

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

INVALIDITY CLAIM CHART Invalidity of U.S. Patent No. 9,629,265 in view of Carl

U.S. Patent No. 9,332,679 (“Carl”) was filed on August 3, 2012, and claims priority to Provisional Application No. 61/574,593 filed on August 5, 2011. Carl therefore qualifies as prior art to the '265 patent under, at least, (pre-AIA) 35 U.S.C. § 102(a) and/or (e). Carl anticipates and/or renders obvious (in combination with the knowledge of a person of ordinary skill in the art) the Asserted Claims of the '265 patent, at least as Dell understands Cloud Byte’s application of the Asserted Claims in an effort to show infringement.

To the extent Cloud Byte argues that any element below is not disclosed by Carl, a person of ordinary skill in the art would have found it obvious to combine the teachings of Carl with the background knowledge of a person of ordinary skill in the art and/or the additional references, and exemplary teachings, set forth in Dell’s Invalidity Contentions and accompanying charts and/or in Appendix D.

The chart below provides representative examples of where each element of each claim is found within Carl.¹ Citations are meant to be exemplary, not exhaustive, and Dell reserves the right to identify and discuss additional portions of the reference in support of its contentions and/or to rebut arguments made by Cloud Byte. Citations to figures, drawings, tables, and the like include reference to any accompanying or related text. All internal cross references are meant to incorporate the cross-referenced material as if fully set forth therein. Where Dell states that Carl “discloses” a limitation, that disclosure may be express, implicit, and/or inherent.

It is Dell’s position that Cloud Byte’s Infringement Contentions have not established that any accused product or service infringes any valid claim. Thus, Dell’s statements below should not be treated as an admission, implication, or suggestion that Dell agrees with Cloud Byte regarding either the scope, construction, or interpretation of any of the Asserted Claims or the infringement theories advanced by Cloud Byte in its Infringement Contentions, including whether any Asserted Claim satisfies 35 U.S.C. §§ 101 or 112. Nothing in this chart is intended to suggest that Dell agrees with Cloud Byte’s application of any claim element, suggest a proposed construction at this stage of the case, or suggest that construction is needed, as the parties are not required to exchange terms for construction or propose claim constructions until a later date.

Cloud Byte has yet to identify any limitation of the Asserted Claims that it contends is not anticipated and/or rendered obvious by Carl. Dell therefore expressly reserves the right to respond to any such contention, including by identifying additional obviousness combinations, if Cloud Byte makes any such contention. This chart is subject to all reservations, objections, and disclaimers in Dell’s

¹ The chart additionally shows where U.S. Provisional Appl. No. 61/574,593 (“Carl Provisional”) discloses the elements of the asserted claims of the '265 patent.

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Invalidity Contentions and any amendment, supplement, or modification thereof, which are incorporated herein by reference in their entirety.

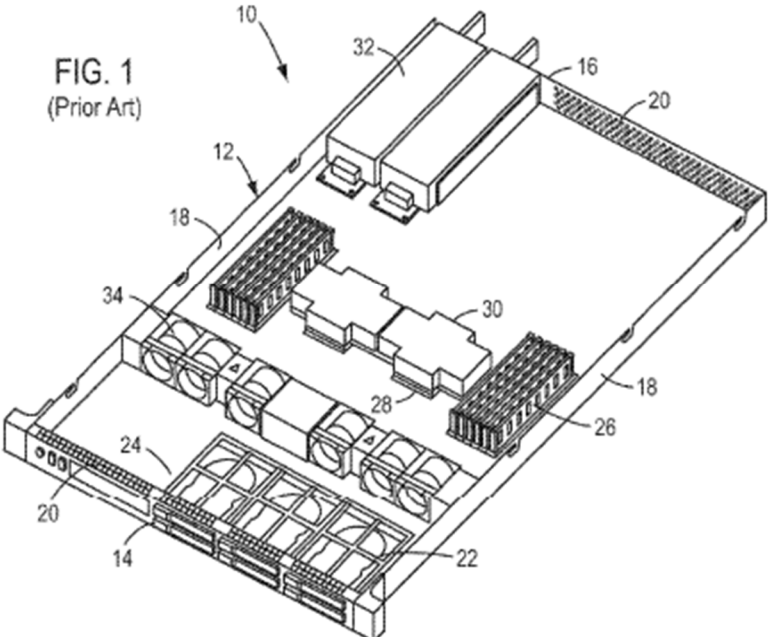
Asserted Claims	Carl
<p>[1.pre] 1. An electronic device comprising:</p>	<p>Dell takes no position in these Invalidity Contentions on whether the entirety of the preamble of this claim limitation. To the extent it is a limitation, Carl discloses, expressly and/or inherently, an electronic device.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>FIG. 1 (Prior Art)</p>

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Asserted Claims	Carl
	<p>Carl at Abstract: A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further includes a plurality of inlet plenums which each communicate with an inlet end of a corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p>Carl at 1:9–20: The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the sidewalls of the enclosure. This will enable the fan assembly to deliver a required airflow through the enclosure with fewer fans. The number of fans can be chosen to achieve operation at peak efficiency without concern for the uniformity of the flow across the enclosure, as would be the case if the fans were mounted parallel to the sidewalls.</p> <p>Carl at 1:21–28: Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>Carl at 1:29–50:</p>

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Asserted Claims	Carl
	<p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number</p>

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Asserted Claims	Carl
	<p>of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:45: FIG. 1 is a perspective view of a prior art computer server;</p> <p>Carl at 3:14–20: The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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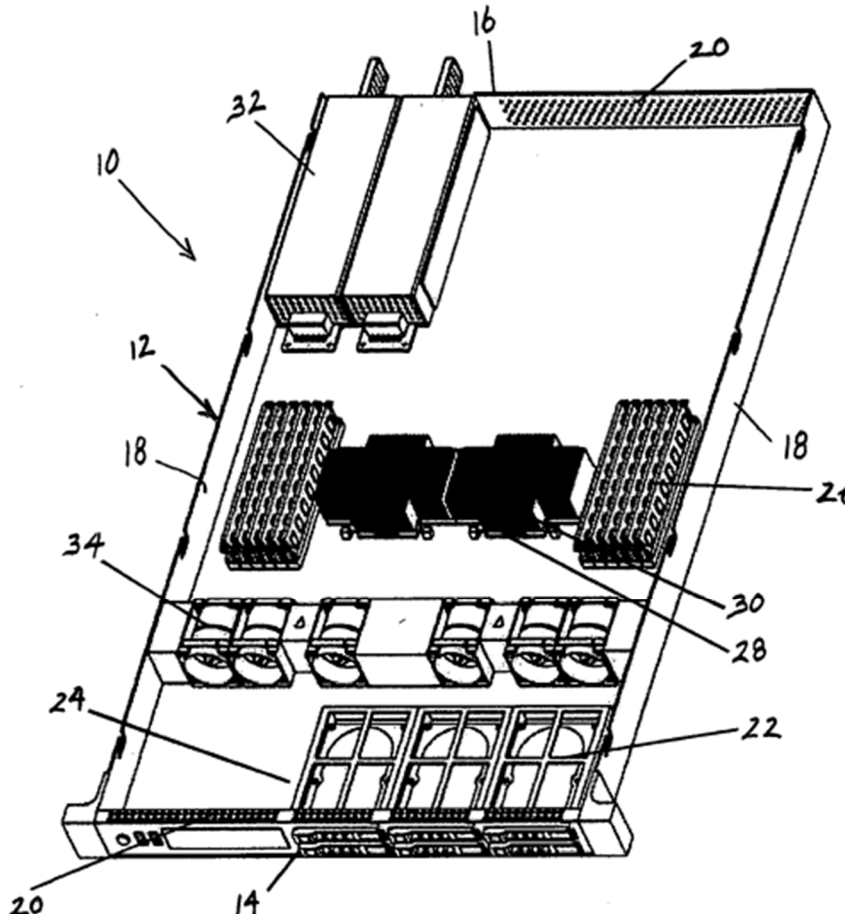
Asserted Claims	Carl
	<p style="text-align: right;">Sh</p> 
<p>[1.a] a housing comprising a front face and a rear face which are distanced from each other in a longitudinal direction;</p>	<p>Carl discloses, expressly and/or inherently, a housing comprising a front face and a rear face which are distanced from each other in a longitudinal direction.</p> <p><i>See, e.g.:</i></p>

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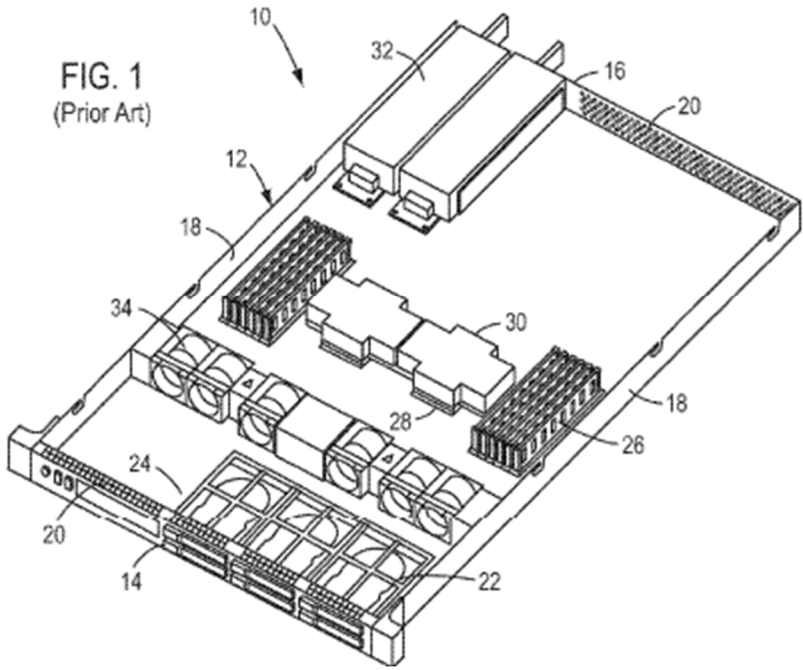
Asserted Claims	Carl
	<p data-bbox="651 298 1134 331">Carl at Fig. 1 and accompanying text:</p>  <p data-bbox="651 1127 1134 1159">Carl at Fig. 2 and accompanying text:</p>

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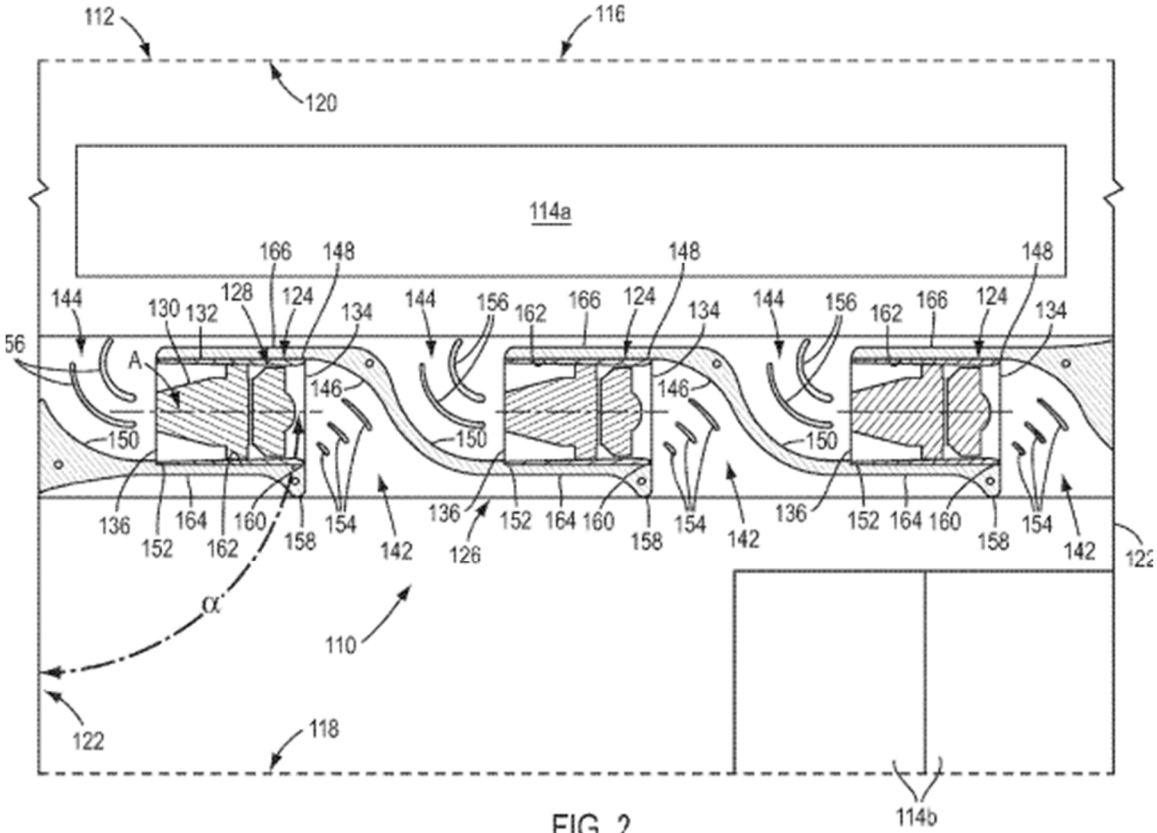
Asserted Claims	Carl
	 <p data-bbox="1192 1088 1276 1128">FIG. 2</p> <p data-bbox="646 1144 861 1177">Carl at Abstract:</p> <p data-bbox="646 1185 1858 1396">A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further includes a plurality of inlet plenums which each communicate with an inlet end of a</p>

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Asserted Claims	Carl
	<p>corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39:</p>

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Asserted Claims	Carl
	<p>Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl at 3:63–4:14: In order to maintain the air flow generated by the fans 124 generally parallel to the sidewalls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the sidewalls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>Carl at 4:46–57: In addition to the inlet guide vanes 154, the inventors have discovered that the distribution of the airflow forward of the fan assembly 110 and through the inlet plenum 142 may be improved by providing each inlet plenum with a corresponding inlet lip 158. As shown most clearly in FIG. 2,</p>

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Asserted Claims	Carl
	<p>each inlet lip 158 comprises a preferably annular projection which extends frontward from a forward edge 160 of the inlet end 134 of the fan housing 132. The configuration of the inlet lip 158 may be determined empirically for a given fan assembly 110 and server computer 112. An optimal geometry for the lip 158 has the lowest power draw and noise for a desired flow through the enclosure 116.</p> <p>Carl at 4:58–5:12: Referring still to FIGS. 2-4, each fan 124 may be mounted in a respective cavity 162 which is formed in the fan tray 126 between a corresponding pair of generally longitudinal front and rear wall sections 164, 166. In this particular embodiment of the invention, the right end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the inlet lip 158 of the adjacent inlet plenum 142. In addition, the left end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the outlet wall section 150 of the adjacent exhaust plenum 144, and the right end (as viewed in FIG. 2) of each rear wall section 166 is connected to or formed integrally with the inlet wall section 146 of the adjacent inlet plenum 142. Furthermore, the inlet wall section 146 of the left inlet plenum 142 may be connected to or formed integrally with the outlet wall section 150 of the middle outlet plenum 144, and the inlet wall section of the middle inlet plenum may be connected to or formed integrally with the outlet wall section of the right outlet plenum. In this manner, each cavity 162, together with its adjacent inlet and exhaust plenums 142, 144, defines a continuous flow path through the fan tray 126 in which a corresponding fan 124 is positioned.</p> <p>Carl at 5:13–37: Referring to FIG. 4, the fan tray 126 may comprise separate top and bottom panels 168, 170 which when connected together lock the fans 124 in position in their corresponding cavities 162. The top and bottom panels 168, 170 may be made of any suitable material, such as plastic, using any appropriate technique, such as injection molding. For the particular shape of fan 124 depicted in the drawings, at least one of the top and bottom panels 168, 170 may be provided with a rectangular cutout 172 for each fan which comprises the same length as the fan housing 132 and the same width as the end flanges 138, 140. In addition, at least one but preferably both of the top and bottom panels 168, 170 may comprise two longitudinally spaced pairs of struts 174 which are configured to engage the fan housing 132 and preferably also the axial inner</p>

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Asserted Claims	Carl
	<p>portions of the end flanges 138, 140 to thereby firmly hold each fan 124 in position in the fan tray 126. In order to ensure that the fan tray 126 provides an airtight boundary between the low pressure side of the enclosure (i.e., the portion of the enclosure upstream of the fan assembly 110) and the high pressure side of the enclosure (i.e., the portion of the enclosure downstream of the fan assembly), the top panel 168 is ideally sealed to the bottom panel 170 using an appropriate number of suitable gaskets 176 positioned between corresponding halves of the wall sections 146, 150, 164, 166 and preferably also the guide vanes 154, 156.</p> <p>Carl at 7:20–39: Also, although the inlet plenums 142 for the first and fourth fans 24 are each defined by a generally concave front facing inlet wall section 146 as described above, the inlet plenums for the second and third fans are each defined by a respective generally concave front facing inlet wall section 212 which is formed on a corresponding side of an inlet plenum arm 214 that is positioned approximately midway between the fans. In a similar fashion, the exhaust plenums 144 are each defined by a respective generally concave rear facing outlet wall section 216 which is formed on a corresponding side of one of two exhaust plenum arms 218, one of which is positioned approximately midway between the first and second fans 124 a, 124 b and the other of which is positioned approximately midway between the third and fourth fans 124 c, 124 d. Also, each outlet plenum arm 218 may be pivotally connected to the fan tray 126 by a transverse pivot bar 220 or other such means in order to allow it to automatically pivot into a blocking position over the outlet end 136 of one of the adjacent fans 124 to thereby prevent the backflow of air through the corresponding exhaust plenum 144 when that fan is not operating.</p> <p>Carl at 7:57–8:8 In contrast to the previous embodiments, in the present embodiment the fans 312 do not comprise separate fan housings. Instead, the fans 312 are mounted directly in the fan tray 314. In this manner, the portions of the fan tray 314 adjacent the fans 312 in effect function as housings for the fans which define respective flow paths through the fan tray. As shown in FIG. 10, the outer ring member 320 of the outlet guide vane assembly 318 is mounted in a cavity 326 formed in the fan tray 314 between the front and rear wall sections 164, 166. The outer ring member 320 may include a radial flange 328 which is received in a corresponding groove to help secure the fan</p>

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Asserted Claims	Carl
	<p>312 in the fan tray 314. A number of elastic elements 330, such as rubber O-rings, may be mounted coaxially around the outer ring member 320 to help isolate the vibrations produced by the fan 312 from the fan tray 314. By incorporating the flow path typically formed by the fan housing directly into the fan tray 314, greater flexibility exists in optimizing the flow path within the footprint available for the fan tray and for isolating the vibrations produced by the motor from the tray.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

Exhibit D1 – Carl Invalidation Claim Chart for '265 Patent

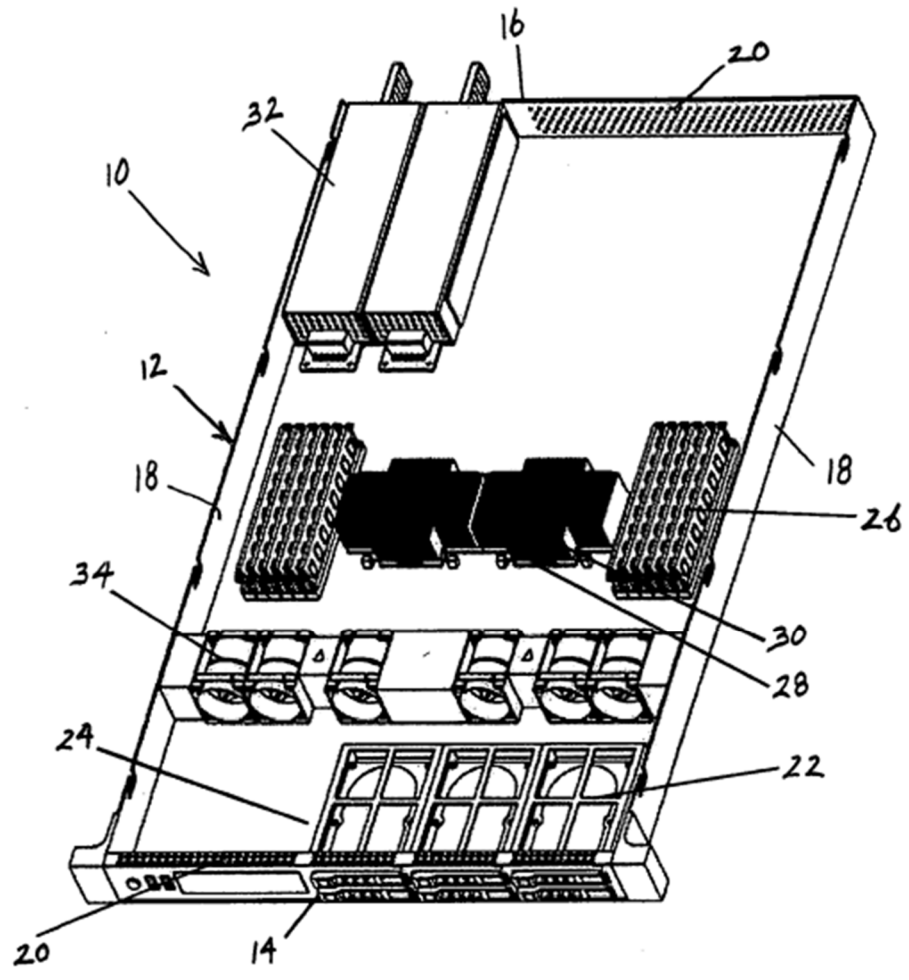
Asserted Claims	Carl
	<p style="text-align: right;">Sh</p>  <p>Carl Provisional at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<div data-bbox="651 308 1761 1141"> <p>Fig. 2</p> </div>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

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Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

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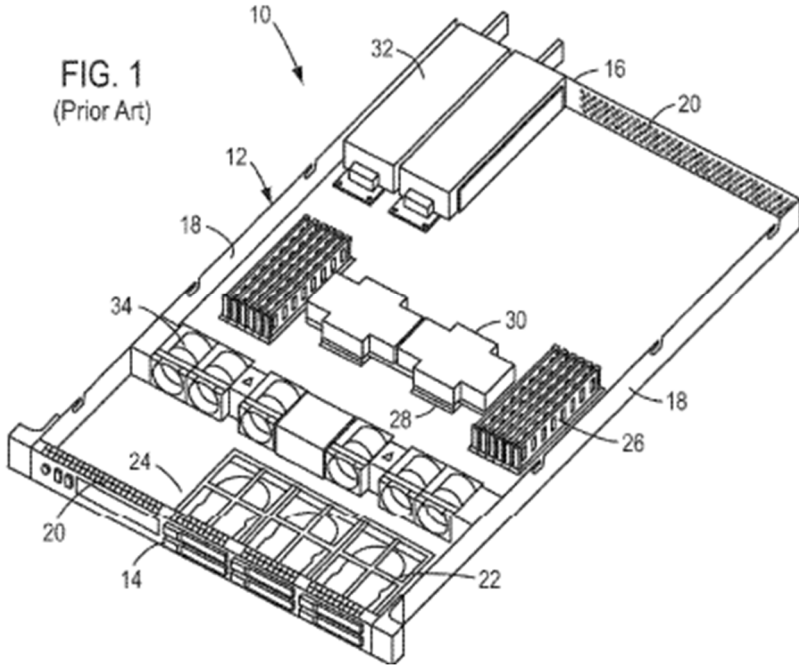
Asserted Claims	Carl
<p>[1.b] a plurality of fans which are arranged inside the housing close to the front face so as to cause cooling air to flow downstream in the longitudinal direction from the front face to the rear face of the housing;</p>	<p>Carl discloses, expressly and/or inherently, a plurality of fans which are arranged inside the housing close to the front face so as to cause cooling air to flow downstream in the longitudinal direction from the front face to the rear face of the housing.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>Carl at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>FIG. 2</p>

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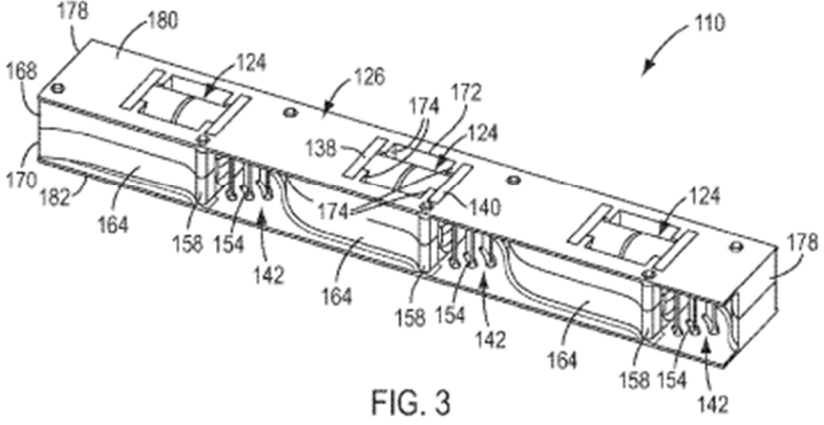
Asserted Claims	Carl
	 <p data-bbox="1087 698 1171 738">FIG. 3</p> <p data-bbox="646 803 1134 836">Carl at Fig. 4 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

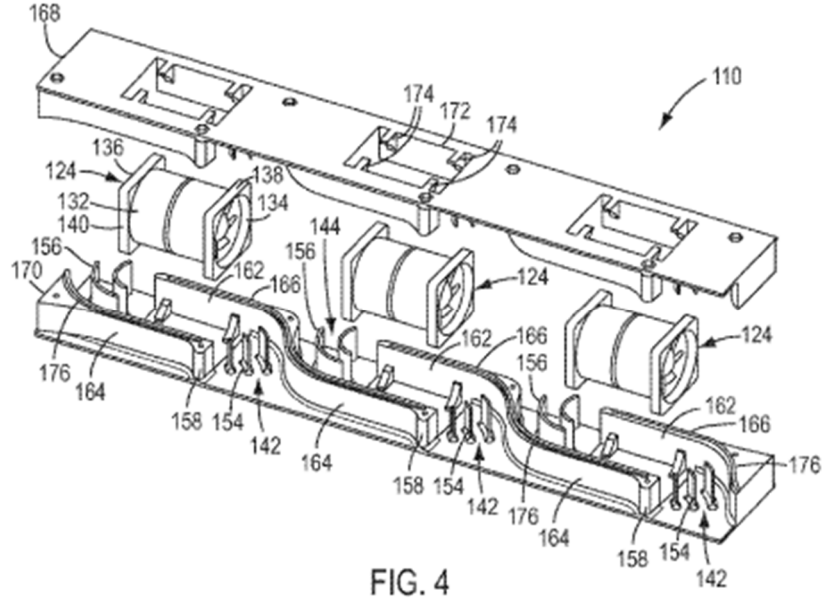
Asserted Claims	Carl
	 <p data-bbox="1115 867 1199 899">FIG. 4</p> <p data-bbox="646 987 1129 1019">Carl at Fig. 5 and accompanying text:</p>

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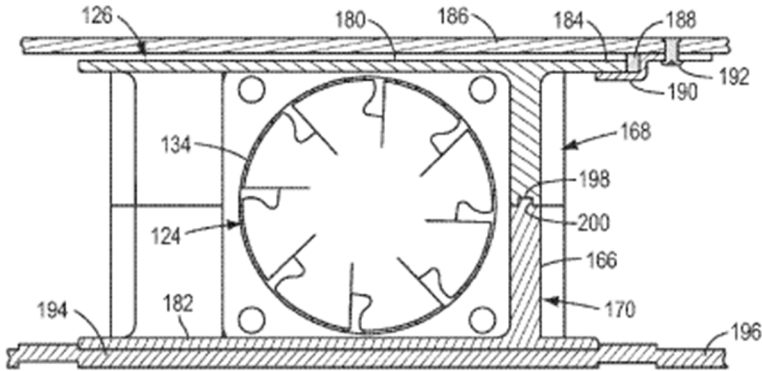
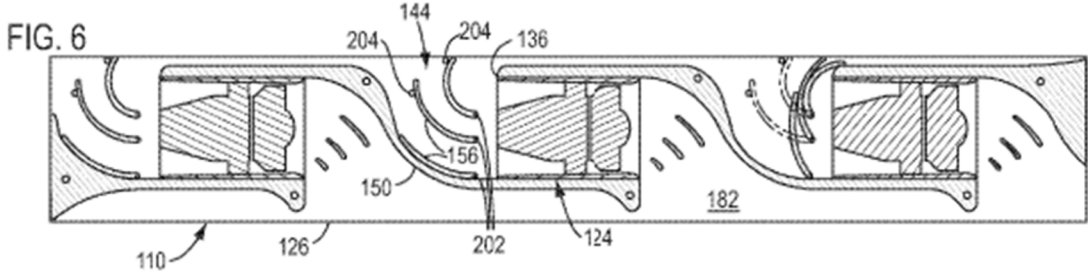
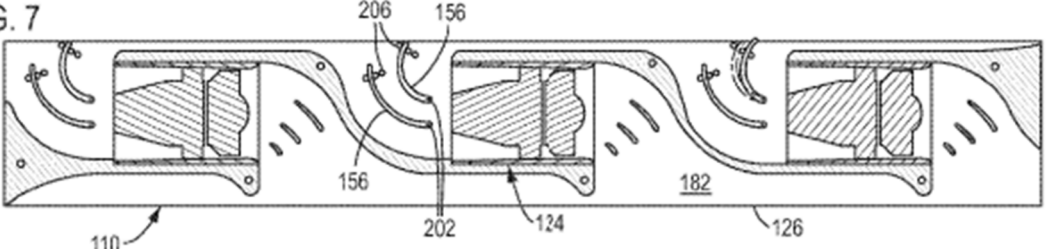
Asserted Claims	Carl
	 <p data-bbox="1003 670 1096 706">FIG. 5</p> <p data-bbox="646 716 1129 751">Carl at Fig. 6 and accompanying text:</p>  <p data-bbox="646 820 745 855">FIG. 6</p> <p data-bbox="646 1092 1129 1128">Carl at Fig. 7 and accompanying text:</p>  <p data-bbox="678 1141 766 1177">FIG. 7</p>

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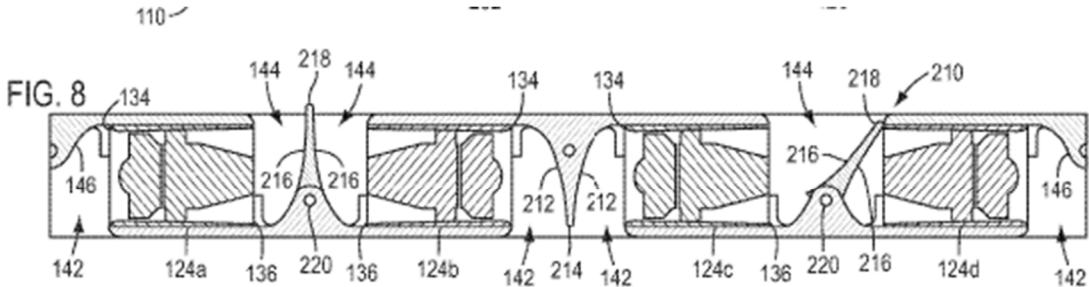
Asserted Claims	Carl
	<p>Carl at Fig. 8 and accompanying text:</p> 

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

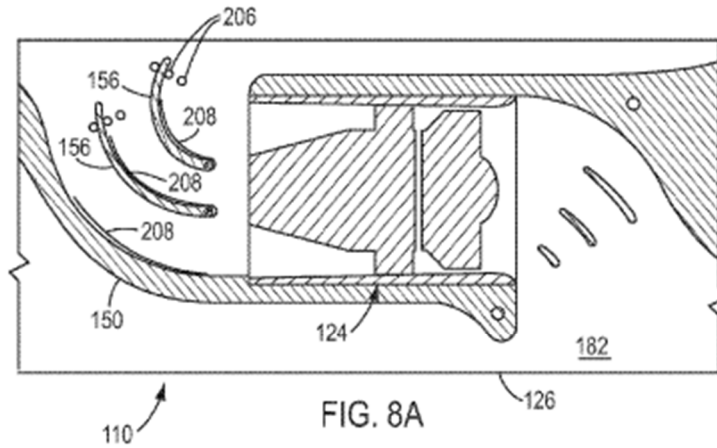
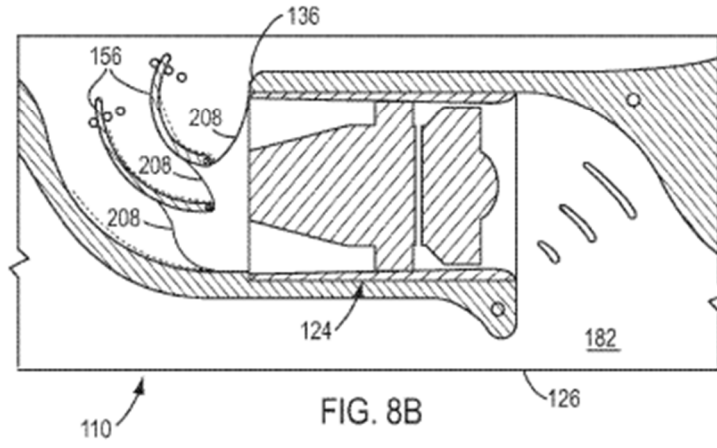
Asserted Claims	Carl
	<div data-bbox="720 263 1432 708">  <p>FIG. 8A</p> </div> <div data-bbox="720 831 1432 1276">  <p>FIG. 8B</p> </div> <p>Carl at Fig. 10 and accompanying text:</p>

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Asserted Claims	Carl
	<div data-bbox="699 292 1837 774" data-label="Image"> </div> <p data-bbox="1236 808 1339 841">FIG. 10</p> <p data-bbox="646 915 861 943">Carl at Abstract:</p> <p data-bbox="646 951 1892 1276">A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further includes a plurality of inlet plenums which each communicate with an inlet end of a corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p data-bbox="646 1333 842 1360">Carl at 1:9–20:</p>

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	<p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the sidewalls of the enclosure. This will enable the fan assembly to deliver a required airflow through the enclosure with fewer fans. The number of fans can be chosen to achieve operation at peak efficiency without concern for the uniformity of the flow across the enclosure, as would be the case if the fans were mounted parallel to the sidewalls.</p> <p>Carl at 1:21–28: Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the</p>

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	<p>rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 1:66–2:21: The present invention addresses these and other limitations in the prior art by providing a fan assembly which requires fewer fans to achieve a desired airflow distribution over the heat generating components of the server computer while also maintaining redundancy. The fan assembly includes a unique fan tray which is mounted in the enclosure and extends between the sidewalls. A number of fans are positioned in the fan tray with their axes of rotation at an angle to the sidewalls, such as ninety degrees. This orientation provides room within the standard envelope for the fan tray to include an exhaust plenum for each fan through which the airflow generated by that fan is directed. In addition, the fan tray includes a number of specially configured guide vanes which are positioned in each exhaust plenum. The exhaust plenum and guide vanes serve to distribute the airflow across a larger portion of the enclosure than would be the case if the fans were oriented with their axes of rotation parallel to the sidewalls as in the prior art. In addition, should one of the fans stop operating, the airflow distribution generated by one or both of the adjacent fans will be sufficient to cool the components. Thus, the fan assembly of the present invention requires fewer fans than the prior art.</p> <p>Carl at 2:22–36:</p>

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	<p>Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 2:45: FIG. 1 is a perspective view of a prior art computer server;</p> <p>Carl at 2:46–49: FIG. 2 is a top cross sectional view of one embodiment of the fan assembly of the present invention shown installed in an exemplary server computer, most of the components of which have been removed for clarity;</p> <p>Carl at 2:50–51: FIG. 3 is a perspective view of the fan assembly shown in FIG. 2;</p> <p>Carl at 2:52–53: FIG. 4 is an exploded perspective view of the fan assembly shown in FIG. 2;</p> <p>Carl at 2:54–56: FIG. 5 is a partial side cross sectional view of one embodiment of means for sealing the fan assembly to the enclosure of the server computer;</p> <p>Carl at 2:57–60:</p>

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	<p>FIG. 6 is a top cross sectional view of another embodiment of the fan assembly of the present invention which comprises one embodiment of a means for preventing the back flow of air through the fan assembly;</p> <p>Carl at 2:61–64: FIG. 7 is a top cross sectional view of a further embodiment of the fan assembly of the present invention which comprises an embodiment of a means for adjusting the orientation of the exhaust guide vane components of the invention;</p> <p>Carl at 2:65–3:3: FIG. 8A is a partial top cross sectional view of another embodiment of the fan assembly of the present invention which comprises both the guide vane adjustment means of FIG. 7 and second embodiment of the backflow prevention means, with the backflow prevention means shown in the open position;</p> <p>Carl at 3:4–5: FIG. 8B is a view similar to FIG. 8A, but showing the backflow preventing means in the closed position;</p> <p>Carl at 3:6–7: FIG. 9 is a top cross sectional view of yet another embodiment of h fan assembly of the present invention; and</p> <p>Carl at 3:8–10: FIG. 10 is a perspective, partial cross sectional view of still another embodiment of the fan assembly of the present invention.</p> <p>Carl at 3:14–20: The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p>

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Asserted Claims	Carl
	<p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl at 3:40–52: Referring also to FIGS. 3 and 4, the fan assembly 110 includes a number of fans 124, in this example three, which are mounted in a generally rectangular fan tray 126. The fans 124 are preferably vane-axial fans, such as the Flurry™ 100 Series vane-axial fan manufactured by Xcelaero Corporation of San Luis Obispo, Calif. In this example, each fan 124 includes an impeller 128 which is driven by a motor 130 that is supported in a cylindrical fan housing 132 defining an inlet end 134 of the fan and an outlet end 136 of the fan. Although not required, the fan housing 132 may also be provided with a generally square inlet end flange 138 which surrounds the inlet end 134 and a generally square outlet end flange 140 which surrounds the outlet end 136.</p> <p>Carl at 3:53–62: As shown most clearly in FIG. 2, each fan 124 is oriented such that its axis of rotation A forms an angle α with the sidewalls 122. The angle α is preferably between about 20° and 90°. More preferably, the angle α is between about 45° and 90°. In the embodiment of the invention shown in FIG. 2, the axis of rotation A of each fan 124 is perpendicular to the sidewalls 122, i.e., the</p>

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Asserted Claims	Carl
	<p>angle α is 90°. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the sidewalls 122.</p> <p>Carl at 3:63–4:14: In order to maintain the air flow generated by the fans 124 generally parallel to the sidewalls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the sidewalls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>Carl at 4:15–28: In designing the inlet and outlet plenums 142, 144, the radius RE of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius RI of the inlet wall sections 146 may then be determined given the radius RE, the number of fans 124 in the fan assembly 110, and the length of the fan tray 126 (which in most cases corresponds to the width of the enclosure 116). Finally, the radii RE and RI may be adjusted empirically to obtain a desired air flow over the components 114. For example, in an embodiment of a fan assembly which comprises three 1.37-inch diameter Flurry™ Series 100 fans mounted in a fan tray 15.87 inches long and oriented with their axes of rotation perpendicular to the sidewalls, RI may be about 1.4 inches and RE may be about 1.4 inches.</p> <p>Carl at 4:29–45:</p>

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	<p>In the exemplary embodiment of the invention shown in the drawings, each inlet plenum 142 is provided with a number of optional inlet guide vanes 154 and each exhaust plenum 144 is provided with a number of exhaust guide vanes 156. The inlet guide vanes 154, if present, assist the inlet plenum 142 in turning the airflow into the fans 124 and also spread the airflow uniformly across the fan inlet 134. The inlet guide vanes 154 also serve as finger guards for the fans 124. In addition to aiding the exhaust plenum 144 in turning the airflow exiting the fans 124 into a direction generally parallel to the sidewalls 122, the exhaust guide vanes 156 spread the airflow across the components 114. The exhaust guide vanes 156 also serve to inhibit the backflow of air through a corresponding fan 124 which is not operating. The number and configuration of the inlet and exhaust guide vanes 154, 156 may be determined empirically for a given fan assembly 110 and server computer 112.</p> <p>Carl at 4:46–57: In addition to the inlet guide vanes 154, the inventors have discovered that the distribution of the airflow forward of the fan assembly 110 and through the inlet plenum 142 may be improved by providing each inlet plenum with a corresponding inlet lip 158. As shown most clearly in FIG. 2, each inlet lip 158 comprises a preferably annular projection which extends frontward from a forward edge 160 of the inlet end 134 of the fan housing 132. The configuration of the inlet lip 158 may be determined empirically for a given fan assembly 110 and server computer 112. An optimal geometry for the lip 158 has the lowest power draw and noise for a desired flow through the enclosure 116.</p> <p>Carl at 4:58–5:12: Referring still to FIGS. 2-4, each fan 124 may be mounted in a respective cavity 162 which is formed in the fan tray 126 between a corresponding pair of generally longitudinal front and rear wall sections 164, 166. In this particular embodiment of the invention, the right end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the inlet lip 158 of the adjacent inlet plenum 142. In addition, the left end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the outlet wall section 150 of the adjacent exhaust plenum 144, and the right end (as viewed in FIG. 2) of each rear wall section 166 is connected to or formed integrally with the inlet wall section 146 of the adjacent inlet plenum 142. Furthermore, the inlet wall section 146 of the left inlet plenum 142 may be connected to or</p>

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	<p>formed integrally with the outlet wall section 150 of the middle outlet plenum 144, and the inlet wall section of the middle inlet plenum may be connected to or formed integrally with the outlet wall section of the right outlet plenum. In this manner, each cavity 162, together with its adjacent inlet and exhaust plenums 142, 144, defines a continuous flow path through the fan tray 126 in which a corresponding fan 124 is positioned.</p> <p>Carl at 5:13–37: Referring to FIG. 4, the fan tray 126 may comprise separate top and bottom panels 168, 170 which when connected together lock the fans 124 in position in their corresponding cavities 162. The top and bottom panels 168, 170 may be made of any suitable material, such as plastic, using any appropriate technique, such as injection molding. For the particular shape of fan 124 depicted in the drawings, at least one of the top and bottom panels 168, 170 may be provided with a rectangular cutout 172 for each fan which comprises the same length as the fan housing 132 and the same width as the end flanges 138, 140. In addition, at least one but preferably both of the top and bottom panels 168, 170 may comprise two longitudinally spaced pairs of struts 174 which are configured to engage the fan housing 132 and preferably also the axial inner portions of the end flanges 138, 140 to thereby firmly hold each fan 124 in position in the fan tray 126. In order to ensure that the fan tray 126 provides an airtight boundary between the low pressure side of the enclosure (i.e., the portion of the enclosure upstream of the fan assembly 110) and the high pressure side of the enclosure (i.e., the portion of the enclosure downstream of the fan assembly), the top panel 168 is ideally sealed to the bottom panel 170 using an appropriate number of suitable gaskets 176 positioned between corresponding halves of the wall sections 146, 150, 164, 166 and preferably also the guide vanes 154, 156.</p> <p>Carl at 5:38–48: The fan tray 126 is also ideally sealed to the enclosure 116 in order to effectively separate the low pressure side of the enclosure from the high pressure side of the enclosure. In order to facilitate this sealing, the fan tray 126 may comprise generally planar ends 178, a generally planar top 180 and a generally planar bottom 182 (FIG. 3). In this manner, the sides 178 may be sealed to the sidewalls 122 of the enclosure 116, the top 180 may be sealed to the top cover of the enclosure and the bottom 182 may be sealed to the bottom of the enclosure using, for example, one or more appropriately configured gaskets (not shown).</p>

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	<p>Carl at 5:49–60:</p> <p>An alternative arrangement for sealing the fan tray 126 to the enclosure 116 is shown in FIG. 5, which is a side cross sectional view of the fan assembly 110 showing the inlet end 134 of one of the fans 124. In this embodiment, the top 180 of the fan tray 126 includes a downstream-side lip 184 which is sealed to a removable top cover 186 of the enclosure 116 with a straight seal 188. The seal 188 may be positioned in an elongated seal support bracket 190 which is secured to the top cover 186 by appropriate means, such as a number of rivets 192. In addition, the bottom 182 of the fan tray 126 may be received in a corresponding recess 194 which is formed in a bottom 196 of the enclosure 116.</p> <p>Carl at 6:3–35:</p> <p>With the fan tray 126 separating the high pressure side of the enclosure 116 from the low pressure side, it is desirably to include means for preventing the backflow of air through the fan assembly 110 should one or more of the fans 124 cease operating. Referring to FIG. 6, for example, an embodiment of the fan assembly 110 is shown in which the exhaust guide vanes 156 are configured to function as a one-way valve for their corresponding exhaust plenums 144. In this embodiment, the upstream end of each exhaust guide vane 156 is connected by a corresponding pivot member 202 to the top 178 or bottom 182, or both, of the fan tray 126 to thereby enable the exhaust guide vanes to swing toward and away from the downstream end 136 of a corresponding fan 124. In addition, the fan tray 126 may be provided with a corresponding stop member for each exhaust guide vane 156 to prevent the guide vane from swinging past its appropriate position when the fan 124 is operating. For example, the stop members for the exhaust guide vanes 156 located adjacent the outlet wall sections 150 may simply be the outlet wall sections themselves, while the stop members for each of the remaining exhaust guide vanes may comprise a small protrusion 204 which is formed on the top 178 or the bottom 182, or both, of the fan tray 126. Thus, under normal operation of the fans 124, the air flow will force the exhaust guide vanes 156 into their open position against the stop members. However, when one of the fans 124 stops operating, the initial backflow of air will force its corresponding guide vanes 156 into the closed position, which is shown for the right-most fan in FIG. 6. In this regard, the closing of the guide vanes 156 may be facilitated by a suitable spring member (not</p>

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Asserted Claims	Carl
	<p>shown), such as a torsion sprang which is connected between the pivot 202 and its corresponding guide vane.</p> <p>Carl at 6:36–51: In another embodiment of the invention which is shown in FIG. 7, the fan assembly 110 is provided with means for enabling the orientation of the exhaust guide vanes 156 to be adjusted. In this embodiment, the upstream end of each exhaust guide vane 156 is connected by a corresponding pivot member 202 to the top 178 or bottom 182, or both, of the fan tray 126. In addition, for each exhaust guide vane 156 the fan tray 126 comprises a series of detents 206 which are formed on the top 178 or the bottom 182, or both, of the fan tray 126. Thus, the orientation of each exhaust guide vane 156 can be adjusted by pivoting the guide vane to a desired position between an adjacent pair of detents 206. In this manner, the orientation of the exhaust guide vanes 156 can be set during installation of the fan assembly 110, which thus allows one set of top and bottom panels 168, 170 to be used in a wide variety of applications.</p> <p>Carl at 6:52–7:3: An embodiment of the fan assembly 110 in which the backflow prevention means of the present invention is combined with the guide vane adjustment means just described is illustrated in FIGS. 8A and 8B. In this embodiment, a flexible membrane 208 is attached by suitable means to the upstream end of each exhaust guide vane 156. The membranes may made of a plastic such as acetate and comprise a rectangular configuration having a height which is sufficient to extend completely between the top 179 and bottom 182 of the fan tray 126. In normal operation of each fan 124, the membranes 208 are forced by the airflow into the open position shown in FIG. 8A against their corresponding guide vanes 156. As shown in FIG. 8B, however, when one of the fan 124 stops operating, the backflow of air forces the membranes 208 to fold back against the adjacent guide vanes 156 or the downstream end 136 of the fan to thereby block the backflow. FIGS. 8A and 8B also illustrate the pivot members 202 and detents 206 which enable each exhaust guide vane to be oriented as desired.</p> <p>Carl at 7:4–19: Yet another embodiment of the fan assembly of the present invention is shown in FIG. 9. The fan assembly of this embodiment, generally 210, is similar in many respects to the fan assembly 110</p>

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Asserted Claims	Carl
	<p>described above. Thus, the fan assembly 210 includes a plurality of fans 124, in this case four, which are mounted in a fan tray 126 that is positioned in the server computer 112 between the sidewalls 122 of the enclosure 116 (not shown). In this embodiment, however, the fans 124 are oriented such that the inlet ends 134 and outlet ends 136 of adjacent fans face each other. For example, the first and second fans 124 a, 124 b (starting from the left side of the fan assembly 210) are oriented with their outlet ends 136 facing each other, the second and third fans 124 b, 124 c are oriented with their inlet ends 134 facing each other, and the third and fourth fans 124 c, 124 d are oriented with their outlet ends facing each other.</p> <p>Carl at 7:20–39: Also, although the inlet plenums 142 for the first and fourth fans 24 are each defined by a generally concave front facing inlet wall section 146 as described above, the inlet plenums for the second and third fans are each defined by a respective generally concave front facing inlet wall section 212 which is formed on a corresponding side of an inlet plenum arm 214 that is positioned approximately midway between the fans. In a similar fashion, the exhaust plenums 144 are each defined by a respective generally concave rear facing outlet wall section 216 which is formed on a corresponding side of one of two exhaust plenum arms 218, one of which is positioned approximately midway between the first and second fans 124 a, 124 b and the other of which is positioned approximately midway between the third and fourth fans 124 c, 124 d. Also, each outlet plenum arm 218 may be pivotally connected to the fan tray 126 by a transverse pivot bar 220 or other such means in order to allow it to automatically pivot into a blocking position over the outlet end 136 of one of the adjacent fans 124 to thereby prevent the backflow of air through the corresponding exhaust plenum 144 when that fan is not operating.</p> <p>Carl at 7:40–56: A further embodiment of the invention is shown in FIG. 10. Similar to the previous embodiments, the fan assembly of this embodiment, generally 310, includes a plurality of fans 312 mounted in a single fan tray 314, the top panel of which has been omitted for clarity. In this embodiment, each fan 312 comprises an impeller 316, a motor (not visible) which is positioned axially downstream of the impeller, and an outlet guide vane assembly 318 which surrounds the motor. The outlet guide vane assembly 318 includes a hub (not shown) which is connected to or formed integrally with the motor, an outer ring member 320 which is positioned coaxially with</p>

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	<p>the hub, and a plurality of outlet guide vanes (not shown) which extend radially between the hub and the ring member. Each fan 312 may also include a diffuser tube 322 which is connected to the downstream end of the motor and a number of support struts 324 which extend radially between the diffuser tube and the fan tray 314.</p> <p>Carl at 7:57–8:8</p> <p>In contrast to the previous embodiments, in the present embodiment the fans 312 do not comprise separate fan housings. Instead, the fans 312 are mounted directly in the fan tray 314. In this manner, the portions of the fan tray 314 adjacent the fans 312 in effect function as housings for the fans which define respective flow paths through the fan tray. As shown in FIG. 10, the outer ring member 320 of the outlet guide vane assembly 318 is mounted in a cavity 326 formed in the fan tray 314 between the front and rear wall sections 164, 166. The outer ring member 320 may include a radial flange 328 which is received in a corresponding groove to help secure the fan 312 in the fan tray 314. A number of elastic elements 330, such as rubber O-rings, may be mounted coaxially around the outer ring member 320 to help isolate the vibrations produced by the fan 312 from the fan tray 314. By incorporating the flow path typically formed by the fan housing directly into the fan tray 314, greater flexibility exists in optimizing the flow path within the footprint available for the fan tray and for isolating the vibrations produced by the motor from the tray.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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Asserted Claims	Carl
	<div data-bbox="1386 251 1415 269" style="text-align: right;">Sh</div> <div data-bbox="714 280 1362 979" style="text-align: center;"> </div> <div data-bbox="646 1032 1283 1068" style="text-align: center;"> <p>Carl Provisional at Fig. 2 and accompanying text:</p> </div>

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Asserted Claims	Carl
	<p>Fig. 2</p>
	Carl Provisional at 1–2:

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	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p>

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	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

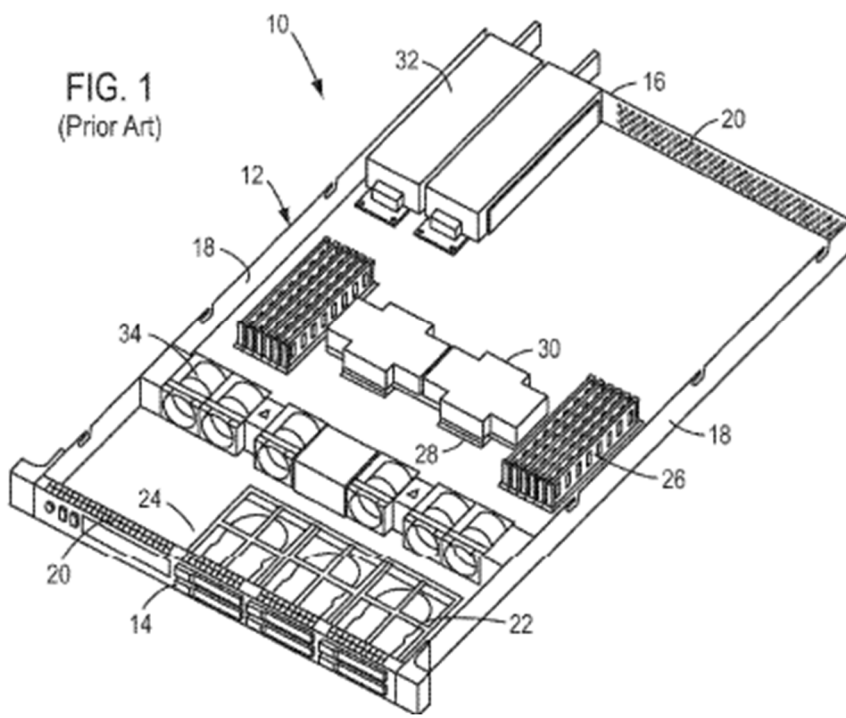
Asserted Claims	Carl
<p>[1.c] a central processing unit (CPU) which is arranged downstream of the plurality of fans in the housing and positioned to allow the cooling air to directly flow therethrough;</p>	<p>Carl discloses, expressly and/or inherently, a central processing unit (CPU) which is arranged downstream of the plurality of fans in the housing and positioned to allow the cooling air to directly flow therethrough.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>FIG. 1 (Prior Art)</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

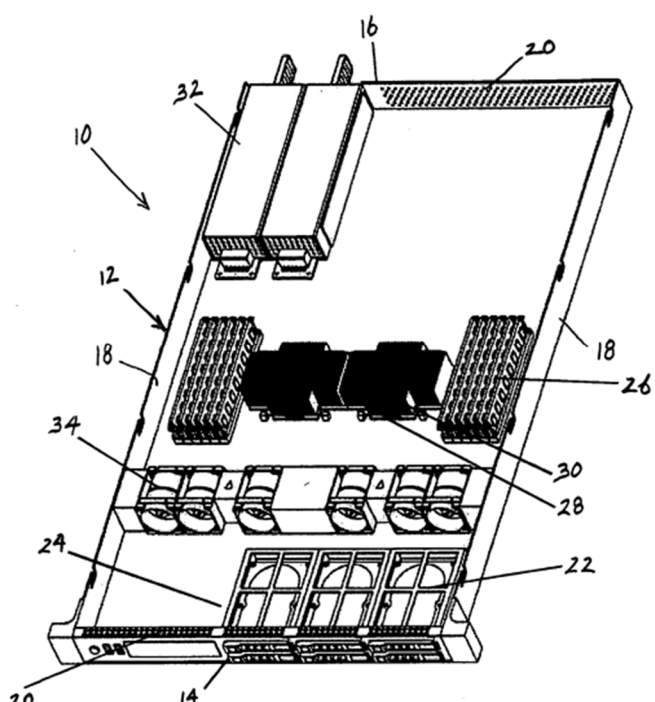
Asserted Claims	Carl
	<p>components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p> <p style="text-align: right;">Sh</p> 

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Carl Provisional at 1–2:</p> <p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

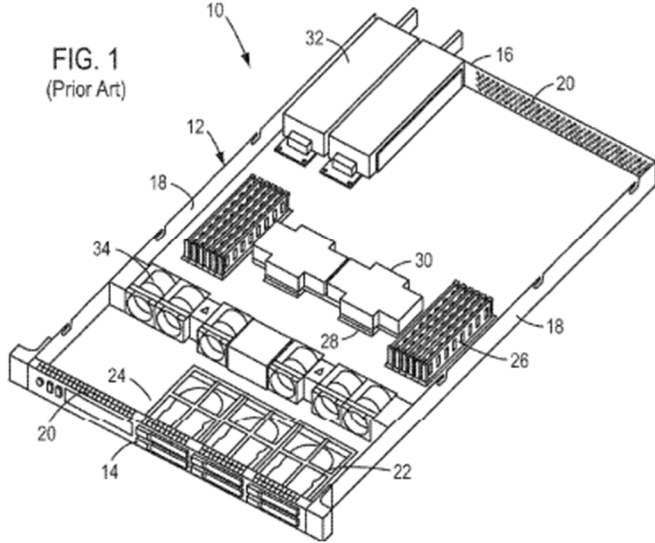
Asserted Claims	Carl
<p>[1.d] a plurality of memory devices adjacent to the CPU in a width direction, substantially normal to the longitudinal direction, of the housing; and</p>	<p>Carl discloses, expressly and/or inherently, a plurality of memory devices adjacent to the CPU in a width direction, substantially normal to the longitudinal direction, of the housing.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>Carl at 1:29–50:</p> <p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p data-bbox="651 259 1866 328">the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p data-bbox="651 386 1285 417">Carl Provisional at Fig. 1 and accompanying text:</p> <div data-bbox="711 422 1421 1149"> <p data-bbox="1388 427 1413 443">Sh</p> </div> <p data-bbox="651 1208 959 1234">Carl Provisional at 1-2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

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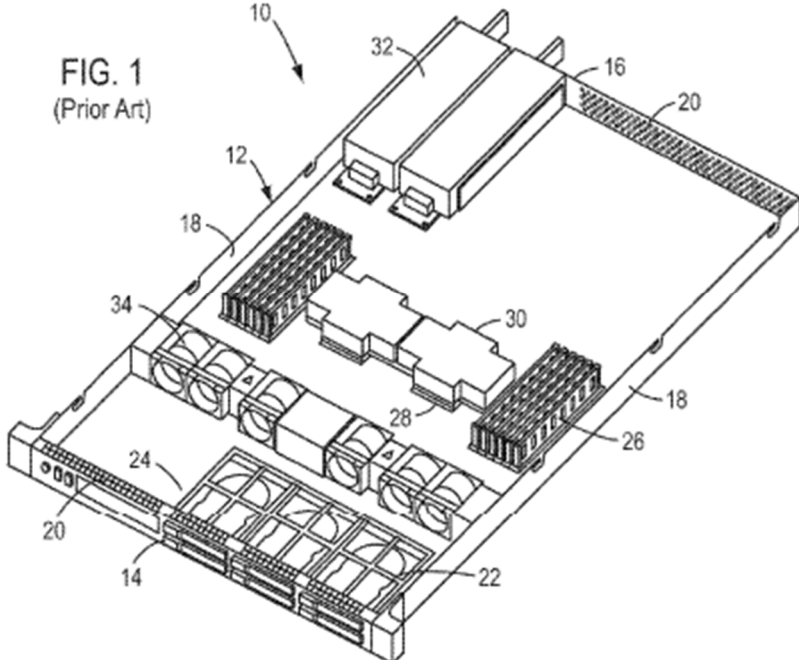
Asserted Claims	Carl
<p>[1.e] a plurality of power source units which are positioned opposite to each other and spaced out from each other in the width direction of the housing,</p>	<p>Carl discloses, expressly and/or inherently, a plurality of power source units which are positioned opposite to each other and spaced out from each other in the width direction of the housing.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>Carl at 1:29–50:</p> <p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p data-bbox="651 256 1896 402">transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p data-bbox="651 456 1283 488">Carl Provisional at Fig. 1 and accompanying text:</p> <div data-bbox="709 492 1415 1222"> </div> <p data-bbox="1381 492 1415 516">Sh</p> <p data-bbox="651 1271 953 1304">Carl Provisional at 1-2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
<p>[1.f] wherein the plurality of power source units are each positioned further downstream of the cooling air from the plurality of memory devices such that the cooling air passing through one of the memory devices passes into one of the power source units, and</p>	<p>Carl discloses, expressly and/or inherently, wherein the plurality of power source units are each positioned further downstream of the cooling air from the plurality of memory devices such that the cooling air passing through one of the memory devices passes into one of the power source units.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p> <div data-bbox="743 652 1533 1318" data-label="Image"> </div> <p>Carl at Fig. 2 and accompanying text:</p>

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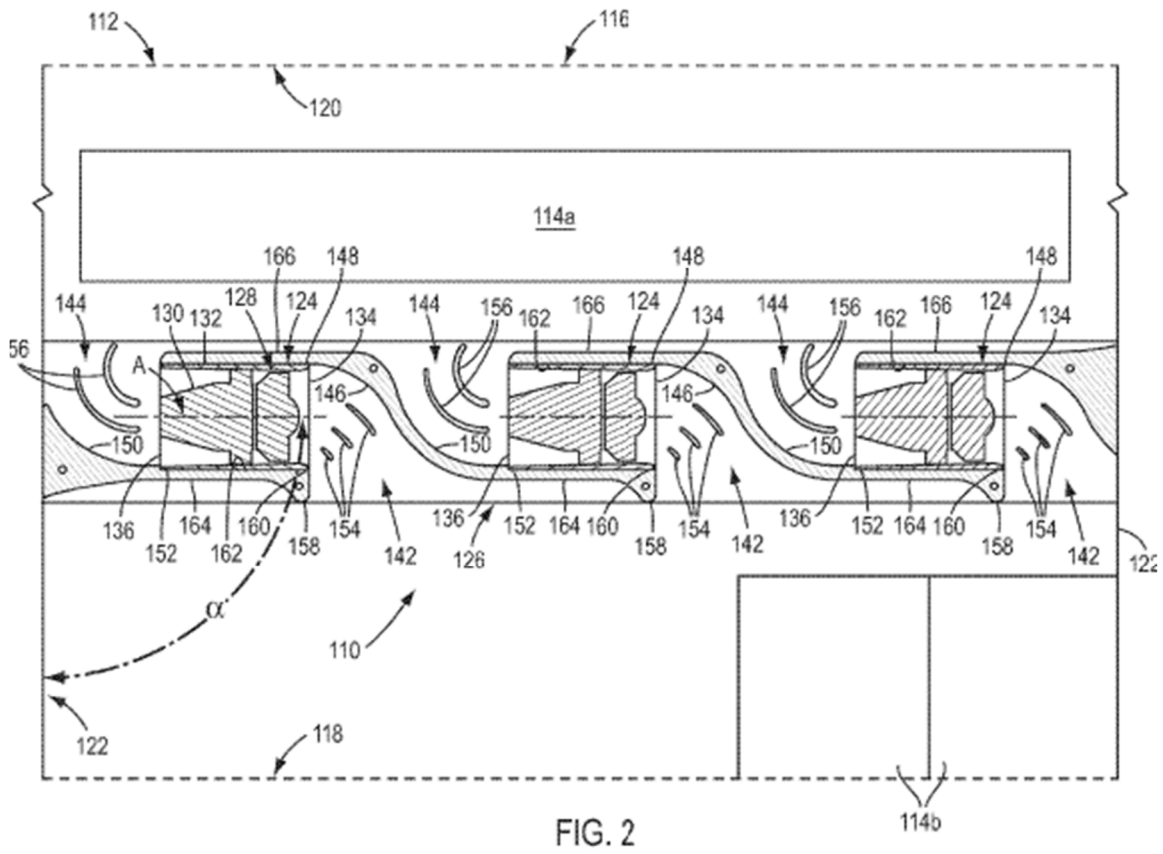
Asserted Claims	Carl
	<div data-bbox="642 279 1797 1128">  <p data-bbox="1188 1088 1274 1125">FIG. 2</p> </div> <p data-bbox="642 1149 1883 1398"> Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a </p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

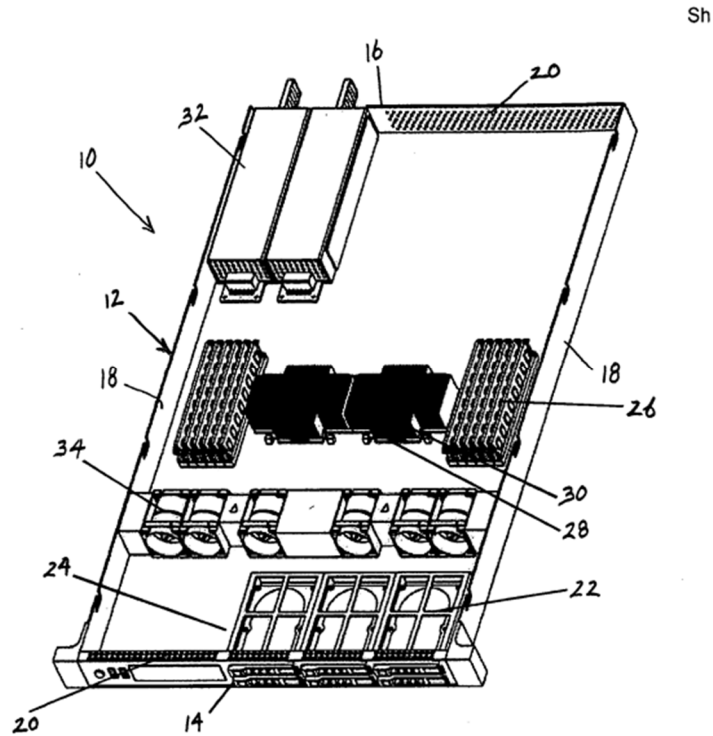
Asserted Claims	Carl
	<p data-bbox="651 300 1281 332">Carl Provisional at Fig. 1 and accompanying text:</p> <div data-bbox="709 337 1417 1068">  </div> <p data-bbox="651 1079 1281 1112">Carl Provisional at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

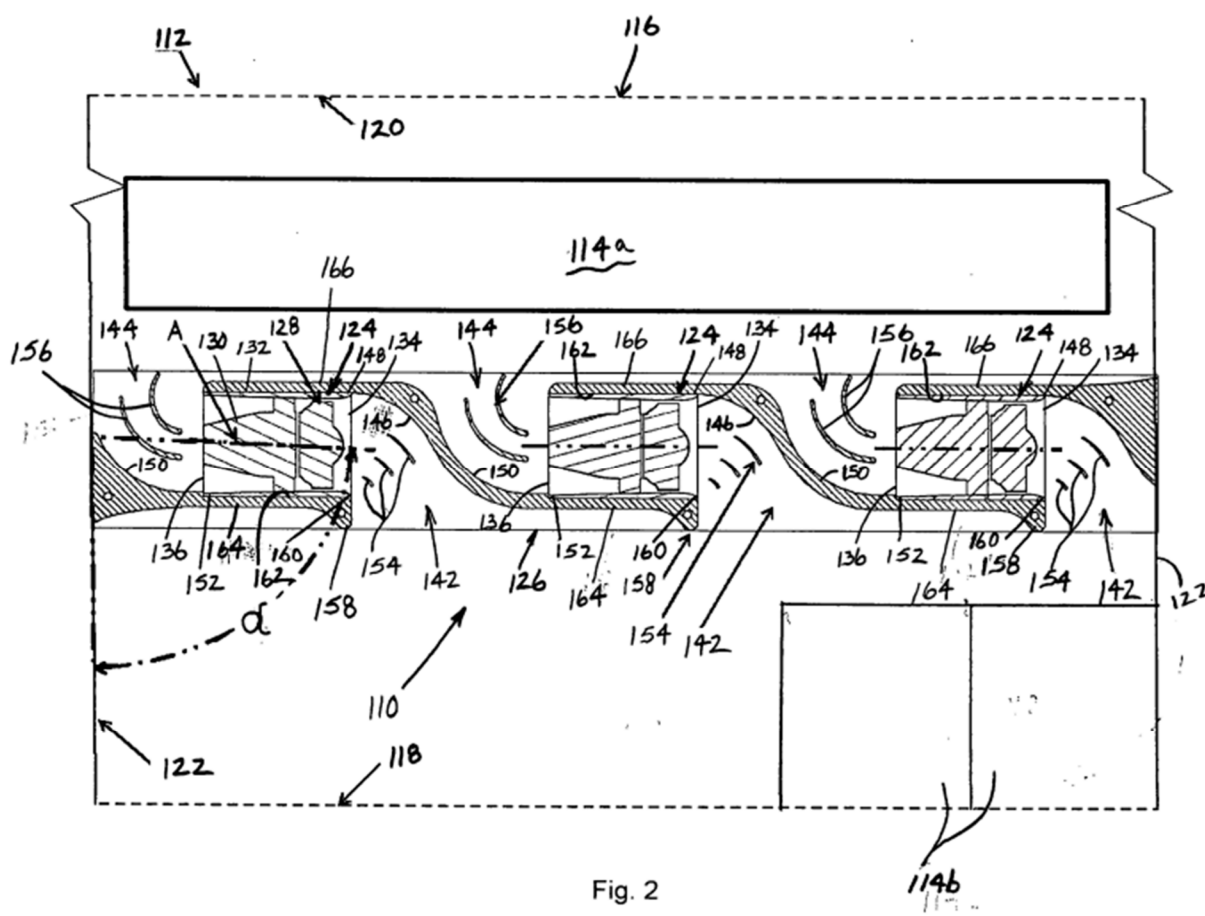
Asserted Claims	Carl
	 <p>Fig. 2</p> <p>Carl Provisional at 1–2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
<p>[1.g] wherein the plurality of power source units are each positioned not to be aligned linearly with the CPU in the longitudinal direction of the housing.</p>	<p>Carl discloses, expressly and/or inherently, wherein the plurality of power source units are each positioned not to be aligned linearly with the CPU in the longitudinal direction of the housing.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p> <div data-bbox="743 579 1533 1243" data-label="Image"> <p>FIG. 1 (Prior Art) is a perspective view of a server computer 10 housed in a 1 u rack 12. The server computer 10 includes a CPU 30, a power source unit 32, and a plurality of power source units 14, 16, 18, 20, 22, 24, 26, 28, 34. The power source units 14, 16, 18, 20, 22, 24, 26, 28, 34 are positioned not to be aligned linearly with the CPU 30 in the longitudinal direction of the housing 12.</p> </div> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

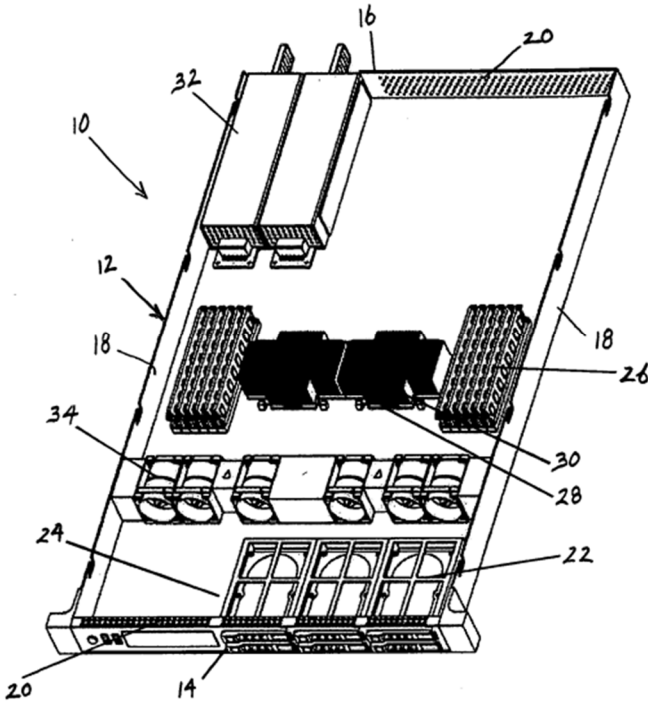
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1070 953 1102">Carl Provisional at 1–2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

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Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

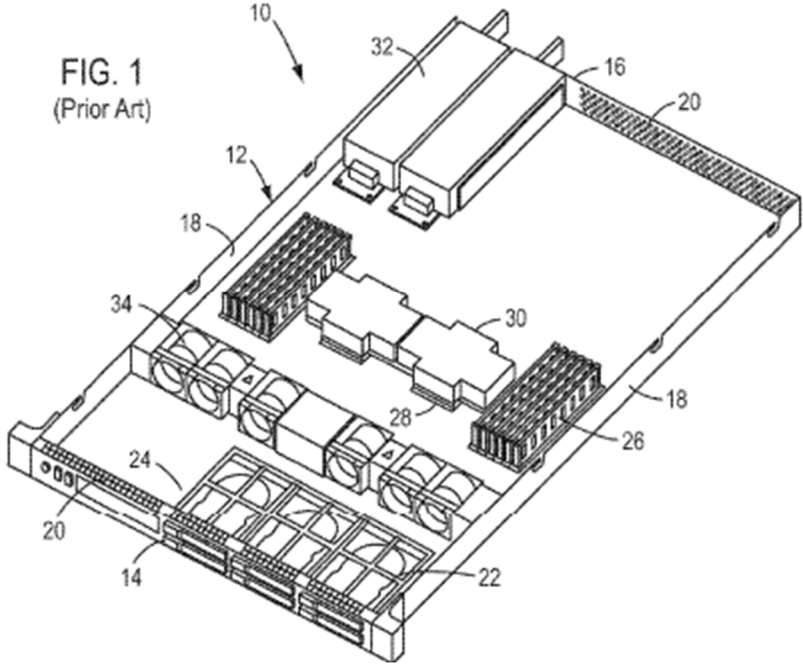
Asserted Claims	Carl
<p>2. The electronic device according to claim 1, wherein the plurality of power source units are each arranged to be pulled out from the rear face of the housing.</p>	<p>Carl discloses, expressly and/or inherently, the electronic device according to claim 1, wherein the plurality of power source units are each arranged to be pulled out from the rear face of the housing.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>Carl at 1:29–50:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <div data-bbox="751 552 1545 1211"> <p>FIG. 1 (Prior Art)</p> </div> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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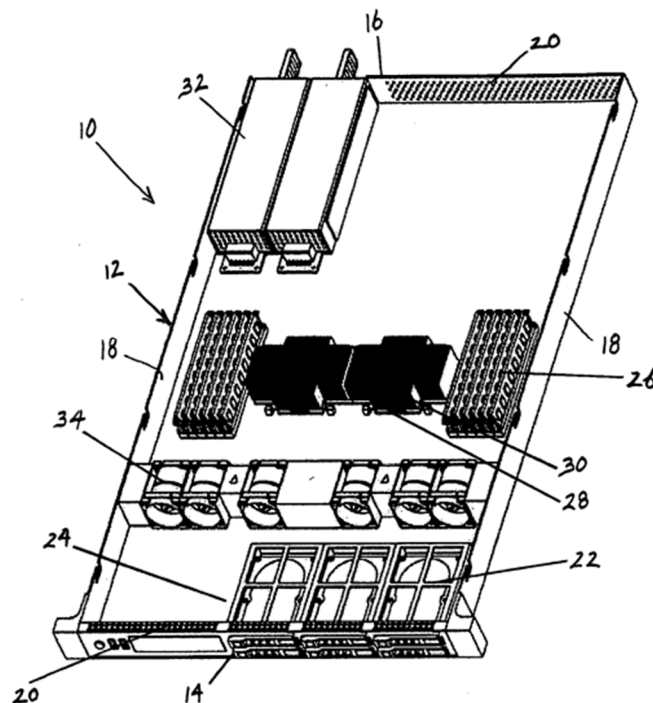
Asserted Claims	Carl
	<p data-bbox="1386 251 1419 267">Sh</p>  <p data-bbox="642 1029 949 1055">Carl Provisional at 1-2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

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Asserted Claims	Carl
<p>3. The electronic device according to claim 1, wherein the plurality of power source units are each kept inside a power box, comprising a top board and a pair of side boards, and positioned close to each of side faces of the housing so as not to directly interfere with the cooling air flown downwardly from the plurality of electronic parts.</p>	<p>Carl discloses, expressly and/or inherently, the electronic device according to claim 1, wherein the plurality of power source units are each kept inside a power box, comprising a top board and a pair of side boards, and positioned close to each of side faces of the housing so as not to directly interfere with the cooling air flown downwardly from the plurality of electronic parts.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p> <div data-bbox="743 652 1533 1318" data-label="Image"> </div> <p>Carl at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<div data-bbox="642 279 1797 1128"> <p style="text-align: center;">FIG. 2</p> </div> <p>Carl at 1:29–50:</p> <p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a</p>

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Asserted Claims	Carl
	<p>plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39:</p>

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Asserted Claims	Carl
	<p>Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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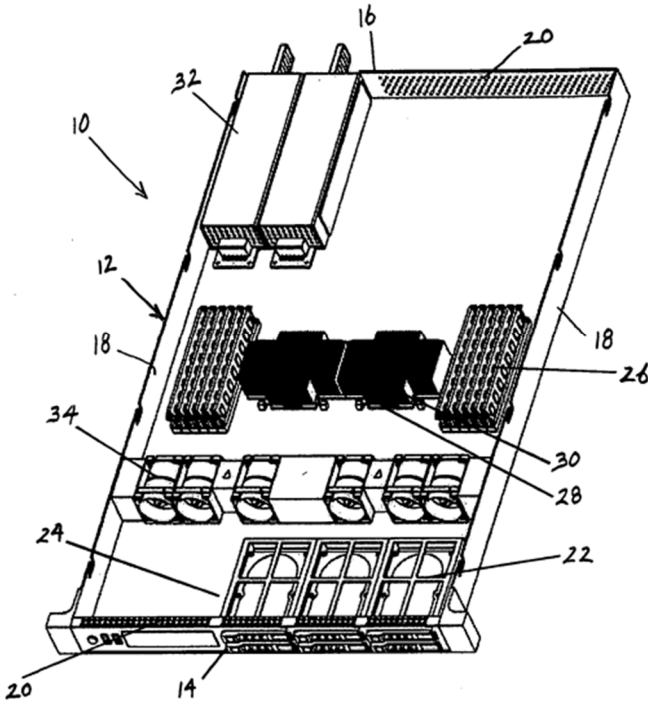
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1036 1283 1068">Carl Provisional at Fig. 2 and accompanying text:</p>

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Asserted Claims	Carl
	<p>Fig. 2</p>
	Carl Provisional at 1-2:

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

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Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
<p>[4.a] 4. A cooling structure of an electronic device comprising a plurality of fans causing cooling air to flow downstream, a central processing unit (CPU), a plurality of memory devices adjacent to the CPU, and a plurality of power source units, all of which are arranged along a flowing direction of the cooling air corresponding to a longitudinal direction in a housing,</p>	<p>Carl discloses, expressly and/or inherently, a cooling structure of an electronic device comprising a plurality of fans causing cooling air to flow downstream, a central processing unit (CPU), a plurality of memory devices adjacent to the CPU, and a plurality of power source units, all of which are arranged along a flowing direction of the cooling air corresponding to a longitudinal direction in a housing.</p> <p><i>See claims 1.pre, 1.b, 1.c, 1.e.</i></p>
<p>[4.b] wherein the CPU is arranged downstream of the plurality of fans and positioned to allow the cooling air to directly flow therethrough,</p>	<p>Carl discloses, expressly and/or inherently, wherein the CPU is arranged downstream of the plurality of fans and positioned to allow the cooling air to directly flow therethrough.</p> <p><i>See claim 1.c.</i></p>
<p>[4.c] wherein the plurality of power source units are each positioned further downstream of the cooling air from the plurality of memory devices such that the cooling air passing through one of the memory devices passes into one of the power source units,</p>	<p>Carl discloses, expressly and/or inherently, wherein the plurality of power source units are each positioned further downstream of the cooling air from the plurality of memory devices such that the cooling air passing through one of the memory devices passes into one of the power source units.</p> <p><i>See claims 1.d, 1.f.</i></p>
<p>[4.d] wherein the plurality of power source units are positioned opposite to each</p>	<p>Carl discloses, expressly and/or inherently, wherein the plurality of power source units are positioned opposite to each other and spaced out from each other in a width direction of the</p>

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Asserted Claims	Carl
<p>other and spaced out from each other in a width direction of the housing such that the plurality of power source units are positioned not to be aligned linearly with the CPU in the longitudinal direction.</p>	<p>housing such that the plurality of power source units are positioned not to be aligned linearly with the CPU in the longitudinal direction.</p> <p><i>See</i> claims 1.e, 1.g.</p>
<p>5. The electronic device according to claim 1, wherein the plurality of power source units are each positioned along an extension downstream from the plurality of memory devices.</p>	<p>Carl discloses, expressly and/or inherently, the electronic device according to claim 1, wherein the plurality of power source units are each positioned along an extension downstream from the plurality of memory devices.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>

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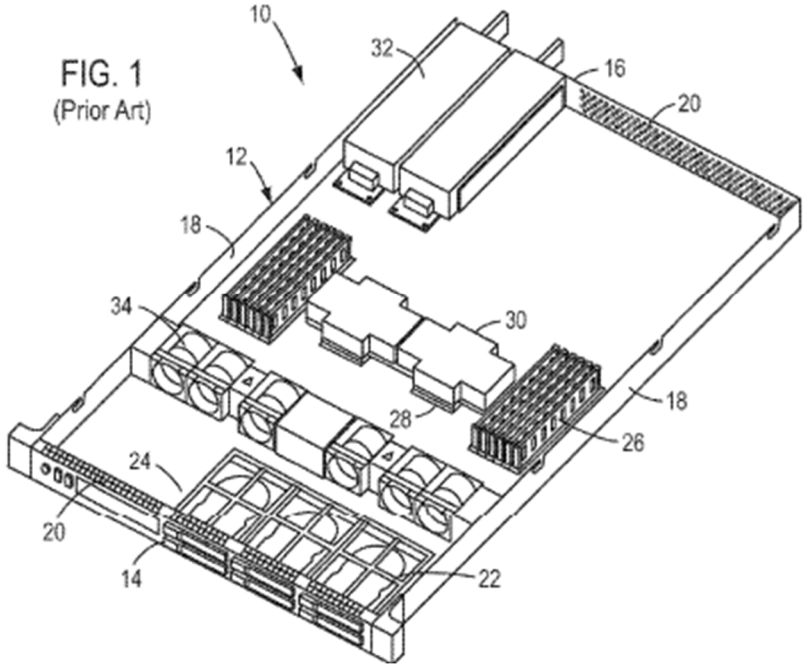
Asserted Claims	Carl
	<p data-bbox="800 380 905 451">FIG. 1 (Prior Art)</p>  <p data-bbox="646 1044 856 1073">Carl at 1:29–50:</p> <p data-bbox="646 1081 1892 1403">An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this</p>

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Asserted Claims	Carl
	<p>case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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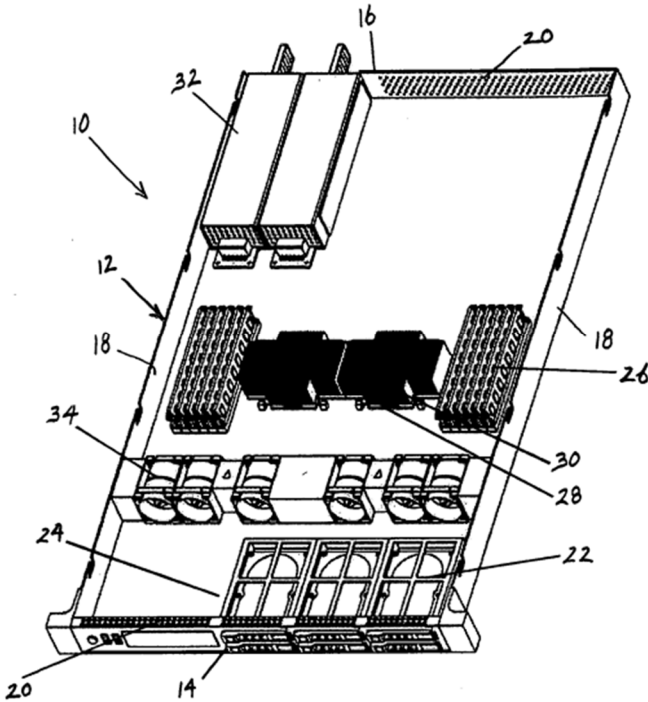
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1070 953 1102">Carl Provisional at 1–2:</p>

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Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

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	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

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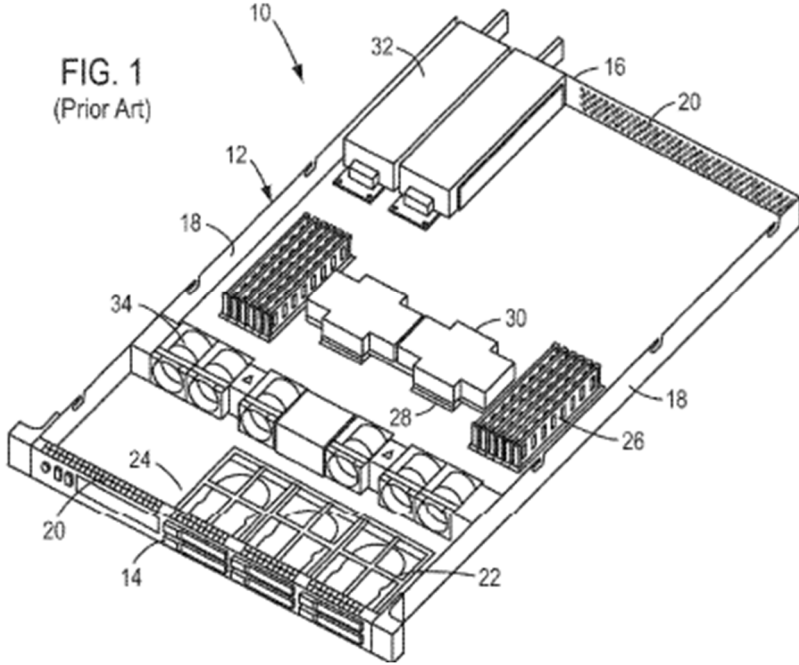
Asserted Claims	Carl
<p>6. The electronic device according to claim 1, wherein the cooling air flows through a heat sink, attached onto the CPU, and further flows downstream via a relatively large space formed between the plurality of power source units.</p>	<p>Carl discloses, expressly and/or inherently, the electronic device according to claim 1, wherein the cooling air flows through a heat sink, attached onto the CPU, and further flows downstream via a relatively large space formed between the plurality of power source units.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>Carl at Fig. 2 and accompanying text:</p>

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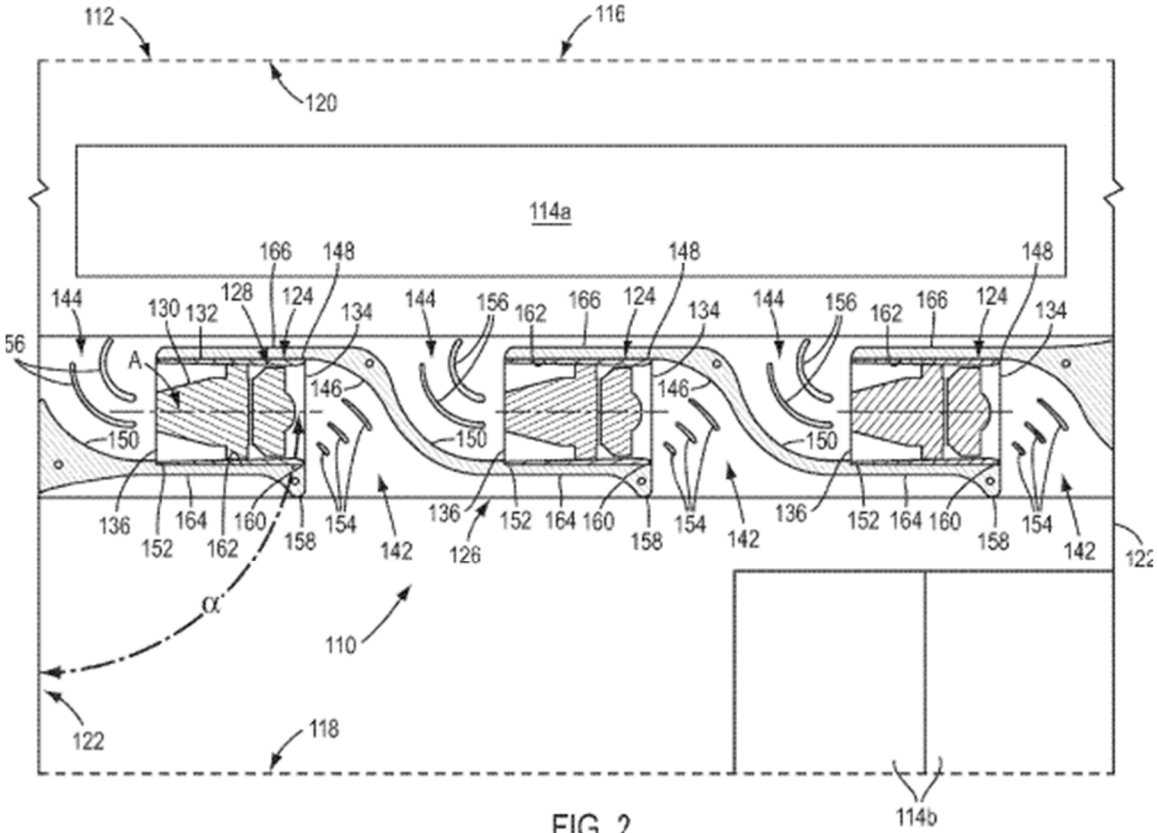
Asserted Claims	Carl
	 <p data-bbox="1192 1088 1276 1128">FIG. 2</p> <p data-bbox="646 1144 861 1177">Carl at 1:29–50:</p> <p data-bbox="646 1185 1879 1399">An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39:</p>

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Asserted Claims	Carl
	<p>Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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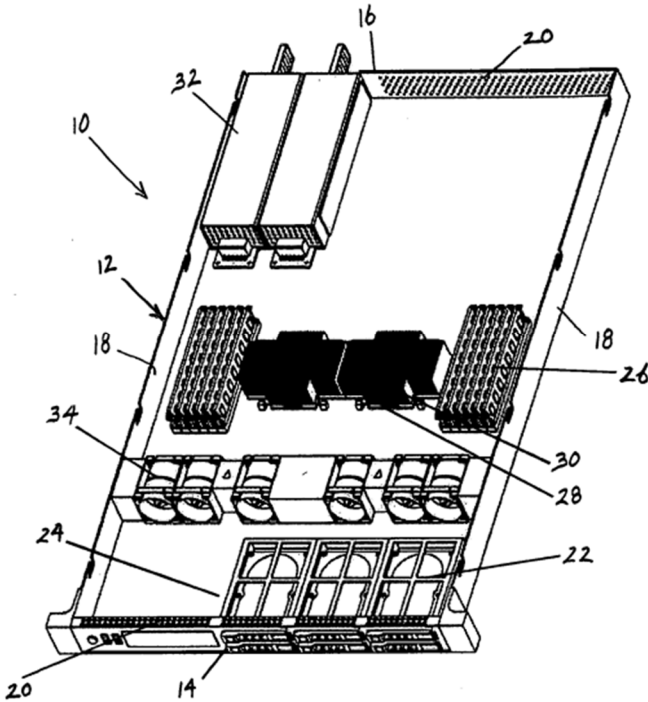
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1036 1283 1068">Carl Provisional at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<div data-bbox="651 316 1862 1211"> </div>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

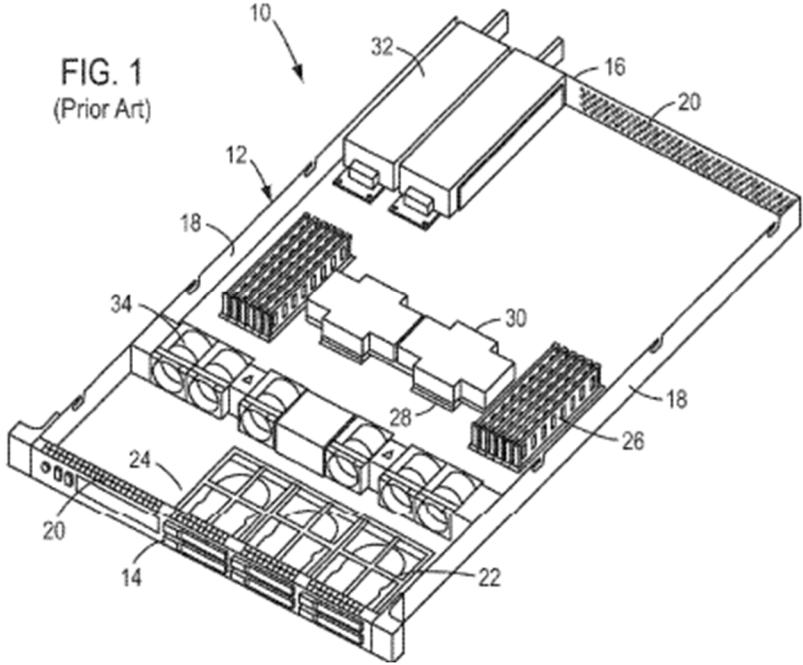
Asserted Claims	Carl
<p>7. The cooling structure of an electronic device according to claim 4, wherein the plurality of power source units are each positioned along an extension downstream from the plurality of memory devices.</p>	<p>Carl discloses, expressly and/or inherently, the cooling structure of an electronic device according to claim 4, wherein the plurality of power source units are each positioned along an extension downstream from the plurality of memory devices.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>Carl at 1:29–50:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50</p>

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Asserted Claims	Carl
	<p>watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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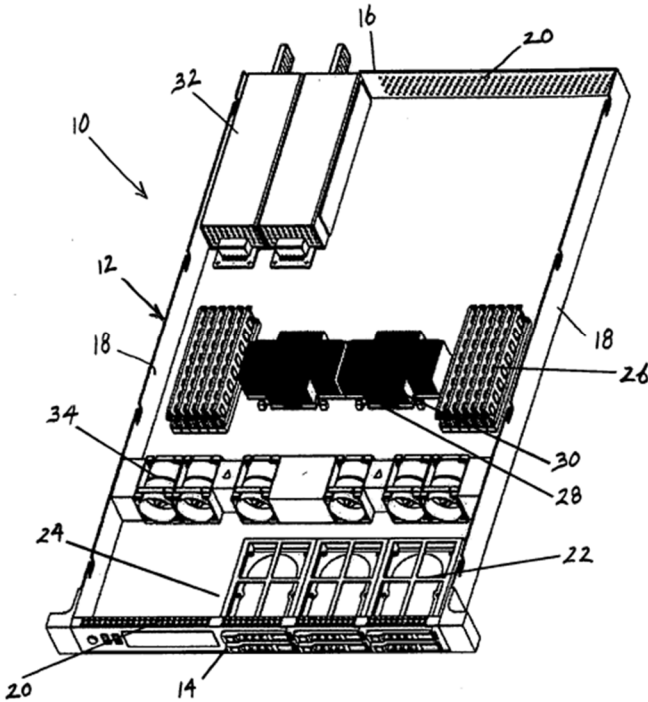
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1070 953 1102">Carl Provisional at 1–2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
[8.pre] 8. The electronic device according to claim 1, wherein	<p>Dell takes no position in these Invalidity Contentions on whether the entirety of the preamble of this claim limitation. Carl discloses, expressly and/or inherently, the electronic device according to claim 1.</p> <p><i>See claim 1.</i></p>
[8.a] the plurality of fans are arranged in a direction normal to the longitudinal direction,	<p>Carl discloses, expressly and/or inherently, the plurality of fans are arranged in a direction normal to the longitudinal direction.</p> <p><i>See claim 1.b.</i></p>
[8.b] the central processing unit is positioned in a first row,	<p>Carl discloses, expressly and/or inherently, the central processing unit is positioned in a first row.</p> <p><i>See claim 1.c.</i></p> <p>Carl at Fig. 1 and corresponding text:</p>

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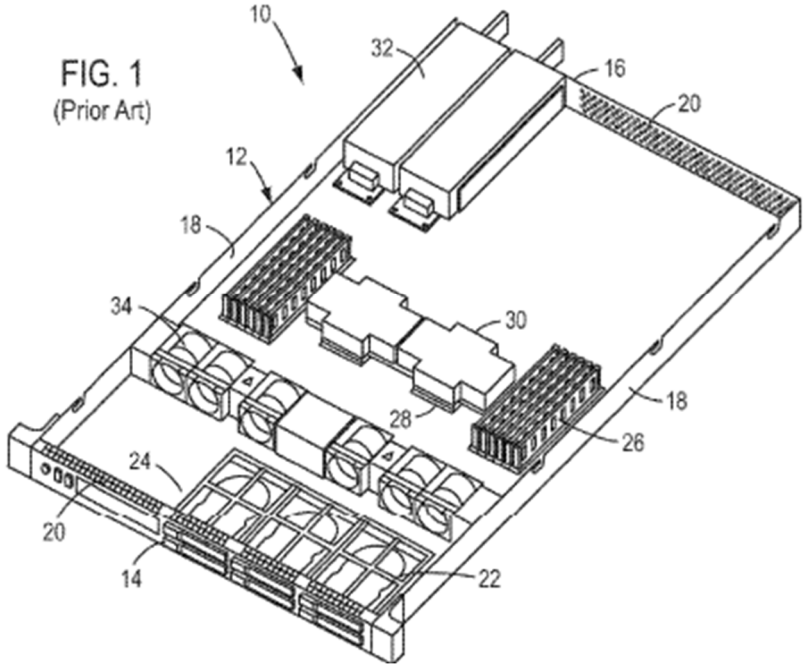
Asserted Claims	Carl
	<p data-bbox="800 380 905 451">FIG. 1 (Prior Art)</p>  <p data-bbox="646 1044 856 1073">Carl at 1:29–50:</p> <p data-bbox="646 1081 1892 1403">An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:22–36: Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further, to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical</p>

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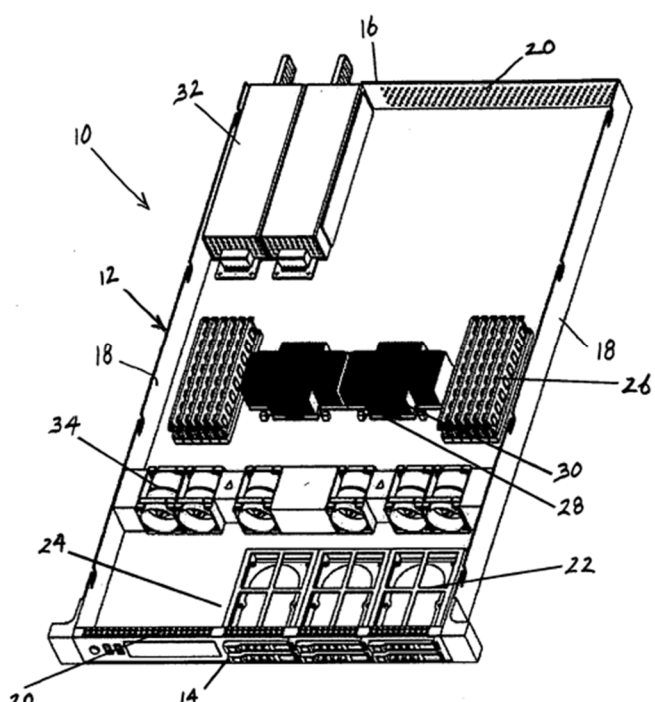
Asserted Claims	Carl
	<p>components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p> <p style="text-align: right;">Sh</p> 

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Carl Provisional at 1–2:</p> <p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p>

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Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

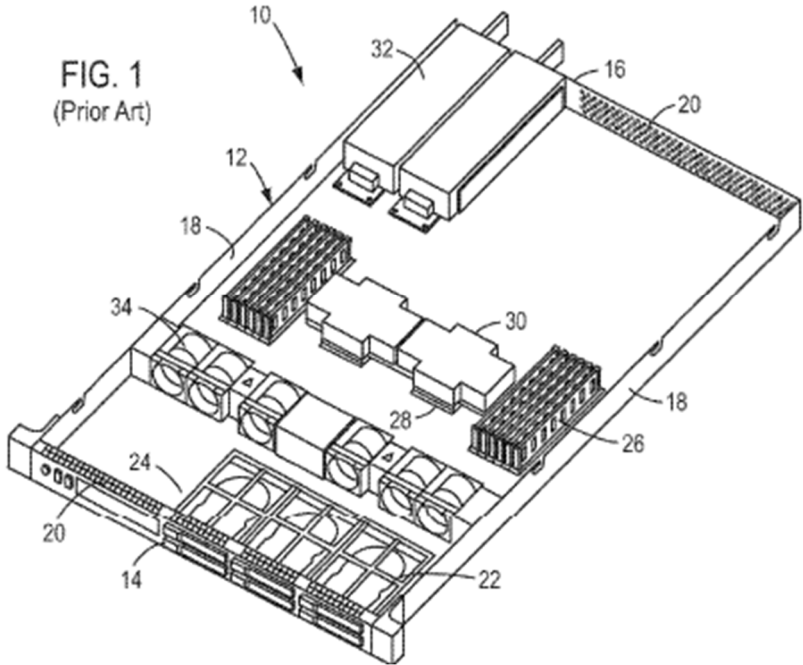
Asserted Claims	Carl
<p>[8.c] the first row extending parallel to the direction,</p>	<p>Carl discloses, expressly and/or inherently, the first row extending parallel to the direction.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and accompanying text:</p>  <p>Carl at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

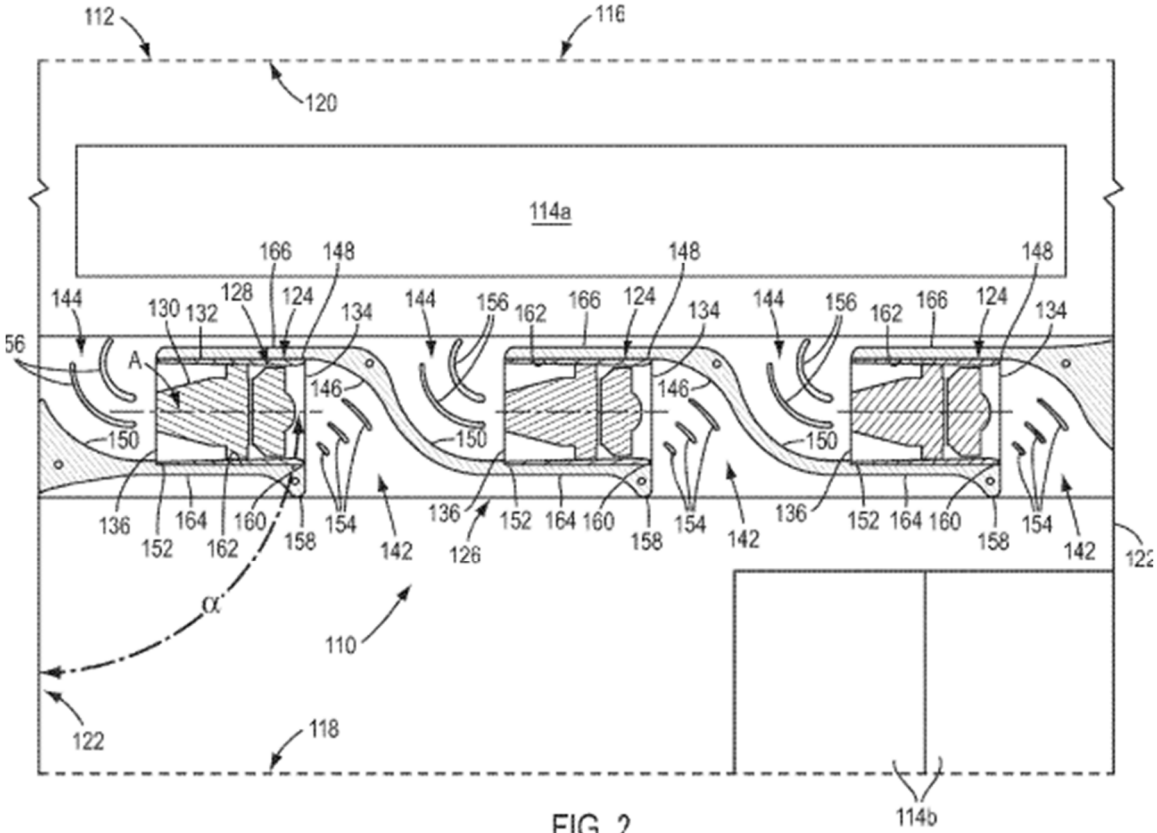
Asserted Claims	Carl
	 <p>FIG. 2</p> <p>Carl at Abstract: A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further includes a plurality of inlet plenums which each communicate with an inlet end of a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl at 3:63–4:14: In order to maintain the air flow generated by the fans 124 generally parallel to the sidewalls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the sidewalls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>Carl at 4:46–57: In addition to the inlet guide vanes 154, the inventors have discovered that the distribution of the airflow forward of the fan assembly 110 and through the inlet plenum 142 may be improved by providing each inlet plenum with a corresponding inlet lip 158. As shown most clearly in FIG. 2,</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>each inlet lip 158 comprises a preferably annular projection which extends frontward from a forward edge 160 of the inlet end 134 of the fan housing 132. The configuration of the inlet lip 158 may be determined empirically for a given fan assembly 110 and server computer 112. An optimal geometry for the lip 158 has the lowest power draw and noise for a desired flow through the enclosure 116.</p> <p>Carl at 4:58–5:12: Referring still to FIGS. 2-4, each fan 124 may be mounted in a respective cavity 162 which is formed in the fan tray 126 between a corresponding pair of generally longitudinal front and rear wall sections 164, 166. In this particular embodiment of the invention, the right end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the inlet lip 158 of the adjacent inlet plenum 142. In addition, the left end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the outlet wall section 150 of the adjacent exhaust plenum 144, and the right end (as viewed in FIG. 2) of each rear wall section 166 is connected to or formed integrally with the inlet wall section 146 of the adjacent inlet plenum 142. Furthermore, the inlet wall section 146 of the left inlet plenum 142 may be connected to or formed integrally with the outlet wall section 150 of the middle outlet plenum 144, and the inlet wall section of the middle inlet plenum may be connected to or formed integrally with the outlet wall section of the right outlet plenum. In this manner, each cavity 162, together with its adjacent inlet and exhaust plenums 142, 144, defines a continuous flow path through the fan tray 126 in which a corresponding fan 124 is positioned.</p> <p>Carl at 5:13–37: Referring to FIG. 4, the fan tray 126 may comprise separate top and bottom panels 168, 170 which when connected together lock the fans 124 in position in their corresponding cavities 162. The top and bottom panels 168, 170 may be made of any suitable material, such as plastic, using any appropriate technique, such as injection molding. For the particular shape of fan 124 depicted in the drawings, at least one of the top and bottom panels 168, 170 may be provided with a rectangular cutout 172 for each fan which comprises the same length as the fan housing 132 and the same width as the end flanges 138, 140. In addition, at least one but preferably both of the top and bottom panels 168, 170 may comprise two longitudinally spaced pairs of struts 174 which are configured to engage the fan housing 132 and preferably also the axial inner</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>portions of the end flanges 138, 140 to thereby firmly hold each fan 124 in position in the fan tray 126. In order to ensure that the fan tray 126 provides an airtight boundary between the low pressure side of the enclosure (i.e., the portion of the enclosure upstream of the fan assembly 110) and the high pressure side of the enclosure (i.e., the portion of the enclosure downstream of the fan assembly), the top panel 168 is ideally sealed to the bottom panel 170 using an appropriate number of suitable gaskets 176 positioned between corresponding halves of the wall sections 146, 150, 164, 166 and preferably also the guide vanes 154, 156.</p> <p>Carl at 7:20–39: Also, although the inlet plenums 142 for the first and fourth fans 24 are each defined by a generally concave front facing inlet wall section 146 as described above, the inlet plenums for the second and third fans are each defined by a respective generally concave front facing inlet wall section 212 which is formed on a corresponding side of an inlet plenum arm 214 that is positioned approximately midway between the fans. In a similar fashion, the exhaust plenums 144 are each defined by a respective generally concave rear facing outlet wall section 216 which is formed on a corresponding side of one of two exhaust plenum arms 218, one of which is positioned approximately midway between the first and second fans 124 a, 124 b and the other of which is positioned approximately midway between the third and fourth fans 124 c, 124 d. Also, each outlet plenum arm 218 may be pivotally connected to the fan tray 126 by a transverse pivot bar 220 or other such means in order to allow it to automatically pivot into a blocking position over the outlet end 136 of one of the adjacent fans 124 to thereby prevent the backflow of air through the corresponding exhaust plenum 144 when that fan is not operating.</p> <p>Carl at 7:57–8:8 In contrast to the previous embodiments, in the present embodiment the fans 312 do not comprise separate fan housings. Instead, the fans 312 are mounted directly in the fan tray 314. In this manner, the portions of the fan tray 314 adjacent the fans 312 in effect function as housings for the fans which define respective flow paths through the fan tray. As shown in FIG. 10, the outer ring member 320 of the outlet guide vane assembly 318 is mounted in a cavity 326 formed in the fan tray 314 between the front and rear wall sections 164, 166. The outer ring member 320 may include a radial flange 328 which is received in a corresponding groove to help secure the fan</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p data-bbox="648 253 1883 470">312 in the fan tray 314. A number of elastic elements 330, such as rubber O-rings, may be mounted coaxially around the outer ring member 320 to help isolate the vibrations produced by the fan 312 from the fan tray 314. By incorporating the flow path typically formed by the fan housing directly into the fan tray 314, greater flexibility exists in optimizing the flow path within the footprint available for the fan tray and for isolating the vibrations produced by the motor from the tray.</p> <p data-bbox="648 524 1285 560">Carl Provisional at Fig. 1 and accompanying text:</p> <div data-bbox="711 566 1415 1294"> <p data-bbox="1390 566 1415 591">Sh</p> </div> <p data-bbox="648 1347 1285 1385">Carl Provisional at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

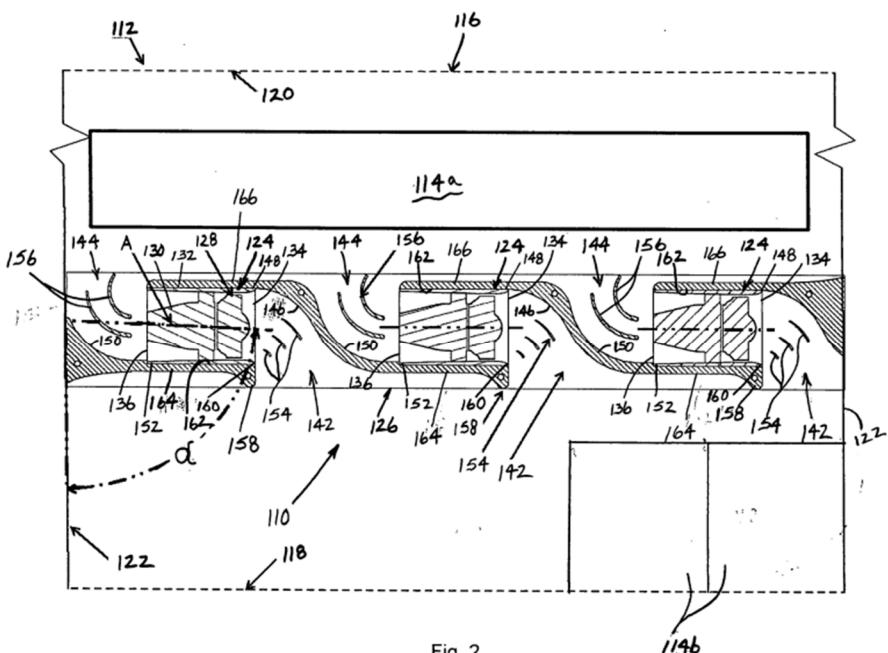
Asserted Claims	Carl
	 <p>Fig. 2</p> <p>114b</p>
	<p>Carl Provisional at 1-2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

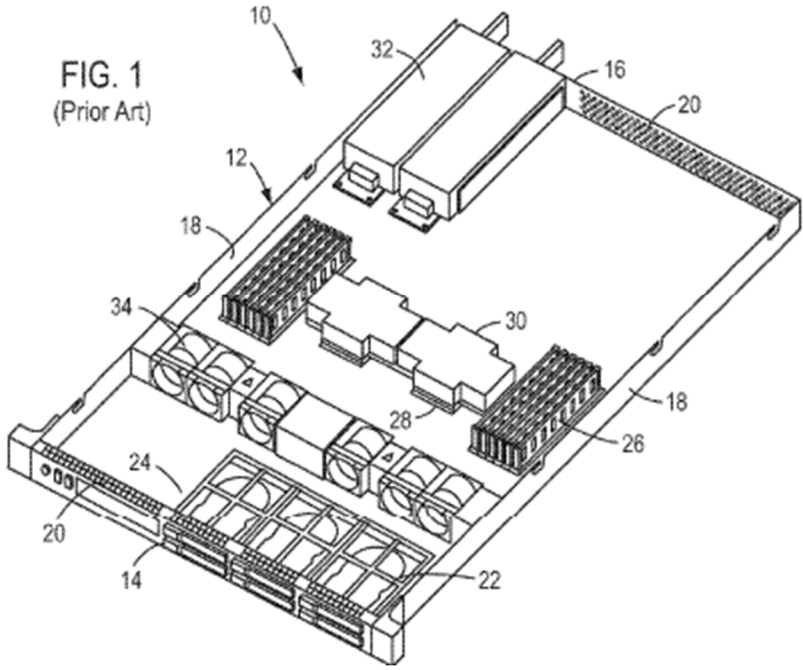
Asserted Claims	Carl
<p>[8.d] the plurality of power source units are each positioned in a second row.</p>	<p>Carl discloses, expressly and/or inherently, the plurality of power source units are each positioned in a second row.</p> <p><i>See claim 1.e.</i></p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and corresponding text:</p>  <p>FIG. 1 (Prior Art)</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Carl at 1:29–50:</p> <p>An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62:</p> <p>In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 2:22–36:</p> <p>Furthermore, installation effects resulting from having impeller leading edge planes in close proximity to those of other parallel impellers and to external obstructions in the enclosure are greatly mitigated, resulting in less power needed to achieve a given airflow. For example, the power required to produce an airflow of 50 cfm through a 1 u enclosure box was reduced from 30 watts for a prior art fan tray to 20 watts for one embodiment of the present invention. Further,</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>to produce 78 cfm through the same 1 u enclosure, the power was reduced from 80 watts to 50 watts. As a further benefit of the invention, noise produced by the fan tray is reduced. For example in free air the noise produced by three fans operating in parallel is 74.5 dB. For the same three fans configured in a tray as in the present invention, the noise was reduced to 73.5 dB for the same net flow.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

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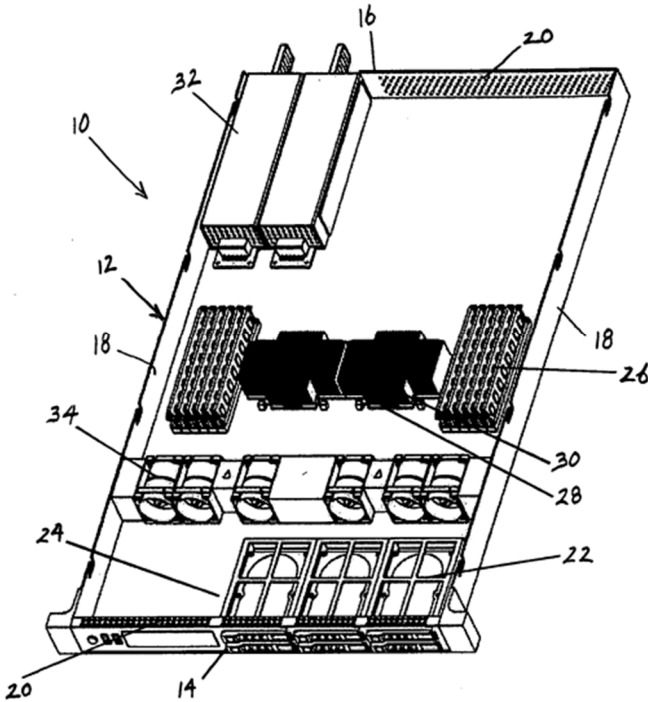
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1036 953 1066">Carl Provisional at 1-2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

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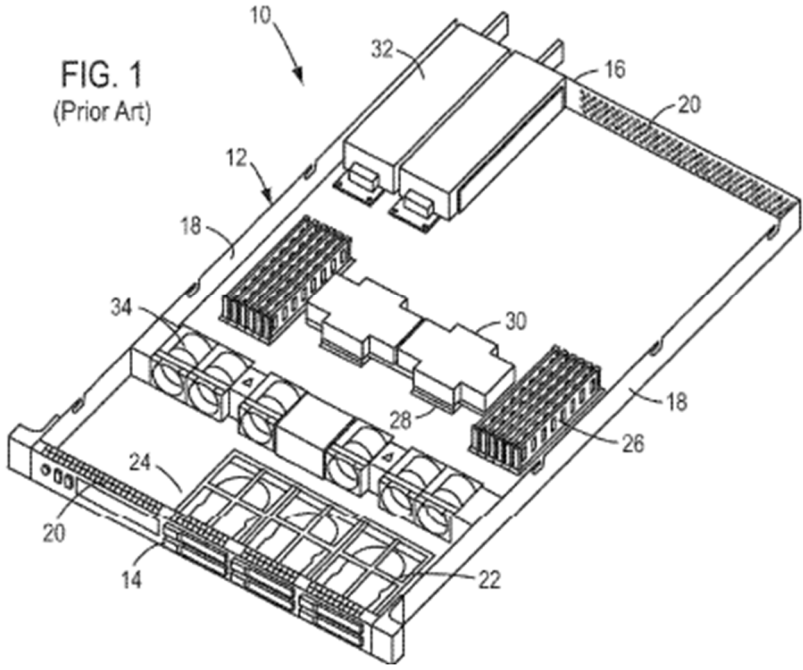
Asserted Claims	Carl
<p>[8.e] the second row extending parallel to the direction,</p>	<p>Carl discloses, expressly and/or inherently, the second row extending parallel to the direction.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and accompanying text:</p>  <p>Carl at Fig. 2 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

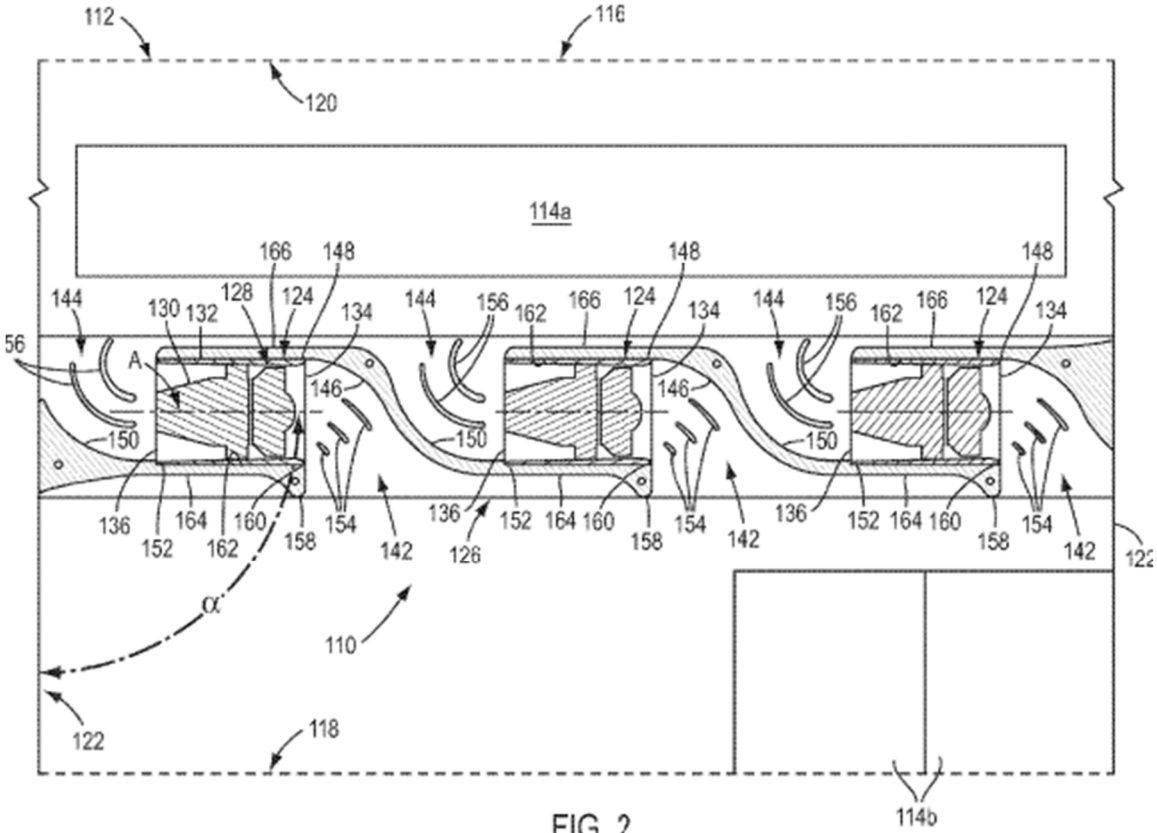
Asserted Claims	Carl
	 <p data-bbox="1192 1088 1276 1128">FIG. 2</p> <p data-bbox="646 1149 861 1182">Carl at Abstract:</p> <p data-bbox="646 1185 1864 1399">A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further includes a plurality of inlet plenums which each communicate with an inlet end of a</p>

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Asserted Claims	Carl
	<p>corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl at 3:63–4:14: In order to maintain the air flow generated by the fans 124 generally parallel to the sidewalls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the sidewalls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>Carl at 4:46–57: In addition to the inlet guide vanes 154, the inventors have discovered that the distribution of the airflow forward of the fan assembly 110 and through the inlet plenum 142 may be improved by providing each inlet plenum with a corresponding inlet lip 158. As shown most clearly in FIG. 2,</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>each inlet lip 158 comprises a preferably annular projection which extends frontward from a forward edge 160 of the inlet end 134 of the fan housing 132. The configuration of the inlet lip 158 may be determined empirically for a given fan assembly 110 and server computer 112. An optimal geometry for the lip 158 has the lowest power draw and noise for a desired flow through the enclosure 116.</p> <p>Carl at 4:58–5:12: Referring still to FIGS. 2-4, each fan 124 may be mounted in a respective cavity 162 which is formed in the fan tray 126 between a corresponding pair of generally longitudinal front and rear wall sections 164, 166. In this particular embodiment of the invention, the right end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the inlet lip 158 of the adjacent inlet plenum 142. In addition, the left end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the outlet wall section 150 of the adjacent exhaust plenum 144, and the right end (as viewed in FIG. 2) of each rear wall section 166 is connected to or formed integrally with the inlet wall section 146 of the adjacent inlet plenum 142. Furthermore, the inlet wall section 146 of the left inlet plenum 142 may be connected to or formed integrally with the outlet wall section 150 of the middle outlet plenum 144, and the inlet wall section of the middle inlet plenum may be connected to or formed integrally with the outlet wall section of the right outlet plenum. In this manner, each cavity 162, together with its adjacent inlet and exhaust plenums 142, 144, defines a continuous flow path through the fan tray 126 in which a corresponding fan 124 is positioned.</p> <p>Carl at 5:13–37: Referring to FIG. 4, the fan tray 126 may comprise separate top and bottom panels 168, 170 which when connected together lock the fans 124 in position in their corresponding cavities 162. The top and bottom panels 168, 170 may be made of any suitable material, such as plastic, using any appropriate technique, such as injection molding. For the particular shape of fan 124 depicted in the drawings, at least one of the top and bottom panels 168, 170 may be provided with a rectangular cutout 172 for each fan which comprises the same length as the fan housing 132 and the same width as the end flanges 138, 140. In addition, at least one but preferably both of the top and bottom panels 168, 170 may comprise two longitudinally spaced pairs of struts 174 which are configured to engage the fan housing 132 and preferably also the axial inner</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>portions of the end flanges 138, 140 to thereby firmly hold each fan 124 in position in the fan tray 126. In order to ensure that the fan tray 126 provides an airtight boundary between the low pressure side of the enclosure (i.e., the portion of the enclosure upstream of the fan assembly 110) and the high pressure side of the enclosure (i.e., the portion of the enclosure downstream of the fan assembly), the top panel 168 is ideally sealed to the bottom panel 170 using an appropriate number of suitable gaskets 176 positioned between corresponding halves of the wall sections 146, 150, 164, 166 and preferably also the guide vanes 154, 156.</p> <p>Carl at 7:20–39: Also, although the inlet plenums 142 for the first and fourth fans 24 are each defined by a generally concave front facing inlet wall section 146 as described above, the inlet plenums for the second and third fans are each defined by a respective generally concave front facing inlet wall section 212 which is formed on a corresponding side of an inlet plenum arm 214 that is positioned approximately midway between the fans. In a similar fashion, the exhaust plenums 144 are each defined by a respective generally concave rear facing outlet wall section 216 which is formed on a corresponding side of one of two exhaust plenum arms 218, one of which is positioned approximately midway between the first and second fans 124 a, 124 b and the other of which is positioned approximately midway between the third and fourth fans 124 c, 124 d. Also, each outlet plenum arm 218 may be pivotally connected to the fan tray 126 by a transverse pivot bar 220 or other such means in order to allow it to automatically pivot into a blocking position over the outlet end 136 of one of the adjacent fans 124 to thereby prevent the backflow of air through the corresponding exhaust plenum 144 when that fan is not operating.</p> <p>Carl at 7:57–8:8 In contrast to the previous embodiments, in the present embodiment the fans 312 do not comprise separate fan housings. Instead, the fans 312 are mounted directly in the fan tray 314. In this manner, the portions of the fan tray 314 adjacent the fans 312 in effect function as housings for the fans which define respective flow paths through the fan tray. As shown in FIG. 10, the outer ring member 320 of the outlet guide vane assembly 318 is mounted in a cavity 326 formed in the fan tray 314 between the front and rear wall sections 164, 166. The outer ring member 320 may include a radial flange 328 which is received in a corresponding groove to help secure the fan</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p data-bbox="648 253 1883 470">312 in the fan tray 314. A number of elastic elements 330, such as rubber O-rings, may be mounted coaxially around the outer ring member 320 to help isolate the vibrations produced by the fan 312 from the fan tray 314. By incorporating the flow path typically formed by the fan housing directly into the fan tray 314, greater flexibility exists in optimizing the flow path within the footprint available for the fan tray and for isolating the vibrations produced by the motor from the tray.</p> <p data-bbox="648 524 1285 560">Carl Provisional at Fig. 1 and accompanying text:</p> <div data-bbox="711 566 1415 1294"> </div>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

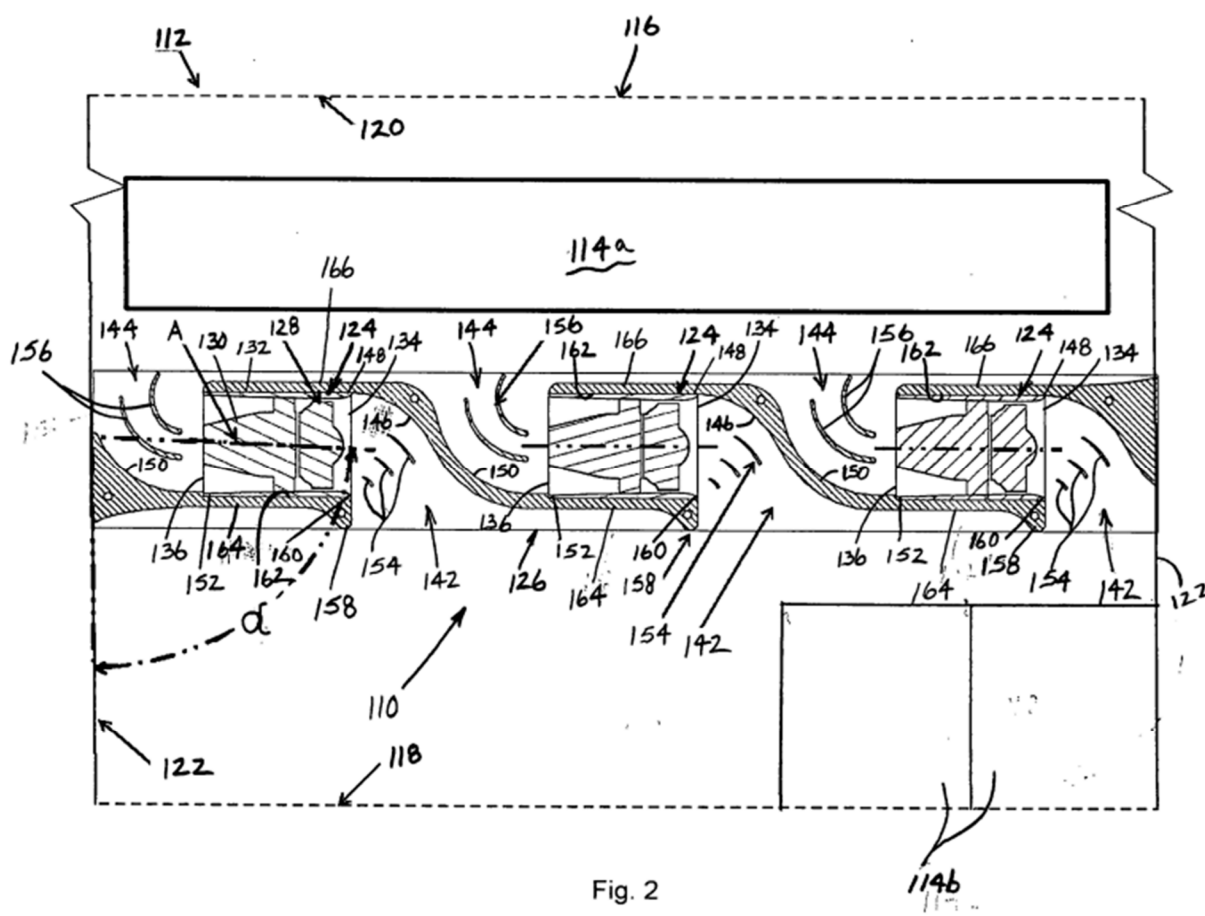
Asserted Claims	Carl
	 <p>Fig. 2</p> <p>Carl Provisional at 1–2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

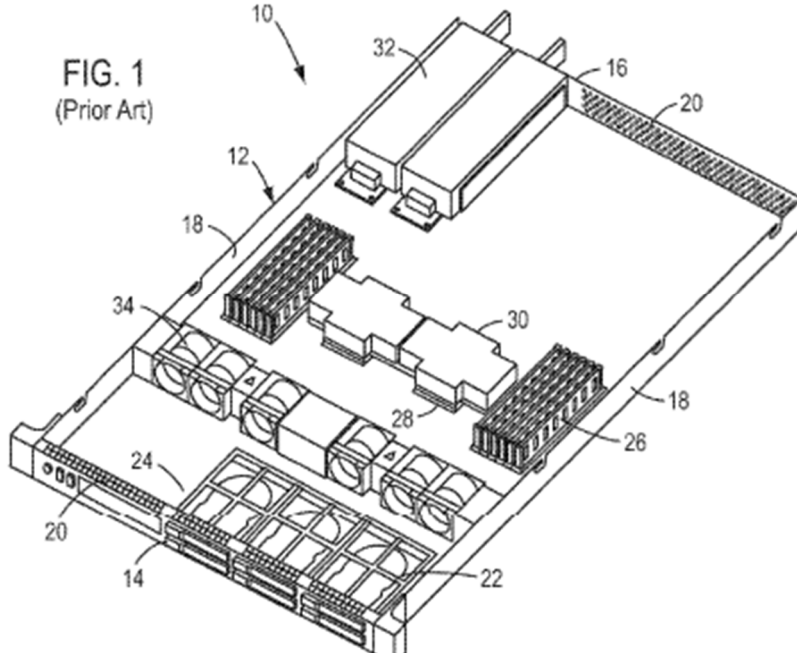
Asserted Claims	Carl
<p>[8.f] the second row being positioned farther from a longitudinal center of the housing than the first row,</p>	<p>Carl discloses, expressly and/or inherently, the second row being positioned farther from a longitudinal center of the housing than the first row.</p> <p><i>See, e.g.:</i></p> <p>Carl at Fig. 1 and accompanying text:</p>  <p>Carl at Abstract:</p> <p>A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further includes a plurality of inlet plenums which each communicate with an inlet end of a corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1 u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side ails as shown in FIG. 1, this often results in the use of a large number</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl at 3:63–4:14: In order to maintain the air flow generated by the fans 124 generally parallel to the sidewalls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the sidewalls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>Carl at 4:46–57: In addition to the inlet guide vanes 154, the inventors have discovered that the distribution of the airflow forward of the fan assembly 110 and through the inlet plenum 142 may be improved by providing each inlet plenum with a corresponding inlet lip 158. As shown most clearly in FIG. 2, each inlet lip 158 comprises a preferably annular projection which extends frontward from a forward edge 160 of the inlet end 134 of the fan housing 132. The configuration of the inlet lip 158 may be determined empirically for a given fan assembly 110 and server computer 112. An optimal geometry for the lip 158 has the lowest power draw and noise for a desired flow through the enclosure 116.</p> <p>Carl at 4:58–5:12: Referring still to FIGS. 2-4, each fan 124 may be mounted in a respective cavity 162 which is formed in the fan tray 126 between a corresponding pair of generally longitudinal front and rear wall sections 164, 166. In this particular embodiment of the invention, the right end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the inlet lip 158 of the adjacent inlet plenum 142. In addition, the left end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the outlet wall section 150 of the adjacent exhaust plenum 144, and the right end (as viewed in FIG. 2) of each rear wall section 166 is connected to or formed integrally with the inlet wall section 146 of the adjacent inlet plenum 142. Furthermore, the inlet wall section 146 of the left inlet plenum 142 may be connected to or formed integrally with the outlet wall section 150 of the middle outlet plenum 144, and the inlet wall section of the middle inlet plenum may be connected to or formed integrally with the outlet wall section of the right outlet plenum. In this manner, each cavity 162, together with its adjacent inlet and exhaust plenums 142, 144, defines a continuous flow path through the fan tray 126 in which a corresponding fan 124 is positioned.</p> <p>Carl at 5:13–37: Referring to FIG. 4, the fan tray 126 may comprise separate top and bottom panels 168, 170 which when connected together lock the fans 124 in position in their corresponding cavities 162. The top and bottom panels 168, 170 may be made of any suitable material, such as plastic, using any appropriate technique, such as injection molding. For the particular shape of fan 124 depicted in the drawings, at least one of the top and bottom panels 168, 170 may be provided</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>with a rectangular cutout 172 for each fan which comprises the same length as the fan housing 132 and the same width as the end flanges 138, 140. In addition, at least one but preferably both of the top and bottom panels 168, 170 may comprise two longitudinally spaced pairs of struts 174 which are configured to engage the fan housing 132 and preferably also the axial inner portions of the end flanges 138, 140 to thereby firmly hold each fan 124 in position in the fan tray 126. In order to ensure that the fan tray 126 provides an airtight boundary between the low pressure side of the enclosure (i.e., the portion of the enclosure upstream of the fan assembly 110) and the high pressure side of the enclosure (i.e., the portion of the enclosure downstream of the fan assembly), the top panel 168 is ideally sealed to the bottom panel 170 using an appropriate number of suitable gaskets 176 positioned between corresponding halves of the wall sections 146, 150, 164, 166 and preferably also the guide vanes 154, 156.</p> <p>Carl at 7:20–39:</p> <p>Also, although the inlet plenums 142 for the first and fourth fans 24 are each defined by a generally concave front facing inlet wall section 146 as described above, the inlet plenums for the second and third fans are each defined by a respective generally concave front facing inlet wall section 212 which is formed on a corresponding side of an inlet plenum arm 214 that is positioned approximately midway between the fans. In a similar fashion, the exhaust plenums 144 are each defined by a respective generally concave rear facing outlet wall section 216 which is formed on a corresponding side of one of two exhaust plenum arms 218, one of which is positioned approximately midway between the first and second fans 124 a, 124 b and the other of which is positioned approximately midway between the third and fourth fans 124 c, 124 d. Also, each outlet plenum arm 218 may be pivotally connected to the fan tray 126 by a transverse pivot bar 220 or other such means in order to allow it to automatically pivot into a blocking position over the outlet end 136 of one of the adjacent fans 124 to thereby prevent the backflow of air through the corresponding exhaust plenum 144 when that fan is not operating.</p> <p>Carl at 7:57–8:8</p> <p>In contrast to the previous embodiments, in the present embodiment the fans 312 do not comprise separate fan housings. Instead, the fans 312 are mounted directly in the fan tray 314. In this manner, the portions of the fan tray 314 adjacent the fans 312 in effect function as housings for</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p>the fans which define respective flow paths through the fan tray. As shown in FIG. 10, the outer ring member 320 of the outlet guide vane assembly 318 is mounted in a cavity 326 formed in the fan tray 314 between the front and rear wall sections 164, 166. The outer ring member 320 may include a radial flange 328 which is received in a corresponding groove to help secure the fan 312 in the fan tray 314. A number of elastic elements 330, such as rubber O-rings, may be mounted coaxially around the outer ring member 320 to help isolate the vibrations produced by the fan 312 from the fan tray 314. By incorporating the flow path typically formed by the fan housing directly into the fan tray 314, greater flexibility exists in optimizing the flow path within the footprint available for the fan tray and for isolating the vibrations produced by the motor from the tray.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

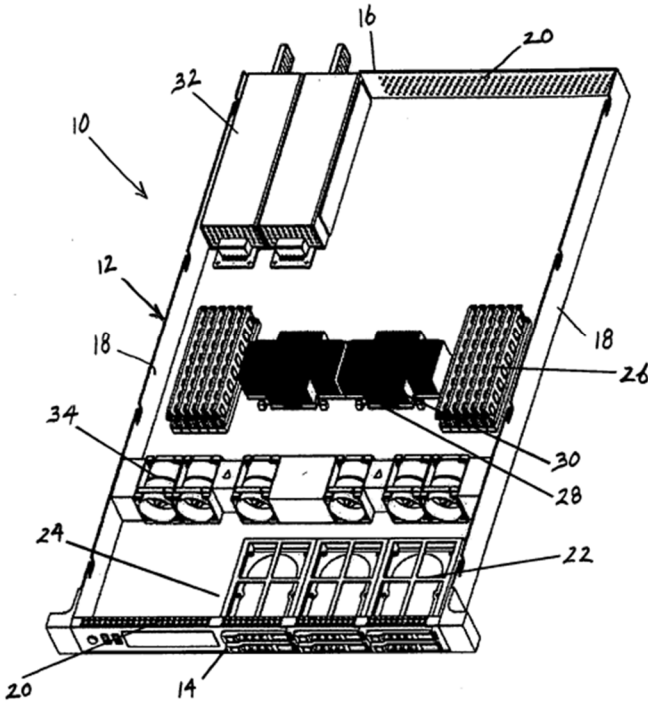
Asserted Claims	Carl
	<p data-bbox="1388 250 1415 271">Sh</p>  <p data-bbox="648 1036 953 1066">Carl Provisional at 1-2:</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p>

Exhibit D1 – Carl Invalidity Claim Chart for '265 Patent

Asserted Claims	Carl
	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>

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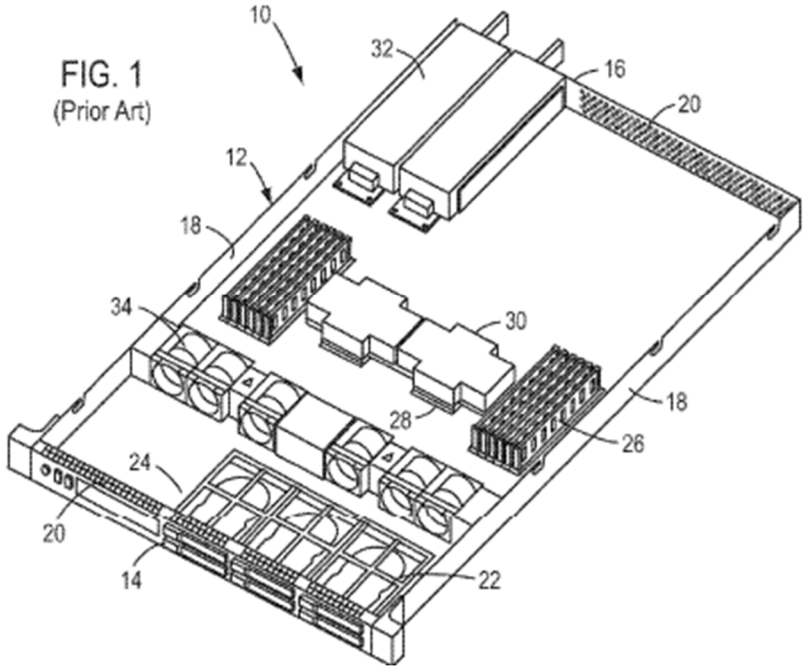
Asserted Claims	Carl
<p>[8.g] and the second row being positioned farther from the plurality of fans that the first row.</p>	<p>Carl discloses, expressly and/or inherently, and the second row being positioned farther from the plurality of fans that the first row.</p> <p><i>See, e.g.:</i> Carl at Fig. 1 and accompanying text:</p>  <p>Carl at Fig. 2 and accompanying text:</p>

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	<p style="text-align: center;">FIG. 2</p>
	<p>Carl at Abstract:</p> <p>A fan assembly for an electrical device which comprises a number of heat generating electrical components mounted in an enclosure that includes a front wall, a rear wall and two generally parallel sidewalls. The fan assembly comprises a plurality of fans which are arranged in a row that extends generally perpendicularly between the sidewalls. Each fan comprises an axis of rotation which is oriented at an angle relative to the sidewalls, and the fan assembly further</p>

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	<p>includes a plurality of inlet plenums which each communicate with an inlet end of a corresponding fan and a plurality of exhaust plenums which each communicate with an outlet end of a corresponding fan. In operation, the fans generate an airflow which is distributed through the enclosure by the inlet and exhaust plenums to thereby cool the electrical components.</p> <p>Carl at 1:29–50: An example of a prior art server computer is shown in FIG. 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel sidewalls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a corresponding heat sink 30), and one or more power supplies 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the sidewalls 18. During operation of the server computer 10, the fans 34 draw air into the enclosure 12 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>Carl at 1:51–62: In order to reduce the power consumed by the server computer, it is desirable to tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as shown in FIG. 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p>

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	<p>Carl at 3:21–39: Referring to FIG. 2, one embodiment of the fan assembly of the present invention, generally 110, is shown installed in a representative server computer 112, such as a 1 u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114 a) located downstream of the fan assembly 110, and a number of disk drives 114 b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid sidewalls 122. As shown in FIG. 2, the fan assembly 110 extends transversely between the sidewalls 122 and is positioned between the front wall 118 and the electrical components 114. In operation, the fan assembly 110 generate flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl at 3:63–4:14: In order to maintain the air flow generated by the fans 124 generally parallel to the sidewalls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the sidewalls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>Carl at 4:46–57: In addition to the inlet guide vanes 154, the inventors have discovered that the distribution of the airflow forward of the fan assembly 110 and through the inlet plenum 142 may be improved by</p>

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	<p>providing each inlet plenum with a corresponding inlet lip 158. As shown most clearly in FIG. 2, each inlet lip 158 comprises a preferably annular projection which extends frontward from a forward edge 160 of the inlet end 134 of the fan housing 132. The configuration of the inlet lip 158 may be determined empirically for a given fan assembly 110 and server computer 112. An optimal geometry for the lip 158 has the lowest power draw and noise for a desired flow through the enclosure 116.</p> <p>Carl at 4:58–5:12: Referring still to FIGS. 2-4, each fan 124 may be mounted in a respective cavity 162 which is formed in the fan tray 126 between a corresponding pair of generally longitudinal front and rear wall sections 164, 166. In this particular embodiment of the invention, the right end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the inlet lip 158 of the adjacent inlet plenum 142. In addition, the left end (as viewed in FIG. 2) of each front wall section 164 is connected to or formed integrally with the outlet wall section 150 of the adjacent exhaust plenum 144, and the right end (as viewed in FIG. 2) of each rear wall section 166 is connected to or formed integrally with the inlet wall section 146 of the adjacent inlet plenum 142. Furthermore, the inlet wall section 146 of the left inlet plenum 142 may be connected to or formed integrally with the outlet wall section 150 of the middle outlet plenum 144, and the inlet wall section of the middle inlet plenum may be connected to or formed integrally with the outlet wall section of the right outlet plenum. In this manner, each cavity 162, together with its adjacent inlet and exhaust plenums 142, 144, defines a continuous flow path through the fan tray 126 in which a corresponding fan 124 is positioned.</p> <p>Carl at 5:13–37: Referring to FIG. 4, the fan tray 126 may comprise separate top and bottom panels 168, 170 which when connected together lock the fans 124 in position in their corresponding cavities 162. The top and bottom panels 168, 170 may be made of any suitable material, such as plastic, using any appropriate technique, such as injection molding. For the particular shape of fan 124 depicted in the drawings, at least one of the top and bottom panels 168, 170 may be provided with a rectangular cutout 172 for each fan which comprises the same length as the fan housing 132 and the same width as the end flanges 138, 140. In addition, at least one but preferably both of the top and bottom panels 168, 170 may comprise two longitudinally spaced pairs of struts</p>

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	<p>174 which are configured to engage the fan housing 132 and preferably also the axial inner portions of the end flanges 138, 140 to thereby firmly hold each fan 124 in position in the fan tray 126. In order to ensure that the fan tray 126 provides an airtight boundary between the low pressure side of the enclosure (i.e., the portion of the enclosure upstream of the fan assembly 110) and the high pressure side of the enclosure (i.e., the portion of the enclosure downstream of the fan assembly), the top panel 168 is ideally sealed to the bottom panel 170 using an appropriate number of suitable gaskets 176 positioned between corresponding halves of the wall sections 146, 150, 164, 166 and preferably also the guide vanes 154, 156.</p> <p>Carl at 7:20–39: Also, although the inlet plenums 142 for the first and fourth fans 24 are each defined by a generally concave front facing inlet wall section 146 as described above, the inlet plenums for the second and third fans are each defined by a respective generally concave front facing inlet wall section 212 which is formed on a corresponding side of an inlet plenum arm 214 that is positioned approximately midway between the fans. In a similar fashion, the exhaust plenums 144 are each defined by a respective generally concave rear facing outlet wall section 216 which is formed on a corresponding side of one of two exhaust plenum arms 218, one of which is positioned approximately midway between the first and second fans 124 a, 124 b and the other of which is positioned approximately midway between the third and fourth fans 124 c, 124 d. Also, each outlet plenum arm 218 may be pivotally connected to the fan tray 126 by a transverse pivot bar 220 or other such means in order to allow it to automatically pivot into a blocking position over the outlet end 136 of one of the adjacent fans 124 to thereby prevent the backflow of air through the corresponding exhaust plenum 144 when that fan is not operating.</p> <p>Carl at 7:57–8:8 In contrast to the previous embodiments, in the present embodiment the fans 312 do not comprise separate fan housings. Instead, the fans 312 are mounted directly in the fan tray 314. In this manner, the portions of the fan tray 314 adjacent the fans 312 in effect function as housings for the fans which define respective flow paths through the fan tray. As shown in FIG. 10, the outer ring member 320 of the outlet guide vane assembly 318 is mounted in a cavity 326 formed in the fan tray 314 between the front and rear wall sections 164, 166. The outer ring member 320 may include a radial flange 328 which is received in a corresponding groove to help secure the fan</p>

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	<p>312 in the fan tray 314. A number of elastic elements 330, such as rubber O-rings, may be mounted coaxially around the outer ring member 320 to help isolate the vibrations produced by the fan 312 from the fan tray 314. By incorporating the flow path typically formed by the fan housing directly into the fan tray 314, greater flexibility exists in optimizing the flow path within the footprint available for the fan tray and for isolating the vibrations produced by the motor from the tray.</p> <p>Carl Provisional at Fig. 1 and accompanying text:</p> <div style="text-align: right; margin-bottom: 10px;">Sh</div> <p>Carl Provisional at Fig. 2 and accompanying text:</p>

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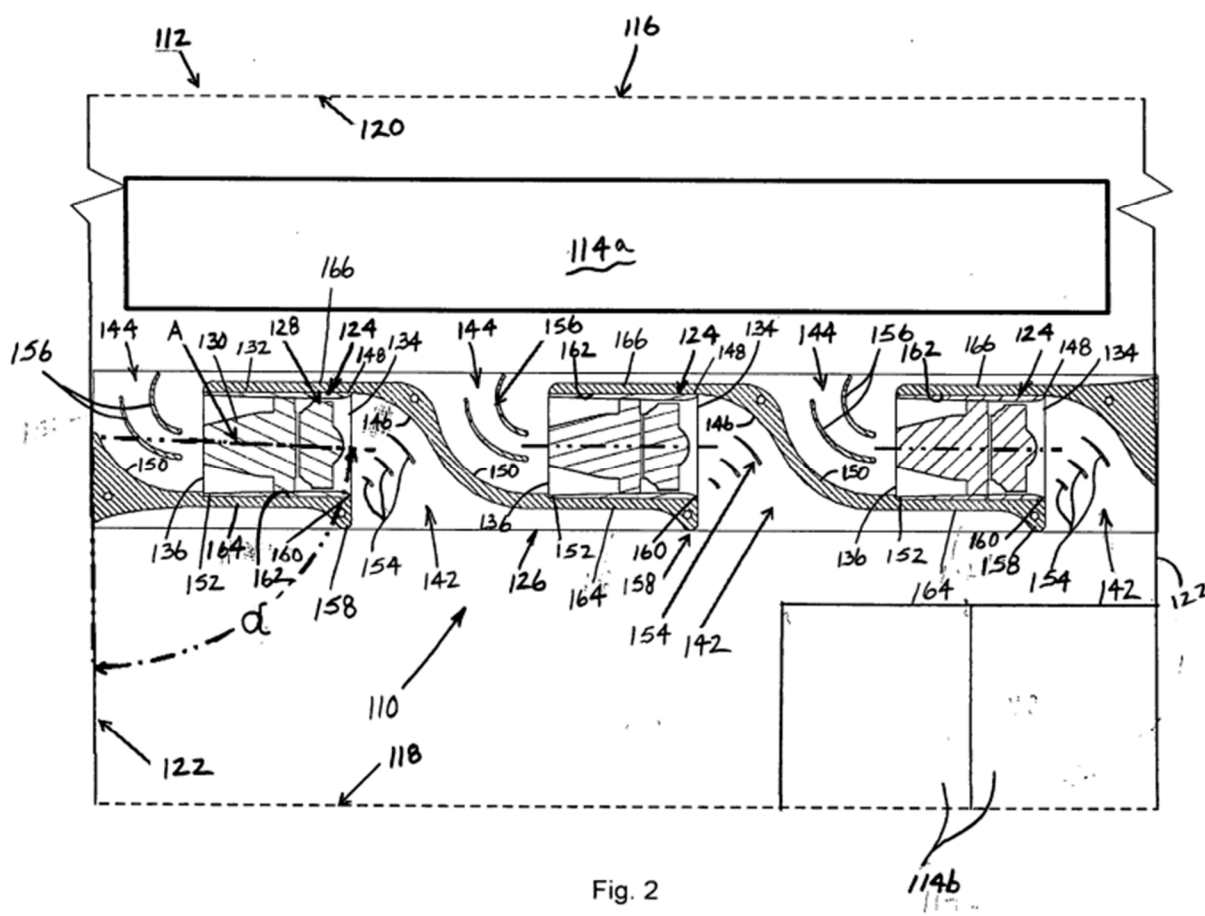
Asserted Claims	Carl
	 <p data-bbox="1218 1169 1302 1201">Fig. 2</p> <p data-bbox="651 1331 945 1364">Carl Provisional at 1-2:</p>

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	<p style="text-align: center;"><u>FAN ASSEMBLY FOR RACK OPTIMIZED SERVER COMPUTERS</u></p> <p>BACKGROUND OF THE INVENTION</p> <p>The present invention relates to a fan assembly for cooling an electronic device comprising a plurality of heat generating electrical components mounted in an enclosure, such as a server computer. In particular, the invention relates to a fan assembly comprising a row of fans which are oriented with their axis of rotation at an angle, such as ninety degrees, to the side walls of the enclosure. The fan assembly enables the required airflow distribution and magnitude through the enclosure with less power, lower noise and fewer fans.</p> <p>Prior art server computers typically include a number of heat generating electrical components mounted in an enclosure. Such computers commonly employ air to cool the components. Thus, prior art server computers usually include a number of internal fans for generating an airflow over the components. The airflow cools the components through the process of convection by absorbing the heat generated by the components and then dissipating the heat outside the enclosure.</p> <p>An example of a prior art server computer is shown in Figure 1. This server computer, generally 10, includes a number of electrical components which in this example are housed in a 1u rack enclosure 12. The rack enclosure 12 comprises a front wall 14, a rear wall 16 and two parallel side walls 18. The front and rear walls each comprise a plurality of holes or apertures 20 through which air can pass. Several of the electrical components generate heat during operation of the server computer 10, such as a number of disk drives 22 which are located in a drive bay 24, a plurality of memory modules 26, two processors 28 (each of which is positioned under a</p> <p style="text-align: center;">1</p>

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	<p style="text-align: right;">ACEL-P012</p> <p>corresponding heat sink 30), and a power supply 32. In order to dissipate the heat generated by these components, the server computer 10 also includes a number of fans 34, in this case six, which are oriented with their axes parallel to the side walls 18.</p> <p>During operation of the server computer 10, the fans 34 draw air into the enclosure 12</p> <p>5 through the apertures in the front wall 14 and force the air over the heat generating components and through the apertures in the rear wall 16. As the air flows over the components, the heat generated by the components is absorbed by the air to thereby cool the components.</p> <p>In order to reduce the power consumed by the server computer, it is desirable to</p> <p>10 tailor the airflow distribution over the components so that each component will receive the airflow required to cool the component sufficiently. The current state of the art requires that a number of fans be distributed across the enclosure to provide a uniform airflow over all of the components, as well as to provide redundancy in the event one of the fans should stop operating. With the fans oriented parallel to the side walls as</p> <p>15 shown in Figure 1, this often results in the use of a large number of fans operating at less than peak efficiency in order to generate the required airflows over each of the components.</p> <p>Carl Provisional at 4–5:</p> <p>DETAILED DESCRIPTION OF THE INVENTION</p> <p>The present invention provides an integral assembly of a plurality of fans which can be used to dissipate the heat generated by the electrical components of an</p> <p>20 electronic device, such as a computer. Although the invention has wide application to a variety of electronic devices, it will be described below in the context of a rack mounted server computer.</p> <p>Referring to Figure 2, one embodiment of the fan assembly of the present</p> <p style="text-align: center;">4</p>

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	<p>invention, generally 110, is shown installed in a representative server computer 112, such as a 1u enterprise class rack optimized server. The server computer 112 includes a number of heat generating electrical components, such as memory modules, processors and power supplies (represented generally by the rectangle 114a) located</p> <p>5 downstream of the fan assembly 110, and a number of disk drives 114b located upstream of the fan assembly. These components are mounted in an enclosure 116 which comprises an air permeable front wall 118, an air permeable rear wall 120 and two parallel, generally solid side walls 122. As shown in Figure 2, the fan assembly 110 extends transversely between the side walls 122 between the front wall 118 and the</p> <p>10 electrical components 114. In operation, the fan assembly 110 generates a flow of air which enters the enclosure 116 through the front wall 118, flows over the electrical components 114 to thereby convectively cool these components, and then exits the enclosure through the rear wall 120.</p> <p>Carl Provisional at 5–6: As shown most clearly in Figure 2, each fan 124 is oriented such that its axis of</p>

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	<p>rotation A forms an angle α of between about 45° and 90° with the sidewalls 122. In the embodiment of the invention shown in Figure 2, for example, the axis of rotation A of each fan 124 is perpendicular to the side walls 122. In this manner, the depth of the envelope occupied by the fans 124 is significantly smaller than would be the case if the fans were oriented with their axes of rotation A parallel to the side walls 122.</p> <p>In order to maintain the air flow generated by the fans 124 generally parallel to the side walls 122 of the enclosure 116, each fan is mounted in the fan tray 126 between an inlet plenum 142 and an exhaust plenum 144. Each inlet plenum 142 is defined by a generally concave front facing inlet wall section 146 which extends frontward from a rear edge 148 of the inlet end 134 of the fan housing 132. Similarly, each exhaust plenum 144 is defined by a generally concave rear facing outlet wall section 150 which extends rearward from a forward edge 152 of the outlet end 136 of the fan housing 132. The function of the inlet plenums 142 is to turn the airflow upstream of the fan assembly 110 into the fans 124, and the function of the outlet plenums 144 is to turn the airflow exiting the fans into a direction generally parallel to the sidewalls 122 of the enclosure 116. In this manner, even with the fans 124 mounted with their axis A at an angle α relative to the side walls 122, the fan assembly 110 is still able to achieve a flow distribution which produces a desired degree of cooling for the components 114.</p> <p>In designing the inlet and outlet plenums 142, 144, the radius R_E of the outlet wall sections 150 is ideally selected so as to obtain a desired pressure recovery in the air flow exiting the fans 124. The radius R_I of the inlet wall sections 146 may then be determined given the radius R_E, the number of fans 124 in the fan assembly 110, and</p> <p style="text-align: center;">6</p>