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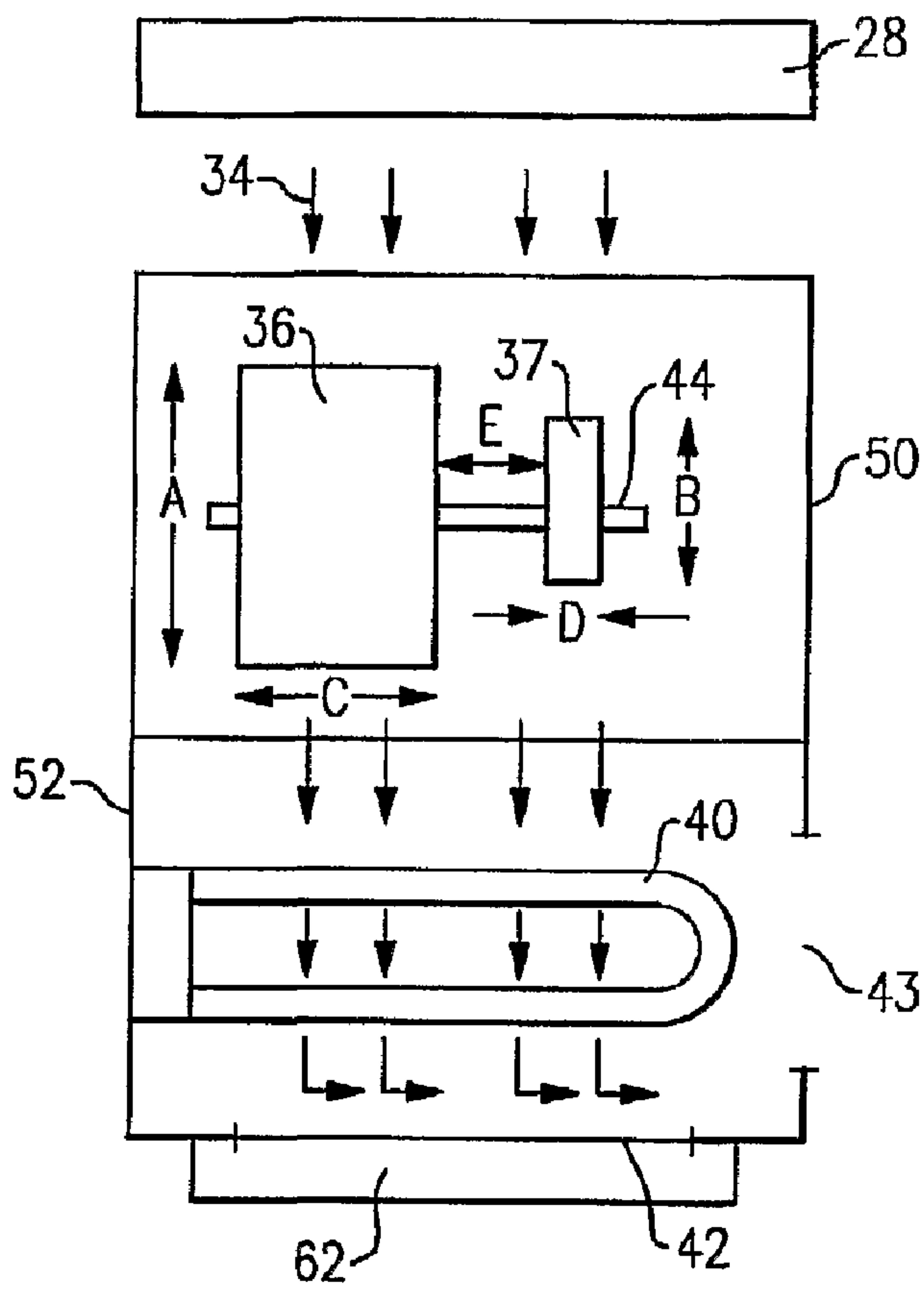
(54) Titre : SYSTEME DE GESTION DU FLUX D'AIR DANS UNE UNITE DE CVCA COMPRENANT DEUX VENTILATEURS DE DIAMETRES DIFFERENTS
(54) Title: AIRFLOW MANAGEMENT SYSTEM IN A HVAC UNIT INCLUDING TWO FANS OF DIFFERENT DIAMETERS



(57) Abrégé/Abstract:
Air is heated by a gas or electric heat exchanger or cooled in an evaporator coil. The air is discharged through a discharge opening to heat or cool an area. Two fans draw an exterior air stream over the gas or electric heat exchanger or the evaporator coil. A first

(57) Abrégé(suite)/Abstract(continued):
fan has a diameter greater than a diameter of a second fan. When in a side discharge configuration, the second fan is located between the first fan and the side discharge opening. The first fan has a larger diameter to produce a stronger airflow to overcome the airflow produced by the second fan, better distributing the airflow from the first fan. The airflow generated by the second fan is directed to the discharge opening relatively unimpeded.

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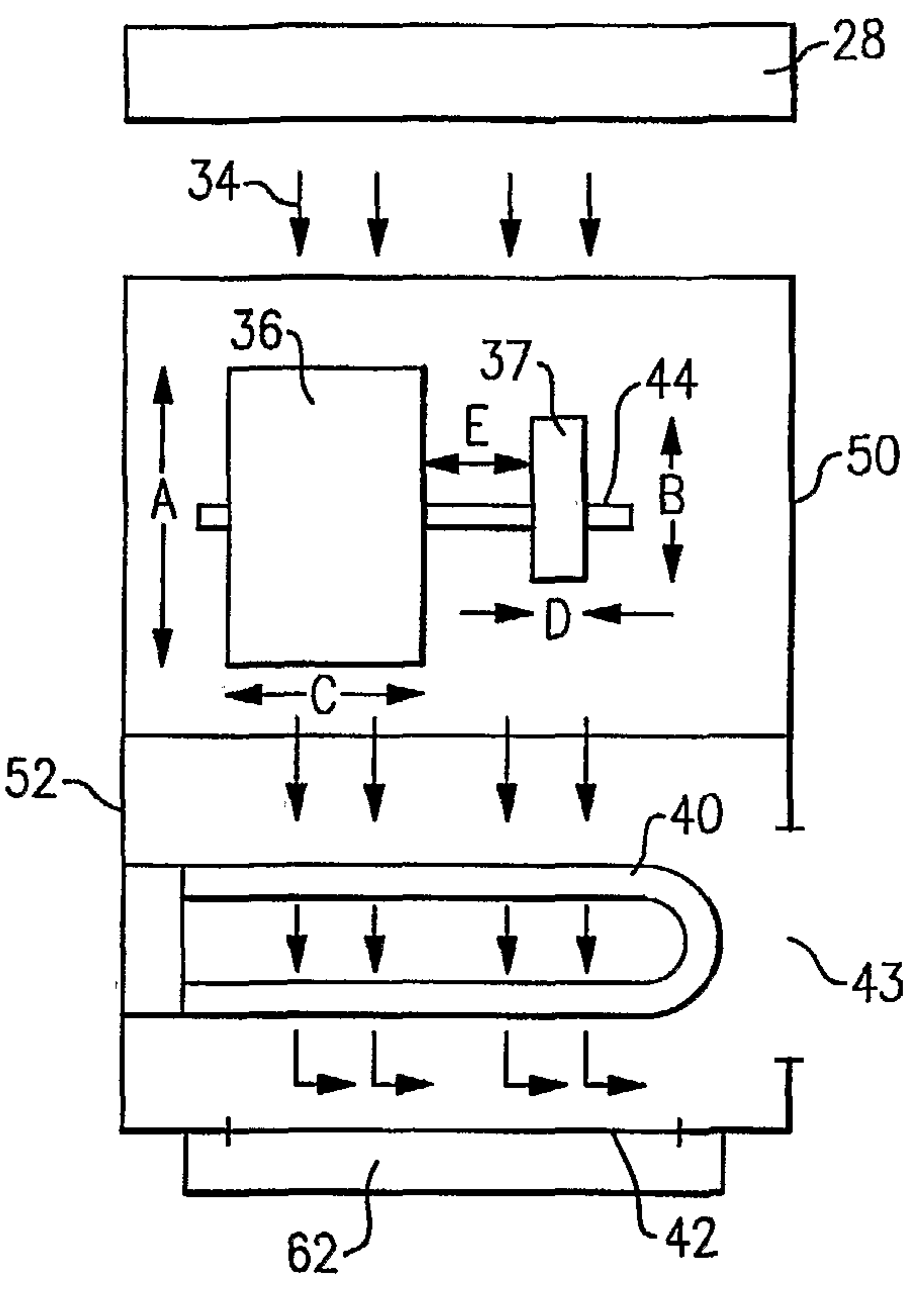
(54) Title: AIRFLOW MANAGEMENT SYSTEM IN A HVAC UNIT INCLUDING TWO FANS OF DIFFERENT DIAMETERS



(57) Abstract: Air is heated by a gas or electric heat exchanger or cooled in an evaporator coil. The air is discharged through a discharge opening to heat or cool an area. Two fans draw an exterior air stream over the gas or electric heat exchanger or the evaporator coil. A first fan has a diameter greater than a diameter of a second fan. When in a side discharge configuration, the second fan is located between the first fan and the side discharge opening. The first fan has a larger diameter to produce a stronger airflow to overcome the airflow produced by the second fan, better distributing the airflow from the first fan. The airflow generated by the second fan is directed to the discharge opening relatively unimpeded.

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AIRFLOW MANAGEMENT SYSTEM IN A HVAC UNIT INCLUDING TWO FANS OF DIFFERENT DIAMETERS

BACKGROUND OF THE INVENTION

The present invention relates generally to an airflow management system including two fans of different diameters that draw air over an evaporator coil and blow the air over a gas or electric heat exchanger.

Large commercial airflow management systems commonly employ two smaller fans of equal diameter to draw air over an evaporator coil and blow the air over a gas or electric heat exchanger into an area. Two smaller fans provide advantages over a single larger fan. For one, the airflow is more evenly distributed over a wider cross-section of the evaporator coil. The airflow is also more evenly distributed over the gas or electric heat exchanger that depends on well-distributed airflow to prevent overheating and to optimize efficiency. Additionally, the diameter of the two fans is smaller than the diameter of a single fan, reducing the height of the cabinet that holds the fans.

A problem with employing the two fans of equal diameter is that they do not always deliver an equal amount of airflow, even when operating at identical speeds. This problem is especially prevalent in airflow management systems that are convertible from a down discharge configuration to a side discharge configuration. In a down discharge configuration, air drawn by both a first fan and a second fan flow directly to a down discharge opening. The airflows from the two fans are approximately equal. In a side discharge configuration, the airflow through a second fan closest to a side discharge opening is relatively unimpeded. However, the airflow through the first fan farther from the side discharge opening has a greater distance to travel and must pass through the blast area of the second fan to exit the side discharge opening. The second fan imposes a backpressure on the airflow generated by the first fan, reducing the flow rate of the air exiting the first fan. The second fan therefore delivers most of the airflow, while the first fan is relatively ineffective. The fans can also interact in a manner that produces surging and generally unstable operation, making it difficult to hold a fixed volumetric airflow and static pressure setpoint.

In the prior art airflow management system, the airflow is unstable over a wide range of fan speeds. Fan power consumption increases because the second fan does most of the work. A large portion of the evaporator coil receives very little airflow, so the gas or electric heat exchanger has high surface temperature and poor thermal efficiency. Temperature activated safety limit switches also behave erratically due to unstable air temperatures.

Hence, there is a need in the art for an airflow management system including two fans of different diameters that draw air over an evaporator coil and blow air over a gas or electric heat exchanger that overcomes the drawbacks and shortcomings of the prior art.

SUMMARY OF THE INVENTION

An airflow management system includes a vapor compression system. In a cooling mode, refrigerant is compressed in a compressor and then enters a condenser coil and rejects heat to an external fluid medium. The refrigerant is then expanded by an expansion device. After expansion, the refrigerant flows through an evaporator coil and accepts heat from an external air stream that is discharged through a discharge opening to cool an area. The refrigerant then re-enters the compressor, completing the cycle. In a heating mode, the evaporator does not cool the external air stream, and the airflow is heated by a gas or electric heat exchanger of a heating section to heat the area.

A first fan and a second fan draw the external air stream over of the evaporator coil and blow the external air stream over the gas or electric heat exchanger. The first fan has a first diameter that is greater than a second diameter of the second fan. A discharge opening is convertible from a down discharge configuration to a side discharge configuration. When in the side discharge configuration, the second fan is located between the first fan and the side discharge opening. In one example, the fans are co-axially arranged. The air drawn by the second fan is directed to the side discharge opening relatively unimpeded. The airflow from the first fan must pass through the blast area of the second fan. The first fan has a larger diameter to produce a stronger airflow to overcome the airflow produced by the second fan, better distributing the airflow from the first fan.

The speeds of the fans can also be adjusted to optimize airflow. The first fan has a higher speed and thus produces a greater airflow than the second fan. Additionally, both the speed of the fans and the diameter of the fans can be adjusted to optimize airflow.

These and other features of the present invention will be best understood from the following specification and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiment. The drawings that accompany the detailed description can be briefly described as follows:

Figure 1 schematically illustrates an airflow management system including a vapor compression system and a heating system;

Figure 2A schematically illustrates a front view of an airflow management system in a down discharge configuration;

Figure 2B schematically illustrates a side view of the airflow management system in the down discharge configuration;

Figure 3A schematically illustrates a front view of the airflow management system in a side discharge configuration; and

Figure 3B schematically illustrates a side view of the airflow management system in the side discharge configuration.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Figure 1 illustrates an airflow management system 10. A control 56 determines if the airflow management system 10 is operating in a cooling mode or a heating mode. This determination can be made by a thermostat or by instructions provided by an operator.

The airflow management system 10 includes a vapor compression system 20 having a compressor 22, a condenser coil 24, an expansion device 26 and an evaporator coil 28. Refrigerant circulates though the closed circuit vapor compression system 20. During the cooling mode, the refrigerant exits the compressor 22 through a discharge port 30 at a high pressure and a high enthalpy.

The refrigerant then flows through the condenser coil 24. An external fluid medium 32, such as water or air, flows through the condenser coil 24 and exchanges heat with the refrigerant flowing through the condenser coil 24. The refrigerant rejects heat to the external fluid medium 32 and exits the condenser coil 24 at a relatively low enthalpy and a high pressure.

The refrigerant is then expanded by the expansion device 26, reducing the pressure of the refrigerant. The expansion device 26 can be a mechanical expansion device (TXV), an electronic expansion valve (EXV) or other type of known expansion device.

After expansion, the refrigerant flows through the evaporator coil 28 and absorbs heat from an external air stream 34. The refrigerant exits the evaporator coil 28 at a relatively high enthalpy and a low pressure. The refrigerant then enters a suction port 38 of the compressor 22, completing the cycle.

When the airflow management system 10 is operating in the cooling mode, the control 56 sends a signal to activate the compressor 22 and pump the refrigerant through the vapor compression system 20 to cool the external air stream 34 in the evaporator coil 28. The control 56 sends a signal to inactivate a gas or electric heat exchanger 40 in a heating section 52. The gas or electric heat exchanger 40 includes several substantially U-shaped heat exchanger coils (shown in Figures 2B and 3B).Fans 36 and 37 (shown in Figures 2A, 2B, 3A and 3B) draw the exterior air stream 34 over the evaporator coil 28 and through an air moving section 50 and blow the exterior air stream 34 through a heating section 52 (not active) and into the area to be cooled through a down discharge opening 42 or a side discharge opening 43 to cool the area.

Returning to Figure 1, when the airflow management system 10 is operating in the heating mode, the control 56 sends a signal to inactivate the compressor 22, stopping the flow of refrigerant through the vapor compression system 20 and the evaporator coil 28. The control 56 sends a signal to activate the gas or electric heat exchanger 40. During the heating mode, the external air stream 34 is heated by the gas or electric heat exchanger 40 in the heating section 52 to heat the external air stream 34 and heat the area. The compressor 22 does not operate during the heating mode, and therefore the refrigerant does not flow through the vapor compression system 20 and exchange heat with the exterior air stream 34. The fans 36 and 37 blow the exterior air stream 34 over the gas or electric heat exchanger 40 to heat the external air stream 34. The heated external air stream 34 exits the heating section 52 through one of the down discharge opening 42 or the side discharge opening 43 to heat the area.

The flow of the refrigerant in the vapor compression system 20 can be reversed by using a heat pump 54. When the flow of the refrigerant is reversed, the refrigerant from the compressor 22 enters the evaporator coil 28 (that acts a condenser) to heat the external air stream 34 to heat the area.

As shown in Figures 2A, 2B, 3A and 3B, fans 36 and 37 in the air moving section 50 draw the exterior air stream 34 over the evaporator coil 28 and blow the external air stream 34 over the gas or electric heat exchanger 40. The fans 36 and 37 operate in parallel. In one example, the first fan 36 and the second fan 37 are co-axially arranged about a common shaft 44. However, it is possible that each of the fans 36 and 37 are mounted on different shafts that are substantially parallel. The exterior air stream 34 is convertible between a down discharge configuration and a side discharge configuration.

The first fan 36 has a diameter A and a width C, and the second fan 37 has a diameter B and a width D. The diameter A of the width C of the first fan 36 is greater than the diameter B and the width D of the second fan 37. The air volume drawn by the fans 36 and 37 depends on the cube of the diameter of each of the fans 36 and 37. The static pressure depends on the square of the diameter of the fans 36 and 37. In one example, the first fan 36 has a diameter A of approximately 15 inches, and the second fan 37 has a diameter B of approximately 12 inches. In one example, the first fan 36 has a width C of approximately 15 inches, and the second fan 37 has a width D of approximately 12 inches. However, these diameters are only example, and any diameters can be employed. The fans 36 and 37 are separated by a distance E. In one example, the distance E is approximately 19 inches.

Figures 2A and 2B show the exterior air stream 34 flowing through the down discharge opening 42 in the heating section 52 when the airflow management system 10 is operating in a down discharge configuration. The exterior air stream 34 is drawn by the fans 36 and 37 over the evaporator coil 28 and blown over the gas or electric heat exchanger 40. The exterior air stream 34 is directed along a substantially straight path to the down discharge opening 42 to heat the area in the heating mode or cool the area in the cooling mode. The airflows from each of the fans 36 and 37 do not interfere with each other. In the down discharge configuration, the side discharge opening 43 is covered by a panel 60 to prevent the external air stream 34 from flowing through the side discharge opening 43. The panel 60 can be connected to the heating section 52 in any manner.

Figures 3A and 3B show the exterior air stream 34 flowing through the side discharge opening 43 in the heating section 52 when the airflow management system 10 is operating in a side discharge configuration. The exterior air stream 34 is drawn by the fans 36 and 37 over the evaporator coil 28 and blown over gas or electric heat exchanger 40. The exterior air stream 34 is directed through the heating section 52 and through the side discharge opening 43. In the view of Figure 3A, the exterior air stream 34 is blown in a direction directed into the page. However, it is to be understood that the air blown by the fans 36 and 37 can be drawn in any horizontal direction towards the side discharge opening 43. In the side discharge configuration, the down discharge opening 42 is covered by a panel 62 to prevent the external air stream 34 from flowing through the down discharge opening 42. The panel 62 can be connected to the heating section 52 in any manner.

The second fan 37 is located proximate to the side discharge opening 43. Therefore, the air drawn by the second fan 37 is directed to the side discharge opening 43 relatively unimpeded. As shown in Figure 3B, the airflow from the fans 36 and 37 hits the panel 62 and is then directed substantially perpendicularly to exit the side discharge opening 43 and heat or cool the area.

The first fan 36 is located on the other side of the second fan 37 and away from the side discharge opening 43. As the airflow from the first fan 36 moves towards the side discharge opening 43, the airflow passes through the blast area of the second fan 37, which interrupts the discharge of air from the first fan 36.

To accommodate for this interruption, the first fan 36 farther away from the side discharge opening 43 is more powerful than the second fan 37 closer to the side discharge opening 43. By making the diameter A and the width C of the first fan 36 larger than the diameter B and the width D of the second fan 37, the first fan 36 can produce a stronger airflow to overcome the airflow through the second fan 37, better distributing the airflow from the first fan 36 to the side discharge opening 43. Because of the stronger airflow, the airflow from the second fan 37 does not impose a back pressure on the airflow from the first fan 36 and does not restrict the flow rate of the air through the first fan 36 as the air flows through the blast area of the second fan 37. The first fan 36 is more powerful because it is located in a position that would otherwise tend to have insufficient airflow, and the second fan 37 is weaker because it is located in a position that would otherwise tend to have excessive airflow. Operation of the airflow management system 10 can be stabilized, and a more desirable airflow balance between the two fans 36 and 37 is possible.

The speeds of the fans 36 and 37 can also be adjusted to optimize airflow. In this example, the first fan 36 operates to produce an airflow having a greater speed than the airflow produced by the second fan 37. In one example, the fans 36 and 37 rotate approximately 496 to 1300 revolutions per minute. In this example, the fans 36 and 37 can have equal diameters A and B, respectively, and equal widths C and D, respectively, or can have unequal diameters. Additionally, both the speeds of the fans 36 and 37 and the diameters or the widths of the fans 36 and 37 can be adjusted to optimize airflow.

The division of the airflow between the two fans 36 and 37 depends on the position, size and speed of the fans 36 and 37. The division of airflow also depends on air intake geometry, heating cavity design and the size and the location of the down discharge opening 42 and the side discharge opening 43.

The foregoing description is only exemplary of the principles of the invention. Many modifications and variations of the present invention are possible in light of the above teachings. The preferred embodiments of this invention have been disclosed, however, so that one of ordinary skill in the art would recognize that certain modifications would come within the scope of this invention. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described. For that reason the following claims should be studied to determine the true scope and content of this invention.

WE CLAIM:

1. A heat exchanger comprising:

a heat exchanger coil;

a first fan to produce a first airflow that exchanges heat with a medium in the heat exchanger coil; and

a second fan to produce a second airflow that exchanges heat with the medium in the heat exchanger coil, wherein the first airflow is stronger than the second airflow, and the first airflow and the second airflow flow through a common discharge opening.

2. The heat exchanger as recited in claim 1 wherein the first fan has a first diameter and the second fan has a second diameter, and the first diameter is greater than the second diameter.

3. The heat exchanger as recited in claim 1 wherein the first fan operates at a first fan speed and the second fan operates at a second fan speed, and the first fan speed is greater than the second fan speed.

4. The heat exchanger as recited in claim 1 wherein the first airflow and the second airflow exit through the common discharge opening, and the first airflow and the second airflow are directed along a substantially straight path from the first fan and the second fan, respectively, to the common discharge opening.

5. The heat exchanger as recited in claim 1 wherein the first airflow and the second airflow exit through the common discharge opening and the second fan is located between the first fan and the common discharge opening.

6. The heat exchanger as recited in claim 1 wherein the first fan and the second fan operate in parallel.

7. The heat exchanger as recited in claim 1 wherein the heat exchanger coil is an evaporator coil, and the first fan and the second fan draw the first airflow and the second airflow, respectively, over the evaporator coil.

8. The heat exchanger as recited in claim 1 wherein the heat exchanger is a gas or electric heat exchanger, and the first fan and the second fan blow the first airflow and the second airflow, respectively, over the gas or electric heat exchanger.

9. An airflow management system comprising:

a vapor compression system including an evaporator coil, wherein refrigerant flows through the evaporator coil;

a heating heat exchanger that produces a heated medium; and

an air moving section including:

a first fan to produce a first airflow that exchanges heat with the refrigerant in the evaporator coil when the airflow management system is operating in a cooling mode and that exchanges heat with the heated medium in the heating heat exchanger when the airflow management system is operating in a heating mode, and

a second fan to produce a second airflow that exchanges heat with the refrigerant in the evaporator coil when the airflow management system is operating in the cooling mode and that exchanges heat with the heated medium in the heating heat exchanger when the airflow management system is operating in the heating mode, wherein the first airflow is stronger than the second airflow, and the first airflow and the second airflow flow through a common discharge opening.

10. The system as recited in claim 9 wherein the vapor compression system includes:

a compressor to compress the refrigerant to a high pressure,

a condenser for exchanging heat between the refrigerant and a fluid, and

an expansion device to expand the refrigerant to a low pressure.

11. The system as recited in claim 9 wherein the first fan has a first diameter and the second fan has a second diameter, and the first diameter is greater than the second diameter.

12. The system as recited in claim 9 wherein the first fan operates at a first fan speed and the second fan operates at a second fan speed, and the first fan speed is greater than the second fan speed.

13. The system as recited in claim 9 wherein the first airflow and the second airflow exit the airflow management system through the common discharge opening, and the first airflow and the second airflow are directed along a substantially straight path from the first fan and the second fan, respectively, to the common discharge opening.

14. The system as recited in claim 9 wherein the first airflow and the second airflow exit the airflow management system through the common discharge opening and the second fan is located between the first fan and the common discharge opening.

15. The system as recited in claim 9 wherein the first fan and the second fan operate in parallel.

16. The system as recited in claim 9 wherein the first fan and the second fan draw the first airflow and the second airflow, respectively, over the evaporator coil.

17. The system as recited in claim 9 wherein the first fan and the second fan blow the first airflow and the second airflow, respectively, over the heating heat exchanger.

18. A method of managing an airflow comprising the steps of:

operating an airflow management system in one of a cooling mode and a heating mode;

generating a first airflow that exchanges heat with a refrigerant in an evaporator coil when the airflow management system is operating in the cooling mode and that exchanges heat with a heated medium in a heating heat exchanger when the airflow management system is operating in the heating mode; and

generating a second airflow that exchanges heat with the refrigerant in the evaporator coil when the airflow management system is operating in the cooling mode and that exchanges heat with the heated medium in the heating heat exchanger when the airflow management system is operating in the heating mode, wherein the first airflow is stronger than the second airflow, and the first airflow and the second airflow flow through a common discharge opening.

19. The method as recited in claim 18 wherein the first airflow is generated by a first fan having a first diameter and the second airflow is generated by a second fan having a second diameter, wherein the first diameter is greater than the second diameter.

20. The method as recited in claim 18 wherein the first airflow has a first speed and the second airflow has a second speed, and the first speed is greater than the second speed.

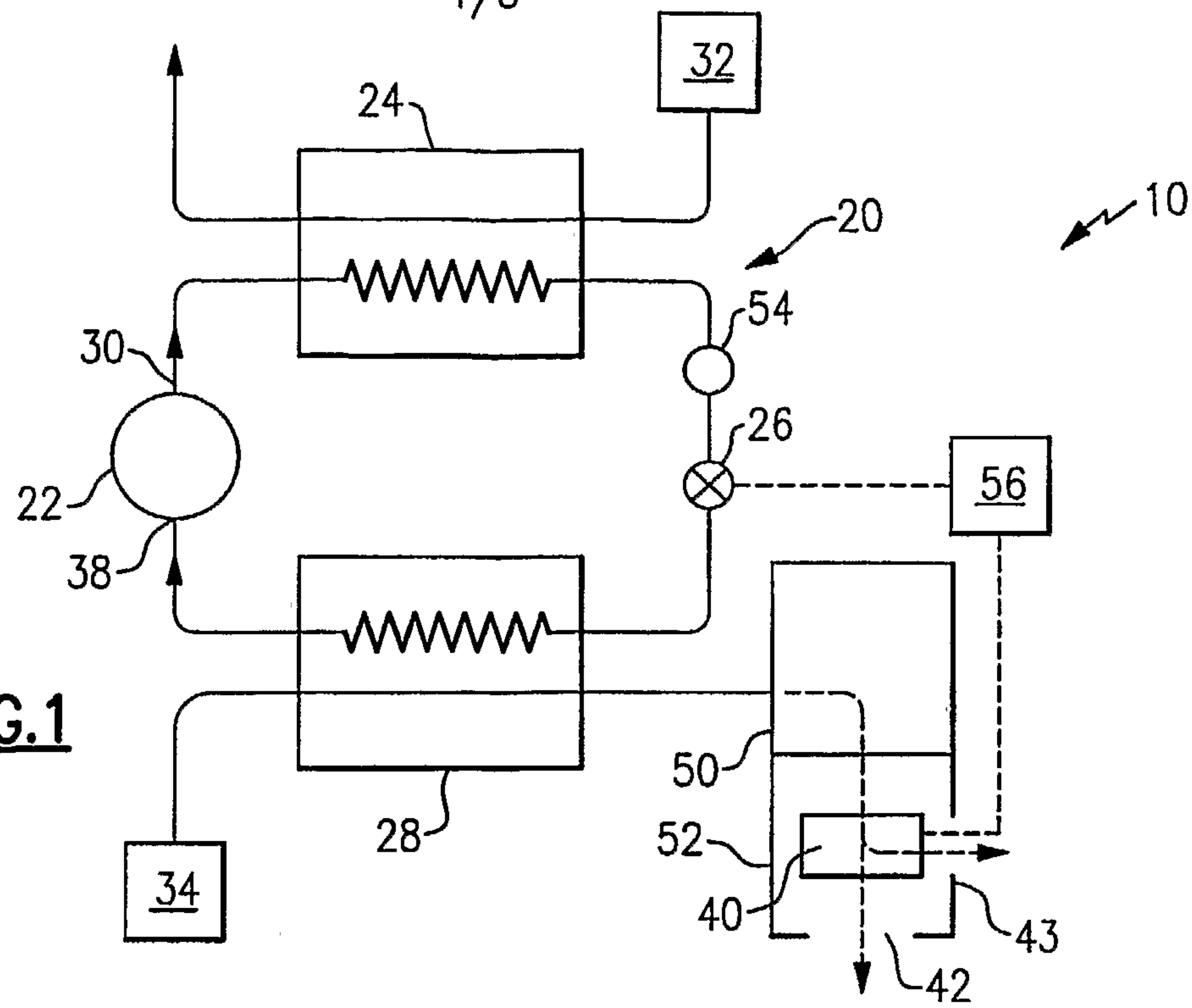
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FIG.1

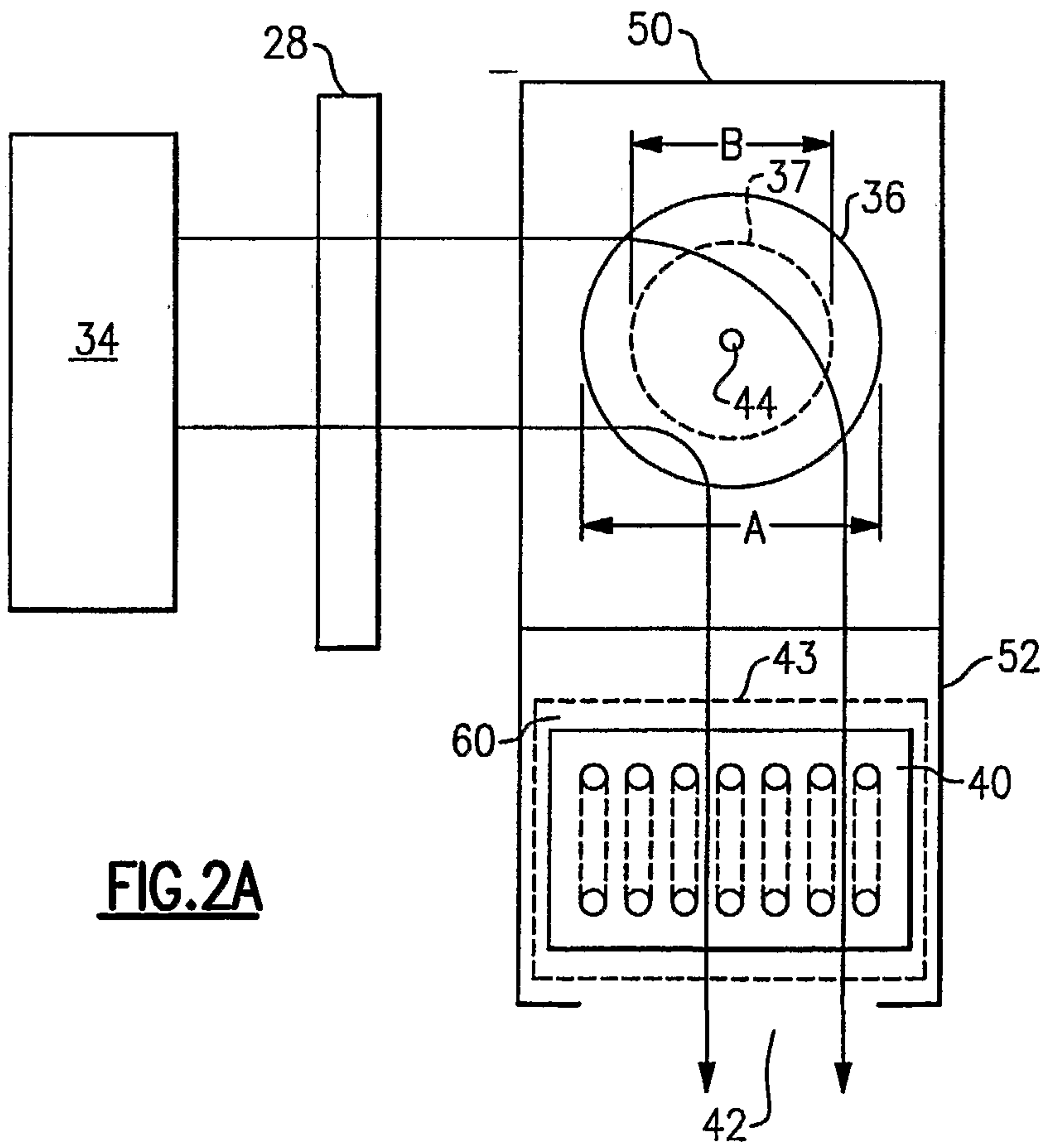
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FIG.2A

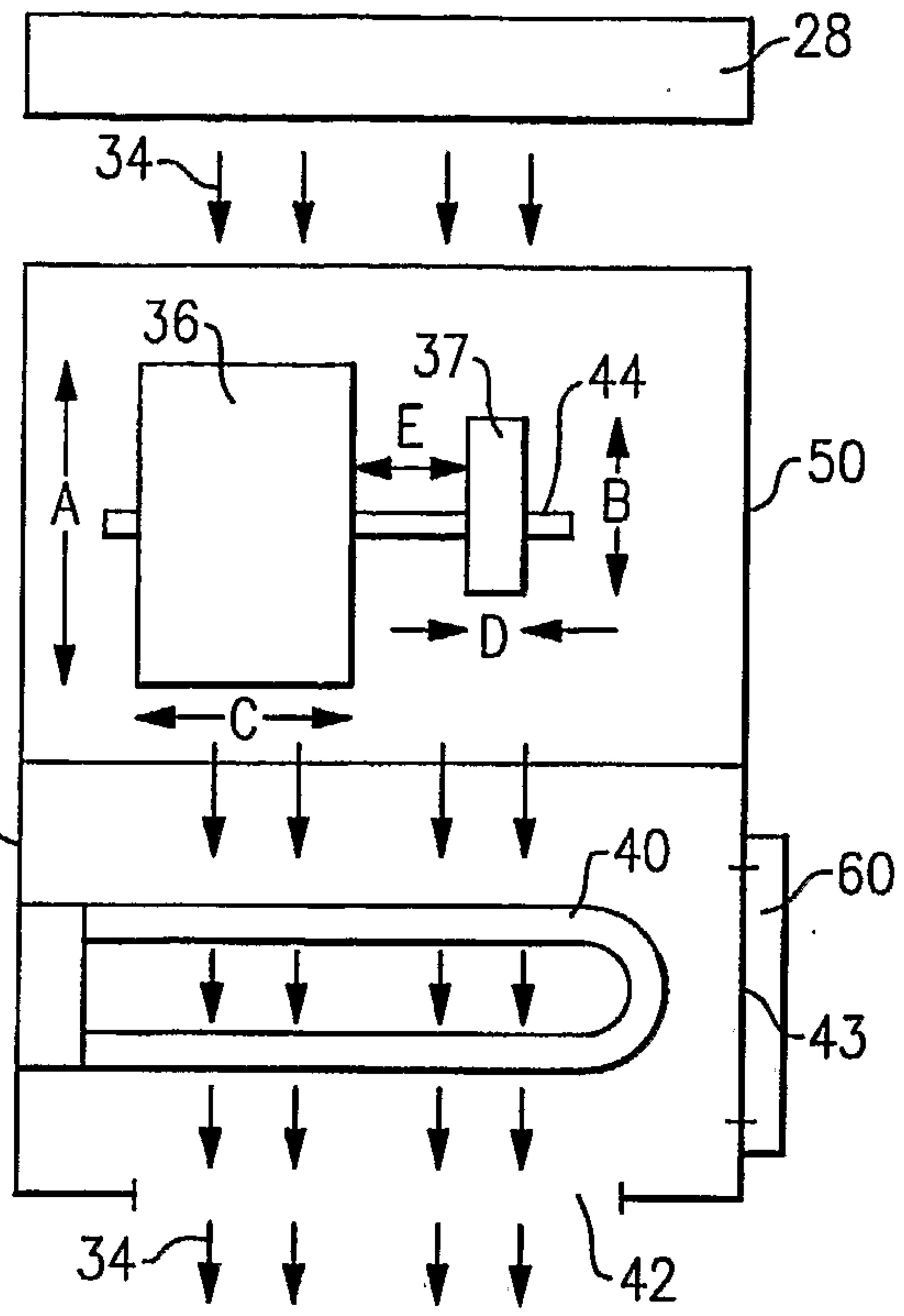
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FIG.2B

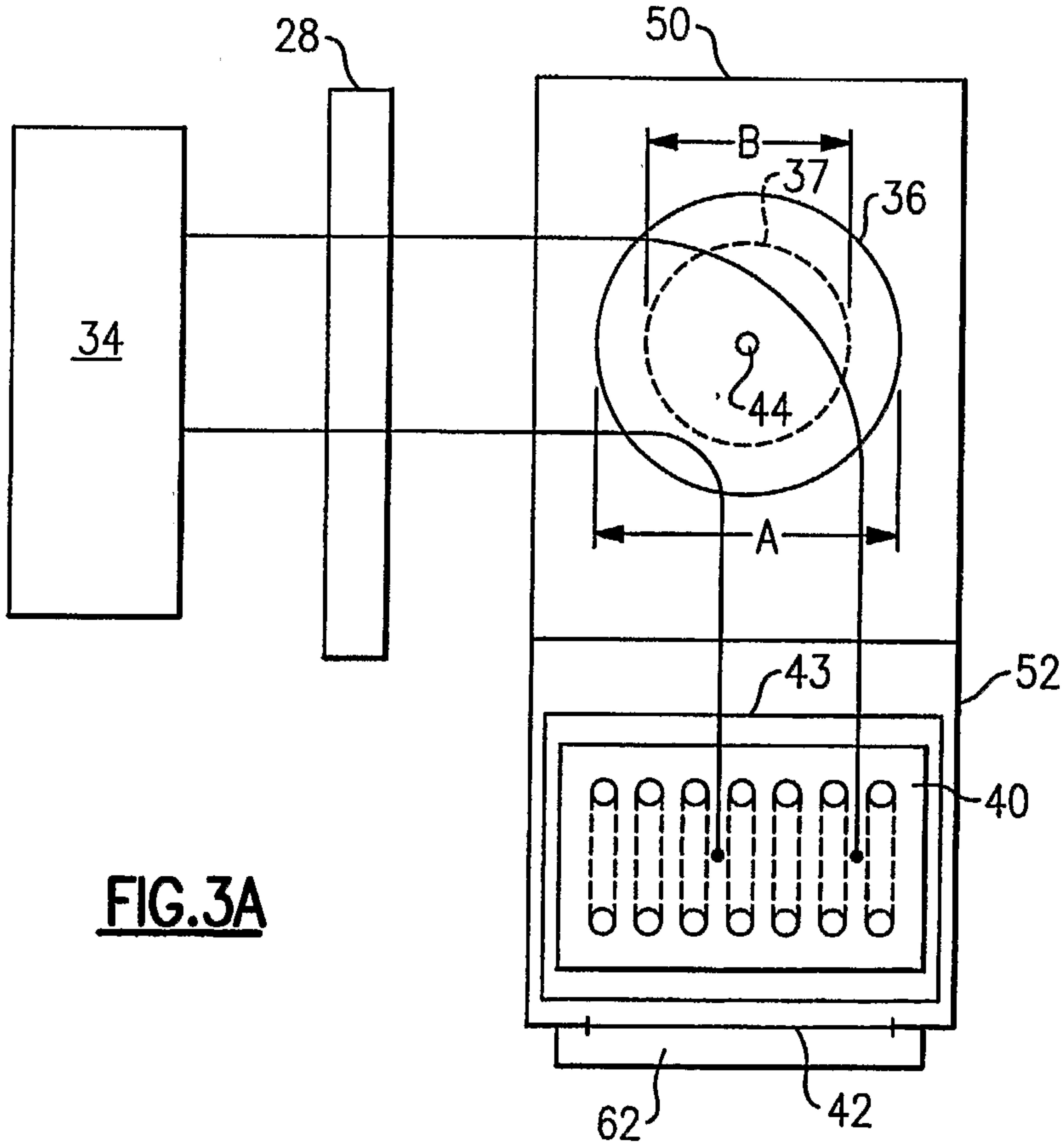
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FIG.3A

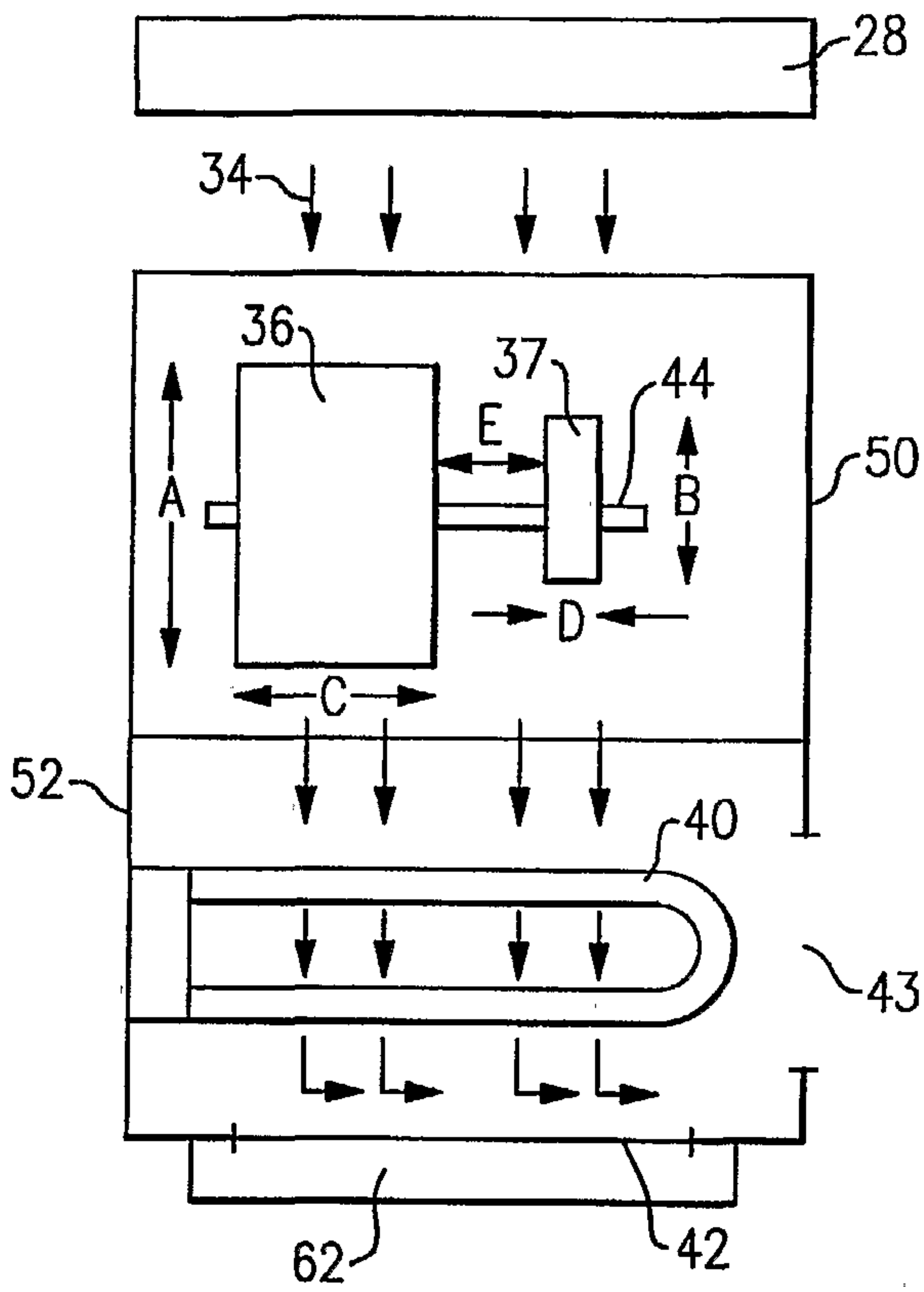
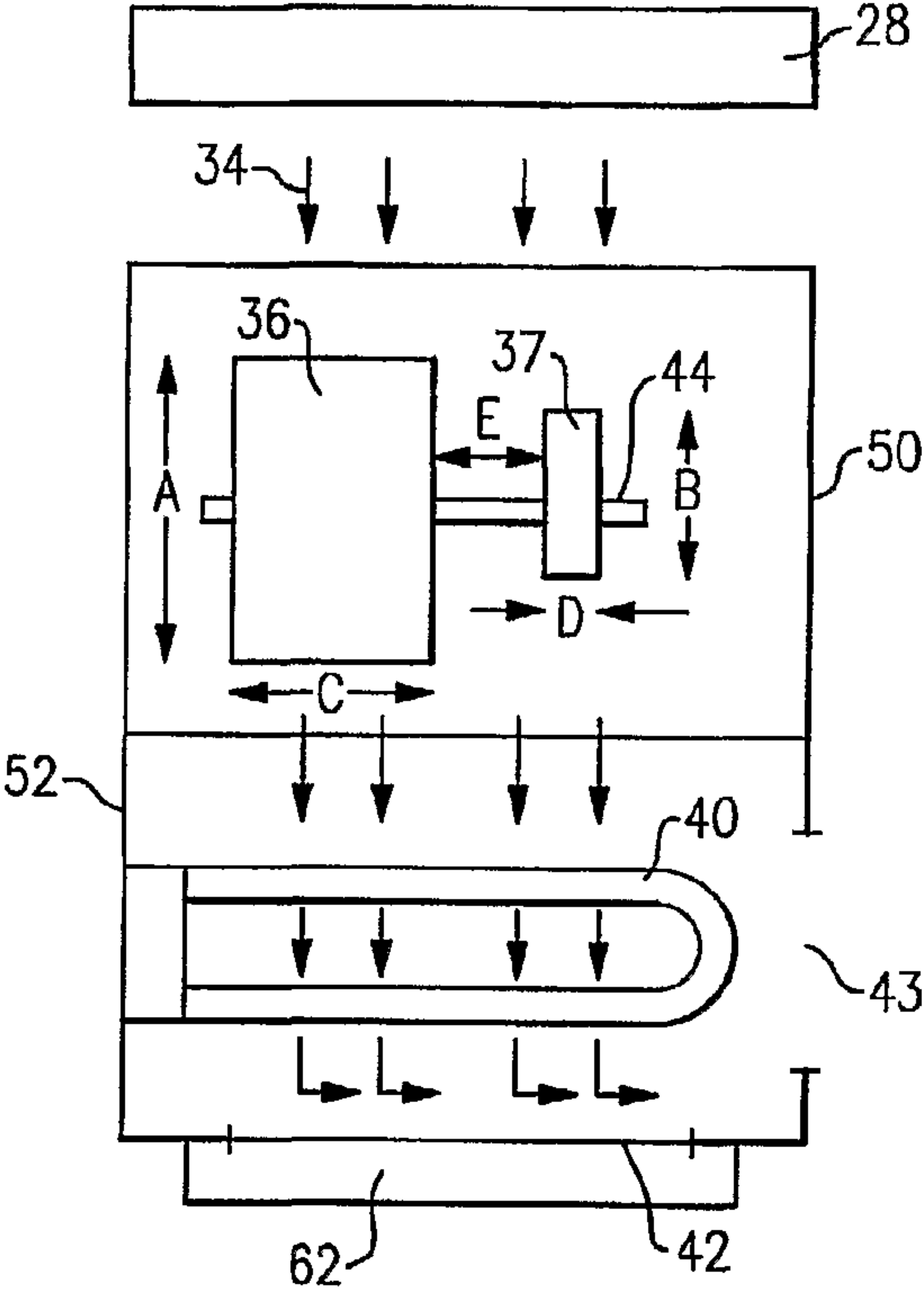


FIG.3B



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