Description

Title of Invention

AIR COMPRESSION DEVICE

Technical Field

[0001] The present invention relates to an air compression device which generates compressed air.

Background Art

[0002] An air compression device which generates compressed air is used for various uses. The compressed air generated by the air compression device mounted to a vehicle (for example, a railroad vehicle) may be supplied to a brake device which applies braking force to the vehicle.

[0003] Patent Literature 1 proposes an air compression device comprising a plurality of compressors. In a case the air compression device comprises the plurality of compressors, a large amount of compressed air can be generated in a short period of time. In addition, the compressed air can be generated continuously by other compressors even if after trouble occurs in a part of the plurality of compressors.

[0004] In a case the air compression device includes a plurality of compressors, it is necessary to form a pipe for guiding an air to each of the plurality of compressors. Accordingly, when a designer intends to assemble the plurality of compressors in the air compression device, the designer needs to design the air compression device with large size. This configuration might lead to difficulty of mounting of the air compression device to other devices (for example, a vehicle).

Citation List

Patent Literature

[0005] Patent Literature 1: JP 3150077 U

Summary of Invention

[0006] An object of the present invention is to provide a small-sized air compression device comprising a plurality of compressors.

[0007] An air compression device according to one aspect of the present invention comprises a first compressor including a first port wall in which a first suction port is formed, a second compressor including a second port wall in which a second suction port is formed and a suction pipe which guides an air to the first suction port and the second suction port. The first port wall and the second port wall are arranged to face each other. The suction pipe is arranged between the first port wall and the second port wall.

[0008] The technique described above can make the air compression device comprising the plurality of compressors small in size.

[0009] The objects, features and advantageous effects of the present invention will become more apparent from the following detailed description and the accompanying drawings.

Brief Description of Drawings

[0010] FIG. 1 is a schematic view of an air compression device according to a first embodiment.

FIG. 2 is a schematic view of an air compression device according to a second embodiment.

FIG. 3A is a schematic perspective view of an air compression device according to a third embodiment.

FIG. 3B is an another perspective view of the air compression device shown in FIG. 3A.

FIG. 4 is a schematic plane view illustrating an inner structure of the air compression device shown in FIG. 3A.

FIG. 5 is a schematic cross-sectional view illustrating a structure of a base end portion of a suction pipe of the air compression device shown in FIG. 3A.

FIG. 6 is a schematic enlarged cross-sectional view of the suction pipe shown in FIG. 5.

FIG. 7 is a schematic enlarged perspective view of a delivery pipe of the air compression device shown in FIG. 3A.

FIG. 8 is a schematic cross-sectional view of a duct portion of the air compression device shown in FIG. 3A.

FIG. 9 is a schematic perspective view of the air compression device shown in FIG. 3A.

FIG. 10A is a schematic perspective view of a cooling air flow adjusting box of the air compression device shown in FIG. 3A (a fourth embodiment).

FIG. 10B is a schematic back view of the cooling air flow adjusting box shown in FIG. 10A.

FIG. 11 is a partially assembled view of the air compression device shown in FIG. 3A (a fifth embodiment).

FIG. 12 is a schematic perspective view of a first transmission portion of the air compression device shown in FIG. 11.

FIG. 13 is a partially assembled view of the air compression device shown in FIG. 3A (a sixth embodiment).

FIG. 14 is a schematic perspective view of a lower support plate of the air compression device shown in FIG. 13.

Description of Embodiments

[0011] First Embodiment

If compressed air is generated by a plurality of compressors, a large space is required to arrange a pipe for supplying air to these compressors. The present inventors created a design technique to house the pipe in a small space. In a first embodiment, a technique capable of supplying air to a plurality of compressors in a small space will be described.

[0012] FIG. 1 is a schematic view of an air compression device 100 according to the first embodiment. The air compression device 100 will be described with reference to FIG. 1.

[0013] The air compression device 100 comprises a first compressor 210, a second compressor 220 and a suction pipe 300. The suction pipe 300 is connected to the first compressor 210 and the second compressor 220. When the first compressor 210 and/or the second compressor 220 is activated, a negative pressure environment is generated in the suction pipe 300 by the first compressor 210 and/or the second compressor 220. As a result, each of the first compressor 210 and the second compressor 220 can suck air via the suction pipe 300. Each of the first compressor 210 and the second compressor 220 generates compressed air by compressing the sucked air. The compressed air is supplied to other device which uses the compressed air from each of the first compressor 210 and the second compressor 220. The supply of the compressed air from each of the first compressor 210 and the second compressor 220 to other device may depend on various known piping techniques. The principle of the present embodiment is not limited to a specific technique for supplying the compressed air to other device.

[0014] For example, after that, the compressed air may be supplied to a brake device (not shown) for generating braking force to a railroad vehicle. Alternatively, the compressed air may be supplied to other device (for example, a pneumatic apparatus (not shown) used for opening and closing a door of a vehicle) which uses the compressed air. The principle of the present embodiment is not limited to a specific use of the compressed air.

[0015] The first compressor 210 includes a first housing 211 and a compression mechanism 212. The compression mechanism 212 is housed in the first housing 211. The compression mechanism 212 may have a structure of a general scroll compressor.

Alternatively, the compression mechanism 212 may have a structure of a general rotary compressor. Further alternatively, the compression mechanism 212 may have a structure of a general swing compressor. Further alternatively, the compression mechanism 212 may have a structure of a general reciprocating type compressor. The principle of the present embodiment is not limited to a specific structure of the compression mechanism 212.

[0016] The first housing 211 includes a first port wall 213 facing the second compressor 220. A first suction port 214 is formed in the first port wall 213. The suction pipe 300 is connected to the first suction port 214. Accordingly, the first compressor 210 can suck air from the first suction port 214 and generate compressed air.

[0017] The second compressor 220 includes a second housing 221 and a compression mechanism 222. The compression mechanism 222 is housed in the second housing 221. The compression mechanism 222 may have a structure of a general scroll compressor. Alternatively, the compression mechanism 222 may have a structure of a general rotary compressor. Further alternatively, the compression mechanism 222 may have a structure of a general swing compressor. Further alternatively, the compression mechanism 222 may have a structure of a general reciprocating type compressor. The principle of the present embodiment is not limited to a specific structure of the compression mechanism 222.

[0018] The second housing 221 includes a second port wall 223 facing the first port wall 213 of the first compressor 210. A second suction port 224 is formed in the second port wall 223. The suction pipe 300 is connected to the second suction port 224. Accordingly, the second compressor 220 can suck air from the second suction port 224 and generate compressed air.

[0019] The suction pipe 300 includes a main pipe 310, a first branch pipe 311 and a second branch pipe 312. Each of the first branch pipe 311 and the second branch pipe 312 is branched from the main pipe 310. The first branch pipe 311 is connected to the first suction port 214 of the first compressor 210. The second branch pipe 312 is connected to the second suction port 224 of the second compressor 220.

[0020] When the first compressor 210 is activated, the negative pressure environment is generated in the suction pipe 300 as described above. As a result, air flows from the main pipe 310 toward the first branch pipe 311. The first branch pipe 311 guides the air to the first suction port 214. When the second compressor 220 is activated, the negative pressure environment is generated in the suction pipe 300 as described above. As a result, air flows from the main pipe 310 toward the second branch pipe 312. The second branch pipe 312 guides the air to the second suction port 224.

[0021] Since the suction pipe 300 is extended between the first port wall 213 and the second port wall 223, the first compressor 210 and the second compressor 220 can share a piping space for sucking air. Accordingly, the designer can design a small space in the air compression device 100 as a piping space for sucking air.

[0022] In the present embodiment, the suction pipe 300 is formed as a branch pipe. Alternatively, the suction pipe may be formed by a pipe which specially guides air supplied to the first compressor 210 and a pipe which specially guides air supplied to the second compressor 220. In this case, these pipes are arranged between the first port wall 213 and the second port wall 223. The principle of the present embodiment is not limited to a specific structure of the suction pipe.

[0023] A base end portion (not shown) of the main pipe 310 of the suction pipe 300 may be communicated with an outer space of a housing (not shown) which forms a housing space in which the first compressor 210 and the second compressor 220 are housed. In this case, air outside the housing can flow directly into the main pipe 310. Alternatively, the base end portion of the main pipe 310 may be housed in the housing. In this case, air in the housing flows into the main pipe 310. The principle of the present embodiment is not limited to a specific arrangement position of the base end portion of the main pipe 310.

[0024] The suction pipe 300 may include therein a filter device which removes dust from the sucked air. In this case, purified air is supplied to the first compressor 210 and the second compressor 220. Alternatively, other appropriate purifying technique may be used for purifying the air supplied to the first compressor 210 and the second compressor 220. The principle of the present embodiment is not limited to a specific purifying technique.

[0025] Second Embodiment

A space in which a delivery pipe guiding compressed air is formed may be shared by a plurality of compressors similar to the suction pipe. In a second embodiment, an air compression device comprising the plurality of compressors connected to the delivery pipe formed in a common space will be described.

[0026] FIG. 2 is a schematic view of an air compression device 100A according to the second embodiment. The air compression device 100A will be described with reference to FIG. 2. The same reference numeral is assigned to a component having the same function as that in the first embodiment. The description in the first embodiment is used for describing the component to which the same reference numeral is assigned.

[0027] Similar to the first embodiment, the air compression device 100A comprises a

suction pipe 300. The description of the first embodiment is used for describing the suction pipe 300.

[0028] The air compression device 100A further comprises a first compressor 210A, a second compressor 220A, a housing 400 and a delivery pipe 500. The housing 400 forms a housing space 410 in which the first compressor 210A and the second compressor 220A are housed. Similar to the first embodiment, each of the first compressor 210A and the second compressor 220A receives air through the suction pipe 300. Each of the first compressor 210A and the second compressor 220A compresses the air received from the suction pipe 300, and generates compressed air. The compressed air is discharged to an outside of the housing 400 through the delivery pipe 500. In the present embodiment, the first compressed air is exemplarily described by the compressed air generated by the first compressor 210A. The second compressed air is exemplarily described by the compressed air generated by the second compressor 220A.

[0029] The delivery pipe 500 may be connected to a cooling equipment for cooling the compressed air. As a result, the compressed air is appropriately cooled. After that, the compressed air may be dehumidified. As a result, dried compressed air is generated. The compressed air passed through the delivery pipe 500 may be subjected to other various treatments. The principle of the present embodiment is not limited to a specific treatment applied to the compressed air passed through the delivery pipe 500.

[0030] Similar to the first embodiment, the first compressor 210A includes a compression mechanism 212. The description of the first embodiment is used for describing the compression mechanism 212.

[0031] The first compressor 210A further includes a first housing 211A. The compression mechanism 212 is housed in the first housing 211A.

[0032] The first housing 211A includes a first port wall 213A facing the second compressor 220A. Similar to the first embodiment, a first suction port 214 is formed in the first port wall 213A. The description of the first embodiment is used for describing the first suction port 214.

[0033] A first delivery port 215 is also formed in the first port wall 213A. The compressed air generated by the compression mechanism 212 is delivered to the delivery pipe 500 through the first delivery port 215.

[0034] Similar to the first embodiment, the second compressor 220A includes a compression mechanism 222. The description of the first embodiment is used for describing the compression mechanism 222.

[0035] The second compressor 220A further includes the second housing 221A. The

compression mechanism 222 is housed in the second housing 221A.

[0036] The second housing 221A includes a second port wall 223A facing the first port wall 213A of the first compressor 210A. Similar to the first embodiment, a second suction port 224 is formed in the second port wall 223A. The description of the first embodiment is used for describing the second suction port 224.

[0037] A second delivery port 225 is also formed in the second port wall 223A. The compressed air generated by the compression mechanism 222 is delivered to the delivery pipe 500 through the second delivery port 225.

[0038] The delivery pipe 500 includes a first delivery pipe 510, a second delivery pipe 520, a confluence portion 530 and a confluence pipe 540. The first delivery pipe 510 is connected to the confluence portion 530 and the first delivery port 215 of the first compressor 210A. The compressed air generated by the first compressor 210A flows from the first delivery port 215 toward the confluence portion 530 through the first delivery pipe 510. The second delivery pipe 520 is connected to the confluence portion 530 and the second delivery port 225 of the second compressor 220A. The compressed air generated by the second compressor 220A flows from the second delivery port 225 toward the confluence portion 530 through the second delivery pipe 520. Since the first delivery pipe 510 and the second delivery pipe 520 are connected to the first delivery port 215 and the second delivery port 225 respectively, the first delivery pipe 510 and the second delivery pipe 520 are arranged between the first port wall 213A and the second port wall 223A.

[0039] The compressed air generated by the first compressor 210A is joined with the compressed air generated by the second compressor 220A at the confluence portion 530. The confluence pipe 540 forms a delivery passage from the confluence portion 530 toward an outside of the housing 400. The compressed air flows from the confluence portion 530 toward the outside of the housing 400 through the confluence pipe 540.

[0040] In the present embodiment, the delivery pipe 500 includes the confluence portion 530. Alternatively, the delivery pipe may be formed by a pipe which guides the compressed air generated by the first compressor 210A toward the outside of the housing 400 and a pipe which guides the compressed air generated by the second compressor 220A toward the outside of the housing 400. In this case, it is not necessary to arrange a confluence element for joining the compressed air generated by the first compressor 210A with the compressed air generated by the second compressor 220A. The principle of the present embodiment is not limited to a specific structure of the delivery pipe.

[0041] Third Embodiment

A designer can design various air compression devices based on the design principle described in connection with the second embodiment. In a third embodiment, an exemplary air compression device will be described. Hereinafter, terminologies of "upper", "lower", "left", "right", "front" and "rear" which indicate respective directions are used. These terminologies are used for clarifying the description. The principle of the air compression device is not limited by these terminologies.

[0042] FIG. 3A and FIG. 3B are schematic perspective views of an air compression device 100B of the third embodiment. The air compression device 100B will be described with reference to FIG. 2 through FIG. 3B.

[0043] The air compression device 100B comprises a housing 400B, a cooling device 610, a dehumidifying device 620 (see FIG. 3B), a control device 630, a right connection portion 650 and a left connection portion 660. The housing 400B corresponds to the housing 400 described with reference to FIG. 2.

[0044] The housing 400B includes a top plate 420 (see FIG. 3A), a bottom plate 430 (see FIG. 3B) and an outer circumferential wall 440. Each of the top plate 420 and the bottom plate 430 is formed in a rectangular shape. The top plate 420 is connected to a lower surface of a vehicle (not shown) by the right connection portion 650 and the left connection portion 660. The bottom plate 430 is laid below the top plate 420. The outer circumferential wall 440 stands between the top plate 420 and the bottom plate 430.

[0045] The outer circumferential wall 440 includes a front mount wall 450 (see FIG. 3A), a rear mount wall 460 (see FIG. 3B), a first wall 470 (see FIG. 3A), a second wall 480 (see FIG. 3B) and a suction wall 479 (see FIG. 3A). The front mount wall 450 forms a plane substantially parallel to a virtually extending plane of a side surface of the vehicle extended along a travel direction of the vehicle. The suction wall 479 is arranged below the front mount wall 450. The suction wall 479 allows air to pass through the suction wall 479. An air at an outside of the housing 400B flows into the housing 400B through the suction wall 479. The rear mount wall 460 stands at a side opposite to the front mount wall 450. The first wall 470 stands between a right side edge of the front mount wall 450 and a right side edge of the rear mount wall 460. The second wall 480 stands between a left side edge of the front mount wall 450 and a left side edge of the rear mount wall 460.

[0046] As shown in FIG. 3A, the front mount wall 450 includes a holding plate 451 and a filter cover 452 formed in a substantially cylindrical shape. The filter cover 452 is fixed to the holding plate 451. The filter cover 452 is protruded toward a front side from the holding plate 451. A filter device described below, which removes dust from

the sucked air, is arranged at the rear of the filter cover 452.

[0047] The filter cover 452 includes an outer shell body 453 formed in a substantially cylindrical shape and a lever lock 454. An operator which checks and repairs the air compression device 100B can operate the lever lock 454 manually without using a tool such as a screwdriver and a wrench. The operator can fix the outer shell body 453 to the holding plate 451 by operating the lever lock 454. In addition, the operator can also separate the outer shell body 453 from the holding plate 451 by operating the lever lock 454. When the outer shell body 453 is removed from the holding plate 451, the operator can access a filter member (not shown) housed in the housing 400B. Accordingly, the operator can replace the filter member easily. The lever lock 454 may be formed by a general lock member sold on the market. Other appropriate fixing mechanism may be used in the filter cover 452 instead of the lever lock 454.

[0048] As shown in FIG. 3B, the rear mount wall 460 includes a holding plate 461 and a duct portion 462. The duct portion 462 is protruded rearward from the holding plate 461. Cooling air flows in the housing 400B in order to cool various devices in the housing 400B. The duct portion 462 forms an opening area elongated in a horizontal direction as an outlet port of the cooling air used in the housing 400B. The cooling air used for cooing the inside of the housing 400B is delivered from the duct portion 462.

[0049] The cooling device 610 includes a cooling pipe 611 extended in a meandering manner and a protection cover 612 which surrounds an extending region of the cooling pipe 611. The compressed air generated in the housing 400B flows into the cooling pipe 611. The cooling pipe 611 is arranged at an outside of the housing 400B in which a heat source (for example, a compressor (not shown)) is housed, and thereby the compressed air in the cooling pipe 611 is cooled efficiently.

[0050] A part of the cooling pipe 611 is arranged to face the duct portion 462. Accordingly, the compressed air in the cooling pipe 611 is also cooled by the cooling air discharged from the housing 400B.

[0051] The dehumidifying device 620 is arranged below the cooling device 610. The air compression device 100B does not have any device below the dehumidifying device 620, and thereby even if leakage of fluid occurs due to failure of the dehumidifying device 620, other device installed in the air compression device 100B is hardly damaged.

[0052] Similar to the dehumidifying device 620, the control device 630 is arranged below the cooling device 610. The control device 630 is arranged next to the dehumidifying device 620. The control device 630 controls a compressor (not shown) or other device arranged in the housing 400B.

[0053] The top plate 420 includes a front side edge 421 (see FIG. 3A), a rear side edge 422, a right side edge 423 (see FIG. 3A) and a left side edge 424 (see FIG. 3B). The front side edge 421 is extended along a corner portion formed by the top plate 420 and the front mount wall 450. The rear side edge 422 is extended along a corner portion formed by the top plate 420 and the rear mount wall 460. The right side edge 423 is extended along a corner portion formed by the top plate 420 and the first wall 470. The left side edge 424 is extended along a corner portion formed by the top plate 420 and the second wall 480.

[0054] As shown in FIG. 3A, the right connection portion 650 includes a right frame member 651 and two vibration isolating rings 652, 653. The right frame member 651 is formed in a substantially C-shape in a section. The right frame member 651 is extended along the right side edge 423 of the top plate 420. The vibration isolating ring 652 is arranged on the corner portion formed by the right side edge 423 and the front side edge 421. The vibration isolating ring 653 is arranged on the corner portion formed by the right side edge 423 and the rear side edge 422. Each of the vibration isolating rings 652, 653 is intervened between the right frame member 651 and the top plate 420. Each of the vibration isolating rings 652, 653 reduces vibration transmitted from the housing 400B to a vehicle (not shown).

[0055] The left connection portion 660 includes a left frame member 661 and two vibration isolating rings 662, 663. The left frame member 661 is formed in a substantially C-shape in a section. The left frame member 661 is extended along the left side edge 424 of the top plate 420. The vibration isolating ring 662 is arranged on the corner portion formed by the left side edge 424 and the front side edge 421. The vibration isolating ring 663 is arranged on the corner portion formed by the left side edge 424 and the rear side edge 422. Each of the vibration isolating rings 662, 663 is intervened between the left frame member 661 and the top plate 420. Each of the vibration isolating rings 662, 663 reduces vibration transmitted from the housing 400B to the vehicle (not shown).

[0056] FIG. 4 is a schematic plane view illustrating an inner structure of the air compression device 100B. The top plate 420 is removed from the air compression device 100B shown in FIG. 4. The air compression device 100B will be further described with reference to FIG. 2 through FIG. 4.

[0057] The air compression device 100B comprises a first compressor 210B, a second compressor 220B, a suction pipe 300B and a delivery pipe 500B. The first compressor 210B corresponds to the first compressor 210A described with reference to FIG. 2. The second compressor 220B corresponds to the second compressor 220A described

with reference to FIG. 2. The suction pipe 300B corresponds to the suction pipe 300 described with reference to FIG. 2. The delivery pipe 500B corresponds to the delivery pipe 500 described with reference to FIG. 2.

[0058] FIG. 5 is a schematic cross-sectional view illustrating a structure of a base end portion of the suction pipe 300B. The suction pipe 300B will be described with reference to FIG. 2, FIG. 3A, FIG. 4 and FIG. 5.

[0059] As shown in FIG. 5, the suction pipe 300B includes a suction duct 310B, a filter device 320 and a trim seal 331. The suction duct 310B corresponds to the main pipe 310 shown in FIG. 2. The filter device 320 is arranged between the filter cover 452 and the suction duct 310B. The trim seal 331 is formed as a rubber ring member which connects the filter device 320 to the suction duct 310B in an airtight manner.

[0060] The suction duct 310B is formed as a hollow box member formed in a substantially rectangular parallelepiped shape. When the first compressor 210B and/or the second compressor 220B is activated, a negative pressure environment is generated in the suction duct 310B. As a result, an air outside the housing 400B is passed through the filter device 320 through the filter cover 452. The filter device 320 removes dust floating in the air flowing into the filter device 320. The air purified by the filter device 320 flows into the suction duct 310B.

[0061] As shown in FIG. 4, the first compressor 210B includes a first port wall 213B. The second compressor 220B includes a second port wall 223B. The first port wall 213B corresponds to the first port wall 213A described with reference to FIG. 2. The second port wall 223B corresponds to the second port wall 223A described with reference to FIG. 2. The first port wall 213B is arranged to face the second port wall 223B.

[0062] The suction duct 310B is extended from the filter device 320 toward the rear mount wall 460 in a space between the first port wall 213B and the second port wall 223B. Accordingly, the air compression device 100B can supply air from an outside of the housing 400B to the first compressor 210B and the second compressor 220B by using a small space.

[0063] FIG. 6 is a schematic enlarged cross-sectional view of the suction pipe 300B around the suction duct 310B. The suction pipe 300B will be further described with reference to FIG. 2, FIG. 4, and FIG. 6.

[0064] The suction pipe 300B includes two joint pipes 311B, 312B and two trim seals 332, 333. The joint pipe 311B corresponds to the first branch pipe 311 shown in FIG. 2. The joint pipe 312B corresponds to the second branch pipe 312 shown in FIG. 2. The trim seal 332 is used for a connection between the joint pipe 311B and the suction

duct 310B. The trim seal 333 is used for the connection between the joint pipe 312B and the suction duct 310B.

[0065] The suction duct 310B includes a base end wall (front end wall) 341, a distal end wall (rear end wall) 342, a right wall 343, a left wall 344, a top wall 345 (see FIG. 4) and a bottom wall 346. The trim seal 331 is mounted to the base end wall 341. A part of the filter device 320 is inserted into the suction duct 310B through the trim seal 331. The distal end wall 342 stands at a side opposite to the base end wall 341. The distal end wall 342 forms a downstream end of the suction duct 310B. The right wall 343 is arranged to face the first port wall 213B of the first compressor 210B. The right wall 343 is extended along the first port wall 213B between the base end wall 341 and the distal end wall 342. The left wall 344 is arranged to face the second port wall 223B of the second compressor 220B. The left wall 344 is extended along the second port wall 223B between the base end wall 341 and the distal end wall 342. The top wall 345 closes a rectangular area surrounded by upper edges of the base end wall 341, the distal end wall 342, the right wall 343 and the left wall 344. The bottom wall 346 closes a rectangular area surrounded by lower edges of the base end wall 341, the distal end wall 342, the right wall 343 and the left wall 344.

[0066] The first port wall 213B of the first compressor 210B includes a first suction port 214B formed in a cylindrical shape and protruded toward the right wall 343 of the suction duct 310B. The first suction port 214B corresponds to the first suction port 214 shown in FIG. 2.

[0067] The trim seal 332 is mounted to the right wall 343 of the suction duct 310B. The trim seal 332 is formed as a rubber ring member. The trim seal 332 is arranged substantially coaxially with the first suction port 214B of the first compressor 210B.

[0068] The joint pipe 311B includes a first end 313 and a second end 314. The first end 313 is inserted into the trim seal 332. A part of the first end 313 may be protruded toward an inside of the suction duct 310B. The trim seal 332 seals an interspace between the first end 313 of the joint pipe 311B and the right wall 343 of the suction duct 310B in an airtight manner. The second end 314 of the joint pipe 311B is inserted into the first suction port 214B of the first compressor 210B. An appropriate seal member such as a seal tape is used for the connection between the second end 314 of the joint pipe 311B and the first suction port 214B of the first compressor 210B.

[0069] The second port wall 223B of the second compressor 220B includes a second suction port 224B formed in a cylindrical shape and protruding toward the left wall 344 of the suction duct 310B. The second suction port 224B corresponds to the second suction port 224 shown in FIG. 2.

[0070] The trim seal 333 is mounted to the left wall 344 of the suction duct 310B. The trim seal 333 is formed as a rubber ring member. The trim seal 333 is arranged substantially coaxially with the second suction port 224B of the second compressor 220B.

[0071] The connecting pipe 312B includes a first end 315 and a second end 316. The first end 315 is inserted into the trim seal 333. A part of the first end 315 may protrude toward an inside of the suction duct 310B. The trim seal 333 is formed to seal between the first end 315 of the connecting pipe 312B and the left wall 344 of the suction duct 310B in an airtight manner. The second end 316 of the connecting pipe 312B is inserted into the second suction port 224B of the second compressor 220B. An appropriate seal member such as a seal tape is used for the connection between the second end 316 of the connecting pipe 312B and the second suction port 224B of the second compressor 220B.

[0072] As shown in FIG. 4, the delivery pipe 500B includes a first delivery pipe 510B, a second delivery pipe 520B, a confluence portion 530B and a confluence pipe 540B. The first compressor 210B receives an air through the connecting pipe 311B (see FIG. 6). The first compressor 210B compresses the air supplied through the connecting pipe 311B and generates compressed air. The second compressor 220B receives an air through the connecting pipe 312B (see FIG. 6). The second compressor 220B compresses the air supplied through the connecting pipe 312B and generates compressed air.

[0073] The first delivery pipe 510B is connected to the first port wall 213B of the first compressor 210B above the suction duct 310B. The second delivery pipe 520B is connected to the second port wall 223B of the second compressor 220B above the suction duct 310B. Accordingly, as shown in FIG. 4, each of the first delivery pipe 510B and the second delivery pipe 520B partially overlaps with the suction duct 310B. A connection portion between the first delivery pipe 510B and the first port wall 213B of the first compressor 210B corresponds to the first delivery port 215 described with reference to FIG. 2. A connection portion between the second delivery pipe 520B and the second port wall 223B of the second compressor 220B corresponds to the second delivery port 225 described with reference to FIG. 2. The first delivery pipe 510B corresponds to the first delivery pipe 510 described with reference to FIG. 2. The second delivery pipe 520B corresponds to the second delivery pipe 520 described with reference to FIG. 2.

[0074] FIG. 7 is a schematic enlarged perspective view of the delivery pipe 500B around the confluence portion 530. The delivery pipe 500B will be described with

reference to FIG. 2, FIG. 4 and FIG. 7.

[0075] As shown in FIG. 4, the confluence portion 530B is arranged near the front mount wall 450 of the housing 400B. Each of the first delivery pipe 510B and the second delivery pipe 520B bends toward the front mount wall 450, and is connected to the confluence portion 530. The compressed air generated by the first compressor 210B flows into the confluence portion 530B through the first delivery pipe 510B. The compressed air generated by the second compressor 220B flows into the confluence portion 530B through the second delivery pipe 520B. The compressed air generated by the first compressor 210B joins the compressed air generated by the second compressor 220B at the confluence portion 530B. The confluence portion 530B corresponds to the confluence portion 530 described with reference to FIG. 2.

[0076] The confluence portion 530B includes a manifold 531, a right check valve 532 (see FIG. 7), a left check valve 533 (see FIG. 7) and two first fixing members 534, 535. The manifold 531 is formed in a substantially rectangular parallelepiped shape. The manifold 531 includes an upper surface 551, a lower surface 552 (see FIG. 7) and a rear surface 553. Each of the right check valve 532 and the left check valve 533 is mounted to the lower surface 552 of the manifold 531. Each of the first fixing members 534, 535 is mounted to the upper surface 551. The confluence pipe 540B is extended from the rear surface 553.

[0077] As shown in FIG. 7, the first delivery pipe 510B is connected to the right check valve 532. The compressed air flowing along the first delivery pipe 510B flows into the manifold 531 through the right check valve 532. The right check valve 532 blocks a flow of the compressed air returned to the first delivery pipe 510B from the manifold 531. The second delivery pipe 520B is connected to the left check valve 533. The compressed air flowing along the second delivery pipe 520B flows into the manifold 531 through the left check valve 533. The left check valve 533 blocks a flow of the compressed air returned to the second delivery pipe 520B from the manifold 531.

[0078] A confluence inner pipe (not shown) which joins two flows of the compressed air is formed in the manifold 531. The compressed air joined by the confluence inner pipe is discharged from the manifold 531 through the confluence pipe 540B.

[0079] As shown in FIG. 7, the first fixing member 534 includes a first mount portion 561 and a second mount portion 562. The first mount portion 561 is connected to the first port wall 213B of the first compressor 210B. The second mount portion 562 is connected to the upper surface 551 of the manifold 531.

[0080] The first mount portion 561 is formed in a substantially L-shape. The first mount portion 561 includes a vertical plate portion 563 and a horizontal plate portion

564. A first adjusting structure 565 is formed in the vertical plate portion 563 as an elongated hole extending in a vertical direction. A manufacturer who assembles the air compression device 100B inserts an appropriate fixing tool such as a screw into the first adjusting structure 565, and thereby the manufacturer can connect the first mount portion 561 to the first port wall 213B of the first compressor 210B. The manufacturer moves the first fixing member 534 in the vertical direction along an extending direction of the first adjusting structure 565, and thereby the manufacturer can change a height position of the manifold 531. Since a relative position of the manifold 531 against the first compressor 210B and the second compressor 220B is adjusted in a height direction, even if a mounting error of the first compressor 210B and the second compressor 220B exists, an excessively large load is not applied to the first delivery pipe 510B and the confluence pipe 540B.

[0081] The horizontal plate portion 564 is extended from an upper end of the vertical plate portion 563 toward the front mount wall 450. The second mount portion 562 is bent from the horizontal plate portion 564, and is extended along the upper surface 551 of the manifold 531. A first adjusting structure 566 is formed in the horizontal plate portion 564 as an elongated hole extending in a horizontal direction (lateral direction). A manufacturer who assembles the air compression device 100B inserts an appropriate fixing tool such as a screw into the first adjusting structure 566, and thereby the manufacturer can connect the second mount portion 562 to the manifold 531. The manufacturer moves the first fixing member 534 in the horizontal direction along an extending direction of the first adjusting structure 566, and thereby the manufacturer can change a horizontal position of the manifold 531. Since a relative position of the manifold 531 against the first compressor 210B and the second compressor 220B is adjusted in the horizontal direction, even if a mounting error of the first compressor 210B and the second compressor 220B exists, an excessively large load is not applied to the first delivery pipe 510B and the confluence pipe 540B.

[0082] As shown in FIG. 7, the first fixing member 535 includes a first mount portion 571 and a second mount portion 572. The first mount portion 571 is connected to the second port wall 223B of the second compressor 220B. The second mount portion 572 is connected to the upper surface 551 of the manifold 531.

[0083] The first mount portion 571 is formed in a substantially L-shape. The first mount portion 571 includes a vertical plate portion 573 and a horizontal plate portion 574. An elongated hole (not shown) extending in the vertical direction is formed in the vertical plate portion 573. A manufacturer who assembles the air compression device 100B inserts an appropriate fixing tool such as a screw into the elongated hole,

and thereby the manufacturer can connect the first mount portion 571 to the second port wall 223B of the second compressor 220B. The manufacturer moves the first fixing member 535 in the vertical direction along an extending direction of the elongated hole, and thereby the manufacturer can change the height position of the manifold 531. Since the relative position of the manifold 531 against the first compressor 210B and the second compressor 220B is adjusted in the height direction, even if a mounting error of the first compressor 210B and the second compressor 220B exists, an excessively large load is not applied to the second delivery pipe 520B and the confluence pipe 540B.

[0084] The horizontal plate portion 574 is extended from an upper end of the vertical plate portion 573 toward the front mount wall 450. The second mount portion 572 is bent from the horizontal plate portion 574, and is extended along the upper surface 551 of the manifold 531. A first adjusting structure 576 is formed in the horizontal plate portion 574 as an elongated hole extending in the horizontal direction (lateral direction). A manufacturer who assembles the air compression device 100B inserts an appropriate fixing tool such as a screw into the first adjusting structure 576, and thereby the manufacturer can connect the second mount portion 572 to the manifold 531. The manufacturer moves the first fixing member 535 in the horizontal direction along an extending direction of the first adjusting structure 576, and thereby the manufacturer can change the horizontal position of the manifold 531. Since the relative position of the manifold 531 against the first compressor 210B and the second compressor 220B is adjusted in the horizontal direction, even if a mounting error of the first compressor 210B and the second compressor 220B exists, an excessively large load is not applied to the second delivery pipe 520B and the confluence pipe 540B.

[0085] In the present embodiment, the manifold 531 is fixed by the first fixing members 534, 535. Alternatively, the manifold 531 may be fixed by one of the first fixing members 534, 535.

[0086] In the present embodiment, each of the first adjusting structures 565, 566, 567 is formed as the elongated hole extending in the vertical direction and/or the elongated hole extending in the horizontal direction. Alternatively, the first adjusting structure may be formed as an elongated notch extending in the vertical direction, the horizontal direction and/or other direction. The principle of the present embodiment is not limited to a specific shape of an opening area for adjusting a position of the manifold 531.

[0087] The first adjusting structure may be formed as a plurality of through holes arranged at different positions to each other. The manufacturer may select an

appropriate hole from the plurality of through holes, and set an appropriate position of the manifold 531. Accordingly, the principle of the present embodiment is not limited to a specific structure of the first adjusting structure.

[0088] The first delivery pipe 510B includes a base end pipe 511 (see FIG. 4), a first elbow pipe 512 (see FIG. 4), a horizontal pipe 513, a second elbow pipe 514 (see FIG. 7), a vertical pipe 515 (see FIG. 7), a first nut 516 (see FIG. 7) and a second nut 517 (see FIG. 7). The base end pipe 511 is connected to the first port wall 213B of the first compressor 210B. A connection portion between the base end pipe 511 and the first port wall 213B corresponds to the first delivery port 215 described with reference to FIG. 2. The base end pipe 511 is extended from the first port wall 213B toward the second port wall 223B of the second compressor 220B. The first elbow pipe 512 is mounted to a distal end portion of the base end pipe 511. The first elbow pipe 512 changes a flow direction of the compressed air generated by the first compressor 210B from a flow direction directed to the second port wall 223B of the second compressor 220B to a flow direction directed to the front mount wall 450.

[0089] The first nut 516 is rotatably mounted to the second elbow pipe 514. An upstream end of the horizontal pipe 513 is screwed with the first elbow pipe 512. A downstream end of the horizontal pipe 513 is screwed with the first nut 516. Accordingly, the manufacturer rotates the first nut 516, and thereby the manufacturer can adjust a distance between the first elbow pipe 512 and the second elbow pipe 514 appropriately.

[0090] The second nut 517 is rotatably mounted to the right check valve 532. A lower end of the vertical pipe 515 is screwed with the second elbow pipe 514. An upper end of the vertical pipe 515 is screwed with the second nut 517. Accordingly, the manufacturer rotates the second nut 517, and thereby the manufacturer can adjust a distance between the right check valve 532 and the second elbow pipe 514 appropriately. In the present embodiment, a bent pipe is exemplarily shown by a combination of the first elbow pipe 512, the horizontal pipe 513, the second elbow pipe 514 and the vertical pipe 515.

[0091] In the present embodiment, a second adjusting structure is exemplarily shown by a combination of the horizontal pipe 513 and the first nut 516 and a combination of the vertical pipe 515 and the second nut 517. The combination of the horizontal pipe 513 and the first nut 516 contributes to an adjustment of a length of a guide section for the compressed air in the horizontal direction. The combination of the vertical pipe 515 and the second nut 517 contributes to an adjustment of a length of a guide section for the compressed air in the vertical direction. Alternatively, the second adjusting

structure may be formed to adjust the length of the guide section for the compressed air only in one of the horizontal direction and the vertical direction.

[0092] The second adjusting structure may be a bellows pipe or other pipe structural body having an extendable structure. The principle of the present embodiment is not limited to a specific structure of the second adjusting structure.

[0093] The second delivery pipe 520B is in a mirror image relation with the first delivery pipe 510B. Accordingly, the description described above relating to the structure of the first delivery pipe 510B is used for describing the second delivery pipe 520B.

[0094] As shown in FIG. 7, the first port wall 213B of the first compressor 210B includes a fixing base 216 formed in a substantially rectangular parallelepiped shape and protruding toward the second compressor 220B. The air compression device 100B includes a second fixing member 580. The second fixing member 580 is arranged on the fixing base 216.

[0095] The second fixing member 580 includes a base end portion 581 and a distal end portion 582. The base end portion 581 is formed in a plate shape. The base end portion 581 is fixed to the fixing base 216 by using an appropriate fixing tool such as a screw. The distal end portion 582 is formed in a substantially C-shape. The distal end portion 582 extends from the base end portion 581 toward the second compressor 220B while curving upward on the fixing base 216. The horizontal pipe 513 of the first delivery pipe 510B is intervened by the distal end portion 582 and the fixing base 216. A fixing technique of the first delivery pipe 510B by the second fixing member 580 and the fixing base 216 may be applied to fixing of the second delivery pipe 520. The second fixing member may have other structure or other shape which enable to connect the horizontal pipe 513 to the first port wall 213B of the first compressor 210B. The principle of the present embodiment is not limited to a specific shape or a specific structure of the second fixing member.

[0096] FIG. 8 is a schematic cross-sectional view of the duct portion 462. FIG. 9 is a schematic perspective view of the air compression device 100B. The cooling device 610 described with reference to FIG. 3B is removed from the air compression device 100B shown in FIG. 9. The delivery pipe 500B will be further described with reference to FIG. 3B, FIG. 4, FIG. 8 and FIG. 9.

[0097] As shown in FIG. 8, the confluence pipe 540B is extended from the manifold 531 (see FIG. 4) toward the rear mount wall 460 to pass through the duct portion 462. The duct portion 462 includes an inner duct portion 463 and an outer duct portion 464. The inner duct portion 463 protrudes from the holding plate 461 of the rear mount wall 460

toward an inner side. The outer duct portion 464 protrudes from the rear mount wall 460 toward an outer side.

[0098] As shown in FIG. 9, the outer duct portion 464 has a frame structure formed in a substantially rectangular shape elongated in the horizontal direction. The outer duct portion 464 includes an upper wall 465, a lower wall 466, a right wall 467 and a left wall 468. The upper wall 465 is extended substantially horizontally along the rear side edge 422 of the top plate 420. The lower wall 466 is extended substantially horizontally below the upper wall 465. The right wall 467 stands between the right side edge of the upper wall 465 and the right side edge of the lower wall 466. The left wall 468 stands between the left side edge of the upper wall 465 and the left side edge of the lower wall 466. The confluence pipe 540B is bent toward the left wall 468 in the outer duct portion 464.

[0099] As shown in FIG. 3B, the confluence pipe 540B is bent leftward in the outer duct portion 464. The confluence pipe 540B penetrates the left wall 468 to appear at an outside of the outer duct portion 464. The confluence pipe 540B is connected to the cooling pipe 611 of the cooling device 610 at the outside of the outer duct portion 464.

[0100] Fourth Embodiment

Since a compressor compresses an air, an amount of heat generation of the compressor and the compressed air is extremely large. Accordingly, a heat exhausting process from a housing and a cooling process of the compressed air are extremely important. In a fourth embodiment, an exemplary heat processing technique will be described.

[0101] As shown in FIG. 4, the air compression device 100B comprises two fan devices 710, 720 and two cooling air flow adjusting boxes 730, 740. A front mount wall 450 of a housing 400B includes a right fan cover 455 and a left fan cover 456. The fan device 710 is mounted to the right fan cover 455. The fan device 720 is mounted to the left fan cover 456. Each of the right fan cover 455 and the left fan cover 456 protrudes frontward from a holding plate 451 of the front mount wall 450. Each of the right fan cover 455 and the left fan cover 456 can be removed from the holding plate 451. When the right fan cover 455 is removed from the holding plate 451, the fan device 710 and the cooling air flow adjusting box 730 are removed from the housing 400B. When the left fan cover 456 is removed from the holding plate 451, the fan device 720 and the cooling air flow adjusting box 740 are removed from the housing 400B.

[0102] The fan device 710 may be an axial fan device including a fan blade. The fan device 710 rotates the fan blade to generate cooling air toward a rear mount wall 460.

Since a first compressor 210B is arranged between the fan device 710 and the rear mount wall 460, the first compressor 210B is appropriately cooled by the cooling air delivered from the fan device 710.

[0103] The fan device 720 may be an axial fan device including a fan blade. The fan device 720 rotates the fan blade to generate cooling air toward the rear mount wall 460. Since a second compressor 220B is arranged between the fan device 720 and the rear mount wall 460, the second compressor 220B is appropriately cooled by the cooling air delivered from the fan device 720.

[0104] The cooling air flow adjusting box 730 is arranged between the fan device 710 and the first compressor 210B. The cooling air flow adjusting box 730 appropriately adjusts a shape of a flow region of the cooling air which flows from the fan device 710 toward the first compressor 210B.

[0105] The cooling air flow adjusting box 740 is arranged between the fan device 720 and the second compressor 220B. The cooling air flow adjusting box 740 appropriately adjusts a shape of a flow region of the cooling air which flows from the fan device 720 toward the second compressor 220B.

[0106] As shown in FIG. 3A, a recess region formed in a mountain shape is formed between the right fan cover 455 and the left fan cover 456. The filter cover 452 described in connection with the third embodiment is arranged in the recess region formed in a mountain shape.

[0107] FIG. 10A is a schematic perspective view of the cooling air flow adjusting box 730. FIG. 10B is a schematic back side view of the cooling air flow adjusting box 730. The cooling air flow adjusting box 730 will be described with reference to FIG. 4 and FIG. 8 through FIG. 10B. The cooling air flow adjusting box 740 described with reference to FIG. 4 has the same structure as the cooling air flow adjusting box 730. Accordingly, the description below relating to a structure of the cooling air flow adjusting box 730 is used for describing the cooling air flow adjusting box 740.

[0108] The cooling air flow adjusting box 730 includes a first adjusting plate 731, a second adjusting plate 732 and an outer circumferential plate 733. The first adjusting plate 731 is arranged to face the fan device 710. The first adjusting plate 731 includes an outer edge 734 and an inner edge 735. The outer edge 734 forms a substantially rectangular outline of the first adjusting plate 731. The inner edge 735 forms a substantially circular opening area. A diameter of the opening area formed by the inner edge 735 is substantially equal to a rotational diameter of the fan blade of the fan device 710. Or alternatively, the diameter of the opening area is set to be slightly larger than the rotational diameter of the fan blade. Accordingly, the cooling air

generated by the fan device 710 can flow efficiently into the cooling air flow adjusting box 730.

[0109] The second adjusting plate 732 stands between the first adjusting plate 731 and the first compressor 210B. The second adjusting plate 732 includes an outer edge 736 and an inner edge 737. Similar to the outer edge 734 of the first adjusting plate 731, the outer edge 736 of the second adjusting plate 732 forms a substantially rectangular outline of the second adjusting plate 732. Similar to other general compressors, the first compressor 210B has a substantially rectangular outline in a section on a vertical virtual plane including a rotational axis of the first compressor 210B. The inner edge 737 of the second adjusting plate 732 forms a substantially rectangular opening area formed to be matched with the sectional shape and the size of the first compressor 210B. The outer circumferential plate 733 is connected to the outer edge 734 of the first adjusting plate 731 and the outer edge 736 of the second adjusting plate 732. Accordingly, the cooling air which flows into the substantially circular opening area formed by the inner edge 735 of the first adjusting plate 731 is discharged from the substantially rectangular opening area formed by the inner edge 737 of the second adjusting plate 732, and thereby the cooling air hits the first compressor 210B efficiently. Accordingly, the first compressor 210B is cooled efficiently.

[0110] As described above, the cooling air generated by the fan devices 710, 720 is delivered toward the rear mount wall 460. Accordingly, the cooling air absorbs heat from the first compressor 210B and the second compressor 220B, and then the cooling air flows toward the rear mount wall 460. Since the cooling air flows in the housing 400B until the cooling air is discharged from the duct portion 462, the cooling air can also cool the compressed air in the delivery pipe 500B which forms a long flow passage in a space between the first compressor 210B and the second compressor 220B, effectively.

[0111] As described with reference to FIG. 8, since the rear mount wall 460 includes the duct portion 462, the cooling air is discharged intensively to the outside of the housing 400B through the duct portion 462. Since the confluence pipe 540B of the delivery pipe 500B is passed through the duct portion 462, the compressed air in the confluence pipe 540B is cooled also in the duct portion 462 by the cooling air after cooling the first compressor 210B and the second compressor 220B.

[0112] As described in connection with the third embodiment, the compressed air flows into the cooling pipe 611 of the cooling device 610. The cooling pipe 611 forms a flow passage of the compressed air extended toward a lower side in a meandering manner. That is, the compressed air after flowing into the cooling device 610 flows

along an upper side flow passage. After that, the compressed air flows along a lower side flow passage.

[0113] As shown in FIG. 8, the upper side flow passage formed by the cooling pipe 611 is arranged to face the duct portion 462. Accordingly, the compressed air in the upper side flow passage is cooled by the cooling air blown from the duct portion 462.

[0114] As shown in FIG. 9, the air compression device 100B is provided with four outer fan devices 750. The four outer fan devices 750 are aligned in the horizontal direction below the lower wall 466 of the outer duct portion 464.

[0115] As shown in FIG. 8, the lower side flow passage formed by the cooling pipe 611 is arranged to face the outer fan device 750. Accordingly, the outer fan device 750 can deliver the cooling air toward the cooling pipe 611 which forms the lower side flow passage. As a result, the compressed air which flows along the lower side flow passage is cooled by the outer fan device 750 effectively.

[0116] In the present embodiment, each of the cooling air flow adjusting boxes 730, 740 is used together with the axial fan device. Alternatively, an adjusting principle of the shape of the flow region derived by the cooling air flow adjusting boxes 730, 740 may be applied to the cooling air generated by other fan device such as a centrifugal fan device. When the cooling air flows from the second adjusting plate 732 to the first adjusting plate 731, the adjusting principle described above can also contribute to the efficient cooling of the compressor.

[0117] Fifth Embodiment

Various devices are mounted to a lower surface of a vehicle. Accordingly, in some cases, an area of a mount surface for mounting an air compression device is small. In a fifth embodiment, a design technique for reducing an area occupied by the air compression device in a horizontal direction will be described.

[0118] FIG. 11 is a partially assembled view of an air compression device 100B. The air compression device 100B will be described with reference to FIG. 11.

[0119] The air compression device 100B comprises a first driving portion 810 and a second driving portion 820. Each of the first driving portion 810 and the second driving portion 820 may be formed as a general motor. The first driving portion 810 generates driving force for driving a first compressor 210B. The second driving portion 820 generates driving force for driving a second compressor 220B. In the present embodiment, first driving force is exemplarily described by the driving force generated by the first driving portion 810. Second driving force is exemplarily described by the driving force generated by the second driving portion 820.

[0120] The first driving portion 810 is arranged below the first compressor 210B. The

second driving portion 820 is arranged below the second compressor 220B. Since a group of the first driving portion 810 and the second driving portion 820 does not cross a horizontal plane crossing a group of the first compressor 210B and the second compressor 220B, the designer can set an area of the housing 400B in a horizontal section to be small.

[0121] The air compression device 100B further comprises a first transmission portion 910 and a second transmission portion 920. The first transmission portion 910 is formed next to a first wall 470. The second transmission portion 920 is formed next to a second wall 480. The first transmission portion 910 transmits the driving force generated by the first driving portion 810 to the first compressor 210B. The second transmission portion 920 transmits the driving force generated by the second driving portion 820 to the second compressor 220B.

[0122] The first compressor 210B includes a right shaft portion 230 protruding in a direction opposite to the second compressor 220B. The right shaft portion 230 includes a cylindrical housing 231 and a rotational shaft 232 (see FIG. 12). The rotational shaft 232 is extended toward a direction opposite to a space used for a pipe for the suction and the delivery. The rotational shaft 232 is rotated in the cylindrical housing 231. The first transmission portion 910 is connected to the rotational shaft 232 supported by the cylindrical housing 231.

[0123] The second compressor 220B includes a left shaft portion 240 protruding in a direction opposite to the first compressor 210B. The left shaft portion 240 includes a cylindrical housing 241 and a rotational shaft (not shown). The rotational shaft is rotated in the cylindrical housing 241. The second transmission portion 920 is connected to the rotational shaft supported by the cylindrical housing 241.

[0124] FIG. 12 is a schematic perspective view of the first transmission portion 910. The first transmission portion 910 will be described with reference to FIG. 12. The second transmission portion 920 described with reference to FIG. 11 may have the same structure as that of the first transmission portion 910. Accordingly, the description below relating to the structure and the operation of the first transmission portion 910 is used for describing the second transmission portion 920.

[0125] The first transmission portion 910 includes an upper pulley 911, a lower pulley 912, a tension pulley 913 and an endless belt 914. The upper pulley 911 is mounted to the rotational shaft 232 of the right shaft portion 230 of the first compressor 210B. The lower pulley 912 arranged below the upper pulley 911 is mounted to the first driving portion 810. The endless belt 914 is wound on the upper pulley 911, the lower pulley 912 and the tension pulley 913. The tension pulley 913 pushes the endless belt

914 toward the rear mount wall 460 at a position between the upper pulley 911 and the lower pulley 912, and thereby appropriate tensile force is applied to the endless belt 914.

[0126] When the first driving portion 810 is rotated, the endless belt 914 is circulated around the upper pulley 911, the lower pulley 912 and the tension pulley 913. As a result, the upper pulley 911 is rotated. The rotational shaft 232 is rotated by the rotation of the upper pulley 911. The rotation of the rotational shaft 232 causes compression operation of the first compressor 210B. As a result, the compressed air is generated.

[0127] Sixth Embodiment

The structure of the housing described in connection with the third embodiment facilitates repairing operation such as replacing of a filter. The housing may have a structure which facilitates repair or check of the driving force transmission mechanism described in connection with the fifth embodiment. In a sixth embodiment, a design technique for facilitating repair or check of the driving force transmission mechanism will be described.

[0128] FIG. 13 is a partially assembled view of an air compression device 100B. The air compression device 100B will be described with reference to FIG. 3A, FIG. 3B, FIG. 11 and FIG. 13.

[0129] The housing 400B includes a support frame 490 and a support plate 481. The support frame 490 includes a first column 491, a second column 492, a third column 493, a fourth column 494, a front beam 495 and a rear beam 496. The first column 491 is extended downward from a corner portion (see FIG. 3A) formed by the front side edge 421 and the right side edge 423 of the top plate 420. The second column 492 is extended downward from a corner portion (see FIG. 3A) formed by the rear side edge 422 and the right side edge 423 of the top plate 420. The third column 493 is extended downward from a corner portion formed by the front side edge 421 (see FIG. 3A) and the left side edge 424 (see FIG. 3B) of the top plate 420. The fourth column 494 is extended downward from a corner portion (see FIG. 3B) formed by the rear side edge 422 and the left side edge 424 of the top plate 420. The front beam 495 is extended substantially horizontally between the first column 491 and the third column 493. The rear beam 496 is extended substantially horizontally between the second column 492 and the fourth column 494. The support plate 481 is supported by the front beam 495 and the rear beam 496. As a result, the support plate 481 is laid between the top plate 420 (see FIG. 3A) and the bottom plate 430 (see FIG. 3B).

[0130] As shown in FIG. 3A and FIG. 13, the first wall 470 is fixed to the first column

491 and the second column 492 by screws. Accordingly, the first wall 470 is detached easily from the support frame 490. As shown in FIG. 11, since the first transmission portion 910 is formed between the first wall 470 and the first compressor 210B which is arranged closer to the first wall 470 than the second wall 480, the operator can access the first transmission portion 910 easily after detaching the first wall 470. Accordingly, the operator can perform the repair or the check of the first transmission portion 910 easily.

[0131] As shown in FIG. 3B and FIG. 13, the second wall 480 is fixed to the third column 493 and the fourth column 494 by screws. Accordingly, the second wall 480 is detached easily from the support frame 490. As shown in FIG. 11, since the second transmission portion 920 is formed between the second wall 480 and the second compressor 220B which is arranged closer to the second wall 480 than the first wall 470, the operator can access the second transmission portion 920 easily after detaching the second wall 480. Accordingly, the operator can perform the repair or the check of the second transmission portion 920 easily.

[0132] Seventh Embodiment

A driving portion may be supported by a support member different from a support member which supports a compressor. Alternatively, the driving portion and the compressor may be mounted to a common support member. In this case, an error relating to a relative position between the driving portion and the compressor is decreased. In a seventh embodiment, a technique for decreasing an error relating to a relative position between a driving portion and a compressor will be described.

[0133] As shown in FIG. 13, a support plate 481 comprises a right support plate 482, a left support plate 483 and a lower support plate 484. Each of the right support plate 482 and the left support plate 483 is mounted on the lower support plate 484. After that, the right support plate 482 and the left support plate 483 are mounted on a front beam 495 or a rear beam 496.

[0134] FIG. 14 is a schematic perspective view of the lower support plate 484. The support plate 481 will be further described with reference to FIG. 11, FIG. 13 and FIG. 14.

[0135] The lower support plate 484 includes a lower plate 485, a frame rib 486, a lattice rib 487 and four ear portions 488. The lower plate 485 is laid below the right support plate 482 and the left support plate 483. The frame rib 486 protrudes upward from a rectangular outer peripheral edge of the lower plate 485. The lattice rib 487 stands in a rectangular space surrounded by the frame rib 486. Each of the right support plate 482 and the left support plate 483 is welded to upper edges of the lattice rib 487 and the

frame rib 486. Each of the four ear portions 488 protrudes from the frame rib 486 toward the front beam 495 or the rear beam 496. Since each of the four ear portions 488 is fixed to the front beam 495 or the rear beam 496, the lower support plate 484 is held appropriately by a support frame 490.

[0136] As shown in FIG. 13 and FIG. 14, a plurality of through holes is formed in each of the right support plate 482, the left support plate 483 and the lower plate 485 of the lower support plate 484. Each through hole is formed after the right support plate 482 and the left support plate 483 are welded to the lower support plate 484. Accordingly, a relative relation of positions of the through holes is substantially equal to a positional relation defined by a design drawing. The through hole formed in the right support plate 482 is used for mounting a first compressor 210B. The through hole formed in the left support plate 483 is used for mounting a second compressor 220B. The through hole formed in the lower plate 485 of the lower support plate 484 is used for mounting a first driving portion 810 and a second driving portion 820. In the present embodiment, an upper surface is exemplarily shown by upper surfaces of the right support plate 482 and the left support plate 483. A lower surface is exemplarily shown by a lower surface of the lower plate 485 of the lower support plate 484.

[0137] The exemplary air compression device described in connection with the above various embodiments is mainly provided with the following features.

[0138] An air compression device according to one aspect of the above embodiment comprises a first compressor including a first port wall in which a first suction port is formed, a second compressor including a second port wall in which a second suction port is formed and a suction pipe which guides an air to the first suction port and the second suction port. The first port wall and the second port wall are arranged to face each other. The suction pipe is arranged between the first port wall and the second port wall.

[0139] According to the above configuration, since the suction pipe is arranged between the first port wall and the second port wall, the first compressor and the second compressor can share a piping space for the suction. Accordingly, the designer can set the air compressor to be small in size.

[0140] Relating to the above configuration, the air compression device may further comprise a delivery pipe which receives a first compressed air from a first delivery port formed in the first port wall, and receives a second compressed air from a second delivery port formed in the second port wall. The first compressed air is generated by the air flowing in through the first suction port is compressed by the first compressor. The second compressed air is generated by the air flowing in through the second suction

port is compressed by the second compressor.

[0141] According to the above configuration, since the delivery pipe receives both of the first compressed air and the second compressed air from the first delivery port formed in the first port wall and the second delivery port formed in the second port wall respectively, a delivery passage is formed between the first port wall and the second port wall. Since the first compressor and the second compressor can share a space between the first port wall and the second port wall for the delivery, the designer can set the air compression device to be small in size.

[0142] Relating to the above configuration, the delivery pipe may include a manifold in which the first compressed air and the second compressed air are joined and a first fixing member which fixes the manifold to at least one of the first compressor and the second compressor. The first fixing member may include a first adjusting structure which enables to adjust a relative position of the manifold against the first compressor and the second compressor.

[0143] According to the above configuration, since the first fixing member includes the first adjusting structure which enables to adjust the relative position of the manifold against the first compressor and the second compressor, an excessive load to the delivery passage caused by a mounting error of the first compressor and the second compressor is hardly generated.

[0144] Relating to the above configuration, the air compression device may further comprise a second fixing member which fixes the delivery pipe to the first port wall at a position different from a position where the first suction port is formed.

[0145] According to the above configuration, since the second fixing member fixes the delivery pipe to the first port wall at the position different from the position where the first suction port is formed, an excessively large load is hardly applied to the delivery pipe.

[0146] Relating to the above configuration, the delivery pipe may include a base end pipe and a bent pipe. The base end pipe extends from the first delivery port toward the second port wall. The bent pipe bends from the base end pipe and guides the first compressed air to the manifold. The bent pipe may include a second adjusting structure which adjusts a length of a guide section extending from the base end pipe toward the manifold.

[0147] According to the above configuration, since the bent pipe includes the second adjusting structure which adjusts the length of the guide section extending from the base end pipe toward the manifold, an excessive load to the delivery passage caused by a mounting error of the first compressor and the second compressor is hardly generated.

[0148] Relating to the above configuration, the air compression device may further comprise a first driving portion which generates a first driving force for driving the first compressor, a first transmission portion which transmits the first driving force to the first compressor, a second driving portion which generates a second driving force for driving the second compressor and a second transmission portion which transmits the second driving force to the first compressor. The housing may include an outer circumferential wall including a first wall and a second wall. The first wall stands at a position next to the first transmission portion. The second wall stands at a position next to the second transmission portion.

[0149] According to the above configuration, since the first transmission portion is arranged at a position next to the first wall and the second transmission portion stands at a position next to the second wall, the operator can repair and/or check the first transmission portion and the second transmission portion easily.

[0150] Relating to the above configuration, the housing may include a top plate to be connected to a vehicle, a bottom plate lying below the top plate, an outer circumferential wall standing at a position between the top plate and the bottom plate and a support plate lying at a position between the top plate and the bottom plate and supporting the first compressor and the second compressor. The support plate may include an upper surface to which the first compressor and the second compressor are mounted and a lower surface to which the first driving portion and the second driving portion are mounted.

[0151] According to the above configuration, since the first compressor and the second compressor are mounted to the upper surface of the support plate, while the first driving portion and the second driving portion are mounted to the lower surface of the support plate, each of the compressors and each of the driving portions are arranged to be aligned in the vertical direction, and therefore the designer can set the air compression device to be small in size in a horizontal direction. Further, since the compressor and the driving portion are unitized via the support plate, a transmission portion which transmits driving force from the driving portion to the compressor can be assembled easily.

[0152] Relating to the above configuration, the air compression device may further comprise a fan device including a fan blade rotating to generate cooling air which cools the first compressor and a cooling air flow adjusting box arranged between the fan device and the first compressor. The cooling air flow adjusting box may include a first adjusting plate facing the fan device and a second adjusting plate facing the first compressor. A circular opening may be formed in the first adjusting plate. A

rectangular opening may be formed in the second adjusting plate.

[0153] According to the above configuration, since the circular opening is formed in the first adjusting plate, while the rectangular opening is formed in the second adjusting plate, the first compressor can receive the cooling air as a whole. Since a shape of a flow region of the cooling air is appropriately adjusted by the cooling air flow adjusting box, the designer can set a distance between the fan device and the first compressor to be small.

[0154] Relating to the above configuration, the suction pipe may include a suction duct extending along the first port wall, a connecting pipe including a first end connected to the suction duct and a second end connected to the first suction port and a trim seal which seals an interspace between the suction duct and the first end.

[0155] According to the above configuration, since the first end of the connecting pipe is connected to the suction duct via the trim seal, an error in a relative position between the first compressor and the suction duct is absorbed by the trim seal. Accordingly, the suction pipe hardly receives an excessively large load caused by a mount error of the first compressor and/or the suction duct.

Industrial Applicability

[0156] The principle of the above embodiment is suitably used in various technical fields which require compressed air.

Claims

1. An air compression device comprising:

a first compressor including a first port wall in which a first suction port is formed;

a second compressor including a second port wall in which a second suction port is formed; and

a suction pipe which guides an air to the first suction port and the second suction port, wherein

the first port wall and the second port wall are arranged to face each other,

the suction pipe is arranged between the first port wall and the second port wall.

2. The air compression device according to claim 1, further comprising a delivery pipe which receives a first compressed air from a first delivery port formed in the first port wall, and receives a second compressed air from a second delivery port formed in the second port wall,

the first compressed air is generated by the air flowing in through the first suction port is compressed by the first compressor,

the second compressed air is generated by the air flowing in through the second suction port is compressed by the second compressor.

3. The air compression device according to claim 2, wherein

the delivery pipe includes a manifold in which the first compressed air and the second compressed air join each other and a first fixing member which fixes the manifold to at least one of the first compressor and the second compressor,

the first fixing member includes a first adjusting structure which enables to adjust a relative position of the manifold against the first compressor and the second compressor.

4. The air compression device according to claim 3, further comprising a second fixing member which fixes the delivery pipe to the first port wall at a position different from a position where the first suction port is formed.

5. The air compression device according to claim 3 or 4, wherein

the delivery pipe includes a base end pipe and a bent pipe,

the base end pipe extends from the first delivery port toward the second port wall,

the bent pipe bends from the base end pipe and guides the first compressed air to the manifold,

the bent pipe includes a second adjusting structure which adjusts a length of a guide section extending from the base end pipe toward the manifold.

6. The air compression device according to any one of claims 2 to 5, further comprising:

a first driving portion which generates a first driving force for driving the first compressor;

a first transmission portion which transmits the first driving force to the first compressor;

a second driving portion which generates a second driving force for driving the second compressor;

a second transmission portion which transmits the second driving force to the first compressor; and

a housing which forms a housing space in which the first compressor, the second compressor, the first driving portion, the first transmission portion, the second driving portion and the second transmission portion are housed, wherein

the housing includes an outer circumferential wall including a first wall and a second wall,

the first wall stands at a position next to the first transmission portion,

the second wall stands at a position next to the second transmission portion.

7. The air compression device according to claim 6, wherein

the housing includes a top plate to be connected to a vehicle, a bottom plate lying below the top plate, an outer circumferential wall standing at a position between the top plate and the bottom plate and a support plate lying at a position between the top plate and the bottom plate and supporting the first compressor and the second compressor,

the support plate includes an upper surface to which the first compressor and the second compressor are mounted and a lower surface to which the first driving portion and the second driving portion are mounted.

8. The air compression device according to claim 6 or 7, further comprising:

a fan device including a fan blade rotating to generate cooling air which cools the first compressor; and

a cooling air flow adjusting box arranged between the fan device and the first compressor, wherein

the cooling air flow adjusting box includes a first adjusting plate facing the fan device and a second adjusting plate facing the first compressor,

a circular opening is formed in the first adjusting plate,

a rectangular opening is formed in the second adjusting plate.

9. The air compression device according to any one of claims 1 to 8, wherein the suction pipe includes a suction duct extending along the first port wall, a connecting pipe including a first end connected to the suction duct and a second end connected to the first suction port and a trim seal which seals an interspace between the suction duct and the first end.