

Compact Unit

The present invention relates to a compact unit, at least consisting of an electric motor accommodated in housing parts of a unit housing, and which drives at least one hydraulic pump and gives off heat in the process, an air-heat exchanging device, and a fan which can be driven to produce an air flow.

Compact units of this type are prior art. Such units are used for supplying pressure to hydraulic circuits, in particular, when working hydraulics are to be supplied with pressurized hydraulic liquid at locations, in which only a limited amount of space is available. When units are required to be operated continuously in cramped locations and, as a result, steps have to be taken for cooling the motor and for cooling the hydraulic fluid, the accommodation of the all the components, including hydraulic pump and heat exchanging device in a housing having small dimensions, creates multiple difficulties. This is true, for example, when hydraulics of manufacturing machines, such as lathes, must be supplied with pressurized fluid in closed factory buildings.

In view of these problems, the object of the invention is to provide a compact unit, which is distinguished by a particularly space-saving design, and in which all elementary components for a functionally reliable operation are integrated in a common housing.

This object is achieved according to the invention by a compact unit, which includes the features of claim 1 in its entirety.

Accordingly, a substantial distinctive feature of the invention is a flow conducting means present in the compact housing, which forms partial flows from the air flow generated by the fan, one of which flows around the electric motor for the purpose of cooling same, and another one flows toward the heat exchanging device, or the airflow flows, in succession, first toward the electric motor and then toward the heat exchanging device, wherein part of the invention also includes in the compact unit solution according to the invention also reversing the direction of the air flow, so that the air flows in each case in the direction opposite that described above. The

formation of partial flows in the interior of the unit housing is advantageous, first of all because it is possible to arrange the components to be cooled in the unit housing in any position relative to the fan that generates the air flow, i.e., at installation points at which the installation space in the unit housing is optimally utilized, and in such a way that a particularly efficient flow around mainly components to be cooled, such as the electric motor, is achieved. Due to the respective potential air flow, it is possible in any case to integrate all elementary components of the compact unit, such as the electric motor, the air-heat exchanging device, as well as the fan, in a single housing. In this way, a functionally more reliable continuous operation of the compact unit is also achieved.

Due to the demonstrated air flow guidance, it is also possible to generate an overpressure to a certain degree in the interior of the device housing, so that all sensitive parts inside the housing are protected by the housing from dust and potential spray water. Because of the overpressure condition present during operation, a higher IP protection class or IP degree of protection, in this case IP 54, can be readily achieved.

For an efficient flow around the electric motor, the arrangement in this regard may be obtained in an advantageous manner, such that the electric motor is disposed in the air flow between the fan and the heat exchanging device.

In particularly advantageous exemplary embodiments, the flow conducting means forms an additional partial flow from the air flow, which serves as a cooling air flow for a frequency converter provided for controlling the electric motor. Controlling the electric motor as needed by means of a frequency converter makes a particularly energy-efficient operation possible, wherein the cooling of the frequency converter by the partial flow divided off from the airflow ensures a high operational safety of the unit, even during continuous operation.

In particularly advantageous exemplary embodiments, the arrangement is obtained such that the flow conducting means for the airflow defines a first flow path, which runs between the front side and the opposing rear side of the unit housing, and in which the fan, the electric motor and a cooling body of the frequency converter are situated, and defines a second flow path diverging therefrom, which branches off

toward one side of the unit housing, preferably at a right angle, and in which the heat exchanging device is disposed. This allows the heat exchanging device with a corresponding large flow-through surface to be disposed along a housing side next to the electric motor in such a way that the base area of the housing is well utilized. The said first flow path and the said additional second flow path may also be disposed in series one behind the other, so that air flows first toward the electric motor and then subsequently toward the heat exchanging device.

In particularly advantageous exemplary embodiments, the electric motor drives both a first hydraulic pump and a second hydraulic pump, which are connected on their intake side to a tank supplying a hydraulic fluid, and of which the first hydraulic pump generates a fluid flow through the heat exchanging device to the tank, and the second hydraulic pump serves to supply pressure to working hydraulics. A filter device is preferably provided in each case between the tank and the intake sides of the hydraulic pumps. The functions of the said pumps may also be switched; if necessary, only one pump is also sufficient in order to ensure the fluid transport function. It is further conceivable, in the case of two pumps, to also actuate one of the pumps by a different, also external drive.

A particular compact design can be implemented if the tank forms a base part in the unit housing, on which the fan, the electric motor and first and second hydraulic pumps are disposed on a cover plate of the tank in an axial direction from the front side to the rear side, and the heat exchanging device is disposed alongside the electric motor and the frequency converter is disposed alongside of the hydraulic pumps.

In a structure of this type, on a tank forming an integral base part of the unit, the support plate of the tank and a housing cover surrounding the fan and the electric motor may be particularly advantageously provided as components of the flow conducting means. In this way, the flow conducting means also forms a type of enclosure for sound insulation. For volume production, these housing elements may be advantageously manufactured as plastic injection molded parts or as die-cast aluminum parts, wherein a favorable sound insulation is also achieved by the respective housing material.

The invention is explained in detail below with reference to an exemplary embodiment depicted in the drawing, in which:

- Figure 1 shows in a symbolic representation the hydraulic circuit of an exemplary embodiment of the compact unit according to the invention;
- Figure 2 shows a perspective diagonal view of the exemplary embodiment, as viewed from a front side and a wide side with a heat exchanging device situated thereon;
- Figure 3 shows a perspective diagonal view of the exemplary embodiment as viewed from the wide side opposite the heat exchanging device and the rear side of the unit housing, and
- Figure 4 shows a top view of the exemplary embodiment on a scale somewhat larger compared to Figure 2 and 3, with a housing cover removed from the housing base part.

As shown in Figure 1, a hydraulic pump 1 and a second hydraulic pump 2 may be jointly driven by an electric motor 3, the speed of which may be regulated by means of a frequency converter 5 visible in Figures 2 and 3. Both hydraulic pumps 1 and 2 are connected on the intake side to a tank 7 supplying hydraulic fluid, wherein a filter element 9 and 11 is disposed in each case in the connection to the intake side of the pumps 1 and 2. The hydraulic pump 1 serves as a delivery pump for a heat exchanging device 14, having a feed line 13 connected on the pressure side 12 of the pump 1, an oil-air heat exchanger 15 and a return line 17 leading to the tank 7. A fan, designated with reference numeral 19, generating an airflow may be actuated by a fan drive, in the present example, in the form of an electric fan motor 21. If desired, a return line filter 23 may be provided in the return line 17, as is depicted in the circuit diagram in Figure 1, wherein the return line filter 23 may be circumvented by a bypass having a bypass valve 25 set to an opening pressure of, for example, 3 bar.

The pressure side 27 of the second hydraulic pump 2 is connected via a check valve 29 to a pressure line 31, which leads to a pressure connection P of the unit, via

which the assigned hydraulic circuit may be supplied, from which the return flow volumes flow back to the tank 7 via a tank connection T and a tank line 33. The pressure line 31 is secured toward the tank 7 via a pressure limiting valve 35, wherein the pressure limiting valve 35 is set, for example, at 45 bar. The electric motor may be set by means of the frequency converter 5 to an operating speed of, for example, 600 to 2000 1/min, at a maximum speed of, for example 3200 1/min with an output of, for example, 1.5 Kw. In addition to the pressure connection P and at least one tank connection T, measurement connections 37 and 39 for a manometer 41 and a pressure sensor 43 are connected to the pressure line 31. The said pumps 1 and 2 may also be switched with one another in terms of their function and, instead of a coupled drive, may be driven individually, if applicable, also by an external drive source situated outside the compact unit. The respective size or the performance capacity of the each hydraulic pump used may differ from one another, in particular, may be kept variable.

Figures 2 through 4 illustrate the mechanical structure of the unit. As shown, the unit housing, designated in its entirety by reference numeral 45, has a largely rectangular contour, wherein the tank 7 forms the base part of the housing 45, and wherein the tank 7 extends approximately over the entire base surface and to approximately half the height of the housing 45. The upper side of the tank 7 is closed off by a planar support plate 47, on which the essential components are assembled. In Figure 2, a fill level indicator 49 attached to the side of the tank 7, as well as a filler neck 51 and the end cap 53 of the optional return line filter 23 (Figure 1) on the upper side of the support plate 47 are visible. A box-like housing cover 55 is visible in both Figures 2 and 3, which, as shown by the comparison with Figure 4, surrounds the fan 19 and the electric motor 3 located at the housing front side 57, the electric motor being connected to the fan 19 away from the housing front side 57 in the direction toward the housing rear side 59. The heat exchanger 15, which connects to an outlet opening 61 of the housing cover 55, the contour line or connecting line of which is indicated on the cover plate 47 in Figure 4 by a double line 63, is mounted on the support plate 47 between the electric motor 3 and the housing side 60 situated below in Figure 4. Other control blocks such as, for example, valve modules having functions other than those described above may also be accommodated on the

support plate 47 and/or inside the device housing 45.

The airflow, indicated with dash-lined flow arrows 65, generated by the fan 19 is guided in the configuration shown in the form of one partial flow designated by light arrow heads 67, which flows around the electric motor 3, as well as a directly following second partial flow, indicated by black arrow heads 63, which flows through the heat exchanger 15 as a transverse flow. An additional third partial flow, which continues the first partial flow 67 in the direction of the housing rear side 59 and, in that respect, again in succession, exits at there, as is shown by an arrow also provided with black arrowhead 71, after which it flows through ventilation blades 73, which form a cooling lamella assembly for cooling the frequency converter 5 connected to the heat exchanger 15. A display 77 for indicating operating data, as well as a sealing flap 79 for covering electrical connection devices are visible on the converter housing 75 of the frequency converter 5 in Figure 2. Thus, the circuit board of the frequency converter 5 is integrated in the housing 45, specifically, in a dust-proof and spray-protected design. A kind of overpressure condition is created inside the housing 45 essentially sealed to the outside, in particular, during operation of the compact unit, which stops foreign particles from outside sources from penetrating into the interior of the housing 45, so that a higher protection class for the compact unit, in this case, IP 54 is readily achieved.

The cooling airflow, conditioned by the rotation of the fan blades of the fan 19, is guided helically around the outer housing of the electric motor 3 and uniformly brushes over the longitudinal cooling ribs disposed on the outside thereof. To achieve a forced guidance for the cooling airflow, the flow conducting means preferably provides a uniform spacing between the outer circumferential side of the electric motor 3 and the cross sectional surface of the housing 45, cylindrical in cross section, to which it may be allocated. To prevent an accumulation of heat on the rear side of the electric motor 3 facing away from the fan 19, a large-dimensioned flow-through space is provided, formed by the rear side of the electric motor and the adjacent front wall of the housing 45 for accommodating the electric motor 3. In this rearward area, the cooling airflow (arrowheads 67) is deflected at a right angle to the other flow-through direction of the fan 19 and, with this diversion, flows through the oil-air heat exchanger 15. The tank 7 used each time, which, as seen upward in the

viewing direction of Figures 2 and 3, is covered by the support plate 47, may be variously designed in terms of its height, and thus may accommodate different tank supply volumes. Even such a tank 7 consists preferably of plastic or die-cast aluminum.

In addition, however, the cooling air is also guided along a straight line and flows through the cooling lamellas of the frequency converter 5 in such a way that the airflow is split and conducted in parallel between the cooling lamellas. After passing the cooling lamellas or cooling vanes 73 of the frequency converter 5, the cross sectional profiles expand toward the surroundings, so that no flow resistance is able to build up as the flow passes through cooling lamella assembly. It is also a great advantage that the fan 19 as described above may not only be driven during operation under pressure, but may also guide the airflow in the opposite direction through the compact unit with its said components, by reversing the direction of rotation of the fan blades while suctioning during negative pressure operation. Such a reverse operation could be practical when, for example, sensors not further depicted determine that the frequency converter 5 or the heat exchanging device 14 is at a temperature higher than the normal operating temperature, in order in this way to cool these components upstream from the electric motor 3 as viewed in the flow direction.

As also indicated in Figures 2 and 3, the hydraulic pumps 1 and 2 are disposed outside the housing cover 55 between said cover and the housing rear side 59, and are provided with the auxiliary devices, such as pressure limiting valve 35, pressure sensor 43 and a contamination indicator 81. If a plastic is provided as the material for the unit housing 45, a corresponding color scheme of the housing may be implemented in a simple manner at the customer's request by dyeing the plastic material. In the case of a transparent design of the tank 7, a fill level indicator could also be eliminated. Owing to the compact design on the tank 7 serving as the housing base, the unit may be simply and conveniently converted for use at alternating locations. The forced ventilation of the electric motor 3 allows the use of cost-effective motor designs and therefore enables a corresponding efficient manufacture. Given the modular construction of the housing 45, support plate 47 and tank 7, the individual said components may be assembled within a broad framework

in the sense of a modular system for adapting the compact unit to on-site demands, wherein this flexibility of the design and assembly also extends even to the hydraulic components of the compact housing being used.

Claims

1. A compact unit, at least consisting of
 - an electric motor (3) accommodated in housing parts (7, 55) of a unit housing (45), which drives at least one hydraulic pump (1) and gives off heat in the process,
 - an air-heat exchanging device (14) and
 - a fan (19), which may be driven to generate an airflow (65),characterized in that a flow conducting means (47, 55) is present in the unit housing (45) which divides the airflow (65) into at least one first partial flow (67), which flows around the electric motor (3) and one second partial flow (69), which flows toward the heat exchanging device (14), or the airflow (65), in succession, flows first toward the electric motor (3) and then toward the heat exchanging device (14), or that the respective flow occurs at least partly in the reverse direction by means of the air flow (65).
2. The compact unit according to Claim 1, characterized in that the electric motor (3) is disposed in the air flow between the fan (19) and the heat exchanging device (14).
3. The compact unit according to Claim 1 or 2, characterized in that the flow conducting means (47, 55) forms a third partial flow from the air flow (71), which serves as a cooling air flow for a frequency converter (5) provided for controlling the electric motor (3).
4. The compact unit according to one of the preceding claims, characterized in that the flow conducting means (47, 55) defines a first flow path for the air flow, which runs between the front side (57) and the opposite rear side (59) of the housing (45), and in which the fan (19), the electric motor (3) and a cooling body (73) of the frequency converter (5) are located, and defines a second flow path branching off therefrom, which branches off toward one side (60) of the unit housing (45), preferably at a right angle, and in which the heat exchanging device (14) is disposed.

5. The compact unit according to one of the preceding claims, characterized in that the electric motor (3) drives a first hydraulic pump (1) and/or a second hydraulic pump (2), which are connected on their intake side to a tank (7) supplying hydraulic fluid, and of which the first hydraulic pump (1) generates a fluid flow through the heat exchanging device (14) to the tank (7) and the second hydraulic pump (2) serves to provide pressure to at least one set of working hydraulics.
6. The compact unit according to one of the preceding claims, characterized in that a filter device (9, 11) is provided between the tank (7) and the intake sides of the hydraulic pumps (1, 2), respectively.
7. The compact unit according to one of the preceding claims, characterized in that the tank (7) in the unit housing (45) forms a base part, on which the fan (19), the electric motor (3) and first and second hydraulic pumps (1, 2) are disposed in an axial direction from the front side (57) to the rear side (59) on a cover plate (47) of the tank (7), and that the heat exchanging device (14) is disposed alongside the electric motor (3) and the frequency converter (5) is disposed alongside the hydraulic pumps (1, 2).
8. The compact unit according to one of the preceding claims, characterized in that the cover plate (47) of the tank (7) as well as the housing cover (55) surrounding the fan (19) and the electric motor (3) are provided as components of the flow conducting means.
9. The compact unit according to one of the preceding claims, characterized in that the unit housing (45) is formed at least partly from plastic or at least partly from die-cast aluminum.