(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 December 2007 (13.12.2007)

PCT

(10) International Publication Number
WO 2007/141596 A2

(51) International Patent Classification:
F01D 5/14 (2006.01)

(21) International Application Number:
PCT/IB2006/004272

(22) International Filing Date:
22 December 2006 (22.12.2006)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/755,041 29 December 2005 (29.12.2005) US
11/644,133 22 December 2006 (22.12.2006) US

(71) Applicant *(for all designated States except US)*: **ROLLS-ROYCE POWER ENGINEERING PLC** [GB/GB]; Moor Lane, Derby DE24 8BJ (GB).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **HURST, Andrew, James** [GB/GB]; Warren Farm, Ham Lane, Gaunts - Prawlett, Nr. Bridgwater, Somerset TA6 4SS (GB). **HARDING, Simon, Charles** [GB/GB]; 14A Shorton Rd., Paignton, Devon TQ3 2NA (GB).

(74) Agent: **HOLMES, Matthew, Peter**; Marks & Clerk, Sussex House, 83-85 Mosley Street, Manchester M2 3LG (GB).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LV, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** AIRFOIL FOR A SECOND STAGE NOZZLE GUIDE VANE

(57) **Abstract:** The present invention provides an airfoil a second stage nozzle guide vane having an external surface with first and second sides. The external surface extends spanwise between a hub and a tip and streamwise between a leading edge and a trailing edge of the airfoil. The external surface includes a contour substantially defined by Table 1 as listed in the specification.

WO 2007/141596 A2

AIRFOIL FOR A SECOND STAGE NOZZLE GUIDE VANE

Related Applications

The present application claims the benefit of Untied States Patent Application No. 60/755,041 filed December 29, 2005, which is incorporated herein by reference.

Field of the Invention

The present invention relates to improved airfoil geometry, and more particularly to a high efficiency airfoil for a turbine nozzle guide vane in a gas turbine engine.

Background

Gas turbine engine designers continuously work to improve engine efficiency, to reduce operating costs of the engine, and to reduce specific exhaust gas emissions such as NOx, CO2, CO, unburnt hydrocarbons, and particulate matter. The specific fuel consumption (SFC) of an engine is inversely proportional to the overall thermal efficiency of the engine, thus, as the SFC decreases the fuel efficiency of the engine increases. Furthermore, specific exhaust gas emissions typically decrease as the engine becomes more efficient. The thermal efficiency of the engine is a function of component efficiencies, cycle pressure ratio and turbine inlet temperature. The present invention contemplates increased thermal efficiency for a gas turbine engine by improving turbine efficiency through a new aerodynamic design of an airfoil for a second stage turbine nozzle guide vane.

Summary

The present invention provides an airfoil with an external surface having first and second sides, the external surface extends spanwise between a hub and a tip and streamwise between a leading edge and a trailing edge. The external surface has a contour substantially defined by Table 1 as listed in the specification.

In another aspect of the present invention, a turbine nozzle guide vane assembly for a gas turbine engine can include an inner shroud having an upper surface and a lower surface, the upper surface of the inner shroud partially defining an inner flow path wall. An airfoil can extend radially outward from the upper surface of the inner shroud relative

to an axis of rotation of the gas turbine engine. The airfoil includes first and second three-dimensional external surfaces that extend between a hub and a tip in a spanwise direction and between a leading edge and a trailing edge in a streamwise direction. A Cartesian coordinate array having X,Y and Z axis coordinates listed in Table 1 of the specification defines the first and second external surfaces of the airfoil.

Another aspect of the present invention provides for a method of forming an airfoil for a turbine nozzle guide vane. The method includes forming a contoured three-dimensional external surface of an airfoil defined by Cartesian (X, Y and Z) coordinates listed in the specification as Table 1, wherein the Z axis coordinates are generally measured in a radial direction from a longitudinal axis, the X axis coordinates are generally measured normal to the Z axis in a streamwise direction, and the Y axis coordinates are generally measured normal to the Z axis and normal to the X axis.

Another aspect of the present invention provides for a method of forming an airfoil for a turbine nozzle guide vane. The method includes forming a contoured three-dimensional external surface of an airfoil defined by Cartesian (X, Y and Z) coordinates listed in the specification as Table 1, wherein the Z axis coordinates are generally measured from an engine centerline axis, the X axis coordinates are generally measured normal to the Z axis in a streamwise direction, and the Y axis coordinates are generally measured normal to the Z axis and normal to the X axis.

Brief Description of the Drawings

The description herein makes reference to the accompanying drawings wherein like reference numerals refer to like parts throughout the several views, and wherein:

FIG. 1 is a schematic representation of a gas turbine engine;

FIG. 2 is a cross-sectional view of a turbine module for the gas turbine engine of FIG. 1;

FIG. 3 is a perspective view of a second stage turbine nozzle guide vane segment illustrated in FIG. 2;

FIG. 4 is a front view of the second stage turbine nozzle guide vane segment illustrated in FIG. 3;

FIG. 5 is a back view of the second stage turbine nozzle guide vane segment illustrated in FIG. 3;

FIG. 6 is a right view of the second stage turbine nozzle guide vane segment illustrated in FIG. 3;

FIG. 7 is a left view of the second stage turbine nozzle guide vane segment illustrated in FIG. 3;

FIG. 8 is a top view of the second stage turbine nozzle guide vane segment illustrated in FIG. 3; and

FIG. 9 is a bottom view of the second stage turbine nozzle guide vane segment illustrated in FIG. 3.

Detailed Description

For purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Referring to FIG. 1, a schematic view of a gas turbine engine 10 is depicted. While the gas turbine engine 10 is illustrated with one spool (i.e. one shaft connecting a turbine and a compressor), it should be understood that the present invention is not limited to any particular engine design or configuration and as such may be used in multi spool engines of the aero or power generation type. The gas turbine engine 10 will be described generally, however significant details regarding general gas turbine engines will not be presented herein as it is believed that the theory of operation and general parameters of gas turbine engines are well known to those of ordinary skill in the art.

The gas turbine engine 10 includes an inlet section 12, a compressor section 14, a combustor section 16, a turbine section 18, and an exhaust section 20. In operation, air is drawn in through the inlet 12 and compressed to a high pressure relative to ambient pressure in the compressor section 14. The air is mixed with fuel in the combustor

section 16 wherein the fuel/air mixture burns and produces a high temperature and pressure working fluid from which the turbine section 18 extracts power. The turbine section 18 is mechanically coupled to the compressor section 14 via a shaft 22. The shaft 22 rotates about a centerline axis 24 that extends axially along the longitudinal axis of the engine 10, such that as the turbine section 18 rotates due to the forces generated by the high pressure working fluid, the compressor section 14 is rotatingly driven by the turbine section 18 to produce compressed air. A portion of the power extracted from the turbine section 18 can be utilized to drive a secondary device 26, which in one embodiment can be an electrical generator. The electrical generator can be run at a substantially constant speed that is appropriate for a desired power grid frequency; a non-limiting example being 50 or 60 Hz. Alternatively the secondary device 26 can be in the form of a compressor or pump for use in fluid pipelines such as oil or natural gas lines.

Referring now to FIG. 2, a partial cross section of the turbine section 18 is shown therein. As the working fluid exits the combustor section 16, the working fluid is constrained between an inner flow path wall 31 and an outer flow path wall 33 as it flows through the turbine section 18. The turbine section 18 includes a turbine inlet or first stage nozzle guide vane (NGV) assembly 30. The first stage NGV assembly 30 includes a plurality of static vanes or airfoils 32 positioned circumferentially around a flow path annulus of the engine 10. The first stage NGV assembly 30 is operable for accelerating and turning the flow of working fluid to a desired direction, as the working fluid exits the combustor section 16 and enters the turbine section 18.

Each airfoil 32 of the first stage NGV assembly 30 extends between a leading edge 34 and a trailing edge 36 in the stream wise direction and between an inner shroud 78 and an outer shroud 80 in the spanwise direction. It should be understood that the terms leading edge and trailing edge are defined relative to the general flow path of the working fluid, such that the working fluid first passes the leading edge and subsequently passes the trailing edge of a particular airfoil. The inner and outer shrouds 38, 40 form a portion of the inner and outer flow path walls 31, 33 respectively at that location in the engine 10.

The turbine section 18 further includes a first stage turbine assembly 42 positioned downstream of the first stage NGV assembly 30. The first stage turbine

assembly 42 includes a first turbine wheel 44 which is comprised of a first turbine disk 46 having a plurality of first stage turbine blades 48 coupled thereto. It should be noted here that in one preferred embodiment the turbine blades 48 and the disk 46 can be separate components, but that the present invention contemplates other forms such as a turbine wheel having the blades and disk integrally formed together. This type of component is commonly called a "BLISK," short for a "Bladed Disk," by those working in the gas turbine engine industry.

Each turbine blade 48 includes an airfoil 50 that rotates with the turbine disk 46. Each airfoil 50 extends between a leading edge 52 and a trailing edge 54 in the stream wise direction and between an inner shroud or platform 56 and an outer shroud 58 in the spanwise direction. The disk 46 may include one or more seals 60 extending forward or aft in the streamwise direction. The seals 60, sometimes called rotating knife seals, limit the leakage of working fluid from the desired flowpath. The first stage turbine assembly 42 is operable for extracting energy from the working fluid via the airfoils 50 which in turn cause the turbine wheel 44 to rotate and drive the shaft 22.

Directly downstream of the first stage turbine assembly 42 is a second stage nozzle guide vane (NGV) assembly 70. The second stage NGV assembly 70 includes a plurality of static vanes or airfoils 72 positioned circumferentially around the flow path of the engine 10. The airfoils 72 of the second stage NGV assembly 70 are operable for accelerating and turning the working fluid flow to a desired direction as the working fluid exits the second stage NGV assembly 70. Each airfoil 72 extends between a leading edge 74 and a trailing edge 76 in the stream wise direction and between an inner shroud 78 and an outer shroud 80 in the spanwise direction. The inner and outer shrouds 78, 80 form a portion of the inner and outer flow path walls 31, 33 respectively at that location in the engine 10. The second stage nozzle guide vane (NGV) assembly 70 will be described in more detail below.

A second stage turbine assembly 82 is positioned downstream of the second stage NGV assembly 70. The second stage turbine assembly 82 includes a second turbine wheel 84 which is comprised of a second turbine disk 86 having a plurality of second stage turbine blades 88 coupled thereto. Each turbine blade 88 includes an airfoil 90 that rotates with the turbine disk 86 when the engine 10 is running. Each airfoil 90 extends

between a leading edge 92 and a trailing edge 94 in the stream wise direction and between an inner shroud or platform 96 and an outer shroud 98 in the spanwise direction. The disk 86 may include one or more seals 100 extending forward or aft in the streamwise direction. In this particular embodiment of the invention, the second stage turbine assembly 82 is connected to the first stage turbine assembly 42 and therefore increases the power delivered to the shaft 22.

A third stage nozzle guide vane (NGV) assembly 110 is located downstream of the second stage turbine assembly 82. The third stage NGV assembly 110 includes a plurality of static vanes or airfoils 112 positioned circumferentially around the flowpath of the engine 10. The airfoils 112 of the third stage NGV assembly 110 are operable for accelerating and turning the working fluid flow to a desired direction as the working fluid exits the third stage NGV assembly 110. Each airfoil 112 extends between a leading edge 114 and a trailing edge 116 in the streamwise direction and between an inner shroud 118 and an outer shroud 120 in the spanwise direction. The inner and outer shrouds 118, 120 form a portion of the inner and outer flow path walls 31, 33 respectively at that location in the engine 10.

A third stage turbine assembly 130 is positioned downstream of the third stage NGV 110. The third stage turbine assembly 130 includes a third turbine wheel 132 which is comprised of a third turbine disk 134 having a plurality of third stage turbine blades 136 coupled thereto. Each turbine blade 136 includes an airfoil 138 that rotates with the turbine disk 134 when the engine 10 is running. Each airfoil 138 extends between a leading edge 140 and a trailing edge 142 in the stream wise direction and between an inner shroud or platform 144 and an outer shroud 146 in the spanwise direction. The third disk 134 may also include one or more seals 148 extending forward or aft of the disk 134 in the streamwise direction. Similar to the second stage turbine assembly 82, the third stage turbine assembly 130 is also connected to the first stage turbine assembly 42 and therefore further increases the power delivered to the shaft 22.

Although not shown in each of the drawings it should be understood the airfoils for both the turbine blades and turbine nozzle guide vanes may include internal cooling flow passages and apertures extending through portions of the external surfaces of the airfoil. Pressurized cooling fluid can then flow from the internal passages through the

apertures to cool the external surface of the airfoils as would be known to those skilled in the art. In this manner, the engine 10 may be run at the higher turbine inlet temperatures, and thus produce higher thermal efficiencies while still providing adequate component life as measured by such parameters as high cycle fatigue limits, low cycle fatigue limits, and creep, etc.

It should be further noted that the airfoils may include coatings to increase component life. The coatings can be of the thermal barrier type and/or the radiation barrier type. Thermal barrier coatings have relatively low heat transfer coefficients which help to reduce the heat load that the cooling fluid is required to dissipate. Thermal barrier coatings are typically ceramic based and can include mullite and zirconia based composites, although other types of coatings are contemplated herein. Radiation barrier coatings operate to reduce radiation heat transfer to the coated component by having highly reflective external surfaces such that radiation emanating from the high temperature exhaust gas is at least partially reflected away and not absorbed by the component. Radiation barrier coatings can include materials from high temperature chromium based alloys as is known to those skilled in the art. The radiation barrier coatings and thermal barrier coatings can be used to coat the entire airfoil, but alternate embodiments include a partial coating and/or a coating with intermittent discontinuities formed therein.

Referring now to FIGS. 3 through 9, the second stage nozzle guide vane (NGV) assembly 70 will be described in more detail. As partially described previously, the second stage nozzle guide vane assembly 70 includes an inner shroud 78 wherein an outer surface 250 of the shroud defines a portion of the inner flow path wall 31 at that particular location in the engine 10. A plurality of airfoils 72 extend radially outward from the outer surface 250 of the shroud 78 from a hub 252 toward a tip 254. Each airfoil 72 is attached to the shroud 78 proximate the hub 252 of the airfoil 72. The airfoils 72 can be integrally formed with the shroud 78 through a casting process or the like or alternatively may be mechanically joined via welding, brazing or by any other joining method known to those skilled in the art. An outer shroud 80 can be attached to the airfoil 72 proximate the tip 254 of the airfoil 72. The outer shroud 80 includes an inner surface 256 which forms a portion of the outer flow path 33 in the turbine section

18. The second stage nozzle guide vane assembly 70 further includes an outer lug 260 positioned above each airfoil. The lugs 260 are operable for reacting torque loads produced by the airfoils 72 through the frame (not shown) of the aircraft engine 10

Each airfoil 72 includes an external surface 261 having first and second sides 263, 265 sometimes called pressure and suction sides respectively. The external surface 261 of the airfoil 72 provides aerodynamic control of the flow of working fluid so as to optimize efficiency in the turbine section 18. The external surface 261 of the airfoil 72 is substantially defined by Table 1 listed below. Table 1 lists data points in Cartesian coordinates that define the external surface of the airfoil 72 at discrete locations. The Z axis coordinates are generally measured radially outward from a reference location. In one form the reference location is the engine centerline axis, and in another form the reference location is the inner shroud 78 from the hub 252. The Z axis defines an imaginary stacking axis from which the contoured external surface is formed. The term "stacking axis," as it is typically used by aerodynamic design engineers, is nominally defined normal to the inner shroud 78 or in a radial direction from the axis of rotation, but in practice can "lean" or "tilt" in a desired direction to satisfy mechanical design criteria as is known to those skilled in the art. The lean or tilt angle is typically within 10°-25° of the normal plane in any direction relative to the inner shroud 78, but can vary with larger angles as necessary to satisfy design criteria. The X axis coordinates are generally measured normal to the stacking axis in a streamwise direction. The Y axis coordinates are generally measured normal to the stacking axis and normal to the X axis. The airfoil 72 defined by Table 1 improves the second stage turbine nozzle guide vane efficiency by 1.38% over prior art designs.

While the external surface of airfoil 72 is defined by discrete points, the surface can be "smoothed" between these discrete points by parametric spline fit techniques and the like. One such method called numerical uniform rational B-spline (NURB-S) is employed by software run on Unigraphics® computer aided design workstations. The data splines can be formed in the streamwise direction and or the spanwise direction of the airfoil 72. Other surface smoothing techniques known to those skilled in the art are also contemplated by the present invention.

The airfoils of the present invention can be formed from any manufacturing process known to those skilled in the art. One such process is an investment casting method whereby the entire second stage NGV assembly 70 is integrally cast as a one-piece component. Alternatively the second stage NGV assembly 70 can be formed in multiple pieces and bonded together. In another form the second stage NGV assembly 70 can be formed from wrought material and finished machined to a desired specification.

The present invention includes airfoils having an external surface formed within a manufacturing tolerance of +/- .025 inches with respect to any particular point in Table 1 or spline curve between discrete points. Furthermore, if the airfoil of the present invention has a material coating applied, the tolerance band will be increased to +/- .050 inches.

Table 1. Coordinates for airfoils on the second stage nozzle guide vane (in).

A. Section height 10.50

X1	=	0.57279	Y1	=	-0.48502	Z1	=	10.50000
X2	=	0.54881	Y2	=	-0.42762	Z2	=	10.50000
X3	=	0.52390	Y3	=	-0.37061	Z3	=	10.50000
X4	=	0.49875	Y4	=	-0.31371	Z4	=	10.50000
X5	=	0.47333	Y5	=	-0.25693	Z5	=	10.50000
X6	=	0.44753	Y6	=	-0.20032	Z6	=	10.50000
X7	=	0.42123	Y7	=	-0.14394	Z7	=	10.50000
X8	=	0.39435	Y8	=	-0.08784	Z8	=	10.50000
X9	=	0.36672	Y9	=	-0.03210	Z9	=	10.50000
X10	=	0.33809	Y10	=	0.02313	Z10	=	10.50000
X11	=	0.30813	Y11	=	0.07766	Z11	=	10.50000
X12	=	0.27642	Y12	=	0.13118	Z12	=	10.50000
X13	=	0.24254	Y13	=	0.18334	Z13	=	10.50000
X14	=	0.20620	Y14	=	0.23383	Z14	=	10.50000
X15	=	0.16726	Y15	=	0.28234	Z15	=	10.50000
X16	=	0.12565	Y16	=	0.32857	Z16	=	10.50000
X17	=	0.08142	Y17	=	0.37231	Z17	=	10.50000
X18	=	0.03458	Y18	=	0.41324	Z18	=	10.50000
X19	=	-0.01492	Y19	=	0.45090	Z19	=	10.50000
X20	=	-0.06719	Y20	=	0.48460	Z20	=	10.50000
X21	=	0.57279	Y21	=	-0.48502	Z21	=	10.50000
X22	=	0.57317	Y22	=	-0.49501	Z22	=	10.50000
X23	=	0.56691	Y23	=	-0.50291	Z23	=	10.50000
X24	=	0.55707	Y24	=	-0.50454	Z24	=	10.50000
X25	=	0.54874	Y25	=	-0.49898	Z25	=	10.50000

X26	=	-0.03935	Y26	=	0.09023	Z26	=	10.50000
X27	=	0.00130	Y27	=	0.07209	Z27	=	10.50000
X28	=	0.04100	Y28	=	0.05195	Z28	=	10.50000
X29	=	0.07957	Y29	=	0.02974	Z29	=	10.50000
X30	=	0.11680	Y30	=	0.00536	Z30	=	10.50000
X31	=	0.15258	Y31	=	-0.02113	Z31	=	10.50000
X32	=	0.18689	Y32	=	-0.04948	Z32	=	10.50000
X33	=	0.21979	Y33	=	-0.07946	Z33	=	10.50000
X34	=	0.25139	Y34	=	-0.11081	Z34	=	10.50000
X35	=	0.28187	Y35	=	-0.14325	Z35	=	10.50000
X36	=	0.31142	Y36	=	-0.17654	Z36	=	10.50000
X37	=	0.34017	Y37	=	-0.21052	Z37	=	10.50000
X38	=	0.36817	Y38	=	-0.24513	Z38	=	10.50000
X39	=	0.39546	Y39	=	-0.28030	Z39	=	10.50000
X40	=	0.42207	Y40	=	-0.31598	Z40	=	10.50000
X41	=	0.44807	Y41	=	-0.35212	Z41	=	10.50000
X42	=	0.47345	Y42	=	-0.38869	Z42	=	10.50000
X43	=	0.49838	Y43	=	-0.42556	Z43	=	10.50000
X44	=	0.52331	Y44	=	-0.46244	Z44	=	10.50000
X45	=	0.54874	Y45	=	-0.49898	Z45	=	10.50000

B. Section height 11.00

X1	=	-0.81291	Y1	=	0.29949	Z1	=	11.00000
X2	=	-0.81537	Y2	=	0.29253	Z2	=	11.00000
X3	=	-0.81609	Y3	=	0.28516	Z3	=	11.00000
X4	=	-0.81510	Y4	=	0.27782	Z4	=	11.00000
X5	=	-0.81229	Y5	=	0.27099	Z5	=	11.00000
X6	=	-0.76311	Y6	=	0.37548	Z6	=	11.00000
X7	=	-0.77736	Y7	=	0.35775	Z7	=	11.00000
X8	=	-0.79049	Y8	=	0.33910	Z8	=	11.00000
X9	=	-0.80229	Y9	=	0.31963	Z9	=	11.00000
X10	=	-0.81291	Y10	=	0.29949	Z10	=	11.00000
X11	=	0.58996	Y11	=	-0.51146	Z11	=	11.00000
X12	=	0.55083	Y12	=	-0.41509	Z12	=	11.00000
X13	=	0.50917	Y13	=	-0.31980	Z13	=	11.00000
X14	=	0.46596	Y14	=	-0.22516	Z14	=	11.00000
X15	=	0.42109	Y15	=	-0.13134	Z15	=	11.00000
X16	=	0.37401	Y16	=	-0.03861	Z16	=	11.00000
X17	=	0.32379	Y17	=	0.05249	Z17	=	11.00000
X18	=	0.26922	Y18	=	0.14104	Z18	=	11.00000
X19	=	0.20908	Y19	=	0.22586	Z19	=	11.00000
X20	=	0.14243	Y20	=	0.30564	Z20	=	11.00000
X21	=	0.06867	Y21	=	0.37896	Z21	=	11.00000
X22	=	-0.01258	Y22	=	0.44382	Z22	=	11.00000
X23	=	-0.10155	Y23	=	0.49750	Z23	=	11.00000
X24	=	-0.19771	Y24	=	0.53683	Z24	=	11.00000

X25	=	-0.29925	Y25	=	0.55874	Z25	=	11.00000
X26	=	-0.40307	Y26	=	0.56130	Z26	=	11.00000
X27	=	-0.50531	Y27	=	0.54324	Z27	=	11.00000
X28	=	-0.60177	Y28	=	0.50474	Z28	=	11.00000
X29	=	-0.68867	Y29	=	0.44794	Z29	=	11.00000
X30	=	-0.76311	Y30	=	0.37548	Z30	=	11.00000
X31	=	0.58996	Y31	=	-0.51146	Z31	=	11.00000
X32	=	0.59013	Y32	=	-0.52055	Z32	=	11.00000
X33	=	0.58429	Y33	=	-0.52761	Z33	=	11.00000
X34	=	0.57533	Y34	=	-0.52900	Z34	=	11.00000
X35	=	0.56778	Y35	=	-0.52389	Z35	=	11.00000
X36	=	0.56778	Y36	=	-0.52389	Z36	=	11.00000
X37	=	0.52010	Y37	=	-0.45446	Z37	=	11.00000
X38	=	0.47225	Y38	=	-0.38515	Z38	=	11.00000
X39	=	0.42217	Y39	=	-0.31744	Z39	=	11.00000
X40	=	0.36951	Y40	=	-0.25172	Z40	=	11.00000
X41	=	0.31410	Y41	=	-0.18830	Z41	=	11.00000
X42	=	0.25579	Y42	=	-0.12754	Z42	=	11.00000
X43	=	0.19409	Y43	=	-0.07023	Z43	=	11.00000
X44	=	0.12858	Y44	=	-0.01732	Z44	=	11.00000
X45	=	0.05921	Y45	=	0.03040	Z45	=	11.00000
X46	=	-0.01368	Y46	=	0.07257	Z46	=	11.00000
X47	=	-0.08949	Y47	=	0.10920	Z47	=	11.00000
X48	=	-0.16789	Y48	=	0.13994	Z48	=	11.00000
X49	=	-0.24828	Y49	=	0.16502	Z49	=	11.00000
X50	=	-0.33002	Y50	=	0.18525	Z50	=	11.00000
X51	=	-0.41284	Y51	=	0.20049	Z51	=	11.00000
X52	=	-0.49637	Y52	=	0.21124	Z52	=	11.00000
X53	=	-0.58025	Y53	=	0.21881	Z53	=	11.00000
X54	=	-0.66418	Y54	=	0.22583	Z54	=	11.00000
X55	=	-0.74734	Y55	=	0.23859	Z55	=	11.00000
X56	=	-0.74734	Y56	=	0.23859	Z56	=	11.00000
X57	=	-0.76512	Y57	=	0.24383	Z57	=	11.00000
X58	=	-0.78246	Y58	=	0.25024	Z58	=	11.00000
X59	=	-0.79923	Y59	=	0.25819	Z59	=	11.00000
X60	=	-0.81229	Y60	=	0.27099	Z60	=	11.00000

C. Section height 11.50

X1	=	-0.83058	Y1	=	0.31646	Z1	=	11.50000
X2	=	-0.83170	Y2	=	0.30851	Z2	=	11.50000
X3	=	-0.83047	Y3	=	0.30059	Z3	=	11.50000
X4	=	-0.82703	Y4	=	0.29333	Z4	=	11.50000
X5	=	-0.82150	Y5	=	0.28753	Z5	=	11.50000
X6	=	-0.77969	Y6	=	0.39445	Z6	=	11.50000
X7	=	-0.79507	Y7	=	0.37677	Z7	=	11.50000
X8	=	-0.80899	Y8	=	0.35792	Z8	=	11.50000

X9	=	-0.82111	Y9	=	0.33785	Z9	=	11.50000
X10	=	-0.83058	Y10	=	0.31646	Z10	=	11.50000
X11	=	0.60695	Y11	=	-0.54228	Z11	=	11.50000
X12	=	0.56820	Y12	=	-0.44357	Z12	=	11.50000
X13	=	0.52607	Y13	=	-0.34625	Z13	=	11.50000
X14	=	0.48190	Y14	=	-0.24983	Z14	=	11.50000
X15	=	0.43580	Y15	=	-0.15432	Z15	=	11.50000
X16	=	0.38714	Y16	=	-0.06010	Z16	=	11.50000
X17	=	0.33516	Y17	=	0.03234	Z17	=	11.50000
X18	=	0.27900	Y18	=	0.12229	Z18	=	11.50000
X19	=	0.21777	Y19	=	0.20887	Z19	=	11.50000
X20	=	0.15045	Y20	=	0.29077	Z20	=	11.50000
X21	=	0.07602	Y21	=	0.36626	Z21	=	11.50000
X22	=	-0.00627	Y22	=	0.43306	Z22	=	11.50000
X23	=	-0.09659	Y23	=	0.48850	Z23	=	11.50000
X24	=	-0.19406	Y24	=	0.52997	Z24	=	11.50000
X25	=	-0.29698	Y25	=	0.55508	Z25	=	11.50000
X26	=	-0.40265	Y26	=	0.56225	Z26	=	11.50000
X27	=	-0.50780	Y27	=	0.54970	Z27	=	11.50000
X28	=	-0.60852	Y28	=	0.51710	Z28	=	11.50000
X29	=	-0.70059	Y29	=	0.46480	Z29	=	11.50000
X30	=	-0.77969	Y30	=	0.39445	Z30	=	11.50000
X31	=	0.60695	Y31	=	-0.54228	Z31	=	11.50000
X32	=	0.60698	Y32	=	-0.55064	Z32	=	11.50000
X33	=	0.60146	Y33	=	-0.55702	Z33	=	11.50000
X34	=	0.59319	Y34	=	-0.55816	Z34	=	11.50000
X35	=	0.58628	Y35	=	-0.55339	Z35	=	11.50000
X36	=	0.58628	Y36	=	-0.55339	Z36	=	11.50000
X37	=	0.53740	Y37	=	-0.48206	Z37	=	11.50000
X38	=	0.48813	Y38	=	-0.41100	Z38	=	11.50000
X39	=	0.43628	Y39	=	-0.34181	Z39	=	11.50000
X40	=	0.38154	Y40	=	-0.27487	Z40	=	11.50000
X41	=	0.32384	Y41	=	-0.21048	Z41	=	11.50000
X42	=	0.26309	Y42	=	-0.14896	Z42	=	11.50000
X43	=	0.19931	Y43	=	-0.09058	Z43	=	11.50000
X44	=	0.13253	Y44	=	-0.03566	Z44	=	11.50000
X45	=	0.06282	Y45	=	0.01548	Z45	=	11.50000
X46	=	-0.00965	Y46	=	0.06264	Z46	=	11.50000
X47	=	-0.08468	Y47	=	0.10560	Z47	=	11.50000
X48	=	-0.16218	Y48	=	0.14392	Z48	=	11.50000
X49	=	-0.24197	Y49	=	0.17722	Z49	=	11.50000
X50	=	-0.32373	Y50	=	0.20533	Z50	=	11.50000
X51	=	-0.40720	Y51	=	0.22780	Z51	=	11.50000
X52	=	-0.49210	Y52	=	0.24419	Z52	=	11.50000
X53	=	-0.57791	Y53	=	0.25466	Z53	=	11.50000
X54	=	-0.66421	Y54	=	0.26019	Z54	=	11.50000

X55	=	-0.75045	Y55	=	0.26608	Z55	=	11.50000
X56	=	-0.75045	Y56	=	0.26608	Z56	=	11.50000
X57	=	-0.76892	Y57	=	0.26907	Z57	=	11.50000
X58	=	-0.78721	Y58	=	0.27313	Z58	=	11.50000
X59	=	-0.80509	Y59	=	0.27862	Z59	=	11.50000
X60	=	-0.82150	Y60	=	0.28753	Z60	=	11.50000

D. Section height 12.00

X1	=	-0.83355	Y1	=	0.28533	Z1	=	12.00000
X2	=	-0.84083	Y2	=	0.29029	Z2	=	12.00000
X3	=	-0.84600	Y3	=	0.29743	Z3	=	12.00000
X4	=	-0.84864	Y4	=	0.30582	Z4	=	12.00000
X5	=	-0.84843	Y5	=	0.31464	Z5	=	12.00000
X6	=	-0.84843	Y6	=	0.31464	Z6	=	12.00000
X7	=	-0.83991	Y7	=	0.33668	Z7	=	12.00000
X8	=	-0.82773	Y8	=	0.35705	Z8	=	12.00000
X9	=	-0.81343	Y9	=	0.37596	Z9	=	12.00000
X10	=	-0.79759	Y10	=	0.39363	Z10	=	12.00000
X11	=	-0.79759	Y11	=	0.39363	Z11	=	12.00000
X12	=	-0.71494	Y12	=	0.46382	Z12	=	12.00000
X13	=	-0.61911	Y13	=	0.51468	Z13	=	12.00000
X14	=	-0.51501	Y14	=	0.54513	Z14	=	12.00000
X15	=	-0.40701	Y15	=	0.55563	Z15	=	12.00000
X16	=	-0.29890	Y16	=	0.54631	Z16	=	12.00000
X17	=	-0.19384	Y17	=	0.51906	Z17	=	12.00000
X18	=	-0.09445	Y18	=	0.47541	Z18	=	12.00000
X19	=	-0.00243	Y19	=	0.41779	Z19	=	12.00000
X20	=	0.08135	Y20	=	0.34870	Z20	=	12.00000
X21	=	0.15711	Y21	=	0.27088	Z21	=	12.00000
X22	=	0.22565	Y22	=	0.18660	Z22	=	12.00000
X23	=	0.28800	Y23	=	0.09764	Z23	=	12.00000
X24	=	0.34530	Y24	=	0.00533	Z24	=	12.00000
X25	=	0.39844	Y25	=	-0.08944	Z25	=	12.00000
X26	=	0.44819	Y26	=	-0.18603	Z26	=	12.00000
X27	=	0.49528	Y27	=	-0.28395	Z27	=	12.00000
X28	=	0.54044	Y28	=	-0.38278	Z28	=	12.00000
X29	=	0.58365	Y29	=	-0.48247	Z29	=	12.00000
X30	=	0.62351	Y30	=	-0.58354	Z30	=	12.00000
X31	=	0.62351	Y31	=	-0.58354	Z31	=	12.00000
X32	=	0.62353	Y32	=	-0.59160	Z32	=	12.00000
X33	=	0.61813	Y33	=	-0.59769	Z33	=	12.00000
X34	=	0.61014	Y34	=	-0.59872	Z34	=	12.00000
X35	=	0.60349	Y35	=	-0.59409	Z35	=	12.00000
X36	=	0.60349	Y36	=	-0.59409	Z36	=	12.00000
X37	=	0.55235	Y37	=	-0.51900	Z37	=	12.00000
X38	=	0.50002	Y38	=	-0.44474	Z38	=	12.00000

X39	=	0.44561	Y39	=	-0.37199	Z39	=	12.00000
X40	=	0.38805	Y40	=	-0.30171	Z40	=	12.00000
X41	=	0.32709	Y41	=	-0.23437	Z41	=	12.00000
X42	=	0.26292	Y42	=	-0.17007	Z42	=	12.00000
X43	=	0.19560	Y43	=	-0.10908	Z43	=	12.00000
X44	=	0.12534	Y44	=	-0.05150	Z44	=	12.00000
X45	=	0.05247	Y45	=	0.00274	Z45	=	12.00000
X46	=	-0.02291	Y46	=	0.05344	Z46	=	12.00000
X47	=	-0.10079	Y47	=	0.10021	Z47	=	12.00000
X48	=	-0.18124	Y48	=	0.14237	Z48	=	12.00000
X49	=	-0.26424	Y49	=	0.17928	Z49	=	12.00000
X50	=	-0.34959	Y50	=	0.21035	Z50	=	12.00000
X51	=	-0.43701	Y51	=	0.23499	Z51	=	12.00000
X52	=	-0.52608	Y52	=	0.25277	Z52	=	12.00000
X53	=	-0.61628	Y53	=	0.26347	Z53	=	12.00000
X54	=	-0.70698	Y54	=	0.26836	Z54	=	12.00000
X55	=	-0.79753	Y55	=	0.27490	Z55	=	12.00000
X56	=	-0.79753	Y56	=	0.27490	Z56	=	12.00000
X57	=	-0.80676	Y57	=	0.27670	Z57	=	12.00000
X58	=	-0.81588	Y58	=	0.27896	Z58	=	12.00000
X59	=	-0.82484	Y59	=	0.28180	Z59	=	12.00000
X60	=	-0.83355	Y60	=	0.28533	Z60	=	12.00000

E. Section height 12.50

X1	=	-0.86654	Y1	=	0.28260	Z1	=	12.50000
X2	=	-0.86645	Y2	=	0.27361	Z2	=	12.50000
X3	=	-0.86340	Y3	=	0.26516	Z3	=	12.50000
X4	=	-0.85779	Y4	=	0.25812	Z4	=	12.50000
X5	=	-0.85014	Y5	=	0.25341	Z5	=	12.50000
X6	=	-0.86654	Y6	=	0.28260	Z6	=	12.50000
X7	=	-0.85882	Y7	=	0.30440	Z7	=	12.50000
X8	=	-0.84725	Y8	=	0.32453	Z8	=	12.50000
X9	=	-0.83373	Y9	=	0.34340	Z9	=	12.50000
X10	=	-0.81872	Y10	=	0.36112	Z10	=	12.50000
X11	=	-0.81872	Y11	=	0.36112	Z11	=	12.50000
X12	=	-0.73552	Y12	=	0.43566	Z12	=	12.50000
X13	=	-0.63840	Y13	=	0.49099	Z13	=	12.50000
X14	=	-0.53223	Y14	=	0.52585	Z14	=	12.50000
X15	=	-0.42132	Y15	=	0.53971	Z15	=	12.50000
X16	=	-0.30981	Y16	=	0.53205	Z16	=	12.50000
X17	=	-0.20139	Y17	=	0.50473	Z17	=	12.50000
X18	=	-0.09901	Y18	=	0.45974	Z18	=	12.50000
X19	=	-0.00437	Y19	=	0.40013	Z19	=	12.50000
X20	=	0.08187	Y20	=	0.32886	Z20	=	12.50000
X21	=	0.16006	Y21	=	0.24879	Z21	=	12.50000
X22	=	0.23077	Y22	=	0.16207	Z22	=	12.50000

X23	=	0.29477	Y23	=	0.07024	Z23	=	12.50000
X24	=	0.35322	Y24	=	-0.02522	Z24	=	12.50000
X25	=	0.40736	Y25	=	-0.12319	Z25	=	12.50000
X26	=	0.45814	Y26	=	-0.22295	Z26	=	12.50000
X27	=	0.50630	Y27	=	-0.32400	Z27	=	12.50000
X28	=	0.55266	Y28	=	-0.42589	Z28	=	12.50000
X29	=	0.59759	Y29	=	-0.52842	Z29	=	12.50000
X30	=	0.63979	Y30	=	-0.63209	Z30	=	12.50000
X31	=	0.63979	Y31	=	-0.63209	Z31	=	12.50000
X32	=	0.63987	Y32	=	-0.64018	Z32	=	12.50000
X33	=	0.63444	Y33	=	-0.64631	Z33	=	12.50000
X34	=	0.62642	Y34	=	-0.64736	Z34	=	12.50000
X35	=	0.61972	Y35	=	-0.64274	Z35	=	12.50000
X36	=	0.61971	Y36	=	-0.64274	Z36	=	12.50000
X37	=	0.56692	Y37	=	-0.56632	Z37	=	12.50000
X38	=	0.51372	Y38	=	-0.49018	Z38	=	12.50000
X39	=	0.45843	Y39	=	-0.41556	Z39	=	12.50000
X40	=	0.40030	Y40	=	-0.34312	Z40	=	12.50000
X41	=	0.33894	Y41	=	-0.27341	Z41	=	12.50000
X42	=	0.27412	Y42	=	-0.20690	Z42	=	12.50000
X43	=	0.20585	Y43	=	-0.14393	Z43	=	12.50000
X44	=	0.13435	Y44	=	-0.08466	Z44	=	12.50000
X45	=	0.06001	Y45	=	-0.02900	Z45	=	12.50000
X46	=	-0.01704	Y46	=	0.02286	Z46	=	12.50000
X47	=	-0.09684	Y47	=	0.07037	Z47	=	12.50000
X48	=	-0.17951	Y48	=	0.11267	Z48	=	12.50000
X49	=	-0.26497	Y49	=	0.14900	Z49	=	12.50000
X50	=	-0.35286	Y50	=	0.17899	Z50	=	12.50000
X51	=	-0.44276	Y51	=	0.20222	Z51	=	12.50000
X52	=	-0.53412	Y52	=	0.21889	Z52	=	12.50000
X53	=	-0.62631	Y53	=	0.23009	Z53	=	12.50000
X54	=	-0.71893	Y54	=	0.23698	Z54	=	12.50000
X55	=	-0.81156	Y55	=	0.24359	Z55	=	12.50000
X56	=	-0.81156	Y56	=	0.24359	Z56	=	12.50000
X57	=	-0.82141	Y57	=	0.24521	Z57	=	12.50000
X58	=	-0.83116	Y58	=	0.24732	Z58	=	12.50000
X59	=	-0.84076	Y59	=	0.25002	Z59	=	12.50000
X60	=	-0.85014	Y60	=	0.25341	Z60	=	12.50000

F. Section height 13.00

X1	=	-0.88469	Y1	=	0.24061	Z1	=	13.00000
X2	=	-0.88451	Y2	=	0.23189	Z2	=	13.00000
X3	=	-0.88152	Y3	=	0.22371	Z3	=	13.00000
X4	=	-0.87611	Y4	=	0.21686	Z4	=	13.00000
X5	=	-0.86876	Y5	=	0.21218	Z5	=	13.00000
X6	=	-0.83409	Y6	=	0.32650	Z6	=	13.00000

X7	=	-0.85000	Y7	=	0.30700	Z7	=	13.00000
X8	=	-0.86441	Y8	=	0.28635	Z8	=	13.00000
X9	=	-0.87666	Y9	=	0.26437	Z9	=	13.00000
X10	=	-0.88469	Y10	=	0.24061	Z10	=	13.00000
X11	=	0.65605	Y11	=	-0.68065	Z11	=	13.00000
X12	=	0.61180	Y12	=	-0.57486	Z12	=	13.00000
X13	=	0.56545	Y13	=	-0.46997	Z13	=	13.00000
X14	=	0.51805	Y14	=	-0.36554	Z14	=	13.00000
X15	=	0.46899	Y15	=	-0.26189	Z15	=	13.00000
X16	=	0.41729	Y16	=	-0.15954	Z16	=	13.00000
X17	=	0.36222	Y17	=	-0.05895	Z17	=	13.00000
X18	=	0.30263	Y18	=	0.03901	Z18	=	13.00000
X19	=	0.23704	Y19	=	0.13305	Z19	=	13.00000
X20	=	0.16434	Y20	=	0.22170	Z20	=	13.00000
X21	=	0.08403	Y21	=	0.30350	Z21	=	13.00000
X22	=	-0.00428	Y22	=	0.37657	Z22	=	13.00000
X23	=	-0.10105	Y23	=	0.43794	Z23	=	13.00000
X24	=	-0.20577	Y24	=	0.48438	Z24	=	13.00000
X25	=	-0.31687	Y25	=	0.51214	Z25	=	13.00000
X26	=	-0.43118	Y26	=	0.51872	Z26	=	13.00000
X27	=	-0.54447	Y27	=	0.50218	Z27	=	13.00000
X28	=	-0.65224	Y28	=	0.46360	Z28	=	13.00000
X29	=	-0.75028	Y29	=	0.40443	Z29	=	13.00000
X30	=	-0.83409	Y30	=	0.32650	Z30	=	13.00000
X31	=	0.65605	Y31	=	-0.68065	Z31	=	13.00000
X32	=	0.65619	Y32	=	-0.68887	Z32	=	13.00000
X33	=	0.65071	Y33	=	-0.69513	Z33	=	13.00000
X34	=	0.64255	Y34	=	-0.69625	Z34	=	13.00000
X35	=	0.63570	Y35	=	-0.69161	Z35	=	13.00000
X36	=	0.63570	Y36	=	-0.69161	Z36	=	13.00000
X37	=	0.58153	Y37	=	-0.61400	Z37	=	13.00000
X38	=	0.52743	Y38	=	-0.53634	Z38	=	13.00000
X39	=	0.47170	Y39	=	-0.45985	Z39	=	13.00000
X40	=	0.41354	Y40	=	-0.38519	Z40	=	13.00000
X41	=	0.35234	Y41	=	-0.31301	Z41	=	13.00000
X42	=	0.28765	Y42	=	-0.24394	Z42	=	13.00000
X43	=	0.21919	Y43	=	-0.17859	Z43	=	13.00000
X44	=	0.14706	Y44	=	-0.11734	Z44	=	13.00000
X45	=	0.07155	Y45	=	-0.06030	Z45	=	13.00000
X46	=	-0.00721	Y46	=	-0.00783	Z46	=	13.00000
X47	=	-0.08917	Y47	=	0.03946	Z47	=	13.00000
X48	=	-0.17442	Y48	=	0.08051	Z48	=	13.00000
X49	=	-0.26266	Y49	=	0.11466	Z49	=	13.00000
X50	=	-0.35332	Y50	=	0.14176	Z50	=	13.00000
X51	=	-0.44583	Y51	=	0.16163	Z51	=	13.00000
X52	=	-0.53949	Y52	=	0.17515	Z52	=	13.00000

X53	=	-0.63364	Y53	=	0.18480	Z53	=	13.00000
X54	=	-0.72795	Y54	=	0.19281	Z54	=	13.00000
X55	=	-0.82224	Y55	=	0.20087	Z55	=	13.00000
X56	=	-0.82224	Y56	=	0.20087	Z56	=	13.00000
X57	=	-0.83413	Y57	=	0.20256	Z57	=	13.00000
X58	=	-0.84592	Y58	=	0.20487	Z58	=	13.00000
X59	=	-0.85750	Y59	=	0.20801	Z59	=	13.00000
X60	=	-0.86876	Y60	=	0.21218	Z60	=	13.00000

G. Section height 13.50

X1	=	-0.88613	Y1	=	0.18801	Z1	=	13.50000
X2	=	-0.89336	Y2	=	0.19240	Z2	=	13.50000
X3	=	-0.89880	Y3	=	0.19889	Z3	=	13.50000
X4	=	-0.90200	Y4	=	0.20672	Z4	=	13.50000
X5	=	-0.90256	Y5	=	0.21517	Z5	=	13.50000
X6	=	-0.90256	Y6	=	0.21517	Z6	=	13.50000
X7	=	-0.89341	Y7	=	0.24449	Z7	=	13.50000
X8	=	-0.87826	Y8	=	0.27136	Z8	=	13.50000
X9	=	-0.85987	Y9	=	0.29615	Z9	=	13.50000
X10	=	-0.83958	Y10	=	0.31940	Z10	=	13.50000
X11	=	-0.83958	Y11	=	0.31940	Z11	=	13.50000
X12	=	-0.75172	Y12	=	0.39465	Z12	=	13.50000
X13	=	-0.65043	Y13	=	0.45070	Z13	=	13.50000
X14	=	-0.54000	Y14	=	0.48534	Z14	=	13.50000
X15	=	-0.42493	Y15	=	0.49781	Z15	=	13.50000
X16	=	-0.30964	Y16	=	0.48739	Z16	=	13.50000
X17	=	-0.19805	Y17	=	0.45648	Z17	=	13.50000
X18	=	-0.09298	Y18	=	0.40775	Z18	=	13.50000
X19	=	0.00430	Y19	=	0.34485	Z19	=	13.50000
X20	=	0.09330	Y20	=	0.27064	Z20	=	13.50000
X21	=	0.17430	Y21	=	0.18775	Z21	=	13.50000
X22	=	0.24779	Y22	=	0.09812	Z22	=	13.50000
X23	=	0.31439	Y23	=	0.00326	Z23	=	13.50000
X24	=	0.37504	Y24	=	-0.09553	Z24	=	13.50000
X25	=	0.43104	Y25	=	-0.19704	Z25	=	13.50000
X26	=	0.48349	Y26	=	-0.30042	Z26	=	13.50000
X27	=	0.53314	Y27	=	-0.40518	Z27	=	13.50000
X28	=	0.58097	Y28	=	-0.51079	Z28	=	13.50000
X29	=	0.62770	Y29	=	-0.61689	Z29	=	13.50000
X30	=	0.67248	Y30	=	-0.72382	Z30	=	13.50000
X31	=	0.67248	Y31	=	-0.72382	Z31	=	13.50000
X32	=	0.67265	Y32	=	-0.73209	Z32	=	13.50000
X33	=	0.66715	Y33	=	-0.73839	Z33	=	13.50000
X34	=	0.65895	Y34	=	-0.73956	Z34	=	13.50000
X35	=	0.65204	Y35	=	-0.73494	Z35	=	13.50000
X36	=	-0.83101	Y36	=	0.17606	Z36	=	13.50000

X37	=	-0.73459	Y37	=	0.16766	Z37	=	13.50000
X38	=	-0.63796	Y38	=	0.16185	Z38	=	13.50000
X39	=	-0.54141	Y39	=	0.15500	Z39	=	13.50000
X40	=	-0.44529	Y40	=	0.14363	Z40	=	13.50000
X41	=	-0.35029	Y41	=	0.12521	Z41	=	13.50000
X42	=	-0.25718	Y42	=	0.09885	Z42	=	13.50000
X43	=	-0.16665	Y43	=	0.06467	Z43	=	13.50000
X44	=	-0.07935	Y44	=	0.02292	Z44	=	13.50000
X45	=	0.00433	Y45	=	-0.02571	Z45	=	13.50000
X46	=	0.08424	Y46	=	-0.08030	Z46	=	13.50000
X47	=	0.16033	Y47	=	-0.14012	Z47	=	13.50000
X48	=	0.23256	Y48	=	-0.20454	Z48	=	13.50000
X49	=	0.30091	Y49	=	-0.27306	Z49	=	13.50000
X50	=	0.36550	Y50	=	-0.34515	Z50	=	13.50000
X51	=	0.42672	Y51	=	-0.42012	Z51	=	13.50000
X52	=	0.48513	Y52	=	-0.49731	Z52	=	13.50000
X53	=	0.54143	Y53	=	-0.57604	Z53	=	13.50000
X54	=	0.59650	Y54	=	-0.65565	Z54	=	13.50000
X55	=	0.65204	Y55	=	-0.73494	Z55	=	13.50000
X56	=	-0.88613	Y56	=	0.18801	Z56	=	13.50000
X57	=	-0.87275	Y57	=	0.18346	Z57	=	13.50000
X58	=	-0.85898	Y58	=	0.18026	Z58	=	13.50000
X59	=	-0.84503	Y59	=	0.17793	Z59	=	13.50000
X60	=	-0.83101	Y60	=	0.17606	Z60	=	13.50000

H. Section height 14.00

X1	=	-0.92003	Y1	=	0.20783	Z1	=	14.00000
X2	=	-0.91902	Y2	=	0.19943	Z2	=	14.00000
X3	=	-0.91542	Y3	=	0.19178	Z3	=	14.00000
X4	=	-0.90966	Y4	=	0.18557	Z4	=	14.00000
X5	=	-0.90223	Y5	=	0.18153	Z5	=	14.00000
X6	=	-0.92003	Y6	=	0.20783	Z6	=	14.00000
X7	=	-0.91256	Y7	=	0.23638	Z7	=	14.00000
X8	=	-0.89856	Y8	=	0.26251	Z8	=	14.00000
X9	=	-0.88092	Y9	=	0.28636	Z9	=	14.00000
X10	=	-0.86114	Y10	=	0.30847	Z10	=	14.00000
X11	=	-0.86114	Y11	=	0.30847	Z11	=	14.00000
X12	=	-0.77006	Y12	=	0.38328	Z12	=	14.00000
X13	=	-0.66503	Y13	=	0.43704	Z13	=	14.00000
X14	=	-0.55140	Y14	=	0.46873	Z14	=	14.00000
X15	=	-0.43379	Y15	=	0.47826	Z15	=	14.00000
X16	=	-0.31647	Y16	=	0.46553	Z16	=	14.00000
X17	=	-0.20298	Y17	=	0.43310	Z17	=	14.00000
X18	=	-0.09583	Y18	=	0.38349	Z18	=	14.00000
X19	=	0.00374	Y19	=	0.32000	Z19	=	14.00000
X20	=	0.09499	Y20	=	0.24500	Z20	=	14.00000

X21	=	0.17793	Y21	=	0.16091	Z21	=	14.00000
X22	=	0.25326	Y22	=	0.06990	Z22	=	14.00000
X23	=	0.32192	Y23	=	-0.02625	Z23	=	14.00000
X24	=	0.38472	Y24	=	-0.12633	Z24	=	14.00000
X25	=	0.44267	Y25	=	-0.22931	Z25	=	14.00000
X26	=	0.49673	Y26	=	-0.33438	Z26	=	14.00000
X27	=	0.54770	Y27	=	-0.44099	Z27	=	14.00000
X28	=	0.59649	Y28	=	-0.54862	Z28	=	14.00000
X29	=	0.64382	Y29	=	-0.65689	Z29	=	14.00000
X30	=	0.68896	Y30	=	-0.76609	Z30	=	14.00000
X31	=	0.68896	Y31	=	-0.76609	Z31	=	14.00000
X32	=	0.68913	Y32	=	-0.77432	Z32	=	14.00000
X33	=	0.68367	Y33	=	-0.78063	Z33	=	14.00000
X34	=	0.67551	Y34	=	-0.78183	Z34	=	14.00000
X35	=	0.66862	Y35	=	-0.77724	Z35	=	14.00000
X36	=	-0.84796	Y36	=	0.17093	Z36	=	14.00000
X37	=	-0.74847	Y37	=	0.16400	Z37	=	14.00000
X38	=	-0.64874	Y38	=	0.16121	Z38	=	14.00000
X39	=	-0.54913	Y39	=	0.15587	Z39	=	14.00000
X40	=	-0.45008	Y40	=	0.14404	Z40	=	14.00000
X41	=	-0.35233	Y41	=	0.12428	Z41	=	14.00000
X42	=	-0.25667	Y42	=	0.09602	Z42	=	14.00000
X43	=	-0.16390	Y43	=	0.05942	Z43	=	14.00000
X44	=	-0.07458	Y44	=	0.01504	Z44	=	14.00000
X45	=	0.01087	Y45	=	-0.03641	Z45	=	14.00000
X46	=	0.09214	Y46	=	-0.09425	Z46	=	14.00000
X47	=	0.16915	Y47	=	-0.15765	Z47	=	14.00000
X48	=	0.24204	Y48	=	-0.22575	Z48	=	14.00000
X49	=	0.31102	Y49	=	-0.29781	Z49	=	14.00000
X50	=	0.37637	Y50	=	-0.37318	Z50	=	14.00000
X51	=	0.43841	Y51	=	-0.45131	Z51	=	14.00000
X52	=	0.49775	Y52	=	-0.53151	Z52	=	14.00000
X53	=	0.55513	Y53	=	-0.61313	Z53	=	14.00000
X54	=	0.61147	Y54	=	-0.69547	Z54	=	14.00000
X55	=	0.66862	Y55	=	-0.77724	Z55	=	14.00000
X56	=	-0.90223	Y56	=	0.18153	Z56	=	14.00000
X57	=	-0.88895	Y57	=	0.17759	Z57	=	14.00000
X58	=	-0.87539	Y58	=	0.17482	Z58	=	14.00000
X59	=	-0.86170	Y59	=	0.17273	Z59	=	14.00000
X60	=	-0.84796	Y60	=	0.17093	Z60	=	14.00000

I. Section height 14.50

X1	=	-0.91908	Y1	=	0.17695	Z1	=	14.50000
X2	=	-0.92675	Y2	=	0.18108	Z2	=	14.50000
X3	=	-0.93264	Y3	=	0.18751	Z3	=	14.50000

X4	=	-0.93623	Y4	=	0.19544	Z4	=	14.50000
X5	=	-0.93705	Y5	=	0.20412	Z5	=	14.50000
X6	=	-0.93705	Y6	=	0.20412	Z6	=	14.50000
X7	=	-0.92901	Y7	=	0.23156	Z7	=	14.50000
X8	=	-0.91468	Y8	=	0.25646	Z8	=	14.50000
X9	=	-0.89703	Y9	=	0.27915	Z9	=	14.50000
X10	=	-0.87735	Y10	=	0.30011	Z10	=	14.50000
X11	=	-0.87735	Y11	=	0.30011	Z11	=	14.50000
X12	=	-0.78244	Y12	=	0.37382	Z12	=	14.50000
X13	=	-0.67370	Y13	=	0.42531	Z13	=	14.50000
X14	=	-0.55701	Y14	=	0.45448	Z14	=	14.50000
X15	=	-0.43689	Y15	=	0.46136	Z15	=	14.50000
X16	=	-0.31753	Y16	=	0.44607	Z16	=	14.50000
X17	=	-0.20232	Y17	=	0.41124	Z17	=	14.50000
X18	=	-0.09366	Y18	=	0.35942	Z18	=	14.50000
X19	=	0.00735	Y19	=	0.29388	Z19	=	14.50000
X20	=	0.09997	Y20	=	0.21691	Z20	=	14.50000
X21	=	0.18413	Y21	=	0.13075	Z21	=	14.50000
X22	=	0.26045	Y22	=	0.03756	Z22	=	14.50000
X23	=	0.33007	Y23	=	-0.06076	Z23	=	14.50000
X24	=	0.39411	Y24	=	-0.16280	Z24	=	14.50000
X25	=	0.45344	Y25	=	-0.26766	Z25	=	14.50000
X26	=	0.50884	Y26	=	-0.37465	Z26	=	14.50000
X27	=	0.56115	Y27	=	-0.48319	Z27	=	14.50000
X28	=	0.61118	Y28	=	-0.59279	Z28	=	14.50000
X29	=	0.65948	Y29	=	-0.70318	Z29	=	14.50000
X30	=	0.70528	Y30	=	-0.81461	Z30	=	14.50000
X31	=	0.70528	Y31	=	-0.81461	Z31	=	14.50000
X32	=	0.70544	Y32	=	-0.82280	Z32	=	14.50000
X33	=	0.70006	Y33	=	-0.82911	Z33	=	14.50000
X34	=	0.69197	Y34	=	-0.83038	Z34	=	14.50000
X35	=	0.68511	Y35	=	-0.82583	Z35	=	14.50000
X36	=	-0.86647	Y36	=	0.16770	Z36	=	14.50000
X37	=	-0.76386	Y37	=	0.16434	Z37	=	14.50000
X38	=	-0.66121	Y38	=	0.16202	Z38	=	14.50000
X39	=	-0.55884	Y39	=	0.15422	Z39	=	14.50000
X40	=	-0.45737	Y40	=	0.13856	Z40	=	14.50000
X41	=	-0.35748	Y41	=	0.11490	Z41	=	14.50000
X42	=	-0.25986	Y42	=	0.08312	Z42	=	14.50000
X43	=	-0.16532	Y43	=	0.04312	Z43	=	14.50000
X44	=	-0.07434	Y44	=	-0.00445	Z44	=	14.50000
X45	=	0.01274	Y45	=	-0.05883	Z45	=	14.50000
X46	=	0.09561	Y46	=	-0.11943	Z46	=	14.50000
X47	=	0.17424	Y47	=	-0.18546	Z47	=	14.50000
X48	=	0.24878	Y48	=	-0.25607	Z48	=	14.50000
X49	=	0.31939	Y49	=	-0.33061	Z49	=	14.50000

X50	=	0.38625	Y50	=	-0.40854	Z50	=	14.50000
X51	=	0.44966	Y51	=	-0.48931	Z51	=	14.50000
X52	=	0.51024	Y52	=	-0.57221	Z52	=	14.50000
X53	=	0.56884	Y53	=	-0.65654	Z53	=	14.50000
X54	=	0.62645	Y54	=	-0.74155	Z54	=	14.50000
X55	=	0.68511	Y55	=	-0.82583	Z55	=	14.50000
X56	=	-0.91908	Y56	=	0.17695	Z56	=	14.50000
X57	=	-0.90622	Y57	=	0.17324	Z57	=	14.50000
X58	=	-0.89308	Y58	=	0.17072	Z58	=	14.50000
X59	=	-0.87980	Y59	=	0.16898	Z59	=	14.50000
X60	=	-0.86647	Y60	=	0.16770	Z60	=	14.50000

J. Section height 15.00

X1	=	-0.95367	Y1	=	0.19718	Z1	=	15.00000
X2	=	-0.95395	Y2	=	0.18793	Z2	=	15.00000
X3	=	-0.95106	Y3	=	0.17915	Z3	=	15.00000
X4	=	-0.94542	Y4	=	0.17181	Z4	=	15.00000
X5	=	-0.93760	Y5	=	0.16688	Z5	=	15.00000
X6	=	-0.95367	Y6	=	0.19718	Z6	=	15.00000
X7	=	-0.94297	Y7	=	0.22202	Z7	=	15.00000
X8	=	-0.92739	Y8	=	0.24429	Z8	=	15.00000
X9	=	-0.90968	Y9	=	0.26491	Z9	=	15.00000
X10	=	-0.89055	Y10	=	0.28422	Z10	=	15.00000
X11	=	-0.89055	Y11	=	0.28422	Z11	=	15.00000
X12	=	-0.79221	Y12	=	0.35825	Z12	=	15.00000
X13	=	-0.68040	Y13	=	0.41011	Z13	=	15.00000
X14	=	-0.56091	Y14	=	0.44005	Z14	=	15.00000
X15	=	-0.43788	Y15	=	0.44711	Z15	=	15.00000
X16	=	-0.31576	Y16	=	0.43072	Z16	=	15.00000
X17	=	-0.19828	Y17	=	0.39342	Z17	=	15.00000
X18	=	-0.08811	Y18	=	0.33810	Z18	=	15.00000
X19	=	0.01377	Y19	=	0.26861	Z19	=	15.00000
X20	=	0.10698	Y20	=	0.18784	Z20	=	15.00000
X21	=	0.19187	Y21	=	0.09834	Z21	=	15.00000
X22	=	0.26852	Y22	=	0.00169	Z22	=	15.00000
X23	=	0.33787	Y23	=	-0.10036	Z23	=	15.00000
X24	=	0.40193	Y24	=	-0.20582	Z24	=	15.00000
X25	=	0.46178	Y25	=	-0.31372	Z25	=	15.00000
X26	=	0.51818	Y26	=	-0.42347	Z26	=	15.00000
X27	=	0.57195	Y27	=	-0.53453	Z27	=	15.00000
X28	=	0.62379	Y28	=	-0.64652	Z28	=	15.00000
X29	=	0.67391	Y29	=	-0.75927	Z29	=	15.00000
X30	=	0.72129	Y30	=	-0.87320	Z30	=	15.00000
X31	=	0.72129	Y31	=	-0.87320	Z31	=	15.00000
X32	=	0.72148	Y32	=	-0.88137	Z32	=	15.00000

X33	=	0.71620	Y33	=	-0.88773	Z33	=	15.00000
X34	=	0.70815	Y34	=	-0.88910	Z34	=	15.00000
X35	=	0.70130	Y35	=	-0.88459	Z35	=	15.00000
X36	=	-0.85707	Y36	=	0.15878	Z36	=	15.00000
X37	=	-0.75325	Y37	=	0.16050	Z37	=	15.00000
X38	=	-0.64977	Y38	=	0.15235	Z38	=	15.00000
X39	=	-0.54738	Y39	=	0.13519	Z39	=	15.00000
X40	=	-0.44648	Y40	=	0.11070	Z40	=	15.00000
X41	=	-0.34732	Y41	=	0.07992	Z41	=	15.00000
X42	=	-0.25040	Y42	=	0.04269	Z42	=	15.00000
X43	=	-0.15654	Y43	=	-0.00168	Z43	=	15.00000
X44	=	-0.06611	Y44	=	-0.05271	Z44	=	15.00000
X45	=	0.02075	Y45	=	-0.10960	Z45	=	15.00000
X46	=	0.10400	Y46	=	-0.17163	Z46	=	15.00000
X47	=	0.18369	Y47	=	-0.23820	Z47	=	15.00000
X48	=	0.25983	Y48	=	-0.30881	Z48	=	15.00000
X49	=	0.33191	Y49	=	-0.38354	Z49	=	15.00000
X50	=	0.39986	Y50	=	-0.46207	Z50	=	15.00000
X51	=	0.46410	Y51	=	-0.54364	Z51	=	15.00000
X52	=	0.52517	Y52	=	-0.62763	Z52	=	15.00000
X53	=	0.58406	Y53	=	-0.71316	Z53	=	15.00000
X54	=	0.64229	Y54	=	-0.79914	Z54	=	15.00000
X55	=	0.70130	Y55	=	-0.88459	Z55	=	15.00000
X56	=	-0.93760	Y56	=	0.16688	Z56	=	15.00000
X57	=	-0.91809	Y57	=	0.16101	Z57	=	15.00000
X58	=	-0.89786	Y58	=	0.15845	Z58	=	15.00000
X59	=	-0.87745	Y59	=	0.15809	Z59	=	15.00000
X60	=	-0.85707	Y60	=	0.15878	Z60	=	15.00000

K. Section height 15.50

X1	=	-0.97023	Y1	=	0.18935	Z1	=	15.50000
X2	=	-0.97184	Y2	=	0.17951	Z2	=	15.50000
X3	=	-0.96983	Y3	=	0.16976	Z3	=	15.50000
X4	=	-0.96454	Y4	=	0.16130	Z4	=	15.50000
X5	=	-0.95657	Y5	=	0.15534	Z5	=	15.50000
X6	=	-0.97023	Y6	=	0.18935	Z6	=	15.50000
X7	=	-0.95460	Y7	=	0.21623	Z7	=	15.50000
X8	=	-0.93196	Y8	=	0.23780	Z8	=	15.50000
X9	=	-0.91007	Y9	=	0.26015	Z9	=	15.50000
X10	=	-0.88801	Y10	=	0.28233	Z10	=	15.50000
X11	=	-0.88801	Y11	=	0.28233	Z11	=	15.50000
X12	=	-0.78339	Y12	=	0.35142	Z12	=	15.50000
X13	=	-0.66788	Y13	=	0.39999	Z13	=	15.50000
X14	=	-0.54579	Y14	=	0.42824	Z14	=	15.50000
X15	=	-0.42055	Y15	=	0.43278	Z15	=	15.50000

X16	=	-0.29682	Y16	=	0.41297	Z16	=	15.50000
X17	=	-0.17869	Y17	=	0.37106	Z17	=	15.50000
X18	=	-0.06895	Y18	=	0.31042	Z18	=	15.50000
X19	=	0.03165	Y19	=	0.23550	Z19	=	15.50000
X20	=	0.12345	Y20	=	0.15000	Z20	=	15.50000
X21	=	0.20732	Y21	=	0.05668	Z21	=	15.50000
X22	=	0.28259	Y22	=	-0.04369	Z22	=	15.50000
X23	=	0.34994	Y23	=	-0.14958	Z23	=	15.50000
X24	=	0.41246	Y24	=	-0.25838	Z24	=	15.50000
X25	=	0.47161	Y25	=	-0.36907	Z25	=	15.50000
X26	=	0.52812	Y26	=	-0.48113	Z26	=	15.50000
X27	=	0.58283	Y27	=	-0.59408	Z27	=	15.50000
X28	=	0.63616	Y28	=	-0.70769	Z28	=	15.50000
X29	=	0.68814	Y29	=	-0.82192	Z29	=	15.50000
X30	=	0.73712	Y30	=	-0.93746	Z30	=	15.50000
X31	=	0.73712	Y31	=	-0.93746	Z31	=	15.50000
X32	=	0.73738	Y32	=	-0.94561	Z32	=	15.50000
X33	=	0.73218	Y33	=	-0.95203	Z33	=	15.50000
X34	=	0.72416	Y34	=	-0.95347	Z34	=	15.50000
X35	=	0.71730	Y35	=	-0.94901	Z35	=	15.50000
X36	=	0.71730	Y36	=	-0.94901	Z36	=	15.50000
X37	=	0.65600	Y37	=	-0.86024	Z37	=	15.50000
X38	=	0.59613	Y38	=	-0.77048	Z38	=	15.50000
X39	=	0.53486	Y39	=	-0.68168	Z39	=	15.50000
X40	=	0.47108	Y40	=	-0.59466	Z40	=	15.50000
X41	=	0.40363	Y41	=	-0.51047	Z41	=	15.50000
X42	=	0.33158	Y42	=	-0.43019	Z42	=	15.50000
X43	=	0.25461	Y43	=	-0.35461	Z43	=	15.50000
X44	=	0.17344	Y44	=	-0.28355	Z44	=	15.50000
X45	=	0.08926	Y45	=	-0.21608	Z45	=	15.50000
X46	=	0.00226	Y46	=	-0.15230	Z46	=	15.50000
X47	=	-0.08769	Y47	=	-0.09274	Z47	=	15.50000
X48	=	-0.18092	Y48	=	-0.03848	Z48	=	15.50000
X49	=	-0.27753	Y49	=	0.00950	Z49	=	15.50000
X50	=	-0.37694	Y50	=	0.05139	Z50	=	15.50000
X51	=	-0.47812	Y51	=	0.08884	Z51	=	15.50000
X52	=	-0.58096	Y52	=	0.12142	Z52	=	15.50000
X53	=	-0.68594	Y53	=	0.14610	Z53	=	15.50000
X54	=	-0.79320	Y54	=	0.15640	Z54	=	15.50000
X55	=	-0.90047	Y55	=	0.14618	Z55	=	15.50000
X56	=	-0.90047	Y56	=	0.14618	Z56	=	15.50000
X57	=	-0.91482	Y57	=	0.14545	Z57	=	15.50000
X58	=	-0.92920	Y58	=	0.14665	Z58	=	15.50000
X59	=	-0.94322	Y59	=	0.14997	Z59	=	15.50000
X60	=	-0.95657	Y60	=	0.15534	Z60	=	15.50000

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiment(s), but on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as permitted under the law. Furthermore it should be understood that while the use of the word preferable, preferably, or preferred in the description above indicates that feature so described may be more desirable, it nonetheless may not be necessary and any embodiment lacking the same may be contemplated as within the scope of the invention, that scope being defined by the claims that follow. In reading the claims it is intended that when words such as "a," "an," "at least one" and "at least a portion" are used, there is no intention to limit the claim to only one item unless specifically stated to the contrary in the claim. Further, when the language "at least a portion" and/or "a portion" is used the item may include a portion and/or the entire item unless specifically stated to the contrary.

Claims

What is claimed is:

1. An airfoil comprising:

an external surface having first and second sides, the external surface extending spanwise between a hub and a tip and streamwise between a leading edge and a trailing edge; and

the external surface having a contour substantially defined by Table 1 as listed in the specification.

2. The airfoil of claim 1, further comprising:

at least one coating formed on the external surface thereof.

3. The airfoil of claim 2, wherein the external surface including the at least one coating substantially meets the contour dimensions defined by Table 1.

4. The airfoil of claim 2, wherein an outer surface of the at least one coating extends outside of the contour dimensions as substantially defined by Table 1.

5. The airfoil of claim 2, wherein the coating includes at least one of a thermal barrier coating and a radiation barrier coating.

6. The airfoil of claim 1, wherein a portion of the external surface includes at least one discontinuity.

7. The airfoil of claim 6, wherein the at least one discontinuity includes a through aperture formed in at least one of the sides of the airfoil to provide an outlet path for cooling fluid to flow therethrough.

8. The airfoil of claim 1, wherein the airfoil is connected to a second stage turbine nozzle guide vane assembly.

9. The airfoil of claim 1, wherein the positional tolerance of the external surface is held to range of about +/- .025 inches for each dimension listed in Table 1.

10. A turbine nozzle guide vane assembly for a gas turbine engine comprising:

an inner shroud having an upper surface and a lower surface, the upper surface of the inner shroud partially defining an inner flow path wall;

an airfoil extending radially outward from the upper surface of the inner shroud relative to an axis of rotation of the gas turbine engine, the airfoil having first and second three-dimensional external surfaces extending between a hub and a tip in a spanwise direction and between a leading edge and a trailing edge in a streamwise direction; and

a Cartesian coordinate array having X,Y and Z axis coordinates listed in Table 1 of the specification defining the first and second external surfaces of the airfoil, wherein the Z axis generally extends radially outward from at least one of the upper surface of the inner shroud or a longitudinal axis of the engine, the X axis generally extends normal to the Z axis in the streamwise direction, and the Y axis generally extends normal to both the X axis and the Z axis in a lateral direction.

11. The turbine nozzle guide vane assembly of claim 10, wherein the external surface of the airfoil is formed within a manufacturing tolerance of about +/- .025 inches of each dimension listed in Table 1.

12. The turbine nozzle guide vane assembly of claim 10, wherein the Z axis further defines a stacking axis extending at a predefined angle from the inner shroud.

13. The turbine nozzle guide vane assembly of claim 12, wherein the angle of the stacking axis is located between a normal position and 25° from the normal position in any direction.

14. The turbine nozzle guide vane assembly of claim 10, further comprising:

at least one coating formed on the external surface of the airfoil.

15. The turbine nozzle guide vane assembly of claim 14, wherein the at least one coating is applied to the airfoil such that an outer surface of the coating is located within a tolerance of +/- .050 inches of the coordinate dimensions defined in Table 1.

16. The turbine nozzle guide vane assembly of claim 14, wherein the coating is at least one of a thermal barrier coating and a radiation barrier coating.

17. The turbine nozzle guide vane assembly of claim 10, wherein a portion of the external surface of the airfoil includes at least one discontinuity.

18. The turbine nozzle guide vane assembly of claim 17, wherein the at least one discontinuity includes a through aperture formed in at least one of the sides of the airfoil to provide an outlet path for cooling fluid to flow therethrough.

19. The turbine nozzle guide vane assembly of claim 10, wherein the airfoil includes an outer shroud formed adjacent the tip.

20. A method of forming an airfoil for a turbine nozzle guide vane comprising:

forming a contoured three-dimensional external surface of an airfoil defined by Cartesian (X, Y and Z) coordinates listed in the specification as Table 1, wherein the Z axis coordinates are generally measured from an inner shroud or an engine centerline axis, the X axis coordinates are generally measured normal to the Z axis in a streamwise direction, and the Y axis coordinates are generally measured normal to the Z axis and normal to the X axis.

21. The method of claim 20, further comprising:

forming the airfoil from a casting process, wherein the casting process includes one of integrally casting the turbine nozzle guide vane in one piece and casting multiple pieces and subsequently bonding the cast pieces together.

22. The method of claim 20, further comprising:

forming the airfoil from a wrought material; and

machine processing a portion of the airfoil to meet a design specification.

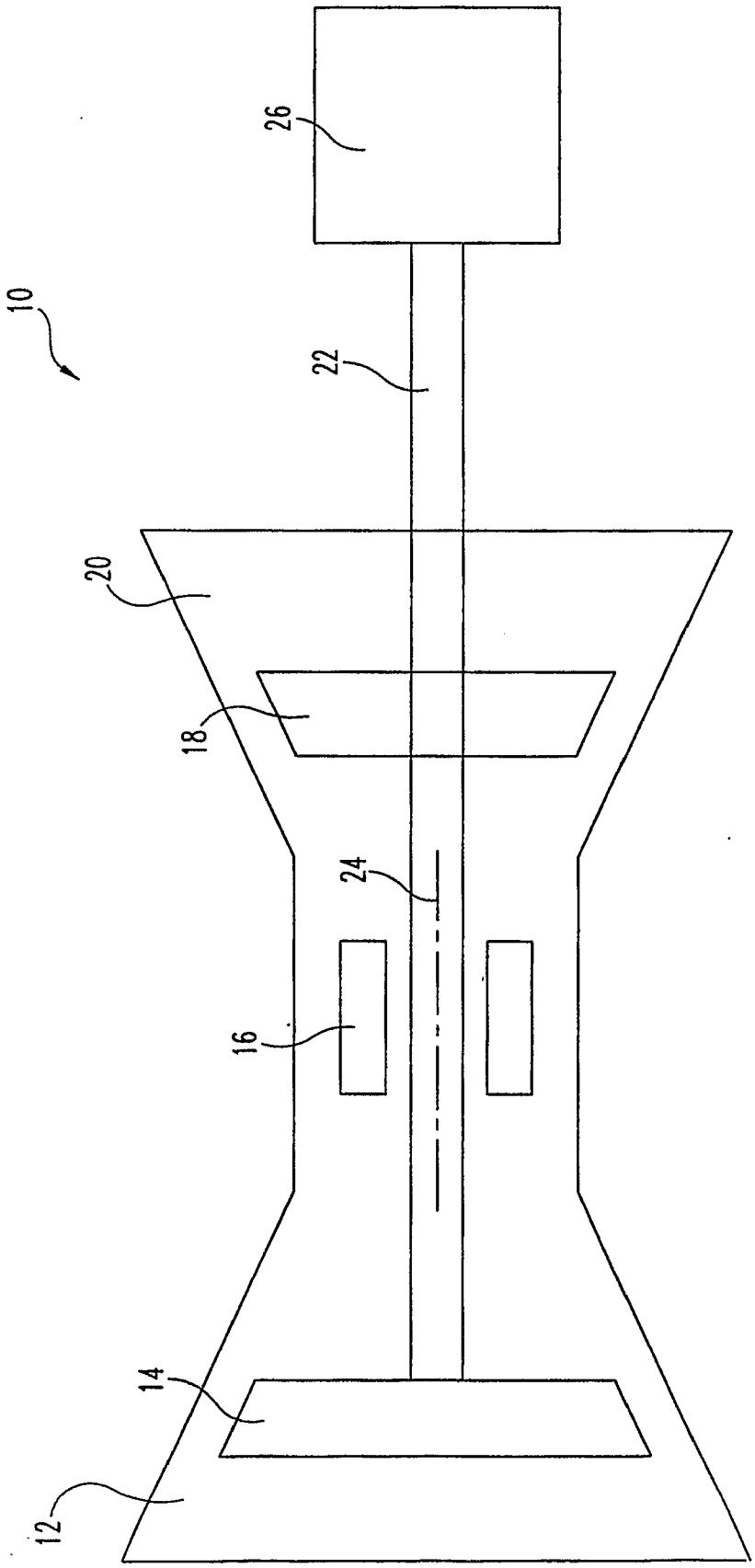


Fig. 1

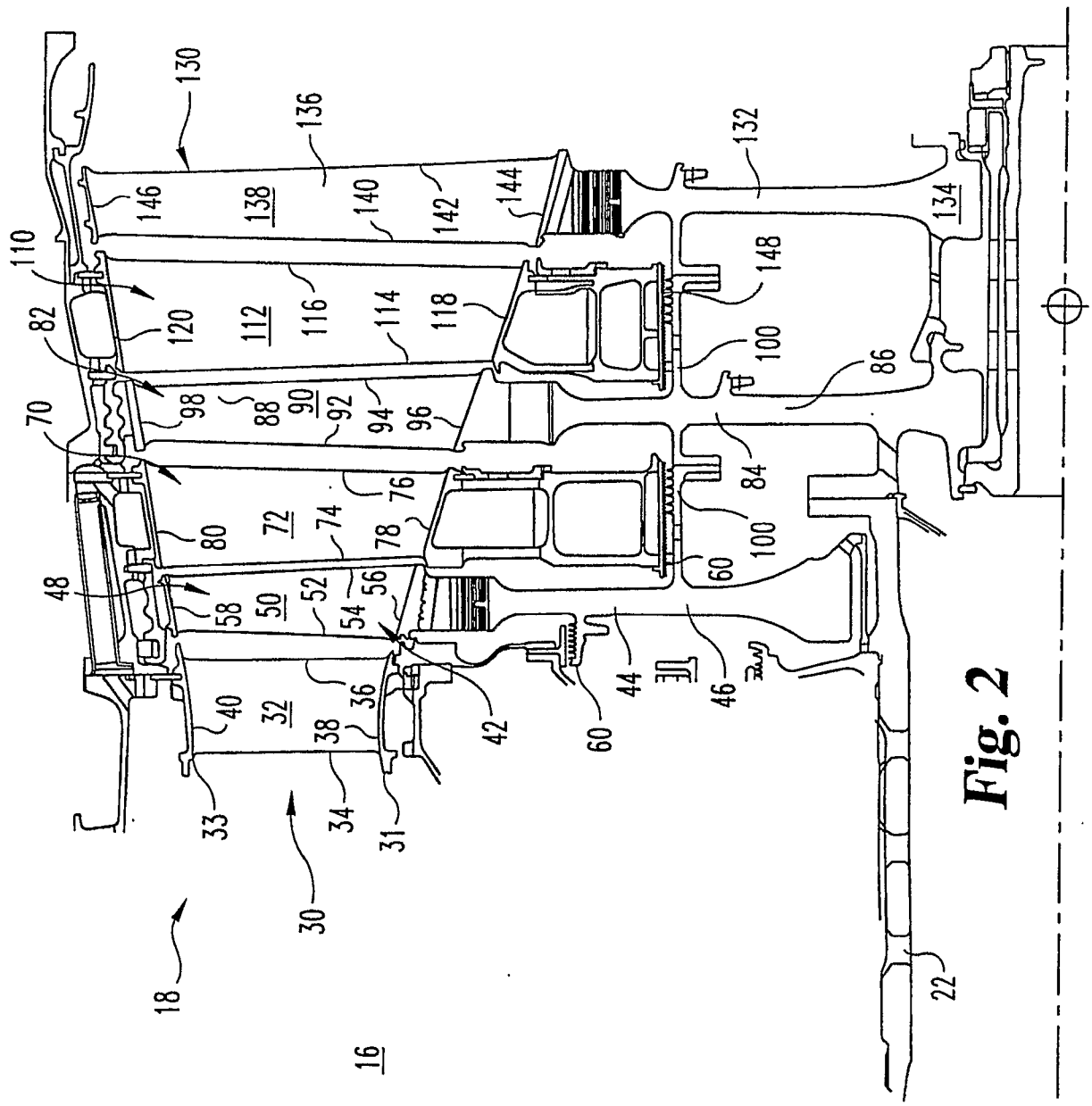

130
136
132
146
138
140
142
144
134
110
148
82
120
112
116
114
118
100
98
88
90
92
94
96
86
70
84
76
80
72
74
78
100
48
60
58
50
52
54
56
40
32
36
38
42
60
44
46
33
34
31
30
18
16
22

Fig. 2

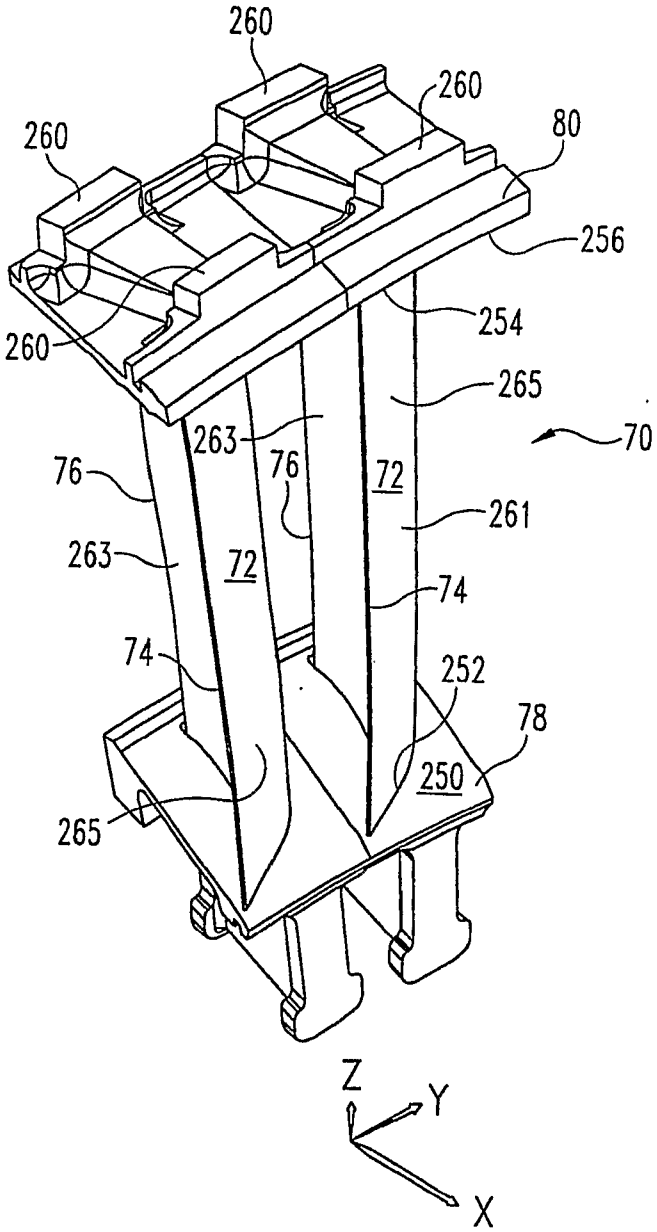

260
260
260
80
256
254
260
265
70
263
76
76
72
261
263
72
74
74
252
78
250
265
Z
Y
X

Fig. 3

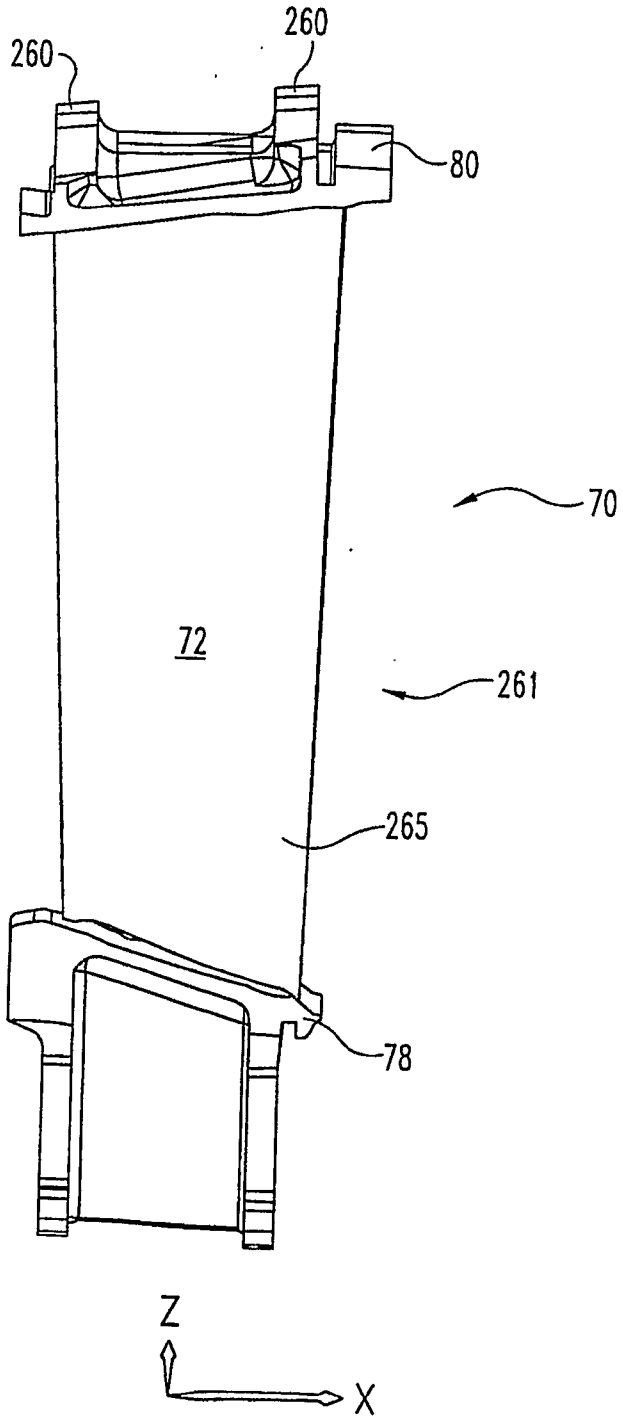


Fig. 4

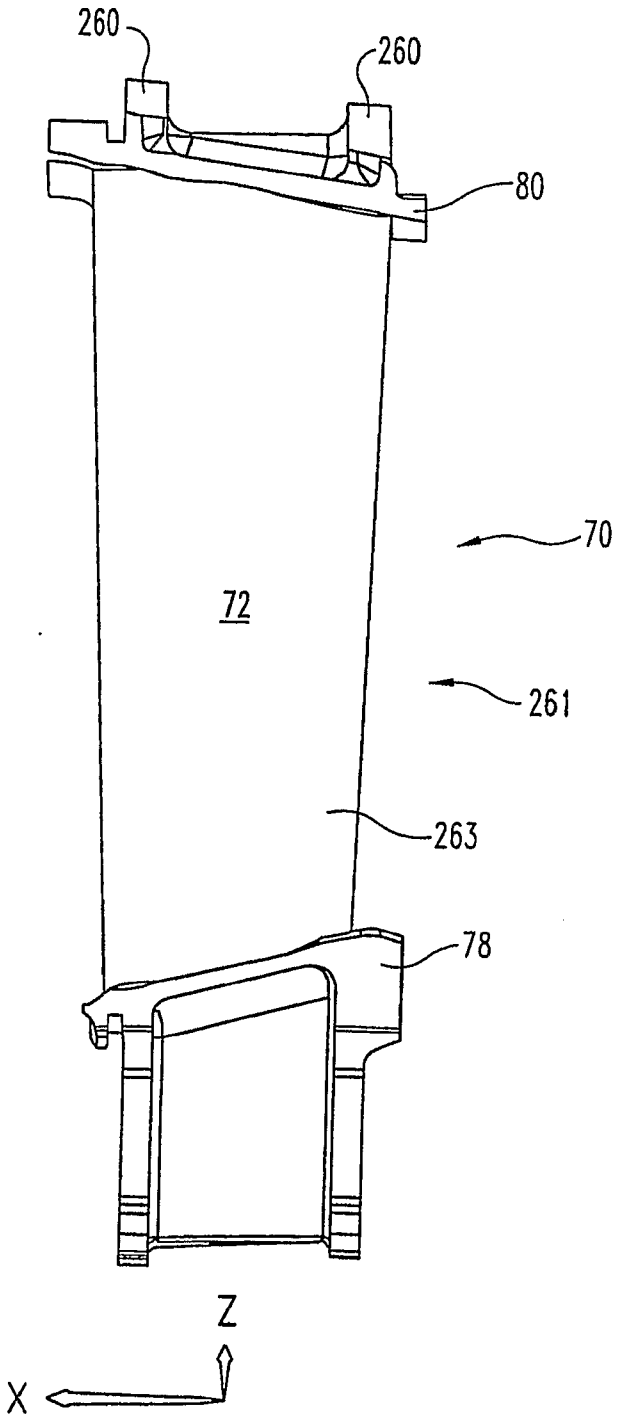


Fig. 5

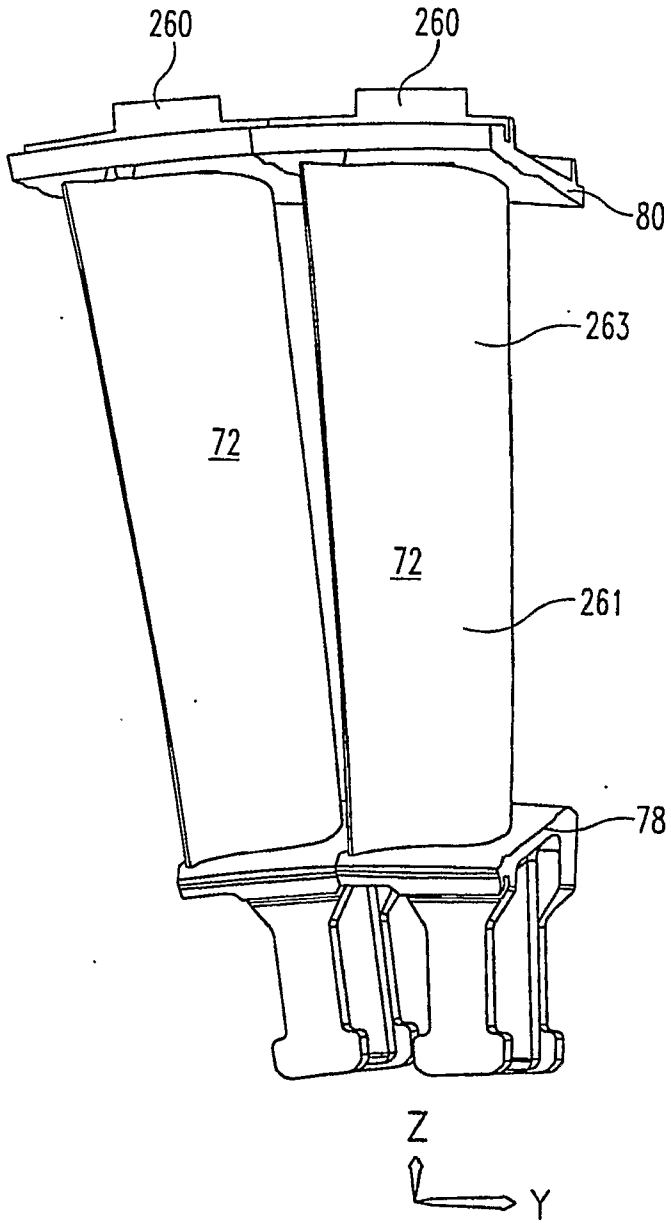


Fig. 6

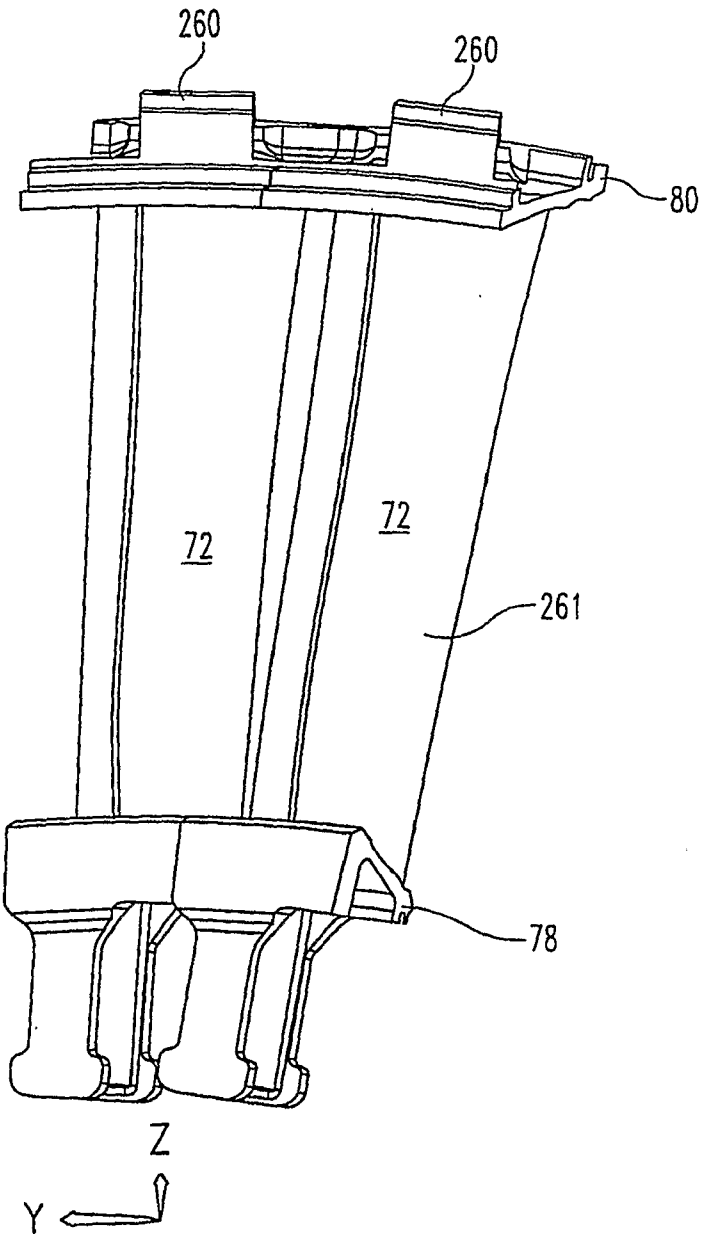


Fig. 7

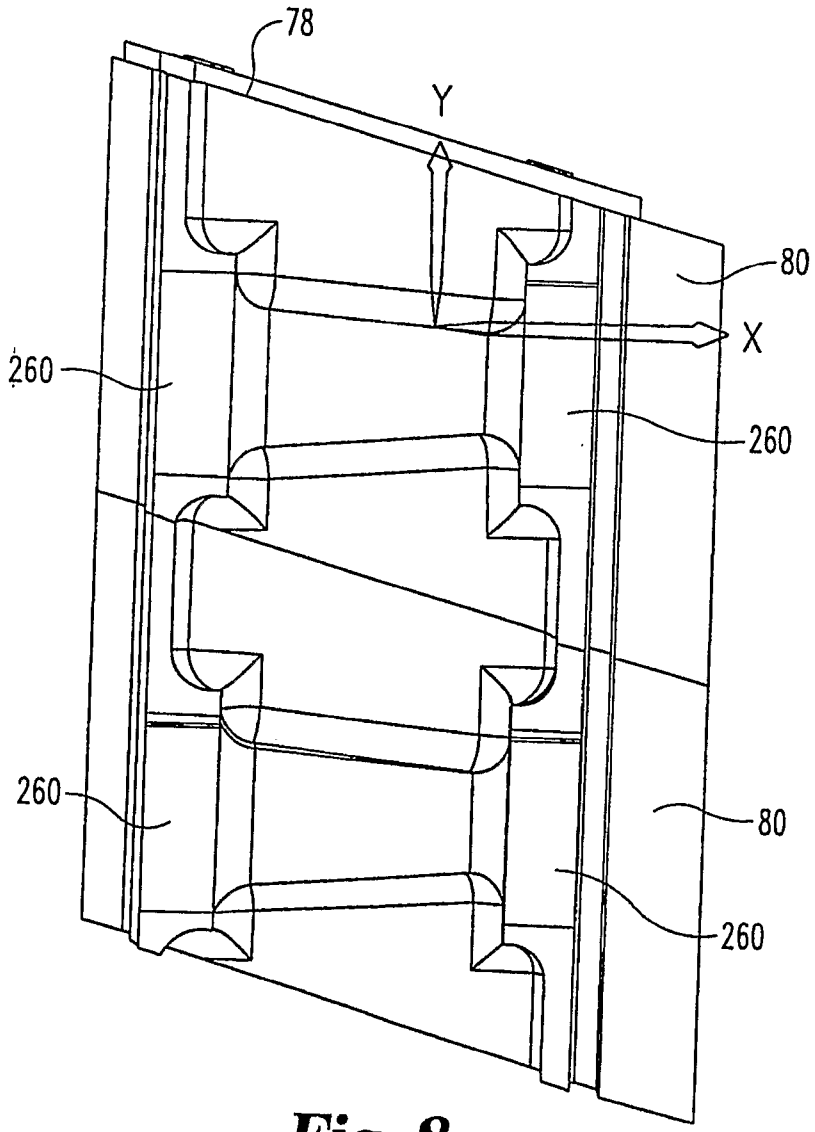


Fig. 8

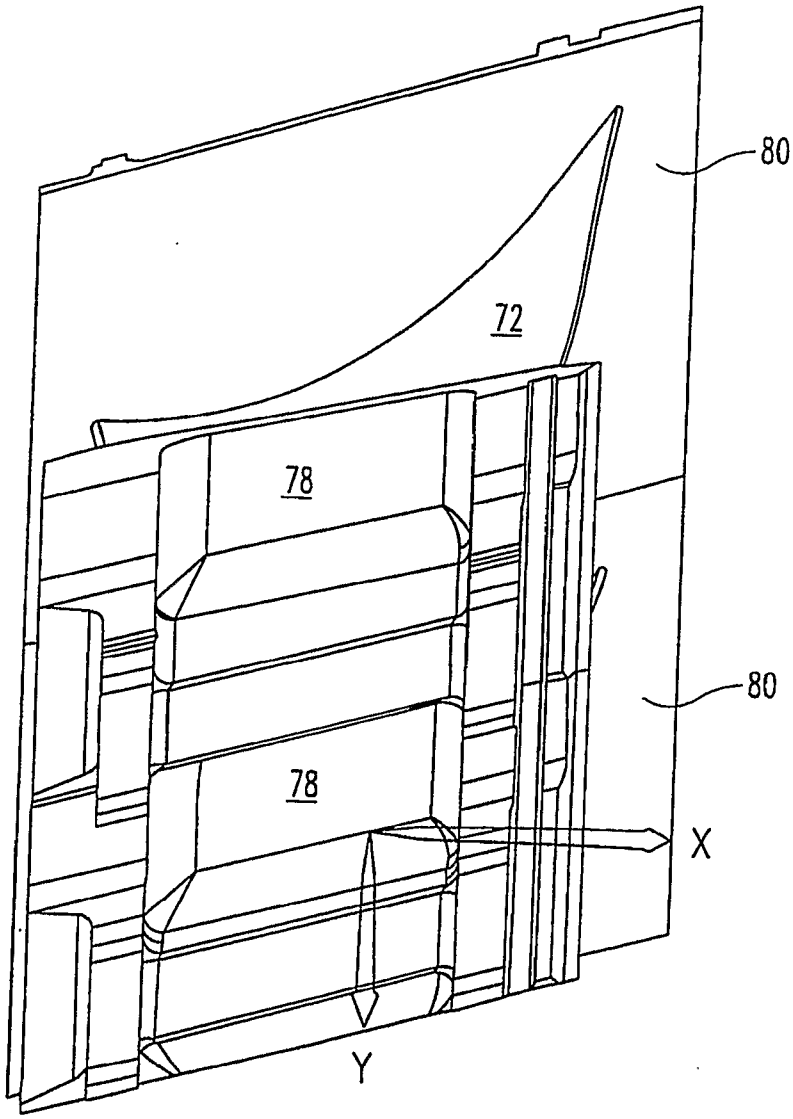


Fig. 9