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ABSTRACT

A combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being secured to the blade support means and blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tips of said blades are higher than root ends of said blades and wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

IMPROVED COMBINED CEILING FAN AND LIGHT FITTING

TECHNICAL FIELD

The invention described herein relates to a combined light fitting and ceiling fan having blades that are compactly folded when the fan is not in use and that move outwardly when the fan is started. More particularly the invention relates to improved fan blades for such an appliance.

BACKGROUND ART

Ceiling fans have long been recognized and used as an inexpensive way to provide movement of air within rooms of buildings. They can be simple to use and install, safe, and inexpensive to buy and run when compared to such alternatives as for example refrigerated and evaporative air conditioning units. They can often provide a surprisingly effective alternative to air conditioning as the air movement they generate can evaporate skin perspiration with a resulting cooling effect.

It is known to combine ceiling fans with lighting means, as firstly it is a common requirement to provide ceiling mounted light sources, and secondly it is convenient to provide a single power supply to operate a combined fan and light fitting.

Less commonly, it has also been known to provide a combined light fitting and ceiling fan with some form of folding or retracting blade arrangement. Le Velle has described three versions. US Patent 1445402 discloses a light fitting and ceiling fan in which blades move outwards under centrifugal force when the fan is switched on, and are retracted by springs when the fan is switched off. US Patents 1458348 and 2079942 disclose improved versions, in which (unlike the early version of Patent 1445402) the inward and outward movements of the blades are synchronized. Synchronizing blade movement is important for preserving satisfactory balance of the rotating parts of the fan. More recently, a combined light fitting and ceiling fan has been disclosed by Villella (see International Patent

Publication No. WO 2007/006096) with a concealed and simple blade movement synchronizing arrangement that lends itself to modern design as well as recognising the need to enhance air moving performance of the blades and/or to improve the energy efficiency.

A problem in the design of a combined light fitting and ceiling fan is to provide blades that when in use can provide useful air moving performance without requiring excessive power and that when not in use can fold into a reasonably compact overall form. The present invention addresses this problem.

SUMMARY OF THE INVENTION

According to the present invention there is provided a combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being secured to the blade support means and blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tips of said blades are higher than root ends of said blades and wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

The present invention also provides a combined ceiling fan and light fitting having folding fan blades, the fan comprising:

a blade support means arranged to be rotated by a motor about a fan rotation axis;

a plurality of fan blades secured to the blade support means, a root end of each blade being pivotable between folded and operative positions about a blade pivot axis being parallel to or canted relative to the fan rotation axis and fixed in the blade support means;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tip ends of said blades in their operating positions rotate in a plane which is higher than that in which the root ends of said blades rotate; and

wherein each of the blades is cambered and are concave downward.

The invention also provides a combined ceiling fan and light fitting having folding fan blades, the fan comprising:

(i) a blade support means arranged to be rotated by a motor about a fan rotation axis;

(ii) a plurality of fan blades, each having a tip and root end, the blades being mounted for rotation relative to the blade support means so that each blade is pivotable between folded and operative positions about a blade pivot axis being parallel to or canted relative to the fan rotation axis and fixed in the blade support means;

(iii) wherein tips of said blades in their operating positions rotate in a plane which is higher than that in which the root ends of said blades rotate; and

(iv) wherein each of the blades is cambered and are concave downward; and

(v) a synchronising mechanism for synchronising movement of the blades between their folded and operative positions.

The invention also provides a combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being mounted for rotation relative to the blade support means, each blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tips of said blades are, in use, higher than root ends of said blades and wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

The invention also provides a combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being mounted for rotation relative to the blade support means, each blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

The invention also provides a combined ceiling fan and light fitting having folding fan blades, the fan comprising:

a blade support means arranged to be rotated by a motor about a fan rotation axis;

a plurality of fan blades each having a root end, tip and leading and trailing edges;

each blade being secured to the blade support means by being pivotally connected at its root end to the blade support means for rotation about an upright blade pivot axis so as to be moveable between a folded and an operative position, each blade being arranged to move from its folded position to its operative position by centrifugal forces when said motor rotates said blade support means;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and wherein

(a) each of the blades is cambered and are concave downward;

(b) each of the blades is generally elongate and arcuate when seen in plan view thereby giving each blade biaxial curvature to enhance aerodynamic performance; and

(c) each of the blades in its folded position lies above and close to the blade support means to give good concealment of the blades in their folded positions.

In this specification, the term "neighbouring blade" here means a blade that is first found by moving peripherally forward (i.e. in the direction of fan rotation) from one blade.

The phrase "turns downwardly" here does not necessarily mean that with increasing distance toward the tip end from such turning down the blade begins to actually descend. Rather it means that the blade increases in height at a lesser rate than before the turning down, which may still be positive although that is not to preclude a zero or negative rate of height increase.

The "specified radius" may be approximately a radius of a light fitting portion that is comprised in the combined ceiling fan and light fitting and located below the blade and that is of circular shape when seen in plan view.

The "datum height" may, purely for example, be the height of an upper surface of a horizontal platelike member to which each of the blades is pivotably mounted as in the case of the construction described by Villella.

Further features, preferences and inventive concepts are disclosed in the following detailed description and appended claims.

In order that the invention may be better understood there will now be described, non-limitingly, preferred embodiments of the invention as shown in the attached Figures, of which:

Figure 1A is a perspective view of a combined ceiling fan and light fitting according to the invention, with its folding blades in working positions;

Figure 2A is a perspective view of the combined ceiling fan and light fitting shown in Figure 1A, now with its folding blades in a stored position;

Figure 3A is a perspective view of the combined ceiling fan and light fitting as shown in Figure 1A, partially cut away;

Figure 4A is a further perspective view of the combined ceiling fan and light fitting as shown in Figure 1A, partially cut away;

Figure 5A is a plan view of the combined ceiling fan and light fitting as shown in Figure 1A, with its folding blades in working positions;

Figure 6A is a plan view of the combined ceiling fan and light fitting shown in Figure 2A, now with its folding blades in stored positions;

Figure 7A is a perspective view of blades and a blade support means of the combined ceiling fan and light fitting as shown in Figure 2A, with the blades in their working positions;

Figure 8A comprises at (a) a partial and schematic plan view and at (b) a partial and schematic side elevation of a further embodiment of a combined ceiling fan and light fitting according to the invention;

Figure 9A shows a partial and schematic plan view of a further embodiment of a combined ceiling fan and light fitting according to the invention;

Figure 1 is a perspective view from above of a modified fan/light with retractable fan blades, shown with its blades deployed to their operating positions;

Figure 2 is a perspective view from below of the fan/light shown in Figure 1 with its blades deployed to their operating positions;

Figure 3 is a perspective from above of the fan/light shown in Figure 1, now with its fan blades shown in their folded, non-operating positions;

Figure 4 is a perspective view from below of the fan/light shown in Figure 1, with its fan blades shown in their folded, non-operating positions;

Figure 5 is a plan view of the fan/light of Figure 1, with its fan blades shown deployed to their operating positions;

Figure 6 is a plan view of the fan/light of Figure 1, with its fan blades shown in their folded, non-operating positions;

Figure 7 is a side view of the fan/light of Figure 1, with its fan blades shown deployed to their operating positions;

Figure 8 is a side view of the fan/light of Figure 1, with its fan blades shown in their folded, non-operating positions;

Figure 9 is a perspective view from below of a subassembly of a fan/light with retractable fan blades;

Figure 10 is a schematic plan view of the fan/light shown in Figure 1 showing one blade in both deployed and retracted positions and the other blades in retracted positions and chain-dotted lines only;

Figure 11 is a schematic plan view of the fan/light shown in Figure 1 with all blades shown in chain-dotted lines in retracted positions and one blade also shown in its deployed position the view further showing positions of a set of cylindrical surfaces intersecting, and located at radially spaced stations along, the extended blade;

Figure 12 is a set of sections (labeled a – l) on radial planes as defined in Figure 10 of retracted blades of the fan/light shown schematically in Figure 10;

Figure 13 is a graph of heights above a datum height of inner and outer edges of a blade of the fan/light shown in Figure 1, as a function of circumferential position when the blade is in a retracted position;

Figure 14 is a graph of radial distance between inner and outer edges of a blade of the fan/light shown in Figure 1, as a function of circumferential position when the blade is in a retracted position;

Figure 15 is a graph of heights above a datum height of inner and outer edges of all blades of the fan/light shown in Figure 1, as a function of circumferential position when the blades are in their retracted positions;

Figure 16 is a set of cross-sections of the extended blade shown in Figure 11 taken on planes tangential to the arcs shown therein an numbered 1 to 8;

Figure 17 is a graph of an angle of incidence to the horizontal of the extended fan blade shown in Figure 11 as a function of radial position on the blade;

Figure 18 is a graph of the chord of the extended blade shown in Figure 11 as a function of radial position on the blade.

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DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Figure 1A shows a combined ceiling fan and light fitting 101 according to the invention. A combined ceiling fan and light fitting will herein be referred to as a fan/light for convenience and brevity. Fan/light 101 has a bowl-shaped enclosure 102 in which is mounted at least one electric lamp 103, and is supported from a ceiling by a tubular support 104 in known manner. Fan/light 101 also has fan blades 112 that are rotatable by an electric motor 106. The electric motor 106 and the lamp 103 are operable separately or together from a source of electric power that is supplied through the tubular support 104. Motor 106 is of the known type, widely used in ceiling fans, that has a rotating casing 107 with a central cavity in which is received the tubular support. An extension 108 of tubular support 104 protrudes below casing 107 and supports non-rotating enclosure 102.

Enclosure 102 includes a translucent bowl-shaped lower section 109 that in use is retained under an upper cover 110 by clips (not shown) arranged around the periphery of cover 110. Lower section 109 is removable (by unclipping) from cover 110 so that lamp 103 can be changed when necessary. Cover 110 is circular in plan view, as is lower section 109, and has a conically-shaped central depression 111 in which is received with clearance the lower part of motor casing 107.

An upper cover 190 is provided on the support 104 above the folded positions of the blades 112, to further enhance appearance and to limit dust movement into the mechanism of the fan/light 101.

Fan/light 101 has blades 112 that each extend outwardly when the motor 106 is switched on and that retract into positions shown in Figure 2A when motor 106 is switched off. Blades 112 are pivotally supported on a blade support 113 that rotates with blades 112, is disc-shaped, is coaxial with the rotation axis 118 of motor 106 and is secured to a peripheral flange 105 of motor casing 107. (When removed from motor casing 107, blade support 113 would be seen to have a central hole (not shown) to permit this way of mounting.)

Pivoting of blades 112 on blade support 113 is about axes 114 that are, in the embodiment shown in Figures 1A and 2A, parallel to the axes of tubular support 104 and the motor 106. When motor 106 is switched on, blades 112 are urged outwardly by centrifugal force, pivoting around their respective pivot axes 114, until the working positions shown in Figures 1A and 5A are reached. In a manner set out below, blades 112 rotate around pivot axes 114 and are retracted to their stored positions as shown in Figures 2A and 6A, when motor 106 is switched off.

Blades 112 are scimitar-shaped in plan view, and in the stored position, slightly overlap each other, and have curved edges 115 lying adjacent to and inside the periphery of light enclosure 102. It will be noted from Figure 2A that in their stored positions blades 112 lie close to the top of enclosure 102. Thus, fan/light 102, when its fan function is not in use (motor off), prevents much of blades 112 from being visible to an observer below. Although there is nothing to stop blades being used that when retracted extend beyond the periphery of enclosure 102 so as to be only partly concealed, the preferred arrangement aesthetically is for the blades when folded to lie within the periphery of the enclosure 102.

For correct balance of the fan/light 101, the blades 112, which are circumferentially equispaced around blade support 113, take up substantially identical positions when extended and move in synchronized manner between their working and stored positions. The way in which this is done will now be described. Secured to blade support 113 on its underside is a sun gear 116. (The term "sun gear" is here used as it is in the art of so-called planetary gearing systems, where it refers to a gear that meshes with a number of "planetary" gears arrayed around its periphery.) Sun gear 116 is coaxial with the motor 106 when support 113 is mounted thereon, and is able to rotate about its axis relative to blade support 113. Meshing with sun gear 116 are planetary gears 117, each of which rotates with one of the blades 112 as that blade pivots about its pivot axis 114. Each gear 117 is secured to a short shaft 139 that passes downwardly from a blade 112 and can rotate within blade support 113 in a suitable sleeve (not visible). The axes 114 and therefore planetary gears 117 are at equal radii from the axis 118 of motor 106 and blade support 113. The effect of this arrangement is that provided blades 112 are identical and identically positioned in their working positions relative to blade support 113, they will be kept synchronized always when they move in and out.

To retract blades 112 when motor 106 is switched off, coil springs 119 are provided. One end of each spring is secured to a peg 122 depending from a lower surface 120 of blade support 113 and the other end is secured to a peg 123 depending from lower surface 121 of sun gear 116. Coil springs 119 are arranged to be in tension when blades 112 are in their retracted position and are extended as centrifugal force urges blades 112 out when motor 106 is started. When motor 106 is stopped, springs 119 urge sun gear 116 to rotate so as to retract the blades. Many other suitable arrangements and types of springs could be used and will suggest themselves to persons skilled in the art.

Depending on the sizes of gears 116 and 117, full rotation of gear 116 relative to blade support means 113 may not be necessary. At least one of blades 112 or sun gear 116 is provided with suitable stops (not shown) that prevent movement of blades 112 outward beyond their working positions or inward beyond a chosen retracted position. For example, a suitable stop could comprise one or more pegs depending from blade support means 113 and received in a slot or slots in gear 116, so that contact between the peg and an end of the slot prevents further rotation of gear 116.

Sun gear 116 is generally in the form of a centreless ring, and is rotatably mounted below lower surface 120 of blade support 113. As shown in Figure 7A, a retaining ring 125 having an upwardly facing shoulder (not visible) is secured to and depends from surface 120 of blade support 113 with gear 116 being captive between the shoulder and surface 120. Ring 125 centres gear 116 as well as holding it captive against blade support means 113.

The blade synchronization arrangement described above has several advantages, when compared with, for example, the mechanism shown in US Patent 2079942. First, it is simpler to assemble and can have a lower parts count. Second, if the gears 116 and 117 are made and positioned sufficiently accurately, there need be little freeplay in the mechanism, which leads to smoother and better-synchronized operation. Gears 116 and 117 lend themselves to accurate manufacture in suitable plastics (e.g. Nylon plastics) although there is no intention here to limit the scope of the invention to such materials. Third, gears 116 and 117 are concealed, as they lie below the blade support 113 and so are less likely to gather dust.

Where operation of the fan in both directions is not required, it is preferred that the direction of rotation be as shown by the arrow 140 in Figures 1A to 9A. This direction has the advantage that aerodynamic drag tends to assist centrifugal force in extending the blades 112.

It is preferred that the tips 141 of blades 112, when blades 112 are extended to their working position, be approximately as far radially outward from motor axis 118 as possible to take advantage of the greater airspeed at that point generated by rotation of the blades 112. As can be seen in Figure 5A, the reference numeral 141 denotes the tip of the blade which is the most forward part of the blade as it rotates in the direction of arrow 140.

Particularly where the blades 112 when folded are to lie wholly within the periphery of enclosure 102, it is much less easy to provide blades 112 with a form having high aerodynamic performance by comparison with a conventional ceiling fan having non-retractable blades. Further, the blades will in most practical designs be smaller in area and length than would the case in a fixed-blade fan. Although only three blades 112 are shown in the diagrams, it is possible to alleviate this problem by providing more blades than three, and this is within the scope of the invention. For example, four blades could be used. The synchronization mechanism described above lends itself readily to synchronizing of a larger number of blades.

A number of approaches can be followed in designing the blades 112 to enhance their air-moving performance and/or improve the energy efficiency of the fan/light 101. These include:

(a) giving the blades 112 an angle of incidence to the horizontal;

(b) twisting the blades 112 to vary their angle of incidence along the blade length;

(c) choosing a cambered cross-section for the blades 112;

(d) providing a form of "dihedral", wherein the blade tips are at a different height from the blade roots when blades 112 are in their extended positions;

(e) providing blades of a shape and/or size in plan view to enhance aerodynamic forces and their distribution.

The requirement to at least partially conceal the blades when in their retracted position places limitations on the way and the degree to which these approaches can be followed. It is desirable for the blades 112 in their folded positions to lie close to the blade support 113 so as to give the best level of concealment of blades 112.

The blades may be made for example by moulding in suitable plastics, which allows for the relatively complex (e.g. cambered) shapes desirable for good aerodynamic performance.

Blades 112 of fan/light 101 are shaped to have cross-sections (shown in Figure 2A by chain-dotted lines 150) with both incidence to the horizontal and camber. The incidence is such that the smaller-radius edges 151 of blades 112 are higher than the larger-radius edges 115. This is found to be advantageous also for compact folding of blades 112. The camber shown by lines 150 is such that the blades are concave downward and is preferred where the direction of rotation is as shown by arrow 140. As shown in Figure 2A, the blades have convex and concave upper and lower surfaces respectively. It can be seen from Figure 2A that the lines 150 which define the cross-sectional shape of the blade that is, in radial planes relative to the fan rotation axis 118 when the blades are in their stored positions, there is an upper portion which is convex and a lower portion which is concave. Because the blades 112 are scimitar shaped (i.e. curved when seen in plan view) and have convex and concave upper and lower surfaces, they necessarily exhibit biaxial curvature.

The angle of incidence of the blades 112 may be varied along their length, although this is not essential. The angle of incidence of blades 112 to the horizontal may be less at the tips. This feature also is not essential but may have energy-efficiency advantages and can assist in arriving at a design where in the blades-folded position the tip of one blade overlaps the root of an adjacent blade.

In US Patent 2079942, Le Velle discloses the idea of slanting backward the axis about which his blades rotate, to allow the blades to overlap in their folded positions. This approach also has the effect of placing each blade at an angle of incidence to the horizontal, and without this there would in fact be little or no vertical movement of air, due to the use of simple flat plate blades.

In the fan/light 110 of the present invention, the pivot axes 114 of blades 112 can be parallel to axis 118 of the motor 106, with the blades being adapted to move air by virtue of camber and/or a built-in angle of incidence to the horizontal. This is the case in fan/light 110 as shown in Figures 1A to 7A. In Figure 5A, axes 114 appear as points for this reason. However, this is not to preclude the blade pivot axes 114 being slanted backwards or forwards to obtain a desired distribution along the blades 112 of angle of angle of incidence to the horizontal in operation. The sun gear 116 and planet gears 117 can be designed for operation with non-parallel axes of rotation by means well known in the gearing art. (For forward or backward slanting, helical teeth would be used on gears 116 and 117.) In Figure 5A dotted lines 114a are added to show exactly what is meant here by backward slanting of the pivot axes 114. Lines 114a represent parts of the blade pivot axes 114 above the blades themselves as they would appear if slanted backwards, as required in general to increase angle of incidence. This assumes the direction of rotation to be as shown by arrow 140.

It has also been found, surprisingly, that advantage can be obtained by optionally canting axes 114 in a radial plane either alone or in combination with forward or backward slanting. In Figure 5A, lines 114b are added to show what is meant here by canting the pivot axes 114 inward. Radially disposed lines 114b represent parts of the blade pivot axes 114 above the blades themselves as they would appear if canted inward. (Such canting, on its own, can be accommodated by making the gears 116 and 117 bevel gears.) In US Patent 6719533, which relates to a fixed blade ceiling fan, it is disclosed that blade "dihedral", here meaning that the blade tips are at a higher elevation than the blade roots, can lead to a better distribution of air movement in the area below the fan (more specifically a reduction in the tendency to concentrate movement of the air to the area directly below a fan). If axes 114 are parallel to axis 118, blades with such dihedral do not in their folded positions lie compactly close to blade support 113 (if the latter is flat). However, blades such as blades 112, if permitted to rotate about axes 114 that are slightly inwardly canted, can be made to lie close to a flat blade support 113 when folded, and when unfolded to exhibit dihedral of the type mentioned above. This is illustrated in the schematic views of Figure 8A, which show in plan (a) and elevation (b) a fan/light 131 comparable to fan/light 101, although with only one blade 133 shown for clarity. Blade 133 is shown in both folded and extended positions, marked 133a and 133b respectively. Fan/light 131 has a fan motor axis 132, and blade 133 pivots about an axis 134 that is slightly canted inward. Blade 133 is scimitar shaped, and lies when folded within the periphery of a circular lamp enclosure 135. Blade 133 is shown as a flat blade for clarity of illustration, and is shown edgewise at 133a in Figure 8A(b). In this folded condition, blade 133 is parallel to the horizontal plane 136 of the upper edge of enclosure 135. However, when blade 133 is extended to its working position (by rotating through 140 degrees about axis 134 in the particular example shown), it is found that blade 133 has dihedral, with its tip 137 higher than its root end 138. The angle of the blade 133 to the horizontal as seen in the elevation of Figure 8A(b) increases progressively from root end 138 to tip 137. Furthermore, assuming the direction of rotation to be as shown by arrow 139, it is found that leading edge 145 of blade 133 is higher than trailing edge 146. That is, blade 133 can lie in a generally horizontal plate when folded, yet have both a positive angle of incidence to the horizontal and dihedral.

In practice, it is preferred to use a blade shape with camber and that has a positive angle of incidence to the horizontal even when in the folded position to obtain a larger air moving effect than is possible from a flat plate blade.

It is emphasized that either or both of backwards/forwards and radial sloping of the pivot axes may be found suitable for a given blade shape, and that in practice camber, incidence to the horizontal even when folded, and blade twist may be applied in addition to such sloping of the pivot axes.

Figure 9A shows yet another option for enhancing air movement. Figure 9A shows one blade 160 only for simplicity (although in practice multiple blades would be used), on a fan/light 161 similar to fan/light 131. Blade 160 (shown in retracted position as 160a and extended position as 160b) does not have substantially parallel arcuate leading and trailing edges like those 145 and 146 of blade 133. Instead the edge 162 that lies closer to support 163 when folded comes closer to support 163 when folded so that the area of blade 160 is greater in plan view than the area of the otherwise comparable blade 133. The width of blade 163, between its root end 164 and tip end 165, first increases to a maximum and thereafter decreases to curved tip 165. This type of plan form can be used where the motor casing (not shown) is positioned (e.g. within lamp enclosure 166) to provide more room for the blades when folded above enclosure 166 than in the case, for example, of fan/light 101. (In that case, casing 107 limits the available plan shape and area of blades 112. Of course, a blade such as blade 160 may be provided with camber and an angle of incidence to the horizontal, and may also have a pivot axis that is not parallel to its fan axis, in the same way as the other blades described above.

Figures 1 to 8 show a modified fan/light 10. Fan/light 10 has a non-rotating bowl-like translucent enclosure 12 in which is mounted at least one electric lamp (not shown), and is supported from a ceiling by a tubular support 13 in known manner. Fan/light 10 also has fan blades 1, 2, 3 and 4 that are rotatable by an electric motor (not shown) about an upright axis 15 coaxial with tubular support 13. The electric motor and the lamp are operable separately or together from a source of electric power that is supplied through the tubular support 13. The motor is of a known type, widely used in ceiling fans, that has a rotating external casing (not shown) with a central cavity in which is received the tubular support 13. Enclosure 12 is circular in plan view, centered on axis 15.

Blades 1-4 each extend outwardly to the operating positions shown in Figures 1, 2, 5 and 7 when the motor is switched on, and retract (fold) into positions shown in Figures 3, 4, 6 and 8 when the motor is switched off. The sense of rotation is as shown by arrow 7. Each one of blades 1-4 is pivotally supported on a blade support plate 14 that supports and rotates with blades 1-4, is disc-shaped, is coaxial with the rotation axis 15 of the motor and is secured to the motor's casing. A decorative dust cover 18 is secured on the support 4 above the blades 1-4 when they are in the folded positions shown in Figures 3, 4, 6 and 8.

Pivoting of blades 1-4 on blade support plate 14 is respectively about axes 21, 22, 23 and 24 parallel to the axis 15 of rotation of the motor. When the motor is switched on, blades 1-4 pivot outwardly under the influence of centrifugal force, pivoting around their respective pivot axes 21-24, until the operating positions shown in Figures 1, 2, 5 and 7 are reached. When the motor is switched off, blades 1-4 are retracted to their stowed positions as shown in Figures 3, 4, 6 and 8, again pivoting about their respective axes 21-24.

The synchronization of the blades can be the same as that described in relation to Figures 1A to 9A above, albeit with three blades instead of the four blades 1-4 of fan/light 10.

In particular, synchronization of the pivoting movement of blades 1-4 and their retraction may be by means of a simple adaptation to four blades, now briefly described. Figure 9 (similar to Figure 7A above) shows a subassembly 30 comprising a motor 34, blade support plate 36 and three blades 31, 32 and 33. Blade support plate 36 is ring shaped and secured to motor 34 (of the rotating casing type previously mentioned) so as to rotate therewith in its own plane.

Secured below blade support plate 36 is a sun gear 38. (The term "sun gear" is here used as it is in the art of so-called planetary gearing systems, where it refers to a gear that meshes with a number of "planetary" gears arrayed around its periphery.) Sun gear 38 is coaxial with the motor 34 when support plate 36 is mounted to motor 34, and is able to rotate about its axis relative to support plate 36. Meshing with sun gear 38 are planetary gears 41, 42 and 43, each of which rotates as its associated one of blades 31-33 pivots between its stowed and operating positions. Each of gears 41-43 is secured to a short shaft (not visible) that passes downwardly from its associated one of blades 31-33 and can rotate within support plate 36. The gears 41-43 are equispaced around the periphery of sun gear 38 and are

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themselves all at the same radius as each other from the rotation axis 35 of motor 34. The effect of this arrangement is that provided blades 31-33 are identical and identically positioned in their working positions relative to support plate 36, they will be kept synchronized always when they pivot between their operating and retracted positions.

To retract blades 31-33 when motor 34 is switched off, coil springs 44 are provided. One end of each spring is secured to a formation 46 depending from support plate 36 and the other end is secured to a formation 48 depending from sun gear 38. Coil springs 44 are arranged to be in tension when blades 31-33 are in their retracted position and are extended as centrifugal force urges blades 31-33 out when motor 34 is started. When motor 34 is stopped, springs 44 urge sun gear 38 to rotate relative to support plate 34 so as to retract the blades 31-33.

In the following description, it will be assumed that blades 1-4 are pivotally mounted to support plate 14 essentially similar to support plate 36 and synchronized and retracted in the same way as blades 31-33 of subassembly 30. However, it is emphasized that the aerodynamic design of blades 1-4 and the way that they "nest" together when retracted are by no means limited to this particular fan/light construction. The configuration and arrangement of blades 1-4 could be applied to fan/lights of other constructions and to fans requiring retractable blades and without any lighting capability.

The blades 1-4 and their arrangement in fan/light 10 will now be described. Blades 1-4 are intended to provide fan/light 10 with a useful balance between satisfactory air-moving performance, compactness when the blades are in their stowed (i.e. retracted or folded) position, together with a diameter of the translucent enclosure 12 that is large enough to provide a reasonably diffuse lighting effect. The blades 1-4 are intended to lie substantially above the translucent enclosure 12 when retracted. In the embodiment shown and described herein, the enclosure 12 has a diameter that is about 39% of the overall diameter of fan/light 10 with its blades 1-4 extended for operation. The diameter of the hub of a conventional ceiling fan or fan/light without retractable blades is typically smaller than

39% of the overall diameter over the blades. The larger the diameter of enclosure 12 for a given overall diameter, the easier it is to meet the requirement of compact folding, with blades 1-4 above enclosure 12, but the more difficult it is to provide satisfactory air moving performance at normal fan rotational speeds. A range of from about 36% to about 42% for the above ratio is believed to be possible by straightforward adaptation of the blade shapes as described herein, but a figure in the region of 38% to 40% is preferred.

The geometry of blades 1-4 will be described below by reference to quantities and sections defined in Figures 10 and 11. In the schematic plan view of Figure 10, enclosure 12 is represented simply by its circular outer peripheral edge 26. Blades 1-4 are all shown in outline in their retracted positions, blade 1 in solid lines and the others in chain-dotted lines, and blade 1 is also shown in solid lines in its deployed position. Blades 1-4 are substantially identical to each other and are generally scimitar-shaped, i.e. of arcuate form so as to lie, when retracted, within the enclosure peripheral edge 26 and around the motor (not shown but centred on axis 15). The pivot axes 21-24 are adjacent to root ends 51-54 respectively (Figure 11) of blades 1–4 and in their retracted position the blades 1-4 extend clockwise to tips (free ends) 61-64 respectively. Item numbers with the postscript "a" are for blade 1 in its deployed position and item numbers with the postscript "b" are for blade 1 in its retracted position.

Blades 1-4 of fan/light 10 are shown (by arrow 7) as rotating clockwise when seen from above. It is to be understood, however, that counter-clockwise rotation could equally well be chosen, in which case the term "counter-clockwise" would be applicable where in the present description "clockwise" now appears, including in the definitions given below of the terms "next blade" and "previous blade". (Note that for counter-clockwise rotation, the blades would be made of opposite hand to blades 1-4, as it is preferred that each blade's leading edge be its concave one.)

In relation to any given one of blades 1-4, the term "next blade" refers to the blade whose pivot axis is 90 degrees in the rotation direction (here clockwise) from the pivot axis of the given blade, and the term "previous blade" refers to the blade whose pivot axis is 90 degrees in a counter-direction opposite to the rotation direction (i.e. counter-clockwise here) from the pivot axis of the given blade. Thus, in relation to blade 1, the next blade is blade 2 and the previous blade is blade 4. The blade shape will be described mainly by reference to blade 1 for convenience, noting that blades 1-4 are substantially identical.

To show how blades 1-4 are arranged relative to each other in nesting fashion when retracted, it will be convenient to use sectional views on radial planes, i.e. planes that include the fan axis 15. Such a plane 42 is shown in Figure 10 and is shown to be at an angle θ (theta) to a similar plane 44 that includes both axis 15 and axis 21 of blade 1.

For discussion of the blade shape from the point of view of aerodynamic characteristics when in the deployed position, it will be useful to consider blade sections taken on surfaces that are cylindrical, coaxial with fan axis 15, and located at stations radially spaced apart along a blade. Arcs numbered 1 to 8 in Figure 11 indicate such stations on blade 1. Stations 1 and 8 are respectively at radii of 39% and 97% of the overall fan radius (i.e. substantially at the edge of enclosure 12) with stations 2-7 radially equispaced between stations 1 and 8.

Each of blades 1-4 pivots through 180 degrees between its retracted and operating positions. From axis 21 to tip 61, representative blade 1 when retracted extends from theta = 0 degrees to theta = approximately 168 degrees. The angle 168 degrees is chosen to be close to, but below, 180 degrees so as to provide a blade 1 whose tip 61 is well clear of enclosure peripheral edge 26 when blade 1 is deployed, but with no more than two of blades 1-4 overlapping each other at any point when the blades are retracted. This is important in keeping the overall height of the group of blades 1-4, when retracted, to a compactly small value. Note that if tip 61 where at theta = 180 degrees, all three of blades 1, 2 and 3 would overlap at theta = 180 degrees.

As can be seen in Figures 1, 5 and 7, representative blade 1 has two distinct portions, namely a root-end portion 80 and a blade portion 82 which in the operating position extends outwardly of peripheral edge 26 of enclosure 12 and is aerodynamically shaped to facilitate air movement. Blade portion 82 is supported cantilever-fashion from blade portion 80 which is pivotably secured to blade support plate 14. In the preferred embodiment, portions 80 and 82 are formed as a single part, for example by injection molding in a suitable plastics material. It follows that in some embodiments the root end of the blade could be formed as a separate part from the blade portion.

Root end portion 80 comprises a plate 84 that lies above and, approximately parallel to support plate upper surface 46. A hole 86 in plate 84 permits a stub shaft (not shown) to pass through it and through to the underside of support plate 14 to be secured there to a planet gear (not shown) of the blade synchronization mechanism as described previously. Root end portion 80 further comprises a blade end plate formation 88 whose function is to provide a suitably strong connection between portions 80 and 82 with blade portion 82 inclined at an angle of incidence to plate 84 (see below).

Figure 12 shows a set of 12 radial sections (i.e. on planes 42) of representative blade 1 and its next and previous blades 2 and 4 in their retracted positions, each section being labeled with its correct value of theta for blade 1. Radii from fan axis 15 increase to the right in sections (a) to (l). In each section, blade support plate 14 is shown, with its outer edge 90 at the same lateral position on each page to facilitate comparison between the sections. Outer edge 90 lies radially just within but is close to the enclosure peripheral edge 26 (not shown in Figure 12).

Sections (a) to (c) of Figure 12 show how portion 80 of blade 1 transitions to the cantilevered air-moving portion 82.

As can be best seen in Figure 10, outer edge 94 of portion 82 of representative blade 1 is very close to a circular arc except near the rounded tip 61, that arc being centred on fan axis 15 when blade 1 is retracted and having a radius very close to the radius of enclosure peripheral edge 26. Accordingly, outer edge 94 of portion 82 of blade 1 lies at almost exactly the same radius as the outer edges of next and previous blades 2 and 4, except near tip 61, as shown in sections (d) to (l) of Figure 12.

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Figure 10 and sections (a) to (f) of Figure 12 show that previous blade 4 overlies representative blade 1 between theta = 0 degrees and slightly less than theta = 90 degrees, but without contact between blades 1 and 4. Between theta = 90 degrees and theta = 165 degrees (sections (g) to (l)) blade 1 itself overlies next blade 2, without contact between blades 1 and 2.

Figure 13 is a graph showing the heights of inner edge 92 and outer edge 94 of representative blade 1 above surface 46 of support plate 14 as a function of angle theta. Inner edge 92 is higher than outer edge 94 for a given value of theta, consistently with blade 1 having an angle of incidence to the horizontal so as to move air downward when deployed (see below). Absolute height figures are used in Figure 13, for a fan/light 10 having an overall swept diameter with blades 1-4 deployed of 1200mm.

Figure 14 is a graph showing the radial distance between inner edge 92 and outer edge 94 of representative blade 1 when in its retracted position as a function of angle theta. Absolute radial distances are used in Figure 13, for a fan/light 10 having an overall swept diameter with blades 1-4 deployed of 1200mm. The curve between data points has not been extended to the data point for theta = 165 degrees because that point is affected by rounding of tip 61.

Figure 15 is a graph showing the same data as Figure 13, but now for all of blades 1-4, in their respective peripheral angle (theta) positions. The initials "LE" and "TE" are used for inner and outer edges 92 and 94 respectively in Figure 15, because the inner edge of a blade is its leading edge and the outer edge is its trailing edge, when in the deployed position. Note that the blade pivot axes 21, 22, 23 and 24 are at angles theta of 0 degrees, 90 degrees, 180 degrees and 270 degrees, respectively.

Figure 12-15 together illustrate how blades 1–4 in their retracted positions "nest" compactly together without any two blades contacting each other. It has been found that the arrangement shown can also give satisfactory air moving performance.

As illustrated by the edge heights in Figures 13 and 15, representative blade 1 rises smoothly from its pivot axis 21 (at theta = 0 degrees) to a point (at about theta = 90 degrees) where it must overlap and clear the next blade 2. However, instead of continuing further upward at the same rate towards its tip 61, blade 1 ceases to rise any higher, as shown by the leveling off and then decreasing of the height of inner edge 92 with increasing theta. This arrangement limits the overall height 96 (Figure 12) above support plate 14 of the group of blades 1-4 when retracted. The maximum value of height 96 occurs for representative blade 1 at about theta = 105 degrees.

It will be noted in Figure 13 and 15 that, after remaining approximately constant between about theta = 90 degrees and theta = 120 degrees, outer edge height 94 increases again beyond about theta = 120 degrees. As can be seen from sections (j) to (l) in Figure 12, and from the slight protrusion of blade 1 shown in Figure 4, this optional feature means that some slight sacrifice of compactness in the blade nesting arrangement is incurred (although without any increase in overall height 96), it is believed to be aerodynamically desirable, as set out later herein, and so is preferred.

Figure 13 can be interpreted as a partial picture of blade 1 as it would appear if projected on an imaginary cylindrical surface coaxial with fan axis, with that surface then being laid flat. It is apparent that blade 1 in such a picture resembles a gull wing, or an aircraft wing with a particular form of varying dihedral, firstly rising with increasing distance from its root end and from a certain point rising no further or at a lesser rate towards its tip end.

Figure 15 shows that the inner edge height 92 of representative blade 1 becomes lower than the leading edge height of its next blade 2 for values of theta greater than about 150 degrees. This can be seen in sections (k) and (l) of Figure 12. It does not mean that there is contact between blades 1 and 2 because the reduction in radial width of blade 1 means that inner edge 92 of blade 1 is radially outward of the corresponding edge of blade

2.

In addition to folding neatly, the blades 1-4 must move air downwards reasonably efficiently when deployed and rotating about fan axis 15, so the shapes of blades 1-4 as they affect air movement will now be discussed. The arcs in Figure 11 that are numbered 1-8 represent a set of spaced apart cylindrical surfaces coaxial with axis 15 and radially spaced apart. Although the downward air flow through fan/light 10 will not in general be precisely axial (i.e. parallel to axis 15) and therefore occur on such surfaces, a reasonable way to discuss blade shape is by reference to the intersections with the cylindrical surfaces 1-8 of representative blade 1 when in its deployed position.

It is also helpful in the following discussion of the representative blade 1 when it is deployed to make mention of values of the angle theta that was used above in describing its geometry when retracted. Theta is in effect a measure of position along the scimitar-shaped blade 1. In Figure 11, there is shown a non-physical point 93 that if blade 1 were to be retracted would fall on axis 15, and that when blade 1 is deployed is displaced by 180 degrees from axis 15 about the blade pivot axis 21. The value of angle theta corresponding to a particular feature on deployed blade 1 can be found using the schematic plan view of Figure 11 by constructing firstly a line joining point 93 to the feature in question and secondly a line 95 joining point 93 and passing through axes 21, 15 and 23. Theta is the angle between these two lines.

Figure 16 shows cross sectional views of blade 1 taken on chords 91 (see Figure 10) that are tangent to the cylindrical surfaces of stations 1 to 8. These are close approximations to the shapes of the cylindrical surfaces of intersection between stations 1 to 8 and blade 1, as those surfaces would appear if laid flat. In the sections of Figure 16, blade 1 moves right to left, so the leading edge 92 and trailing edge 94 are positioned as shown. Although trailing edge 94 is of course not straight in reality, the views in Figure 16 are so positioned that the trailing edge 94 in all sections is vertically aligned to facilitate comparisons among them.

Figure 17 is a graph showing alpha (α), the angle of incidence to the horizontal of representative blade 1 at stations 2 to 8, the meaning of alpha being illustrated in the section for station 7 in Figure 16. The values of alpha plotted in Figure 17 are not taken from the approximate sections of Figure 16, but are estimates of the values that would be obtained in the manner shown if the sections of Figure 16 were laid-flat developments of the true surfaces of intersection between the cylindrical surfaces numbered 2 to 8 and blade 1.

Figure 18 is a graph showing values of the true chord (i.e. distance measured directly from leading edge 92 to trailing edge 94) of blade 1 at intersections with the cylindrical surfaces numbered 1 to 8. The chord values are not taken from the approximate sections of Figure 16, but are estimates of the values that would be obtained if the true surfaces of intersection between blade 1 and the cylindrical surfaces numbered 1 to 8 were obtained and laid flat.

It has been found that fan/light 10 with blades 1-4 having the geometry shown does move air reasonably satisfactorily despite the comparatively large ratio of the diameter of enclosure 12 to the overall diameter swept by the deployed blades 1-4 and the scimitar-like shape (in plan view) of the blades.

Generally, the blades 1–4 thrust air downward (and themselves experience a corresponding reactive lifting force) as they rotate. The effectiveness of a blade in this (for a given speed of rotation) is believed to be dependent on, at least, its aerofoil-type cross sectional shape, its incidence to the horizontal, its size (for example its chord as measured from leading edge to trailing edge), the distribution of these along the blade's length (span) and its shape as seen in plan view.

As seen in the cross-sections of representative blade 1 in Figure 16, blades 1–4 have an aerofoil-type cross-sectional shape, being cambered so that their lower faces are concave and their upper faces are convex. Their leading edges (e.g. leading edge 92 of representative blade 1) are rounded and their trailing edges (e.g. edge 94 of representative blade 1) are sharp. Generally, blades 1-4 are preferred to have cambered aerofoil sections.

Representative blade 1 has positive incidence to the horizontal (and is of cambered aerofoil cross-section) near its pivot end where, when deployed, it crosses the enclosure peripheral edge 26, and this is believed to be one factor in its air-moving performance. This positive incidence (alpha greater than zero) is apparent in the section numbered 1 in Figure 16.

It is thought desirable that the lift distribution (and the consequent distribution of air moving effect) along the length of a blade should be generally smoothly varying and in particular that there should be no strong concentration of the effect close to the outer (tip) end. Such a concentration is thought to produce a tendency for high pressure air below the tip area to "leak" upward over the tip end (61 in representative blade 1) to the area above the tip area, merely agitating the air locally (and wasting power) rather than moving it bodily downward. Therefore, the distribution of incidence angle alpha shown in Figure 17 shows that the peak blade incidence of about 20 degrees is at about the radius of station 3 (see Figure 11) and smoothly decreases with increasing radius to about 10 degrees at station 8. (Station 3 corresponds very approximately to theta = 60 degrees.)

The incidence distribution shown in Figure 17 is due in part to the optional upsweeping of the blade trailing edge beyond about theta = 120 degrees that was discussed above. Although a slightly more compact nesting of blades 1-4 is achievable if this upsweeping is not incorporated, it does appear to be beneficial to the blades' performance due to its effect on the incidence distribution achieved.

A further way to influence the lift distribution along the blade is by control of its width (chord) distribution. If one imagines a scimitar shaped blade of constant width along its length (for example for all values of the theta) deployed in the way shown for blades 1 4 in Figure 11, an effect of the scimitar shape would be that the blade chord, as measured in the circumferential direction with the blade deployed, would be highest at the blade tip and root end and lower therebetween. To offset this effect and so limit the tendency to concentrate the lifting effect at the tip and root ends, blades 1-4 are not of constant width. Referring to Figure 14, the blade width as seen in plan view) is greatest at about theta = 90

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degrees and progressively reduces towards the tip end (61 for representative blade 1). As can be seen in Figure 11, theta = 90 degrees corresponds approximately to station 5. This reduction serves the dual purposes of compact nesting of the blades when retracted (as discussed above) and obtaining the desired blade lift distribution.

Figure 18 shows the blade chord increasing from a minimum in the region of stations 2 and 3 before falling away at station 8 due to tip rounding. However, the rate of increase in chord with radius is less than it would be if the blade width did not vary with angle theta in the way described herein. See also Figure 16, where the alignment of the sections numbered 1 to 8 on the page allows the distribution of chord with radius to be seen.

As mentioned above the blades may be made conveniently by injection molding in suitable plastics materials. As unobtrusiveness is a desired feature of fan/lights according to the invention, one way of enhancing this is to provide that the blades be formed from a transparent or at least translucent material. This feature is believed to be inventive in itself.

Although the blade stowage arrangement and method described herein provides for stowage of the blades without contact between blades, the described stowage positions of the blades are such that slight sagging of one blade so as to contact another may not cause failure to deploy. It will be noted in Figure 12 that the sectional view showing the smallest clearance between blade 1 and its next blade 2 is section (g), corresponding to theta = 90 degrees. This is thought to be a suitable position for minimum clearance and so for first contact between blades 1 and 2 to occur if after a period of stowage without fan use, blade 1 should sag slightly. It is thought that after such contact between blades 1 and 2, the tendency to further sagging would be limited and the moment arm about axis 21 of any friction force due to blade contact less than for contact between tip 61 of blade 1 and the underlying blade 2, thus, limiting the possibility of a failure of blade 1 to deploy on fan startup.

The possibility of blades that are comparatively thin (so that they may sag over time if not used) also means that the blades when in use may flex upwardly toward their tip ends.

This can, it is believed, advantageously direct air slightly more outwardly as well as downwardly than if the blades were rigid.

The particular shape of the translucent lower section 9 of enclosure 2 is by no means the only possible one. Even a shape that is not of the circular shape in plan, as shown in the Figures 1 to 7 could be used as an alternative aesthetic choice.

The "sun gear" described above may comprise a single member to which toothed segments are secured for engagement with the "planet gears", instead of a complete gear. This possibility, which it has been found can reduce manufacturing costs arises because suitable sun and planet gear proportions can be chosen which do not require the sun gear to rotate far enough during deployment and retraction for any one tooth thereof to encounter more than one planet gear.

It will be readily apparent to persons skilled in the art that many other variations and choices can be made to the fan/light described above without exceeding the scope of the invention as stated.

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

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THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being secured to the blade support means and blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tips of said blades are higher than root ends of said blades and wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

2. A combined ceiling fan and light fitting having folding fan blades, the fan comprising:

a blade support means arranged to be rotated by a motor about a fan rotation axis;

a plurality of fan blades secured to the blade support means, a root end of each blade being pivotable between folded and operative positions about a blade pivot axis being parallel to or canted relative to the fan rotation axis and fixed in the blade support means;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tip ends of said blades in their operating positions rotate in a plane which is higher than that in which the root ends of said blades rotate; and

wherein each of the blades is cambered and are concave downward.

3. A combined ceiling fan and light fitting having folding fan blades, the fan comprising:

(i) a blade support means arranged to be rotated by a motor about a fan rotation axis;

(ii) a plurality of fan blades, each having a tip and root end, the blades being mounted for rotation relative to the blade support means so that each blade is pivotable between folded and operative positions about a blade pivot axis being parallel to or canted relative to the fan rotation axis and fixed in the blade support means;

(iii) wherein tips of said blades in their operating positions rotate in a plane which is higher than that in which the root ends of said blades rotate; and

(iv) wherein each of the blades is cambered and are concave downward; and

(v) a synchronising mechanism for synchronising movement of the blades between their folded and operative positions.

4. A combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being mounted for rotation relative to the blade support means, each blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein tips of said blades are, in use, higher than root ends of said blades and wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

5. A combined ceiling fan and light fitting having folding fan blades including:

a blade support means arranged to be rotated by an electric motor about a fan rotation axis;

a plurality of fan blades each having a tip, root end, leading edge and trailing edge, each blade being mounted for rotation relative to the blade support means, each blade being pivotable between folded and operative positions about a blade pivot axis fixed in the blade support means, the blade pivot axis being parallel to or canted relative to the fan rotation axis;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and

wherein, in cross-section through the blades in their folded positions at a radial plane which includes the fan rotation axis, the cross-sectional shape of the blade is defined by upper and lower edges which include convex and concave portions respectively.

6. A combined ceiling fan and light fitting having folding fan blades, the fan comprising:

a blade support means arranged to be rotated by a motor about a fan rotation axis;

a plurality of fan blades each having a root end, tip and leading and trailing edges;

each blade being secured to the blade support means by being pivotally connected at its root end to the blade support means for rotation about an upright blade pivot axis so as to be moveable between a folded and an operative position, each blade being arranged to move from its folded position to its operative position by centrifugal forces when said motor rotates said blade support means;

a synchronising mechanism for synchronising movement of the blades between their folded and operative positions; and wherein

(a) each of the blades is cambered and are concave downward;

(b) each of the blades is generally elongate and arcuate when seen in plan view thereby giving each blade biaxial curvature to enhance aerodynamic performance; and

(c) each of the blades in its folded position lies above and close to the blade support means to give good concealment of the blades in their folded positions.

7. A combined ceiling fan and light fitting as claimed in any one of claims 1 to 5 wherein each of the blades is generally elongate and arcuate when seen in plan view thereby giving each blade biaxial curvature to enhance aerodynamic performance.

8. A combined ceiling fan and light fitting as claimed in claim 7 wherein each of the blades in its folded position lies above and close to the blade support means to give good

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concealment of the blades in their folded positions.

9. A combined ceiling fan and light fitting as claimed in claim 6 or 8 wherein the synchronising mechanism is located below and close to the blade support means.

10. A combined ceiling fan and light fitting as claimed in any preceding claim wherein the trailing edges of the blades are convexly curved as seen in plan view.

11. A combined ceiling fan and light fitting as claimed in any preceding claim wherein each blade has a root end portion and a blade portion.

12. A combined ceiling fan and light fitting as claimed in claim 11 wherein said root end portion of each blade is formed as a single part with said blade portion.

13. A combined ceiling fan and light fitting as claimed in any preceding claim wherein the leading edges of the blades are higher than the trailing edges of the blades whereby the blades have an angle of incidence to the horizontal in their operative positions.

14. A combined ceiling fan and light fitting as claimed in any preceding claim wherein, in normal use of the fitting, the blades rotate in a first sense such that the tips or tip ends rotate in a plane which is higher than that in which the root ends rotate and are operable to direct air downwardly, and wherein the leading and trailing edges of each blade are concavely and convexly curved respectively when viewed in plan, and wherein the blade support means has an outer peripheral portion and wherein in the folded positions of the blades their trailing edges lie generally adjacent to the outer peripheral portion of the blade support means.

15. A combined ceiling fan and light fitting as claimed in any preceding claim wherein the upper edge is convex from the leading edge of the blade to the trailing edge of the blade and the lower edge is concave from the leading edge of the blade to the trailing edge of the blade.

16. A combined ceiling fan and light fitting as claimed in any preceding claim, wherein:

(a) there are four of said blades equally spaced about said fan rotation axis; and

(b) each blade between its pivot axis and its tip end subtends an angle of about 160° to 170° at the fan rotation axis,

whereby the blades are compactly nested in their stowed positions and have good air moving performance when operating in their deployed positions.

17. A combined ceiling fan and light fitting as claimed in claim 16 wherein each blade in its folded position lies within a space bounded by:

(a) an inner cylindrical surface coaxial with said fan rotation axis and touching an inner edge of an air moving portion of each blade;

(b) an outer cylindrical surface coaxial with said fan rotation axis and touching an outer edge of said blade portion;

(c) a first radial plane containing said fan rotation axis and said blade pivot axis; and

(d) a second radial plane containing said fan rotation axis and that touches a tip of the blade,

so that associated with every point on said blade portion is an angle theta being an angle between said first radial plane and a radial plane containing the fan rotation axis and that point; and

within a continuous section of the blade portion that lies between said first and second radial planes, said inner edge increases in height above a datum height with increasing theta.

18. A combined ceiling fan and light fitting as claimed in any preceding claim wherein the leading edge of each blade is stepped upwardly at a location adjacent to its pivot axis.

19. A combined ceiling fan and light fitting as claimed in any preceding claim wherein, when the blades are in their stowed positions, the concave part of each blade is adjacent to the convex part of its neighbouring blade, in cross-section in radial planes which include the

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fan rotation axis.

20. A combined ceiling fan and light fitting as claimed in any preceding claim wherein the synchronising mechanism includes first and second gear means and wherein:

each blade has first gear means arranged to rotate with that blade; and

second gear means mounted so as to be rotatable coaxially relative to the fan rotation axis and the blade support means;

wherein each first gear means meshes with the second gear means so that as the blades pivot between their folded and operative positions they are constrained to move in synchronisation with each other because of the meshing of the first and second gear means.

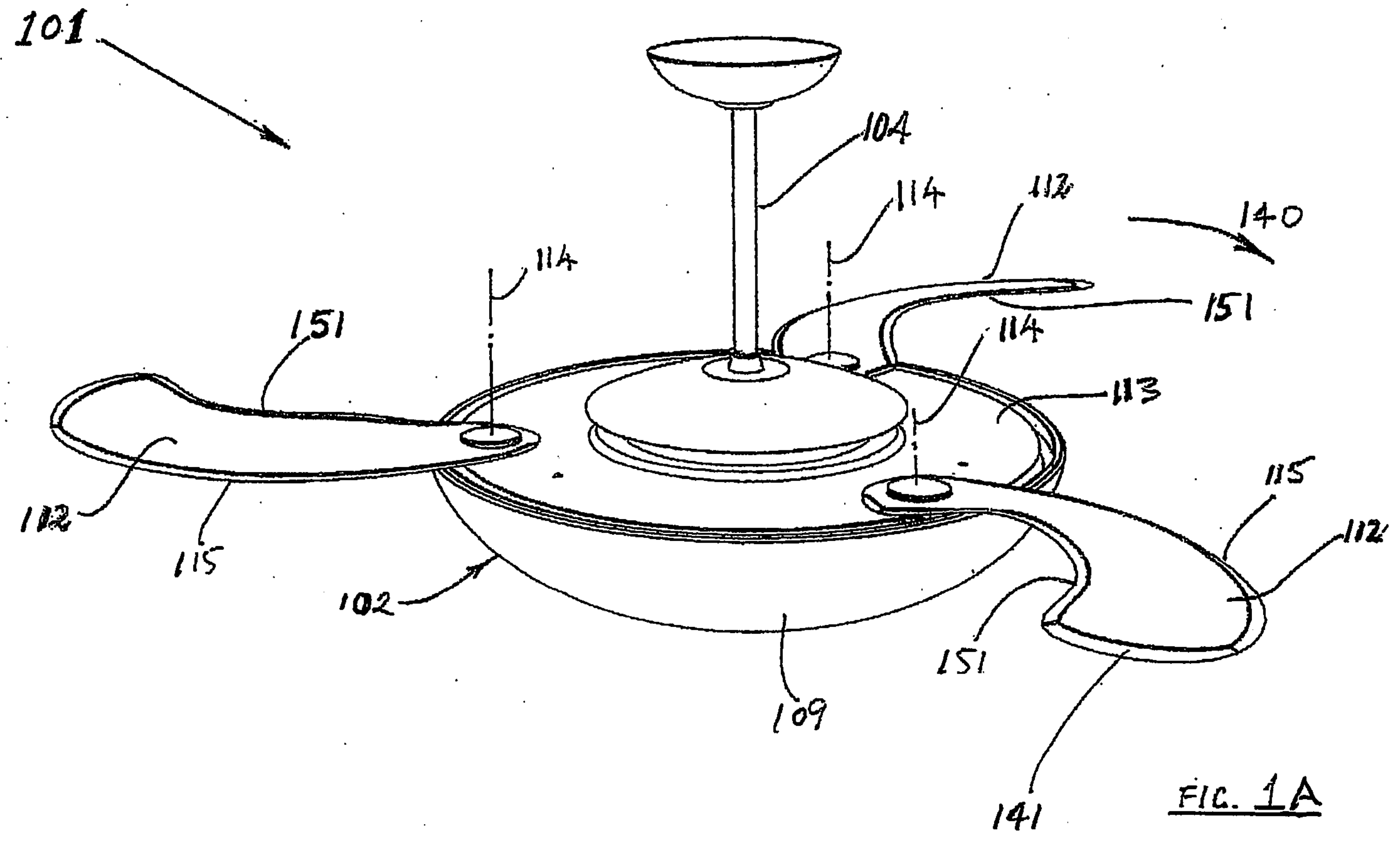
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FIG. 1A

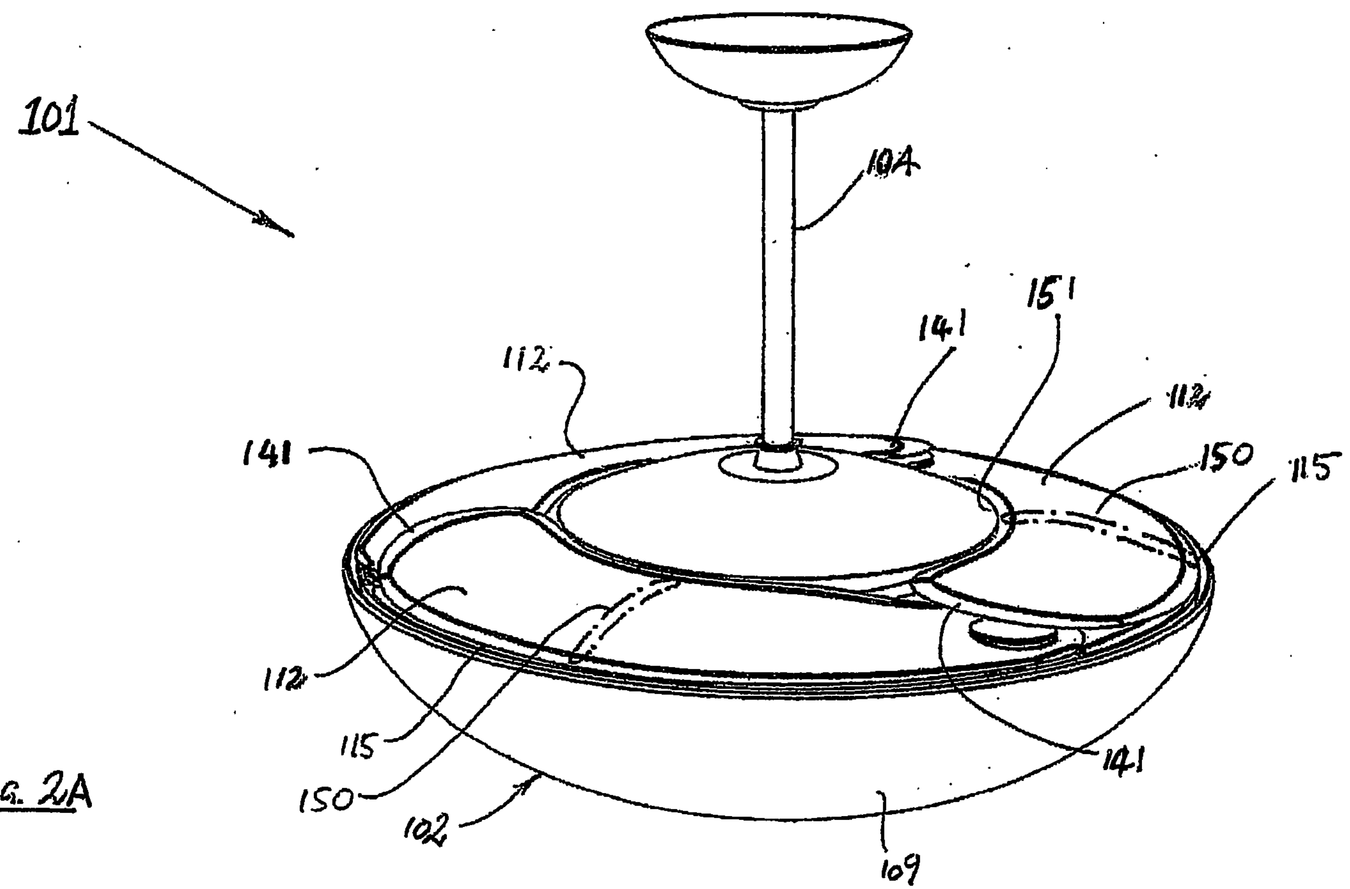

FIG. 2A

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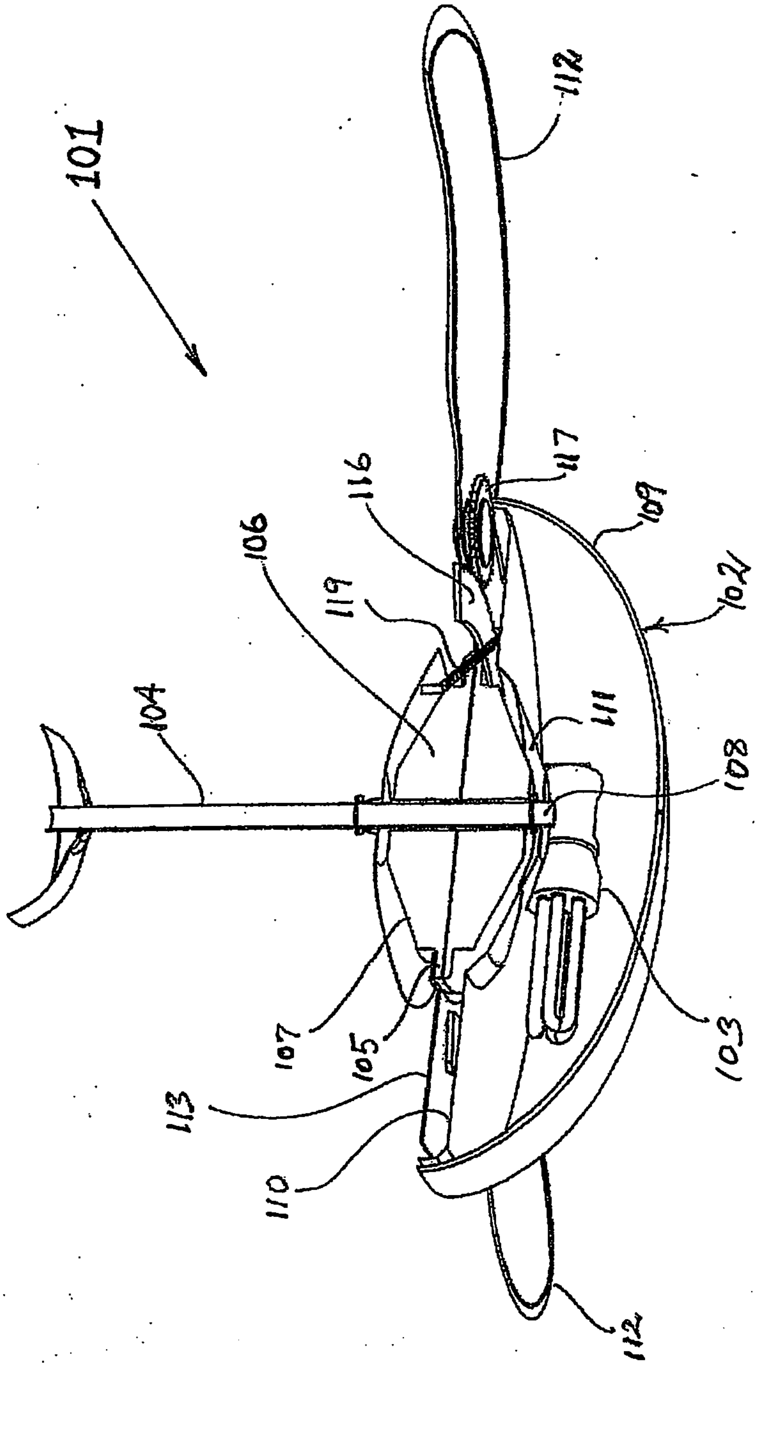

FIG. 3A

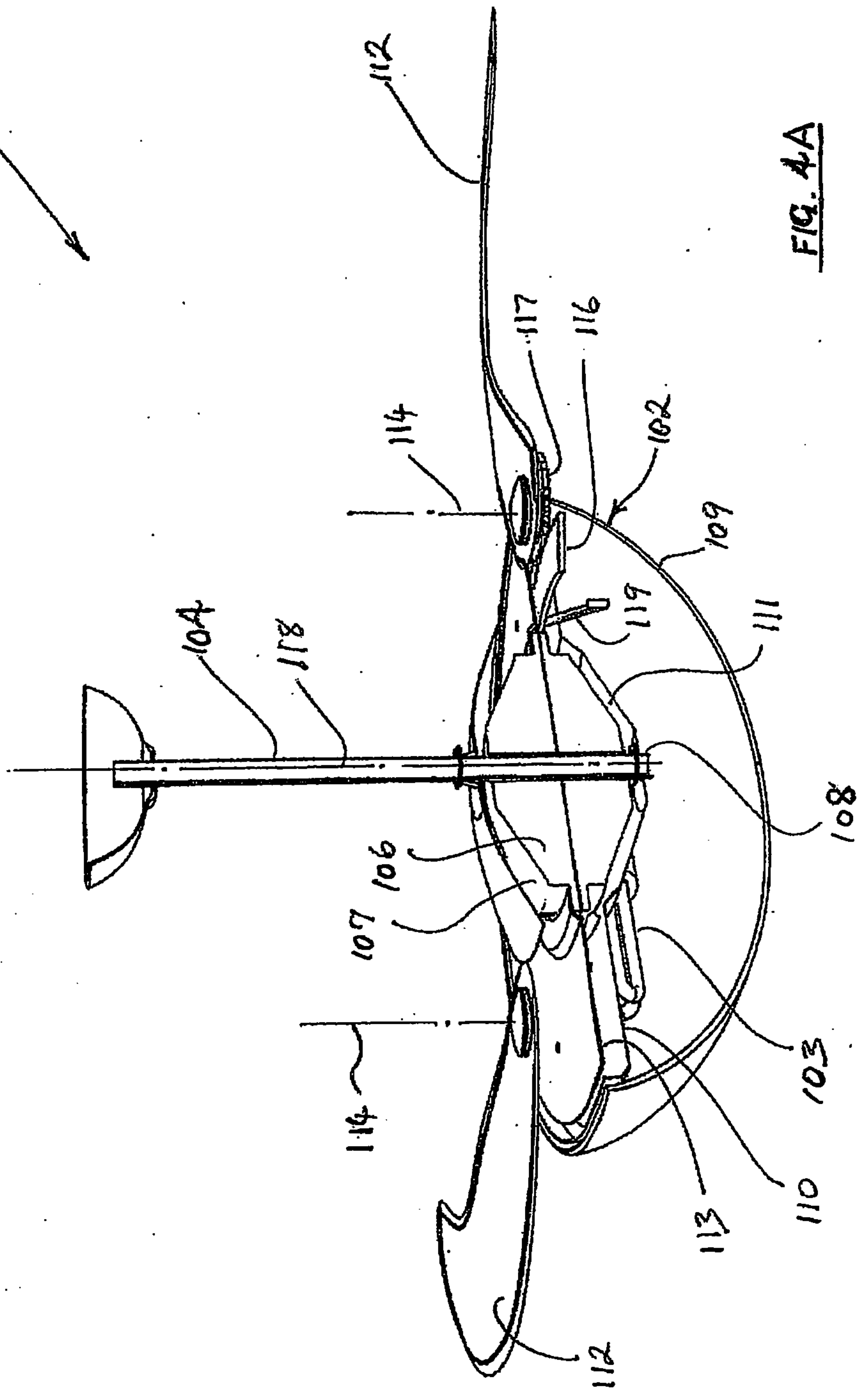
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FIG. 4A

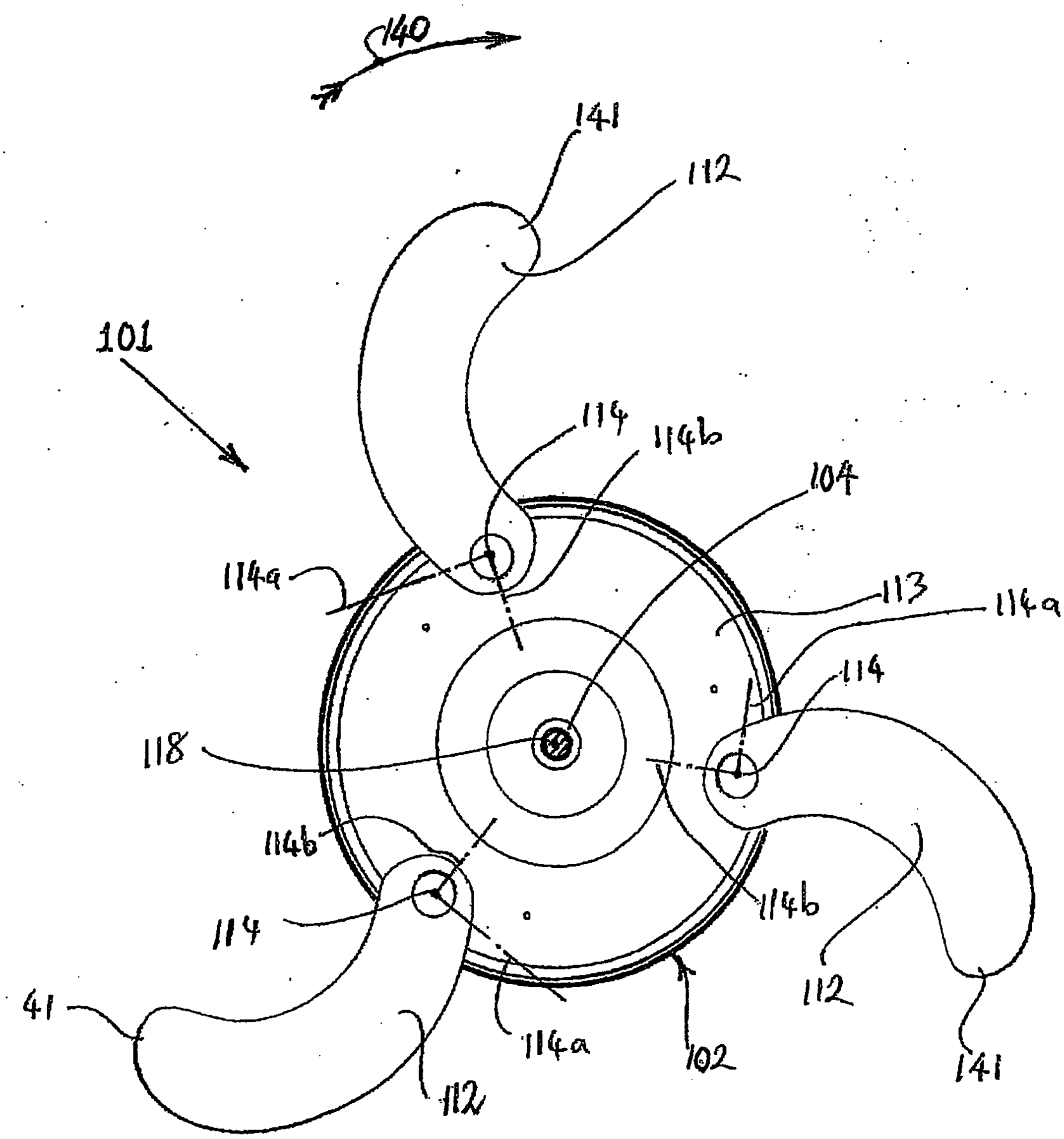
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FIG. 5A

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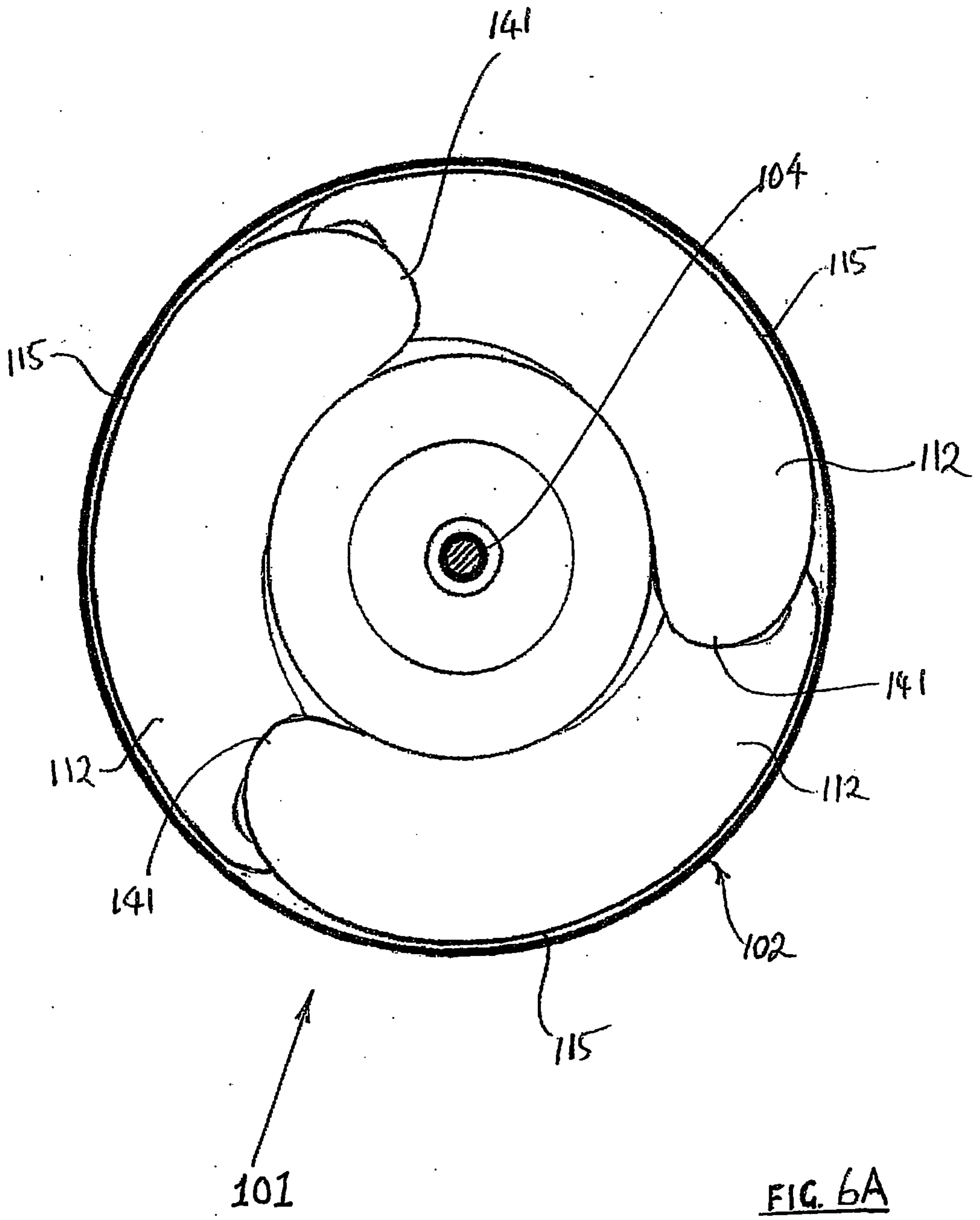

FIG. 6A

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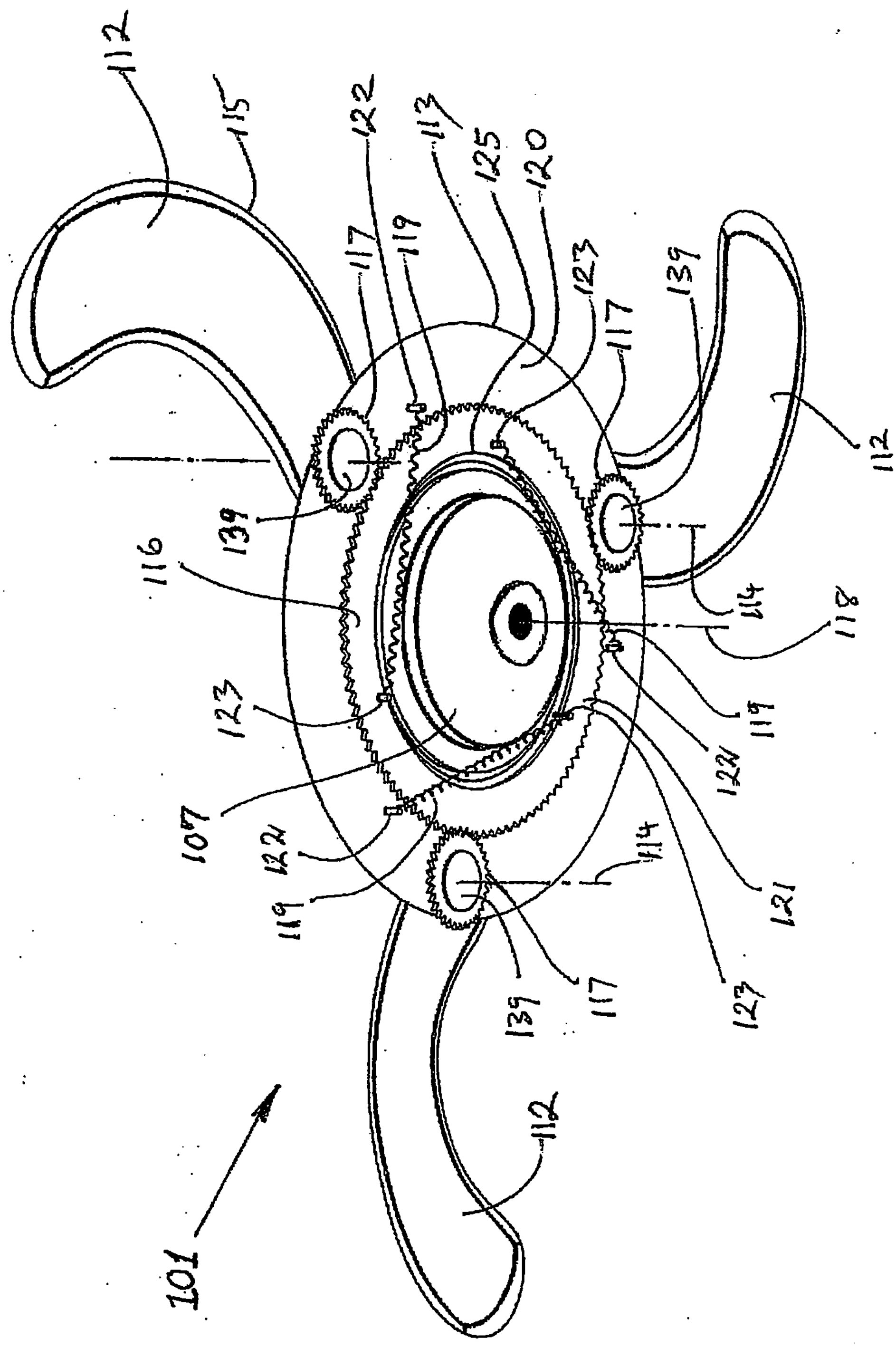

FIG. 7A

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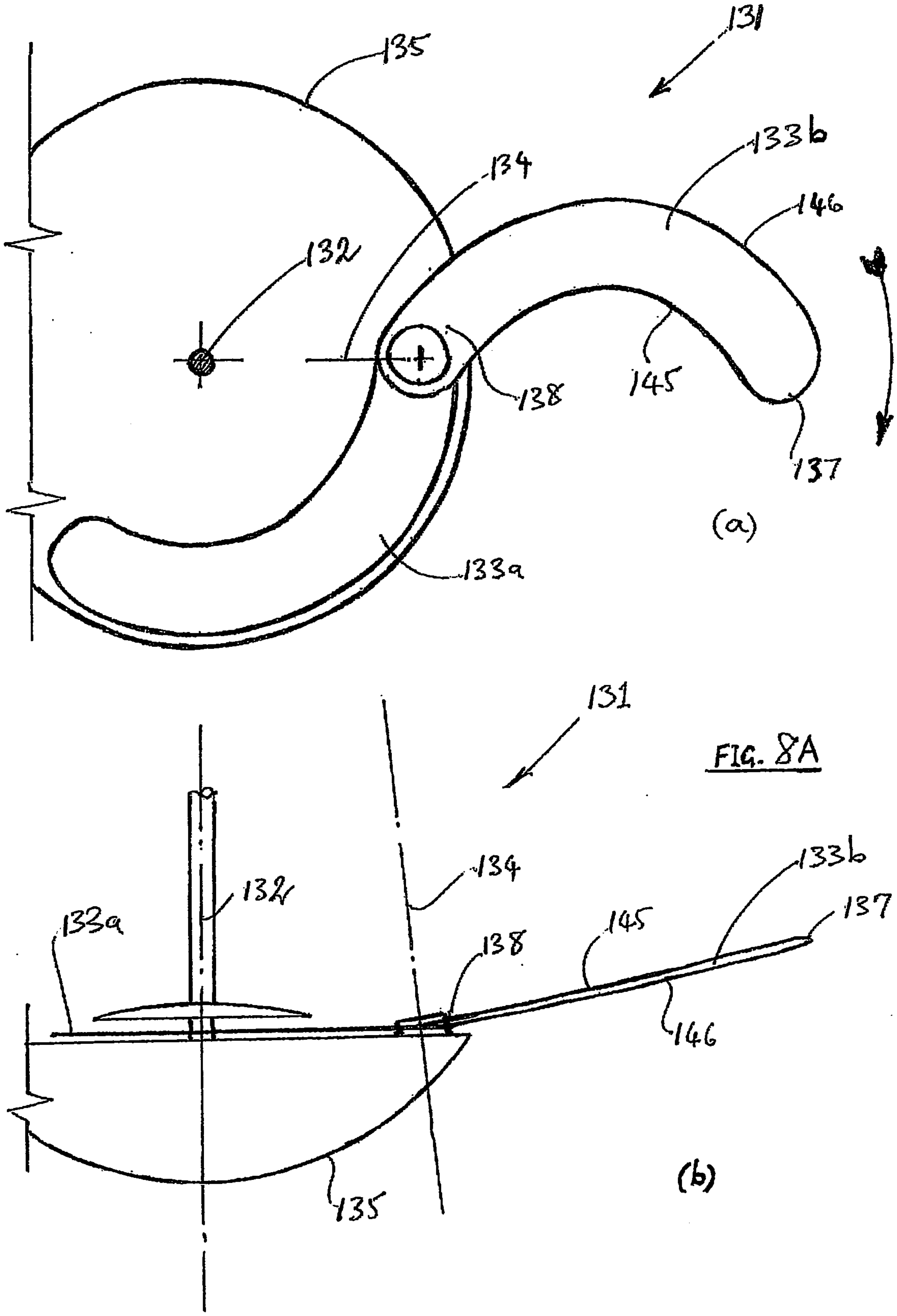

FIG. 8A

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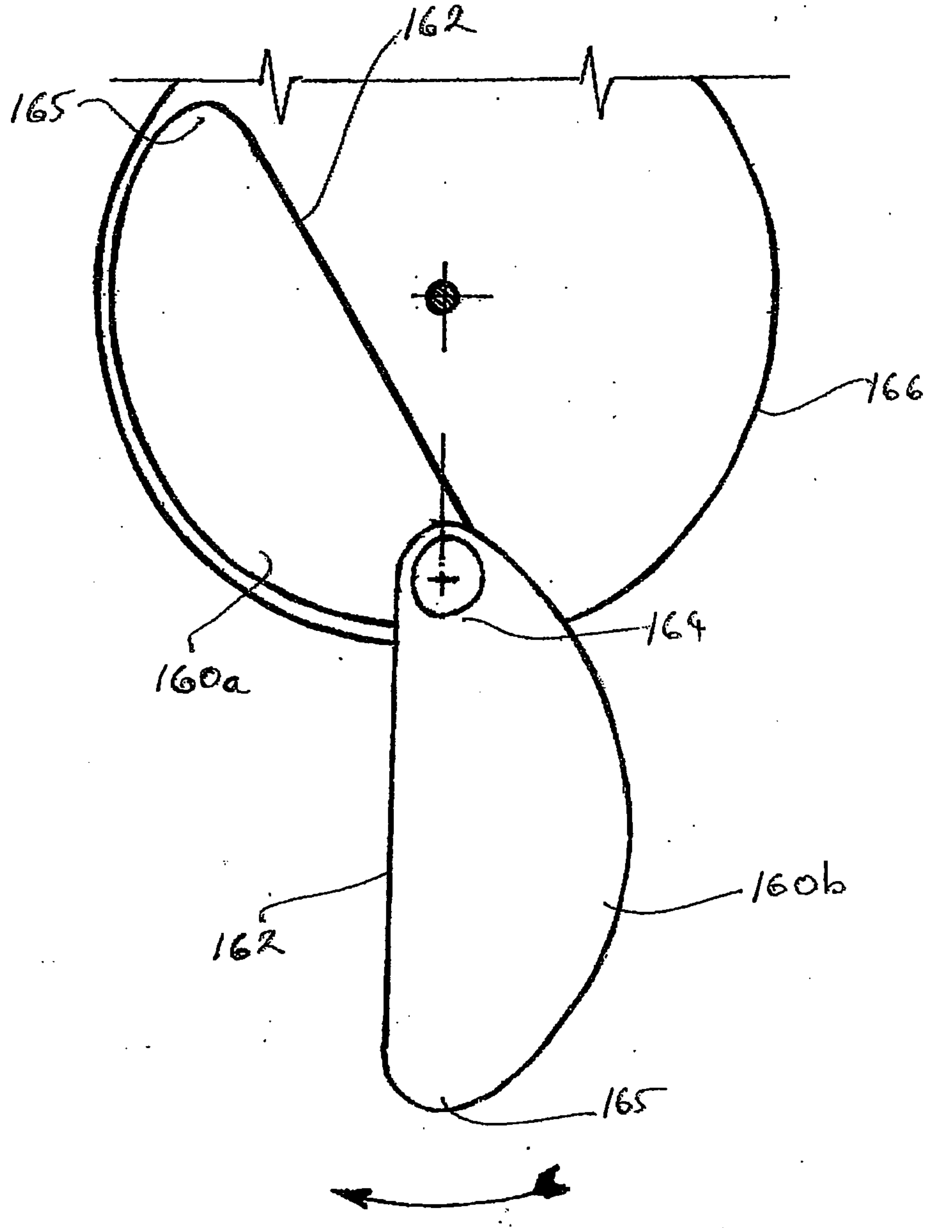

FIG. 9A

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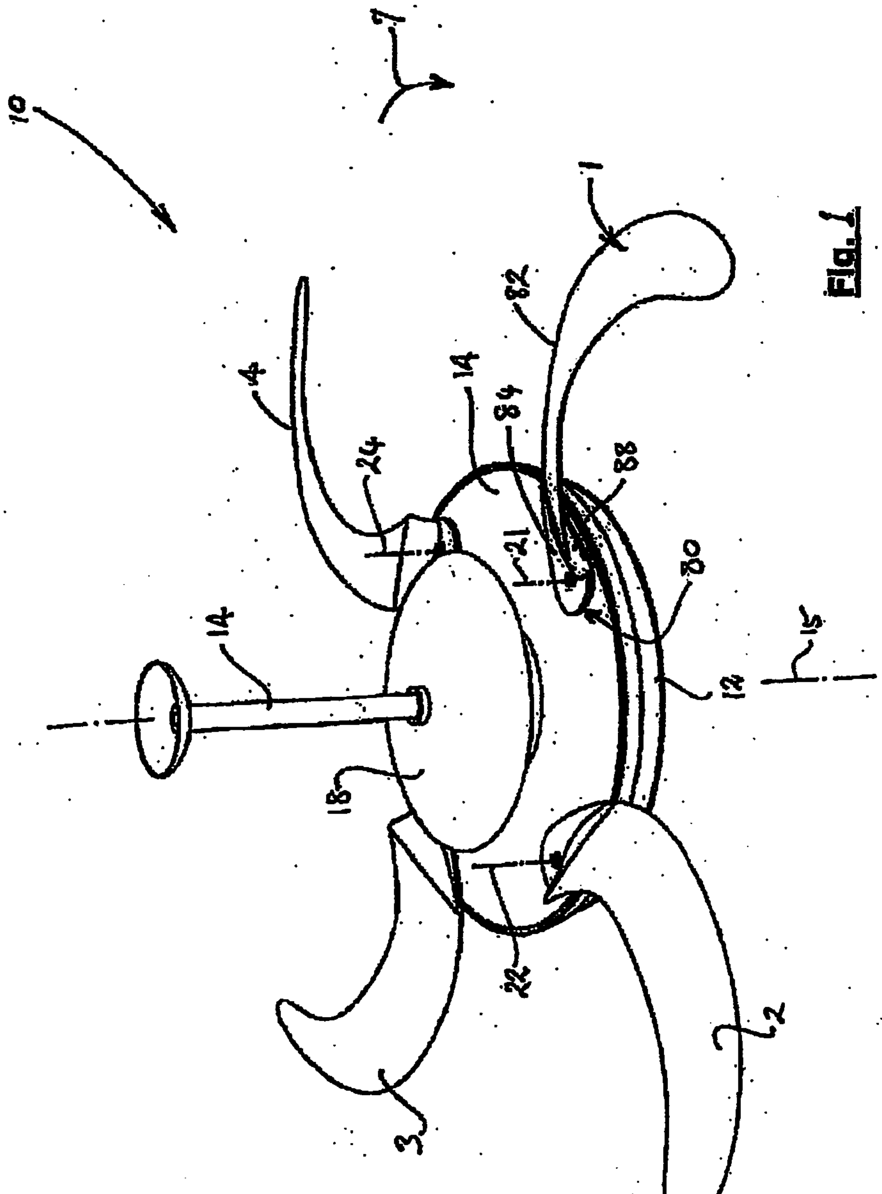

Fig. 1

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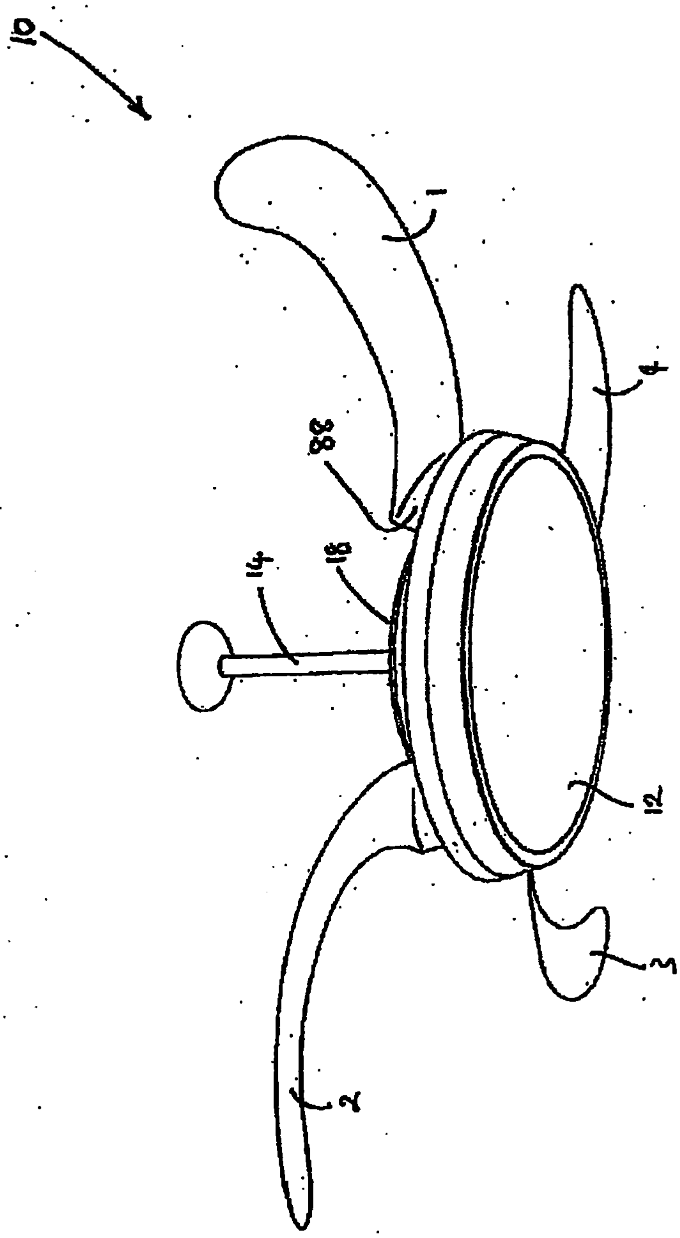

Fig. 2

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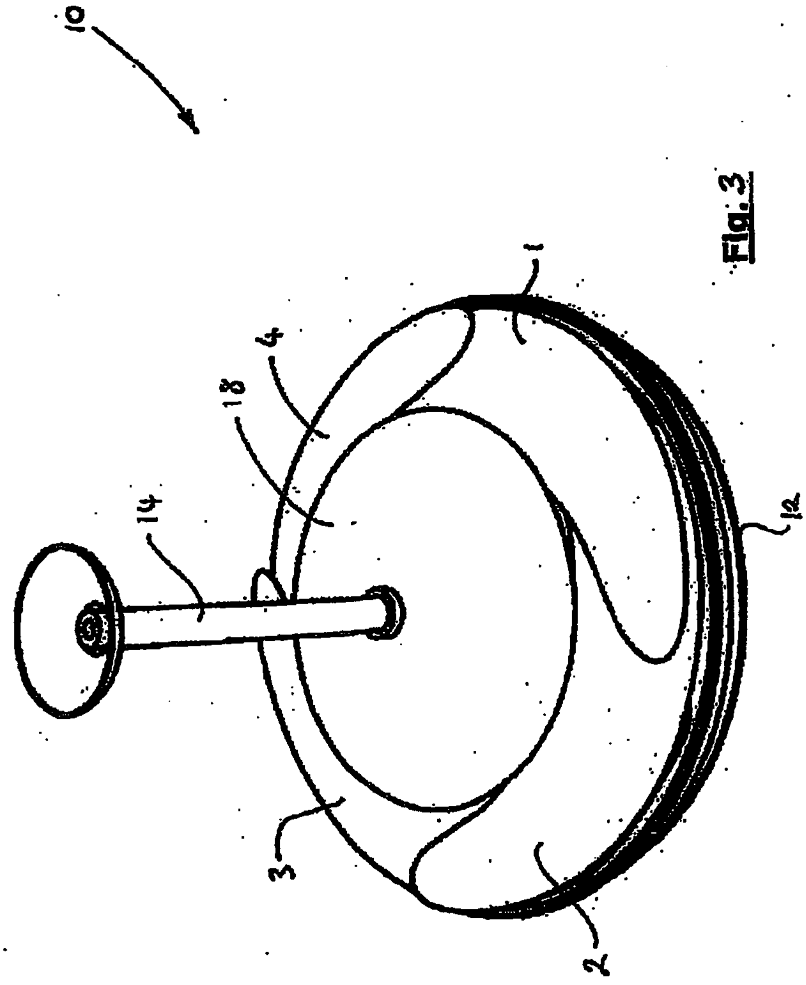

Fig. 3

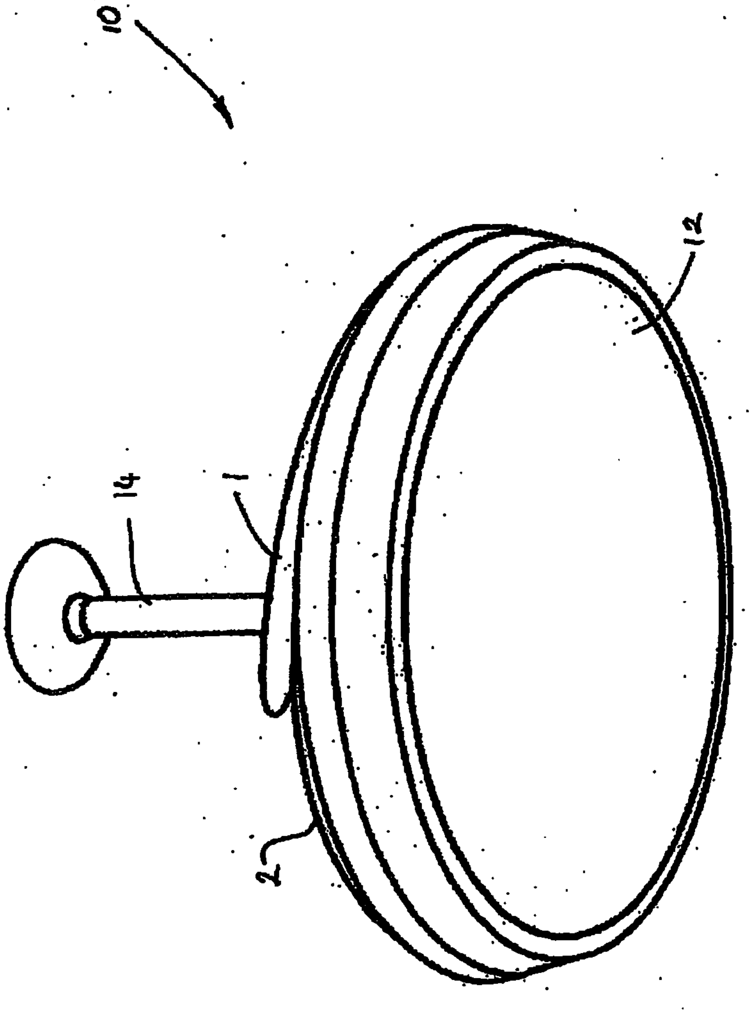

Fig. 4

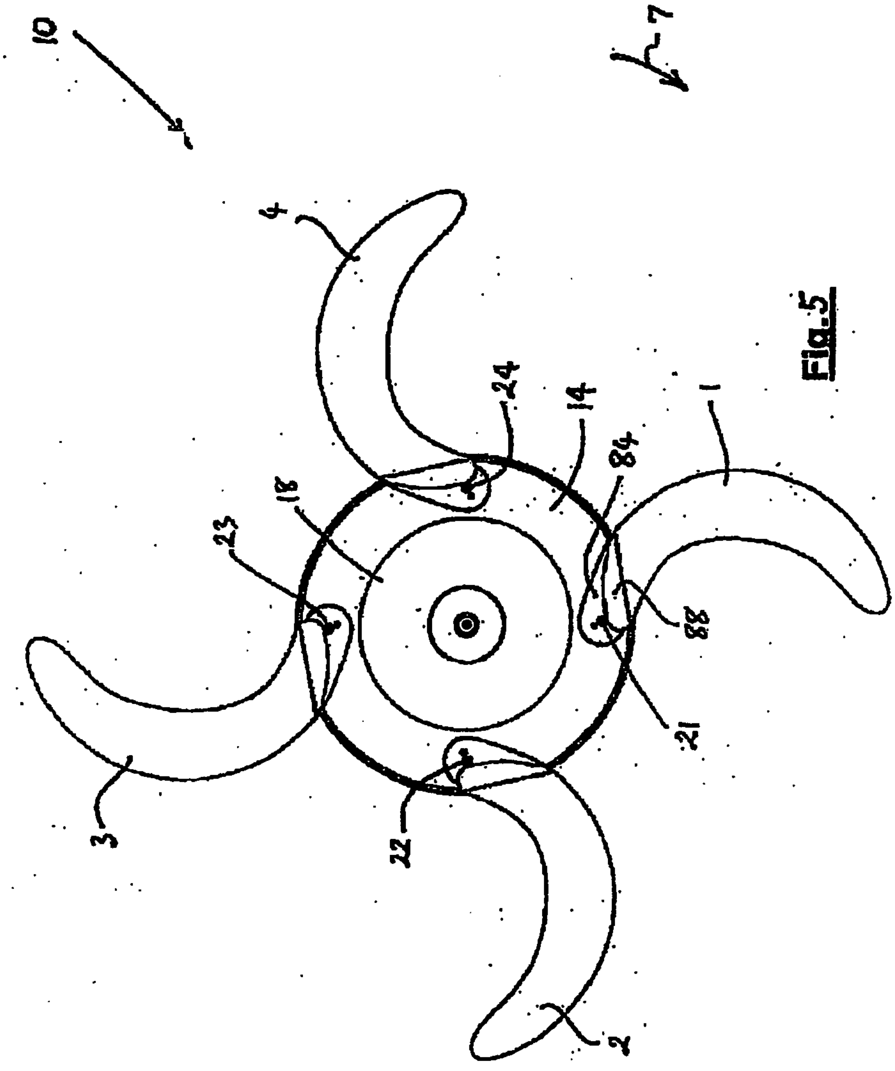

Fig.5

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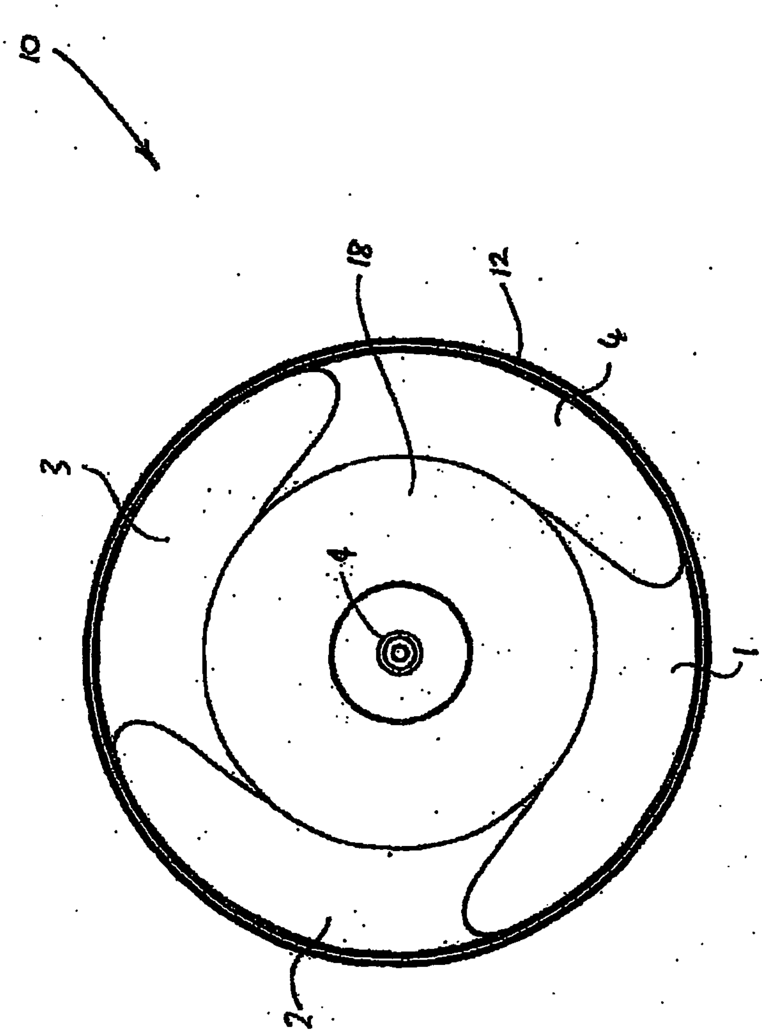

Fig. 6

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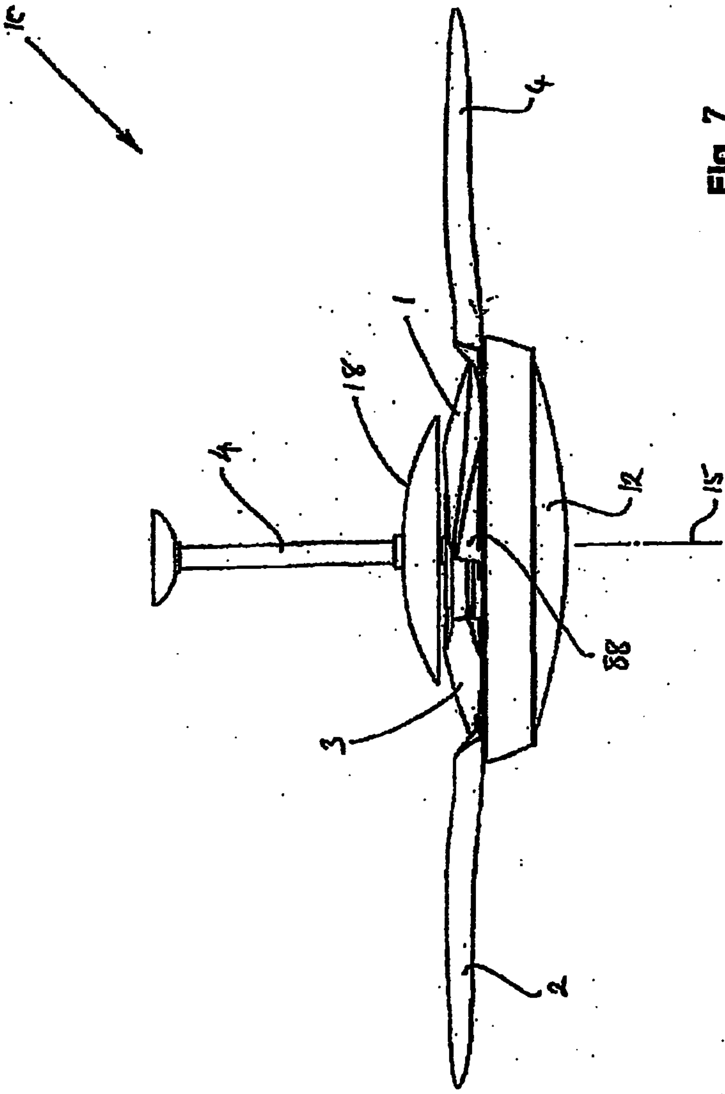

Fig. 7

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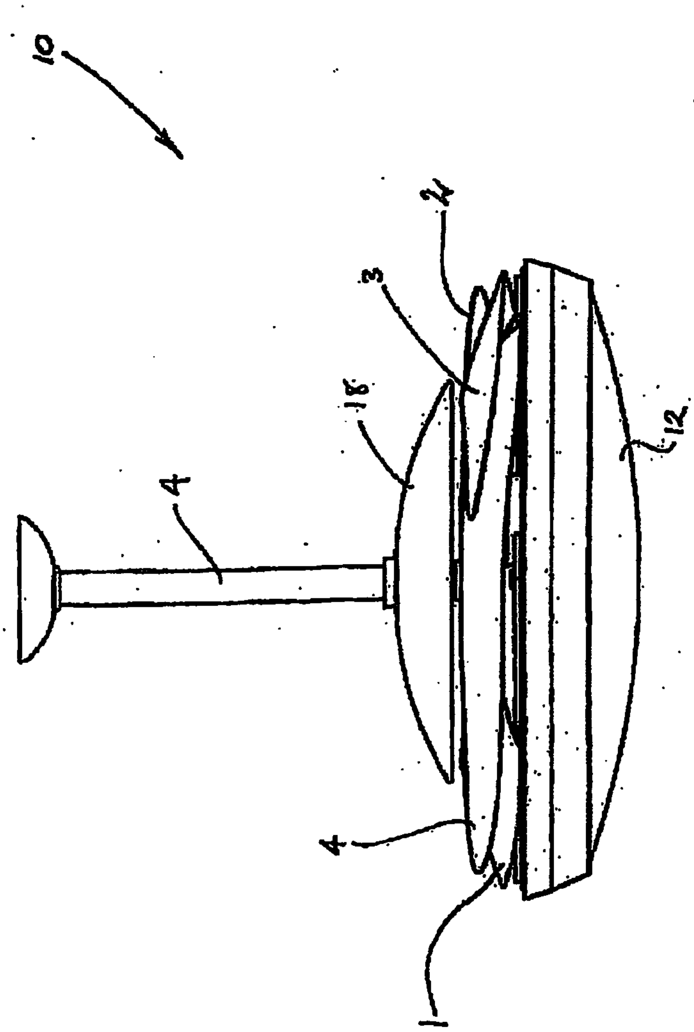

Fig. 8

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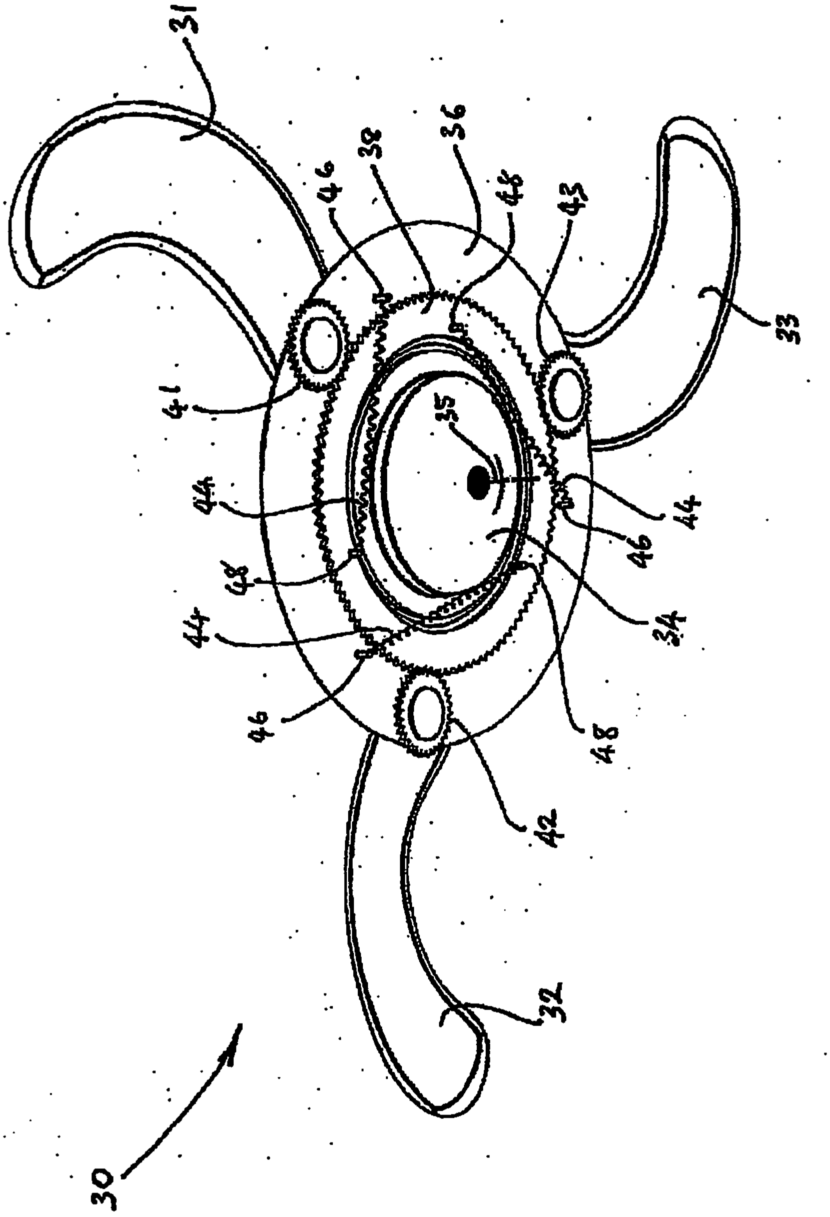

FIG. 9

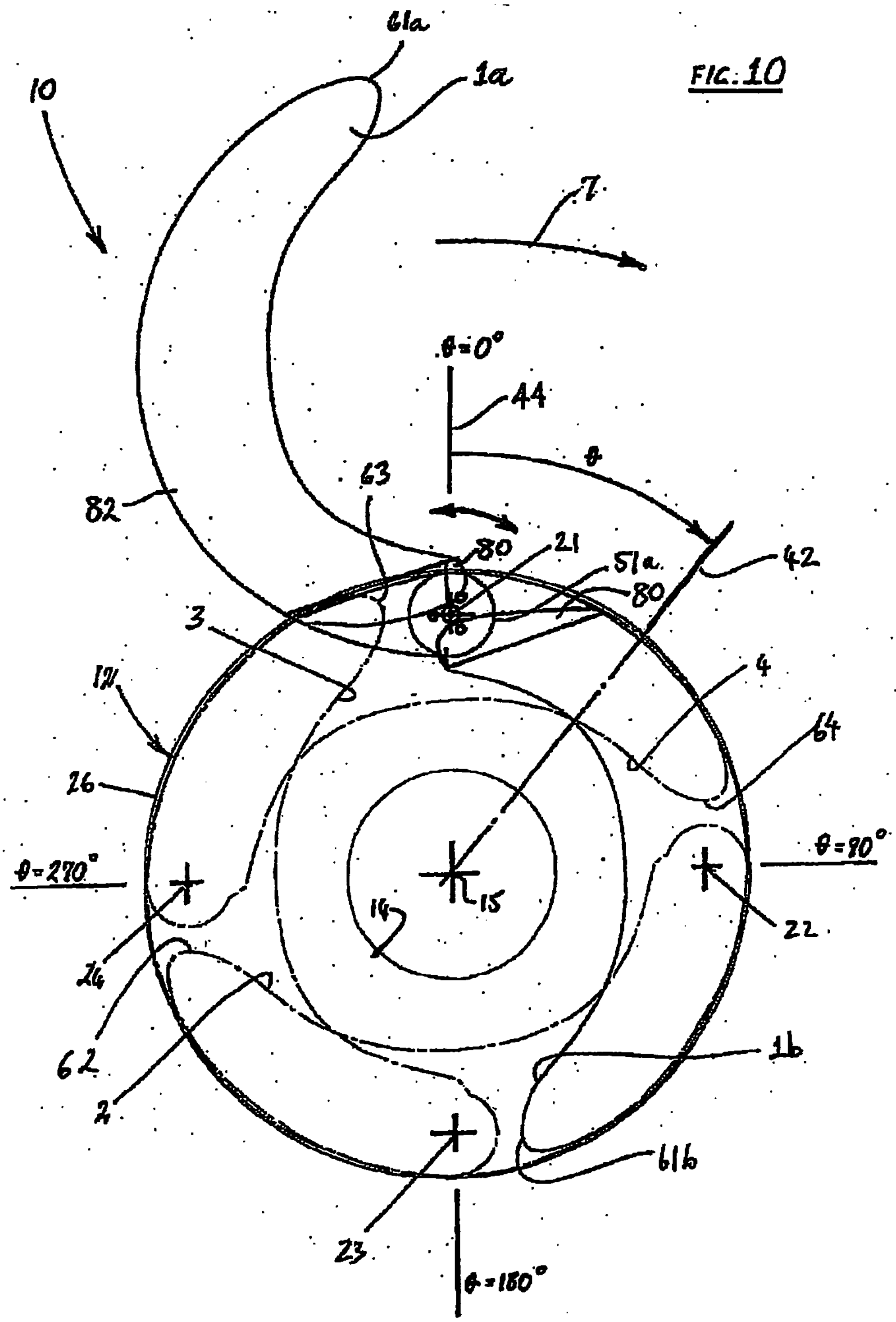
61a
1a
10
7
θ=0°
44
θ
82
63
80
21
51a
80
42
3
4
12
64
26
θ=270°
θ=90°
15
14
22
24
62
1b
2
61b
23
θ=180°

FIG. 10

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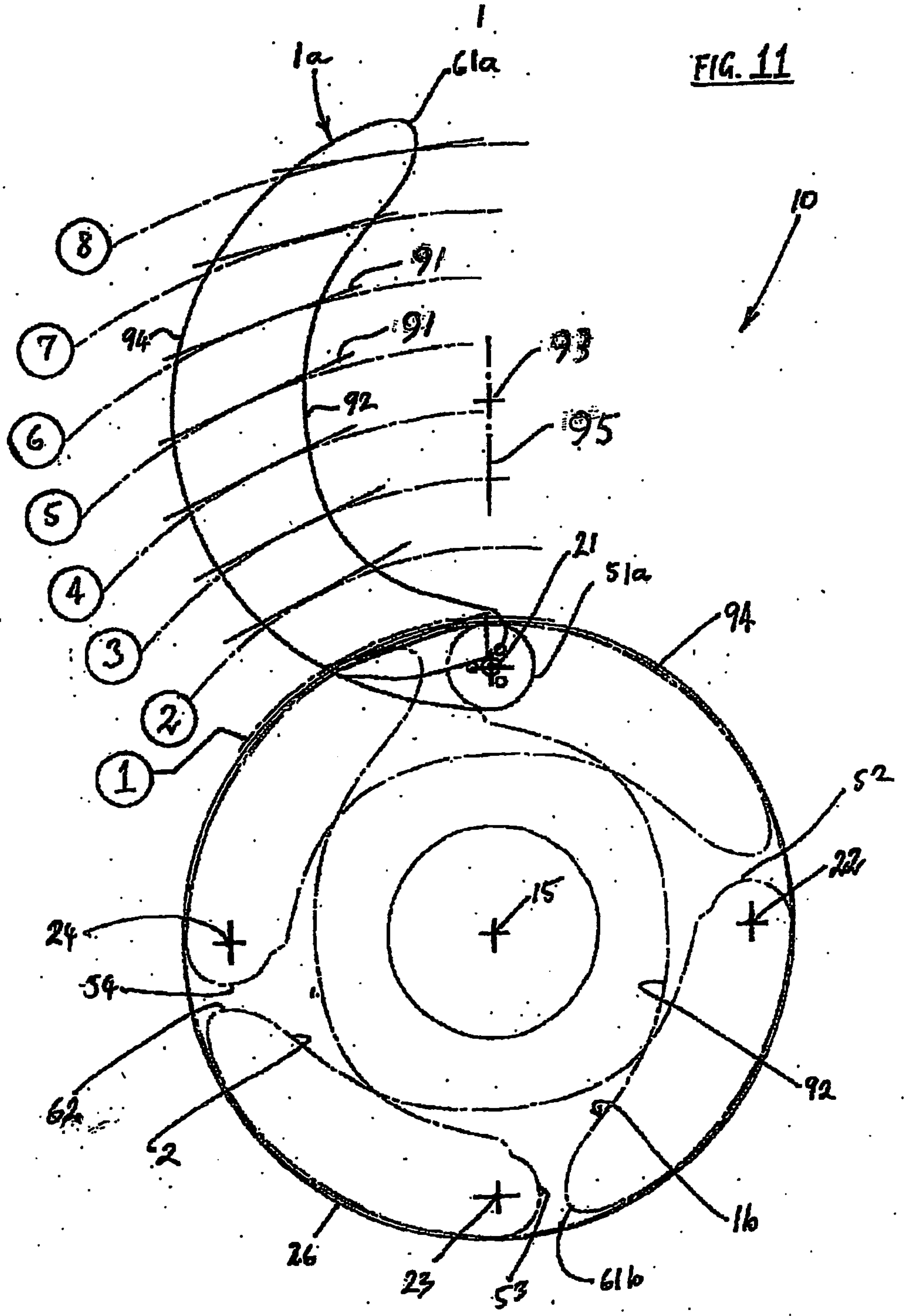
FIG. 11



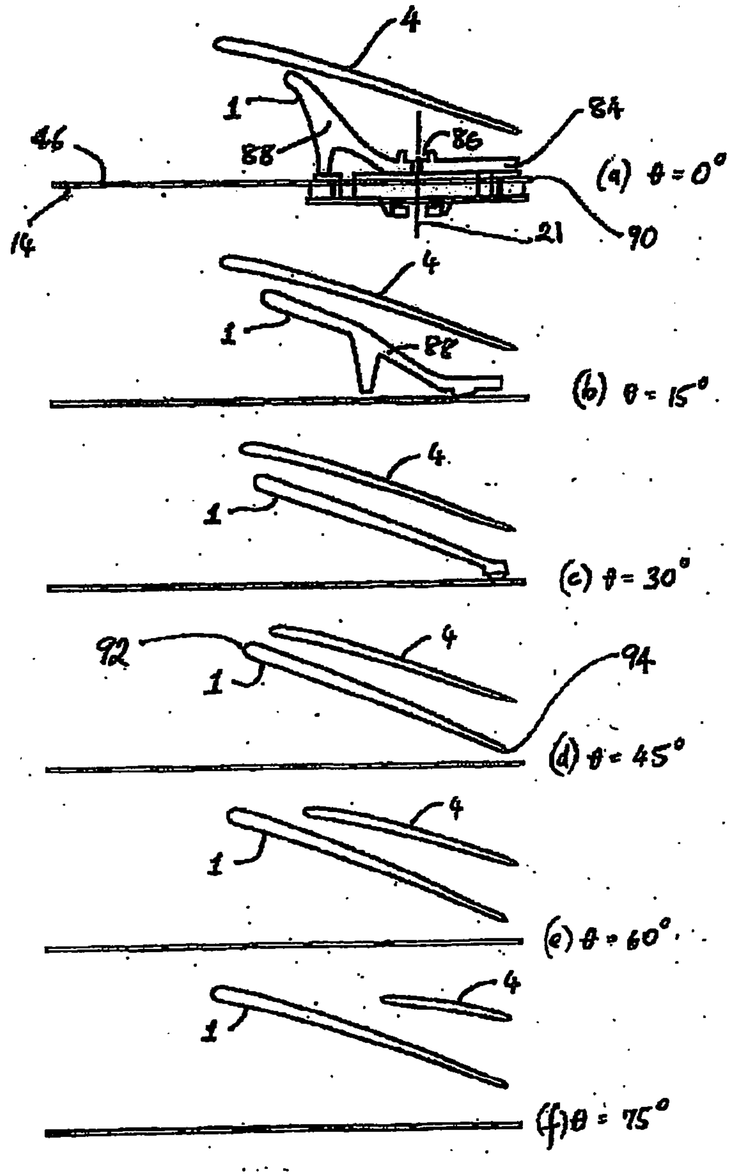

4
1
84
86
88
46
(a) θ = 0°
14
21
90
4
1
88
(b) θ = 15°
4
1
(c) θ = 30°
92
4
1
94
(d) θ = 45°
4
1
(e) θ = 60°
4
1
(f) θ = 75°

FIG. 12 (1 of 2)

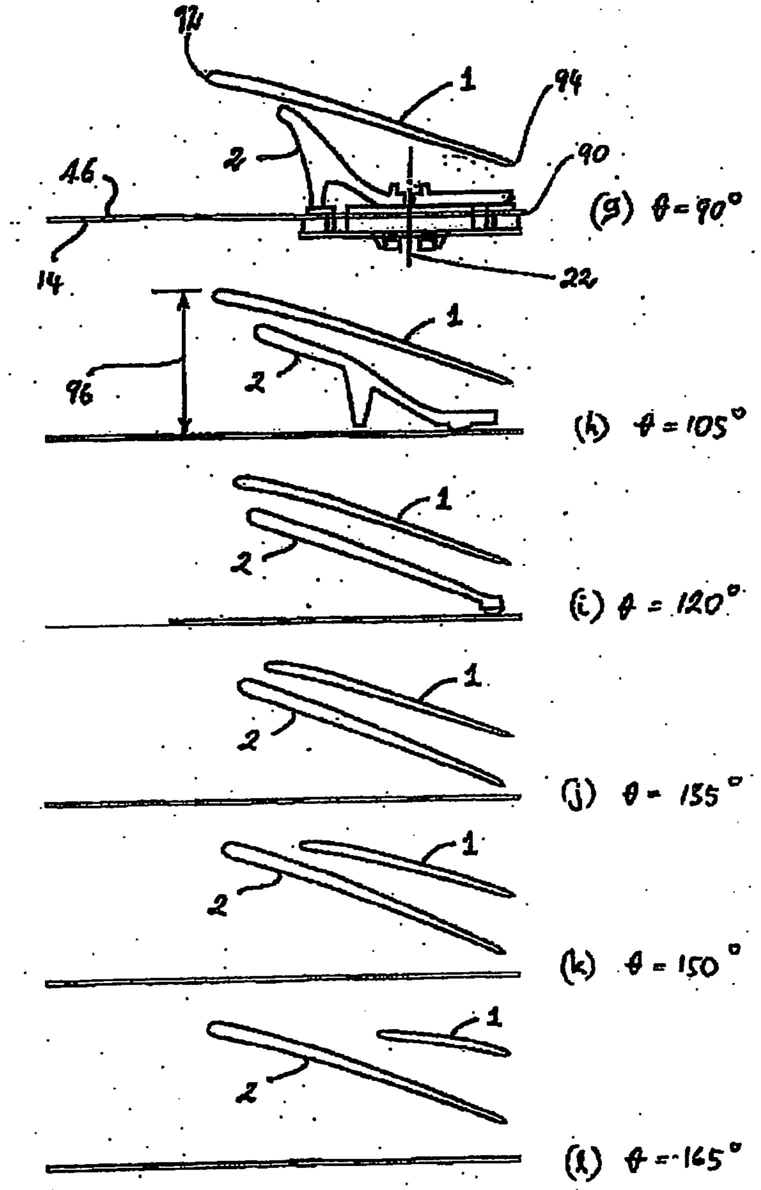


FIG. 12 (2 of 2)

Fig. 13 - Blade inner and outer edge heights

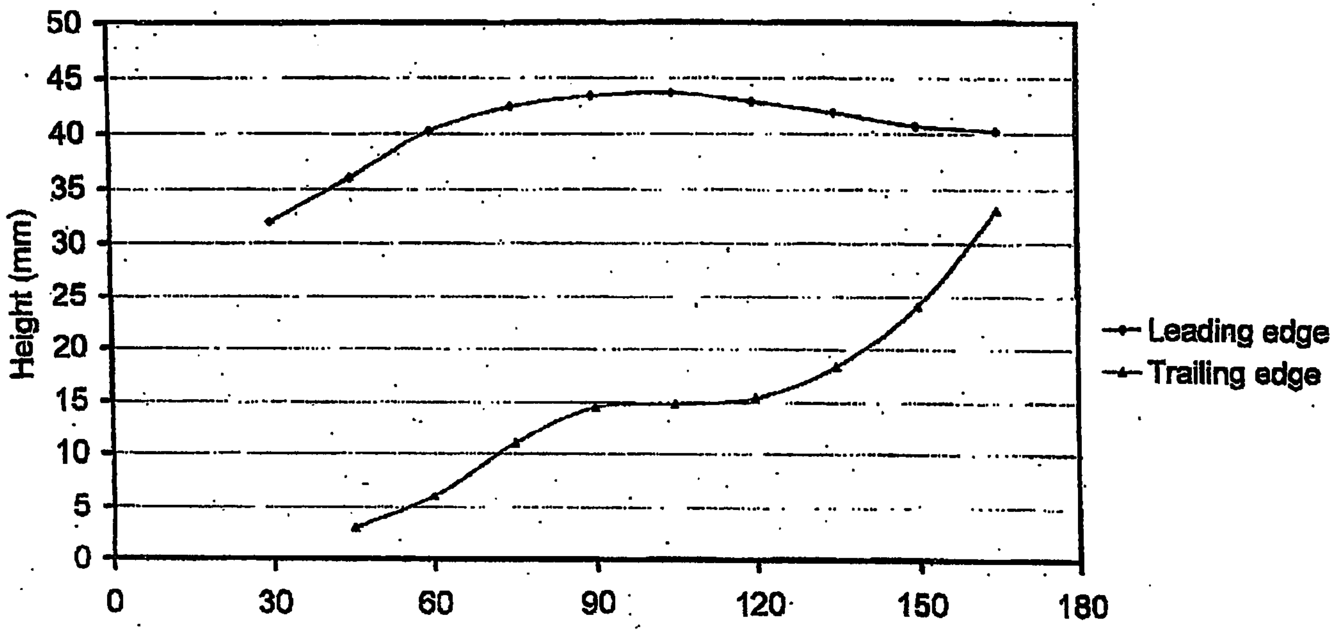


Fig. 14 - Blade width (radial, when folded)

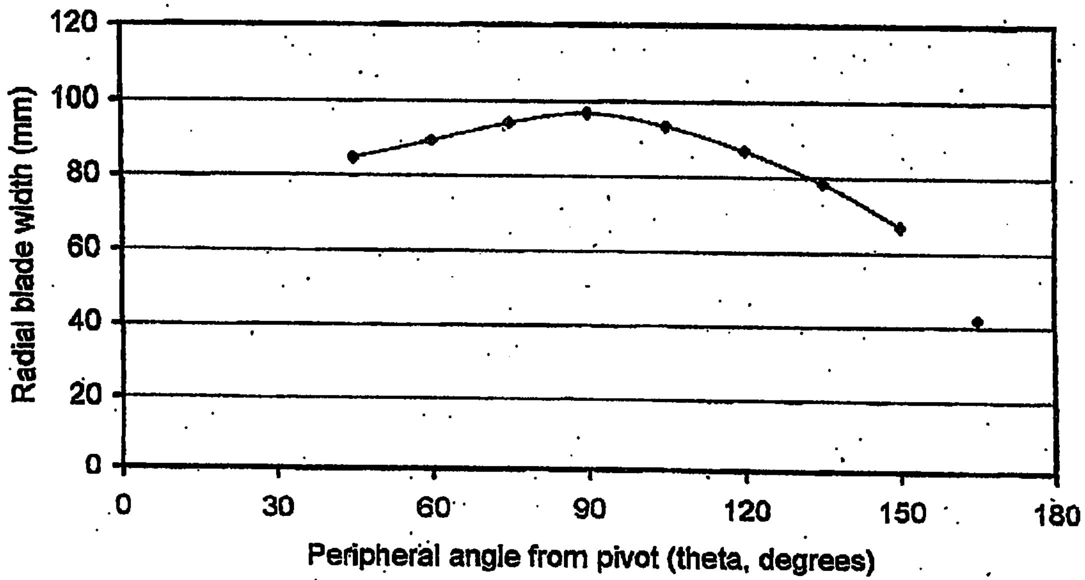
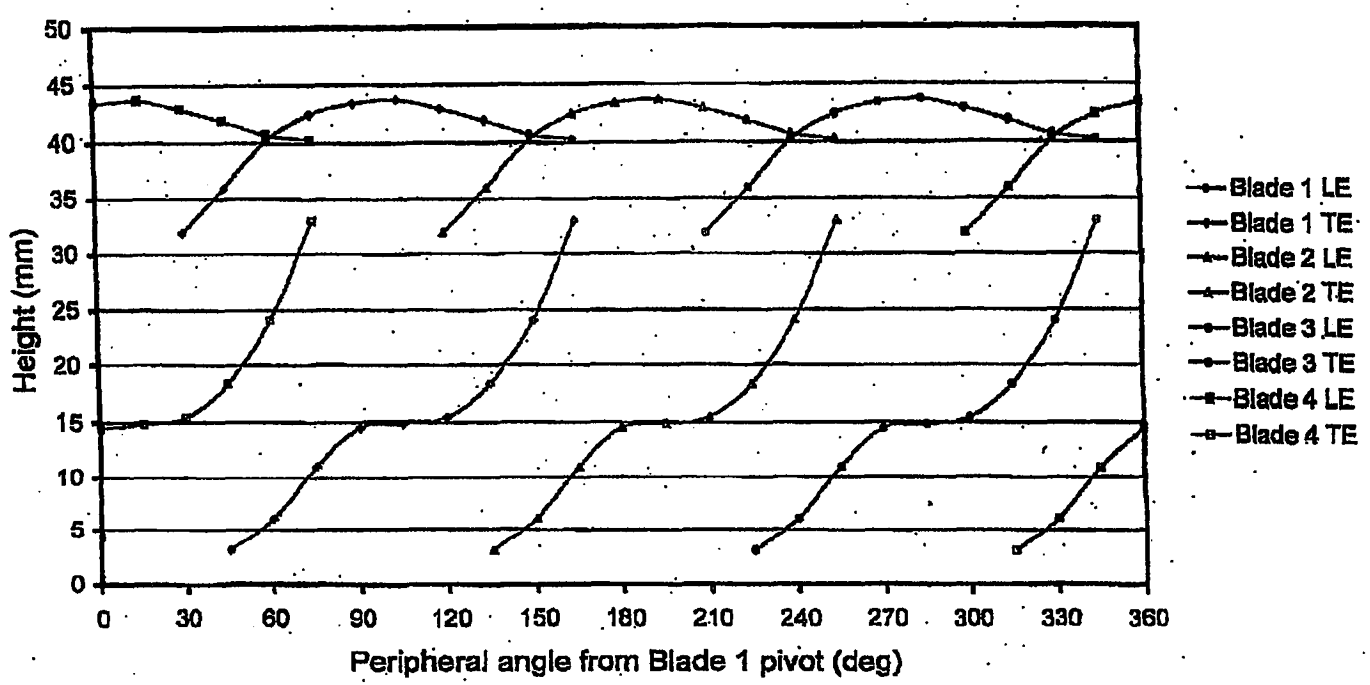


Fig. 15 - Blade inner and outer edge heights



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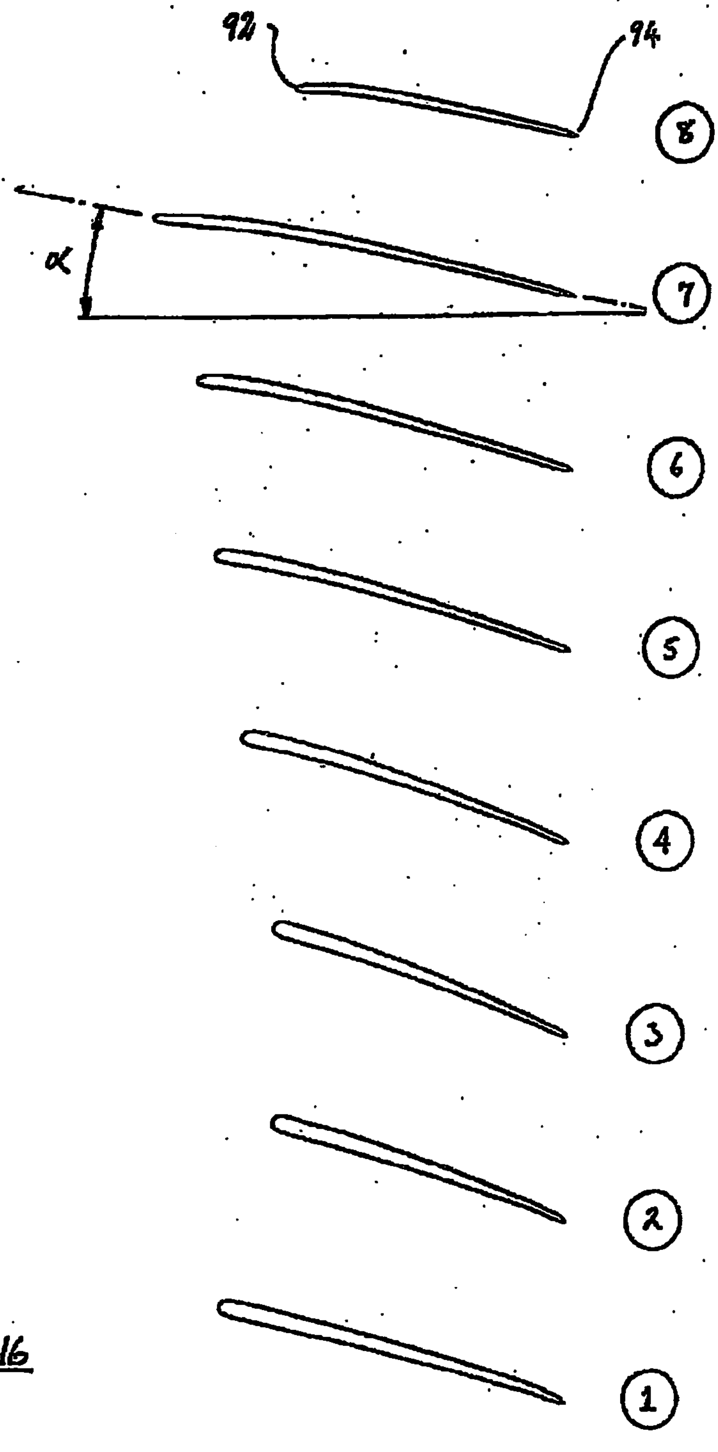
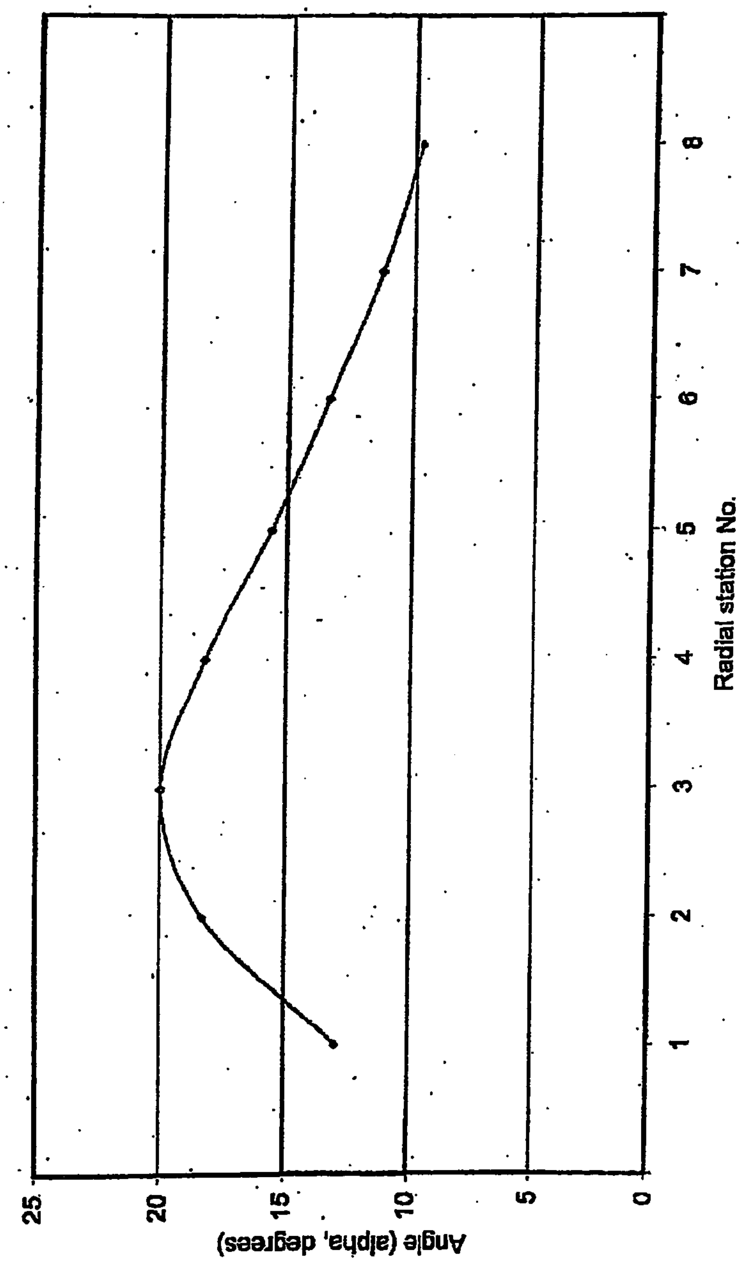


FIG. 16

Fig. 17 - Blade angle of incidence (to horizontal) at radial stations



20262014404 25 Feb 2026

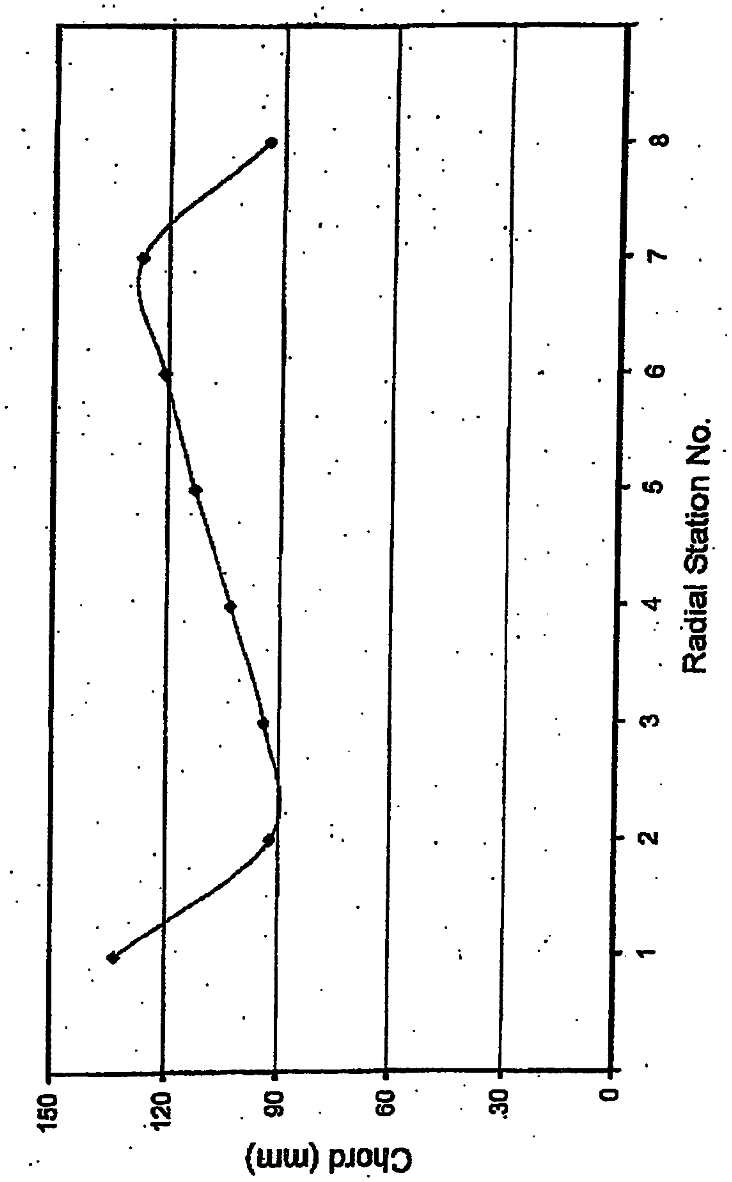


Fig. 18 - Blade chord at radial stations