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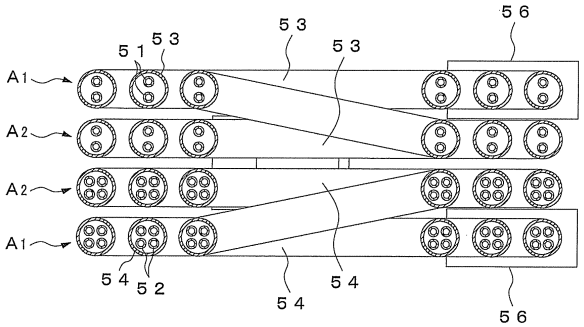
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(54) Heat exchanger and hot water supply apparatus using the same

(57) An heat exchanger and hot water supply apparatus using the same can avoid the blocking of flow by means of stacking of scale without forming whole of the outer pipe or the downstream side of the outer pipe using the larger diameter pipe. The number of the first inner pipes 51, which are disposed on downstream side of the hot water, is smaller than the number of the second inner pipes 52, which are disposed on upstream side of the hot water. By this, it is secured that the sectional area for flowing water between the first outer pipe 53 and each of the inner pipes 51 becomes larger than that between the second outer pipe 54 and each of the second inner pipes 52. Therefore, it is not necessary that the outer pipes 53, 54 or downstream side of the outer pipe 53 is made of a larger diameter pipe. Moreover, the first and second inner pipes 51, 52 are made of copper alloy pipes having a composition comprising, by mass, 0.005 to 0.2 % Zirconium (Zr), 0.05 to 3.0% Tin (Sn), 0.001 to 0.2 % Phosphorus (P), 0.05 to 5.0% Zink (Zn), and the balance copper (Cu) with inevitable impurities. By this, it is possible to prevent the piling up of the scale onto the inner pipes 51, 52.

Fig. 5



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Description

FIELD OF THE INVENTION

[0001] The present invention relates to, for example, a heat exchanger which is used as a water-heat exchanger of a heat pomp type hot water supply apparatus, and hot water supply apparatus using the heat exchanger.

DESCRIPTION OF THE RELATED ART

[0002] As a heat pump type hot water supply apparatus, an apparatus (disclosed in JP-A-2006-46877, for example) is known and that apparatus has a heating unit for heating water, which will be used for supplying hot water, by heat pump circuit, and a tank unit for storing hot water generated by the heating unit, the hot water in the tank unit is supplied to a bus tub and kitchen.

[0003] The heating unit of the hot water supply apparatus has a refrigerant circuit comprising a compressor, evaporator, water-heat exchanger (gas cooler), and the like. The heating unit heats the water, which will be used for supplying hot water, by water-heat exchanger. Also, the heating unit supplies the hot water to the tank unit through a hot water passage. Also, the water-heat exchange consists of an inner pipe in which the high-temperature refrigerant of the heat pump circuit goes through and an outer pipe housing the inner pipe. The water-heat exchanger is configured to perform heat exchange between the refrigerant and the water, which will be used for supplying hot water, through the inner pipe when the water, which will be used for supplying hot water, flows between the inner and outer pipe.

[0004] On the other hand, for example, scale consists mainly of calcium carbonate and the like included in the water, which will be used for supplying hot water, usually adheres to the said inner and outer pipe. Also when the refrigerant and the water, which will be used for supplying hot water, flow in the opposite direction with each other, the said scale especially stacks and adheres tightly on the downstream side (high-temperature side) of the water which will be used for supplying hot water. By this, the scale may block the flow of the water which will be used for supplying hot water. Therefore, conventionally, whole of the outer pipe or only the downstream side of the outer pipe is made of a larger diameter pipe, the sectional area for flowing the water between the inner pipe and the outer pipe is secured, and, by this, the flow of the water, which is used for supplying hot water, is not prevented if the scale is stacked.

[0005] However, if whole of the outer pipe or only the downstream side of the outer pipe is made of the larger diameter pipe, many kinds of pipe member for the outer pipe is needed and the cost for the outer pipe may become high, and the productivity must be reduced.

BRIEF SUMMARY OF THE INVENTION

[0006] An object of the present invention is to provide a heat exchanger and hot water supply apparatus using the same, which can avoid the blocking of flow by means of stacking of scale without forming whole of the outer pipe or the downstream side of the outer pipe using the larger diameter pipe.

[0007] To achieve the above object, a heat exchanger of the present invention comprises a heat conductive inner pipe in which a first heat medium flows and an outer pipe in which the inner pipe is disposed, and the heat exchange between the first heat medium and the second heat medium is performed through the inner pipe, and

characterized in that the number of the inner pipes which are disposed at a downstream side of the second heat medium is smaller than the number of the inner pipes which are disposed at an upstream side of the second heat medium, at least one of the inner pipe and the outer pipe is made of a copper alloy pipe having a composition comprising 0.005 to 0.2 mass% Zirconium (Zr) and the balance copper (Cu) with inevitable impurities.

[0008] By this, the number of the first inner pipes, which are disposed on downstream side of the second heat medium, is smaller than the number of the second inner pipes, which are disposed at upstream side of the second heat medium. Therefore, it is secured that the sectional area for flowing water between the outer pipe and inner pipe, which are disposed at downstream side of the second heat medium, become larger than that between the outer pipe and inner pipe, which are disposed at upstream side of the second heat medium. Therefore, for example, even if the scale is piled up at the downstream side of the hot water, which is as the second heat medium, the flowing of the second heat medium may not be blocked. Also, the number of the first inner pipes, which are disposed on upstream side of the second heat medium, is larger than the number of the second inner pipes, which are disposed at downstream side of the second heat medium. Therefore, the hot water is heated sufficiently by each of the inner pipes which are disposed at the upstream side. Moreover, at least one of the inner pipe and the outer pipe is made of a copper alloy pipe having a composition comprising 0.005 to 0.2 mass% Zirconium (Zr) and the balance copper (Cu) with inevitable impurities. Therefore, piling up of the scale between the inner pipe and the outer pipe is prevented.

[0009] According to this invention, it is secured that the sectional area for flowing water between the outer pipe and inner pipe, which are disposed at downstream side of the second heat medium, is larger than that between the outer

pipe and inner pipe, which are disposed at upstream side of the second heat medium. Therefore, it is possible to effectively prevent the blocking of the flow due to the piling up of the scale at the downstream side in the outer pipe, even if whole of the outer pipe or downstream side of the outer pipe is not made of a larger diameter pipe. Therefore, it is possible to increase the productivity without increase in variety or cost of the pipes which is the material for the outer pipes. In this case, since the hot water is heated sufficiently by the inner pipes which are disposed at the upstream side of the second heat medium, an advantage that the heat exchange efficiency is not reduced is achieved. Also, since the piling up of the scales between outer pipe and the inner pipe may be prevented, it is effective for preventing the piling up.

[0010] The above and other objects, features, and advantages of the present invention will become more apparent from the following description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is an outline structural view showing a heat pomp type hot water apparatus as an embodiment of the present invention;
FIG. 2 is a side sectional perspective view of a water-heat exchanger;
FIG. 3 is a top plan view of the water-heat exchanger;
FIG. 4 is a side view of the water-heat exchanger;
FIG. 5 is an X-X arrow line sectional view indicated in the FIG. 3;
FIG. 6 is a graph showing a result of an experiment;
FIG. 7 is a top plan view of a first water-heat exchanger showing another embodiment of the present invention;
FIG. 8 is a side view of the first water-heat exchanger;
FIG. 9 is a Y-Y arrow line sectional view indicated in the FIG. 7.

BEST MODE FOR CARRYING OUT THE INVENTION

[0012] Figs. 1 through 6 show an embodiment of the present invention.

[0013] A heat pump type hot water supply apparatus shown in the Figures include a refrigerant circuit 10 for circulating a refrigerant, a first hot water circuit 20 in which hot water flows, a second hot water circuit 30 in which hot water flows, a bath tub circuit 40 in which a water for bath tub flows, a first water-heat exchanger 50 for performing heat exchange between the refrigerant in the refrigerant circuit 10 and the water for supplying hot water, and a second water-heat exchanger 60 for performing heat exchange between the water for supplying hot water and the water for the bath tab. The first water-heat exchanger performs as a heat exchanger of the present invention.

[0014] The refrigerant circuit 10 is constructed by connecting a compressor 11, an expander 12, an air-heat exchanger 13, and the water-heat exchanger 50. And the refrigerant circuit 10 circulates the refrigerant in an order of the compressor 11, the first water-heat exchanger 50, the expander 12, the air-heat exchanger 13, and the compressor 11. Also, the refrigerant used in this refrigerant circuit 10 is a natural refrigerant, such as carbon dioxide for example.

[0015] The first hot water circuit 20 is constructed by connecting a hot water storage tank 21, a first pump 22, and the first water-heat exchanger 50. And the first hot water circuit 20 circulates the hot water in an order of the hot water storage tank 21, the first pump 22, the first water-heat exchanger 50, and the hot water storage tank 21. A water supply pipe 23 and the second hot water circuit 30 is connected to the hot water storage tank 21, and the water for supplying hot water, which is supplied from the water supply pipe 23, flows in the first hot water circuit 20 through the hot water storage tank 21. The hot water storage tank 21 and a bath tub 41 are connected to each other through a passage 25 which is provided with a second pump 24. Also, the water for supplying hot water in the hot water storage tank 21 is supplied to the bath tab 41 by the second pump 24.

[0016] The second hot water circuit 30 is constructed by connecting the hot water storage tank 21, a third pump 31, and the second water-heat exchanger 60. And the second hot water circuit 30 circulates the hot water in an order of the hot water storage tank 21, the second water-heat exchanger 60, the third pump 31, and the hot water storage tank 21.

[0017] The bath tub circuit 40 is constructed by connecting the bath tub 41, a forth pump 42, and the second water-heat exchanger 60. The bath tub circuit 40 circulates the water for bath tub in an order of the bath tub 41, the forth pump 42, the second water-heat exchanger 60, and the bath tub 41.

[0018] The first water-heat exchanger 50 is connected to both of the refrigerant circuit 10 and the first hot water circuit 20, and the first water-heat exchanger 50 performs heat exchange between the refrigerant as a first heat medium which flows in the refrigerant circuit 10 and the hot water as a second heat medium which flows in the first hot water circuit 20. The first water-heat exchanger has first and second inner pipes 51, 52 in which the refrigerant goes through, the first and second inner pipes 51, 52 have heat conductivity, first and second outer pipes 53, 54 housing the first and second inner pipes 51, 52 respectively, a pair of first end headers 55 to which one ends of the first and second inner pipes 51,

52 are connected respectively, a pair of second end headers 56 to which one ends of the outer pipes 53, 54 are connected respectively, a first middle header 57 to which the other ends of the first and second inner pipes 51, 52 are connected, and a second middle header 58 to which the other ends of the first and second outer pipes 53, 54 are connected. The first and second inner pipes 51, 52 and the first and second outer pipes 53, 54 are wound spirally. In this case, two pieces of first inner pipes 51 are disposed in the first outer pipe 53, and four pieces of second inner pipes 52 are disposed in the second outer pipe 54.

[0019] Each of the first end headers 55 is connected to the refrigerant circuit 10, a refrigerant inflow pipe 55a and an refrigerant outflow pipe 55b are connected to each of the first end headers 55. In this case, each of the first inner pipes 51 is connected in parallel with each other to the first end header 55 which is inflow side, each of the second inner pipes 52 is connected in parallel with each other to the first end header 55 which is outflow side. Each of the second end header 56 is connected to the first hot water circuit 20, a hot water inflow pipe 56a and a hot water outflow pipe 56b are connected to each of the second end headers 56. In this case, each of the second inner pipes 52 is penetrating the second end header 56 which is inflow sides, and each of the first inner pipes 51 is penetrating the second end header 56 which is outflow side.

[0020] The first middle header 57 has a pair of header portions 57a and a communication pipe 57b which communicates to each of the header portions 57a. Each of the first inner pipes 51 is connected in parallel with each other to one of the header portions 57a, and each of the second inner pipes 52 is connected in parallel with each other to another header portion 57a. In this case, the first and second inner pipes 51, 52 are connected from the same direction to the first middle header 57. The first and second outer pipes 53, 54 are connected from the same direction to the second middle header 58, and the first and second inner pipes 51, 52 are penetrating the second middle header 58.

[0021] Also, with respect to the first inner pipes 51 and the first outer pipe 53, there are a wound portion A1 which is wound from outside to inside and a wound portion A2 which is wound from inside to outside, and the wound portion A1 and the wound portion A2 are arranged at the upper and lower stages with each other. Each of the wound portions A1, A2 is formed so as to communicate with each other by bending the pipes inside the wound portions A1, A2. With respect to the second inner pipes 52 and the second outer pipe 54, there are a wound portion A2 which is wound from inside to outside and a wound portion A1 which is wound from outside to inside, and the wound portion A1 and the wound portion A2 are arranged at the upper and lower stage with each other. Each of the wound portions A1, A2 is formed so as to communicate with each other by bending the pipes inside the wound portions A1, A2. The wound portions A1, A2 of the first inner pipes 51 and the first outer pipe 53 are disposed over the wound portions A1, A2 of the second inner pipes 52 and the second outer pipe 54 so that the wound portions A1, A2 are arranged in vertical four stages.

[0022] Moreover, the first and second inner pipes 51, 52 are made of copper alloy pipes having a composition comprising, by mass, 0.005 to 0.2 % Zirconium (Zr), 0.05 to 3.0 % Tin (Sn), 0.001 to 0.2 % Phosphorus (P), 0.05 to 5.0 % Zink (Zn), and the balance copper (Cu) with inevitable impurities.

[0023] The second water-heat exchanger 60 is connected to both of the second hot water circuit 30 and the bath tub circuit 40, and the second water-heat exchanger 60 performs heat exchange between the hot water in the second hot water circuit 30 and the water for bath tub in the bath tub circuit 40.

[0024] Also, the said hot water supply apparatus has a heating unit 70 which comprises the refrigerant circuit 10 and the first water-heat exchanger 50, and a tank unit 80 which comprises the hot water storage tank 21, the first pump 22, the second pump 24, the second hot water circuit 30, the forth pump 42, and the second water-heat exchanger 60. The heating unit 70 and the tank unit 80 are connected through the first hot water circuit 20.

[0025] In the above mentioned hot water supply apparatus, heat exchange between the high-temperature refrigerant in the refrigerant circuit 10 and the hot water in the hot water circuit 20 is performed with the first water-heat exchanger 50, and then the hot water is heated. In the first water-heat exchanger 50, as shown by broken line arrows in Fig. 2, the refrigerant in the refrigerant circuit 10 flows into the each of the first inner pipes 51 through one of the first end headers 55, and after the refrigerant went through each of the first inner pipes 51, the refrigerant flows into each of the second inner pipes 52 through the first middle header 57, and after the refrigerant went through each of the second inner pipes 52, the refrigerant flows out through the other first end header 55. Also, as shown by static arrows in Fig. 2, hot water in the hot water circuit 20 flows into the second outer pipe 54 through one of the second end headers 56, and after the hot water went through between the second outer pipe 54 and the each of the second inner pipes 52, the hot water flows into the first outer pipe 53 through the second middle header 58, and after the hot water went through between the fist outer pipe 53 and each of the first inner pipes 51, the hot water flows out through the other second end header 56. Thus, in the first water-heat exchanger 50, the refrigerant and the hot water flow in the opposite direction with each other. In this case, the number of the first inner pipes 51, which are disposed on downstream side of the hot water, is smaller than the number of the second inner pipes 52, which are disposed on upstream side of the hot water. This is why, it may be secured that the sectional area for flowing water between the first outer pipe 53 and each of the first inner pipes 51 becomes larger than that between the second outer pipe 54 and each of the second inner pipes 52. Therefore, although some scales are piled up on the downstream side of the hot water, flowing of the hot water is not blocked. Also, the number of the second inner pipes 52 on the downstream side of the hot water is larger than that of the first inner pipes

52 on the downstream side of the hot water. Therefore, the hot water is well heated by each of the second inner pipes 52.

[0026] Also, in this embodiment, the first and second inner pipes 51, 52 are made of copper alloy pipes having a composition comprising, by mass, 0.005 to 0.2% Zirconium (Zr), 0.05 to 3.0% Tin (Sn), 0.001 to 0.2% Phosphorus (P), 0.05 to 5.0 % Zink (Zn), and the balance copper (Cu) with inevitable impurities. Therefore, the piling up of the scales to the first and inner pipes 51, 52 may be prevented.

[0027] The calcium carbonate scale is produced by the reaction as shown in the following formula.

$$Ca(HCO_3)_2 \rightarrow CO_2 + H_2O + CaCO_3$$

The speed of this reaction becomes higher when the temperature of the water becomes higher. It is thought that the scale piles up on the cupper pipe because particles of the produced $CaCO_3$ stick to the wall of the copper pipe, and the particles work as cores, and then the scale grows up. Therefore, if the sticking of the particles of the $CaCO_3$ is prevented, the piling up of the scale shall be prevented. It is also known that the surface of the $CaCO_3$ is charged to the negative polarity. On the other hand, Cu_2O existing on the surface of the copper is charged to the positive polarity. Therefore, $CaCO_3$ and Cu_2O attract each other, and then the $CaCO_3$ scale sticks to and piles up on the surface of the copper member.

[0028] On the other hand, the inventor got to know that any precipitates which are produced by incorporating Zr into copper member are charged to the same polarity as the $CaCO_3$ scale, the particles of the $CaCO_3$ do not stick to the copper alloy including Zn, and the scale does not pile up.

[0029] Also, the inventor got to know that an oxide of an additive element is appropriately concentrated on the surface by adding Sn as an element which is effective to the type II pitted corrosion which is easy to occur in a water condition including 1 ppm or more residual chlorine, and by heat-treating this in an inert gas atmosphere or a reducing gas atmosphere, when the temperature is high of between 50°C and 90°C. Also, the inventor got to know that the said process can provide both resistance against scale and resistance against pitting corrosion to the surface.

[0030] On the other hand, in the case of a phosphorous deoxidized copper member which is usually used in the market, when the member is touching to a water which includes 15 mg/L or more free carbon dioxide which is at a low temperature of 15°C or less, and when the amount of residual carbon sticking to the surface is larger than 5.0 mg/m^2, it is said that the type I pitting corrosion is easy to occur. With regard to the surface of the copper alloy member in this embodiment, the inventor got to know that the possibility of occurring the type I pitting corrosion of copper becomes high, when 10.0 mg/m^2 or more residual carbon is sticking to the surface of the copper alloy. The said copper alloy member has an excellent resistance against the type II pitting corrosion when the copper alloy member has an appropriate distribution of the additive element in the depth direction. However, it is insufficient to the said type I pitting corrosion, and it is preferable to reduce the amount of the residual carbon to 10.0 mg/m^2 or less.

[0031] The residual carbon is made by adhesion of the remaining lubricating oil for processing onto the surface at the time of the annealing step or the heat treatment step. The method for produce a copper member of which the surface has a predetermined amount or less residual carbon is not limited in this way. Thus, a method which performs an annealing process in an inert gas or reducing gas atmosphere including a predetermined amount of oxygen, or other similar heat treatments, a method which performs an annealing process in an hydrogen atmosphere, or other similar heat treatments, a method which performs the usual annealing process after oil cleaning by the organic solvent, the oil detergent, or the like, a method which heat members to the annealing temperature in a relatively short time like the induction heating annealing or electric heating annealing, and other similar method may be applicable.

[0032] The following is describing about why the composition of the copper alloy is limited in this invention.

[0033] "As to having Zr in a parent phase as a solid solution, a simple substance and/or a compound in the amount of 0.005 to 0.2 mass% (in terms of Co in the case of compound)"

[0034] If the amount of the Zr becomes less than 0.005 mass%, the effect of preventing piling up of the scale is not achieved. Also, if the amount of the Zr becomes larger than 0.2 mass%, mechanical character of the copper alloy member is changed, and wrinkles are easy to occur when the copper alloy member is under the bending process. Also, the amount of the Zr oxide existing on the surface of the copper alloy member becomes large, wettability of brazing filler metal becomes low.

[0035] "As to having Sn in the amount of 0.05 to 3.0 mass%"

[0036] Sn provides the member with resistance against the type II pitting corrosion. If the amount of the Sn becomes less than 0.05 mass % , the resistance against the type II pitting corrosion becomes insufficient. If the amount of the Sn becomes larger than 3.0 mass%, mechanical character of the copper alloy member is changed, and wrinkles are easy to occur when the copper alloy member is under the bending process. Also, the amount of the Sn oxide existing on the surface of the copper alloy member becomes large, wettability of brazing filler metal becomes low.

[0037] "As to having P in the amount of 0.001 to 0.2 mass%"

[0038] In this invention, P is generally added as a deoxidizer in the melting stage or the casting stage. if the deoxidizing is not necessary, omitting deoxidizer does not change the character of the alloy. However, it is thought that the added P is charged to the negative polarity, this situation can prevent piling up and growing of the scale. Therefore, 0.2 mass%

or less of P shall be permitted. If the amount of the P is less than 0.001 mass%, the effect is not expected. Also, if the amount of the P becomes larger than 0.2 mass%, some defects will appear in the casing stage, and the quality of the alloy will not be rectified in the following stages. Also, this result affects the corrosion resistance.

[0039] "As to having Zn in the amount of 0.05 to 5.0 mass%"

[0040] Zn provides the copper alloy member of this invention with an excellent workability, although the copper alloy member of this invention has possibility of reduction of the workability by including each of the elements. Especially, it can improve the service life of cutting tools for cutting board members and pipes into a predetermined size. Also, it is expected that the service life of manufacturing tools for forming grooves by form rolling process or rolling process becomes extended. If the amount of the Zn becomes less than 0.05 mass%, the effect becomes insufficient. If the amount of the Zn becomes larger than 0.5 mass % , the increase of the effect becomes flat, and the strength of the member becomes high unnecessarily. Therefore, some troubles will be caused in the plastic working such as bending process. Also, if the amount of the Zn becomes larger than 5.0 mass % , the resistance against corrosion may be reduced in water circumstances, and effects regarding the dezincification corrosion and the stress corrosion crack will begin to occur. Also, when the amount of the Zn becomes larger, work hardening becomes easier to occur. Therefore, especially in the case of processing the copper alloy pipe, the number of annealing process become larger than that of phosphorous deoxidized copper. Therefore, the costs for processing may become high. Thus, it is preferable to remain the amount of the Zn at 3.0 mass% or less, in the case the workability is important.

[0041] With regard to this embodiment and a comparative example, we did an experiment about resistance of scale sticking, and got the result shown in Fig. 6. In this experiment, as the embodiment, the copper alloy pipe which includes 0.03 mass % of Zr, 0.26 mass% of Sn, 0.028 mass% of P, and the balance Cu with inevitable impurities is used. Also, as the comparative example, standard material (the copper pipe C1220 defined in the JIS H 3300) is used.

[0042] In this experiment, $NaCO_3$ concentrated liquid and $CaCL_2$ concentrated liquid drops a water into tank respectively so that concentrations of Na+ and Ca+ in the water tank become a predetermined level by automatic dropping device. Also, waters of the outlet and the inlet of the gas cooler (the first water-heat exchanger 50 of said embodiment) are sampled, a pressure loss factor is measured, analyzing the concentration of the calcium ion using the capillary electrophoresis device. In this embodiment, the pressure loss factor is a calculated amount by calculating pressure loss which changes as time changes compared with the pressure loss at the beginning of the experiment. And the pressure loss at the beginning of the experiment is regarded as 1. Also, this experiment is conducted under a condition in which the room temperature is 25°C, the temperature of the water which flows into the gas cooler is 20°C, the temperature of the water which flows out from the gas cooler is 90°C, the frequency of the compressor is 50Hz, the temperature of the gas which flows out from the compressor is around 110°C (it is caused by adjusting the temperature of the water, which flows out from the gas cooler, to 90°C), the flow rate of the water in the gas cooler is 1.0 L/min. Also, the experiment is conducted, adjusting the temperature of the flow-out gas by opening of the expansion valve manually.

[0043] In this experiment, operation time is measured until the pressure loss factor becomes double with regard to the embodiment and the comparative example, and the one which have the measured time longer than the other is regarded as a good one. In the result, the operation time T2 of the embodiment was 2.4 times the operation time T1 of the comparative example. Therefore, with respect to the resistance against scale, the embodiment is better than the comparative example.

[0044] By this, according to this embodiment, the number of the first inner pipes 51, which are disposed on downstream side of the hot water, is smaller than the number of the second inner pipes 52, which are disposed on upstream side of the hot water. By this, it is secured that the sectional area for flowing water between the first outer pipe 53 and each of the inner pipes 51 becomes larger than that between the second outer pipe 54 and each of the second inner pipes 52. Therefore, it is possible to effectively prevent the blocking of the flow due to the piling up of the scale at the downstream side in the outer pipe 53, even if whole of the outer pipes 53, 54 or downstream side of the outer pipe 53 is not made of a larger diameter pipe. Therefore, it is possible to increase the productivity without increase in variety or cost of the pipes which is the material for the outer pipes 53, 54. In this case, the number of the second inner pipes 52, which are disposed at upstream side of the hot water, is larger than the number of the first inner pipes 51, which are disposed at downstream side of the hot water. Therefore, the hot water is heated sufficiently by each of the second inner pipes 52. Thus, an advantage that the heat exchange efficiency is not reduced is achieved.

[0045] Moreover, in this embodiment, the first and second inner pipes 51, 52 are made of copper alloy pipes having a composition comprising 0.005 to 0.2 mass% Zr, and the balance copper (Cu) with inevitable impurities. Thus, the piling up of the scales between outer pipes 53, 54 and the inner pipes 51, 52 may be prevented. Therefore, it is effective for preventing the piling up. In this case, if the copper alloy pipes have a composition further including 0.05 to 3.0 mass% Sn is used, it is possible to increase the corrosion resistance. Also, if the copper alloy pipes have a composition further including 0.001 to 0.2 mass% P, the resistance for the piling up could be increased. Moreover, if the copper alloy pipes have a composition further including 0.05 to 5.0 mass% Zn, it is possible to improve the workability of the pipes.

[0046] Moreover, between the upstream side and the downstream side of the hot water, the first middle header 57 to which the first inner pipes 51 and the first outer pipe 53 are connected from the same direction is provided, and the

second middle header 58 to which the first inner pipes 52 and the first outer pipe 54 are connected from the same direction is provided. Also, the passages of the hot water and the refrigerant are curved to the opposite side by each of the middle headers 57, 58. Each inner pipe 51, 52 and each outer pipe 53, 54 do not become long, and it is possible to make whole of the first water-heat exchanger 50 small.

[0047] Moreover, the each inner pipe 51, 52 and each outer pipe 53, 54 are wound spirally. Also, the wound portion A1 which is wound from outside to inside and the wound portion A2 which is wound from inside to outside are arranged at the upper and lower stages with each other. Adjacent wound portions A1, A2 are formed so as to communicate with each other by bending the pipes inside the wound portions A1, A2. Therefore, each inner pipe 51, 52 and each outer pipe 53, 54, each having long length, could be effectively wound, and it is advantageous to make the water-heat exchanger 50 small.

[0048] Moreover, in the above mentioned embodiment, Adjacent wound portions A1, A2 are formed so as to communicate with each other by bending the pipes inside the wound portions A1, A2. On the other hand, it is possible to communicate adjacent wound portions A1, A2 by bending the pipes outside the wound portions A1, A2.

[0049] In the above mentioned embodiment, although only inner pipes 51, 52 are made of said copper alloy pipes, it is possible that only outer pipes 53, 54 are made of said copper alloy pipes, or both inner pipes 51, 52 and outer pipes 53, 54 are made of said copper alloy pipes. In this case, it is possible to employ said copper alloy pipes as the first inner pipes 51 and the first outer pipe 53 which are disposed downstream side where the scale is easily piled up, and to employ the phosphorous deoxidized copper pipes as the second inner pipes 52 and the second outer pipes 54 which are disposed upstream side.

[0050] Moreover, in the above mentioned embodiment, although the water-heat exchanger 50 is used as a heat exchanger of the present invention, the present invention is applicable to other heat exchangers which are used to conduct heat exchange between a first heat medium and a second heat medium.

[0051] Fig. 7 through Fig. 9 are showing another embodiment of the present invention. The same elements are shown with the same symbols of the above mentioned embodiment.

[0052] In this embodiment, lower side two stages of the wound portions A1, A2 are formed so as to protrude toward a certain direction by a predetermined length L relative to the other wound portions A1, A2, and the certain direction is perpendicular to the arrangement direction of the wound portions A1, A2. Also, that protruded portion 54a is located under the evaporator 13 of the heating unit 70. If the protruded portion 54a is not located under the evaporator 13, the space under the evaporator 13 becomes a dead space. However, the protruded portion 54a is located under the space. By forming the protruded portion 54a, it is possible to lengthen the second outer pipe 54 and increase the capacity. Also, it is possible to increase ability of the first water-heat exchanger 50.

[0053] In this embodiment, the protruded portion 54a of the first water-heat exchanger 50 is located under the evaporator 13. On the other hand, it is possible to locate the protruded portion 54a under other devices.

[0054] The preferred embodiments described in this specification are illustrative and not restrictive. The scope of invention is given by the appended claims, and all changes and modifications included in the meaning of claims are embraced in the present invention.

Claims

1. A heat exchanger (50) comprising a heat conductive inner pipe (51) in which a first heat medium flows and an outer pipe (52) in which the inner pipe (51) is disposed, wherein the heat exchange between the first heat medium and a second heat medium is performed through the inner pipe (51), **characterized in that**

   the number of the inner pipes (51) which are disposed at a downstream side of the second heat medium is smaller than the number of the inner pipes (51) which are disposed at an upstream side of the second heat medium,
   at least one of the inner pipe (51) and the outer pipe (52) is made of a copper alloy pipe having a composition comprising 0.005 to 0.2 mass% Zirconium (Zr) and the balance copper (Cu) with inevitable impurities.

2. The heat exchanger according to claim 1, wherein
   said copper alloy pipe has a composition further comprising 0.05 to 3.0 mass% Tin (Sn).

3. The heat exchanger according to claim 1 or 2, wherein
   said copper alloy pipe has a composition further comprising 0.001 to 0.2 mass% Phosphorus (P).

4. The heat exchanger according to any one of claims 1-3, wherein
   said copper alloy pipe has a composition further comprising 0.05 to 5.0 mass% Zink (Zn).

5. The heat exchanger according to any one of claims 1-4, further comprising:

a first middle header (57) provided between the inner pipe (51) disposed at the upstream side of the second heat medium and the inner pipe (51) disposed at the downstream side, the first middle header (57) to which the upstream side inner pipe 51 and the downstream side inner pipe 51 are connected from the same direction; and

a second middle header (58) provided between the outer pipe (52) disposed at the upstream side of the second heat medium and the outer pipe (52) disposed at the downstream side, the second middle header (58) to which the upstream side outer pipe 52 and the downstream side outer pipe 52 are connected from the same direction.

6. The heat exchanger according to any one of claims 1-5, wherein
said inner pipe (51) and said outer pipe (52) are wound spirally, a wound portion (A1) which is wound from outside to inside and a wound portion (A2) which is wound from inside to outside are arranged mutually, adjacent wound portions (A1, A2) are formed so as to communicate with each other by bending the pipes inside or outside the wound portions (A1, A2).

7. The heat exchanger according to claim 6, wherein
a part of the wound portions (A1, A2) of each of the wound portions (A1, A2) is protruded toward a certain direction relative to the other wound portion (A1, A2), the certain direction is perpendicular to the arrangement direction of each of the wound portions (A1, A2).

8. A hot water supply apparatus, comprising the heat exchanger (50) of any one of claims 1-7, wherein
the outer pipe (52) of the heat exchanger (50) flows a hot water as the second heat medium, and each inner pipe (51) flows the first heat medium for heating the hot water.

Fig. 1

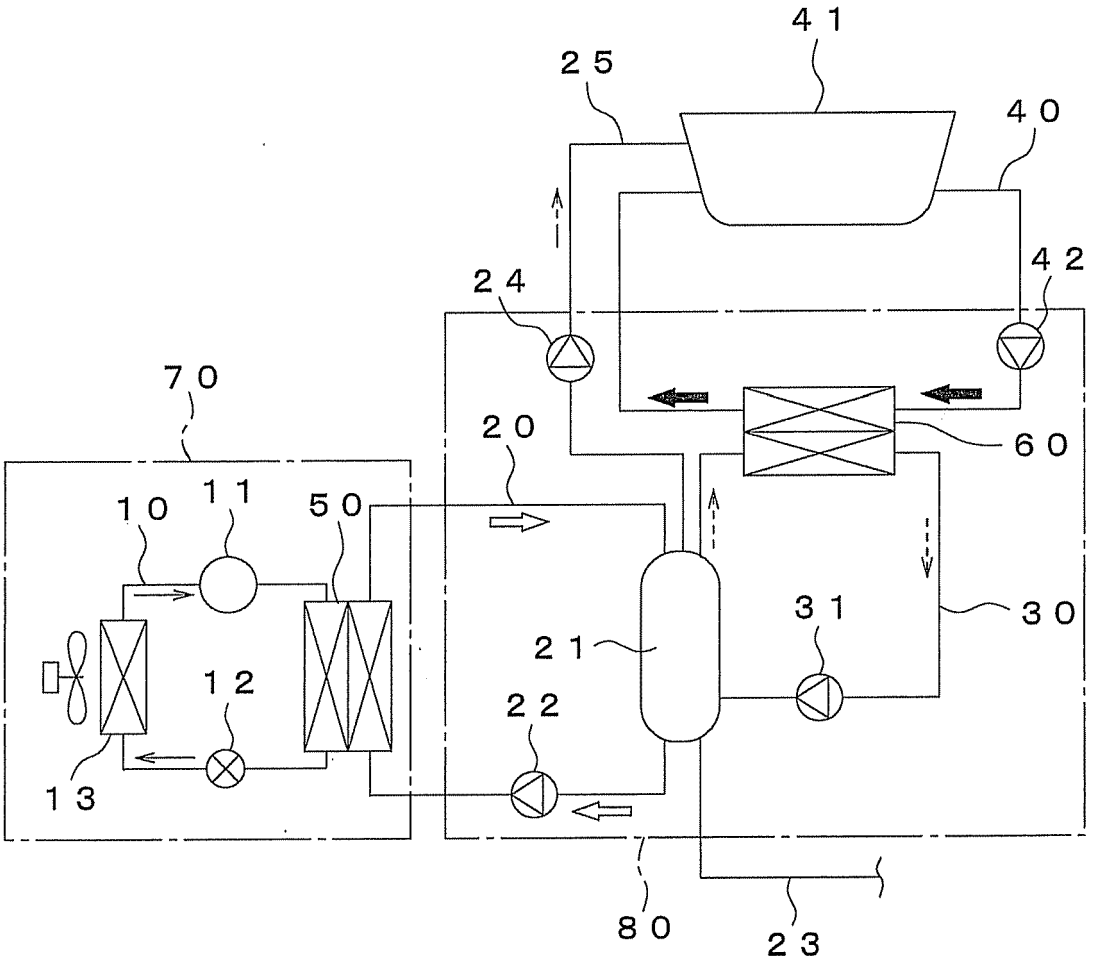


Fig. 2

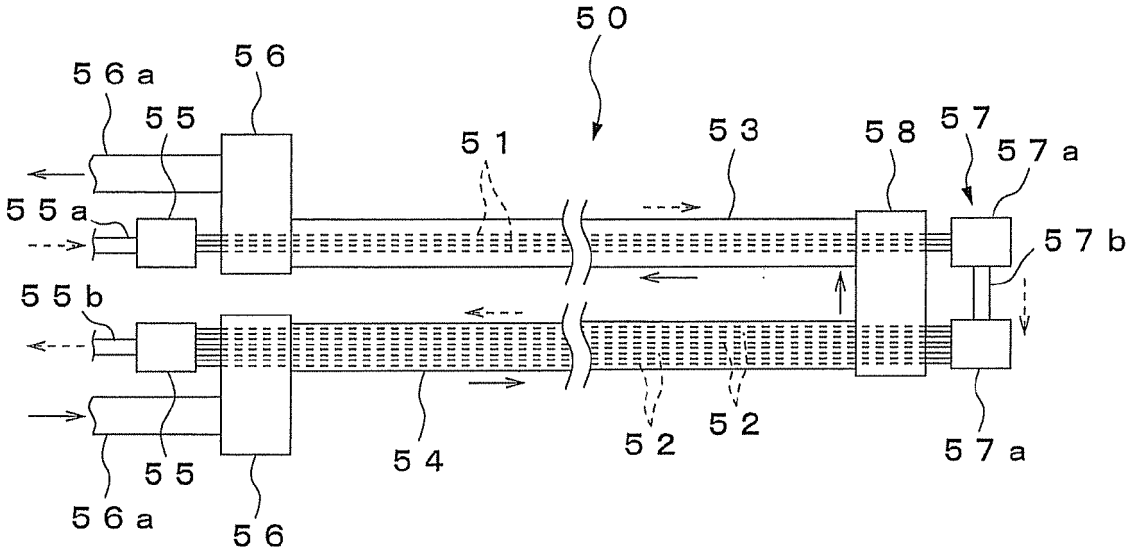

50
56a
56
55
51
53
58
57
57a
55a
57b
55b
54
52
52
55
56a
56
57a

Fig. 3

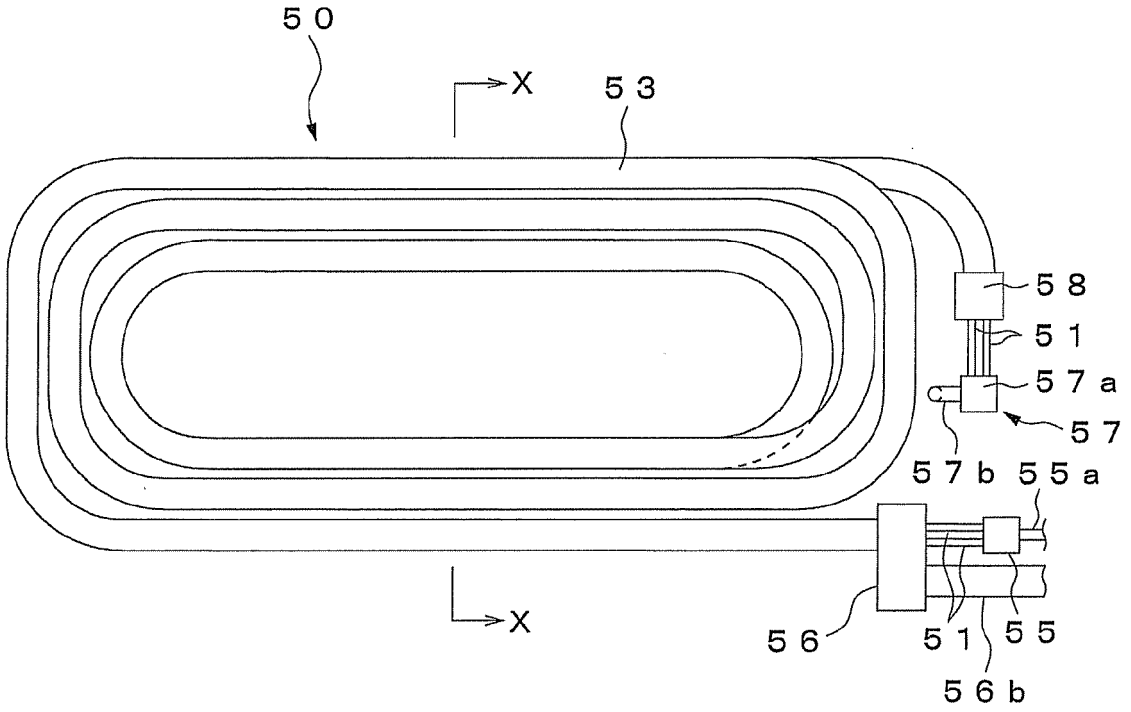

50
X
53
58
51
57a
57
57b
55a
56
51
55
56b
X

Fig. 4

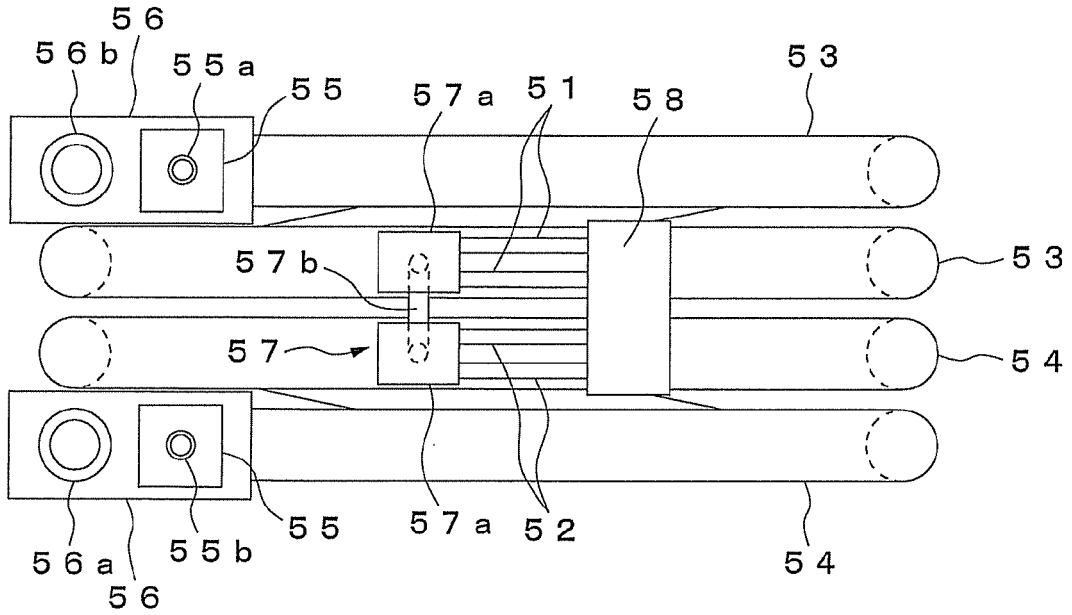

56
56b
55a
55
57a
51
58
53
57b
53
57
54
56a
55b
55
57a
52
54
56

Fig. 5

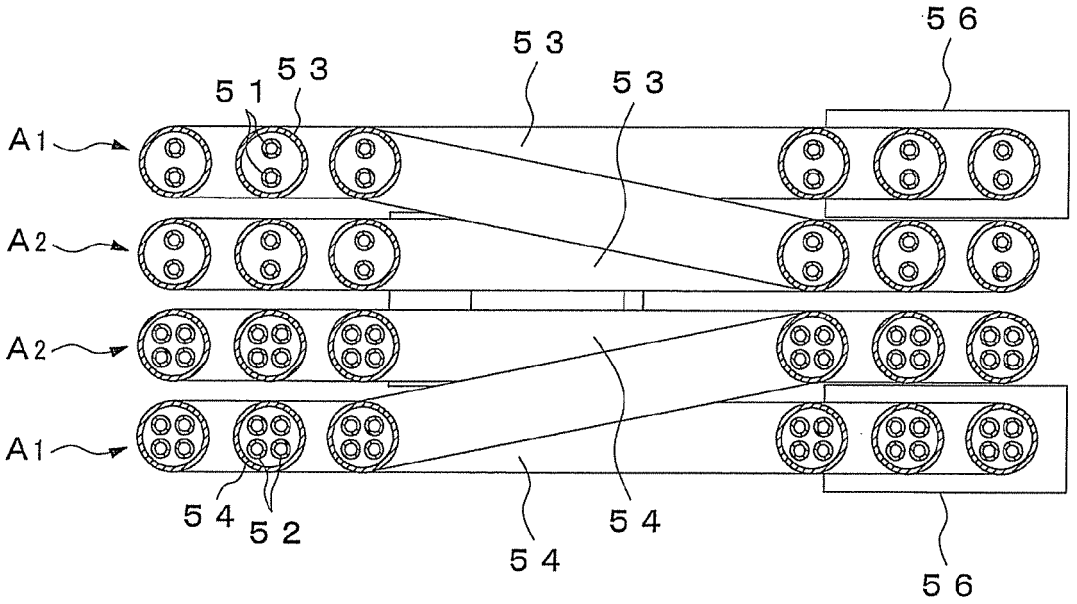

56
53
53
51
53
A1
A2
A2
A1
54
52
54
54
56

Fig. 6

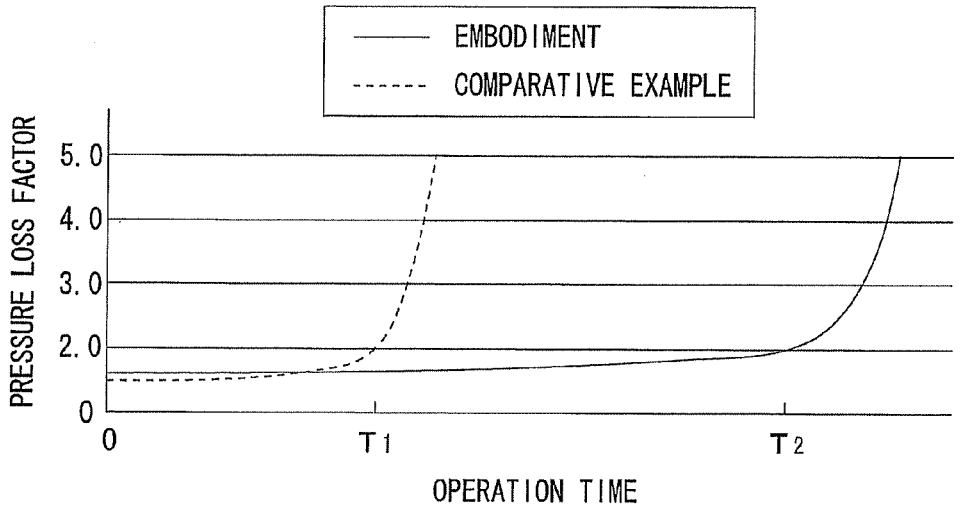

EMBODIMENT
COMPARATIVE EXAMPLE
PRESSURE LOSS FACTOR
5.0
4.0
3.0
2.0
0
0
T1
T2
OPERATION TIME

Fig. 7

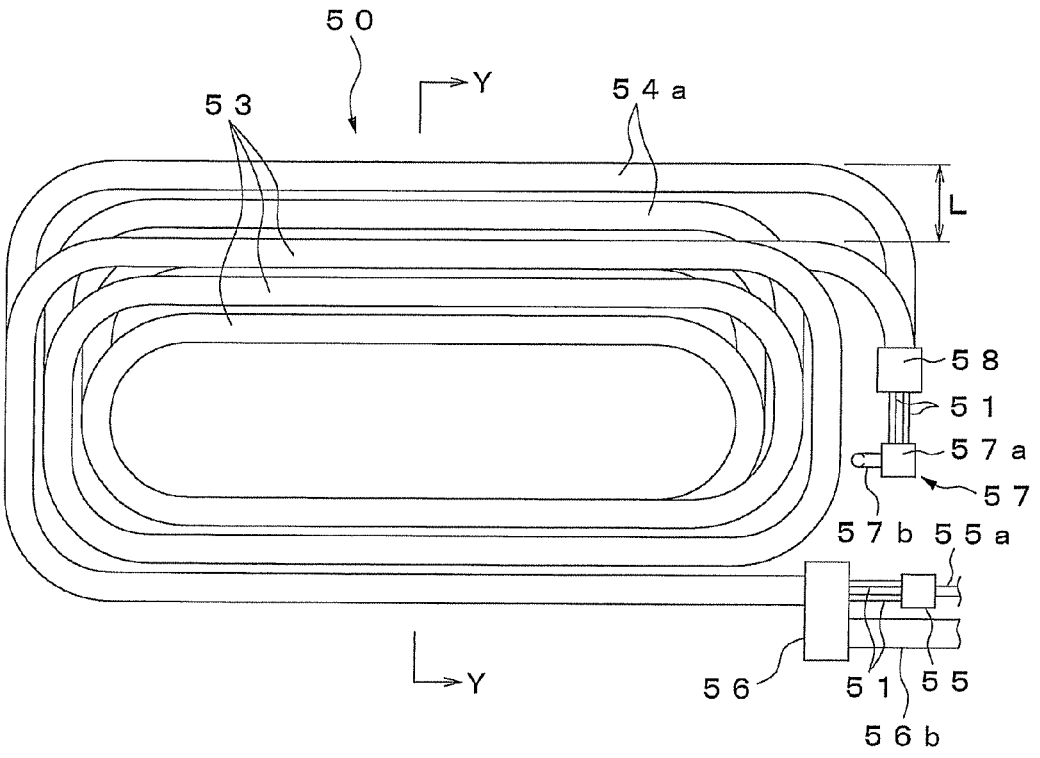

50
Y
53
54a
L
58
51
57a
57
57b
55a
Y
56
51
55
56b

Fig. 8

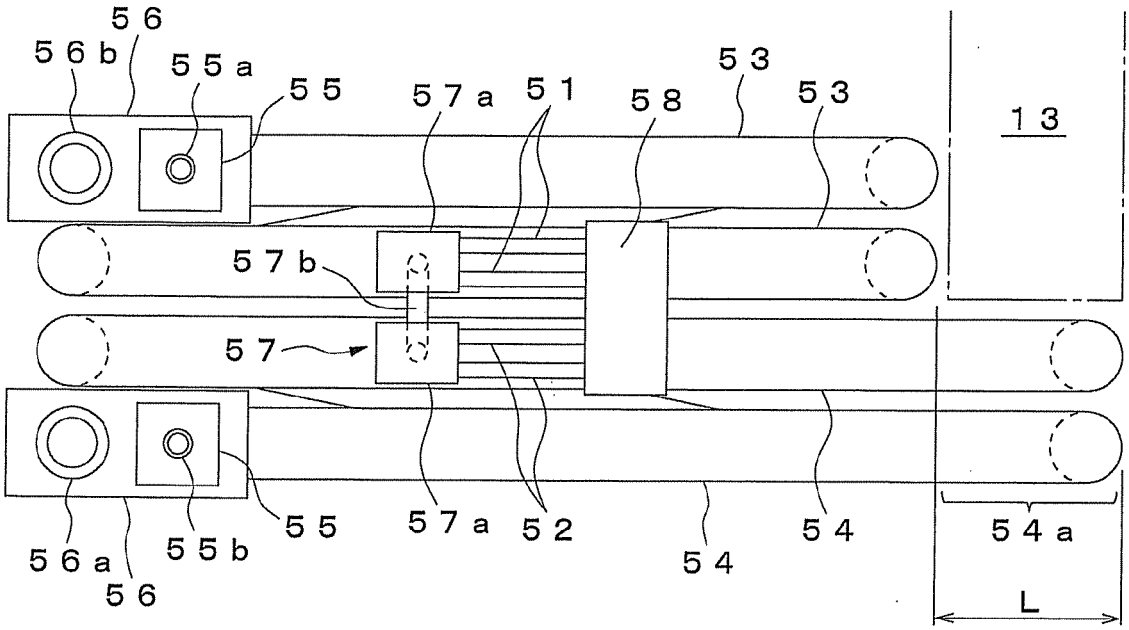
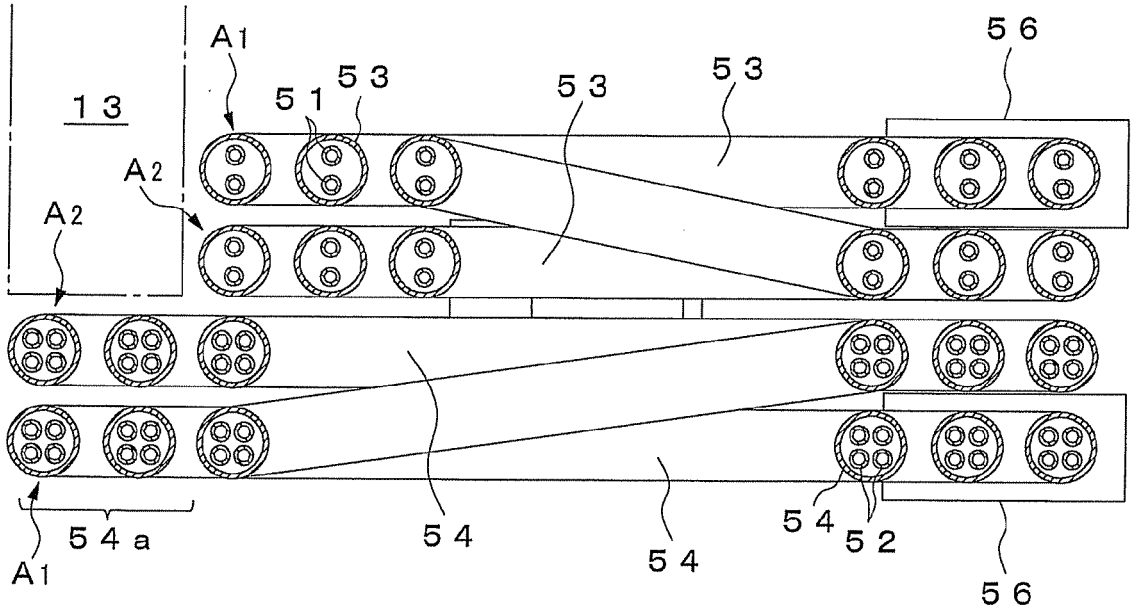

56
56b
55a
55
57a
51
58
53
53
13
57b
57
56a
56
55b
55
57a
52
54
54
54a
L

Fig. 9


A1
13
A2
A2
51
53
53
53
56
54a
A1
54
54
54
52
56

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EUROPEAN SEARCH REPORT

Application Number
EP 09 17 8235

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F28F
C22C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
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