Sept. 6, 1966 E. A. GLUCKSMAN 3,270,805

AIR MOVING DEVICES AND AIR CONDITIONERS

Filed Dec. 11, 1964 3 Sheets-Sheet 1

FIG. 1

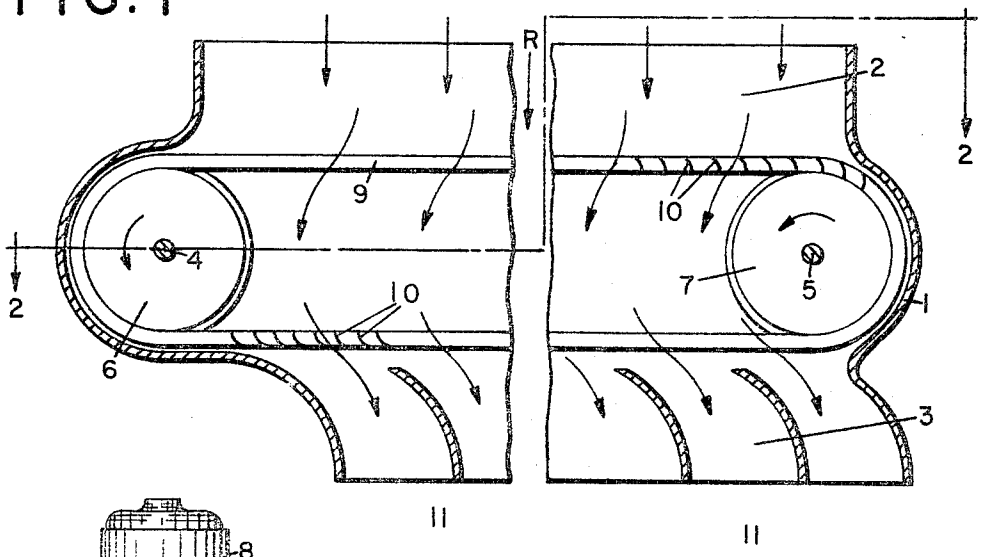
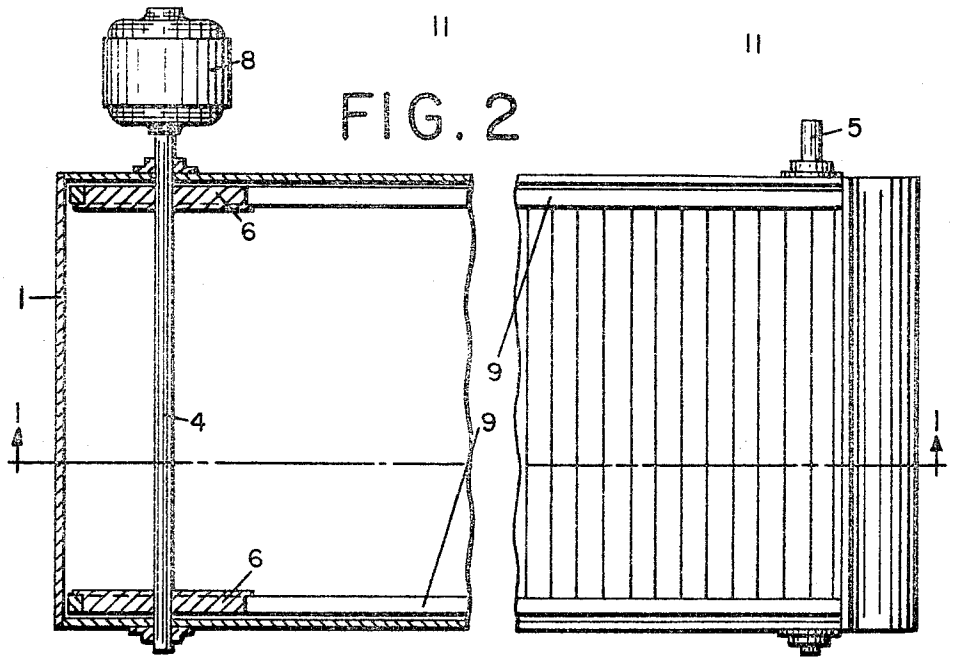


FIG. 2



INVENTOR.

Ernst A. Glucksman

BY Irwin Kalpin atty

Sept. 6, 1966 E. A. GLUCKSMAN 3,270,805

AIR MOVING DEVICES AND AIR CONDITIONERS

Filed Dec. 11, 1964 3 Sheets-Sheet 2

FIG. 3 FIG. 4 FIG. 5

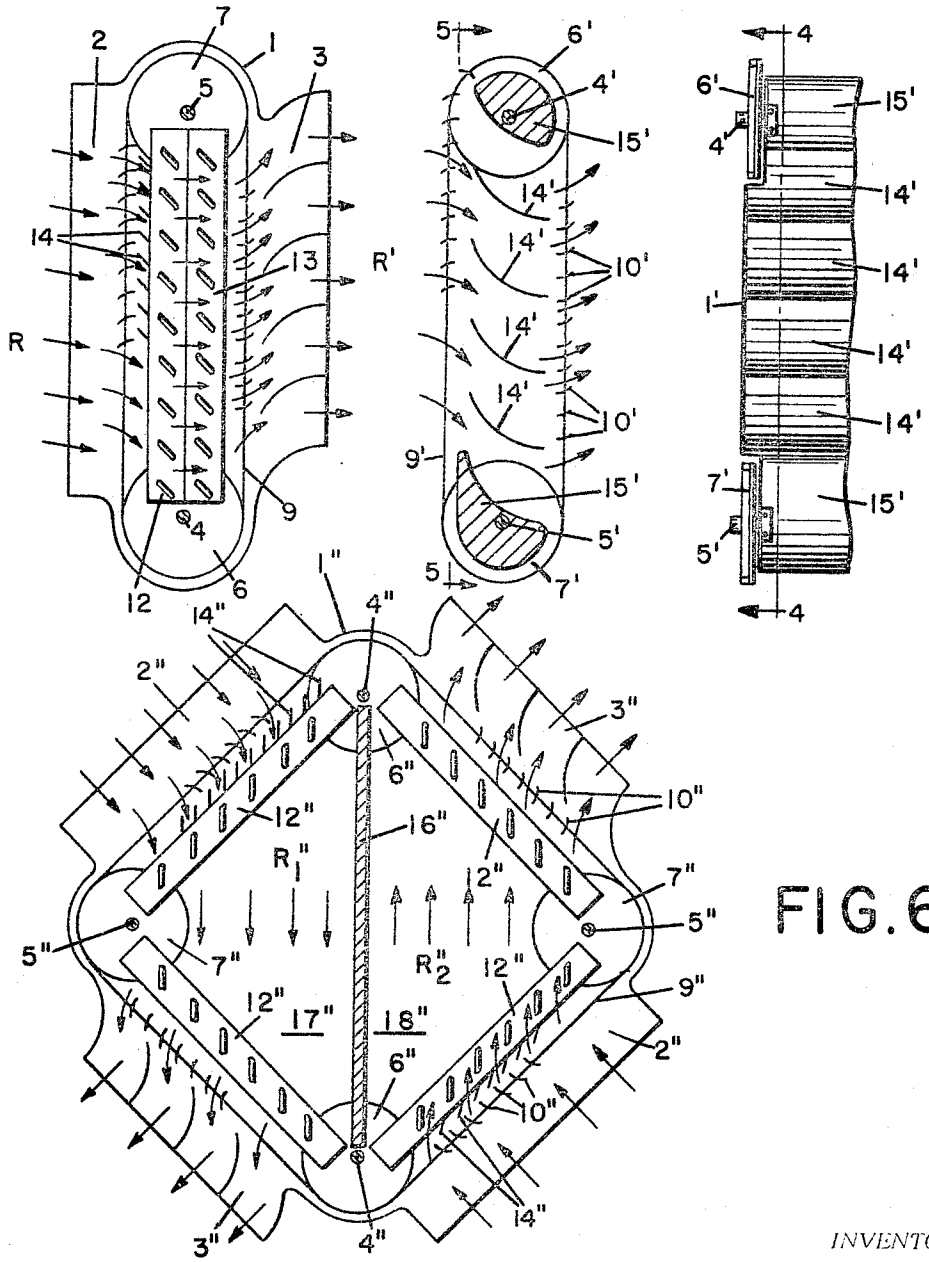


FIG. 6

INVENTOR.

Ernst A. Glucksman

BY Irwin Ralph, atty.

Sept. 6, 1966 E. A. GLUCKSMAN 3,270,805

AIR MOVING DEVICES AND AIR CONDITIONERS

Filed Dec. 11, 1964 3 Sheets-Sheet 3

FIG. 7

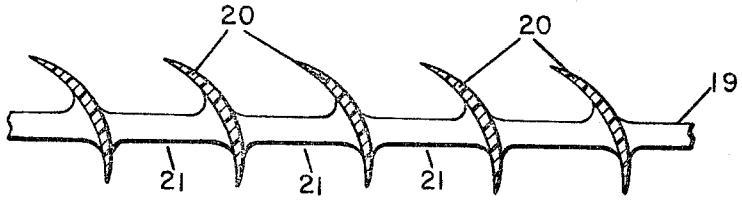


FIG. 8

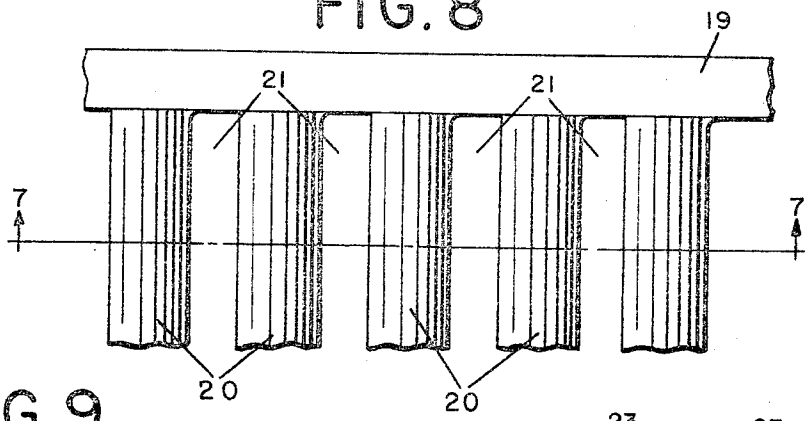


FIG. 9

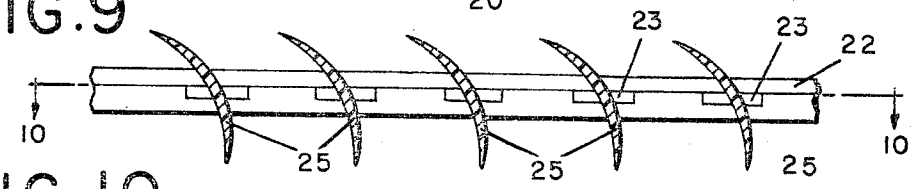
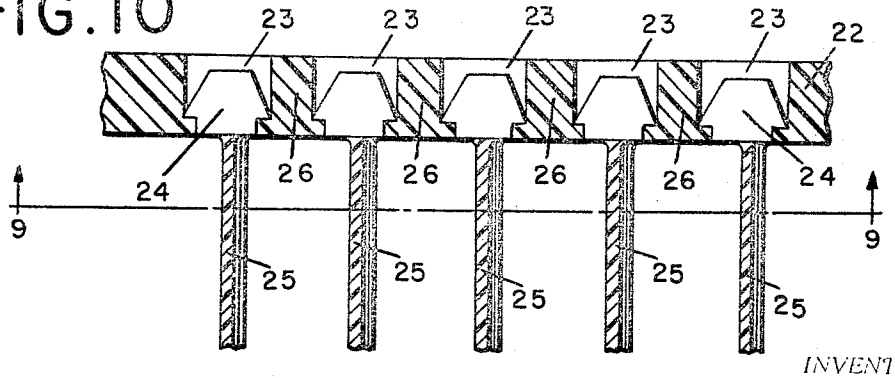


FIG. 10



INVENTOR.

Ernst A. Glucksman

BY Irwin Kalpern Attn.

United States Patent Office 3,270,805 Patented Sept. 6, 1966

3,270,805

AIR MOVING DEVICES AND AIR CONDITIONERS

Ernst A. Glucksman, 13 Dalia Road, Haifa, Israel

Filed Dec. 11, 1964, Ser. No. 417,842
14 Claims. (Cl. 165—122)

This invention is concerned with, and relates to, heat exchangers and more particularly room air conditioners.

It is one object of this invention to provide novel heat exchangers and air conditioners having a minimum of depth.

Another object of this invention is to provide air conditioning equipment forming compact, and more particularly flat, air conditioning units.

Radial type blowers include a rotating wheel that draws air in axial direction and discharges the same radially through a scroll. In most cases heat exchangers of air conditioning equipment have a larger area than the cross-sectional area of the discharge opening of a radial type blower. This requires provision of ducts allowing the flow of air produced by the blower to expand to the larger area of the heat exchangers. The depth of radial type blowers as such tends to be large, and the provision of the aforementioned expansion ducts results in a further significant increase of the depth requirements of air conditioning systems including radial blowers.

It is, therefore, another object of this invention to provide units comprising air moving devices and heat exchangers not subject to the aforementioned drawbacks and limitations of air conditioning equipment including radial blowers.

Axial blowers and fans have relatively limited depth requirements. Since the discharge opening of this type of air moving devices is circular, and since heat exchangers are generally in the shape of four-sided prisms having a rectangular front or upstream surface, this difference in the geometry of the two aforementioned pieces of equipment which go into an air conditioner results in difficulties such as, for instance, insufficient utilization of the area of the heat exchanger.

It is, therefore, another object of this invention to provide units comprising air moving devices and heat exchangers not subject to the drawbacks and limitations of air conditioning equipment including axial blowers or fans.

Another object of this invention is to provide heat exchangers and/or room air conditioners having air moving devices which establish air streams which are rectangular in cross-section at their inception, and therefore do not need to be converted from the relatively small cross-sectional-area-circular-cross-section-shape to a relatively large-cross-sectional-area-rectangular-cross-section-shape.

All air conditioning equipment requiring the conversion of air streams of relatively small cross-sectional area into air streams of relatively large cross-sectional area involves a reduction of the velocity of the air streams as their cross-sectional area increases. This calls for air moving devices having a relatively high number of revolutions per minute, and therefore tending to operate noisily.

It is, therefore, another object of this invention to provide heat exchangers and/or air conditioners including air moving devices which produce air streams which encompass at their inception relatively large cross-sectional areas, and which air moving devices may be operated at but relatively small numbers of revolutions per minute, and which air moving devices tend, therefore, to operate quietly.

Still another object of this invention is to provide room air conditioners including air moving devices having substantially the geometrical configuration of a rectangular

window, or other rectangular aperture in the side of a building, requiring a minimum of depth, when combined with air conditioning equipment, in particular when combined with fin-tube-heat-exchangers.

Another object of this invention is to provide novel air conditioners having a minimum of depth and including air moving devices lending themselves to be made of a synthetic resin and, therefore, at relatively small cost.

Further objects and advantages of my invention will become apparent as the following description proceeds, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to, and forming part of, this specification.

For a better understanding of the invention reference may be had to the accompanying drawings in which

FIG. 1 is a horizontal diagrammatic section of an air moving device for an air conditioner embodying the present invention taken along 1—1 of FIG. 2;

FIG. 2 is a vertical diagrammatic section of the air moving device of FIG. 1 taken along 2—2 of FIG. 1;

FIG. 3 is a diagrammatic section across a combined air moving device and a heat exchanger embodying this invention;

FIG. 4 is a diagrammatic section across another air moving device for a heat erchanger embodying this invention taken along 4—4 of FIG. 5;

FIG. 5 is a diagrammatic section along 5—5 of FIG. 4;

FIG. 6 is a diagrammatic section across the air moving part of an air conditioner embodying this invention;

FIG. 7 is a diagrammatic section along 7—7 of FIG. 8 and shows a combined blade and endless belt structure for use in any of the apparatus shown in FIGS. 1–6;

FIG. 8 is a top-plan view of the structure of FIG. 7;

FIG. 9 is a section along 9—9 of FIG. 10 and shows another combined blade and endless belt structure for use in any of the apparatus shown in FIGS. 1–6; and

FIG. 10 is a top plan view of the structure of FIG. 9.

Referring now to the drawings, and more particularly to FIGS. 1 and 2 thereof, reference numeral 1 has been applied to indicate a frame structure defining an air intake duct 2 and an air discharge duct 3. Frame structure 1 supports a pair of parallel shafts 4, 5 of which the former is being driven by an electromotor 8. Shaft 4 supports a pair of spaced pulleys 6 and shaft 5 supports a pair of spaced pulleys 7 (not shown in the right portion of FIG. 2). Pulleys 6, 7 support an endless belt 9 which, in turn, supports a system of blades 10. When motor 8 causes belt 9 to revolve, blades 10 establish an air flow R substantially transversely across frame structure 1. The outlet duct 3 is provided with guide vanes 11 for directing the flow of air leaving frame structure 1.

The flow of air of the structure of FIGS. 1 and 2 has been indicated in FIG. 1 by a system of arrows. The air entering into the space between the two parallel sides of endless belt 9 has a velocity component from right to left, as indicated by the upper arrows in FIG. 1. The air leaving the space between the parallel sides of endless belt 9 and flowing into discharge duct 3 has a velocity component from left to right, as indicated by the lower arrows in FIG. 1. The air flow inside the space bounded by the two parallel sides of endless belt 9 is convex from right to left, or slightly U-shaped, as is also apparent from FIG. 1. In the structure of FIGS. 1 and 2 guide vanes 11 are primarily responsible for the aforementioned slightly U-shaped geometry of the lines of flow of air transversely across endless belt 9. It will be apparent from FIG. 1 that guide vanes 11 define passageways for the flow of air whose cross-sectional area increases progressively from the upstream end to the downstream end of these passageways. This reduces the velocity of the air leaving discharge duct 3. It will further be apparent

from FIG. 1 that intake duct 2 defines by its cross-section a first rectangle, and that the shafts 4, 5 define a second rectangle which is out of registry with the first mentioned rectangle, i.e. the second mentioned rectangle is laterally displaced from right to left relative to the first mentioned rectangle. This results in a corresponding lateral displacement of belt 9 and of the portion of frame structure 1 intermediate air intake 2 and air discharge 3. The aforementioned geometry of parts 2, 4 and 5 and of the portion of frame structure 1 intermediate its portions 2 and 3 is conducive to the aforementioned slightly U-shaped pattern of the lines of flow between the straight parallel portions of endless belt 9. It will further be observed from FIG. 1 that each blade 10 encloses with the inner end thereof a predetermined angle with the straight parallel portions of the loop formed by endless belt 9 substantially in excess of the angle enclosed between the outer end of each blade 10 and said straight parallel portions of the loop formed by belt 9. This geometry of blades 10 is likewise conducive to achieving the desired substantially transverse or slightly U-shaped flow pattern across the space bounded by the two straight parallel portions of endless belt 9. As shown in FIG. 1 the angle enclosed between the inner ends of blades 10 and the straight parallel portions of belt 9 is almost a right angle, while the angle between the outer ends of blades 10 and the straight parallel portions of belt 9 is a much smaller acute angle.

In FIGS. 1 and 2 the center portions of frame structure 1 and of belt 9 have been broken away. The actual shape of the air moving device is wide and flat, thus providing a relatively large area for the passage of the aforementioned air flow R, but requiring relatively little depth. In other words, the required depth of the device is substantially equal to the diameter of the pulleys 6 and 7. Intake duct 2 and exhaust duct 3 may be designed as shallow, or as flat, as desired and do not contribute significantly to the required depth of the device. Belt 9 forms a loop and the space inside said loop may be used to accommodate air conditioning equipment as will be explained below more in detail in connection with FIG. 3.

FIG. 3 shows substantially the same air moving device as FIGS. 1 and 2 and does not call for any additional description inasmuch as the structure shown therein does not differ from that of FIGS. 1 and 2. As shown in FIG. 3, the space inside of the loop formed by belt 9 accommodates a finned tube heat exchanger 12 across which the air flow R is directed. Heat exchanger 12 comprises fins 13 arranged parallel to the plane of the paper on which FIG. 3 is drawn and a system of tubes extending substantially at right angles to that plane. Small guiding fins or vanes 14 arranged at the upstream end of heat exchanger 12 are fashioned to guide the air in the desired direction.

The structure of FIGS. 4 and 5 comprises a pair of shafts 4', 5' supporting pulleys 6', 7' which, in turn, support endless belt 9'. Shafts 4', 5' are supported by a frame structure 1' and blades 10' on belt 9' establish an air flow R' transversely across frame structure 1'. Belt 9' forms a loop, and a system of fixed blades 14' supported by the same frame structure 1' as shafts 4', 5' guides the air flow R' inside of the space bounded by the loop formed by belt 9'. Fixed blades or vanes 14' defines ducts which may be used to accommodate heat exchanger structure. The structure of FIGS. 4 and 5 further includes a pair of substantially box-shaped vane bodies 15' having substantially the same function as vanes 14', and defining the upper and lower boundaries of frame structure 1'.

The structure of FIG. 6 comprises four parallel shafts 4'', 5'' arranged in a polygon pattern, which may be a rectangular or square pattern. Each shaft supports on the ends thereof a pair of pulleys 6'', 7''. Shafts 4'', 5'' are supported by a frame structure 1'' forming inlet ducts 2'' and discharge ducts 3''. Partition 16'' extends parallel to shafts 4'', 5'' and subdivides the space bounded by shafts 4'', 5'' into two substantially equal compartments 17'' and 18''. In the structure of FIG. 6 shafts 4'', 5'' are arranged in the form of a square, and partition 16'' extends diagonally across that square. Spaces 17'', 18'' are, therefore, in the shape of equilateral triangles as seen from above and as shown in FIG. 6. Endless belt 9'' is supported by pulleys 6'', 7'' and supports a system of blades 10'' establishing air flows R_1'' and R_2'' in opposite directions on opposite sides of partition 16''. Reference numeral 12'' has been applied to indicate the heat exchanging components of an air conditioning or air refrigerating system arranged to be exposed to the two streams R_1'' and R_2'' of air. Compartment 17'' houses two finned tube heat exchangers or convectors 12'' and compartment 18'' houses two additional finned tube heat exchangers or convectors 12''.

In the structure of FIG. 6 the compartment 17'' is the condenser side of a self-contained air conditioning unit and compartment 18'' the evaporator side of such a unit. Hence compartment 17'' should be outside of, and compartment 18'' form part of, the space or room to be air conditioned. The amount of air required for the condenser portion of an air conditioner is substantially larger than the amount of air required for the evaporator portion of an air conditioner. Roughly the former amount of air is twice the latter amount of air. To better comply with this requirement—and where space limitations do not dictate to do otherwise—compartment 17'' should be considerably larger than compartment 18'', e.g. the former should be twice as large as the latter. About two thirds of the total length of belt 9'' may be arranged in compartment 17'' and one third thereof in compartment 18''.

The motor for driving belt 9'' and the compressor forming part of the unit have not been shown in FIG. 6. These parts may be arranged separate from the air moving and heat exchanging portion of the air conditioner.

Referring now to FIGS. 7 and 8, numeral 19 has been applied to generally indicate a portion of an endless belt of a synthetic resin. Portions of that belt constitute a system of air moving blades 20. The structure of FIGS. 7 and 8 is formed from a wide strip of thermoplastic material by combined punching and thermal molding operations. The center portion of the aforementioned strip is fashioned to form a system of alternating air moving blades 20 and air passages 21 and the lateral portions of the strip remain in their initial condition to form supports for the blades for the blade-forming portion of the strip. Passages 21 are formed wherever material has been removed from the strip to form a blade 20.

In the structure shown in FIGS. 9 and 10, the endless belt and the system of air moving blades are formed by separate and distinct parts. The endless belt is made of a pair of parallel spaced strips 22 of which but one has been shown in FIGS. 9 and 10. Each of these strips is formed by superimposed layers defining recesses 23 for receiving the dovetailed ends 24 of air moving blades 25. Fasteners 26 project transversely across strips 22, integrating the constituent layers thereof into a structural unit and firmly maintaining blades 25 in their proper positions.

It will be apparent from the foregoing that my invention is concerned with the coordination of heat-exchanging equipment and of air-moving equipment, and vice versa. Thus one aspect of the invention consists in wrapping a belt-type air moving device around a heat exchanger which is substantially in the shape of a four-sided rectangular prism. Another aspect of the invention consists in establishing by means of a belt-type air moving device an air flow which is substantially rectangular in cross-section, and in arranging in the path of said air flow a fin-tube-heat-exchanger having substantially the same cross-section as said air flow. The heat exchanger is pref-

erably arranged inside of the loop formed by the endless belt-type air moving structure.

It will be understood that although several embodiments of the invention have been shown and described in detail, the invention is not limited thereto, and that the illustrated embodiments may be modified, or other embodiments made, without departing from the spirit or scope of the invention as set forth in the accompanying claims.

It is claimed:

1. A heat exchange apparatus including endless belt means supporting blades having a fixed inclination relative to the straight portions of said belt means, motor means for operating said belt means, duct means having an upstream entrance and a downstream exhaust and forming a substantially straight passageway between said entrance and said exhaust, substantially at right angles to both said straight portions of said belt means, fixed air guiding vanes inside said passageway to cause said blades to establish an air flow substantially transversely through both said straight portions of said belt means, and heat exchange structure arranged inside said passageway between said straight portions of said belt means.

2. A heat exchange apparatus including a fixed frame structure defining a substantially straight air passage between an entrance and an exhaust thereof, pulley means supported by said frame structure, an endless belt structure having a pair of straight portions arranged substantially at right angles to said passage and supported by said pulley means, motor means for driving said belt structure, a system of blades supported by said belt structure and having a fixed inclination relative to the straight portions thereof, a system of fixed air-guiding vanes supported by said frame structure for controlling an air flow substantially transversely across said frame structure, and a heat exchange structure arranged inside the space bounded by said endless belt structure.

3. A heat exchange apparatus including a fixed frame structure defining an air passage, pulley means supported by said frame structure, an endless belt structure forming a loop supported by said pulley means, motor means for driving said belt structure, a system of blades supported by said belt structure for establishing an air flow substantially transversely across said loop formed by said belt structure and substantially transversely across said frame structure, the constituent blades of said system of blades having a fixed inclination relative to the straight portions of said belt structure, a system of guide vanes fixedly supported by said frame structure arranged inside of said loop for guiding said air flow inside of the space bounded by said loop, and heat exchange means arranged inside of said frame structure and inside of said loop.

4. A heat exchange apparatus including a fixed frame structure, pulley means supported by said frame structure, an endless belt structure forming a loop supported by said pulley means, motor means for driving said belt structure, a system of blades supported by said belt structure for establishing an air flow transversely across said loop formed by said belt structure and transversely across said frame structure, the constituent blades of said system of blades having a fixed inclination relative to the straight portions of said belt structure, a heat exchanger arranged inside the space defined by said loop, and a system of guide vanes supported by said frame structure arranged outside said loop at the downstream side of said air flow, said system of guide vanes defining passages of progressively increasing cross-sectional area in the direction of said air flow.

5. A heat exchange apparatus including a plurality of parallel shafts arranged in a polygon pattern, a plurality of pairs of spaced pulleys each supported by one of said plurality of shafts, a partition parallel to said plurality of shafts subdividing the space bounded by said plurality of shafts into two compartments, an endless belt structure supported by said plurality of pairs of pulleys, motor means for driving said belt structure, a system of blades supported by said belt structure establishing air flows of opposite directions on opposite sides of said partition, a system of fixed air vanes, and heat exchange means arranged inside of said space bounded by said plurality of shafts in the paths of said air flows.

6. A heat exchange apparatus including four pairs of spaced pulleys arranged in a polygon pattern, a partition inside the space bounded by said four pairs of pulleys diagonally subdividing said space into two compartments, an endless belt structure supported by said four pairs of pulleys, motor means for driving said belt structure, a system of blades fixedly supported by said belt structure establishing air flows of opposite directions on opposite sides of said partition, a system of fixed air vanes, and heat exchange means arranged inside said space bounded by said four pairs of pulleys in the paths of said air flows.

7. An air conditioner including a fixed frame structure, said frame structure defining an air entrance duct and an air outlet duct and an intermediate duct between said air entrance duct and said air outlet duct, said air outlet duct defining a plurality of passageways progressively increasing in cross-sectional area toward the outlet end thereof, pulley means supported by a pair of shafts supported by said frame structure and arranged inside said intermediate duct, said pair of shafts defining a rectangle out of registry with said air entrance duct, an endless belt structure forming a loop supported by said pulley means, motor means for driving said belt structure, a system of blades fixedly supported by said belt structure for establishing an air flow substantially transversely across said frame structure and transversely across said loop formed by said belt structure, and means supported by said frame structure arranged inside of said loop for conditioning said air flow.

8. An air conditioner including a fixed substantially rectangular relatively flat frame structure having a pair of relatively long sides and a pair of relatively short sides, pulley means supported by said frame structure adjacent said relatively short sides thereof, an endless belt structure forming a loop supported by said pulley means, motor means for driving said belt structure, a system of blades fixedly supported by said belt structure for establishing an air flow substantially transversely across said frame structure, each blade of said system of blades enclosing at the inner end thereof a predetermined angle with the straight portions of said loop substantially in excess of the angle enclosed between the outer end of each blade of said system of blades and said straight portions of said loop, a system of guide vanes for controlling said air flow fixedly supported by said frame structure, and an air conditioning unit supported by said frame structure arranged inside said loop for conditioning said air flow.

9. A heat exchanger including a plurality of pulley means, a pair of spaced endless belts each supported by said pulley means, a plurality of air moving blades arranged transversely to said pair of belts each having one end integral with one of said pair of belts and another end integral with the other of said pair of belts, and each of said plurality of air-moving blades having a fixed inclination relative to the straight portions of said pair of belts, motor means for driving said pair of belts to cause said plurality of air moving blades to establish a flow of air, and a plurality of vanes for guiding said flow of air, said plurality of vanes including vanes arranged at the downstream end of said flow of air and defining air passages of progressively increasing cross-sectional area, and a heat exchange structure arranged inside of a space bounded by parallel portions of said pair of belts.

10. A heat exchanger including a plurality of pulley means, a pair of spaced endless belts of a thermoplastic material each supported by said pulley means, a plurality of air moving blades of thermoplastic material integral with said pair of belts and projecting out of the surface

defined by said pair of belts, said pair of belts and said plurality of blades defining air passages between contiguous blades allowing the flow of air across the space bounded by said pair of belts, motor means for driving said pair of belts to cause said plurality of blades to establish a flow of air, and a plurality of vanes for guiding said flow of air, said plurality of vanes including vanes arranged at the downstream end of said flow of air and defining air passages of progressively increasing cross-sectional area, and a heat exchange structure arranged inside of a space bounded by parallel portions of said pair of belts.

11. A heat exchanger including a plurality of pulley means, a pair of spaced endless belts each supported by said pulley means, a plurality of spaced air moving blades extending transversely to said pair of belts, fastener means securing the ends of each of said plurality of blades to one of said pair of belts, and each of said plurality of air-moving blades having a fixed inclination relative to the straight portions of said pair of belts, motor means for driving said pair of belts to cause said plurality of air moving blades to establish a flow of air, substantially straight duct means defining an admission opening at one side of the space bounded by parallel portions of said pair of belts and defining an exhaust opening at the other side of the space bounded by parallel portions of said pair of belts, a plurality of vanes for guiding said flow of air, said plurality of vanes including vanes arranged at the downstream end of said flow of air and defining air passages of progressively increasing cross-sectional area, and a heat exchange structure arranged inside of a space bounded by parallel portions of said pair of belts.

12. In combination:

(a) a fin-tube-heat-exchanger substantially in the shape of a four-sided prism having a rectangular front surface and a rectangular rear surface; and

(b) means for establishing a flow of air across said front surface and across said rear surface of said heat exchanger, said air-flow-establishing means including an endless belt structure wrapped around said heat exchanger and having portions extending substantially parallel to said front surface and to said rear surface thereof, motor means operating said belt structure, and a system of blades supported by said belt structure and shaped to move air substantially transversely to said portions of said belt structure extending substantially parallel to said front surface and to said rear surface of said heat exchanger when being moved by said belt structure.

13. In combination:

(a) a belt-type air moving device including air moving blades fixedly supported by a belt structure forming an endless loop, said air-moving device further including a plurality of stationary air-guiding vanes and establishing an air flow substantially rectangular in cross-section; and

(b) a substantially prismatic fin-tube-heat-exchanger having a front and a rear surface for the passage of air having substantially the same cross-section as said air flow and being arranged in the path of said air flow.

14. In combination:

(a) a belt-type air moving device including air moving blades fixedly supported by a belt structure forming an endless loop, said air-moving device further including a plurality of stationary air-guiding vanes and establishing an air flow substantially rectangular in cross-section; and

(b) a substantially prismatic fin-tube-heat-exchanger having a front and a rear surface for the passage of air having substantially the same cross-section as said air flow and being arranged inside of the loop formed by said belt structure.

References Cited by the Examiner

UNITED STATES PATENTS

2,548,615	4/1951	Petr	230—240
2,553,001	5/1951	Petr	230—240

LAURENCE V. EFNER, *Primary Examiner.*