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(54) **DIAPHRAGM PUMP WITH TWO DIAPHRAGM HEADS AND TWO SEPARATE PUMP HOUSINGS**

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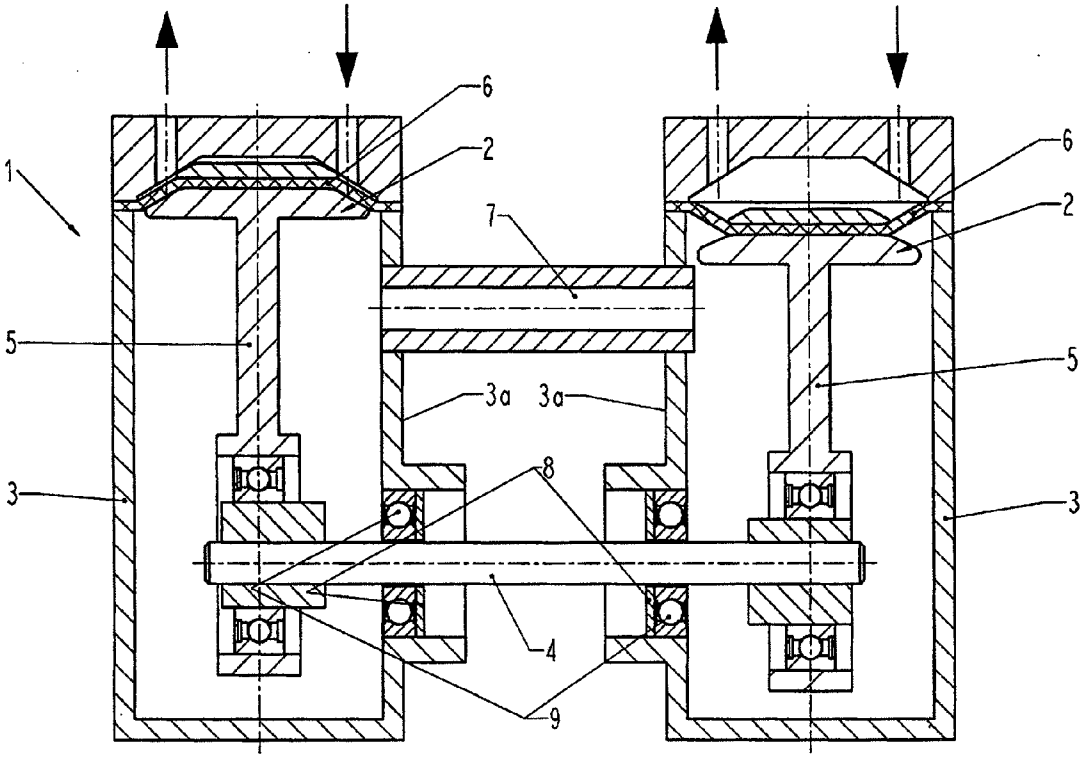
(57) **ABSTRACT**

A diaphragm pump (**1**) having two diaphragm heads (**15**), in each case two diaphragms (**6**) and two separate pump housings (**3**) in which the connecting rods (**5**) for the diaphragms (**6**) are arranged, which connecting rods (**5**) can be driven by a common shaft (**4**). The drive for the shaft (**4**) can be arranged between the two pump housings (**3**). Here, the two pump housings (**3**) are connected to one another in an air-permeable fashion in particular by a connecting line (**7**), such that the air displaced in each case by the one diaphragm (**6**) can be moved into the other pump housing (**3**) in which the associated diaphragm (**6**) leads to a space enlargement as a result of being driven in the opposite direction.



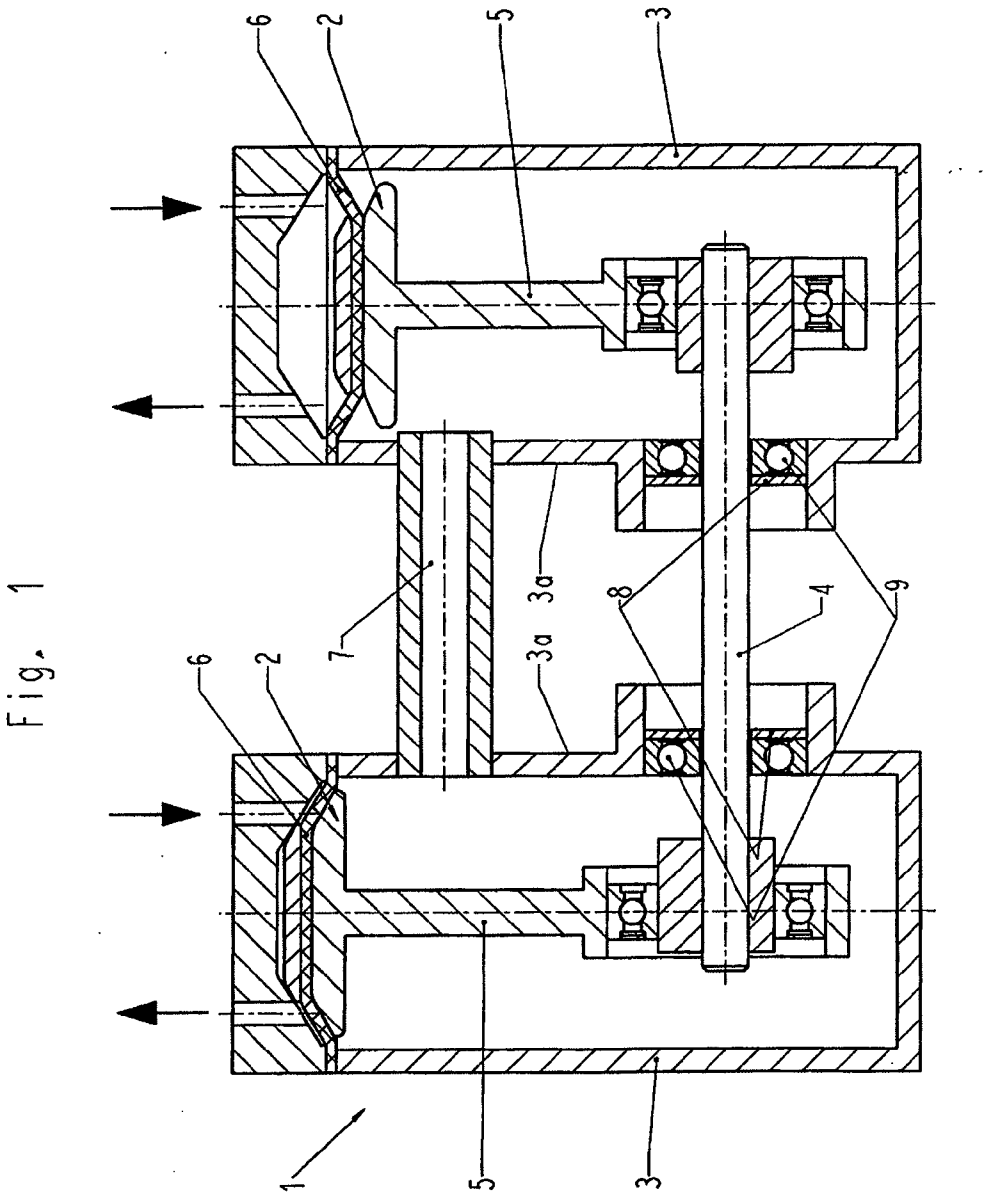


Fig. 1

Fig. 3

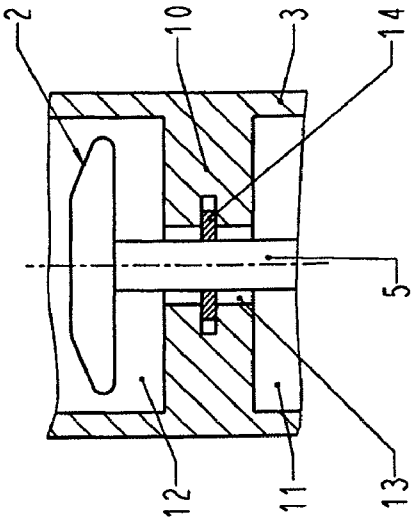
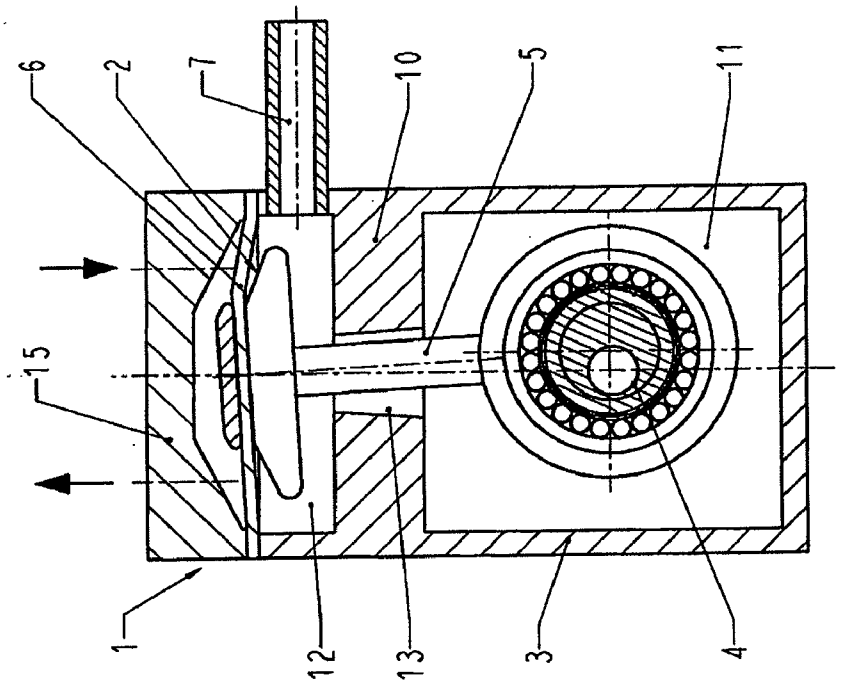


Fig. 2



DIAPHRAGM PUMP WITH TWO DIAPHRAGM HEADS AND TWO SEPARATE PUMP HOUSINGS

BACKGROUND

[0001] The invention relates to a diaphragm pump with two diaphragm heads and two separate pump housings and diaphragms provided therein, with the pump housings being arranged adjacent to each other and the drive of the diaphragms being off-set by 180 degrees such that the direction of the simultaneous deflections of the diaphragms of the two diaphragm heads each are in opposite directions.

[0002] Such diaphragms are known and are proven.

[0003] Here, the air moved from the respective bottom of the diaphragms must be exhaled from the respective pump housing through bearings or other places, when the diaphragms perform their suctioning motion, and the air must again be suctioned in, when the membrane moves in its driving phase. These air motions result in considerable noise.

SUMMARY

[0004] Therefore the object is to provide a diaphragm pump with two diaphragm heads and two separate pump housings having the advantages of such a "dual" diaphragm pump, but reducing or avoiding the noise development by the air moved by the bottom of the diaphragm.

[0005] In order to attain this seemingly contradictory object, the diaphragm pump defined at the outset is characterized in that the two—separate—pump housings are connected to each other in an air-permeable fashion. This way it is achieved that the air moved by the membranes in the pump housings no longer or only to a minor extent has to exit to the outside, because the air displaced by one membrane can flow into the other pump housing when its membrane is expanding the interior space of the second pump housing. The respectively displaced air can therefore be moved back and forth between the two sealed pump housings. This way they can be embodied in an air-tight or largely air-tight fashion in reference to their environment.

[0006] Here, it is particularly advantageous when at least one connecting line is provided between the pump housings, essentially arranged parallel in reference to each other, and when the cross-section and/or the flow resistance of the connecting line or the connecting lines is determined such that at least a portion or all of the air moved or displaced by the bottom of the diaphragm can be fed to the respectively other pump housing. Therefore, at least one connecting line is provided for the air that is moved back and forth as a particularly simple air-permeable connection so that the design of the diaphragm pump and its separate pump housings can remain unchanged and only one appropriate connecting line needs to be provided.

[0007] The connecting line may particularly connect the sides or walls of the two pump housings facing each other in a straight fashion. This practically represents the shortest connection for the air line, so that therefore its flow resistance is correspondingly low. Furthermore, usually sufficient unused space is available in the immediate space between the two pump housings, in order to allow placing such a connecting line.

[0008] The two separate pump housings and/or the displacement volume per stroke of the two membranes arranged therein may beneficially be of the same size. This results in a best-possible compensation of the respectively displaced air from one to the other pump housing and back.

[0009] In order to prevent air from leaking at any other location during its movement back and forth from one pump housing into the other and back, for example at the bearings or ball bearings, it is beneficial when in the area of the bearing and penetrating opening at least one seal is provided at the respective pump housing, particularly for the common drive shaft, with its flow resistance being greater than the one of the connecting line between the two pump housings. A combination of the seal of respective openings at the pump housings with one or more common connecting lines can provide better prevention of any air from exiting the pump housing, so that not only respective noise but also potential contamination of the environment of the diaphragm pump can be avoided.

[0010] Here, at the bearing of the drive shaft a felt washer covering each bearing may be provided in the area of the penetration through the pump housing. Felt washers are effective seals, themselves not causing any or hardly any noise.

[0011] Here, the felt washer can be located at the side of the bearing or ball bearing facing towards and/or facing away from the inside of the pump housing. This may depend on the respective design of the bearing of the drive shaft.

[0012] Another or an additional measure may be that the respective pump housing has an intermediate wall in the area of the connecting rod for driving of the diaphragm to separate the crank case from the motion chamber of the diaphragm head, provided with a penetrating opening for said connecting rod, and that the connection or connecting line of the two pump housings is particularly provided between this intermediate wall and the bottom of the respective diaphragm head. This way, too, the air moved by the diaphragms and/or the diaphragm heads inside the pump housing is primarily or exclusively guided into the connecting line and thus any risks for air leaking from the pump housings are further reduced or avoided.

[0013] Here, it is beneficial for the penetrating opening in the intermediate wall for the connecting rod to have a close tolerance and/or a seal or felt washer impinging the connecting rod and allowing its motion. This way the pneumatic resistance inside the pump housing against air passing through the connection line is further increased.

[0014] Primarily in a combination of one or more of the above-described features and measures a diaphragm pump with two diaphragm heads and two separate pump housings as well as a common drive shaft for the two connecting rods is provided, in which the air moved by the diaphragms and diaphragm heads no longer needs to exit to the outside because it can be moved back and forth between the two pump housings via the common air-permeable connection or connecting line and thus any compressions and relaxations of the respective air volumes in the pump housings, caused by the movements of the diaphragm heads, can be compensated.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] In the following, exemplary embodiments of the invention are explained in greater detail using the drawing. It shows in a partially schematic illustration:

[0016] FIG. **1** is a longitudinal cross-section of a diaphragm pump according to the invention with two diaphragm heads and two separate pump housings containing them, which are connected to each other via a connecting line in an air-permeable fashion, with one of the diaphragms being shown at

the upper dead center and accordingly the other diaphragm driven opposite thereto shown at its lower dead center so that the air displaced by the diaphragm located at its lower dead center is transported into the other pump housing,

[0017] FIG. **2** is a longitudinal cross-section through one of the pump housings, rotated by 90 degrees in reference to FIG. **1**, which shows an intermediate wall between the motion chamber of the diaphragm and the crank case penetrated by the connecting rod and the connecting line to the second pump housing, not shown, being arranged between the bottom of the diaphragm and/or the diaphragm and said intermediate wall, and

[0018] FIG. **3** is a partial longitudinal cross-section similar to FIG. **2**, rotated by 90 degrees in reference thereto, with additionally a seal being provided for the connecting rod in the penetrating opening in the intermediate wall.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] A diaphragm pump, in its entirety marked **1**, has two diaphragms **6** and two separate pump housings **3**, containing them and arranged adjacent in reference to each other, as well as two diaphragm heads **15**, with a common drive shaft **4** driving the connecting rods **5** for the two membranes **6**. Here, the drive of the two diaphragms **6** and/or the two mushroom-shaped connecting rod heads **2** carrying them, as clearly shown in FIG. **1**, are off-set by 180 degrees such that the direction of the simultaneous deflections of the membranes **6** of the two rod heads **2** are opposing each other.

[0020] It is clearly discernible in FIG. **1** that the rod head **2**, with the diaphragm **6** shown at the left, has just reached the top position, while the other rod head **2** with its diaphragm **6**, according to the off-set of the drive by 180 degrees, has reached the opposite position, namely the bottom position. While one rod head **2** is located at the upper dead center, the other rod head **2** has therefore reached the bottom dead center, which constantly alternates during the operation of the diaphragm pump **1**.

[0021] FIGS. **1** and **2** show that the two pump housings **3** are connected to each other in an air-permeable fashion with the help of a connecting line **7**, so that the air displaced by the rod head **2** moving downwards can be transported via this connecting line **7** into the other pump housing **3**, where the upward motion of the rod head **2** just leads to an enlargement of the air volume inside the pump housing **3** so that a continuous exchange of the respectively displaced and required air volumes between the two pump housings **3** is possible via the connecting line **7**. Therefore, no amount of air displaced by the connecting rod heads **2** and the diaphragms **6** needs to exit the pump housing **3** so that consequently no noise develops caused by such exhalation.

[0022] The cross-section of the connecting line **7** provided between the pump housings **3** essentially arranged parallel in reference to each other and their flow resistance are here sized such that, to the extent possible, the entire air moved and displaced by the respective bottom of the membrane is transported into the respectively other pump housing **3**.

[0023] This is fostered in that the two pump housings **3** and primarily the transportation volume resulting from each stroke of the diaphragms **6** are of identical size so that for each stroke of one of the connecting rod heads **2** with the diaphragms **6** simultaneously the air volume is accepted in the respective pump housing **3** which is displaced by the motion of the opposite stroke in the adjacent pump housing **3**.

[0024] In FIG. **1** it is discernible that the connection line **7** connects the two pump housings **3** at their sides or walls **3***a* facing each other in a straight line so that a connecting line **7** is enabled as short as possible, which may be either flexible or stiff, in order to connect the two pump housings **3** to each other in a stable fashion.

[0025] FIG. **1** also shows that in the area of the bearing or penetrating opening for the entire drive shaft **4**, at the respective pump housing **3**, at least one seal **8** is provided, with its flow resistance being greater than the one of the connecting line **7** between the two pump housings **3**, which additionally contributes to the air respectively displaced by the bottom of the connecting rod heads **2** and the membranes **6** is moved practically in its entirety back and forth through the connecting line **7**. Here, a felt washer each is provided at the respective bearing **9** of the drive shaft **4** in the area of the penetration through the wall of the pump housing, covering the bearing **9** as a seal **8**, which is mounted in the exemplary embodiment at the side of the bearing or ball bearing **9** facing away from the interior of the respective pump housing **3**. However, it may also be provided at the side or the two sides of the respective bearings facing towards the interior of the pump housing **3**.

[0026] In FIGS. **2** and **3**, as an additional measure to largely transport exclusively the respectively displaced air through the connecting line **7**, it is shown that the respective pump housing **3** in the area of the connecting rod **5** has an intermediate wall **10** for separating the crank case **11** from the motion chamber **12** of the diaphragm **6**, with a penetrating opening **13** being necessary and provided for the connecting rod **5** and the connecting line of the two pump housings **3** being arranged between said intermediate wall **10** and the bottom of the respective connecting rod head **2**. The intermediate wall and a penetrating opening **13** as narrow as possible improve the transportation of the air displaced at the bottom of the respective connecting rod head during its downward motion into and through the connecting line **7**.

[0027] In addition to a close tolerance of said penetrating opening **13** in reference to the connecting rod **5** additionally, according to FIG. **3**, a seal **14** may be provided, impinging the connecting rod **5** and allowing its motion, for example a felt washer, which according to FIG. **3** engages the recesses of the edge of the penetrating opening **13**.

[0028] By the air-tight connection of the two parallel separate pump housings **3** via at least one connection line **7** the air respectively displaced by the motion of the diaphragms **6** can be transported from one into the other pump housing **3** and back due to the opposite motions so that an exhalation of said displaced aid from the pump housings **3** and thus any noise connected thereto can be avoided or largely avoided.

[0029] The diaphragm pump **1** has two diaphragm heads **15**, two diaphragms **6** each, and two separate pump housings **3**, in which the connecting rods **5** with connecting rod heads **2** for the diaphragms **6** is arranged, which may be driven by a common shaft **4**, and the drive for the shaft **4** may be arranged between the two pump housings **3**. The two pump housings **3** are here connected to each other in an air-permeable fashion, particularly via a connection line **7**, so that the air respectively displaced by one diaphragm **6** can be moved into the other pump housing **3**, in which the corresponding diaphragm **6** leads to an expanding space due to the opposite drive.

1. A diaphragm pump (**1**) comprising two diaphragm heads (**15**) and two separate pump housings (**3**) and diaphragms (**6**) provided therein, with the pump housings (**3**) being arranged adjacent to each other, and a drive of the diaphragms (**6**) being

offset by 180 degrees such that a direction of simultaneous deflection of the diaphragms (**6**) of the two pump housings (**3**) are opposite each other, the two pump housings (**3**) are connected to each other in an air-permeable fashion.

2. The diaphragm pump according to claim **1**, wherein as an air-permeable connection at least one connection line (**7**) is provided between the two pump housings (**3**), which are arranged essentially parallel in reference to each other, and at least one of a cross-section or a flow resistance of the at least one connection line (**7**) is sized such that at least a portion or all of the air transported or displaced by a bottom of the diaphragm can be transported into the other respective pump housing (**3**).

3. A diaphragm pump according to claim **2**, wherein the at least one connection line (**7**) connects sides or walls (**3***a*) of the two pump housings (**3**) facing each other.

4. A diaphragm pump according to claim **1**, wherein at least one of the two pump housings are of equal size (**3**) or a displacement volume of the two diaphragms (**6**) per stroke are of equal size.

5. A diaphragm pump according to claim **2**, further comprising a common drive shaft for the diaphragms, and at least one seal (**8**) is provided in an area of a bearing and penetrating opening for the common drive shaft (**4**) at the respective pump housing (**3**), with a flow resistance of the seal being greater than the connection line (**7**) between the two pump housings (**3**).

6. A diaphragm pump according to claim **5**, wherein a felt washer is provided as the seal (**8**) at each of the bearings (**9**) of the drive shaft (**4**) in an area of penetration through the pump housings, covering said bearings (**9**).

7. A diaphragm pump according to claim **6**, wherein the felt washer is provided at least at a side of the bearing (**9**) facing towards an interior of the pump housing (**3**).

8. A diaphragm pump according to claim **2**, wherein each of the respective pump housings (**3**) has an intermediate wall (**10**) in an area of a connection rod (**5**) to separate a crank case (**11**) from a motion chamber (**12**) of a diaphragm head (**2**), the intermediate wall includes a penetration opening (**13**) for the connection rod (**5**), and the air-permeable connection or connection line (**7**) of the two pump housings (**3**) is provided between the intermediate wall (**10**) and a bottom of the respective diaphragm head (**2**).

9. A diaphragm pump according to claim **8**, wherein the penetrating opening (**13**) has at least one of a close tolerance in the intermediate wall (**10**) for the connection rod (**5**) in reference thereto or comprises a seal (**14**) or a felt washer that contacts the connection rod (**5**) and allows for its motion.

10. A diaphragm pump according to claim **7**, wherein the felt washer is provided at a side of the bearing facing away from an interior of the pump housing (**3**).

11. A diaphragm pump according to claim **6**, wherein the felt washer is provided at a side of the bearing facing away from an interior of the pump housing (**3**).

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