We Claim

1. A connection piece for connecting a fluid pipe and a hollow turning vane to allow a heat exchange medium to flow through the hollow turning vane in a heat exchanger, the connection piece comprising:

a body having an upper and lower surface and a hollow interior;

a hollow pipe connection extending from the upper surface and connecting to the interior;

the lower surface being shaped to correspond to one end of the hollow turning vane;

the connection piece having a plurality of attachment points for attaching to the end of the hollow turning vane, the attachment points all being accessible from a top side;

the connection piece forming a fluid tight connection to the end of the hollow turning vane when the connection piece is removably attached to the hollow turning vane at only at the connection points; and

the connection piece being formed as a single unit.

2. The apparatus of claim 1 wherein the connection piece is formed in a two piece injection mold.
3. The apparatus of one of claims 1 to 2 wherein at least one of the attachment points is accessible through the hollow pipe connection and at least one attachment point is located on the upper surface of the body.
4. The apparatus of one of claims 1 to 3 wherein at the least one point attachment accessible through the hollow pipe connection is located on a cross member located inside the interior of the body.
5. The apparatus of one of claims 1 to 4 further comprising at least one cross members, each of said at least one cross member having an attachment point.

6. The apparatus of one of claims 1 to 5 the attachment points are screw bosses and wherein the turning vane including the screw bosses is formed in an extrusion mold.

7.The apparatus of one of claims 1 to 6 further comprising a recess on the lower surface shaped to correspond one end of the hollow turning vane.

8.The apparatus of one of claims 1 to 7 wherein a sealing gasket is placed inside the recess.

9.The apparatus of one of claims 4 to 8 wherein the height of the cross member is less than the height of the hollow interior such that a majority of the hollow interior is open.

10. The apparatus of one of claims 1 to 9 wherein at least one of the connection points further comprises a sealing gasket.

11. The apparatus of one of claims 1 to 10 wherein the connection points are threaded holes and screws are used to removably attach the connecting piece to the connection piece to the turning vane.

12. A heat exchanger turning vane assembly for a re-circulating wind tunnel comprising:

a rack;

a plurality of hollow turning vanes formed to allow a fluid to flow through the vanes, said hollow turning vanes mounted in the rack;

connection pieces at each end of the hollow turning vanes to connect the turning vanes to a fluid pipe system; and

said connection pieces being formed of a single piece and connecting in a fluid tight manner to the hollow turning vanes without heat or chemical bonding.

13. The apparatus of claim 12 wherein the connection pieces connect to the turning vane at connection points that are within the hollow area of the turning vane.

14. The apparatus of one of claims 12 to 13 wherein the connection points are screw bosses.

15. The apparatus of one of claims 13 to 14 wherein the turning vanes have internal cross bracing and the connection pieces connect to the internal cross bracing with a removable mechanical connector.

16. The apparatus of one of claims 12 to 15 wherein the connection pieces is one of the connection pieces claimed in one of claims 1-11.

17. A vane array comprising:

a plurality of hollow vanes, each having substantially constant cross section, the vanes disposed substantially parallel to each other;

each vane having a first end and a second end;

the array having a first edge defined by first ends of the plurality of vanes;

the array having a second edge defined by second ends of the plurality of vanes;

each vane's cross section defining at least two screw bosses formed therein;

each vane having at its first end a first respective connection piece, first respective connection piece secured fluid tight thereto by means of screws, each screw threadingly engaged with a respective screw boss;

each vane having at its second end a second respective connection piece, second respective connection piece secured fluid tight thereto by means of screws, each screw threadingly engaged with a respective screw boss;

a first manifold disposed along the first edge;

a second manifold disposed along one of the first edge and the second edge; and

pipes connecting the first manifold, the connection pieces, and the second manifold, thereby defining a plurality of fluid flow paths, each fluid flow path passing from the first manifold and through at least one of the vanes to the second manifold.

18. The apparatus of claim 17, wherein the pipe connection to each connection piece defines an opening thereinto;

the screw bosses formed into each vane's cross section including at least one screw boss positioned such that the screw threadingly engaged therewith has an axis passing through the opening.

19. The apparatus of one of claims 17 to 18, wherein the number of screw bosses is at least four, and wherein the number of screw bosses positioned such that the screw threadingly engaged therewith has an axis passing through the opening is at least two.
20. The apparatus of one of claims 17 to 19 wherein the connection piece is the connection piece of one of claims 1-10.

21. A method for use with a plurality of hollow turning vanes, the method comprising the steps of:

flowing a working fluid at a first temperature through a pipe system to a first heat exchange unit;

the heat exchange unit formed of at least one turning vane having single unit connections pieces at each end of the hollow turning vane, the connection pieces being removably attached fluid tight to the turning vane;

the connection pieces having been removably connected to the hollow turning vanes with mechanical connectors;

the heat exchange unit connected to the pipe system such that fluid can flow from the pipe system into the heat exchange unit;

passing the working fluid from the first heat exchange unit into a second heat exchange unit; and

the method further comprising the steps, performed contemporaneously with the passing steps, of turning air as the air passes past the hollow turning vanes, and cooling the air as the air passes past the hollow turning vanes by transferring heat to the working fluid and thereby raising the temperature of the working fluid from the first temperature to a second temperature .

22. The method of claim 21, wherein the connections are fluid tight.
23. The method of one of claims 21 to 22 further comprising the steps of flowing the working fluid through a second turning vane.

24. The method of one of claims 21 to 23 further comprising the steps of transporting the heated working fluid to a second location and transferring the heat to another fluid through a heat exchange system.
25. The method of one of claims 21 to 24 further comprising the steps of transporting the heated working fluid to a second location and utilizing the heated working fluid at the second location.
26. The method of one of claims 21 to 25 further comprising the steps of transporting the now cooled working fluid from the second location back to the first hollow turning vane once the fluid has returned to the first working temperature.
27. The method of one of claims 21 to 26 wherein the working fluid is a liquid or a gas.
28. The method of one of claims 21 to 27 wherein the working fluid is selected from the group consisting of water, Freon®, gas, salt water, or compressed gas.
29. The method of one of claims 21 to 28 wherein the working fluid at the second temperature is used to heat the environment at the second location.
30. The method of one of claims 21 to 29 wherein the connection piece is one of the connection pieces claimed in one of claims 1 to 10.

CLAIMS

1. A connection piece for connecting a fluid pipe and a hollow turning vane to allow a heat exchange medium to flow through the hollow turning vane in a heat exchanger turning vane for a re-circulating wind tunnel, the connection piece comprising:

a body having an upper and lower surface and a hollow interior;

a hollow pipe connection piece extending from the upper surface and connecting to the interior; the pipe connection piece connecting to a fluid pipe;

the lower surface being shaped to correspond to one end of the hollow turning vane;

the connection piece having a plurality of attachment points for attaching to the end of the hollow turning vane, the attachment points all being accessible from a top side;

the connection piece forming a fluid tight connection to the end of the hollow turning vane when the connection piece is removably attached to the hollow turning vane at only at the attachment points; and

the connection piece being formed as a single unit.

2. The apparatus of claim 1 wherein the connection piece is formed in a two piece injection mold.
3. The apparatus of claim 1 wherein at least one of the attachment points is accessible through the hollow pipe connection and at least one attachment point is located on the upper surface of the body.
4. The apparatus of claim3 wherein the least one point attachment accessible through the hollow pipe connection is located on a cross member located inside the interior of the body.
5. The apparatus of claim 1 further comprising at least one cross members, each of said at least one cross member having an attachment point.
6. The apparatus of claim 5 the attachment points are screw bosses and wherein the turning vane including the screw bosses is formed in an extrusion mold.

7. The apparatus of claim 1 further comprising a recess on the lower surface shaped to correspond to one end of the hollow turning vane.
8. The apparatus of claim 7 wherein a sealing gasket is placed inside the recess.
9. The apparatus of claim 5 wherein a height of the cross member is less than the height of the hollow interior such that a majority of the hollow interior is open.
10. The apparatus of claim 1 wherein at least one of the connection points further comprises a sealing gasket.
11. The apparatus of claim 1 wherein the connection points are threaded holes and screws are used to removably attach the connecting piece to the connection piece to the turning vane.
12. A heat exchanger turning vane for a re-circulating wind tunnel comprising:

    a rack;

    a plurality of hollow turning vanes formed to allow a fluid to flow through the vanes, said hollow turning vanes mounted in the rack;

    connection pieces at each end of the hollow turning vanes to connect the turning vanes to a fluid pipe system; and

    said connection pieces being formed of a single piece and connecting in a fluid tight manner to the hollow turning vanes without heat or chemical bonding.
13. The apparatus of claim 12 wherein the connection pieces connect to the turning vane at connection points that are within the hollow area of the turning vane.
14. The apparatus of one of claims 12 to 13 wherein the connection points are screw bosses.
15. The apparatus of one of claims 13 to 14 wherein the turning vanes have internal cross bracing and the connection pieces connect to the internal cross bracing with a removable mechanical connector.
16. The apparatus of one of claims 12 to 15 wherein the connection pieces is one of the connection pieces claimed in one of claims 1-11.
17. A heat exchanger vane array for a re-circulating wind tunnel having a plurality of turning vanes comprising:

the plurality of hollow vanes each having substantially constant cross section, the vanes disposed substantially parallel to each other;

each vane having a first end and a second end;

the array having a first edge defined by first ends of the plurality of vanes;

the array having a second edge defined by second ends of the plurality of vanes;

each vane's cross section defining at least two screw bosses formed therein;

each vane having at its first end a first respective connection piece, first respective connection piece secured fluid tight thereto by means of screws, each screw threadingly engaged with a respective screw boss;

each vane having at its second end a second respective connection piece, second respective connection piece secured fluid tight thereto by means of screws, each screw threadingly engaged with a respective screw boss;

a first manifold disposed along the first edge;

a second manifold disposed along one of the first edge and the second edge; and

pipes connecting the first manifold, the connection pieces, and the second manifold, thereby defining a plurality of fluid flow paths, each fluid flow path passing from the first manifold and through at least one of the vanes to the second manifold.

18. The apparatus of claim 17, wherein the pipe connection to each connection piece defines an opening thereinto;

the screw bosses formed into each vane's cross section including at least one screw boss positioned such that the screw threadingly engaged therewith has an axis passing through the opening.

19. The apparatus of one of claims 17 to 18, wherein the number of screw bosses is at least four, and wherein the number of screw bosses positioned such that the screw threadingly engaged therewith has an axis passing through the opening is at least two.

20. The apparatus of one of claims 17 to 19 wherein the connection piece is the connection piece of one of claims 1-10.

21. A method for use with a heat exchanger turning vane for a re-circulating wind tunnel having a plurality of hollow turning vanes, the method comprising the steps of:

flowing a working fluid at a first temperature through a pipe system to a first heat exchange unit;

the heat exchange unit formed of at least one turning vane having single unit connections pieces at each end of the hollow turning vane, the connection pieces being removably attached fluid tight to the turning vane;

the connection pieces having been removably connected to the hollow turning vanes with mechanical connectors;

the heat exchange unit connected to the pipe system such that fluid can flow from the pipe system into the heat exchange unit;

passing the working fluid from the first heat exchange unit into a second heat exchange unit; and

the method further comprising the steps, performed contemporaneously with the passing steps, of turning air as the air passes past the hollow turning vanes, and cooling the air as the air passes past the hollow turning vanes by transferring heat to the working fluid and thereby raising the temperature of the working fluid from the first temperature to a second temperature.

22. The method of claim 21, wherein the connections are fluid tight.

23. The method of one of claims 21 to 22 further comprising the steps of flowing the working fluid through a second turning vane.

24. The method of one of claims 21 to 23 further comprising the steps of transporting the heated working fluid to a second location and transferring the heat to another fluid through a heat exchange system.

25. The method of one of claims 21 to 24 further comprising the steps of transporting the heated working fluid to a second location and utilizing the heated working fluid at the second location.

26. The method of one of claims 21 to 25 further comprising the steps of transporting the now cooled working fluid from the second location back to the first hollow turning vane once the fluid has returned to the first working temperature.
27. The method of one of claims 21 to 26 wherein the working fluid is a liquid or a gas.
28. The method of one of claims 21 to 27 wherein the working fluid is selected from the group consisting of water, Freon®, gas, salt water, or compressed gas.
29. The method of one of claims 21 to 28 wherein the working fluid at the second temperature is used to heat the environment at the second location.
30. The method of one of claims 21 to 29 wherein the connection piece is one of the connection pieces claimed in one of claims 1 to 10.