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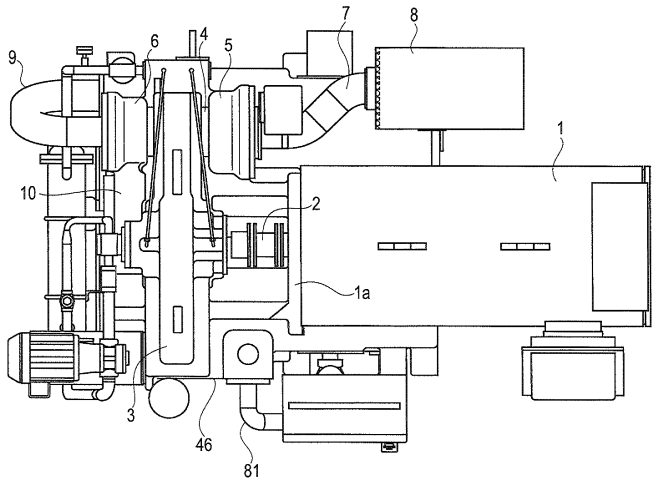
(54) TURBOCOMPRESSOR

(57) A turbocompressor provided with a case (46), a centrifugal first stage and second stage compressing unit (5, 6) disposed on the case (46), and a driver unit (1) for driving the first stage and second stage compressing units (5, 6), wherein the interior of the case (46) is partitioned into a first cooling area (44) which houses a first cooling device (47) and to which external air compressed by means of the first stage compressing unit (5) is fed, a second cooling area (45) which houses a second cooling device (48) and to which air that passed through the first cooling area and was further compressed by means of the second stage compressing unit (6) is fed, an oil tank (60) which houses lubricant oil that is fed to the driver unit (1), and a blowoff silencer chamber (80) to which the air that passed through the second cooling area (45) and was not used is fed; and the blowoff silencer chamber (80) is located between the oil tank (60) and the first cooling area (44) and the second cooling area (45) in the interior of the case (46).

FIG. 1



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Description

[Technical Field]

[0001] The present invention relates to a turbocompressor used as a power source in a factory or a process compressor, or particularly to a turbocompressor provided with a blowoff silencer.

[Background Art]

[0002] PTL 1 proposes a two-stage turbocompressor configured to: compress a fluid by a first stage compressor, then further compress the fluid by a second stage compressor, and discharge the fluid. This turbocompressor includes a case formed from a casting, and the first stage compressor and the second stage compressor which are disposed on the case. An impeller of the first stage compressor and an impeller of the second stage compressor are connected to each other with a rotating shaft. The rotating shaft is disposed parallel to an output shaft of a drive motor, and is driven by the drive motor through a gear system located at a central portion of the rotating shaft.

[0003] In the turbocompressor, external air is taken in from an intake port, and the external air is compressed by the first stage compressor and then fed to a first cooling area of the case. A first cooling device is housed in the first cooler. The compressed air is cooled by the first cooling device, fed from the first cooler to the second stage compressor, and further compressed. The air compressed by the second stage compressor is fed to a second cooler of the case. A second cooling device is housed in the second cooler. The compressed air is cooled by the second cooling device and is discharged from the second cooler through an exhaust port.

[0004] The turbocompressor described in PTL 1 is devised in a layout inside the case in order to achieve a reduction in size. The first cooler which houses the first cooling device, the second cooler which houses the second cooling device, and an oil tank which houses lubricant oil are arranged close to each other inside the case.

[0005] In a general centrifugal turbocompressor, pressure at an outlet of the compressor rises when the compressed air becomes excessive in a factory or the like and an amount of the compressed air consumed becomes smaller than an amount of the external air taken-in. In this case, when a pressure value detected by a sensor installed at an outlet portion of the compressor exceeds a preset value, a blowoff valve installed at an outlet of the second cooler is opened and the compressed air is discharged to the external air. In addition, in the above-described compressor, a blowoff silencer is installed at a position between the blowoff valve and a blowoff port to the atmosphere in order to reduce noise caused by opening the blowoff valve.

[Citation List]

[Patent Literature]

[0006] [PTL 1] Japanese Patent No. 3470410

[Summary of Invention]

[0007] In the meantime, a silencer with a low pressure loss has to be used as the blowoff silencer for the turbocompressor as described above in order to avoid surging. The surging is a phenomenon that backflow of air occurs inside an impeller. The occurrence of the surging leads to severe pulsation and disables normal operation. In this regard, it is common practice to silence and decelerate the air in the blowoff silencer by using a muffler with a small pressure loss, a duct to which a noise absorption material is attached, and the like. However, since a noise reduction effect increases in proportion to the size of the blowoff silencer, there is a problem that a centrifugal turbocompressor made in a compact size cannot suppress blowoff noise sufficiently.

[0008] The present invention has been made in view of the above-described circumstances. An object of the present invention is to provide a turbocompressor capable of being installed in a small space together with a blowoff silencer and sufficiently decreasing noise caused when compressed air is discharged to the external air.

[0009] To solve the problem and to attain the object, a turbocompressor according to an embodiment of the present invention includes any of the following configurations.

[Configuration 1]

[0010] A turbocompressor includes a case, a centrifugal first stage compressing unit disposed on the case, a centrifugal second stage compressing unit disposed on the case, and a driver unit configured to drive the first stage compressing unit and the second stage compressing unit. The case is partitioned into: a first cooling area which houses a first cooling device and to which external air compressed by the first stage compressing unit is fed; a second cooling area which houses a second cooling device and to which air that passes through the first cooling area and is further compressed by the second stage compressing unit is fed; an oil tank which houses lubricant oil that is fed to the driver unit; and a blowoff silencer chamber to which the air that passes through the second cooling area and is discharged to an atmosphere is fed, and, in the interior of the case, the blowoff silencer chamber houses a blowoff silencer and is located between the oil tank and the first cooling area as well as the second cooling area.

[Configuration 2]

[0011] In the turbocompressor having Configuration 1,

the case includes partition plates which partition the interior of the case into the first cooling area, the second cooling area, the oil tank, and the blowoff silencer chamber. Moreover, the second cooling area, the oil tank, and the blowoff silencer chamber are integrally formed from a casting.

[0012] Since the turbocompressor has Configuration 1, the blowoff silencer chamber is located between the oil tank and the first cooling area as well as the second cooling area in the interior of the case. Thus, a silencing effect by the blowoff silencer can be increased. In addition, since there is an air layer between the oil tank and the first as well as the second cooling areas, heat transfer occurring between the air inside the cooling areas and the lubricant oil inside the oil tank is suppressed.

[0013] Moreover, the turbocompressor can achieve lower manufacturing costs by a reduction in the number of components, and can be installed in a small space together with the blowoff silencer.

[0014] Meanwhile, since the turbocompressor has Configuration 2, the case is formed from the casting integrally with the partition plates to partition the interior of the case. Thus, the silencing effect of the blowoff silencer can be increased.

[0015] In other words, it is possible to provide the turbocompressor, which can be installed in a small space together with the blowoff silencer, and sufficiently reduce noise when exhaust air is discharged to the external air.

[Brief Description of Drawings]

[0016]

[Fig. 1]
Fig. 1 is a plan view of a turbocompressor according to an embodiment of the present invention.
[Fig. 2]
Fig. 2 is a side view of the turbocompressor in Fig. 1.
[Fig. 3]
Fig. 3 is a front view of the turbocompressor in Fig. 1.
[Fig. 4]
Fig. 4 is a transverse sectional view showing a configuration of a case of the turbocompressor in Fig. 1.

[Description of Embodiments]

[0017] An embodiment of the present invention will be described below on the basis of the drawings.

[0018] Fig. 1 is a plan view of a turbocompressor according to an embodiment of the present invention, Fig. 2 is a side view of the turbocompressor in Fig. 1, and Fig. 3 is a front view of the turbocompressor in Fig. 1.

[0019] The turbocompressor according to the embodiment of the present invention is a so-called geared turbocompressor. As shown in Fig. 1 to Fig. 3, the turbocompressor is a two-stage compressor including a case 46 formed from a casting, and a centrifugal first stage compressing unit 5 as well as a centrifugal second stage compressing unit 6 which are disposed on the case 46.

[0020] The turbocompressor rotates impellers of the first stage and second stage compressing units 5, 6 at a high speed by using an output shaft 2 of a drive motor 1 serving as driving means and through a gear system 3, imparts kinetic energy to air (gas) that is taken in, efficiently decelerates the air thus taken in and converts the air into pressure, and thereby compresses the air. The turbocompressor is configured to improve overall compression efficiency by performing intermediate cooling and approaching isothermal compression.

[0021] The drive motor 1 is a so-called flange motor, which is fixed on the case 46 with a flange 1a interposed in between. A rotating shaft 4 is disposed parallel to an output shaft 2 of the drive motor 1 and is connected to the output shaft 2 through the gear system (a speed-up gear) 3. The first stage compressing unit 5 is provided at an end portion of the rotating shaft 4 near the drive motor 1. The second stage compressing unit 6 is provided at the other end of the rotating shaft 4. A drive force is transmitted to a central portion of the rotating shaft 4 through the gear system 3. The impeller of the first stage compressing unit 5 is attached to the end side of the rotating shaft 4 near the drive motor 1 while the impeller of the second stage compressing unit 6 is attached to the other end side thereof.

[0022] Each of the first stage and second stage compressing units 5, 6 includes a diffuser and a scroll chamber which are located around the impeller attached to the rotating shaft 4. With the impellers subjected to rotation at the high speed, each of the first stage and second stage compressing units 5, 6 accelerates the air (gas), which is sucked in a central portion of the corresponding impeller, outward in the radial direction. The accelerated air passes through the corresponding diffuser and scroll chamber for deceleration, whereby the kinetic energy imparted to the air is converted into pressure energy.

[0023] In the gear system 3, a large gear (a bull gear) is connected to the output shaft 2 of the drive motor 1. A small gear (a pinion gear) meshing with the large gear rotates with increased speed and transmits the drive force to the rotating shaft 4.

[0024] Fig. 4 is a transverse sectional view showing a configuration of the case of the turbocompressor in Fig. 1.

[0025] The interior of the case 46 is partitioned into first and second cooling areas 44, 45 serving as air-guiding passages, an oil tank 60 filled with lubricant oil necessary for bearings in the rotating shaft 4 and for the gear system 3, and a blowoff silencer chamber (a blow tank) 80. A first cooling device (an intercooler) 47 and a second cooling device (an aftercooler) 48 for cooling the air are housed in the first cooling area 44 and the second cooling area 45, respectively. The case 46 is formed from the casting integrally with partition plates. Here, the partition plates partition the interior of the case 46 into the first cooling area 44, the second cooling area 45, the oil tank 60, and the blowoff silencer chamber 80. The blowoff silencer chamber 80 houses a blowoff silencer 82, and

is located between the oil tank 60 and the first cooling area 44 as well as the second cooling area 45.

[0026] Meanwhile, as shown in Fig. 1, an intake pipe 7 and an intake filter 8 of the first stage compressing unit 5 are disposed beside the drive motor 1. The intake filter 8 is provided for avoiding intake of a foreign object in atmospheric air. In the turbocompressor, external air is taken in from the intake pipe 7 by the first stage compressing unit 5, and the external air is compressed by the first stage compressing unit 5. Then, as shown in Fig. 4, the compressed air passes through an air passage unit of the case 46 and is fed from an inlet 44a of the first cooling area 44 into the first cooling area 44 of the case 46.

[0027] While the compressed air is heated to about 200°C at the time of being fed to the first cooling area 44, the air is cooled down to about 40°C by the first cooling device 47. The air cooled by the first cooling device 47 is fed from the first cooling area 44 to the second stage compressing unit 6 through an outlet 44b of the first cooling area 44 and piping 9.

[0028] The second stage compressor 6 further compresses the air thus fed, and then feeds the compressed air from an inlet 45a of the second cooling area 45 into the second cooling area 45 of the case 46 through an air passage unit 10 of the case 46. The air at about 200°C fed to the second cooling area 45 is cooled down to about 40°C by the second cooling device 48. The air cooled by the second cooling device 48 is discharged from the second cooling area 45 through an outlet 45b of the second cooling area 45. The air discharged from the outlet 45b of the second cooling area 45 is fed through not-illustrated piping for use in a factory or the like.

[0029] In the turbocompressor, pressure at an outlet of the compressor rises when the compressed air becomes excessive in a factory or the like and an amount of the compressed air consumed becomes smaller than an amount of the external air taken-in. Then, a blowoff valve 83 is opened when a pressure value detected with a sensor installed at an outlet portion of the compressor exceeds a preset value. In this case, the compressed exhaust air not for use is fed into the blowoff silencer chamber 80 through piping 81 that connects the outlet 45b of the second cooling area 45 and a blowoff silencer chamber inlet 80a. The exhaust air fed to the blowoff silencer chamber 80 passes through the blowoff silencer 82 housed in the blowoff silencer chamber 80, and is discharged from a blowoff silencer chamber outlet 80b to the external air. The blowoff silencer 82 is configured to reduce noise at a blowoff port of the turbocompressor by silencing and discharging the compressed air inside the blowoff silencer chamber 80 and decelerating a flow rate of the exhaust air. The blowoff silencer 82 has a structure including a muffler with a small pressure loss and a duct to which a noise absorption material is attached, and is configured to suppress the noise.

[0030] In the turbocompressor, all other units constituting the turbocompressor, namely, an intake control valve for controlling a flow rate of the air, a control panel for controlling a control valve as well as operation and shutdown, an oil supply system necessary for lubricating the bearings and the gears, a flue gas system configured to keep the interior of the case 46 at negative pressure in order to prevent the lubricant oil from leaking out of the case 46, and the like are installed on the case 46, and thereby space saving is achieved.

[0031] Moreover, in the turbocompressor, the blowoff silencer 82 is housed in the case 46 and the number of components is thereby reduced. Thus, the turbocompressor can achieve lower manufacturing costs and can also be installed in a small space together with the blowoff silencer.

[0032] Furthermore, in the turbocompressor, the blowoff silencer chamber 80 is located between the oil tank 60 and the first as well as the second cooling areas 44, 45. In addition, the case 46 is integrally formed from the casting. Thus, it is possible to increase a silencing effect of the blowoff silencer 82. When the compressed air is discharged to the atmosphere, its sound pressure level reaches 120 dB or higher. This blowoff sound can be shielded and attenuated by the blowoff silencer chamber 80. Thus, it is possible to sufficiently reduce the noise outside the turbocompressor.

[0033] If the oil tank 60 is built in the case 46, heat exchange will occur at its partition walls with the first and second cooling areas 44, 45 whereby the lubricating oil will absorb the heat from the high-temperature air and will raise the temperature of the cooled air again. If such a phenomenon occurs, the capacity of an oil cooler has to be increased and deterioration in efficiency of the compressor is caused by a rise in temperature of the air. In this turbocompressor, however, a rise in temperature of the lubricating oil inside the oil tank 60 is suppressed, and it is therefore unnecessary to increase the capacity of the oil cooler. In addition, no deterioration in efficiency of the compressor occurs due to a rise in temperature of the air.

[Industrial Applicability]

[0034] The present invention is applicable to a turbocompressor used as a power source or for a process in a factory, or more specifically, is applicable to a turbocompressor which is made in a compact size and suppresses noise by building a blowoff silencer chamber inside a case.

Claims

1. A turbocompressor comprising:

a case;
a centrifugal first stage compressing unit disposed on the case;
a centrifugal second stage compressing unit dis-

posed on the case; and
a driver unit configured to drive the first stage compressing unit and the second stage compressing unit, wherein
the case is partitioned into a first cooling area which houses a first cooling device and to which external air compressed by the first stage compressing unit is fed, a second cooling area which houses a second cooling device and to which air that passes through the first cooling area and is further compressed by the second stage compressing unit is fed, an oil tank which houses lubricant oil to be fed to the driver unit, and a blowoff silencer chamber to which the air that passes through the second cooling area and is to be discharged to atmosphere is fed, and
the blowoff silencer chamber houses a blowoff silencer, and is located between the oil tank and the first cooling area as well as the second cooling area in an interior of the case.

2. The turbocompressor of claim 1, wherein
the case comprises partition plates which partition the interior of the case into the first cooling area, the second cooling area, the oil tank, and the blowoff silencer chamber, and
the first cooling area, the second cooling area, the oil tank, and the blowoff silencer chamber are integrally formed from a casting.

FIG. 1

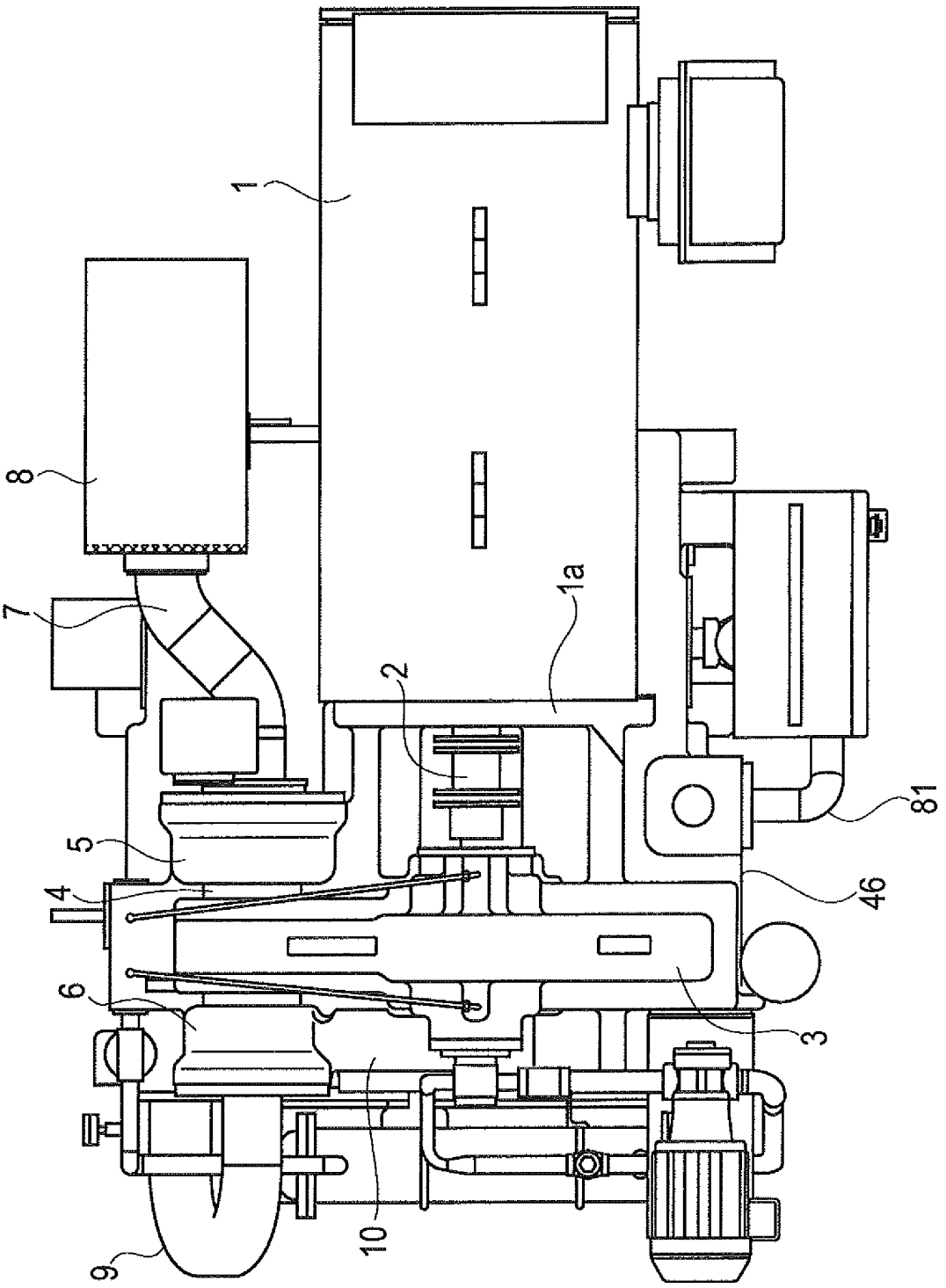


FIG. 2

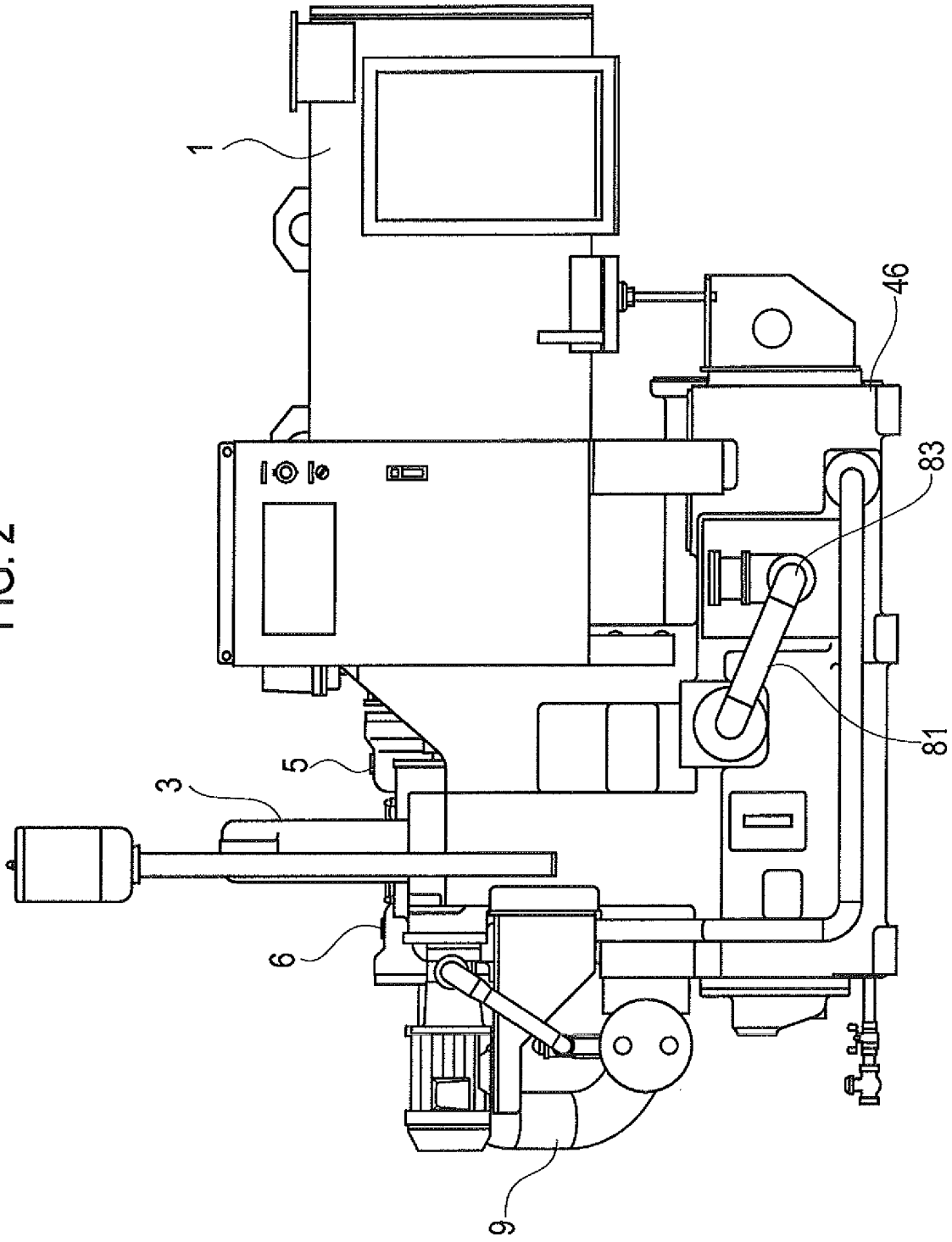


FIG. 3

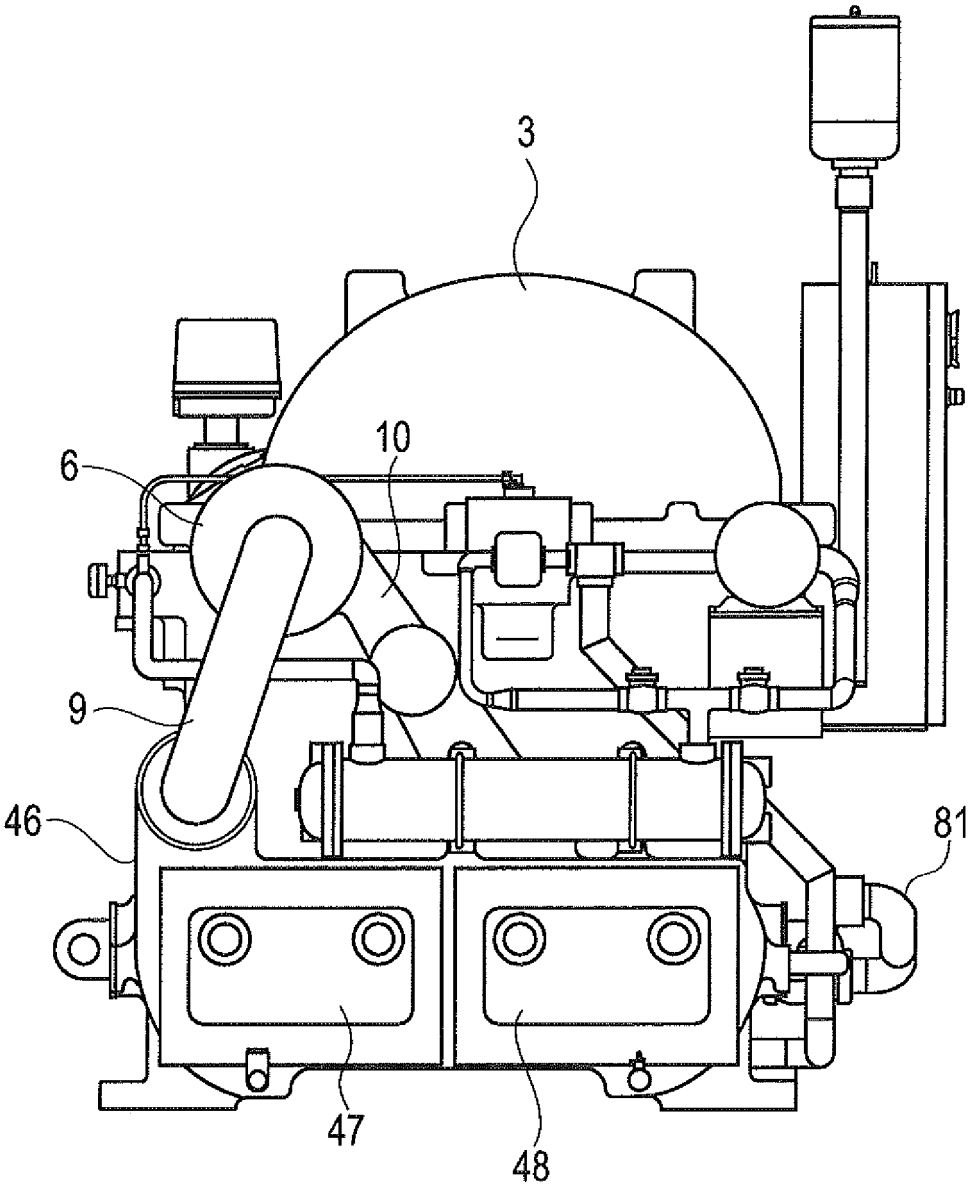
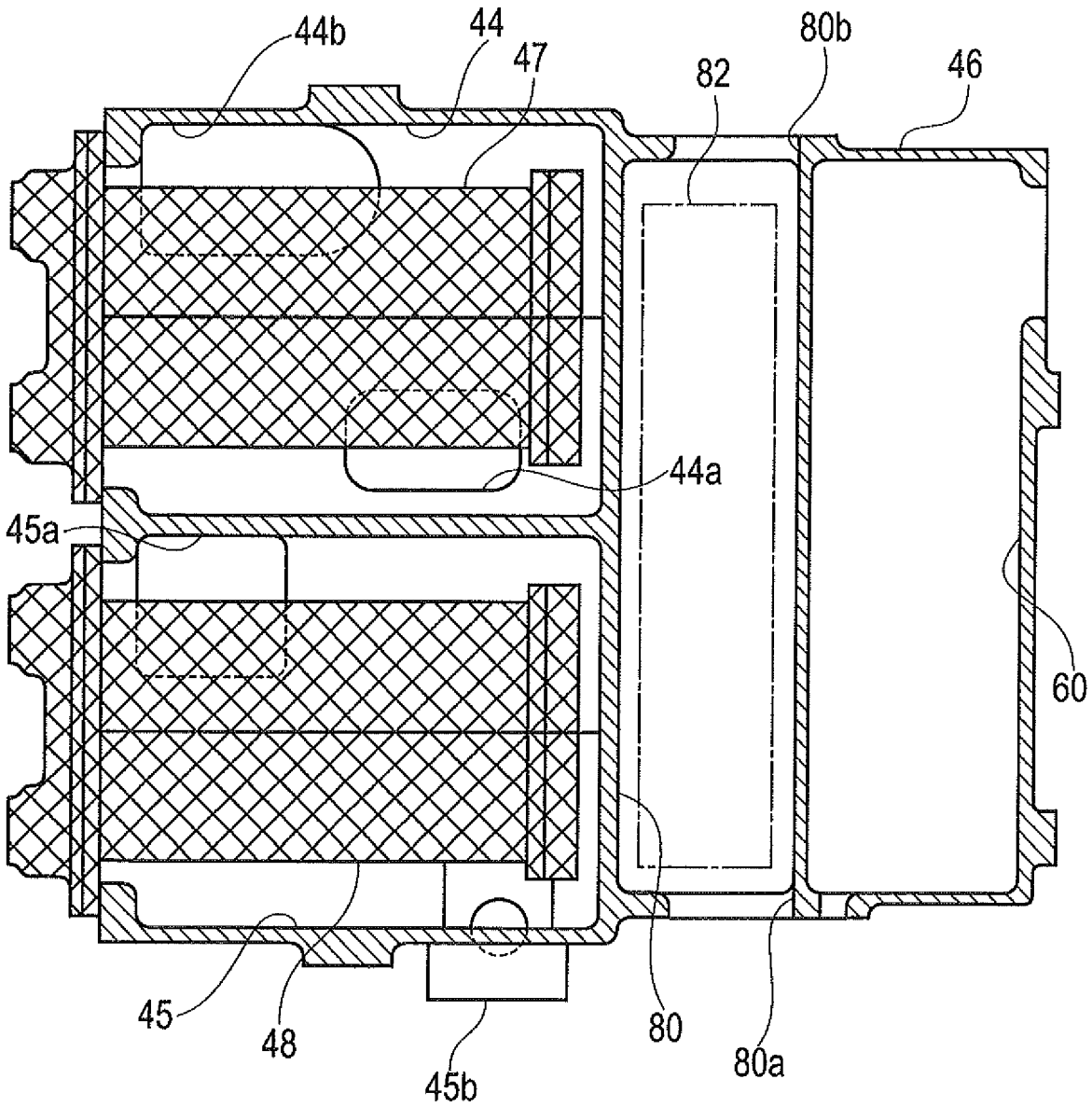


FIG. 4



INTERNATIONAL SEARCH REPORT

International application No.
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A. CLASSIFICATION OF SUBJECT MATTER
F04D29/58(2006.01)i, *F04D17/12*(2006.01)i, *F04D29/66*(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)
F04D29/58, F04D17/12, F04D29/66

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2012
Kokai Jitsuyo Shinan Koho	1971-2012	Toroku Jitsuyo Shinan Koho	1994-2012

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2005-248832 A (Ishikawajima-Harima Heavy Industries Co., Ltd.), 15 September 2005 (15.09.2005), entire text; all drawings (Family: none)	1,2
A	JP 4483194 B2 (IHI Corp.), 16 June 2010 (16.06.2010), entire text; all drawings & US 2006/0185334 A1 & US 2009/0320283 A1 & EP 1634634 A1 & EP 1997548 A1 & WO 2004/085031 A1	1,2

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

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Date of the actual completion of the international search 19 September, 2012 (19.09.12)	Date of mailing of the international search report 02 October, 2012 (02.10.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/066239

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 53-27865 B2 (Hitachi, Ltd.), 10 August 1978 (10.08.1978), entire text; all drawings & US 4125345 A & GB 1510019 A & DE 2541715 A1	1,2

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 3470410 B **[0006]**