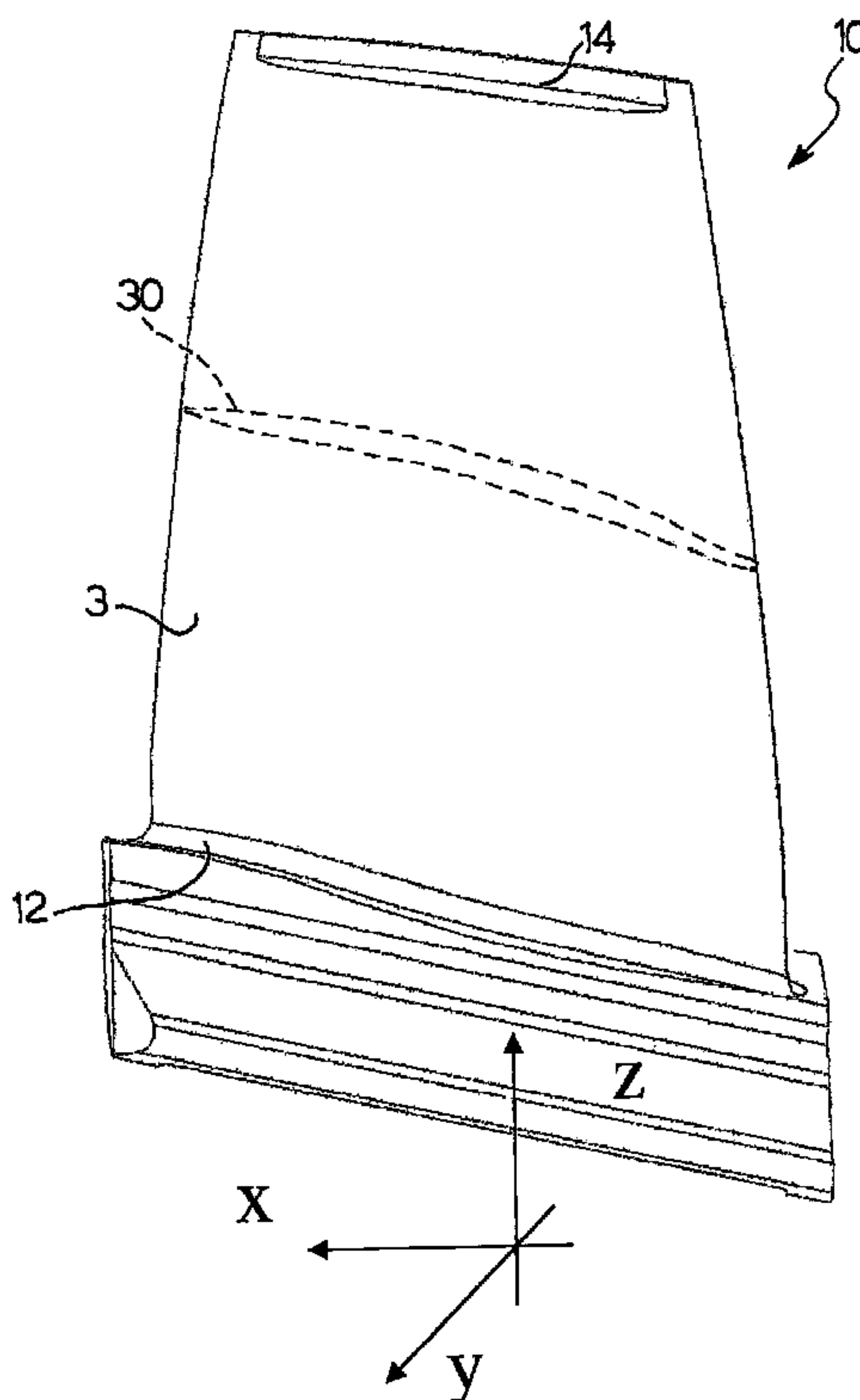




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(54) Titre : AUBE DE ROTOR POUR UNE DEUXIEME PHASE D'UN COMPRESSEUR  
(54) Title: ROTOR BLADE FOR A SECOND PHASE OF A COMPRESSOR



(57) **Abrégé/Abstract:**

The invention relates to a blade (10) of a rotor of a second phase of a compressor, which can be defined by coordinates of a discreet combination of points, in a Cartesian reference system (X, Y, Z), wherein the axis (Z) is a radial axis intersecting the central axis of the compressor, said blade (10) having a profile which can be identified by means of a series of closed intersection curves between the profile itself and planes (X, Y) lying at distances (Z) from the central axis, said blade (10) also comprising a thickening (30), substantially parallel to a base portion (12) of the blade (10) itself, fixable to said rotor, said thickening (30) being substantially situated midway up the blade (10) and being suitable for shifting the natural resonance frequencies of the blade (10) itself outside a functioning velocity range of said rotor.

## ROTOR BLADE FOR A SECOND PHASE OF A COMPRESSOR

## ABSTRACT

The invention relates to a blade (10) of a rotor of a second phase of a compressor, which can be defined by coordinates of a discreet combination of points, in a Cartesian reference system (X, Y, Z), wherein the axis (Z) is a radial axis intersecting the central axis of the compressor, said blade (10) having a profile which can be identified by means of a series of closed intersection curves between the profile itself and planes (X, Y) lying at distances (Z) from the central axis, said blade (10) also comprising a thickening (30), substantially parallel to a base portion (12) of the blade (10) itself, fixable to said rotor, said thickening (30) being substantially situated midway up the blade (10) and being suitable for shifting the natural resonance frequencies of the blade (10) itself outside a functioning velocity range of said rotor.

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## ROTOR BLADE FOR A SECOND PHASE OF A COMPRESSOR

The present invention relates to a blade of a rotor of a second phase of a compressor.

More specifically, the invention relates to a blade of a rotor having a high aerodynamic efficiency of a second phase of a compressor.

Compressors normally pressurize in their interior air removed from the outside.

The fluid penetrates the compressor through a series of inlet ducts.

In these channels, the gas has low pressure and low temperature characteristics, whereas as it passes through the compressor, the gas is compressed and its temperature increases.

In order to increase the efficiency, the compressor is normally divided into various phases, each of which has a rotor and a stator respectively equipped with a series of blades.

In recent years, technologically advanced compressors have been further improved, obtaining an increased improvement in efficiency, operating in particular on the aerodynamic conditions.

The geometric configuration of the blades in fact significantly influences the aerodynamic efficiency.

This depends on the fact that the geometric characteristics of the blade cause a distribution of the relative velocities in the fluid, consequently influencing the distribution of the limit layers along the walls and, ultimately, losses due to friction.

In particular, in the case of rotor blades of a second phase of a compressor an extremely high efficiency is required, at the same time maintaining an appropriate aerodynamic and mechanical load.

An objective of the present invention is to provide a blade of a rotor of a second phase of a compressor which avoids, or in any case reduces, resonance problems due to the

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stimulation of natural frequencies and at the same time allows a high aerodynamic efficiency.

Another objective is to provide a blade of a rotor of a second phase of a compressor which avoids or in any case reduces resonance problems due to the stimulation of natural frequencies and which allows a useful life of the blade itself.

A further objective of the present invention is to provide a rotor of a second phase of a compressor which allows a high aerodynamic efficiency and at the same time allows a high reliability of the compressor to be obtained with a consequent increase in the power of the turbine itself, with the same compressor dimensions.

These objectives according to the present invention are achieved by providing a rotor blade of a second phase of a compressor as specified in claim 1.

Further characteristics of the invention are indicated in the subsequent claims.

The characteristics and advantages of a rotor blade of a second phase of a compressor according to the present invention will appear more evident from the following illustrative and non-limiting description, referring to the enclosed schematic drawings in which:

figure 1 is a raised view of a rotor blade of a compressor produced with an aerodynamic profile according to the present invention;

figure 2 is a raised view of the opposite side of the blade of figure 1; and

figure 3 is a diagram of the maximum thickness trend of a blade according to the present invention, with respect to its height.

With reference to the figures, a blade 10 is provided of a rotor of a second phase of a compressor.

Said blade 10 is defined by means of coordinates of a discreet combination of points, in a Cartesian reference system (X,Y,Z), wherein the axis (Z) is a radial axis intersecting the central axis of the compressor, not shown.

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The profile of the blade 10 is identified by means of a series of closed intersection curves between the profile itself and planes (X,Y) lying at distances (Z) from the central axis.

The profile of said blade 10 comprises a first substantially concave surface 3, which is pressurized, and a second substantially convex surface 5 which is in depression and opposite the first.

The two surfaces 3, 5 are continuous and joined to each other, and together form the profile of said blade 10.

At a base portion 12, commonly called "foot" of the blade 10, according to the known art there is a connecting joint with the aerodynamic profile of the blade 10 itself, said base portion 12 being suitable for being fixed to said rotor of said compressor.

Said blade 10 comprises a thickening 30, i.e. a prolonged portion having a greater thickness with respect to the adjacent portions, which is substantially parallel to said base portion 12 so as to shift the resonance frequencies of said blade 10 outside the functioning frequency range of the rotor itself, thus reducing or in any case avoiding problems of instability and vibrations of the blade 10 and rotor.

This advantageously leads to an increase in both the useful life and reliability of the rotor and compressor itself.

Said thickening 30 relates to at least one section or closed curve, and is also substantially situated midway up the blade 10.

In other words, said thickening 30 confers a dynamic behaviour to said blade 10 which is such as to have flexural frequencies which fall outside a functioning velocity range of the rotor of said compressor and consequently such that there is no intensification of the maximum flexural deformation of the blade during the functioning of the compressor.

This consequently leads to a higher performance of the compressor, of the rotor and a longer useful life of its components, as problems of resonance such as those described above are avoided.

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The clearances and tolerances of the blade and stator can consequently be dimensioned so as to further increase the performances of the compressor itself.

This is possible as the blade, upon deforming, is prevented from causing a contact and relative friction against the relative stator.

In particular, each closed curve has a maximum thickness determined by the maximum distance between said first surface 3 and said second surface 5.

Said maximum surface of each closed curve, along the height of the blade 10, moving towards a free end 14 of the blade 10, has a decreasing trend whose slope varies three times, defining four regions. For example, the variation in the trend of the maximum thickness is shown in figure 3, in which it is compared with the maximum thickness trend of a blade according to the known art. In particular, in figure 3, the abscissa indicates the height of the blade 10, whereas the ordinate represents the maximum thickness of the blade 10, adimensionalized by putting the thickness in correspondence with the foot of the blade equal to 1. In the diagram shown in figure 3, the upper line represents the maximum thickness trend of a blade according to the known art, whereas the lower line shows the trend of the maximum thickness of the blade according to the present invention.

Along the height of the blade 10 in the direction of a free end 14 of the blade 10, said maximum thickness preferably has a trend according to a polynomial function of the sixth degree and in particular said polynomial function is:

$$T_{\max} = -21.119 \cdot h^6 + 70.467 \cdot h^5 - 85.603 \cdot h^4 + 44.523 \cdot h^3 - 7.8323 \cdot h^2 - 1.1541 \cdot h + 0.997$$

wherein  $h$  represents the percentage of the height of the blade 10, and wherein  $T_{\max}$  is the maximum adimensionalized thickness relating to the closed curve corresponding to that percentage of the height of the blade 10.

The profile of each blade 10 was also suitably shaped to be able to maintain the same efficiency at high levels.

The aerodynamic profile of each blade 10 is preferably defined by means of a series

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of closed curves whose coordinates are defined with respect to a Cartesian reference system X, Y, Z, wherein the axis Z is a radial axis intersecting the central axis of the turbine, and said closed curves lying at distances Z from the central axis are defined according to Table I, whose values, expressed in millimeters, refer to an aerodynamic profile at room temperature, in particular 25°C.

Table I

X	Y	Z			
-32.517	32.876	230.276	5.572	-1.445	230.276
-32.501	32.886	230.276	7.741	-3.134	230.276
-32.466	32.898	230.276	9.952	-4.768	230.276
-32.392	32.903	230.276	12.212	-6.339	230.276
-32.249	32.868	230.276	14.528	-7.836	230.276
-32.039	32.773	230.276	16.816	-9.204	230.276
-31.685	32.561	230.276	19.065	-10.452	230.276
-31.241	32.234	230.276	21.267	-11.595	230.276
-30.677	31.764	230.276	23.415	-12.647	230.276
-29.982	31.164	230.276	25.500	-13.615	230.276
-29.084	30.379	230.276	27.518	-14.510	230.276
-28.056	29.463	230.276	29.464	-15.340	230.276
-26.970	28.476	230.276	31.249	-16.077	230.276
-25.756	27.357	230.276	32.869	-16.731	230.276
-24.412	26.106	230.276	34.322	-17.310	230.276
-22.940	24.725	230.276	35.604	-17.818	230.276
-21.407	23.274	230.276	36.717	-18.256	230.276
-19.816	21.752	230.276	37.658	-18.626	230.276
-18.164	20.161	230.276	38.462	-18.946	230.276
-16.447	18.505	230.276	39.135	-19.219	230.276
-14.664	16.784	230.276	39.688	-19.446	230.276
-12.813	15.003	230.276	40.130	-19.629	230.276
-10.890	13.163	230.276	40.469	-19.771	230.276
-8.894	11.268	230.276	40.723	-19.878	230.276
-6.886	9.385	230.276	40.900	-20.024	230.276
-4.864	7.518	230.276	40.972	-20.196	230.276
-2.823	5.670	230.276	40.974	-20.337	230.276
-0.759	3.847	230.276	40.927	-20.475	230.276
1.327	2.052	230.276	40.798	-20.620	230.276
3.436	0,19861	230.276	40.567	-20.693	230.276
			40.271	-20.713	230.276

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39.877	-20.737	230.276
39.363	-20.764	230.276
38.722	-20.793	230.276
37.941	-20.822	230.276
37.012	-20.849	230.276
35.926	-20.871	230.276
34.642	-20.885	230.276
33.160	-20.882	230.276
31.482	-20.846	230.276
29.607	-20.760	230.276
27.538	-20.601	230.276
25.290	-20.348	230.276
22.967	-19.991	230.276
20.570	-19.516	230.276
18.104	-18.909	230.276
15.573	-18.154	230.276
12.979	-17.233	230.276
10.333	-16.134	230.276
7.676	-14.853	230.276
5.106	-13.432	230.276
2.621	-11.879	230.276
0,14583	-10.207	230.276
-2.134	-8.429	230.276
-4.417	-6.555	230.276
-6.626	-4.601	230.276
-8.756	-2.579	230.276
-10.809	-0.493	230.276
-12.787	1.657	230.276
-14.694	3.867	230.276
-16.534	6.134	230.276
-18.254	8.374	230.276
-19.866	10.579	230.276
-21.378	12.741	230.276
-22.797	14.854	230.276
-24.130	16.912	230.276
-25.380	18.908	230.276
-26.547	20.840	230.276
-27.636	22.706	230.276
-28.605	24.412	230.276
-29.461	25.958	230.276
-30.203	27.342	230.276

-30.879	28.650	230.276
-31.447	29.793	230.276
-31.874	30.677	230.276
-32.205	31.389	230.276
-32.423	31.936	230.276
-32.547	32.360	230.276
-32.587	32.602	230.276
-32.583	32.758	230.276
-32.557	32.832	230.276
-32.532	32.863	230.276
-32.587	31.887	235.273
-32.571	31.897	235.273
-32.536	31.910	235.273
-32.462	31.913	235.273
-32.320	31.877	235.273
-32.113	31.778	235.273
-31.763	31.560	235.273
-31.324	31.231	235.273
-30.763	30.762	235.273
-30.071	30.163	235.273
-29.179	29.378	235.273
-28.157	28.463	235.273
-27.073	27.480	235.273
-25.860	26.368	235.273
-24.517	25.127	235.273
-23.041	23.759	235.273
-21.502	22.327	235.273
-19.899	20.828	235.273
-18.230	19.265	235.273
-16.493	17.642	235.273
-14.686	15.959	235.273
-12.808	14.219	235.273
-10.857	12.423	235.273
-8.830	10.575	235.273
-6.793	8.737	235.273
-4.744	6.914	235.273
-2.680	5.107	235.273
-0.598	3.321	235.273
1.506	1.562	235.273
3.634	-0.166	235.273
5.789	-1.860	235.273

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12.468	-6.663	235.273
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17.044	-9.496	235.273
19.272	-10.741	235.273
21.453	-11.886	235.273
23.579	-12.941	235.273
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27.646	-14.820	235.273
29.575	-15.659	235.273
31.344	-16.407	235.273
32.950	-17.070	235.273
34.389	-17.658	235.273
35.661	-18.173	235.273
36.764	-18.616	235.273
37.698	-18.991	235.273
38.494	-19.314	235.273
39.163	-19.588	235.273
39.712	-19.816	235.273
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40.577	-21.058	235.273
40.284	-21.072	235.273
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39.384	-21.105	235.273
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-26.287	20.196	235.273
-27.412	22.002	235.273
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-30.083	26.506	235.273
-30.795	27.775	235.273
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-31.854	29.741	235.273
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-32.444	30.964	235.273
-32.588	31.376	235.273
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-32.601	31.874	235.273
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-12.818	13.451	241.239
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-8.799	9.887	241.239
-6.742	8.090	241.239
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39.747	-20.326	241.239
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6.369	-12.758	241.239
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-8.762	9.605	244.222
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-2.532	4.271	244.222
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3.856	-0.875	244.222
6.034	-2.522	244.222
8.240	-4.128	244.222
10.476	-5.691	244.222
12.743	-7.208	244.222
15.042	-8.677	244.222
17.298	-10.048	244.222
19.508	-11.324	244.222
21.669	-12.509	244.222
23.772	-13.608	244.222
25.814	-14.626	244.222
27.791	-15.570	244.222
29.697	-16.448	244.222
31.448	-17.229	244.222
33.038	-17.921	244.222
34.465	-18.531	244.222
35.726	-19.064	244.222
36.821	-19.520	244.222
37.749	-19.904	244.222
38.542	-20.232	244.222
39.208	-20.509	244.222
39.755	-20.739	244.222
40.192	-20.924	244.222
40.527	-21.067	244.222

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40.950	-21.324	244.222
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41.006	-21.635	244.222
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40.825	-21.905	244.222
40.600	-21.974	244.222
40.312	-21.977	244.222
39.928	-21.979	244.222
39.428	-21.977	244.222
38.804	-21.968	244.222
38.045	-21.948	244.222
37.143	-21.912	244.222
36.089	-21.854	244.222
34.844	-21.769	244.222
33.411	-21.645	244.222
31.791	-21.468	244.222
29.985	-21.219	244.222
27.996	-20.879	244.222
25.842	-20.431	244.222
23.621	-19.881	244.222
21.337	-19.220	244.222
18.992	-18.437	244.222
16.590	-17.527	244.222
14.134	-16.479	244.222
11.625	-15.286	244.222
9.085	-13.951	244.222
6.612	-12.525	244.222
4.202	-11.012	244.222
1.853	-9.415	244.222
-0.436	-7.738	244.222
-2.669	-5.983	244.222
-4.847	-4.154	244.222
-6.976	-2.257	244.222
-9.059	-0.298	244.222
-11.097	1.718	244.222
-13.086	3.778	244.222
-15.028	5.881	244.222
-16.861	7.952	244.222
-18.592	9.986	244.222
-20.224	11.980	244.222

-21.763	13.928	244.222
-23.212	15.828	244.222
-24.571	17.676	244.222
-25.846	19.466	244.222
-27.041	21.197	244.222
-28.106	22.784	244.222
-29.048	24.224	244.222
-29.869	25.514	244.222
-30.628	26.731	244.222
-31.273	27.792	244.222
-31.758	28.616	244.222
-32.133	29.282	244.222
-32.394	29.793	244.222
-32.565	30.188	244.222
-32.637	30.415	244.222
-32.654	30.567	244.222
-32.639	30.641	244.222
-32.619	30.674	244.222
-32.528	30.632	247.206
-32.513	30.643	247.206
-32.478	30.654	247.206
-32.404	30.652	247.206
-32.266	30.603	247.206
-32.069	30.488	247.206
-31.738	30.243	247.206
-31.317	29.893	247.206
-30.772	29.405	247.206
-30.100	28.786	247.206
-29.233	27.974	247.206
-28.234	27.035	247.206
-27.168	26.034	247.206
-25.968	24.908	247.206
-24.633	23.660	247.206
-23.160	22.292	247.206
-21.615	20.866	247.206
-19.999	19.383	247.206
-18.311	17.844	247.206
-16.549	16.250	247.206
-14.712	14.602	247.206
-12.799	12.902	247.206
-10.811	11.151	247.206

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-8.745	9.349	247.206
-6.670	7.557	247.206
-4.584	5.779	247.206
-2.484	4.017	247.206
-0.366	2.275	247.206
1.773	0,38958	247.206
3.935	-1.120	247.206
6.125	-2.764	247.206
8.342	-4.369	247.206
10.588	-5.934	247.206
12.864	-7.458	247.206
15.171	-8.937	247.206
17.432	-10.323	247.206
19.641	-11.616	247.206
21.795	-12.821	247.206
23.890	-13.942	247.206
25.924	-14.987	247.206
27.891	-15.962	247.206
29.787	-16.872	247.206
31.527	-17.686	247.206
33.106	-18.410	247.206
34.523	-19.050	247.206
35.776	-19.609	247.206
36.864	-20.088	247.206
37.786	-20.489	247.206
38.575	-20.832	247.206
39.237	-21.121	247.206
39.781	-21.360	247.206
40.216	-21.553	247.206
40.551	-21.701	247.206
40.801	-21.814	247.206
40.969	-21.965	247.206
41.027	-22.138	247.206
41.018	-22.275	247.206
40.963	-22.406	247.206
40.829	-22.538	247.206
40.602	-22.597	247.206
40.314	-22.587	247.206
39.930	-22.572	247.206
39.431	-22.548	247.206
38.808	-22.512	247.206

38.052	-22.457	247.206
37.152	-22.381	247.206
36.102	-22.276	247.206
34.863	-22.137	247.206
33.436	-21.952	247.206
31.824	-21.709	247.206
30.028	-21.393	247.206
28.056	-20.988	247.206
25.920	-20.479	247.206
23.718	-19.875	247.206
21.456	-19.167	247.206
19.134	-18.344	247.206
16.758	-17.401	247.206
14.329	-16.328	247.206
11.850	-15.119	247.206
9.323	-13.767	247.206
6.843	-12.321	247.206
4.426	-10.794	247.206
2.073	-9.191	247.206
-0.219	-7.515	247.206
-2.453	-5.767	247.206
-4.630	-3.952	247.206
-6.756	-2.075	247.206
-8.834	-0.140	247.206
-10.868	1.848	247.206
-12.862	3.885	247.206
-14.816	5.970	247.206
-16.665	8.027	247.206
-18.410	10.049	247.206
-20.055	12.029	247.206
-21.604	13.966	247.206
-23.062	15.854	247.206
-24.430	17.690	247.206
-25.713	19.470	247.206
-26.916	21.190	247.206
-27.989	22.768	247.206
-28.937	24.200	247.206
-29.764	25.483	247.206
-30.529	26.693	247.206
-31.179	27.750	247.206
-31.667	28.570	247.206

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-32.045	29.233	247.206
-32.308	29.741	247.206
-32.482	30.133	247.206
-32.556	30.360	247.206
-32.575	30.511	247.206
-32.561	30.586	247.206
-32.542	30.619	247.206
-32.262	30.914	253.172
-32.247	30.924	253.172
-32.211	30.934	253.172
-32.137	30.928	253.172
-32.000	30.873	253.172
-31.807	30.747	253.172
-31.485	30.486	253.172
-31.073	30.119	253.172
-30.541	29.610	253.172
-29.883	28.965	253.172
-29.034	28.121	253.172
-28.055	27.147	253.172
-27.008	26.110	253.172
-25.828	24.946	253.172
-24.514	23.656	253.172
-23.063	22.242	253.172
-21.540	20.771	253.172
-19.946	19.241	253.172
-18.278	17.654	253.172
-16.537	16.012	253.172
-14.718	14.317	253.172
-12.819	12.574	253.172
-10.837	10.783	253.172
-8.772	8.949	253.172
-6.692	7.133	253.172
-4.596	5.334	253.172
-2.485	3.554	253.172
-0.355	1.795	253.172
1.797	0.063	253.172
3.974	-1.635	253.172
6.177	-3.298	253.172
8.408	-4.923	253.172
10.666	-6.510	253.172
12.950	-8.061	253.172

15.262	-9.573	253.172
17.521	-10.996	253.172
19.723	-12.333	253.172
21.867	-13.588	253.172
23.950	-14.765	253.172
25.969	-15.869	253.172
27.921	-16.906	253.172
29.802	-17.880	253.172
31.527	-18.753	253.172
33.094	-19.532	253.172
34.500	-20.222	253.172
35.743	-20.825	253.172
36.823	-21.341	253.172
37.738	-21.775	253.172
38.521	-22.144	253.172
39.179	-22.455	253.172
39.720	-22.712	253.172
40.152	-22.919	253.172
40.484	-23.079	253.172
40.732	-23.199	253.172
40.899	-23.353	253.172
40.952	-23.530	253.172
40.936	-23.667	253.172
40.872	-23.794	253.172
40.728	-23.916	253.172
40.496	-23.953	253.172
40.210	-23.919	253.172
39.829	-23.872	253.172
39.333	-23.806	253.172
38.715	-23.717	253.172
37.965	-23.600	253.172
37.075	-23.451	253.172
36.035	-23.264	253.172
34.809	-23.030	253.172
33.399	-22.740	253.172
31.806	-22.385	253.172
30.033	-21.952	253.172
28.088	-21.428	253.172
25.982	-20.800	253.172
23.811	-20.086	253.172
21.578	-19.276	253.172

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19.287	-18.364	253.172
16.941	-17.343	253.172
14.543	-16.205	253.172
12.096	-14.945	253.172
9.603	-13.556	253.172
7.148	-12.082	253.172
4.732	-10.523	253.172
2.373	-8.894	253.172
0.077	-7.198	253.172
-2.160	-5.439	253.172
-4.340	-3.619	253.172
-6.468	-1.743	253.172
-8.548	0,12847	253.172
-10.584	2.160	253.172
-12.576	4.181	253.172
-14.525	6.249	253.172
-16.366	8.294	253.172
-18.104	10.310	253.172
-19.745	12.293	253.172
-21.293	14.235	253.172
-22.749	16.128	253.172
-24.118	17.967	253.172
-25.405	19.749	253.172
-26.612	21.471	253.172
-27.689	23.049	253.172
-28.641	24.482	253.172
-29.473	25.765	253.172
-30.241	26.975	253.172
-30.894	28.032	253.172
-31.384	28.852	253.172
-31.764	29.515	253.172
-32.030	30.023	253.172
-32.208	30.414	253.172
-32.286	30.640	253.172
-32.307	30.792	253.172
-32.295	30.867	253.172
-32.276	30.900	253.172
-31.891	31.429	259.138
-31.875	31.439	259.138
-31.839	31.448	259.138
-31.764	31.439	259.138

-31.629	31.378	259.138
-31.440	31.244	259.138
-31.125	30.972	259.138
-30.720	30.590	259.138
-30.198	30.065	259.138
-29.554	29.400	259.138
-28.721	28.530	259.138
-27.761	27.526	259.138
-26.733	26.459	259.138
-25.575	25.261	259.138
-24.283	23.934	259.138
-22.856	22.480	259.138
-21.357	20.966	259.138
-19.786	19.394	259.138
-18.143	17.764	259.138
-16.425	16.077	259.138
-14.630	14.337	259.138
-12.755	12.546	259.138
-10.797	10.708	259.138
-8.755	8.825	259.138
-6.694	6.963	259.138
-4.615	5.121	259.138
-2.518	3.300	259.138
-0.400	1.502	259.138
1.741	-0.268	259.138
3.908	-2.005	259.138
6.100	-3.709	259.138
8.318	-5.378	259.138
10.562	-7.015	259.138
12.830	-8.618	259.138
15.122	-10.188	259.138
17.358	-11.671	259.138
19.538	-13.073	259.138
21.657	-14.396	259.138
23.715	-15.644	259.138
25.708	-16.821	259.138
27.633	-17.932	259.138
29.488	-18.978	259.138
31.190	-19.920	259.138
32.735	-20.762	259.138
34.121	-21.509	259.138

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35.347	-22.162	259.138
36.412	-22.724	259.138
37.315	-23.195	259.138
38.087	-23.597	259.138
38.736	-23.936	259.138
39.269	-24.216	259.138
39.695	-24.441	259.138
40.022	-24.614	259.138
40.267	-24.745	259.138
40.431	-24.904	259.138
40.476	-25.083	259.138
40.451	-25.220	259.138
40.379	-25.342	259.138
40.225	-25.451	259.138
39.991	-25.466	259.138
39.708	-25.408	259.138
39.332	-25.328	259.138
38.844	-25.221	259.138
38.235	-25.082	259.138
37.496	-24.906	259.138
36.620	-24.688	259.138
35.597	-24.423	259.138
34.390	-24.099	259.138
33.003	-23.711	259.138
31.437	-23.248	259.138
29.695	-22.701	259.138
27.785	-22.061	259.138
25.716	-21.315	259.138
23.582	-20.488	259.138
21.387	-19.574	259.138
19.134	-18.566	259.138
16.826	-17.457	259.138
14.467	-16.242	259.138
12.060	-14.913	259.138
9.608	-13.465	259.138
7.194	-11.943	259.138
4.819	-10.347	259.138
2.481	-8.678	259.138
0,13125	-6.938	259.138
-2.042	-5.141	259.138
-4.215	-3.288	259.138

-6.333	-1.383	259.138
-8.401	0,39514	259.138
-10.421	2.565	259.138
-12.395	4.606	259.138
-14.322	6.690	259.138
-16.141	8.747	259.138
-17.856	10.771	259.138
-19.474	12.756	259.138
-21.000	14.699	259.138
-22.439	16.593	259.138
-23.795	18.436	259.138
-25.071	20.223	259.138
-26.271	21.952	259.138
-27.341	23.538	259.138
-28.288	24.976	259.138
-29.114	26.264	259.138
-29.877	27.479	259.138
-30.527	28.539	259.138
-31.014	29.363	259.138
-31.391	30.029	259.138
-31.655	30.538	259.138
-31.834	30.930	259.138
-31.912	31.156	259.138
-31.934	31.307	259.138
-31.923	31.382	259.138
-31.905	31.415	259.138
-31.464	32.050	265.104
-31.447	32.060	265.104
-31.411	32.068	265.104
-31.336	32.056	265.104
-31.203	31.990	265.104
-31.017	31.850	265.104
-30.707	31.569	265.104
-30.309	31.177	265.104
-29.797	30.638	265.104
-29.165	29.955	265.104
-28.349	29.063	265.104
-27.406	28.034	265.104
-26.397	26.941	265.104
-25.258	25.714	265.104
-23.988	24.354	265.104

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-22.584	22.865	265.104
-21.110	21.316	265.104
-19.563	19.706	265.104
-17.944	18.038	265.104
-16.249	16.313	265.104
-14.478	14.533	265.104
-12.627	12.701	265.104
-10.694	10.821	265.104
-8.678	8.894	265.104
-6.644	6.988	265.104
-4.592	5.102	265.104
-2.521	3.237	265.104
-0.431	1.395	265.104
1.681	-0.423	265.104
3.817	-2.213	265.104
5.978	-3.975	265.104
8.166	-5.707	265.104
10.378	-7.409	265.104
12.614	-9.081	265.104
14.872	-10.722	265.104
17.074	-12.279	265.104
19.220	-13.757	265.104
21.305	-15.159	265.104
23.326	-16.489	265.104
25.282	-17.749	265.104
27.169	-18.944	265.104
28.986	-20.076	265.104
30.652	-21.098	265.104
32.165	-22.014	265.104
33.521	-22.829	265.104
34.721	-23.543	265.104
35.763	-24.157	265.104
36.647	-24.674	265.104
37.403	-25.115	265.104
38.037	-25.486	265.104
38.559	-25.793	265.104
38.975	-26.039	265.104
39.295	-26.230	265.104
39.535	-26.373	265.104
39.695	-26.537	265.104
39.731	-26.720	265.104

39.699	-26.856	265.104
39.619	-26.974	265.104
39.458	-27.072	265.104
39.224	-27.066	265.104
38.947	-26.987	265.104
38.578	-26.881	265.104
38.099	-26.739	265.104
37.502	-26.557	265.104
36.778	-26.330	265.104
35.919	-26.053	265.104
34.916	-25.720	265.104
33.735	-25.319	265.104
32.376	-24.843	265.104
30.842	-24.285	265.104
29.137	-23.636	265.104
27.268	-22.889	265.104
25.242	-22.033	265.104
23.150	-21.100	265.104
20.996	-20.084	265.104
18.782	-18.978	265.104
16.513	-17.778	265.104
14.192	-16.477	265.104
11.823	-15.067	265.104
9.409	-13.541	265.104
7.033	-11.947	265.104
4.696	-10.285	265.104
2.398	-8.554	265.104
0,10278	-6.763	265.104
-2.046	-4.919	265.104
-4.185	-3.026	265.104
-6.272	-1.086	265.104
-8.311	0,62361	265.104
-10.304	2.926	265.104
-12.250	4.995	265.104
-14.151	7.106	265.104
-15.945	9.186	265.104
-17.638	11.231	265.104
-19.234	13.236	265.104
-20.740	15.195	265.104
-22.159	17.106	265.104
-23.495	18.963	265.104

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-24.752	20.765	265.104
-25.934	22.507	265.104
-26.989	24.105	265.104
-27.922	25.554	265.104
-28.736	26.852	265.104
-29.488	28.076	265.104
-30.127	29.144	265.104
-30.606	29.973	265.104
-30.976	30.644	265.104
-31.234	31.157	265.104
-31.409	31.551	265.104
-31.486	31.777	265.104
-31.507	31.928	265.104
-31.496	32.004	265.104
-31.477	32.037	265.104
-31.019	32.811	271.071
-31.002	32.820	271.071
-30.965	32.827	271.071
-30.891	32.813	271.071
-30.759	32.743	271.071
-30.575	32.597	271.071
-30.268	32.308	271.071
-29.875	31.906	271.071
-29.371	31.352	271.071
-28.750	30.650	271.071
-27.947	29.735	271.071
-27.020	28.679	271.071
-26.027	27.557	271.071
-24.905	26.298	271.071
-23.654	24.904	271.071
-22.270	23.377	271.071
-20.816	21.788	271.071
-19.290	20.137	271.071
-17.692	18.427	271.071
-16.019	16.657	271.071
-14.269	14.831	271.071
-12.440	12.952	271.071
-10.530	11.022	271.071
-8.536	9.045	271.071
-6.523	7.088	271.071
-4.492	5.150	271.071

-2.443	3.232	271.071
-0.376	1.334	271.071
1.711	-0.544	271.071
3.818	-2.400	271.071
5.946	-4.233	271.071
8.098	-6.040	271.071
10.274	-7.819	271.071
12.472	-9.568	271.071
14.692	-11.291	271.071
16.856	-12.932	271.071
18.962	-14.496	271.071
21.005	-15.987	271.071
22.984	-17.407	271.071
24.896	-18.760	271.071
26.740	-20.046	271.071
28.514	-21.268	271.071
30.140	-22.377	271.071
31.614	-23.374	271.071
32.936	-24.263	271.071
34.104	-25.044	271.071
35.118	-25.718	271.071
35.978	-26.287	271.071
36.712	-26.773	271.071
37.328	-27.183	271.071
37.835	-27.521	271.071
38.239	-27.793	271.071
38.549	-28.003	271.071
38.782	-28.161	271.071
38.934	-28.334	271.071
38.962	-28.518	271.071
38.922	-28.652	271.071
38.834	-28.765	271.071
38.666	-28.851	271.071
38.432	-28.824	271.071
38.160	-28.726	271.071
37.798	-28.594	271.071
37.329	-28.419	271.071
36.743	-28.196	271.071
36.034	-27.921	271.071
35.192	-27.588	271.071
34.210	-27.191	271.071

181517 (72NP)

33.052	-26.717	271.071
31.719	-26.159	271.071
30.215	-25.511	271.071
28.544	-24.767	271.071
26.712	-23.917	271.071
24.724	-22.956	271.071
22.671	-21.918	271.071
20.555	-20.798	271.071
18.381	-19.591	271.071
16.150	-18.293	271.071
13.867	-16.896	271.071
11.535	-15.394	271.071
9.160	-13.780	271.071
6.823	-12.103	271.071
4.525	-10.360	271.071
2.269	-8.553	271.071
0.065	-6.696	271.071
-2.087	-4.794	271.071
-4.189	-2.847	271.071
-6.244	-0.857	271.071
-8.253	1.174	271.071
-10.215	3.245	271.071
-12.133	5.356	271.071
-14.004	7.508	271.071
-15.771	9.627	271.071
-17.436	11.708	271.071
-19.007	13.746	271.071
-20.488	15.737	271.071
-21.883	17.676	271.071
-23.197	19.561	271.071
-24.434	21.387	271.071
-25.596	23.152	271.071
-26.633	24.772	271.071
-27.549	26.240	271.071
-28.349	27.554	271.071
-29.087	28.793	271.071
-29.715	29.874	271.071
-30.186	30.712	271.071
-30.548	31.391	271.071
-30.799	31.910	271.071
-30.968	32.308	271.071

-31.043	32.537	271.071
-31.064	32.689	271.071
-31.052	32.764	271.071
-31.033	32.798	271.071
-30.546	33.685	277.037
-30.529	33.694	277.037
-30.491	33.700	277.037
-30.417	33.682	277.037
-30.286	33.607	277.037
-30.105	33.456	277.037
-29.802	33.159	277.037
-29.414	32.746	277.037
-28.918	32.177	277.037
-28.309	31.457	277.037
-27.520	30.518	277.037
-26.609	29.436	277.037
-25.632	28.285	277.037
-24.529	26.994	277.037
-23.297	25.565	277.037
-21.935	23.999	277.037
-20.503	22.370	277.037
-19.000	20.677	277.037
-17.425	18.922	277.037
-15.778	17.105	277.037
-14.055	15.229	277.037
-12.254	13.297	277.037
-10.372	11.313	277.037
-8.407	9.280	277.037
-6.422	7.266	277.037
-4.419	5.271	277.037
-2.398	3.294	277.037
-0.358	1.336	277.037
1.700	-0.602	277.037
3.778	-2.522	277.037
5.876	-4.421	277.037
7.995	-6.297	277.037
10.134	-8.149	277.037
12.293	-9.977	277.037
14.472	-11.782	277.037
16.595	-13.508	277.037
18.657	-15.157	277.037

181517 (72NP)

20.657	-16.734	277.037
22.592	-18.241	277.037
24.460	-19.681	277.037
26.259	-21.055	277.037
27.988	-22.365	277.037
29.571	-23.557	277.037
31.004	-24.633	277.037
32.287	-25.594	277.037
33.421	-26.442	277.037
34.404	-27.175	277.037
35.236	-27.795	277.037
35.947	-28.325	277.037
36.543	-28.771	277.037
37.033	-29.141	277.037
37.424	-29.437	277.037
37.723	-29.666	277.037
37.948	-29.839	277.037
38.096	-30.018	277.037
38.116	-30.205	277.037
38.068	-30.338	277.037
37.974	-30.445	277.037
37.799	-30.518	277.037
37.566	-30.471	277.037
37.300	-30.355	277.037
36.947	-30.198	277.037
36.488	-29.993	277.037
35.915	-29.733	277.037
35.221	-29.413	277.037
34.398	-29.027	277.037
33.437	-28.571	277.037
32.303	-28.027	277.037
30.999	-27.392	277.037
29.527	-26.659	277.037
27.890	-25.824	277.037
26.095	-24.880	277.037
24.145	-23.820	277.037
22.130	-22.683	277.037
20.053	-21.466	277.037
17.917	-20.163	277.037
15.726	-18.770	277.037
13.482	-17.280	277.037

11.191	-15.686	277.037
8.857	-13.983	277.037
6.560	-12.221	277.037
4.302	-10.400	277.037
2.089	-8.524	277.037
-0.073	-6.604	277.037
-2.185	-4.641	277.037
-4.249	-2.636	277.037
-6.265	-0.591	277.037
-8.236	1.493	277.037
-10.161	3.617	277.037
-12.041	5.779	277.037
-13.876	7.980	277.037
-15.606	10.145	277.037
-17.237	12.269	277.037
-18.776	14.347	277.037
-20.226	16.375	277.037
-21.593	18.347	277.037
-22.882	20.262	277.037
-24.094	22.117	277.037
-25.234	23.907	277.037
-26.251	25.549	277.037
-27.150	27.037	277.037
-27.934	28.368	277.037
-28.658	29.623	277.037
-29.274	30.717	277.037
-29.736	31.565	277.037
-30.090	32.252	277.037
-30.334	32.777	277.037
-30.498	33.179	277.037
-30.571	33.410	277.037
-30.591	33.562	277.037
-30.579	33.638	277.037
-30.560	33.672	277.037
-30.017	34.618	283.003
-29.999	34.626	283.003
-29.961	34.630	283.003
-29.887	34.609	283.003
-29.758	34.528	283.003
-29.581	34.369	283.003
-29.284	34.061	283.003

181517 (72NP)

-28.904	33.634	283.003
-28.416	33.050	283.003
-27.819	32.310	283.003
-27.044	31.346	283.003
-26.148	30.235	283.003
-25.187	29.054	283.003
-24.102	27.730	283.003
-22.890	26.263	283.003
-21.549	24.656	283.003
-20.139	22.983	283.003
-18.658	21.245	283.003
-17.106	19.443	283.003
-15.482	17.577	283.003
-13.784	15.650	283.003
-12.009	13.665	283.003
-10.155	11.624	283.003
-8.219	9.529	283.003
-6.264	7.452	283.003
-4.291	5.393	283.003
-2.300	3.350	283.003
-0.291	1.325	283.003
1.737	-0.682	283.003
3.784	-2.671	283.003
5.849	-4.640	283.003
7.933	-6.588	283.003
10.035	-8.516	283.003
12.156	-10.423	283.003
14.294	-12.311	283.003
16.376	-14.120	283.003
18.398	-15.853	283.003
20.358	-17.513	283.003
22.252	-19.103	283.003
24.079	-20.625	283.003
25.836	-22.083	283.003
27.523	-23.476	283.003
29.065	-24.746	283.003
30.460	-25.895	283.003
31.709	-26.922	283.003
32.810	-27.829	283.003
33.765	-28.615	283.003
34.573	-29.280	283.003

35.263	-29.849	283.003
35.842	-30.329	283.003
36.316	-30.725	283.003
36.695	-31.043	283.003
36.986	-31.288	283.003
37.203	-31.473	283.003
37.351	-31.657	283.003
37.368	-31.848	283.003
37.314	-31.983	283.003
37.213	-32.086	283.003
37.032	-32.146	283.003
36.802	-32.078	283.003
36.543	-31.945	283.003
36.197	-31.766	283.003
35.749	-31.532	283.003
35.189	-31.237	283.003
34.511	-30.874	283.003
33.707	-30.439	283.003
32.767	-29.927	283.003
31.659	-29.317	283.003
30.384	-28.608	283.003
28.944	-27.794	283.003
27.343	-26.870	283.003
25.585	-25.832	283.003
23.675	-24.674	283.003
21.699	-23.440	283.003
19.661	-22.127	283.003
17.564	-20.729	283.003
15.411	-19.242	283.003
13.206	-17.659	283.003
10.955	-15.973	283.003
8.662	-14.178	283.003
6.407	-12.330	283.003
4.190	-10.428	283.003
2.021	-8.481	283.003
-0.099	-6.493	283.003
-2.169	-4.465	283.003
-4.193	-2.397	283.003
-6.170	-0.291	283.003
-8.101	1.852	283.003
-9.989	4.032	283.003

181517 (72NP)

-11.832	6.249	283.003
-13.631	8.502	283.003
-15.328	10.715	283.003
-16.930	12.883	283.003
-18.440	15.001	283.003
-19.865	17.065	283.003
-21.209	19.071	283.003
-22.475	21.017	283.003
-23.666	22.900	283.003
-24.787	24.717	283.003
-25.788	26.382	283.003
-26.672	27.891	283.003
-27.445	29.239	283.003
-28.158	30.510	283.003
-28.764	31.618	283.003
-29.219	32.476	283.003
-29.566	33.171	283.003
-29.806	33.703	283.003
-29.968	34.109	283.003
-30.040	34.341	283.003
-30.061	34.494	283.003
-30.050	34.571	283.003
-30.031	34.605	283.003
-28.759	36.487	294.936
-28.741	36.495	294.936
-28.702	36.495	294.936
-28.629	36.467	294.936
-28.506	36.373	294.936
-28.339	36.197	294.936
-28.055	35.865	294.936
-27.693	35.410	294.936
-27.228	34.789	294.936
-26.658	34.005	294.936
-25.916	32.986	294.936
-25.056	31.813	294.936
-24.133	30.566	294.936
-23.087	29.169	294.936
-21.918	27.622	294.936
-20.622	25.928	294.936
-19.258	24.164	294.936
-17.822	22.333	294.936

-16.316	20.434	294.936
-14.738	18.469	294.936
-13.086	16.438	294.936
-11.361	14.342	294.936
-9.561	12.183	294.936
-7.685	9.962	294.936
-5.794	7.753	294.936
-3.889	5.556	294.936
-1.969	3.371	294.936
-0.033	1.200	294.936
1.918	-0.956	294.936
3.887	-3.096	294.936
5.872	-5.219	294.936
7.875	-7.327	294.936
9.895	-9.419	294.936
11.932	-11.495	294.936
13.983	-13.557	294.936
15.978	-15.538	294.936
17.914	-17.441	294.936
19.788	-19.269	294.936
21.598	-21.023	294.936
23.342	-22.707	294.936
25.018	-24.320	294.936
26.627	-25.864	294.936
28.097	-27.273	294.936
29.427	-28.547	294.936
30.617	-29.688	294.936
31.666	-30.695	294.936
32.575	-31.568	294.936
33.344	-32.307	294.936
34.001	-32.939	294.936
34.551	-33.472	294.936
35.003	-33.911	294.936
35.363	-34.263	294.936
35.640	-34.535	294.936
35.848	-34.739	294.936
35.992	-34.931	294.936
36.001	-35.126	294.936
35.936	-35.259	294.936
35.823	-35.351	294.936
35.633	-35.386	294.936

181517 (72NP)

35.415	-35.282	294.936
35.170	-35.117	294.936
34.844	-34.897	294.936
34.422	-34.611	294.936
33.894	-34.251	294.936
33.255	-33.811	294.936
32.495	-33.286	294.936
31.608	-32.669	294.936
30.562	-31.937	294.936
29.357	-31.089	294.936
27.996	-30.121	294.936
26.482	-29.030	294.936
24.819	-27.812	294.936
23.011	-26.462	294.936
21.139	-25.035	294.936
19.206	-23.528	294.936
17.214	-21.937	294.936
15.167	-20.258	294.936
13.070	-18.487	294.936
10.927	-16.616	294.936
8.742	-14.642	294.936
6.592	-12.625	294.936
4.480	-10.569	294.936
2.410	-8.475	294.936
0,26389	-6.343	294.936
-1.609	-4.173	294.936
-3.558	-1.966	294.936
-5.468	0,19167	294.936
-7.340	2.554	294.936
-9.173	4.863	294.936
-10.967	7.201	294.936
-12.723	9.568	294.936
-14.384	11.884	294.936
-15.954	14.144	294.936
-17.436	16.345	294.936
-18.834	18.484	294.936
-20.151	20.558	294.936
-21.390	22.566	294.936
-22.555	24.503	294.936
-23.649	26.368	294.936
-24.626	28.074	294.936

-25.491	29.618	294.936
-26.246	30.998	294.936
-26.941	32.298	294.936
-27.531	33.432	294.936
-27.976	34.308	294.936
-28.314	35.018	294.936
-28.547	35.560	294.936
-28.705	35.973	294.936
-28.780	36.207	294.936
-28.803	36.362	294.936
-28.793	36.440	294.936
-28.774	36.474	294.936
-27.378	38.739	306.868
-27.359	38.746	306.868
-27.319	38.743	306.868
-27.248	38.709	306.868
-27.130	38.604	306.868
-26.975	38.413	306.868
-26.712	38.055	306.868
-26.376	37.570	306.868
-25.944	36.911	306.868
-25.411	36.083	306.868
-24.714	35.010	306.868
-23.900	33.778	306.868
-23.021	32.471	306.868
-22.023	31.007	306.868
-20.901	29.389	306.868
-19.656	27.617	306.868
-18.342	25.773	306.868
-16.961	23.856	306.868
-15.512	21.867	306.868
-13.997	19.804	306.868
-12.414	17.669	306.868
-10.762	15.462	306.868
-9.042	13.185	306.868
-7.252	10.837	306.868
-5.455	8.495	306.868
-3.650	6.158	306.868
-1.839	3.827	306.868
-0.018	1.503	306.868
1.814	-0.812	306.868

181517 (72NP)

3.660	-3.117	306.868
5.521	-5.409	306.868
7.400	-7.687	306.868
9.296	-9.952	306.868
11.210	-12.202	306.868
13.140	-14.437	306.868
15.022	-16.584	306.868
16.852	-18.645	306.868
18.629	-20.622	306.868
20.350	-22.518	306.868
22.011	-24.333	306.868
23.611	-26.073	306.868
25.147	-27.737	306.868
26.549	-29.256	306.868
27.818	-30.632	306.868
28.952	-31.862	306.868
29.952	-32.949	306.868
30.819	-33.891	306.868
31.552	-34.689	306.868
32.177	-35.371	306.868
32.703	-35.944	306.868
33.134	-36.417	306.868
33.479	-36.796	306.868
33.744	-37.087	306.868
33.942	-37.306	306.868
34.081	-37.504	306.868
34.079	-37.696	306.868
34.006	-37.822	306.868
33.883	-37.904	306.868
33.687	-37.911	306.868
33.483	-37.773	306.868
33.255	-37.581	306.868
32.952	-37.325	306.868
32.558	-36.991	306.868
32.065	-36.573	306.868
31.468	-36.064	306.868
30.759	-35.456	306.868
29.930	-34.744	306.868
28.953	-33.900	306.868
27.827	-32.924	306.868
26.554	-31.815	306.868

25.136	-30.570	306.868
23.575	-29.186	306.868
21.875	-27.661	306.868
20.114	-26.057	306.868
18.295	-24.369	306.868
16.424	-22.593	306.868
14.504	-20.724	306.868
12.539	-18.758	306.868
10.533	-16.692	306.868
8.490	-14.520	306.868
6.483	-12.316	306.868
4.513	-10.082	306.868
2.582	-7.818	306.868
0,47639	-5.525	306.868
-1.174	-3.205	306.868
-3.001	-0.859	306.868
-4.797	1.512	306.868
-6.564	3.905	306.868
-8.305	6.319	306.868
-10.020	8.753	306.868
-11.708	11.209	306.868
-13.311	13.602	306.868
-14.832	15.930	306.868
-16.274	18.192	306.868
-17.639	20.385	306.868
-18.929	22.506	306.868
-20.148	24.556	306.868
-21.296	26.531	306.868
-22.376	28.431	306.868
-23.341	30.168	306.868
-24.192	31.740	306.868
-24.934	33.146	306.868
-25.613	34.473	306.868
-26.187	35.630	306.868
-26.619	36.524	306.868
-26.947	37.248	306.868
-27.174	37.799	306.868
-27.328	38.219	306.868
-27.402	38.456	306.868
-27.423	38.613	306.868
-27.412	38.692	306.868

-27.393	38.726	306.868
-26.617	40.211	312.835
-26.598	40.218	312.835
-26.558	40.214	312.835
-26.488	40.177	312.835
-26.373	40.067	312.835
-26.223	39.870	312.835
-25.972	39.501	312.835
-25.650	39.001	312.835
-25.236	38.325	312.835
-24.725	37.476	312.835
-24.054	36.376	312.835
-23.270	35.113	312.835
-22.421	33.774	312.835
-21.452	32.275	312.835
-20.362	30.620	312.835
-19.148	28.809	312.835
-17.864	26.926	312.835
-16.512	24.969	312.835
-15.095	22.938	312.835
-13.612	20.831	312.835
-12.066	18.647	312.835
-10.456	16.388	312.835
-8.782	14.051	312.835
-7.047	11.637	312.835
-5.307	9.227	312.835
-3.564	6.818	312.835
-1.817	4.413	312.835
-0.063	2.013	312.835
1.701	-0.380	312.835
3.477	-2.764	312.835
5.268	-5.136	312.835
7.077	-7.494	312.835
8.907	-9.837	312.835
10.758	-12.164	312.835
12.629	-14.474	312.835
14.455	-16.693	312.835
16.231	-18.824	312.835
17.957	-20.869	312.835
19.628	-22.830	312.835
21.242	-24.709	312.835

22.797	-26.509	312.835
24.291	-28.230	312.835
25.658	-29.799	312.835
26.896	-31.218	312.835
28.004	-32.487	312.835
28.982	-33.606	312.835
29.829	-34.577	312.835
30.546	-35.398	312.835
31.157	-36.101	312.835
31.671	-36.692	312.835
32.093	-37.178	312.835
32.430	-37.568	312.835
32.689	-37.868	312.835
32.883	-38.093	312.835
33.024	-38.294	312.835
33.021	-38.488	312.835
32.943	-38.612	312.835
32.816	-38.688	312.835
32.619	-38.682	312.835
32.423	-38.531	312.835
32.203	-38.327	312.835
31.910	-38.056	312.835
31.529	-37.703	312.835
31.053	-37.261	312.835
30.476	-36.724	312.835
29.790	-36.083	312.835
28.988	-35.332	312.835
28.042	-34.442	312.835
26.953	-33.414	312.835
25.722	-32.244	312.835
24.352	-30.932	312.835
22.845	-29.475	312.835
21.206	-27.868	312.835
19.508	-26.179	312.835
17.754	-24.404	312.835
15.949	-22.541	312.835
14.096	-20.585	312.835
12.200	-18.533	312.835
10.263	-16.380	312.835
8.293	-14.121	312.835
6.360	-11.833	312.835

4.465	-9.516	312.835
2.609	-7.170	312.835
0,54722	-4.799	312.835
-1.000	-2.403	312.835
-2.759	0.015	312.835
-4.491	2.452	312.835
-6.199	4.907	312.835
-7.886	7.378	312.835
-9.552	9.865	312.835
-11.198	12.366	312.835
-12.767	14.799	312.835
-14.261	17.160	312.835
-15.681	19.450	312.835
-17.030	21.667	312.835
-18.307	23.811	312.835
-19.514	25.880	312.835
-20.650	27.875	312.835
-21.717	29.794	312.835
-22.667	31.550	312.835
-23.505	33.140	312.835
-24.232	34.561	312.835
-24.897	35.903	312.835
-25.459	37.073	312.835
-25.880	37.978	312.835
-26.200	38.709	312.835
-26.422	39.266	312.835
-26.574	39.688	312.835
-26.644	39.928	312.835
-26.664	40.086	312.835
-26.653	40.164	312.835
-26.633	40.199	312.835
-25.909	41.869	318.801
-25.890	41.875	318.801
-25.850	41.870	318.801
-25.779	41.831	318.801
-25.665	41.718	318.801
-25.520	41.516	318.801
-25.278	41.137	318.801
-24.968	40.624	318.801
-24.568	39.932	318.801
-24.073	39.065	318.801

-23.423	37.940	318.801
-22.663	36.649	318.801
-21.838	35.280	318.801
-20.897	33.748	318.801
-19.837	32.055	318.801
-18.655	30.203	318.801
-17.403	28.277	318.801
-16.082	26.277	318.801
-14.695	24.201	318.801
-13.243	22.048	318.801
-11.729	19.817	318.801
-10.156	17.504	318.801
-8.526	15.110	318.801
-6.840	12.634	318.801
-5.153	10.157	318.801
-3.464	7.682	318.801
-1.772	5.209	318.801
-0.074	2.741	318.801
1.633	0,19306	318.801
3.351	-2.176	318.801
5.085	-4.620	318.801
6.836	-7.050	318.801
8.608	-9.466	318.801
10.401	-11.867	318.801
12.215	-14.252	318.801
13.986	-16.543	318.801
15.713	-18.742	318.801
17.393	-20.852	318.801
19.021	-22.874	318.801
20.596	-24.812	318.801
22.115	-26.666	318.801
23.575	-28.439	318.801
24.911	-30.056	318.801
26.121	-31.518	318.801
27.205	-32.825	318.801
28.160	-33.979	318.801
28.987	-34.980	318.801
29.687	-35.828	318.801
30.283	-36.552	318.801
30.784	-37.162	318.801
31.196	-37.664	318.801

31.525	-38.066	318.801
31.778	-38.375	318.801
31.967	-38.607	318.801
32.108	-38.811	318.801
32.104	-39.007	318.801
32.022	-39.130	318.801
31.890	-39.201	318.801
31.693	-39.183	318.801
31.504	-39.019	318.801
31.292	-38.805	318.801
31.008	-38.521	318.801
30.639	-38.151	318.801
30.179	-37.687	318.801
29.619	-37.124	318.801
28.955	-36.453	318.801
28.178	-35.667	318.801
27.261	-34.736	318.801
26.205	-33.661	318.801
25.012	-32.439	318.801
23.683	-31.069	318.801
22.220	-29.549	318.801
20.629	-27.874	318.801
18.983	-26.115	318.801
17.284	-24.267	318.801
15.537	-22.327	318.801
13.745	-20.293	318.801
11.912	-18.160	318.801
10.043	-15.924	318.801
8.142	-13.583	318.801
6.278	-11.215	318.801
4.450	-8.820	318.801
2.657	-6.400	318.801
0,62292	-3.955	318.801
-0.833	-1.489	318.801
-2.537	0,69236	318.801
-4.217	3.500	318.801
-5.876	6.017	318.801
-7.516	8.546	318.801
-9.138	11.087	318.801
-10.744	13.638	318.801
-12.282	16.114	318.801

-13.752	18.513	318.801
-15.154	20.836	318.801
-16.486	23.083	318.801
-17.748	25.256	318.801
-18.938	27.353	318.801
-20.057	29.375	318.801
-21.107	31.321	318.801
-22.042	33.100	318.801
-22.865	34.711	318.801
-23.580	36.151	318.801
-24.233	37.510	318.801
-24.785	38.694	318.801
-25.197	39.611	318.801
-25.509	40.351	318.801
-25.726	40.914	318.801
-25.875	41.341	318.801
-25.942	41.583	318.801
-25.959	41.743	318.801
-25.946	41.822	318.801
-25.925	41.856	318.801
-25.198	43.989	324.767
-25.178	43.995	324.767
-25.138	43.989	324.767
-25.068	43.948	324.767
-24.957	43.829	324.767
-24.818	43.619	324.767
-24.589	43.227	324.767
-24.295	42.698	324.767
-23.915	41.986	324.767
-23.444	41.094	324.767
-22.823	39.939	324.767
-22.092	38.613	324.767
-21.296	37.209	324.767
-20.383	35.639	324.767
-19.353	33.904	324.767
-18.201	32.007	324.767
-16.981	30.033	324.767
-15.693	27.983	324.767
-14.340	25.854	324.767
-12.924	23.646	324.767
-11.448	21.358	324.767

-9.913	18.986	324.767
-8.323	16.530	324.767
-6.680	13.989	324.767
-5.037	11.447	324.767
-3.393	8.905	324.767
-1.748	6.365	324.767
-0.098	3.827	324.767
1.558	1.294	324.767
3.223	-1.233	324.767
4.902	-3.751	324.767
6.598	-6.258	324.767
8.312	-8.753	324.767
10.048	-11.232	324.767
11.805	-13.696	324.767
13.525	-16.063	324.767
15.203	-18.335	324.767
16.838	-20.515	324.767
18.424	-22.604	324.767
19.959	-24.606	324.767
21.438	-26.523	324.767
22.859	-28.358	324.767
24.157	-30.033	324.767
25.332	-31.548	324.767
26.382	-32.904	324.767
27.307	-34.102	324.767
28.108	-35.141	324.767
28.783	-36.022	324.767
29.360	-36.775	324.767
29.843	-37.408	324.767
30.241	-37.930	324.767
30.559	-38.347	324.767
30.803	-38.669	324.767
30.986	-38.910	324.767
31.125	-39.119	324.767
31.118	-39.318	324.767
31.030	-39.440	324.767
30.894	-39.505	324.767
30.697	-39.474	324.767
30.516	-39.298	324.767
30.310	-39.074	324.767
30.036	-38.775	324.767

29.680	-38.385	324.767
29.236	-37.899	324.767
28.695	-37.307	324.767
28.053	-36.603	324.767
27.301	-35.778	324.767
26.415	-34.803	324.767
25.393	-33.675	324.767
24.237	-32.396	324.767
22.949	-30.963	324.767
21.530	-29.375	324.767
19.985	-27.629	324.767
18.385	-25.796	324.767
16.735	-23.873	324.767
15.037	-21.857	324.767
13.298	-19.743	324.767
11.522	-17.528	324.767
9.713	-15.208	324.767
7.876	-12.780	324.767
6.076	-10.328	324.767
4.312	-7.850	324.767
2.580	-5.351	324.767
0,60903	-2.831	324.767
-0.799	-0.292	324.767
-2.451	2.262	324.767
-4.084	4.830	324.767
-5.698	7.410	324.767
-7.295	10.000	324.767
-8.878	12.599	324.767
-10.448	15.206	324.767
-11.952	17.734	324.767
-13.392	20.183	324.767
-14.764	22.552	324.767
-16.069	24.844	324.767
-17.304	27.059	324.767
-18.469	29.196	324.767
-19.564	31.256	324.767
-20.591	33.238	324.767
-21.503	35.051	324.767
-22.304	36.692	324.767
-22.997	38.160	324.767
-23.627	39.545	324.767

-24.155	40.754	324.767
-24.547	41.690	324.767
-24.841	42.446	324.767
-25.043	43.021	324.767
-25.181	43.456	324.767
-25.241	43.702	324.767
-25.252	43.864	324.767
-25.236	43.943	324.767
-25.214	43.977	324.767
-24.469	46.543	330.733
-24.449	46.549	330.733
-24.408	46.542	330.733
-24.339	46.498	330.733
-24.231	46.375	330.733
-24.097	46.158	330.733
-23.879	45.754	330.733
-23.598	45.209	330.733
-23.236	44.477	330.733
-22.787	43.560	330.733
-22.195	42.372	330.733
-21.494	41.010	330.733
-20.726	39.569	330.733
-19.840	37.958	330.733
-18.836	36.181	330.733
-17.709	34.238	330.733
-16.513	32.217	330.733
-15.252	30.116	330.733
-13.931	27.933	330.733
-12.551	25.665	330.733
-11.114	23.313	330.733
-9.621	20.875	330.733
-8.073	18.351	330.733
-6.473	15.740	330.733
-4.877	13.126	330.733
-3.286	10.509	330.733
-1.699	7.889	330.733
-0.113	5.269	330.733
1.474	2.649	330.733
3.067	0.034	330.733
4.672	-2.575	330.733
6.293	-5.174	330.733

7.935	-7.758	330.733
9.600	-10.328	330.733
11.289	-12.883	330.733
12.943	-15.339	330.733
14.556	-17.698	330.733
16.127	-19.963	330.733
17.651	-22.136	330.733
19.125	-24.219	330.733
20.547	-26.215	330.733
21.913	-28.125	330.733
23.161	-29.868	330.733
24.291	-31.445	330.733
25.301	-32.856	330.733
26.190	-34.102	330.733
26.960	-35.184	330.733
27.609	-36.100	330.733
28.162	-36.884	330.733
28.627	-37.543	330.733
29.009	-38.086	330.733
29.314	-38.520	330.733
29.549	-38.854	330.733
29.725	-39.105	330.733
29.860	-39.320	330.733
29.850	-39.522	330.733
29.757	-39.643	330.733
29.617	-39.703	330.733
29.420	-39.660	330.733
29.246	-39.472	330.733
29.048	-39.237	330.733
28.784	-38.923	330.733
28.440	-38.515	330.733
28.010	-38.005	330.733
27.488	-37.386	330.733
26.867	-36.648	330.733
26.141	-35.784	330.733
25.285	-34.761	330.733
24.298	-33.580	330.733
23.183	-32.240	330.733
21.939	-30.739	330.733
20.571	-29.075	330.733
19.083	-27.245	330.733

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17.542	-25.326	330.733
15.953	-23.315	330.733
14.319	-21.207	330.733
12.646	-19.001	330.733
10.938	-16.692	330.733
9.198	-14.277	330.733
7.434	-11.755	330.733
5.707	-9.209	330.733
4.017	-6.639	330.733
2.362	-4.047	330.733
0,51111	-1.436	330.733
-0.866	1.190	330.733
-2.449	3.829	330.733
-4.017	6.476	330.733
-5.574	9.131	330.733
-7.122	11.791	330.733
-8.660	14.456	330.733
-10.189	17.127	330.733
-11.654	19.716	330.733
-13.055	22.223	330.733

-14.391	24.649	330.733
-15.663	26.993	330.733
-16.868	29.256	330.733
-18.007	31.439	330.733
-19.079	33.541	330.733
-20.081	35.563	330.733
-20.968	37.413	330.733
-21.743	39.089	330.733
-22.409	40.590	330.733
-23.011	42.006	330.733
-23.513	43.242	330.733
-23.882	44.199	330.733
-24.157	44.973	330.733
-24.342	45.560	330.733
-24.469	46.004	330.733
-24.522	46.255	330.733
-24.528	46.418	330.733
-24.509	46.498	330.733
-24.486	46.532	330.733

At the same time, each blade 10 therefore has an aerodynamic profile which allows a high conversion efficiency and a high useful life to be maintained.

Furthermore, the aerodynamic profile of the blade 10 according to the invention is obtained with the values of Table I by piling up the series of closed curves and grouping them so as to obtain a continuous aerodynamic profile.

In order to take into account the dimensional variability of each blade 10, the profile of each blade 10 can have a tolerance of +/- 2 mm in a normal direction with respect to the profile of the blade 10 itself.

The profile of each blade 10 can also comprise a coating, applied subsequently and which varies the profile itself.

Said antiwear coating preferably has a thickness defined in a normal direction at each surface of the blade 10 and ranging from 0 to 0.5 mm.

It is evident, moreover, that the values of the coordinates of Table I can be multiplied or divided by a corrective constant to obtain a profile in a greater or smaller scale, maintaining the same form.

According to another aspect of the present invention, a rotor of a second phase of a compressor is provided, which comprises a series of blades 10 of the type described above, each of which having a shaped aerodynamic profile, which are fixed to an outer surface of said rotor so as to be uniformly distanced thereon, and also oriented so as to confer a high efficiency to the compressor in which said rotor is preferably inserted.

According to another aspect of the present invention, a compressor is provided, comprising a rotor of the type described above.

It can thus be seen that a blade of a rotor of a second phase of a compressor according to the present invention achieves the objectives specified above.

The rotor blade of a second phase of a compressor of the present invention thus conceived, can undergo numerous modifications and variants, all included in the same inventive concept.

Furthermore, in practice, the materials used, as also the dimensions and components, can vary according to technical requirements.

## CLAIMS

1. A blade (10) of a rotor of a second phase of a compressor, which can be defined by coordinates of a discreet combination of points, in a Cartesian reference system (X, Y, Z), wherein the axis (Z) is a radial axis intersecting the central axis of the compressor, said blade (10) having a profile which can be identified by means of a series of closed intersection curves between the profile itself and planes (X, Y) lying at distances (Z) from the central axis, said blade (10) being characterized in that it comprises a thickening (30), substantially parallel to a base portion (12) of the blade (10) itself, fixable to said rotor, said thickening (30) being substantially situated halfway up the blade (10) and being suitable for shifting the natural resonance frequencies of the blade (10) itself outside a functioning velocity range of said rotor.

2. The blade (10) according to claim 1, characterized in that it comprises a profile which is identified by a first substantially concave surface (3), which is pressurized, and a second substantially convex surface (5) which is in depression and which is opposite to the first, said two surfaces (3, 5) being continuous and joined to each other to form the profile of said blade 10.

3. The blade (10) according to claim 2, characterized in that each closed curve has a maximum thickness determined by the maximum distance between said first surface (3) and said second surface (5), said maximum thickness of each closed curve, along the height of the blade 10 in the direction of a free end (14) of the blade (10), having a non-linearly variable trend.

4. The blade (10) according to claim 3, characterized in that along the height of the blade (10) in the direction of its free end (14), said maximum thickness has a trend according to a polynomial function of the sixth degree.

5. The blade (10) according to claim 4, characterized in that said polynomial function of the sixth degree is:

$$T_{\max} = -21.119 \cdot h^6 + 70.467 \cdot h^5 - 85.603 \cdot h^4 + 44.523 \cdot h^3 - 7.8323 \cdot h^2 - 1.1541 \cdot h + 0.997$$

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wherein  $h$  represents the percentage of the height of the blade (10), and wherein  $T_{max}$  is the maximum adimensionalized thickness relating to the closed curve corresponding to that percentage of the height of the blade (10).

6. The blade (10) according to any of the previous claims, characterized in that said closed curves are defined according to Table I, whose values, expressed in millimeters, refer to a profile at room temperature.

7. The blade (10) according to any of the previous claims, characterized in that the profile of each blade (10) has a tolerance of  $\pm 2$  mm in a normal direction with respect to the profile of the blade (10) itself.

8. The blade (10) according to any of the previous claims, characterized in that the profile of each blade (10) comprises an antiwear coating.

9. The blade (10) according to claim 8, characterized in that said coating has a thickness ranging from 0 to 0.5 mm.

10. A rotor of a second phase of a compressor, characterized in that it comprises a series of blades (10) according to any of the previous claims.

11. The rotor according to claim 10, characterized in that said series of blades (10) is constrained to an outer surface of said rotor and said series of blades (10) is also uniformly distributed thereon in order to maximize the efficiency of the rotor itself.

12. A compressor characterized in that it comprises a rotor according to claim 10 or 11.

Fig.1

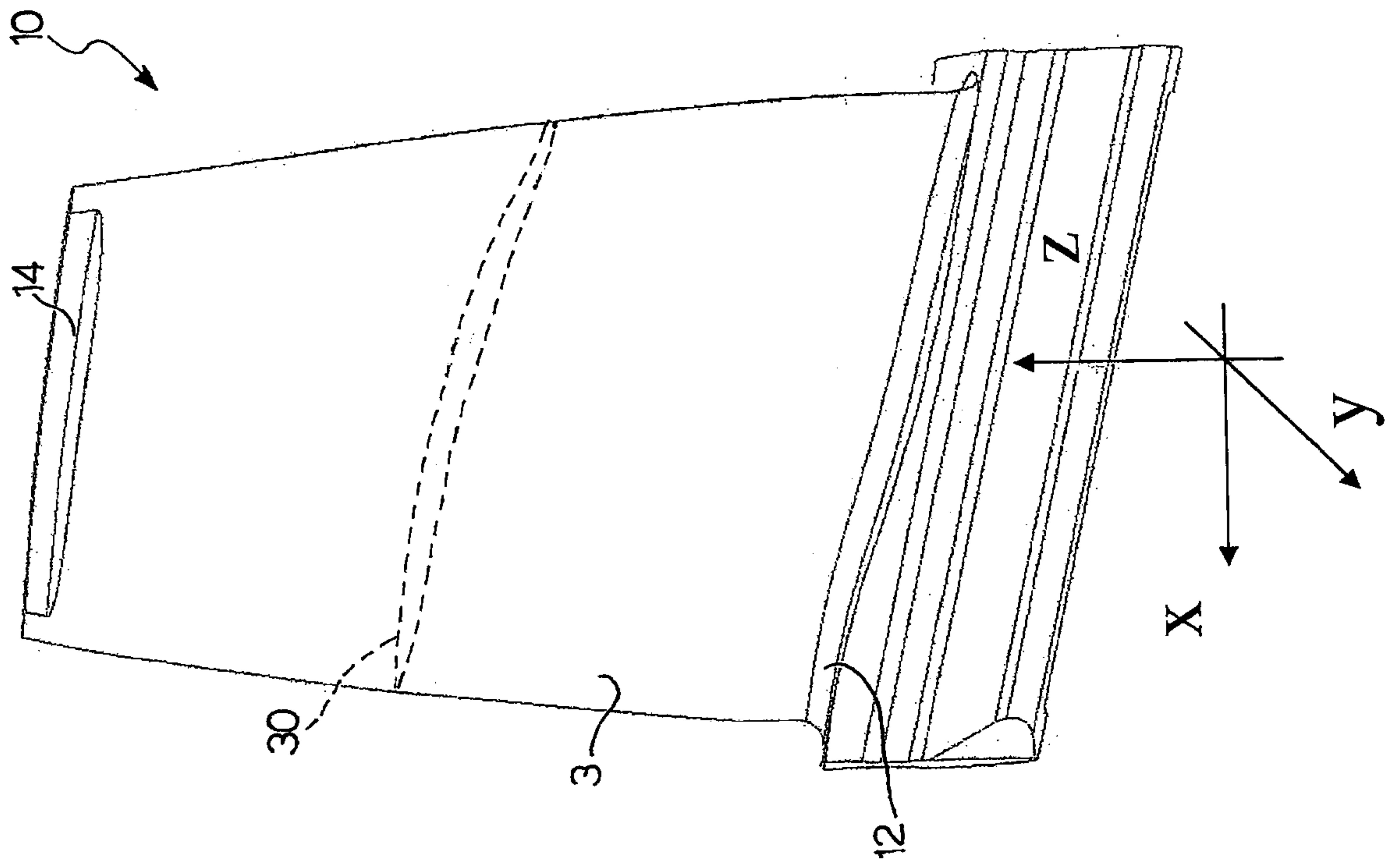


Fig. 2

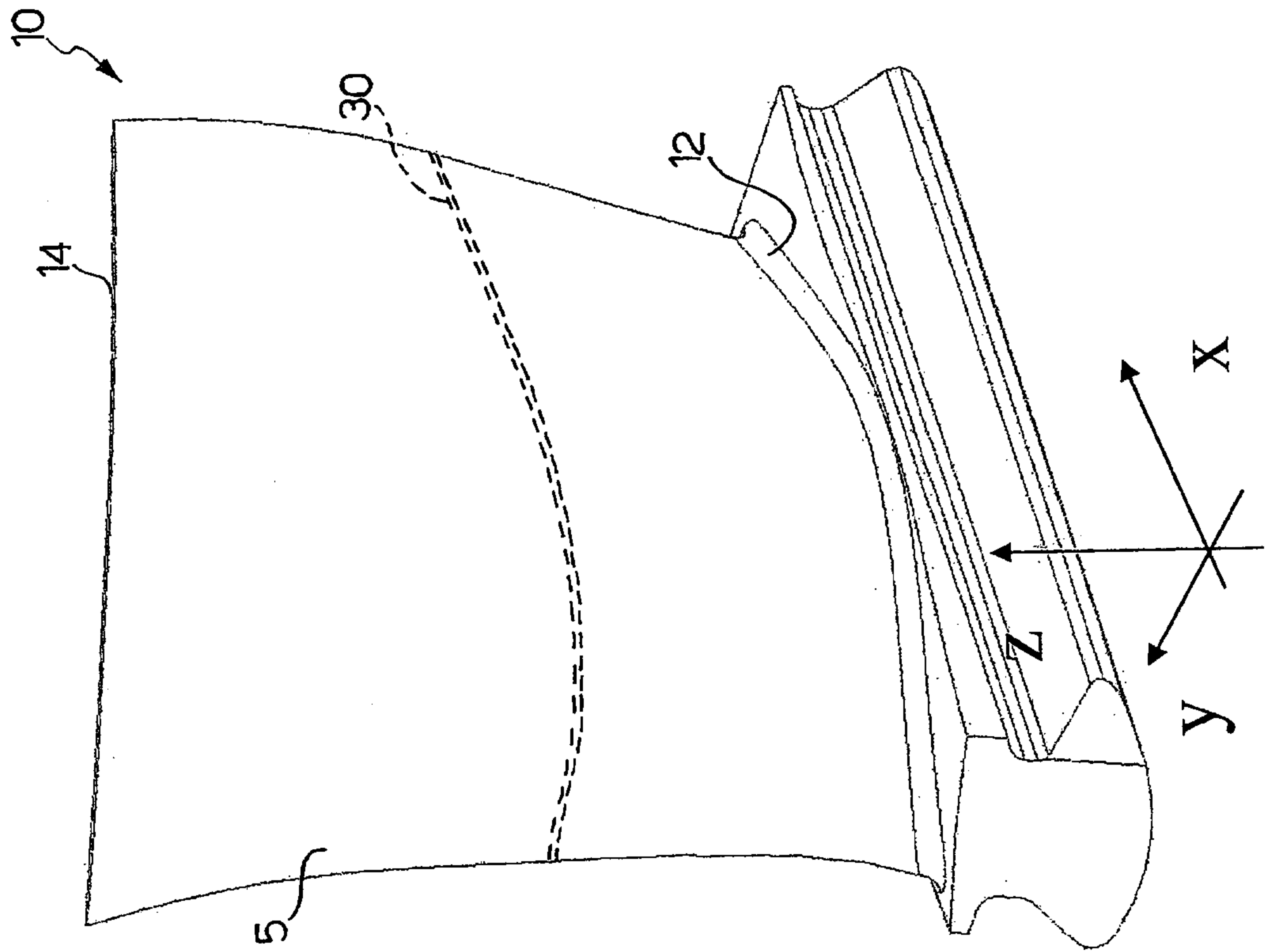


Fig. 3

