(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 704 624 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.04.1996 Bulletin 1996/14

(51) Int. Cl.[6]: **F04D 25/16**, F04D 29/58

(21) Application number: **95115153.9**

(22) Date of filing: **26.09.1995**

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **28.09.1994 JP 233882/94**
29.09.1994 JP 235462/94

(71) Applicant: **Ishikawajima-Harima Heavy Industries Co., Ltd.**
Chiyoda-ku, Tokyo (JP)

(72) Inventors:
- **Hasegawa, Kazumitsu**
  Narashino-shi, Chiba (JP)
- **Matsubayashi, Yujiroh**
  Kami-Ina-gun, Nagano (JP)
- **Ashizawa, Kazuo**
  Shiojiri-Shi, Nagano (JP)

(74) Representative: **Schaumburg, Thoenes & Thurn**
Postfach 86 07 48
D-81634 München (DE)

(54) Turbo compressor

(57) A turbo compressor wherein a rotary shaft (4) with a first stage compressor (5) connected at one end and a second stage compressor (6) connected at the other end is located in parallel with a output shaft (2) of a drive motor (1) by way of a gear unit (3) characterized in that:

the first stage compressor (5) is located at one end of the rotary shaft (4) which end is on the drive motor's side while the second stage compressor (6) is located at the other end of the rotary shaft (4); and air inlet tube (7) and an air inlet filter (8) of the first stage compressor (5) are located proximate to and in parallel with a side of the drive motor (1).

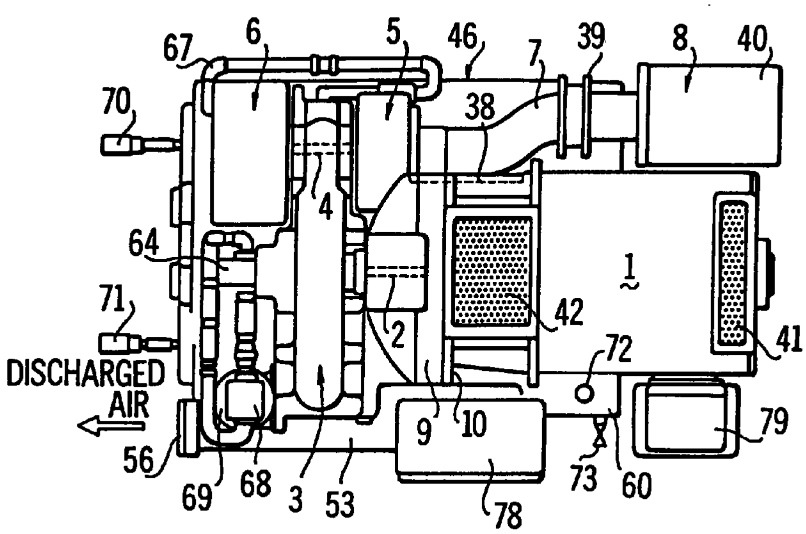

FIG. 1

EP 0 704 624 A1

Description

BACKGROUND OF THE INVENTION

Technical Field

The present invention relates to a turbo compressor used in a factory for power source and processing, and more particularly to a turbo compressor which has a reduced size and is easier for maintenance.

Background Art

As an industrial turbo compressor, the two-step type turbo compressor is known wherein fluid is compressed by its first stage compressor at the first step and further compressed by its second stage compressor at the second step, then eventually discarded. In the conventional turbo compressor above, the impellers of the first and second stage compressors are linked with a rotary shaft which is rotated by a drive motor by way of a gear unit.

More precisely, the rotary shaft is arranged in parallel with the output shaft of the drive motor, wherein a gear of the gear unit is engaged with a gear in the middle of the rotary shaft, and an impeller of the second stage compressor is mounted at one end of the rotational shaft on the drive motor's side, while an impeller of first stage compressor is mounted at the other end of the shaft.

However, locating the first stage compressor so that it be opposite with the drive motor results in air inlet tube connected with the first stage compressor and air inlet filter projecting opposite to the drive motor, increasing the installation area of the turbo compressor as a whole. Further, since the second stage compressor is located adjacent to the side of the drive motor, size-reduction attempted by shortening the distance between the output shaft of the drive motor and the rotation shaft of the second stage compressor inevitably causes the compressor to interfere with the drive motor. Thus, in the prior art the compressor cannot be removed without together removing the drive motor when the maintenance of the compressor is needed.

In addition, since the shaft coupling which connects the output shaft of the drive motor with the input shaft of the gear unit is covered with a casing, the gear unit cannot be removed without together removing the drive motor when the maintenance of the gear unit is needed. However, the drive motor is very heavy (approximately 850 kg) and the removal and resetting of the motor would require a crane to be employed, which is practically almost impossible.

SUMMARY OF THE INVENTION

The first object of the present invention proposed in consideration with the problems above is to provide a turbo compressor which allows size-reduction by introducing new arrangement of components.

The second object of the present invention is to provide a turbo compressor which allows compressors and a gear unit to be replaced with new ones without demanding the removal of a drive motor.

The first aspect. In order to achieve the first object of the present invention, the turbo compressor has an arrangement in which a rotational shaft with a first stage compressor connected at one end and a second stage compressor connected at the other end is located in parallel with a output shaft of a drive motor by way of a gear unit, wherein the first stage compressor is located at the end of the rotational shaft which is on the drive motor's side while the second stage compressor is located at the other end of the rotational shaft, and an air inlet tube and an air inlet filter of the first stage compressor are located proximate to and in parallel with a side of the drive motor.

The second aspect. A substantially rectangular-parallelepiped box of which inside is divided into two cooling chambers is provided underneath the first stage compressor, the second stage compressor and the gear unit, wherein one of the cooling chambers may be provided with a heat exchanger for an intercooler which cools a fluid emitted from the first stage compressor down then introduces the fluid into the second stage compressor, while the other cooling chamber may be provided with a heat exchanger for aftercooler which cools the fluid emitted from the second stage compressor down and then emits it out.

The third aspect. Each of the heat exchangers is elongated in the longitudinal direction along the associated cooling chamber, wherein each heat exchanger is located in the middle of the associated cooling chamber defining an entrance chamber and an exit chamber according to the flow direction. An air inlet with an elongated shape may be formed along each heat exchanger on one longitudinal end of the entrance chamber while an air outlet may be formed on the longitudinally opposite end of the exit chamber.

The fourth aspect. Further, in order to achieve the second object of the present invention, the turbo compressor has an arrangement in which a rotary shaft is located in parallel with a output shaft of the drive motor by way of a gear unit, wherein the first stage compressor is located at one end of the rotational shaft which end is on the drive motor's side while the second stage compressor is located at the other end of the rotational shaft, a distance between the output shaft and the rotational shaft is shortened so that the periphery of the drive motor and that of the first stage compressor partially overlap each other, the gear unit is integrally formed with the casing of the first stage compressor, and recesses are formed in the drive motor itself as well as in the drive motor mounting flange of the casing for the convenience in axially removing the inlet block of the first stage compressor.

The fifth aspect. A window portion may be provided for exposing a shaft coupling which connects the output shaft of the drive motor and the input shaft of the gear unit.

The structure according to the first aspect allows an arrangement in which the first stage compressor is located on the drive motor's side while the second stage compressor is located on the opposite side, and the air inlet tube and the air inlet filter of the first stage compressor are located proximate to and in parallel with a side of the drive motor. This arrangement prevents the air inlet tube and the air inlet filter from projecting outwardly, enabling a substantially rectangular installation area of the turbo compressor as a whole, which results in size-reduction. That is, the arrangement in which the first and second stage compressors, the gear unit, the drive motor, the air inlet tube and the air inlet filter of the first stage compressor form a substantially rectangular installation area as viewed from the top reduces the installation area of the whole apparatus.

The structure according to the second aspect allows an arrangement in which the heat exchanger for the intercooler and the heat exchanger for the aftercooler are accommodated in a substantially rectangular-parallelepiped box provided underneath the first and the second stage compressors and the gear unit. This arrangement reduces the size of the whole structure of the turbo compressor including the cooling mechanism. That is, the two story structure wherein the cooling mechanism is provided in the first story section of the box while the compression mechanism as well as the drive mechanism that drives the compression mechanism are located in the second story section, reduces the size of the whole structure of the apparatus (a turbo compressor).

The structure according to the third aspect allows an arrangement in which the air entrance with an elongated shape is formed on one longitudinal end of the associated entrance chamber along each heat exchange, while the air exit is formed on the longitudinally opposite end of the associated exit chamber. This arrangement achieves a substantially even flow of the fluid through the heat exchanger as the fluid introduced into the entrance chamber from the air entrance flows to the exit chamber to be eventually emitted out of the emission vent, and the even flow of the fluid improves the heat exchange rate. That is, the arrangement wherein the elongated-shaped air entrance is formed at one longitudinal end of the associated entrance chamber along each heat exchange while the air exit is formed at the longitudinally opposite end of the associated exit chamber achieves a substantially even flow of the fluid through the heat exchanger, thus improving the heat exchange.

The structure according to the fourth aspect provides the recesses with the casing and the drive motor respectively, and each recess prevents the inlet block and the motor to interfere with each other when the inlet block of the first stage compressor is axially displaced for removal. Thus, the inlet block of the first stage compressor can be removed without removing the drive motor from the drive motor mounting flange of the casing, which considerably facilitates the maintenance of the gear unit and the like.

The structure according to the fifth aspect allows the shaft coupling that connects the output shaft of the drive motor with the input shaft of the gear unit to be exposed through the window portion provided in the gear casing. The window portion allows the shaft coupling to be disconnected through the window portion and thus the gear unit to be removed without dismounting the drive motor, which considerably facilitates the maintenance of the gear unit and the like.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a plan view of a turbo compressor which represents an embodiment of the first aspect of the present invention.

Fig. 2 is a side view of the turbo compressor of Fig. 1

Fig. 3 is a front view of the turbo compressor of Fig. 1

Fig. 4 shows the first and the second stage compressors and the gear unit of Fig. 1

Fig. 5 shows the flow of compressed air.

Fig. 6 shows the flow of air in the cooling chamber.

Fig. 7 is a plan view of the turbo compressor which represents an embodiment of the second aspect of the present invention.

Fig. 8 is a sectional view taken along the line VIII-VIII of Fig. 7.

Fig. 9 shows the first and the second stage compressors and the gear unit of Fig. 7.

Fig. 10 is a side view of the drive motor.

Fig. 11 is an illustration as viewed from the direction indicated by the line XI-XI of Fig. 10.

Fig. 12 is a perspective view showing the crescent-shaped recess.

Fig. 13 is a perspective view showing the window portion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of the first aspect of the present invention will be described hereinafter in accordance with the accompanying drawings.

Fig. 1 is a plan view of a turbo compressor in accordance with the first aspect of the present invention. Fig. 2 is its side view and Fig. 3 is its front view. As shown in Fig. 1, a rotary shaft 4 is arranged in parallel with a output shaft 2 of a drive motor 1 by way of a gear unit 3 between the two shafts. A first stage compressor 5 is provided at one end of the rotary shaft 4 which is on the drive motor's 1 side, while a second stage compressor 6 is provided at the other end of the rotary shaft 4. An air inlet tube 7 and an air inlet filter 8 of the first stage compressor 5 is located in parallel with a side of the drive motor 1.

The drive motor 1 is so-called a flange motor mounted to a gear case 9 of the gear unit 3 by way of a flange 10 and its output shaft 2 is connected to a gear shaft 11 of the gear unit 3 (shown in Fig. 4) with bolt and nut through a shaft coupling 12. The gear shaft 11 is rotatably supported in the gear case 9 through bearings

13 with a larger gear 14 mounted in the middle of the gear shaft 11. The larger gear 14 is engaged with a smaller gear 15 mounted on the rotary shaft 4. The rotation velocity of the output shaft 2 of the drive motor 1 is increased and transmitted to the rotary shaft 4 by the gear unit 3.

The rotary shaft 4 has the smaller gear 15 mounted in the middle, an impeller 16 of the first stage compressor 5 at one end which is on the drive motor's 1 side, and an impeller 17 of the second stage compressor 6 at the other end. The portion between the smaller gear 14 and the impeller 16, as well as the portion between the smaller gear 14 and the impeller 17 are supported in the gear case 9 through bearings 18. The impeller 16 of the first stage compressor 5 is accommodated in a cylindrical recess 19 formed in a side of the gear case 9, while the impeller 17 of the second stage compressor 6 is accommodated in a cylindrical recess 20 formed in the opposite side of the gear case 9. Blocks 25, 26 having scroll chambers 21,22 and air inlet passages 23, 24 are inserted in these recesses 19, 20, respectively. Diffusers 27, 28 are formed between the block 25 and the recess 19 as well as between the block 26 and the recess 20, respectively.

The impeller 16 of the first stage compressor 5 draws in air from the air inlet passage 23 and radially and outwardly increases the flow velocity of the air. When the air with increased velocity passes through the diffuser 27 and the scroll chamber 21, its velocity is decreased and converted into pressure, then the air reaches an intercooler 29 shown in Fig. 5. The air which is cooled down in the intercooler 29 is led to a link passage 30 to the second stage compressor 6. As shown in Fig. 4, the link passage 30 is spirally formed outside the scroll chamber 22 of the second stage compressor 6, and defined when a cover 31 covers the recess 20.

Spirally forming the link passage 30 outside the scroll chamber 22 prevents the link passage 30 from projecting beyond the frame of the cover 31. A disk-shaped passage 32 is formed between the cover 31 and the block 26. The air inside the link passage 30 passes through the disk-shaped passage 32 and the inlet passage 24, then the impeller 17 of the second stage compressor 6 radially and outwardly increases the flow velocity of the air. When the air with increased velocity passes through the diffuser 28 and the scroll chamber 22, its velocity is converted into pressure then the air reaches an aftercooler 33 shown in Fig. 5. The air is cooled down in the aftercooler 33 and eventually emitted out.

The gear case 9 is separable into the upper part (the cover, not shown) and the lower part (the case body) by a horizontal sectional plane shown in Fig. 4. The cover can be mounted to the case body with bolts by screwing the bolts into apertures 34. Thus, maintenance of the gear shaft 11, the larger gear 14, the smaller gear 15, the rotary shaft 4 and the impellers 16, 17 can be easily performed by removing the cover. Further, the cover 31 and the block 26 of the second stage compressor 6 as well as the block 25 of the first stage compressor 5 can be removed by unscrewing bolts 35.

As shown in Fig. 4, a crescent-shaped portion is cut off from the motor mounting flange 36 in the gear case 9, thus defining a recess 37 so that the block 25 of the first stage compressor 5 can be pulled out without removing the drive motor 1. As shown in Fig. 1, another recess 38 of minimum length required for pulling the block 25 out is formed in the drive motor 1 itself.

As shown in Fig. 1, the air inlet tube 7 and the air inlet filter 8 are connected with the inlet passage 23 of the first stage compressor 5. The inlet tube 7 and the inlet filter 8 are located in parallel with the side of the drive motor 1. The inlet tube 7 is S-curved in the plan view and connected with the air inlet filter 8 by way of an inlet control valve 39. The inlet filter 8 includes a casing 40 which has a reversed L-shape in the side view as shown in Fig. 2, and functions for removing dusts from the sucked air as well as for muting the noise during suction. An air inlet 41 of the drive motor 1 and an air outlet 42 of the drive motor 1 are also shown in Fig. 1.

Referring to Fig. 5, a substantially rectangular-parallelepiped box 46 which is located underneath the first stage compressor 5, the second stage compressor 6 and the gear unit 3 is integrally molded with the gear case 9. The box is separated into a cooling chamber 44 containing the intercooler 29 and a cooling chamber 45 containing the aftercooler 33 by a partition wall 43. In the cooling chamber 44, a heat exchanger 47 for the intercooler 29 is provided so that the air from the first stage compressor 5 can be cooled by the intercooler 29 prior to its being led to the second stage compressor 6. In the other cooling chamber 45, a heat exchanger 48 for the aftercooler 33 is provided so that the air from the second stage compressor 6 can be cooled and then emitted out.

As shown in Fig. 1-Fig. 3, the substantially rectangular-parallelepiped box 46 having two cooling chambers 44, 45 is integrally molded with the gear case 9, and functions as a base which supports the first stage compressor 5, the second stage compressor 6, the gear unit 3, the drive motor 1 and the inlet filter 8. The box is so formed as to have an installation area (an installation area viewed from the top) which corresponds to the substantially rectangular installation area of the compressor 5 and other parts.

As shown in Fig. 5, each of the heat exchangers 47, 48 is formed with a longitudinally elongated shape along the associated cooling chamber 44, 45, and is located in the middle of the associated chamber 44, 45 dividing the chamber into an entrance chamber 49 and an exit chamber 50, respectively. A gap exists between the top/bottom of each heat exchanger 47, 48 (seal baffles 58) and the inner surface of the associated cooling chamber 44, 45. An air entrance 51 having an longitudinally elongated rectangular shape is provided, at one longitudinal end of the associated entrance chamber 49 along each heat exchanger 47, 48 respectively, while an exit 52 is provided on the longitudinally opposite end of the associated exit chamber 50 along each heat exchanger 47,48 respectively. The air entrance 51 of the cooling chamber 44 containing the intercooler 29 is connected to the scroll chamber 21 of the first stage compressor 5, while the exit 52 of the cooling chamber 44 is connected to the link passage 30 of the second stage compressor 6. On the other hand, the air entrance 51 of the cooling chamber 45 containing the aftercooler 33 is connected to the scroll chamber 22 of the second stage compressor 6 while the exit 52 of the cooling chamber 45 is connected to an emission tube 53.

Fig. 6 shows a plan view of the cooling chamber 45 containing the aftercooler 33. As shown in Fig. 6, the cooling chamber 45 of which installation area is rectangular in the plan view is divided into the entrance chamber 49 and the exit chamber 50 by the heat exchanger 48 for the aftercooler 33 which has an elongated shape. An air entrance 51 with an elongated rectangular shape is provided at one longitudinal end of the associated entrance chamber 49 along the heat exchanger 48. The air entrance 51 is connected to the scroll chamber 22 of the second stage compressor 6 by way of a link passage 55 of which cross section becomes larger as it approaches the air entrance as shown in Fig. 5. On the other hand, an exit 52 is provided at the longitudinally opposite end of the associated entrance chamber 50. The exit 52 is connected to an emission tube 53 which is integrally molded with a side of the box 46. An emission vent 56 is formed at the fee end of the emission tube 53.

The heat exchangers 47, 48 are provided with: a plurality of fin plates 57 oriented so that they vertically intersect the longitudinal axis of the exchangers; a plurality of water pipes which penetrate and extend through the fin plates 57 (not shown); seal baffles 58 extending both upon and beneath the fin plates 57; and seal members 59 mounted to the seal baffles 58. The seal baffle 58 guides the introduced air from one side to the other of the heat exchangers 47,48, and the seal members 59 seal the gaps between the seal baffles 58 and the inner surface of the cooling chambers 44, 45, preventing the air from leaking through the gaps. The seal members now clearly divides each cooling chamber 44, 45 into the entrance chamber 49 and the exit chamber 50.

As shown in Fig. 5, next to the cooling chambers 44, 45 an oil chamber 60 is integrally molded with the box 46. The oil chamber 60 reserves oil for lubricating the components in the gear unit 3 such as the larger and the smaller gears 14, 15, the rotary shaft 4 on which the impellers 16, 17 are mounted, and the like. The level of oil surface inside the oil chamber 60 is indicated by an oil level gauge 6, while the oil pressure is indicated by a manometer 62 as shown in Fig. 2.

The oil in the oil chamber 60 is pumped up through an oil tube 63 by a main oil pump 64 that is directly coupled with the gear shaft 11, and reaches the oil cooler 66 through an oil tube 65. After cooled, the oil is supplied to the bearings 18 of the rotary shaft 4 and the like through the oil tube 67. The supplied oil is eventually retrieved into the oil chamber 60. A sub oil pump 68 is also illustrated in Fig. 1-Fig. 3. The sub oil pump 68 is driven by its own motor 69 prior to the starting of the drive motor 1 which drives the main oil pump 64, in order to send a preliminary supply of oil to the bearings 18 of the rotary shaft 4 and the like.

Other components are also provided such as a drain 70 of the intercooler 29, a drain 71 of the aftercooler 33, an oil supply opening 72 of the oil tank 60, an oil discharge outlet 73 of the oil tank 60, an inlet 74 of the cooling water for the intercooler 29 and the aftercooler 33, an outlet 75 of the cooling water for the intercooler 29 and the aftercooler 33, an inlet 76 of the cooling water for the oil cooler 66, an outlet 77 of the cooling water for the oil cooler 66, a control panel 78, and a terminal box 79.

Now the function of the first embodiment of the present invention which includes the components above will be described.

In the arrangement described above, the first stage compressor 5 is located on the drive motor's side while the second stage compressor 6 is located on the opposite side, and the air inlet tube 7 and the air inlet filter 8 of the first stage compressor 5 are located in parallel with the side of the drive motor 1. This arrangement, in contrast with that of the prior art, prevents the air inlet tube 7 and the air inlet filter 8 from projecting out of the frame of the casing, achieving a substantially rectangular installment area which is 25% smaller than the previously required, thus reducing the whole size of the turbo compressor.

Further, accommodating the heat exchanger 47 for the intercooler 29 and the heat exchanger 48 for the aftercooler 33 in the substantially rectangular parallelepiped box 46 which is provided underneath the first and second stage compressors 5, 6 and the gear unit 3 allows the size-reduction of the turbo compressor as a whole including the cooling mechanism. That is, the box 46 functions not only as an accommodating box of the cooling mechanism such as the intercooler 29, but also as a support base of the compressor 5 and the like.

The turbo compressor of the present invention has a two-story structure in which the heat exchangers 47, 48 as the cooling mechanism are provided in the first story (more precisely in the box 46), while the compressors 5, 6 as the compression mechanism and the drive motor 1 as the drive mechanism which drives the compressors are provided in the second story. This two-story structure allows the size-reduction of the turbo compressor as a whole. Further, the box 46 can accommodate the oil storing chamber 60 in it, which also contributes to the size-reduction of the whole structure.

Additionally, the arrangement in which the elongated rectangle-shaped air entrance 51 is formed at one longitudinal end of the associated entrance chamber 49 of each cooling chamber 44, 45 along each heat exchange 47, 48, and the further arrangement in which the air exit 52 is formed at the longitudinally opposite end of the exit chamber 50 are provided. These arrangements allow substantially even air flow through the heat exchangers 47, 48 when the air introduced from the air entrance 51 into the entrance chamber 49 flow to the exit chamber 50 and is eventually emitted out of the exit 52. The substantially even air flow through the heat exchangers 47, 48 improves the heat exchanger rate.

Next, a preferred embodiment of the second aspect of the present invention will be described in accordance with Fig. 7-13 of the accompanying drawings.

As shown in Fig. 7, a rotary shaft 104 is arranged in parallel with a output shaft 102 of a drive motor 100 by way of a gear unit 103 between the two shafts. A first stage compressor 105 is provided at the end of the rotary shaft 104 which end is on the drive motor's 100 side, while a second stage compressor 106 is provided at the other end of the rotary shaft 104. An inlet tube 107 and an inlet filter 108 of the first stage compressor 105 are located in parallel with a side of the drive motor 100.

As shown in Fig. 10 and Fig. 11, a drive motor 100 has at one edge a motor-side flange 109 (which corresponds to the drive motor mounting flange of claim 4). The motor-side flange 109 is mounted to a casing-side flange 111 with bolt and nut, wherein the casing-side flange 111 is formed in a casing 110 which accommodates the gear unit 103 as shown in Fig. 8 and Fig. 9. Bolt bores 112 are also shown in the drawings. A output shaft 102 of the drive motor 100 is connected to an input shaft 114 of the gear unit 103 through a shaft coupling 115 with bolt and nut. The output shaft 114 is rotatably supported in the casing 110 through bearings 116, with a larger gear 117 mounted in the middle of the input shaft 114. The larger gear 117 is engaged with the smaller gear 118 which is provided on the rotary shaft 104. The rotational velocity of the output shaft 102 of the drive motor 100 is increased and transmitted to the rotary shaft 104 by the gear unit 103.

The diameter of the smaller gear 118 has been reduced to the ultimately minimized size which is substantially the same as the shaft diameter of the rotary shaft 104, in order to achieve size-reduction by ultimately minimizing the distance between the gear shaft 114 and the rotary shaft 104. Due to the operational characteristics the turbo compressor requires its gear unit 103 to have a predetermined speed increasing ratio, thus a predetermined ratio should exit between the diameter (the number of the gear teeth) of the larger gear 117 and that of the smaller gear 118. Therefore, making the diameter of the smaller gear 118 larger than that of the present embodiment would inevitably result in enlarging the diameter of the larger gear 117, thus widening the distance between the gear shaft 114 and the rotary shaft 104, increasing the whole size of the apparatus. In the embodiment of the present invention, the periphery of the drive motor 100 arid that of the first stage compressor 105 overlap each other due to the ultimately shortened distance between the two shafts.

The rotary shaft 104 has the smaller gear 118 mounted in the middle, an impeller 119 of the first stage compressor 105 at one end which is on the drive motor's 100 side, and an impeller 120 of the second stage compressor 106 at the other end. The portion between the smaller gear 118 and the impeller 119, as well as the portion between the smaller gear 118 and the impeller 120 are supported in the casing 110 through bearings 121. The impeller 119 of the first stage compressor 105 is accommodated in a cylindrical recess 122 formed on a side of the casing 110, while the impeller 120 of the second stage compressor 106 is accommodated in a cylindrical recess 123 formed on the opposite side of the casing 110. That is, the casing 110 functions as a casing not only for the gear unit 103 but also for the compressors 105, 106. Inlet blocks 128, 129 having scroll chambers 124, 125 and air inlet passages 126, 127 are inserted in the recesses 122, 123, respectively. Diffusers 130, 131 are formed between the top of the block 25 and the base of the recess 122, as well as between the top of the inlet block 129 and the base of the recess 123, respectively.

The impeller 119 of the first stage compressor 105 draws in air from the air inlet passage 126 and radially and outwardly increases the flow velocity of the air. When the air with increased velocity passes through the diffuser 130 and the scroll chamber 124, its velocity is decreased and converted into pressure, then the air reaches an intercooler located in a box 132 shown in Fig. 7. The box is integrally molded with the casing 110. The air which is cooled down in the intercooler in the box 132 is lead to the link passage 133 of the second stage compressor 106. As shown in Fig. 9, the link passage 133 is spirally formed outside the scroll chamber 125 of the second stage compressor 106, and defined when a cover 134 covers the recess 123.

Spirally forming the link passage 133 outside the scroll chamber 125 prevents the link passage 133 from projecting beyond the frame of the cover 134. A disk-shaped passage 135 is formed between the cover 134 and the block 129. The air inside the link passage 133 passes through the disk-shaped passage 135 and the inlet passage 127, then the impeller 120 of the second stage compressor 106 radially and outwardly increases the flow velocity of the air. When the air with increased velocity passes through the diffuser 131 and the scroll chamber 125, its velocity is converted into pressure then the air reaches an aftercooler accommodated in the box 132. The air is cooled down in the aftercooler and eventually emitted out.

The casing 110 is separable into the upper part (a cover, not show) and the lower part (the case body) by a horizontal sectional plane shown in Fig. 9. The cover can be mounted to the case body with bolts by screwing the bolts into apertures 136. Thus, maintenance of the input shaft 114, the larger gear 117, the smaller gear 118, the rotary shaft 104 and the impellers 119, 120 can be easily performed by removing the cover. Further, the cover 134 and the inlet block 129 of the second stage compressor 106 as well as the inlet block 128 of the first stage compressor 105 can be removed by unscrewing bolts 137.

As shown in Fig. 12, a crescent-shaped portion is cut off from the case-side flange 111 on the casing 110 and from the motor-side flange 109 on the drive motor

100, defining recesses 138, 139 respectively, so that the inlet block 128 of the first stage compressor 105 can be pulled out without removing the drive motor 100. Further, another crescent-shaped recess 140 of minimum length required for pulling the inlet block 128 out is formed in the drive motor 100 itself.

As shown in Fig. 10, a crescent-shaped cylindrical cover 141 is attached to the recess 140. The cover 141 guides the inlet block 128 when the block is pulled out.

The front body 100a of the drive motor 100 which is provided with the recess 140 includes a motor emission vent 142 but does not accommodate any substantial rotary drive mechanism such as coils and electro-magnetics. The substantial rotary drive mechanism is accommodated in the rear body 100b which is defined behind the flange 143 wherein the flange is located in the middle of the drive motor 100. Thus, providing the front body 100a with the recess 140 does not cause any problems in terms of the function of the drive motor 100. The motor emission vent 142 emits the cooled air which is drawn in from the motor air inlet 144 located in the rear body 100b of the drive motor 100.

As shown in Fig. 8 and Fig. 12, a arc-shaped reinforcement rib 145 is formed along the recess 138 defined in the case-side flange 111 wherein the case-side flange 111 is provided in the casing 110. The reinforcement rib 145 functions for compensating the loss of binding rigidity which results from the formation of the recess 138.

Further, a grease injection tube 146 through which grease is injected into the bearings of the output shaft 102 of the drive motor 100 is shown in Fig. 11 along with a grease discard tube 147 which discards grease when a handle 148 is pulled to the left-hand side.

Additionally, as shown in Fig. 7 and Fig. 13, a window 149 is provided in the gear casing 110a which accommodates the gear unit 103 of the casing 110, wherein the window exposes the shaft coupling 115 which connects the output shaft 102 of the drive motor 100 and the input shaft 114 of the gear unit 103. The window 149 is a rectangular-shaped opening on the upper surface of the case-side flange 111 of the gear casing 110a, and as shown in Fig. 7, upwardly exposes the shaft coupling 115 which connects the input shaft 114 of the gear unit 103 and the output shaft 102 of the drive motor 100. Further, a net member 150 for protection is releasably attached to the window 149.

The function of the of the present embodiment which includes the components above will be now described.

As shown in Fig. 7, the shaft coupling 115 which connects the output shaft 102 of the drive motor 100 and the input shaft 114 of the gear unit 103 is exposed in the window 149 provided in the casing 110a. Thus, maintenance of each of the components constituting the gear unit 103 (such as the larger gear 117, the input shaft 114 and the like) will be easily performed because the gear unit including the shaft coupling 115 can solely be removed without moving the drive motor 100 on the case-side flange 111 of the casing 110. The removal of the gear unit is, of course, preceded by removal of the net material 150 attached to the window 149, disconnection of the shaft coupling 115 through the window 149, and removal of the cover attached to the upper side of the body of which sectional view is horizontally taken and shown in Fig. 9. That is, the drive motor 100 which is heavy (weighs about 850 kg) and difficult to remove may remain attached to the casing 110, with its motor-side flange 109 connected to the case-side flange 111.

In addition, as shown in Fig. 9, when the inlet block 128 of the first stage compressor 105 is axially displaced for removal, the interference between the inlet block 128 and the drive motor 100 can be avoided owing to the three recesses wherein the three recesses are the recess 138 provided in the case-side flange 111, the recess 139 provided in the motor-side flange and the recess 140 provided on a side of the drive motor 140. Thus, the inlet block 128 of the first stage compressor 105 can be removed without removing the drive motor 100 from the casing 110.

Further, when the cover 134 and the inlet block 129 of the second stage compressor 106 are also removed, the maintenance of each component of the first and the second stage compressors 105, 106 (such as the impellers 119, 120, the rotary shaft 104 and the like) may be performed without removing the drive motor 100 from the casing 110.

Claims

1. A turbo compressor wherein a rotary shaft (4) with a first stage compressor (5) connected at one end and a second stage compressor (6) connected at the other end is located in parallel with a output shaft (2) of a drive motor (1) by way of a gear unit (3) characterized in that:

   the first stage compressor (5) is located at one end of the rotary shaft (4) which end is on the drive motor's side while the second stage compressor (6) is located at the other end of the rotary shaft (4); and air inlet tube (7) and an air inlet filter (8) of the first stage compressor (5) are located proximate to and in parallel with a side of the drive motor (1).

2. A turbo compressor having first stage and second stage compressors (5), (6), a gear unit (3) and a drive motor (1) characterized in that a substantially rectangular-parallelepiped box (46) of which inside is divided into two cooling chambers (44), (45) is provided underneath the first and second stage compressors (5), (6) functioning as a compression mechanism, and the gear unit (3) and the drive motor (1) functioning as a drive mechanism for driving the compression mechanism,

   wherein a heat exchanger (47) for an intercooler (29) which cools a fluid emitted from the first stage compressor (5) down and then introduces the fluid into the second stage compressor (6) is provided within one of the cooling chambers (44), while a heat exchanger (48) for an aftercooler (33) which cools the fluid emitted form the second stage compressor (6) down and then discards the fluid is provided within the other cooling chamber (45).

3. A turbo compressor having first stage and second stage compressors (5), (6) characterized in that each of cooling chambers (44), (45) into which a fluid is introduced from the first and second compressors (5), (6) is so formed as to be substantially rectangular-parallelepiped, and the cooling chambers (44), (45) accommodate heat exchangers (47), (48) inside thereof,

   wherein each heat exchanger (47), (48) is so formed along the associated cooling chamber (44), (45) as to have a longitudinally elongated shape and is located in the middle of the associated cooling chamber (44), (45) defining an entrance chamber (49) and an exit chamber (50) according to flow direction, and an air inlet (51) with an elongated shape is formed along each heat exchanger (47), (48) at one longitudinal end of the entrance chamber (49) while an air outlet (52) is formed at the diagonally opposite end of the exit chamber (50).

4. A turbo compressor wherein a rotary shaft (104) with a first stage compressor (105) connected at one end and a second stage compressor (106) connected at the other end is located in parallel with a output shaft (102) of a drive motor (100) by way of a gear unit (103) characterized in that:

   the first stage compressor (105) is located at one end of the rotary shaft (104) which end is on the drive motor's (100) side while the second stage compressor (106) is located at the other end of the rotary shaft (104);

   a distance between the output shaft (102) and the rotary shaft (104) is shortened so that periphery of the drive motor (100) and periphery of the first stage compressor (105) partially overlap each other;

   the gear unit (103) is integrally formed with a casing (110) of the first stage compressor 105;

   and, recesses (138), (139) are formed on the drive motor (100) itself as well as in a drive motor mounting flange (111) of the casing (110) for the convenience in axially removing an inlet block (128) of the first stage compressor (105).

5. The turbo compressor according to claim 4 characterized in that a window portion (149) for exposing a shaft coupling which connects the output shaft (102) of the drive motor (100) and the input shaft (114) of the gear unit (103) is formed in the casing (110) so that the window portion (149) is located in a gear casing portion (110a) which accommodates the gear unit (103).

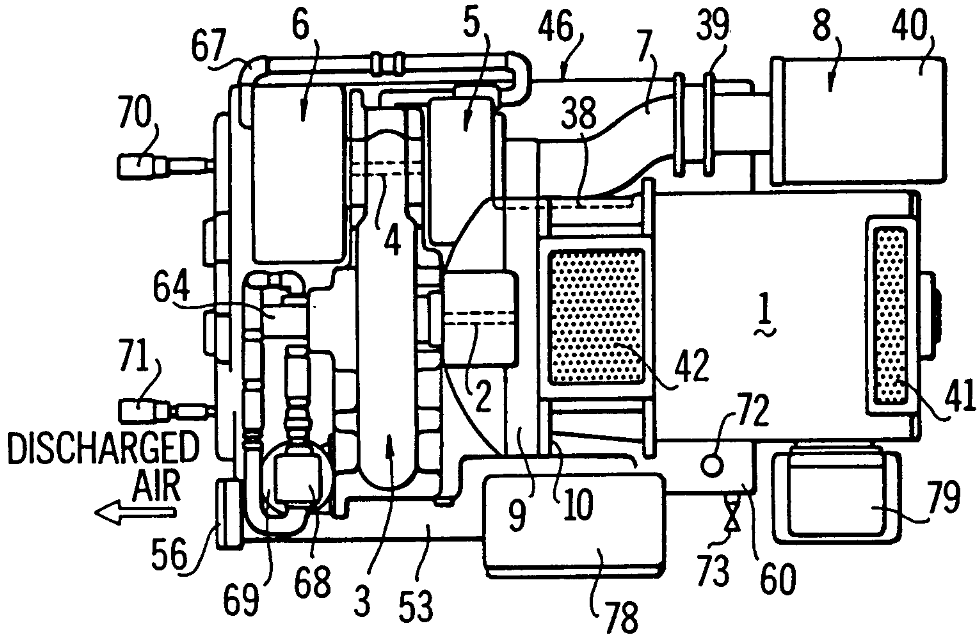
67
6
5
46
7
39
8
40
70
38
4
64
1
71
2
42
41
72
DISCHARGED
AIR
9
10
79
56
69
68
3
53
73
60
78

FIG. 1

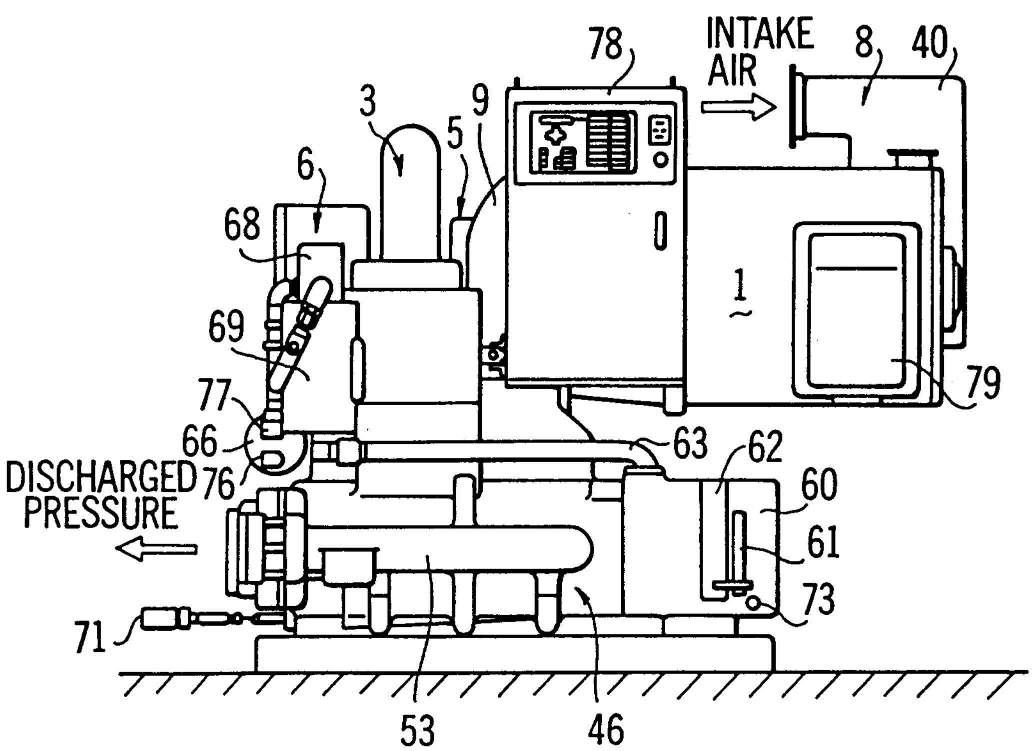
78
INTAKE
AIR
8
40
3
9
5
6
68
1
69
79
77
66
63
62
DISCHARGED
PRESSURE
76
60
61
73
71
53
46

FIG. 2

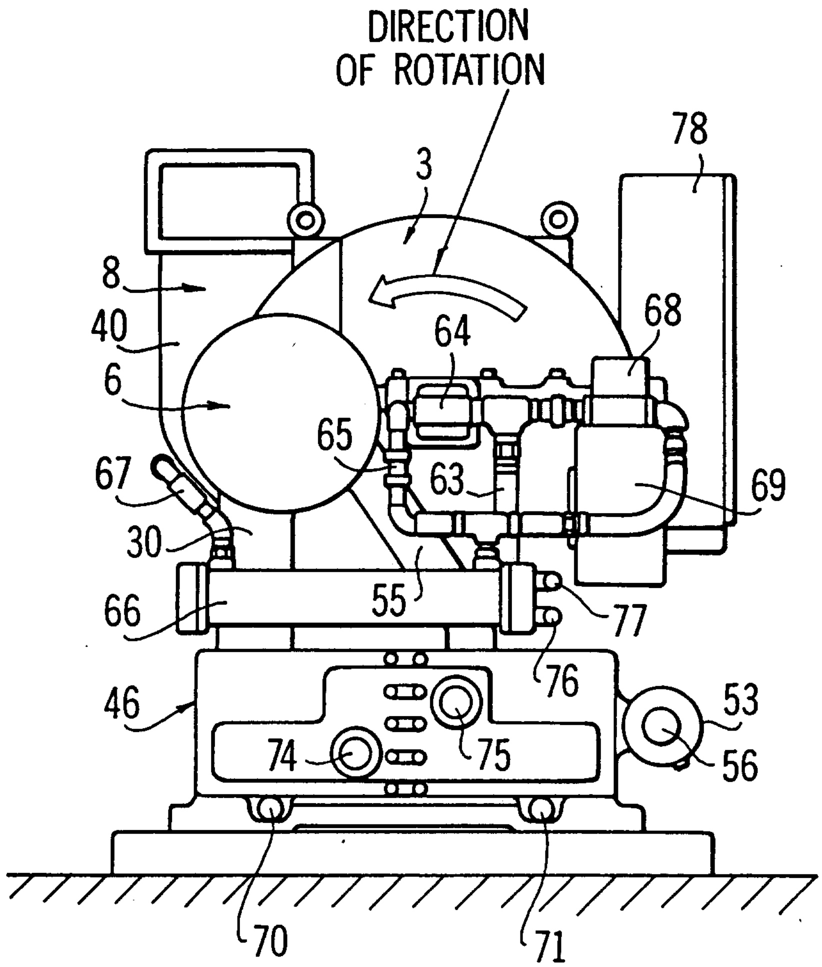
DIRECTION
OF ROTATION
78
3
8
40
6
64
68
65
67
63
69
30
55
66
77
76
46
53
74
75
56
70
71

FIG. 3

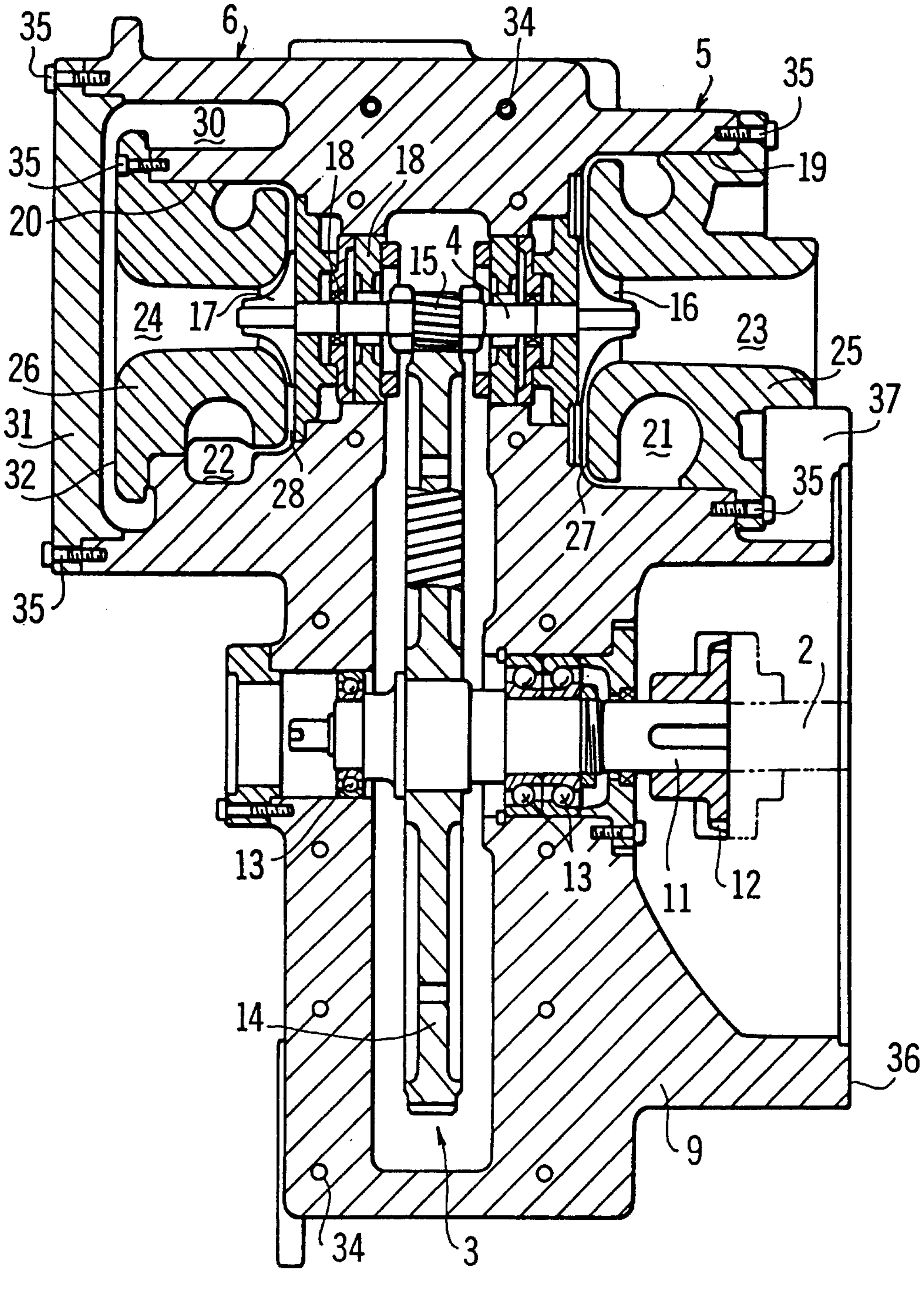
35
6
34
5
35
30
18
18
19
35
20
4
15
17
24
16
23
26
25
31
37
21
32
22
35
28
27
35
2
13
13
11
12
14
36
9
34
3

FIG. 4

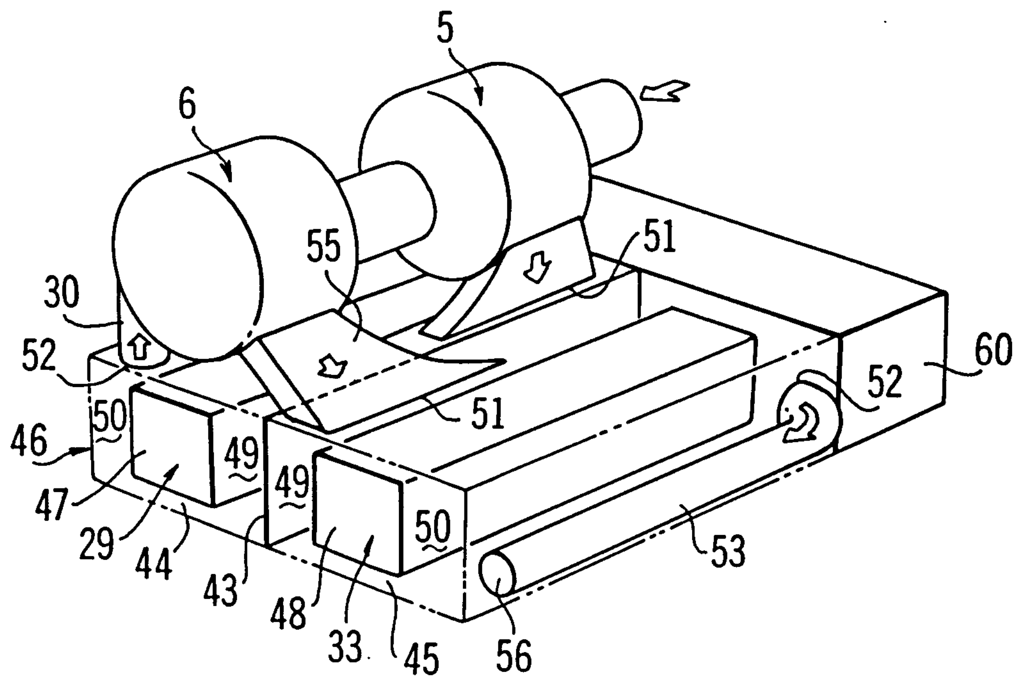
5
6
55
51
30
52
50
46
49
47
29
44
43
48
33
45
56
53
52
60
51

FIG. 5

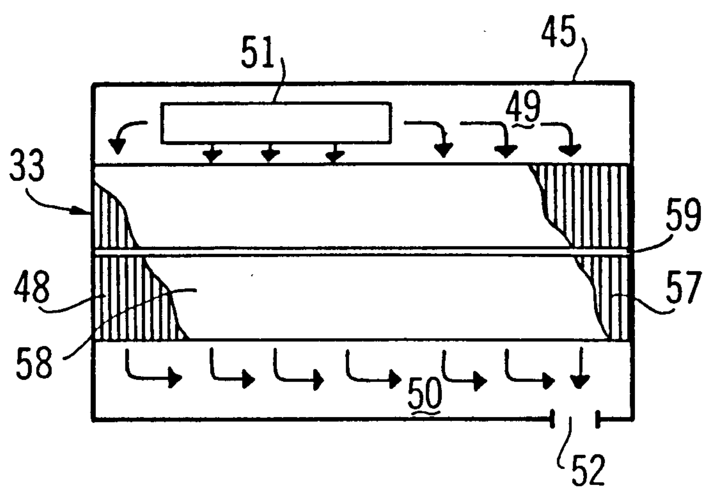
51
45
49
33
59
48
57
58
50
52

FIG. 6

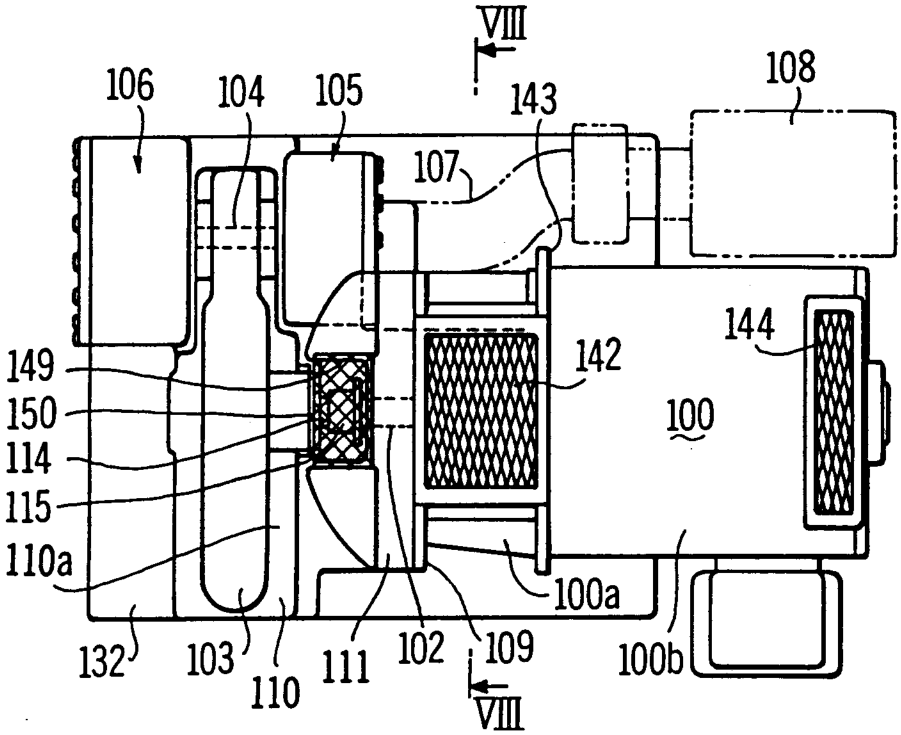
VIII
106
104
105
143
108
107
149
150
114
115
110a
142
144
100
100a
132
103
110
111
102
109
100b
VIII

FIG. 7

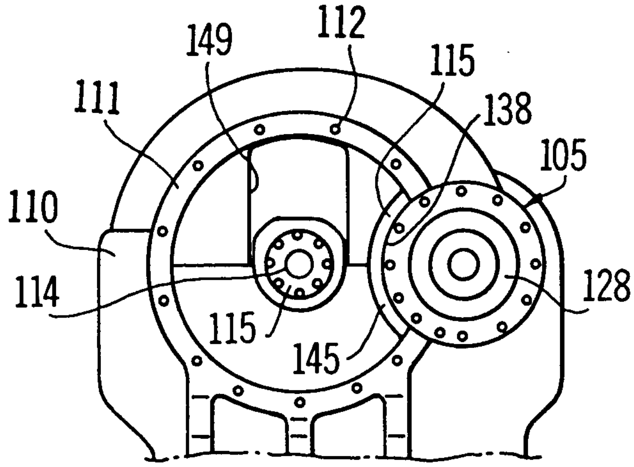
112
149
115
111
138
105
110
114
115
145
128

FIG. 8

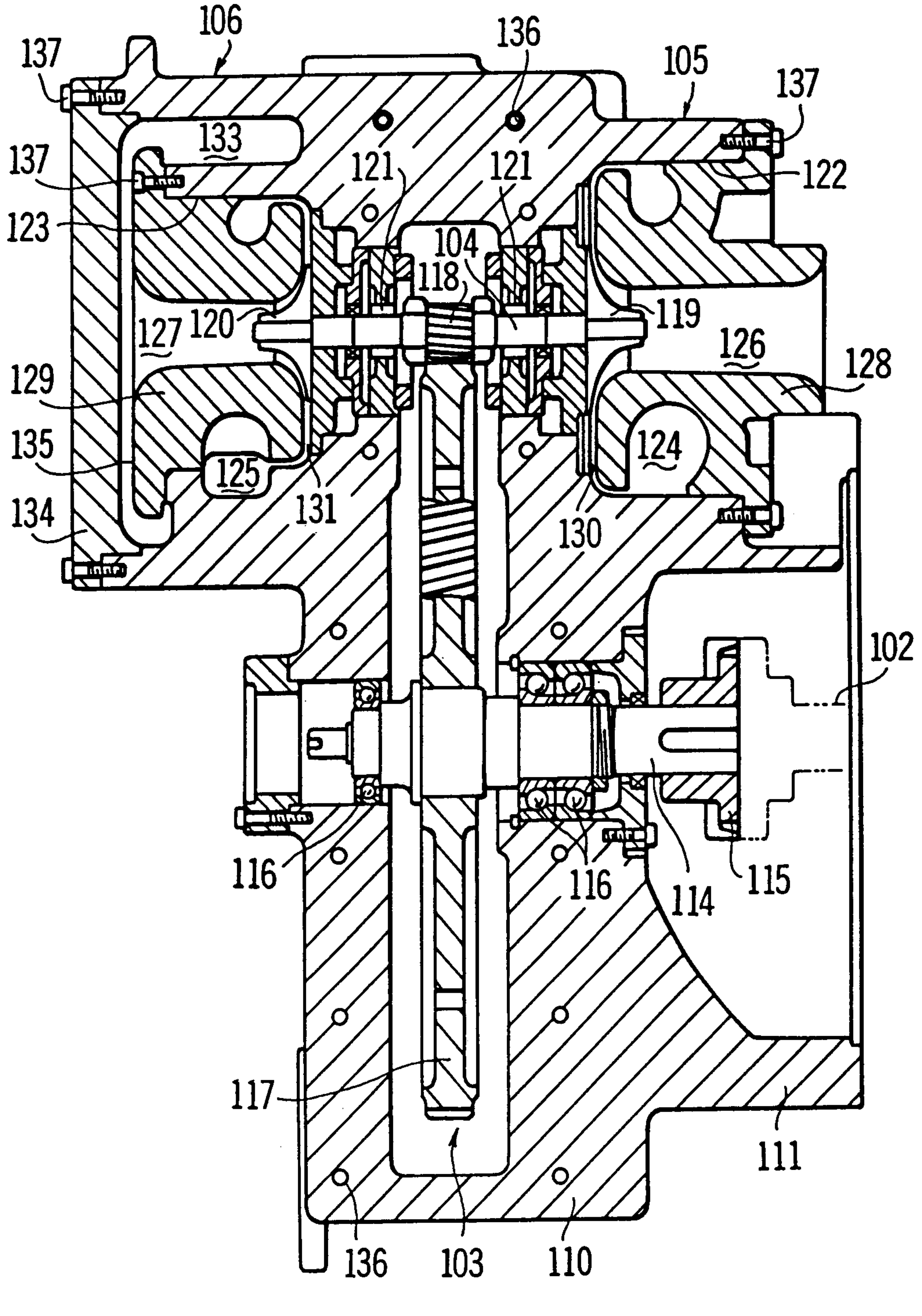
106
136
105
137
137
133
121
121
122
137
123
104
118
120
119
127
126
128
129
135
124
125
131
130
134
102
116
116
115
114
117
111
136
103
110

FIG. 9

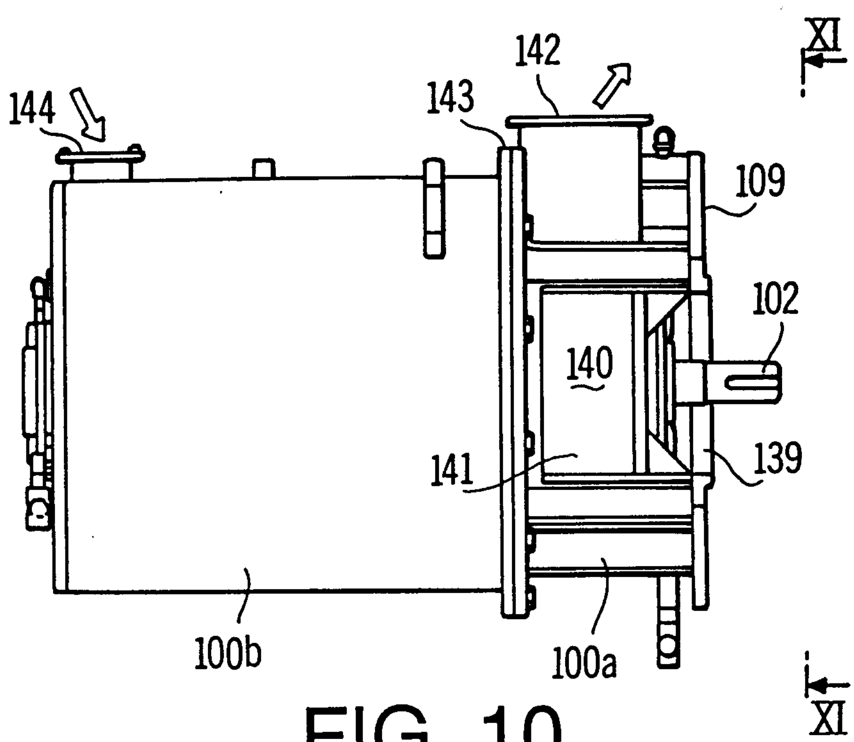
144
143
142
XI
109
102
140
141
139
100b
100a
XI

FIG. 10

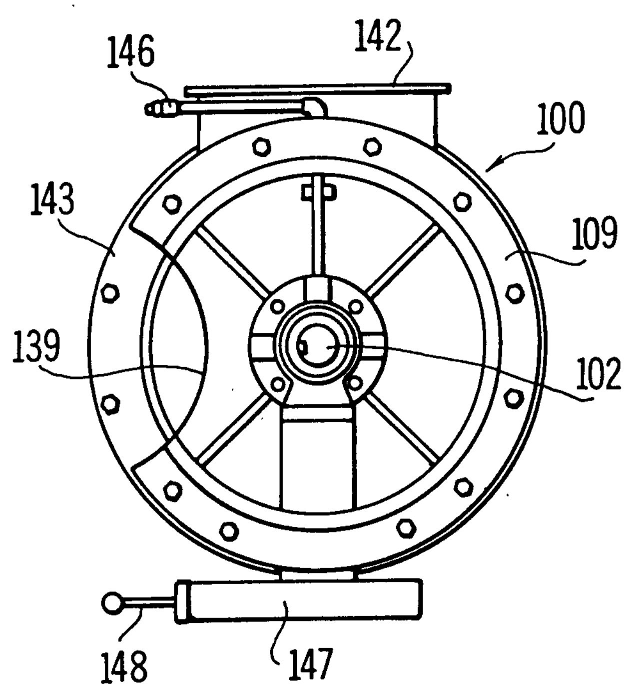
146
142
100
143
109
139
102
148
147

FIG. 11

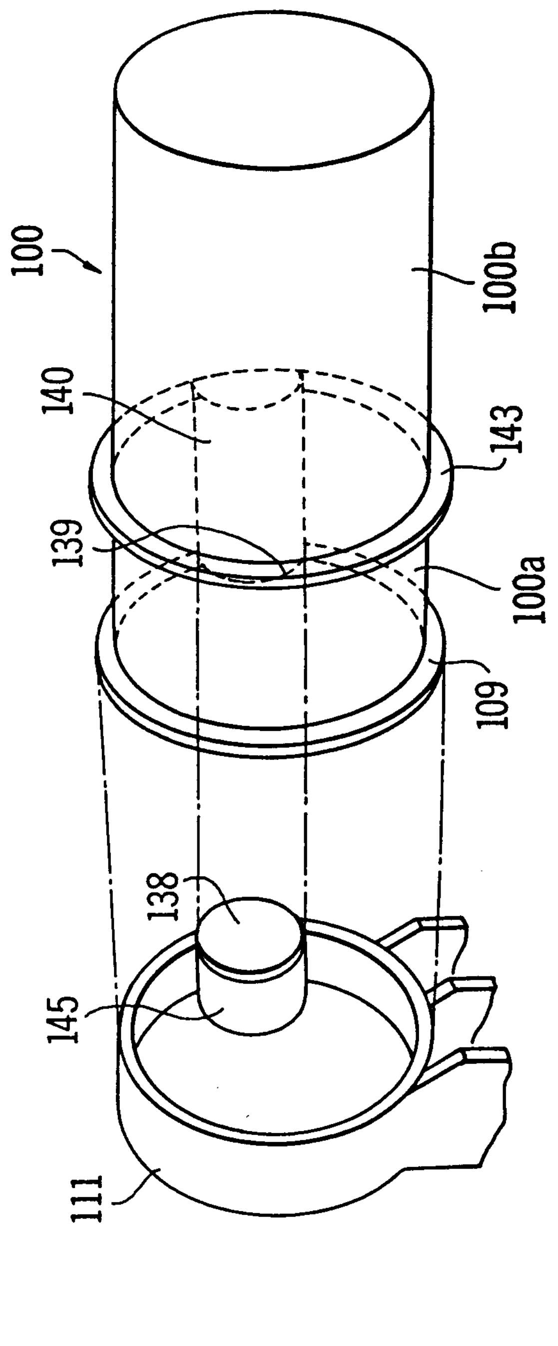

FIG. 12

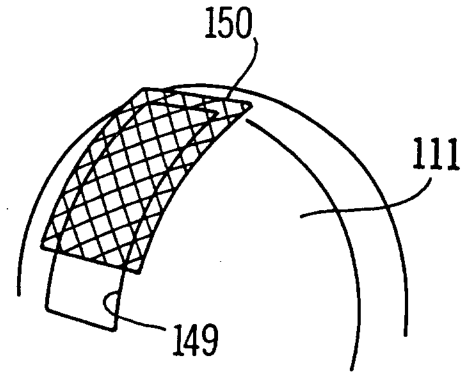

FIG. 13

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 95 11 5153

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	US-A-3 476 485 (KUNDERMAN) * the whole document * ---	1-4	F04D25/16 F04D29/58
A	DE-A-21 28 233 (CARRIER) * the whole document * ---	1-4	
A	FR-A-2 180 732 (WORTHINTON-CEI) * the whole document * ---	1-5	
A	GB-A-2 163 247 (MANNESMANN) * the whole document * ---	1-5	
A	GB-A-714 765 (TULIPAN) * the whole document * ---	1-4	
A	US-A-3 658 442 (HEITMANN) * the whole document * -----	1-4	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			F04D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23 January 1996	Teerling, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)