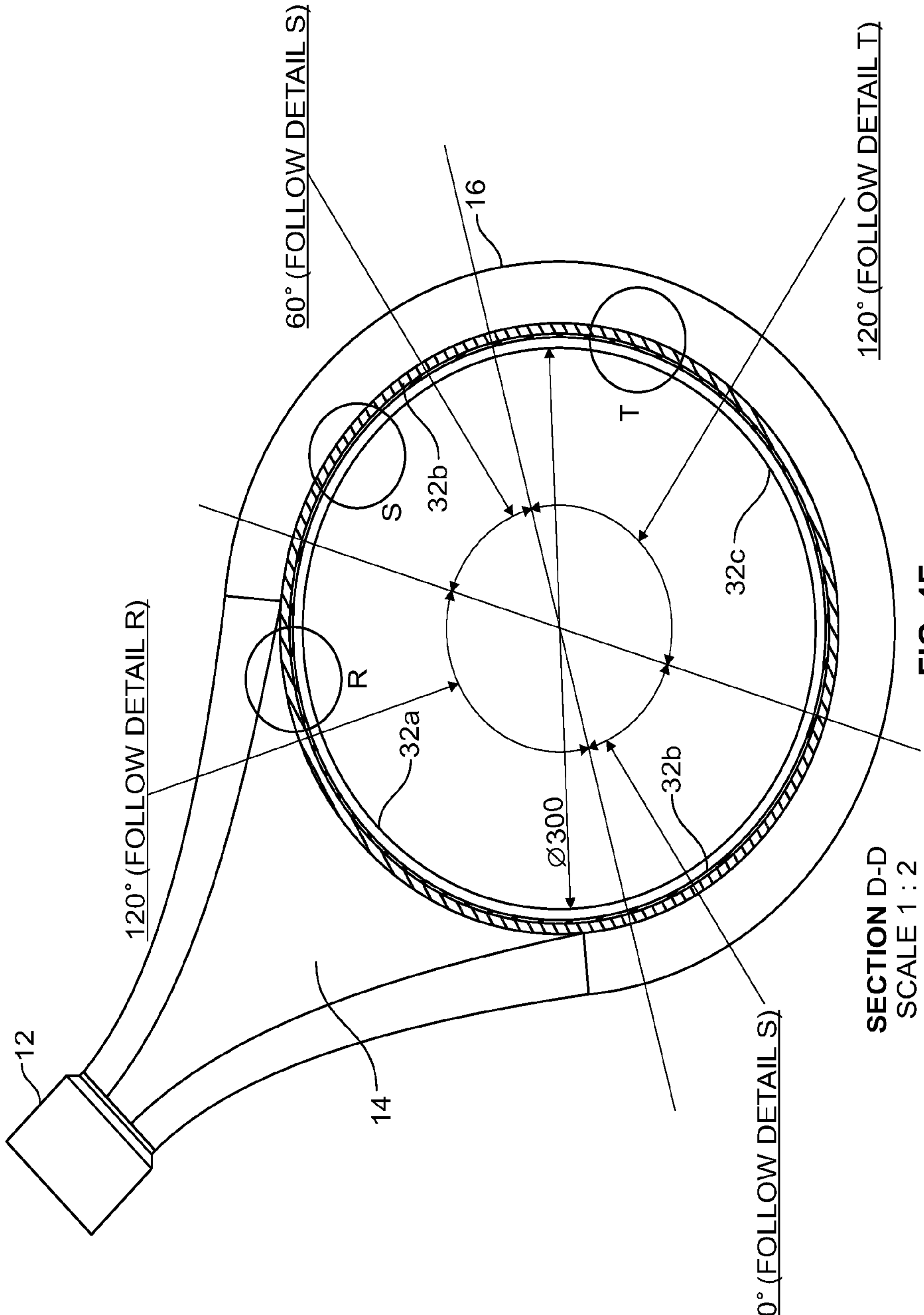
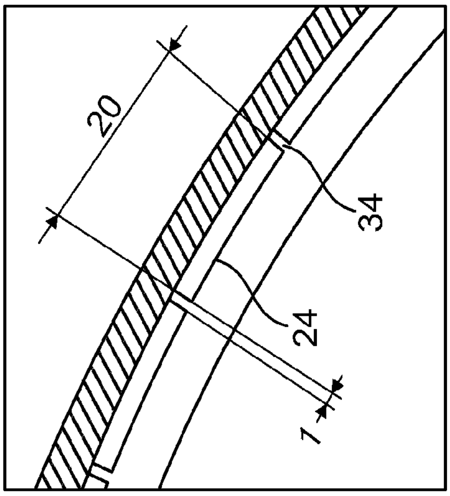
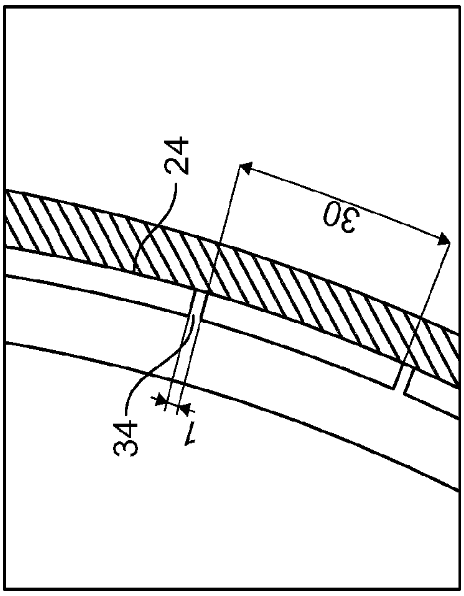

60° (FOLLOW DETAIL S)
120° (FOLLOW DETAIL T)
120° (FOLLOW DETAIL R)
60° (FOLLOW DETAIL S)
16
T
S
R
32b
32b
32c
32a
Ø300
12
14
SECTION D-D
SCALE 1 : 2

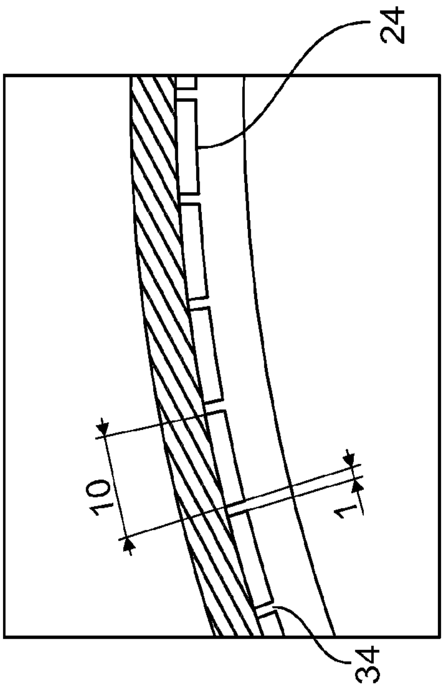
FIG. 4F



DETAIL S
SCALE 1 : 1
FIG. 4H



DETAIL T
SCALE 1 : 1
FIG. 4I



DETAIL R
SCALE 1 : 1
FIG. 4G

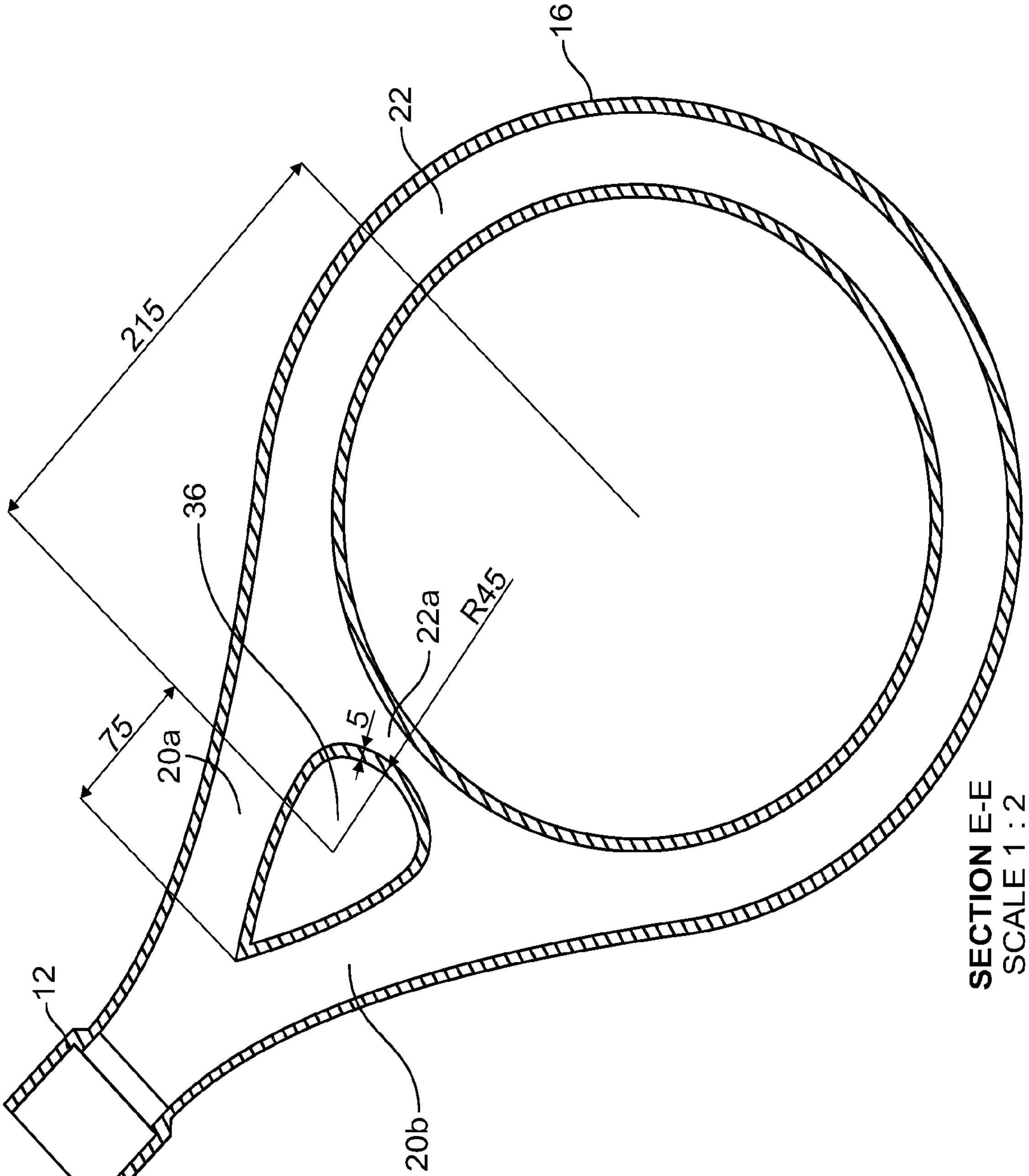


FIG. 4J

SECTION E-E
SCALE 1 : 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2021/087217

A. CLASSIFICATION OF SUBJECT MATTER

F24F 7/04(2006.01)i; F24F 13/02(2006.01)i; F04F 5/16(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F24F; F04F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, CNPAT, CNKI: air, amplif+, compress+, ventilat+, coanda, valve, slot, cool, pipe

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2545246 A (INTELLIGENT ENERGY LTD.) 14 June 2017 (2017-06-14) description, page 5 line 29 to page 13 line 34 and figures 1-4	1-14
Y	GB 2545246 A (INTELLIGENT ENERGY LTD.) 14 June 2017 (2017-06-14) description, page 5 line 29 to page 13 line 34 and figures 1-4	15
Y	CN 109606076 A (WUHAN SCIENCE & TECHNOLOGY UNIVERSITY) 12 April 2019 (2019-04-12) description, paragraphs 0052-0086 and figures 1-2	15
X	CN 105275892 A (XIAN MODERN CHEMISTRY RESEARCH INSTITUTE) 27 January 2016 (2016-01-27) description, paragraphs 0021-0040 and figures 1-6	1-14
X	CN 207377668 U (GENERAL ELECTRIC CO.) 18 May 2018 (2018-05-18) description, paragraphs 0041-0062 and figures 1-17	1-14
A	CN 201925247 U (SHENZHEN HUAQIANG INTELLIGENT TECHNOLOGY CO., LTD.) 10 August 2011 (2011-08-10) the whole document	1-15

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

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- "E" earlier application or patent but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
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- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 June 2021	**14 July 2021**

Name and mailing address of the ISA/CN

National Intellectual Property Administration, PRC
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100088
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Facsimile No. **(86-10)62019451**

Authorized officer

LI,Cong

Telephone No. **86-10-53961064**

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 201771874 U (WUXI YINGWEI HUAYAO TECHNOLOGY CO., LTD.) 23 March 2011 (2011-03-23) the whole document	1-15
A	CN 103225630 A (XU, Jingxian) 31 July 2013 (2013-07-31) the whole document	1-15
A	KR 20090042414 A (KIM, Yeonghun) 30 April 2009 (2009-04-30) the whole document	1-15

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2021/087217

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
GB	2545246	A	14 June 2017	GB	201521791	D0	27 January 2016
CN	109606076	A	12 April 2019		None		
CN	105275892	A	27 January 2016	CN	105275892	B	08 August 2017
CN	207377668	U	18 May 2018	EP	3241999	A1	08 November 2017
				US	2017306845	A1	26 October 2017
CN	201925247	U	10 August 2011		None		
CN	201771874	U	23 March 2011		None		
CN	103225630	A	31 July 2013	CN	106368989	A	01 February 2017
				CN	106321529	B	30 October 2020
				CN	106321529	A	11 January 2017
				CN	106368989	B	22 March 2019
				CN	103225630	B	22 February 2017
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