

May 10, 1966

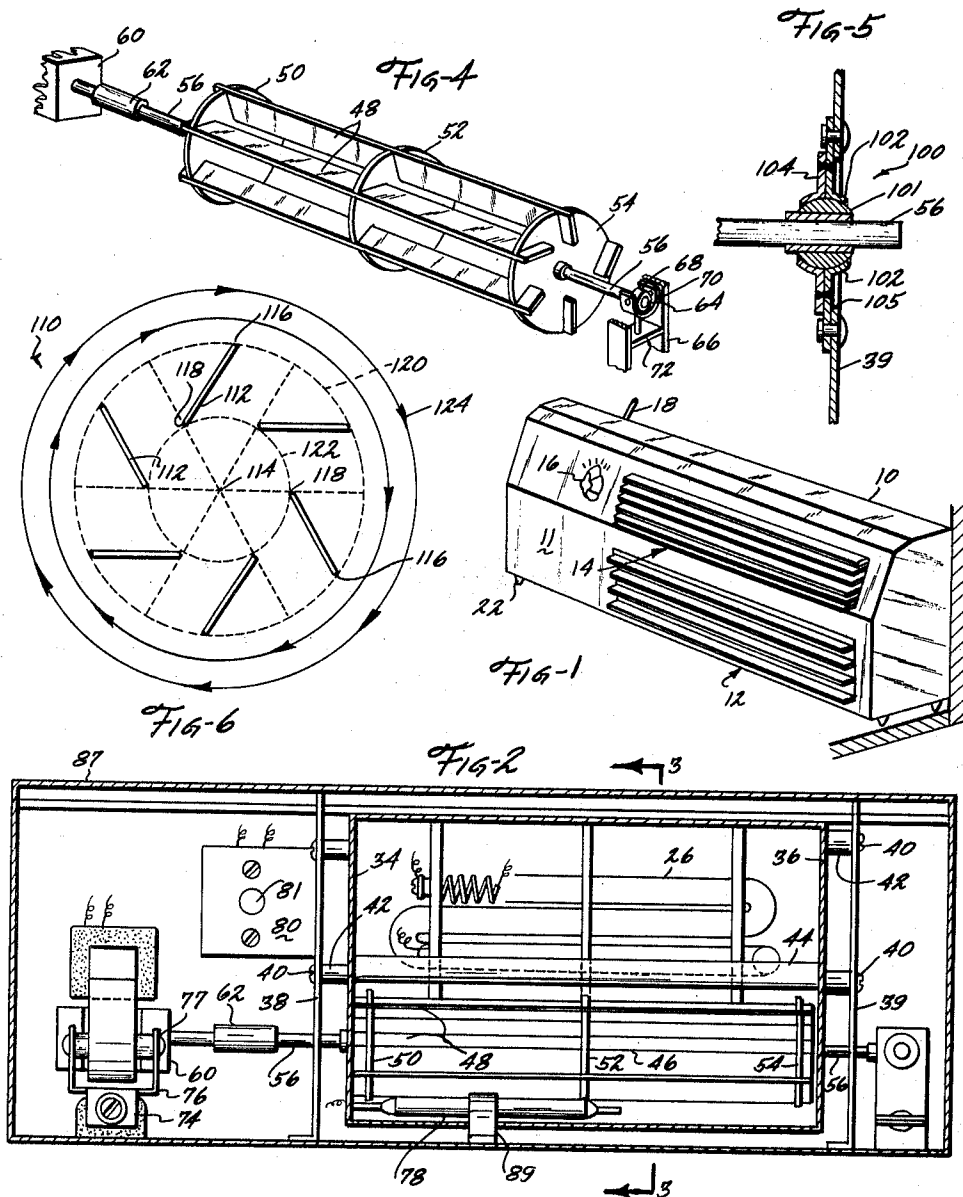
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3,250,457

AIR MOVEMENT APPARATUS

Filed Aug. 6, 1964

2 Sheets-Sheet 1



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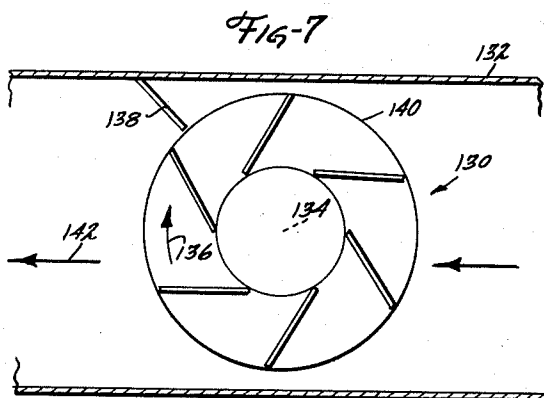
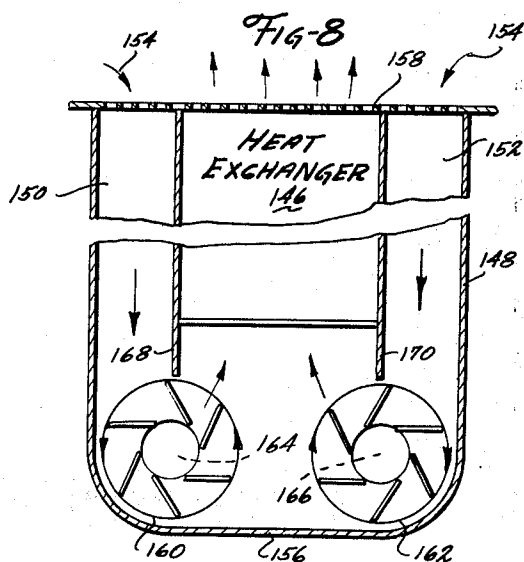
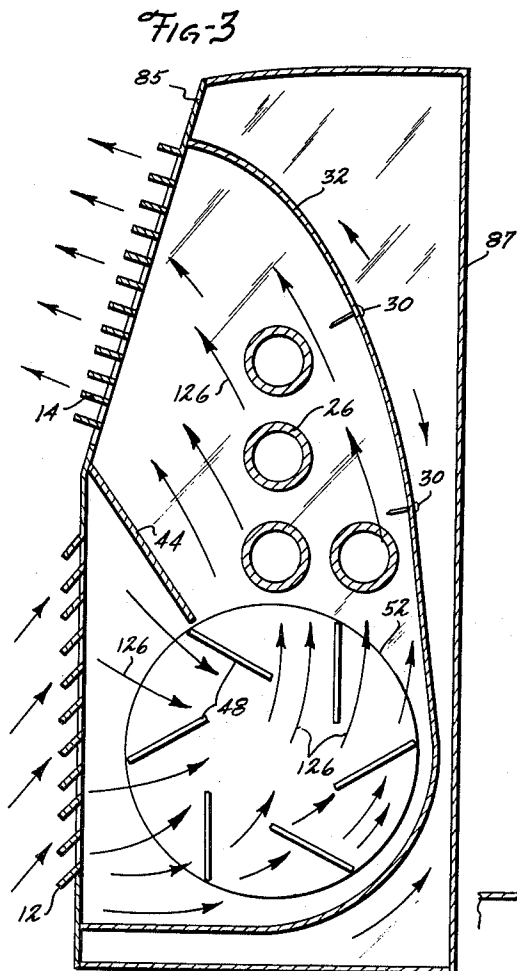
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2 Sheets-Sheet 2



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AIR MOVEMENT APPARATUS

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Filed Aug. 6, 1964, Ser. No. 387,746

3 Claims. (Cl. 230-117)

This application is a continuation-in-part of co-pending application Serial No. 095,173 entitled "Convection Heating Apparatus," filed March 13, 1961 by the present applicant, now Patent No. 3,147,368.

This invention relates generally to mechanical means for moving fluids, including gasses and liquids, and more particularly to novel rotary apparatus for directing such fluids along selected paths or directions.

Although the present invention finds particularly useful application in the field of forced air space heaters and although, in the cause of providing a clear teaching of the invention, much of the following discussion of examples of the invention relates thereto, it is stressed that the advantages of the invention are equally apparent in and applicable to other fields of art such as air-conditioning systems, fluid pumps, gas relay stations, air distribution systems, and the like.

In the field of baseboard type electric room heaters, the general prior art approach has been to provide low profile convection type heaters along a major portion of the baseboard of the room to be heated. Such baseboard heaters are installed in a wall or against a wall adjacent to the floor, and are widely employed in residential, industrial and business establishments. Typically, these units consist simply of an electrical resistance element mounted in a compact natural convection housing. In operation the heating element attains a high temperature, usually through electrical resistance effects, and produces considerable heat which passes from the unit by radiation and natural convection. Generally, in order to obtain the required amount of heat for a given room and in order to keep the wattage and temperature per lineal foot of baseboard heater within safe limits, a great length of baseboard, often more than is available, is required.

Furthermore, such convection baseboard heaters have an indifferent circulation. That is, the heated air for the most part flows straight up the walls above the heaters, which causes soiling of the walls and increases radiation losses therefrom to the outside. In addition, in maximizing the magnitude of heat output per lineal foot of heater, the temperature of the electric heating element is typically chosen to be so high as to cause the familiar odor of scorched dust particles throughout the space being heated, and shortens the useful lifetime of the heating elements since they are usually exposed directly to the air and its chemically active constituents.

A general solution to these problems in a baseboard type heater is to alter their principle of operation to one of forced convection of the air past the heating elements. In such a unit the air is moved over the heating element, then forced into the room which is to be heated. The heated air may be directed away from the walls, eliminating their soiling and, by directing the heat into the room, the high radiation losses from the walls to the outside are avoided. The heat exchange efficiency from the heating element to the forced air is higher than with natural convection currents of air. The heating element is markedly cooled by the heat exchange process so that a far greater output wattage per lineal foot may be attained with a much lower temperature of heating element; and of course the heating element in an apparatus of this type is safer regarding hazards of fire and has a much longer heating element lifetime.

Attempts in the past however, to provide forced air baseboard heaters have generally been directed toward the use of conventional blowers which provide a flow of

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air along the length of the heating element and then deflect it outwardly into the room. Other attempts have utilized elongated squirrel cage type blowers.

In the case of the former, the end blowers draw air from a relatively small inlet port and force it along a chamber including the heating elements. The heated air is then forced out of this chamber through a distribution of openings the sizes of which vary along the length of the unit, with the smaller openings near the fan end, in order to distribute the heated air into the room as evenly as possible. However, this type of system is inherently noisy because of the relatively high air velocity required for the air passing through the small intake to the fan and then through the distribution of even smaller output apertures. Furthermore, the distribution of heated air from the unit is not satisfactorily even or constant along the length of the heater.

In the case of elongated squirrel cage blowers, those heretofore observed cannot truly be designated as low profile baseboard type heaters, and are relatively expensive to manufacture in view of the size of apparatus required to move the air over the heating element without vibration or noise. The elongated unit in order to minimize vibration and noise, as well as to remain reliably aligned with its bearings, even though the unit is installed against an uneven floor or wall, typically has required a very rigid and relatively bulky overall structure.

It is therefore an object of the present invention to provide apparatus for moving air and other fluids which is not subject to these and other disadvantages and deficiencies of the prior art.

It is another object to provide such apparatus which is highly efficient and inherently quiet in operation.

It is another object to provide such apparatus which gated, large area opening and direct it along another direction through an equally large and elongated opening with an even distribution of air velocity over the full area of both inlet and outlet.

It is another object to provide such apparatus which may be utilized in combination with air-conditioning, forced air heating, gas distributing systems, and the like.

Briefly, these and other objects are achieved in accordance with the structural features of an example of the invention in which an elongated impeller assembly is formed by a plurality of six elongated substantially planar impeller blades having their lengths aligned parallel to the axis of rotation of the assembly. Each blade is radially spaced from the axis by a distance comparable to the width of the blades, and each blade is inclined tangentially forwardly from the radial by an angle of approximately 60°. The blades are supported by a plurality of axially spaced circular discs radially oriented which, in cooperation with the blades themselves, form a structurally rigid, lightweight impeller assembly. The assembly may include an actual axial shaft or may have axially extending stub shaft members protruding outwardly from the end supporting discs.

One end of the assembly is in this example, supported by a self-aligning, flexible bearing, and the other end is affixed to a driving motor which is mounted in angularly flexible support means so that the base, supporting structure, or housing, need not be extremely rigid and elaborate.

In operation, the assembly is rotated by the motor and the individual blades push air ahead of them. The angle of the blades causes the assembly to create a rotating cylinder of air which is held against centrifugal spreading within a fairly well defined diameter by the inwardly, effectively, directed action of the blades. When the assembly is thusly rotated in an open environment there is no appreciable outward draft from the rotating air cylinder. When, however, an elongated, radially oriented, station-

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ary peeler blade is combined with the impeller assembly and placed radially closely thereto, a flowing sheet of air is quietly removed from the cylinder and directed outwardly along one face of the peeler blade. Similarly, a draft of air is drawn into the rotating cylinder along the opposite face of the peeler blade.

The resultant flow or pumping of air is exceedingly quiet and has a lineal velocity almost equal to the tangential velocity of the outer edges of the impeller blades. Both of these factors indicates that a relatively highly efficient pumping action is achieved: the quietness indicating a low level of turbulence and a low rate of conversion of the rotary energy to undesirable acoustical energy; and the relationship of resultant lineal air velocity to driving blade velocity indicating very little frictional losses due to a slippage between blades and air stream.

Further details of these and other novel features and their operation as well as additional objects and advantages of this and other examples of the impeller system of the invention will become apparent and be best understood from a consideration of the following description taken in connection with the accompanying drawings which are presented by way of illustrative example only and in which:

FIG. 1 is a perspective view of an example of an apparatus which combines the air movement structure constructed in accordance with one form of the present invention;

FIG. 2 is a front elevational view of the apparatus of FIG. 1 with its front cover removed;

FIG. 3 is a vertical sectional view of the structure of FIG. 2 taken along the lines 3—3 thereof;

FIG. 4 is a perspective view of an example of the air movement apparatus constructed in accordance with the principles of the present invention and is a component portion of the combination shown in FIG. 3;

FIG. 5 is a fractional vertical sectional view of an alternative form of a portion of an apparatus similar to that of FIG. 1;

FIG. 6 is a schematic diagram illustrating certain aspects of the operation of the structure of FIG. 4; and

FIG. 7 and FIG. 8 are sectional views illustrating additional alternative examples of air movement apparatus constructed in accordance with the principles of the present invention.

With specific reference now to the figures in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion only and are presented in the cause of providing what is believed to be the most useful and readily understood description of the principles and structural concepts of the invention. In this regard no attempt is made to show structural details of the apparatus in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawing making apparent to those skilled in the art how the several forms of the invention may be embodied in practice. Specifically, the detailed showing is not to be taken as a limitation upon the scope of the invention which is defined by the appended claims forming, along with the drawings, a part of this specification.

Referring initially to FIG. 1 in which an electric base-board heater utilizing an example of the air moving combination of the present invention is illustrated, the apparatus shown includes a housing 10 having a front panel 11 containing intake louvers 12 and exhaust louvers 14, which constitute intake and exhaust ports respectively. Also disposed at the front panel 11 is a control knob 16 which is connected to a control mechanism, illustrated below, for turning the heater on and off and for regulating the amount of heat convected through the exhaust louvers 14.

The unit is energized through an electrical conductor 18 which may be variously connected to a source of electrical power convenient to the operating location of the

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unit. This heater example of the present invention is normally affixed or otherwise disposed on the floor adjacent the wall and supported by a set of legs 22 which may be formed of heat insulating material. However, it should be noted that the unit in its basic form as an air convector may also be used as a wall insert fan or heater or as a portable unit and moved to various locations as desired.

Referring to FIG. 2, the heating element 26 in this heater example of the invention comprises a coiled length of resistance wire which may extend in four lengths as shown, along the length of the unit, and be supported by fiber insulation boards 28 to form an elongated structure. The supporting insulation boards may be formed of asbestos solidified in a binder material or of various other heat resistant insulating materials. As shown in FIG. 3, the boards 28 may be held in position by wire brads 30 which pass supportingly through a duct member 32. Referring again to FIG. 2, the duct member 32 includes end sections 34 and 36 by which it is affixed to vertically oriented brackets 38 and 39 with screws 40 carrying spacers 42. The duct member 32 also includes a sheet metal vane or peeler blade 44 which is supported between the vertical brackets 38 and 39 for peeling air from the periphery of the impeller of the air moving apparatus of the invention, shown in more detail below. It may therefore be observed that these elements and the other portions of the duct member 32 define a continuous air passage between the intake louvers 12 and the exhaust louvers 14.

An elongated rotary impeller 46 is mounted in the air passage thusly defined by the duct member 32 so as to be disposed contiguously to the intake louvers 12 and parallel to the elongated heating element 26. The impeller assembly of this example (see also FIG. 4) includes a plurality of six elongated, angularly offset impeller blades 48 which are supported with their length dimension disposed parallel to the axis of rotation on axially spaced supporting discs 50, 52, and 54. A mounting shaft 56 is, in this example, disposed concentrically through the impeller assembly passing through the center of each of the supporting discs 50, 52, and 54 and extending as shown from either end of the assembly toward rotary suspending bearing means; one end of the shaft 56 being coupled to a motor 60 by a coupling 62 while the other end is journaled into a bearing 64 mounted in a support structure 66. The bearing 64 is supported on a stub shaft 68 which is in turn held by a yoke 70 that is pivotally affixed to a bracket 72. Accordingly, the bearing 64 may be seen to be essentially floating and may be variously and automatically aligned to accommodate angular deviations occurring by the shaft 56 with respect to the housing structure 10.

Similarly, the mounting of the motor 60 is flexible to accommodate the self-alignment of the impeller assembly 46. Specifically, the motor 60 is pivotally mounted on a bracket 74 which supports a yoke 76 which supports the motor 60 in a pivotal, gimbal-like mounting 77.

The electric motor 60 and the resistance element 26 utilized in this heater example of the combination of the invention are energized through control of a thermostat sensor 78 and a thermostat control unit 80 which comprises a rotative shaft 81 and an on-off switch. The conductors in the input cable 18 may be joined through a series circuit including the resistance element 26 and the control unit 80. The motor 60 may be connected across a portion of the resistance element 26 by other leads not shown. Thus the current flow through the resistance element 26 is controlled by the control unit 80 in accordance with the temperature sensed by the thermostat sensor 78 and the setting of the shaft 81. The motor 60 is similarly energized, however a reduced potential may be applied to the motor 60 by varying the portion of the resistance element across which the motor is connected. Accordingly, the motor 60 need not be specially manufactured; that is, an inexpensive motor can be utilized

with the proper operating voltage provided simply and easily by selectively connecting the motor across a predetermined desired portion of the resistance element 26.

The housing 10 of this heater example of the invention may be stamped or otherwise formed of two separate sheet metal members 85 and 87 (see FIG. 3) with the louvers formed in the front panel 11. The brackets 38 and 39 may be affixed to the back housing member 87 as by spot welding or riveting to provide the support for affixing the duct member 32 and the peeler blade 44 thereto. The impeller assembly and the resistance element may then be placed in a parallel axially aligned position and the impeller assembly connected to the motor 60 and journaled into the bearings 64. It is stressed that by reason of the mounting for the motor 60 and the support structure 66 the impeller is self-aligning thereby obviating the requirement for precise alignment procedures. The control unit 80 may be affixed to the bracket 38 and a thermostat 70 and the thermostat sensor 78 positioned contiguously to the intake louvers of the apparatus and supported by a clamp 89. The electrical connections may then be made between the control unit 80, the motor 60, and the resistance element 26 after which the front housing portion 85 may be placed on the unit and secured by clips or screws, not shown.

In the operation of the heater example as disclosed, the impeller assembly 48 forces air over the thermostat sensor 78, then over the heating element 26 and then expelled through the exhaust louvers 14. As the air is thusly forced through the passage by the action of the rotary impeller assembly, pressure fluctuations tend to build up at the back of the heater between the impeller assembly 46 and the heating element 26. Normally this would tend to cause the existence of undesired forces in the apparatus producing vibration and noise, however, in the present system as discussed below, unbalanced pressures do not develop and the apparatus operation is smooth and substantially noiseless. As air from the space to be heated passes through the heater, the thermostat sensor 78 receives it at an average temperature resulting from a combination of air from the several louvers 12. As a result, the control unit 80 operates to regulate the current flow through the resistance element 26 in accordance with the composite temperature sensed by the sensor 78 and the setting of the rotative shaft 81 of the control unit 80 to which the knob 16 is affixed. In general, this control by the thermostat means is exercised to regulate the temperature in the room or other space. However, in addition, the operation of the control unit provides considerable safety in the operation of the heater. For example, if an obstacle such as a window drape should restrict the air flow through the heater, the temperature therein would rise but the action of the thermostatic control system would cut off the electrical current flow through the resistance element 26 and thereby prevent dangerously extreme temperatures. This feature in conjunction with the relatively complete shielding provided for the resistance element 26 and its lower operating temperature as discussed above, results in an elongated, low-profile type electric heater which is considerably safer than similar prior devices.

Another important feature of the present invention resides in the parallel-mounted blower and heating elements which enable a structure that is simply and easily installed without removing sections of baseboard, to be capable of efficiently converting electrical energy to heat at power rates of up to and more than 1500 watts per lineal foot of heater.

FIG. 5 illustrates an alternative form of a self-aligning bearing assembly for the "non-driven" end of the shaft 56. A bearing assembly 100 includes a ball 101 seated in a half bearing plate 102, which is secured to the bracket 39. An opening in the plate 102 receives the other plate 104 which may be spot welded to the plate 102. Thus the plates are held in the opening 105 in the bracket 39

by screws or rivets 106 to provide a flexible self-aligning support for the shaft 56.

In the schematic diagram of FIG. 6 the operation of an example of a rotary impeller assembly 110 of a fluid moving apparatus constructed in accordance with the principles of the present invention is illustrated. The assembly 110 includes an array of impeller blades 112 symmetrically disposed about the axis 114 of rotation. Each of the blades has a leading edge 116 and a trailing edge 118, the leading edges defining a circumscribing cylinder 120 and the trailing edges defining an inscribed cylinder 122. The width of the blades 112 between their leading and trailing edges is typically approximately one-half radius of the cylinder 120; and the radius of the cylinder 122 is typically one-third to two-thirds that of the outer cylinder 120. The blades 112 are angularly inclined forwardly of the radial by an acute angle which is of the order of 60°.

The circular and concentric arrows 124 indicate the direction of rotary drive of the assembly 110 and also indicate the existence of a rotating envelope of air flowing contiguously in a cylinder about the outer diameter of the impeller assembly. Smoke tests show that when the assembly is thusly rotated in an open environment, there is substantially no centrifugal spreading of air beyond the cylinder outlined by the arrows 124. Furthermore, there is substantially no turbulence within the cylinder and its operation is unobviously quiet.

When a peeler blade, such as blade 44 of FIG. 3 is affixed in a substantially radial orientation with a length approximately equal to that of the impeller blades, to structure which is at rest with respect to the rotation of the impeller assembly 110, the envelope of air indicated by the arrows 124 is peeled off in a flowing sheet along one surface of the peeler blade while a partial vacuum is created on the opposite side thereof. Further in this connection and with additional reference to FIG. 3, smoke testing of the apparatus in its baseboard type heater example configuration has shown that the peeler blade 44 not only causes a stream of flow through the duct member 32 toward the output or exhaust louvers 14, but also creates the vacuum previously mentioned immediately under the peeling blade 44, which causes the outside air to rush into and through the impeller assembly at that point, and all along the intake, following the lines indicated by the arrows 126 in FIG. 3.

A basic advantage of the impeller assembly and peeler blade combination of the present invention is that the blades 112, being at an angle to the radius, cut into the air and do not create the turbulence that would occur if they were radially oriented. This tends to make the fan inherently more silent and thereby more efficient than others, particularly those constructed as a paddle wheel fan. The unobvious efficiency has further been indicated by imperial data showing that a 2¼ inch diameter fan approximately three feet long driven at a rotational speed of 1760 revolutions per minute produces a sheet jet of air moving at 950 lineal feet per minute or only slightly less than the tangential velocity of the leading edges 116 of the blades 112.

Referring to FIG. 7 an example of the invention is illustrated in which a rotary impeller assembly 130 is mounted in a straight line segment of duct 132. The impeller is rotated about an axis 134 of rotation in the direction indicated by the arrow 136. A radially oriented peeler blade 138 extends from the cylindrical surface 140 defined by the rotating leading edges of the impeller blades of the impeller assembly 130 to the inner surface of the duct 132 at a point somewhat forwardly of the axis 134, along the direction of the resulting flow of the air stream indicated by the arrows 142. The operation of the impeller system of FIG. 7 is substantially identical to that of the previous figures, namely the peeler blade 138 slices the rotating cylinder of air away from the im-

PELLER assembly and causes it to create a smooth flow of air downstream along the duct 132.

In FIG. 8 an example of the invention is illustrated in which a pair of rotary impellers constructed along the lines of those of the previous figures are shown utilized in combination with a floor mounted heat exchange system such as a floor furnace or an air-conditioning unit or a combination of both. In such a unit a heat exchanger 146 is inserted within a housing body 148 in a manner to define a pair of duct members 150, 152 symmetrically disposed at either side of the heat exchanger and within the housing 148. Air flowing downwardly through the ducts 150, 152 as indicated by the arrows 154 is turned in the region of the bottom 156 of the housing 148 and returned upwardly through the heat exchanger 146 and thence through a grill 158 back into the room or other space, the air of which is being treated by the effects of the heat exchanger 146.

A rotary impeller 160, 162 is disposed at the juncture of each of the ducts 150, 152 with the bottom region 156 of the housing 148 so that their axes 164, 166 respectively, are approximately in line with a pair of peeler blade extensions 168, 170 which extend downwardly theretoward from the side of the heat exchanger 146.

Air conditioners and furnaces constructed along these lines are relatively silent and exceedingly efficient whether operated as floor units, wall insert units, or as portable apparatus.

There have thus been disclosed a number of examples of fluid movement apparatus systems which achieve the objects and exhibit the advantages set forth herein above.

What is claimed is:

1. A horizontally elongated low profile forced air apparatus comprising:

an elongated thin wall housing having a frontal face portion and a horizontal length which is long compared to its height and horizontal depth;

continuous air passage means in said housing including elongated intake and exhaust ports disposed in said frontal face portion for taking in and exhausting air in generally the same direction;

an electric motor-impeller unitary assembly horizontally mounted in said air passage means, said motor-impeller assembly including

a motor,

an elongated rotary impeller connected at one end to said motor and having an axis of rotation, and including approximately six elongated impeller blades each disposed parallel to said axis and each being disposed substantially in a plane which is angularly offset from the radial, and a plurality of lightweight, spaced apart supporting discs connecting said blades in a unitary, supporting relationship;

a pivotal, self-aligning bearing means for rotatably supporting the other end of said impeller, and self-aligning pivotal means for pivotally supporting said motor.

2. Air movement apparatus comprising:

first air duct means defining an elongate input port; second air duct means defining an elongate output port, said ports being substantially coplanar;

said first and second duct means having a common portion of duct wall terminating along a line perpendicular to the lengths of said duct means and defining a peeler blade;

rotary impeller assembly having an axis disposed parallel to said peeler blade and spaced therefrom by a first radial distance, said impeller assembly comprising:

a plurality of substantially planar impeller blades each having a length approximately equal to

that of said peeler blade and disposed parallel to said axis, each of said impeller blades having a leading edge lying substantially on a first cylindrical surface coaxial with said axis and having a radius equal to said first radial distance, each said impeller blade having a trailing edge lying on a cylindrical surface concentric with said first cylindrical surface having a radius equal to approximately one-third to two-thirds that of said first cylindrical surface, said blades being inclined forwardly from the radial by an angle of approximately 60° so that said leading edges are disposed forwardly of respective ones of said trailing edges by approximately 30°;

axially spaced supporting means forming in cooperation with said impeller blades a unitary assembly;

bearing means carried by said duct means and connected to said unitary assembly for permitting rotation thereof about said axis; and duct wall means connecting said first and second duct means and being disposed contiguously to said first cylindrical surface along a portion thereof approximately diametrically opposite from said peeler blade.

3. Air movement apparatus comprising:

air duct means defining an input port and an output port;

peeler blade means affixed to a wall of said duct means between said input and output ports along a line perpendicular to the length of said duct means;

rotary impeller assembly having an axis disposed parallel to said peeler blade and spaced therefrom by a first radial distance, said axis being disposed toward said input port from said peeler blade, said impeller assembly comprising:

a plurality of substantially planar impeller blades each having a length approximately equal to that of said peeler blade and disposed parallel to said axis,

each of said impeller blades having a leading edge lying substantially on a first cylindrical surface coaxial with said axis and having a radius equal to said first radial distance, each said impeller blade having a trailing edge lying on a cylindrical surface concentric with said first cylindrical surface having a radius equal to approximately one-third to two-thirds that of said first cylindrical surface, each said blade being inclined forwardly from the radial-axial plane containing its said trailing edge by an angle of approximately 60°;

axially spaced supporting means forming in cooperation with said impeller blades a unitary assembly; and bearing means carried by said duct means and connected to said unitary assembly for permitting rotation thereof about said axis.

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