Oct. 17, 1967 N. LAING 3,347,059

HEAT PUMP

Filed July 18, 1966 7 Sheets-Sheet 1

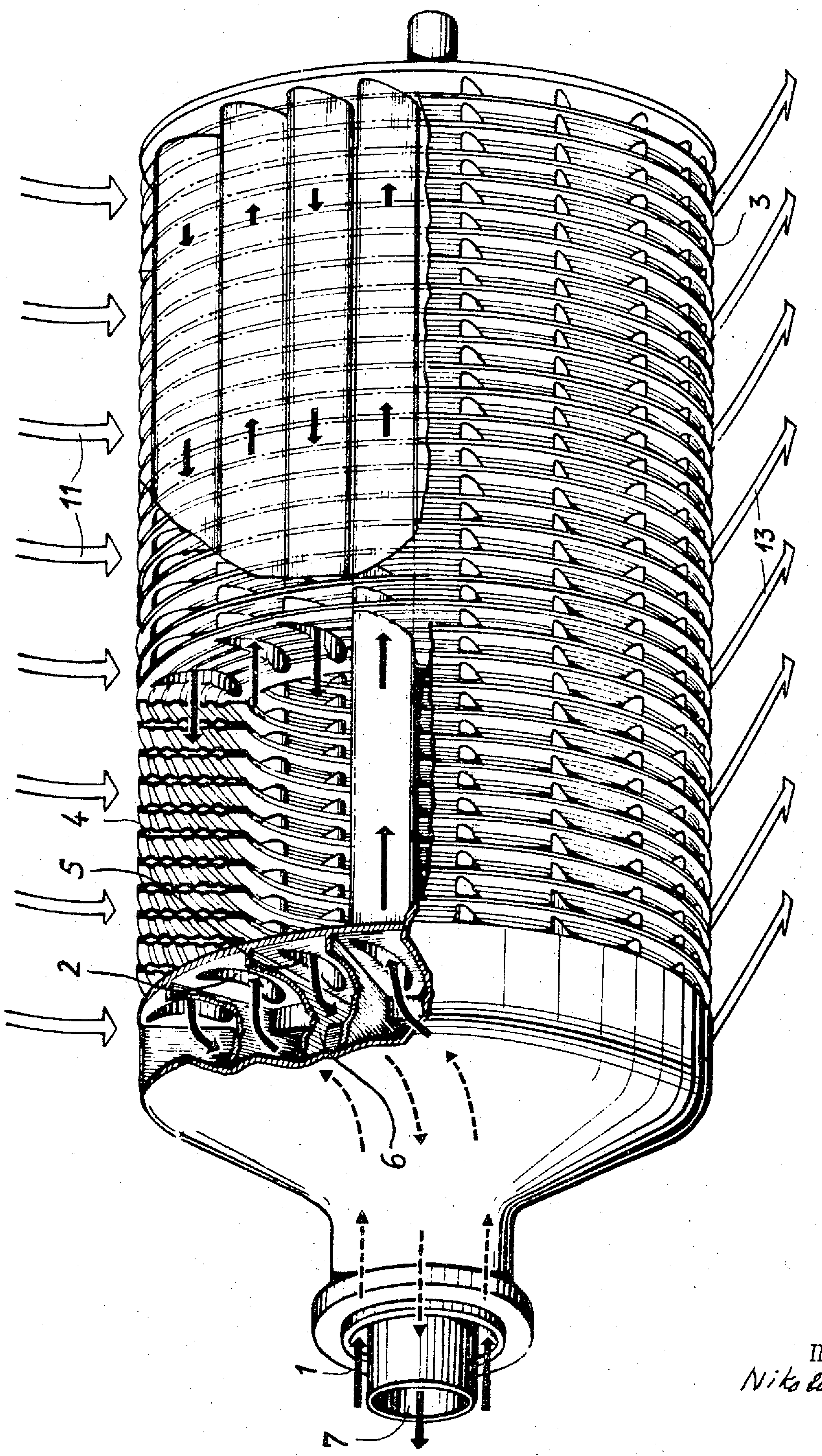

Fig. 1

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Fig. 2

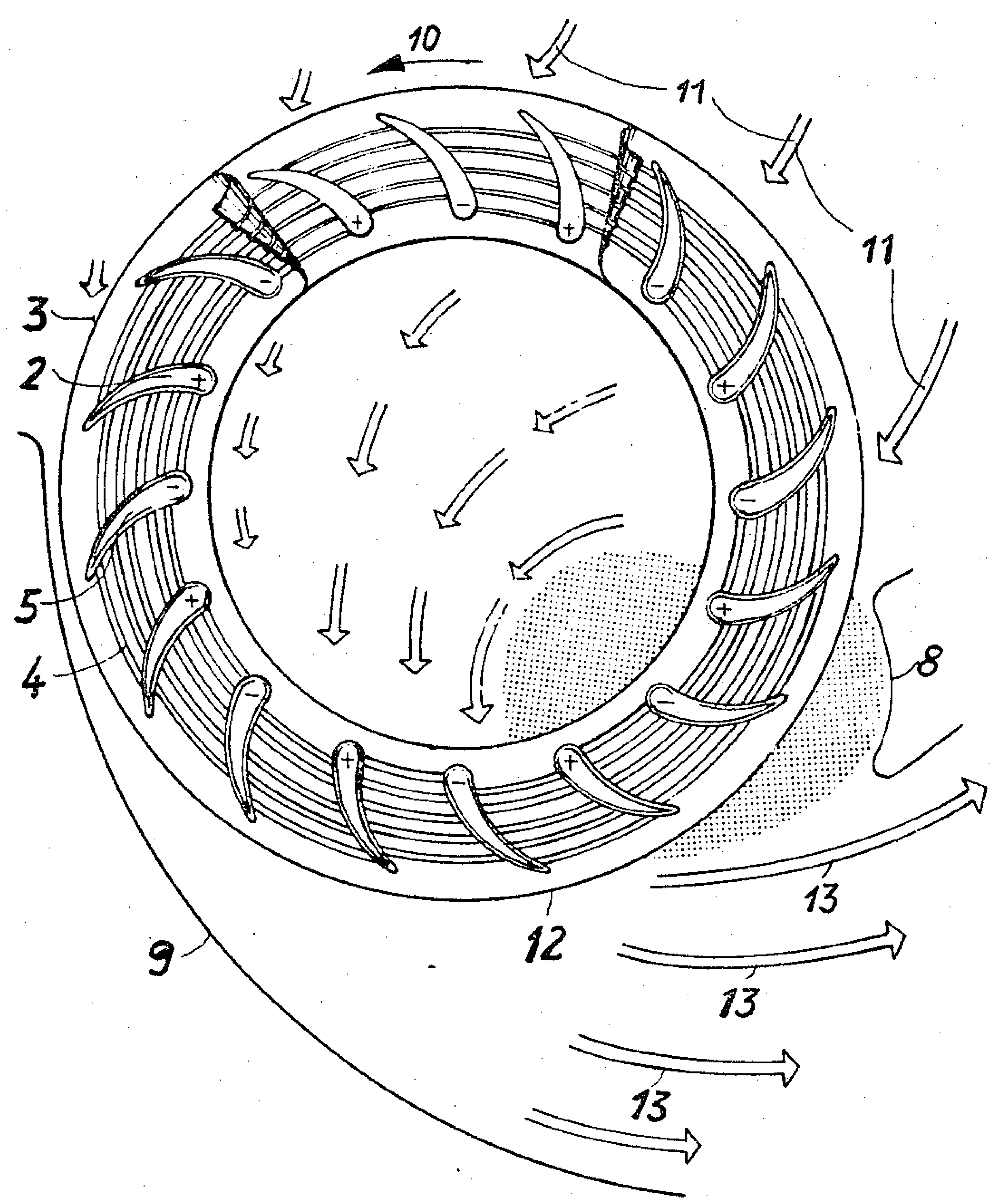

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Fig. 3

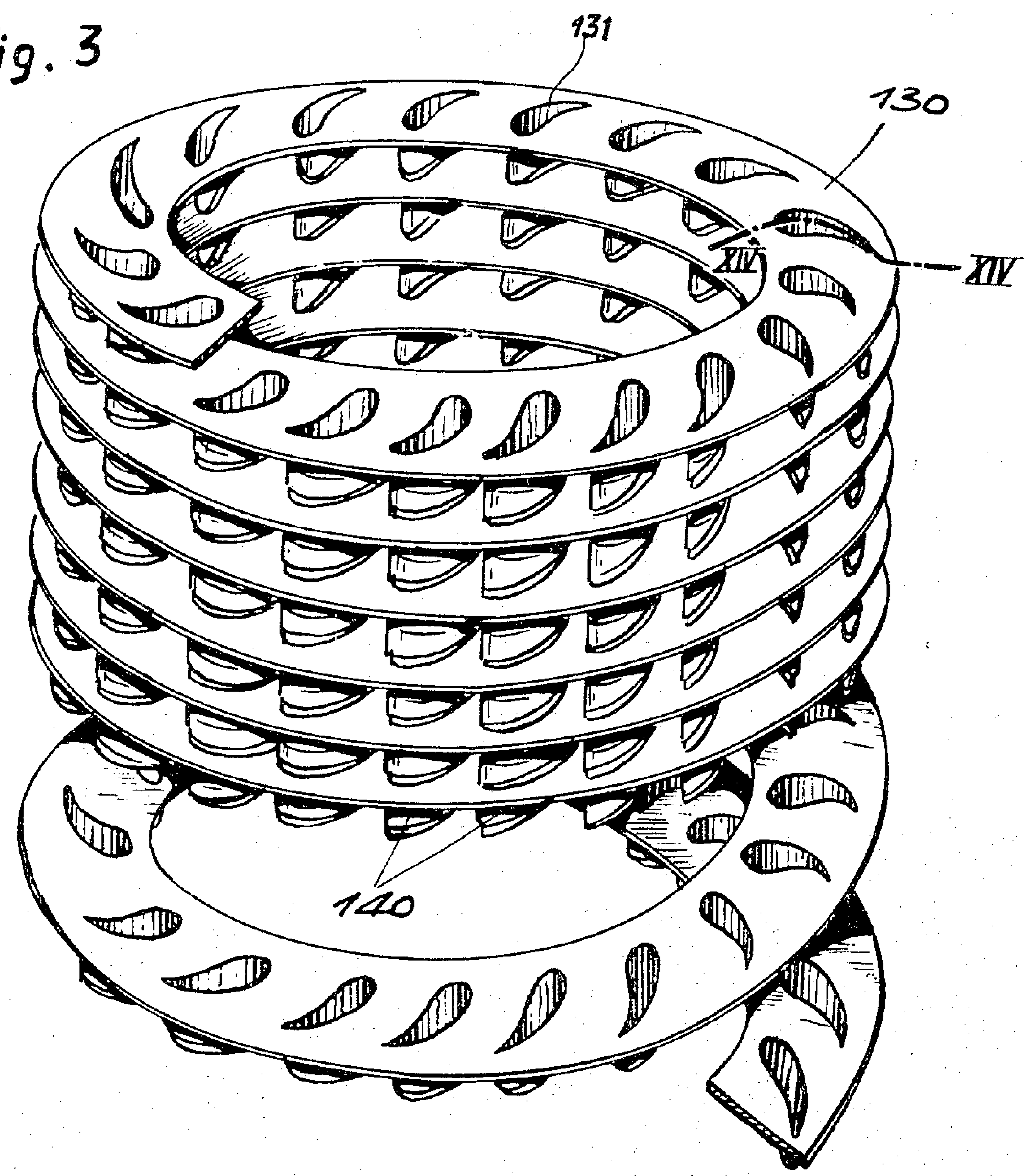
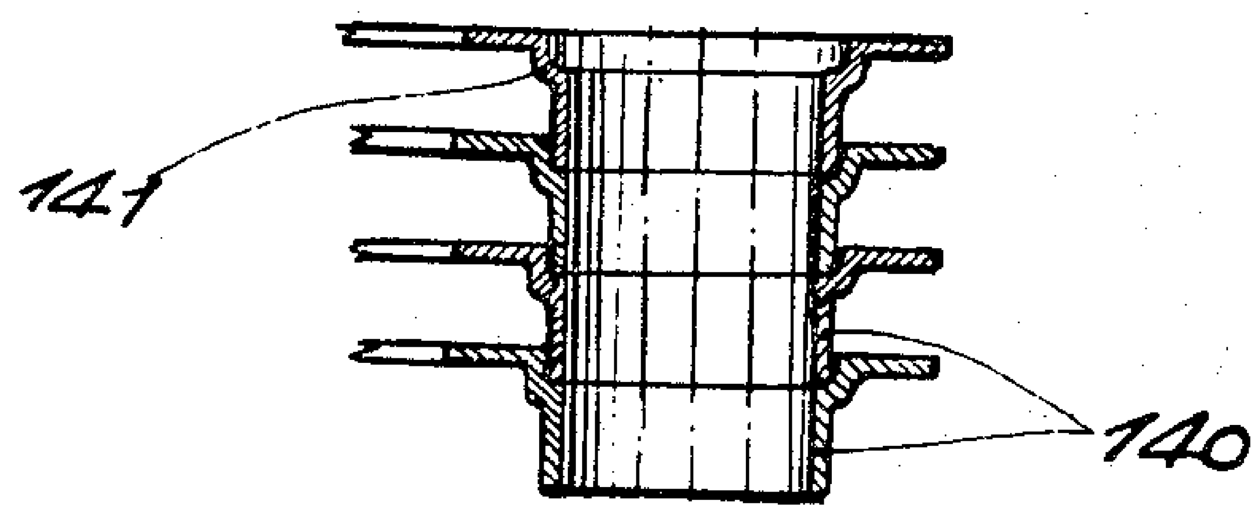


Fig. 4



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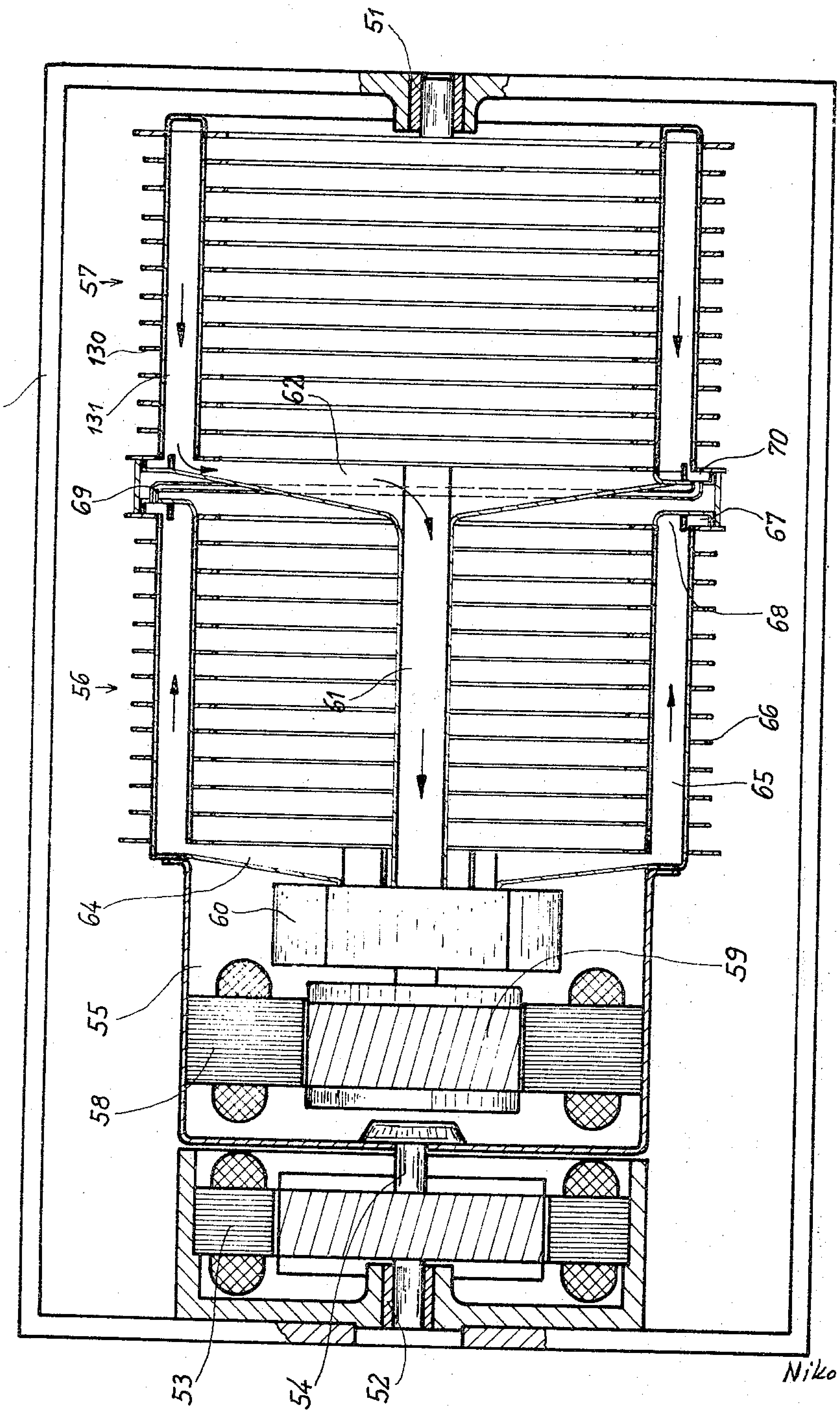

Fig. 5

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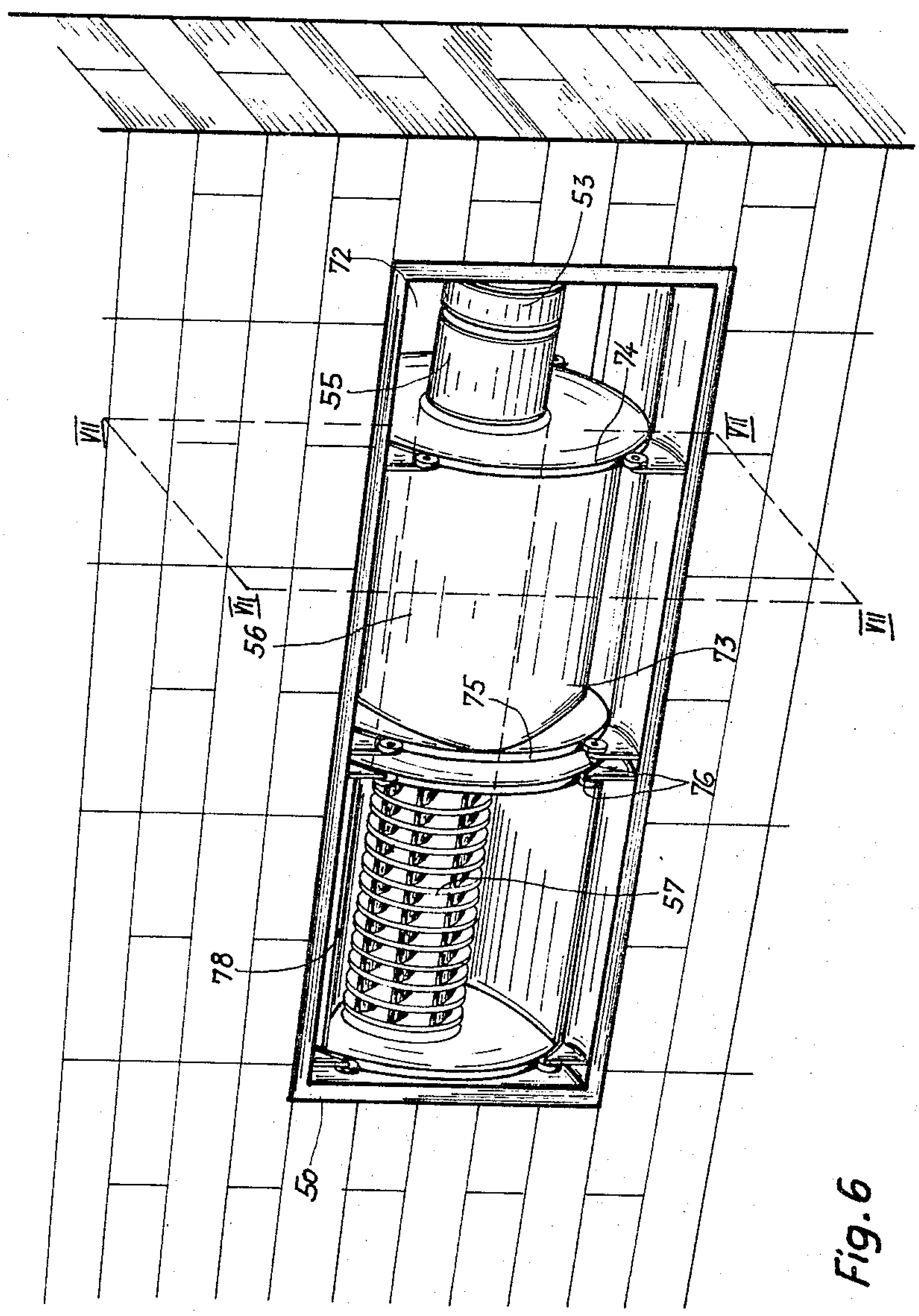

Fig. 6

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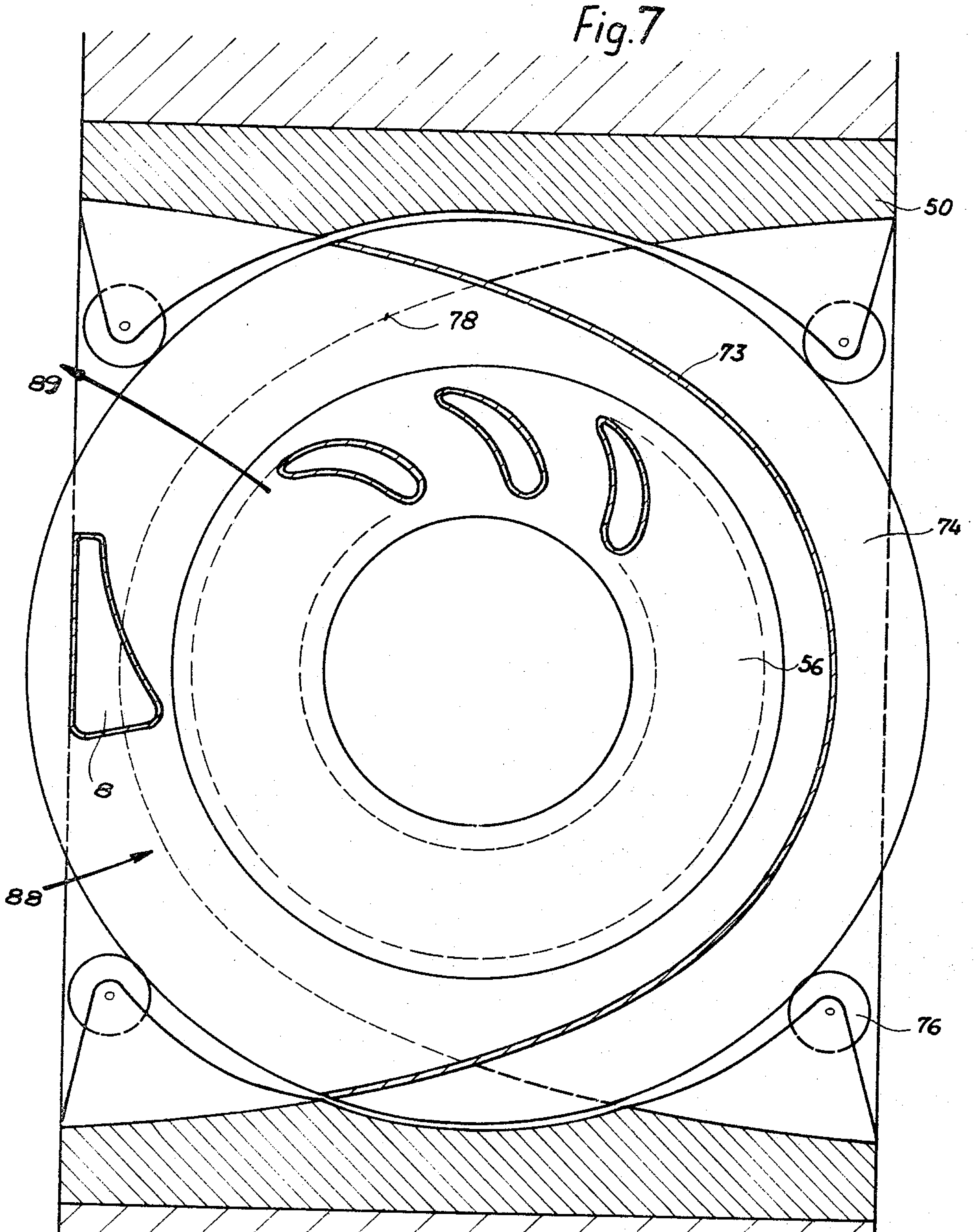
Fig. 7



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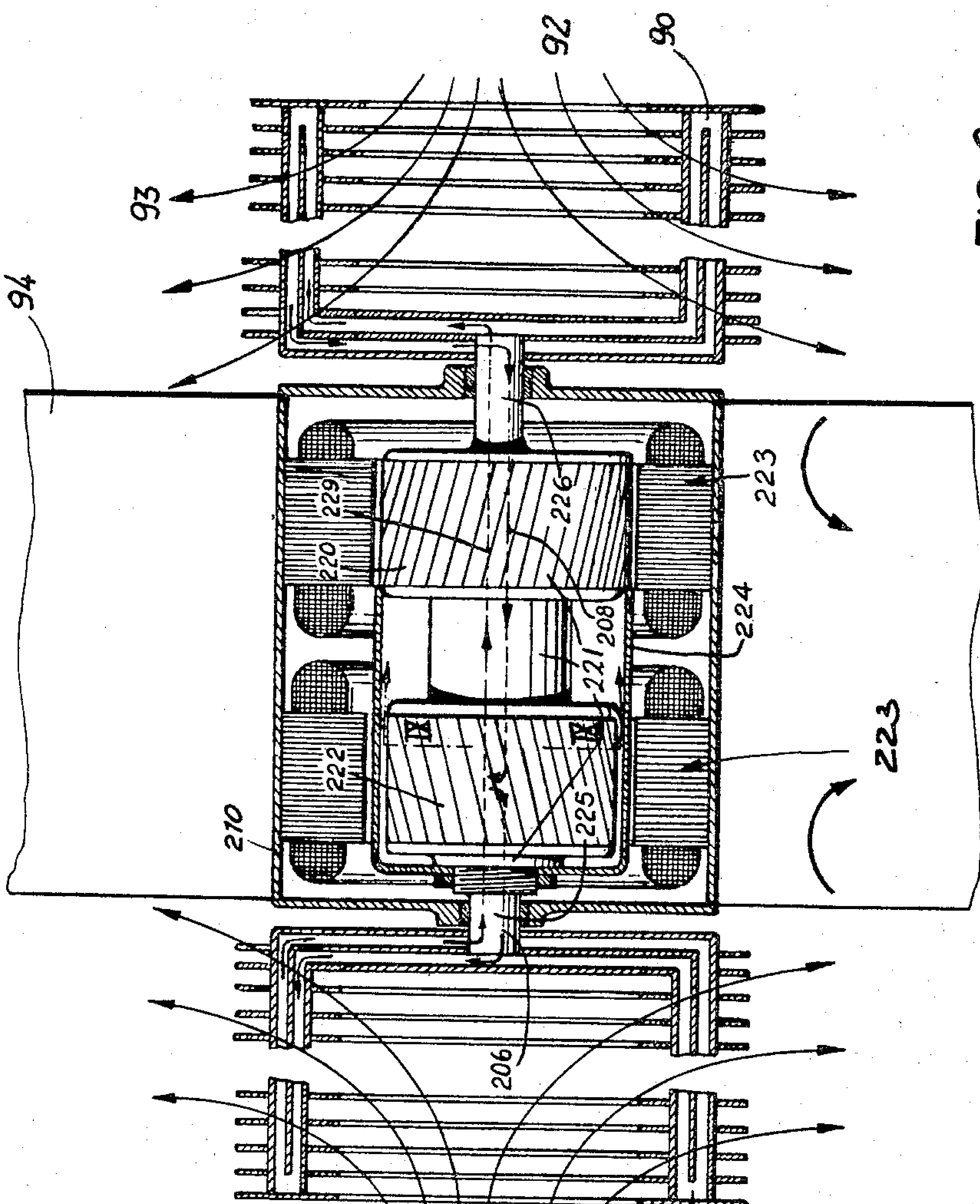

FIG. 8

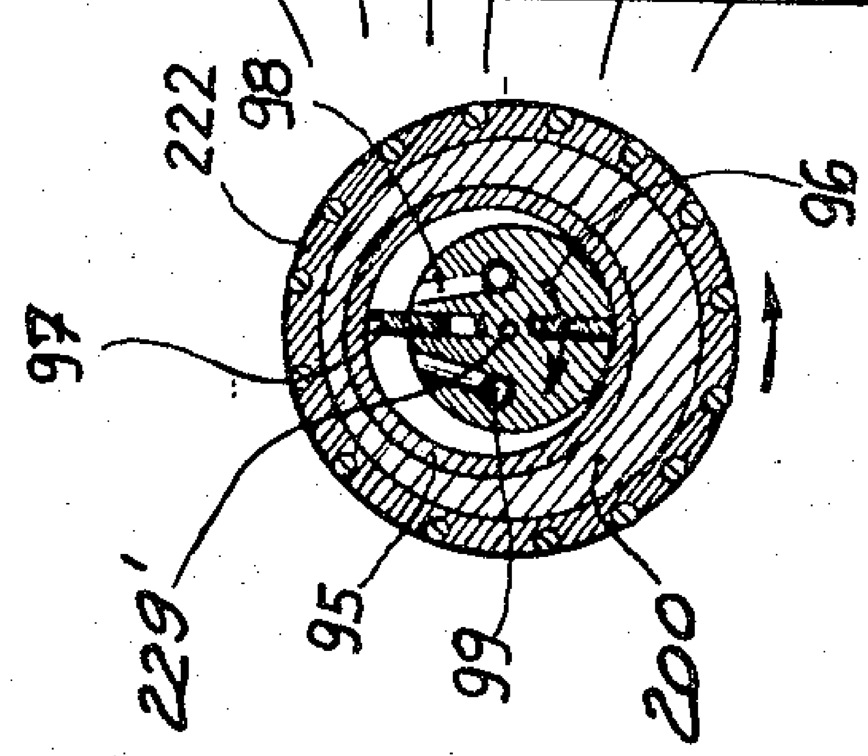

FIG. 9

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United States Patent Office

3,347,059

Patented Oct. 17, 1967

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HEAT PUMP

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Continuation of application Ser. No. 427,323, Jan. 22, 1965. This application July 18, 1966, Ser. No. 566,088
Claims priority, application Germany, Jan. 22, 1964, L 46,844, L 46,845
17 Claims. (Cl. 62—325)

This application is a continuation of application Ser. No. 427,323, filed Jan. 1, 1965.

The invention relates to heat pumps, i.e., to devices consisting of a heat exchanger operated as a heat source, a device transforming heat—such as for instance a compressor, an absorber circuit or a Peltier battery—and a heat exchanger operated as a heat sink with a cooling effect.

Up to now these devices which are employed for instance as air conditioners or cooling units for refrigerators use stationary heat exchangers. Therefore these devices require generally two additional fans, one for the heat exchanger operating as a heat source, the other for the heat exchanger operated as a heat sink, besides the heat transforming device which as a rule is a compressor.

In the patent specification the inventor suggests to use a rotating heat exchanger as a condenser for cooling units. These rotating heat exchangers have the advantage that they combine the functions of a fan and a heat exchanger in one and the same unit and are furthermore much less noisy than fans located behind heat exchangers—the dynamic energy of the air stream being reconsumed already within the rotating heat exchanger—and that they can be designed much smaller than stationary heat exchanger, for the intervals between the fins can be made smaller. This is due to the fact that the centrifugal force narrows the boundary layers predetermining these intervals. Furthermore the heat transfer coefficient increases with decreasing width of the boundary layer, so that the total surface, if compared with the same throughout velocity, can be much smaller than that of stationary heat exchangers.

Eventually the effect improving the heat transfer becomes especially favourable if these rotating heat exchangers are transversed by the throughput flow twice in opposite directions, as this is the case in crossflow fans.

The invention relates to heap pumps in which both heat exchangers are rotating heat exchangers, and in which furthermore the heat transforming device—as a rule the compressor—is combined with the two rotating heat exchangers in one and the same rotating unit. This allows for the construction of extremely compact heat pumps, for instance air conditioners, which have the additional advantage of an extremely low noise level.

FIG. 1 is a diagrammatic view of a rotating heat exchanger according to the present invention;

FIG. 2 is a transverse cross section of the heat exchanger of FIG. 1;

FIG. 3 is a partial perspective view of another embodiment;

FIG. 4 is a partial cross section of FIG. 3;

FIG. 5 is an axial cross section through a further embodiment;

FIG. 6 is a perspective view of the embodiment shown in FIG. 5;

FIG. 7 is a cross section taken along the plane VII—VII of FIG. 5 and drawn to an enlarged scale;

FIG. 8 is an axial cross section through a fourth embodiment; and

FIG. 9 is a cross section taken along the line IX—IX of FIG. 8.

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The following description of the figures explains the process:

FIG. 1 is a diagrammatic view of a rotating heat exchanger in which the coolant enters the heat exchanger at **1**, is conducted from there to the even-numbered blades **2**, through the annular-shaped fins **3** which are equipped with channels **4**, to the uneven-numbered blades **5** and from there back to the channels **6** communicating to the inner tube **7**.

FIG. 2 is a cross section of the device shown in FIG. 1 and shows the guide walls **8** and **9**. If the rotor rotates in direction of the arrows **10**, air **11** is sucked into the rotor and blown out again in the outlet area **12** following the streamlines **13**. In this way this heat exchanger is at the same time a fan and a large surface heat exchanger. In this embodiment the coolant is cooled not only in the hollow blades but also in the small channels **4** connecting the even-numbered blades **2** to the uneven-numbered blades **5**.

FIG. 3 shows the main features of a rotating heat exchanger rotor in which the annular-shaped surfaces **130** are indirect heat exchange surfaces, so that the heat exchange of the coolant is effected exclusively between the hollow blades **131** formed by the projecting parts **140**.

FIG. 4 shows the arrangement of the projecting parts **140** which are soldered together in the region **141**.

FIG. 5 shows a rotating heat pump according to the invention in which two heat exchangers are located side by side similar to the arrangement shown in FIG. 3. The frame **50** has bearings **51** and **52** at both ends, furthermore it support the stator **53** of a small electrical motor inducing the rotor to rotate. The rotor itself is fixed to the axis **54** of the motor **53** and consists of a compressor **55**, a condenser heat exchanger **56** and an evaporator heat exchanger **57**. The compressor consists of a stator **58**, an armature **59** and a rotary compressor **60**. The rotary compressor **60** sucks the coolant fom the cylinder-shaped space **62** through the duct **61**, the coolant having been evaporated in the hollow blades **131** and thus having cooled the blades **131** and the fins **130**. The compressor transports the compressed coolant through the annular space **64** into the blades **65** where it is condensed, thereby dissipating heat via the fins **66**, and collected in a ring of fluid **67** in the space **68**. From there it flows through the capillary tubes **69** into the annular space **70** where the circuit starts once more.

FIG. 6 is a diagrammatic view of a rotating heat exchanger as per FIG. 5 built in the wall of a building. The frame **50** is inserted in a wall opening. The space **72** containing the compressor **55** and the drive motor **53** is sealed; however, it is shown open in the drawing to make it more spectacular. A guide wall **73** runs around the condenser heat exchanger **56**. (A cross section of this guide wall is shown in FIG. 7.) This guide wall is supported at both ends by circular plates **74** and **75**. These plates are mounted on balls **76** and are pivotable in all directions. The present embodiment is an example in which the guide wall **73** is pivoted in a way that the condenser heat exchange is evtracted from the room and transferred to the building. The guide wall **78**, however, is pivoted in a way that the evaporator heat exchanger **57** communicates with the room inside the building. In this arrangement heat is extracted from the room and transferred to the ambient air outside the building. If the guide wall **73** is pivoted by 90°, the heat exchanger **56** which has now only the function of a fan extracts air from the room to the outside; if the guide wall **78** is pivoted by 90° the heat exchanger **57** sucks air from the outside into the rom, this air being cooled in the process. If the cooling effect is not required, the compressor is switched off.

If the guide wall **73** is pivoted by 180°, both heat exchangers **56** and **57** communicate with the air in the room. The heat exchanger **57** extracts humidity from the room air by means of a condenser effect at its cool surface; the heat exchanger **56** transfers heat to the room. The humidity at the heat exchanger **57** is sprayed in tiny drops against the guide wall **78** where it is conducted to the outside through a tiny tube which is not shown. In this arrangement the device reduces the relative humidity in the room, i.e. it has an air drying effect. If the guide wall **78** is pivoted by 180° while the guide wall **73** remains in its position communicating to the air outside, the heat pump assumes the function of a room heater.

FIG. 7 is a cross section of FIG. 6 in the plane VII—VII. The air enters the rotor near **88** and leaves the rotor in direction of the arrow **89**. As it is already shown in FIG. 2, an additional guide body **8** is required beside the guide wall **73**. All other parts are marked with the same numbers as in FIG. 6.

FIG. 8 is a diagrammatic cross section of another heat pump in which the rotors **90** and **91** are centrifugal-rotors through which the flow passes radially to the outside. The air enters near **92**; the heated or cooled air leaves the rotor in radial direction near **93**. The rigidly mounted housing **210** contains two pole rings **221** and **223**.

The shaft ends **225** and **226** are mounted in this rigidly mounted housing. The rotors **90** and **91** are mounted on these shafts at the outside; at the inside they bear the armature **220** which is sealed to the housing **224**. The housing **224** is made of a magnetically ineffective material, for instance stainless steel. Inside the housing **224** which rotates at the same r.p.m. with the fan determined by the armature **220** there is another armature **222** which is allowed to rotate freely inside the housing. Inside this armature **222** is a rotary compressor. In the present case the housing **224** is rotating anti-clockwise, while the armature **222** rotates clockwise induced by the rotating field of the pole ring **223**. In this way the r.p.m. are added for the compressor, so that the compressor may be very small.

The compressor sucks the coolant along the lines **208** and transports the compressed coolant along the lines **206** into the heat exchanger **91** which dissipates heat and is employed as a condenser. Then the cooled and compressed gas flows along the line **229** through a duct which may be a capillary tube into the second rotating heat exchanger **90** where it evaporates so that this heat exchanger is cooled. Then the evaporated coolant returns to the compressor along the lines **208**.

The housing **210** may be built in the wall of a building. It may also be built in the wall of a refrigerator.

If the direction of rotation of the pole ring **221** is reversed, both rotating systems turn in the same direction.

Assuming that the armature **220** runs at 1100 r.p.m. and the armature **222** runs at 3300 r.p.m., this means 4400 r.p.m. for the compressor in the arrangement described above (with opposite directions of rotation); as soon as the direction of rotation of the pole ring **223** is changed, this means 2200 r.p.m., which means that the cooling capacity is reduced to one half. On the other hand, the direction of rotation of the armature **222** may also be changed by a corresponding arrangement of the pole ring **223**. The result is an inversed circuit, i.e. the flow of the coolant whose direction is shown by the arrows is reversed, and the heat exchanger **91** becomes a heat extracting evaporator while the heat exchanger **90** becomes a heat dissipating condenser. Also in this case the performance of the compressor may be altered in a relationship of 2:1 by changing the direction of rotation of the armature **220**.

FIG. 9 shows a cross section of FIG. 8 along the line IX—IX. Inside the armature **222** is a sleeve **95** eccentric to the axis which contains a centered body **96** equipped with radial slides **97** and two openings **98** and **99** which may be used alternatively as an inlet or outlet opening for the compressor.

I claim:

1. A heat pump comprising, in combination, support means, condenser heat exchanger means for heating a first fluid circuit; evaporator heat exchanger means for cooling a second fluid circuit in communication with said first fluid circuit; compressor means for compressing a coolant leaving said evaporator heat exchanger means in gaseous state and conveying it to said condenser heat exchanger means, said condenser heat exchanger means and said evaporator heat exchanger means being constructed as fan rotors having air revolving means transversed by the coolant, said condenser heat exchanger means, said evaporator heat exchanger means and said compressor means being connected to each other to form a single unit mounted in said support means turnable about an axis; and drive means for rotating said unit about said axis.

2. A heat pump as set forth in claim **1**, wherein said drive means include a pair of motors, one connected to said unit for rotating the same about said axis and the other connected to said compressor means for driving the same.

3. A heat pump as set forth in claim **2**, wherein said pair of motors are arranged coaxially with said axis.

4. A heat pump as set forth in claim **1**, wherein both of said heat exchanger means and said compressor means are hermetically sealed to the outside.

5. A heat pump as set forth in claim **1**, wherein said heat pump is built in an opening of a wall in such a way that one of said heat exchanger means communicates with the air at one side of the wall and the other heat exchanger means with the air at the other side of said wall.

6. A heat pump as set forth in claim **5**, wherein said first and said second circuit may be reversed so that air to one side of said wall may be heated and the air of the other side of the wall may be cooled, and vice versa.

7. A heat pump as set forth in claim **6**, wherein said drive means is reversible so that reversal of said circuits may be effected by changing the direction of rotation of the heat pump.

8. A heat pump as set forth in claim **1**, wherein at least one of said heat exchanger means is a radial blower.

9. A heat pump as set forth in claim **1**, wherein at least one of said heat exchanger means is a tangential blower.

10. A heat pump as set forth in claim **1**, wherein said air revolving means are in the form of hollow blades and including fins connected to said hollow blades of said fan rotors.

11. A heat pump as set forth in claim **10**, wherein said hollow blades are elongated and extend substantially parallel to said axis, and wherein said fins have annular shape and are respectively located in planes extending transverse to the elongation of said blades.

12. A heat pump as set forth in claim **1**, wherein said heat pump is built in an opening of a wall and including a housing for each of said heat exchanger means having an air inlet and an air outlet, each of said housings being mounted in said opening of said wall pivotally about an axis between two positions in such a manner that the respective housing may communicate, when turned to one of said positions, with the air to one side of the wall and, when turned to the other of said positions, with the air to the other side of the wall.

13. A heat pump as set forth in claim **12**, wherein the housing of said condenser heat exchanger means may be turned independently from the housing of the evaporator heat exchanger means and in a direction opposite thereto so that the evaporator heat exchanger means communicates with the air to one side of the wall and the condenser heat exchanger means communicates with the air at the other side of the wall.

14. A heat pump as set forth in claim **12**, wherein said housings may be turned so that both of said housings communicate with the air to one side of the wall so that humidity is extracted from the air of a room at said one side of said wall.

15. A heat pump as set forth in claim **2**, wherein said one motor has a stator fixed to said support means and a rotor and wherein said unit includes a housing surrounding said compressor means and being fixedly connected to said heat exchanger means for turning with the same about said axis, said rotor of said one motor being fixed to said housing for turning the latter about said axis and said other motor having a stator located in and fixed to said housing for rotation therewith and a rotor fixed to said compressor means for driving the latter.

16. A heat pump as set forth in claim **2**, wherein each of said pair of motors has a stator fixedly carried by said support means and a rotor, and wherein the rotor of said other motor is turnable relative to the rotor of said one motor.

17. A heat pump as set forth in claim **16**, wherein said stators and said rotors of said pair of motors are constructed so that said compressor means turns in a direction opposite to the direction of rotation of said heat exchanger means.

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