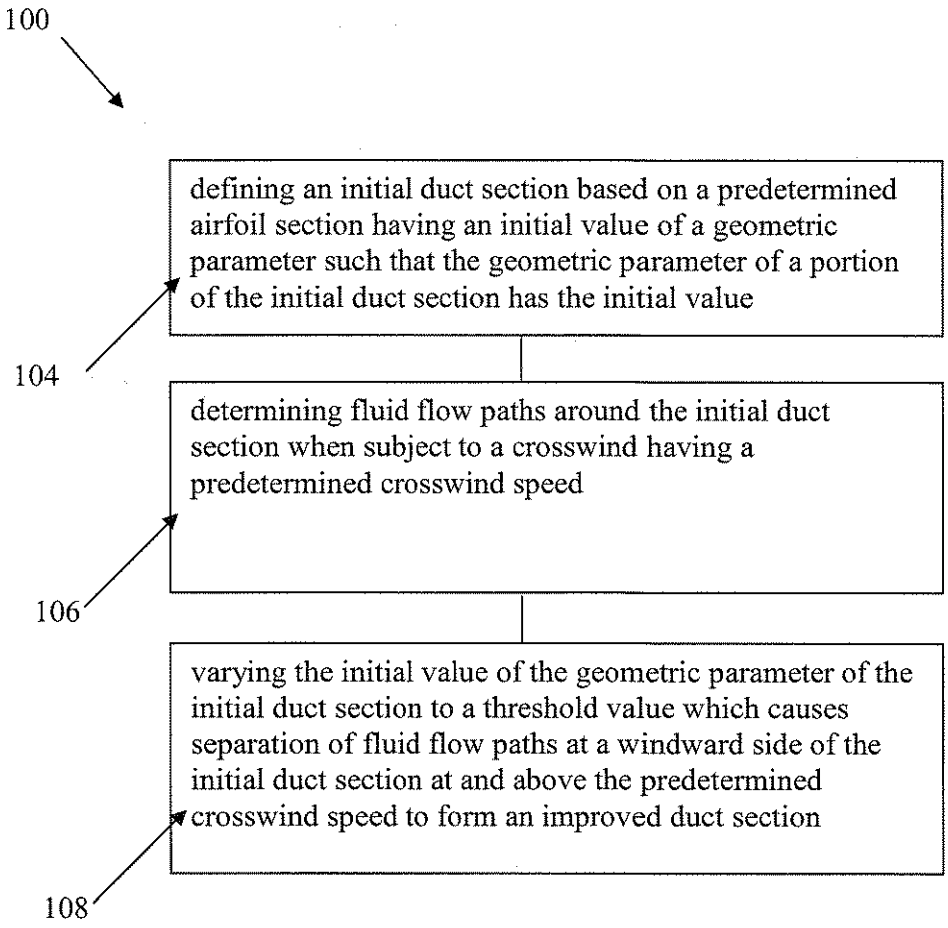

100
defining an initial duct section based on a predetermined airfoil section having an initial value of a geometric parameter such that the geometric parameter of a portion of the initial duct section has the initial value
104
determining fluid flow paths around the initial duct section when subject to a crosswind having a predetermined crosswind speed
106
varying the initial value of the geometric parameter of the initial duct section to a threshold value which causes separation of fluid flow paths at a windward side of the initial duct section at and above the predetermined crosswind speed to form an improved duct section
108

Fig. 1

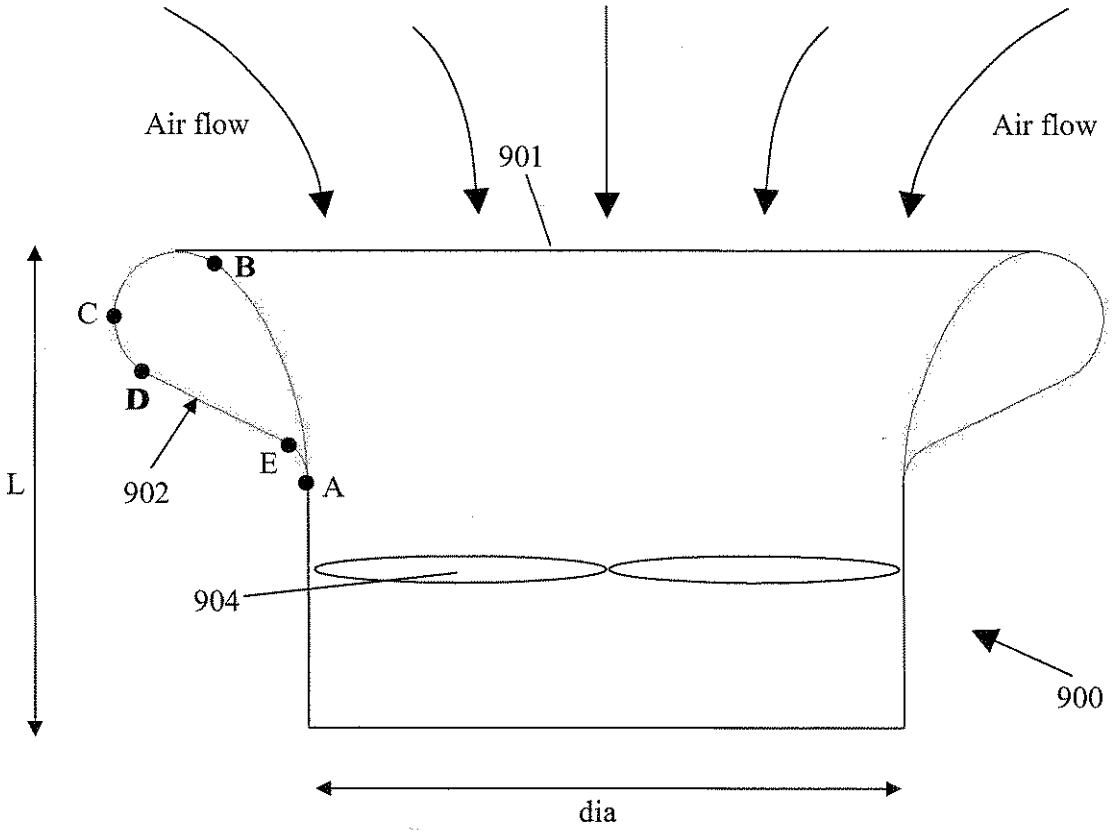
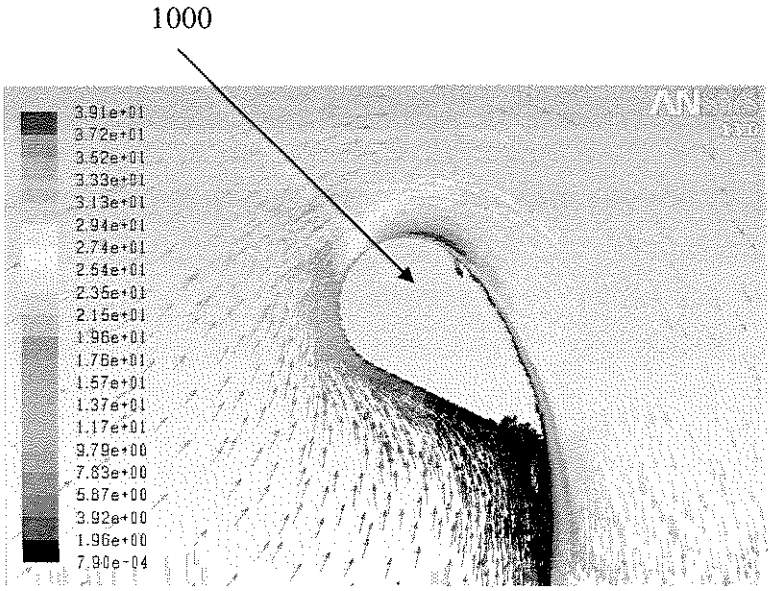
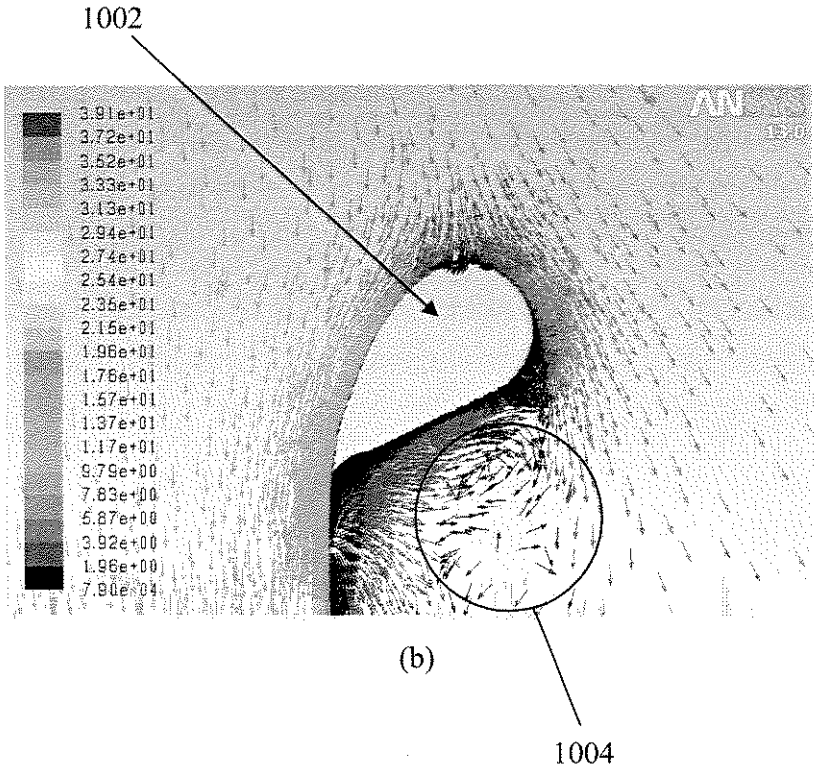


Fig. 2


1000
3.91e+01
3.72e+01
3.52e+01
3.33e+01
3.13e+01
2.94e+01
2.74e+01
2.54e+01
2.35e+01
2.15e+01
1.96e+01
1.76e+01
1.57e+01
1.37e+01
1.17e+01
9.79e+00
7.83e+00
5.87e+00
3.92e+00
1.96e+00
7.90e-04

(a)


1002
3.91e+01
3.72e+01
3.52e+01
3.33e+01
3.13e+01
2.94e+01
2.74e+01
2.54e+01
2.35e+01
2.15e+01
1.96e+01
1.76e+01
1.57e+01
1.37e+01
1.17e+01
9.79e+00
7.83e+00
5.87e+00
3.92e+00
1.96e+00
7.90e-04
1004

(b)

Fig. 3

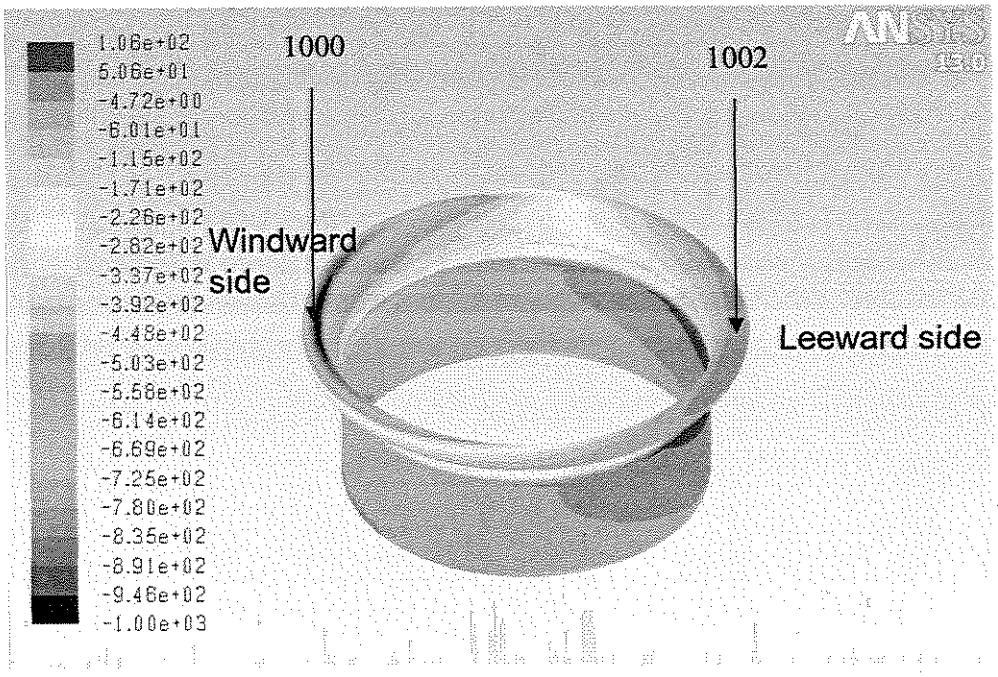

1.06e+02
5.06e+01
-4.72e+00
-6.01e+01
-1.15e+02
-1.71e+02
-2.26e+02
-2.82e+02
-3.37e+02
-3.92e+02
-4.48e+02
-5.03e+02
-5.58e+02
-6.14e+02
-6.69e+02
-7.25e+02
-7.80e+02
-8.35e+02
-8.91e+02
-9.46e+02
-1.00e+03
1000
1002
Windward side
Leeward side

Fig. 4

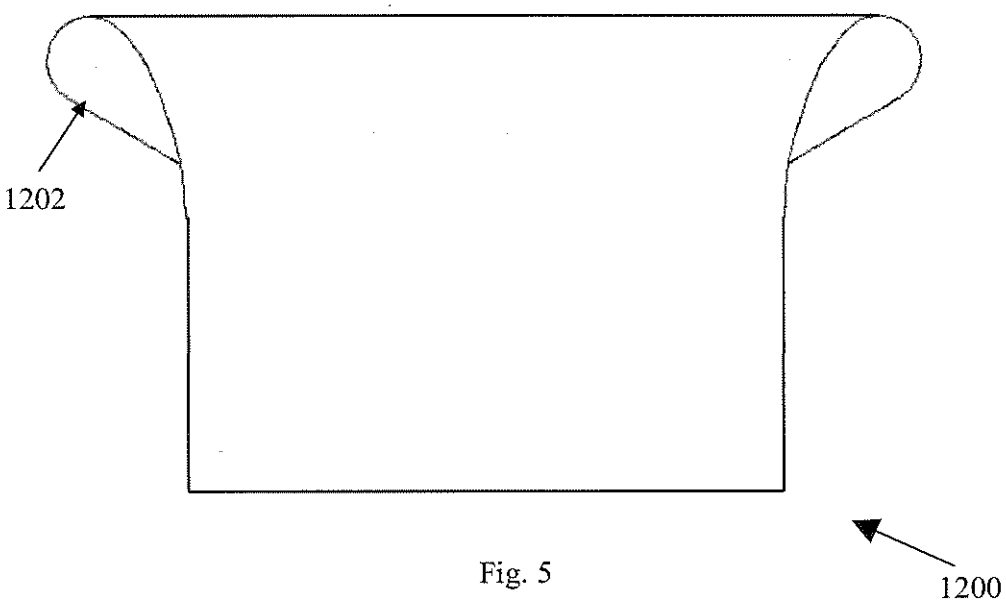


Fig. 5

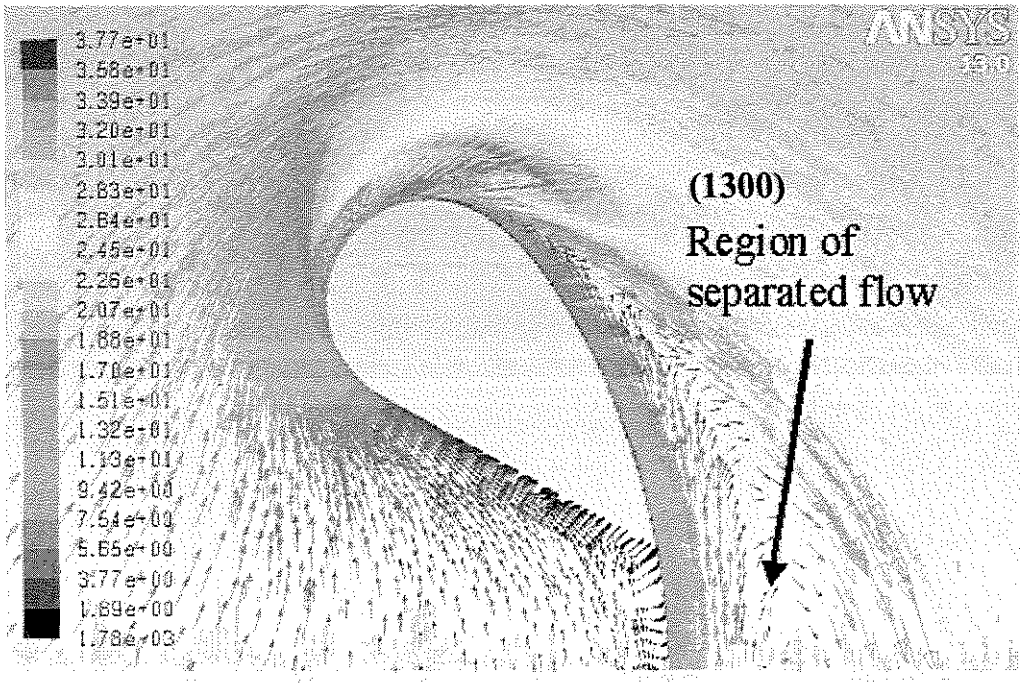

3.77e+01
3.58e+01
3.39e+01
3.20e+01
3.01e+01
2.83e+01
2.64e+01
2.45e+01
2.26e+01
2.07e+01
1.88e+01
1.70e+01
1.51e+01
1.32e+01
1.13e+01
9.42e+00
7.54e+00
5.65e+00
3.77e+00
1.89e+00
1.78e-03
ANSYS
(1300)
Region of
separated flow

Fig. 6

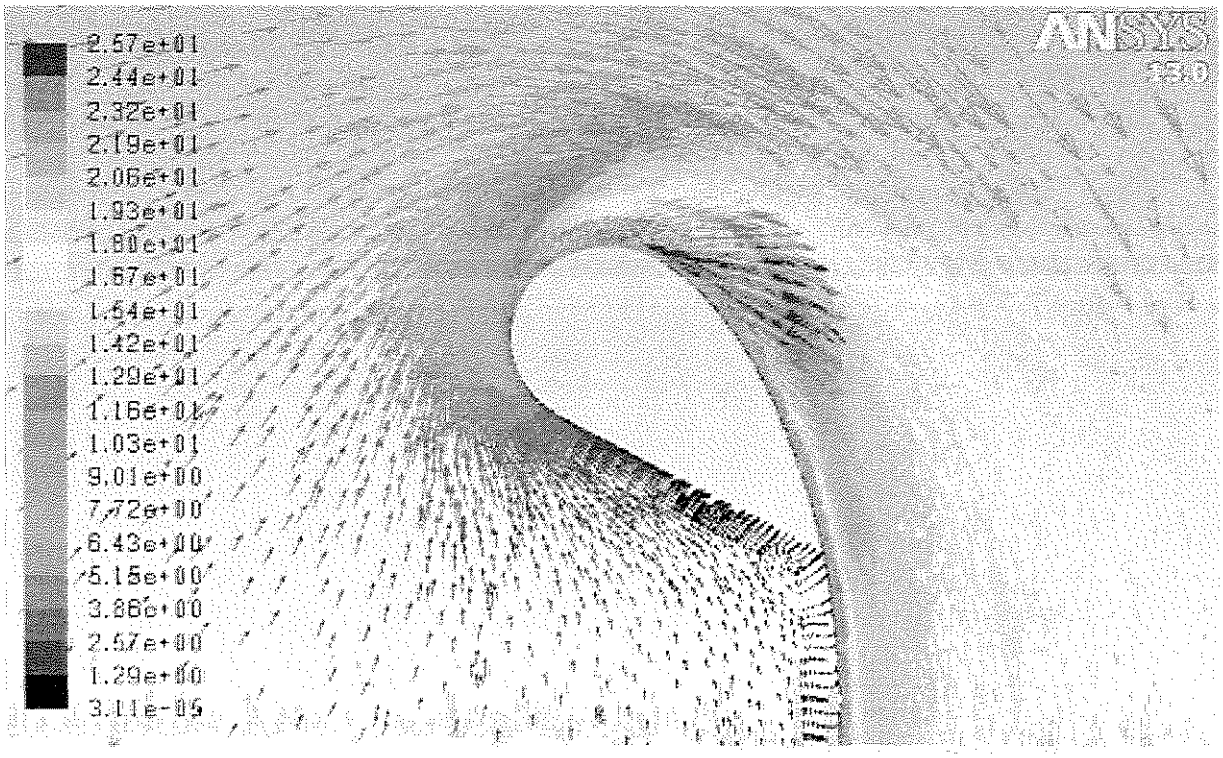

2.57e+01
2.44e+01
2.32e+01
2.19e+01
2.06e+01
1.93e+01
1.80e+01
1.67e+01
1.54e+01
1.42e+01
1.29e+01
1.16e+01
1.03e+01
9.01e+00
7.72e+00
6.43e+00
5.15e+00
3.86e+00
2.57e+00
1.29e+00
3.11e-05
ANSYS

Fig. 7

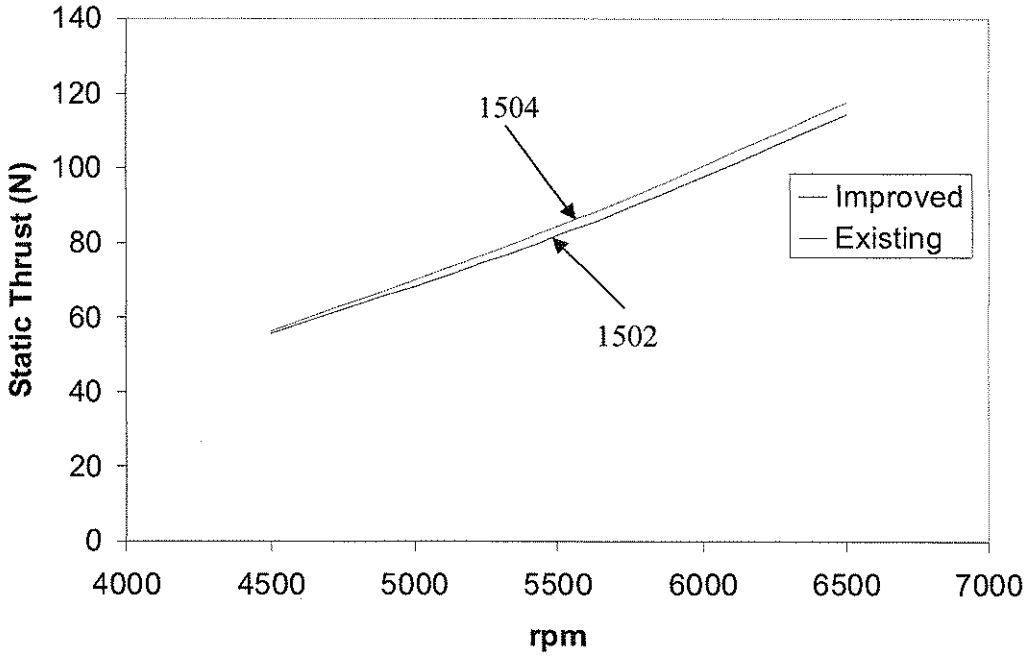

140
120
100
80
60
40
20
0
Static Thrust (N)
4000
4500
5000
5500
6000
6500
7000
rpm
1504
1502
Improved
Existing

Fig. 8

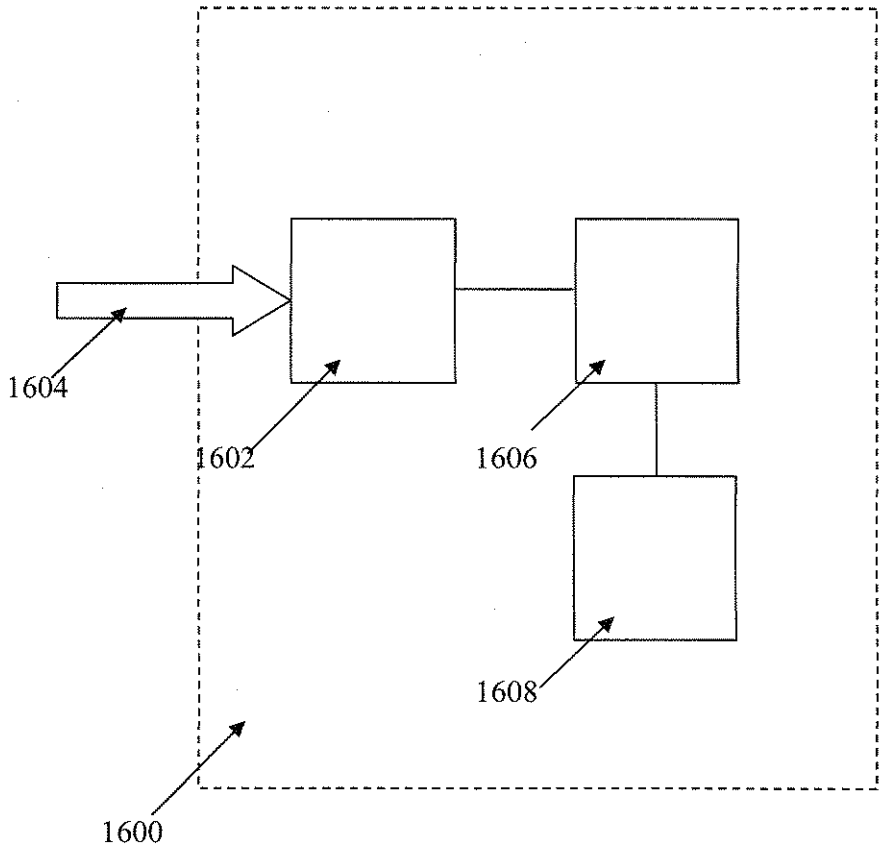


Fig. 9

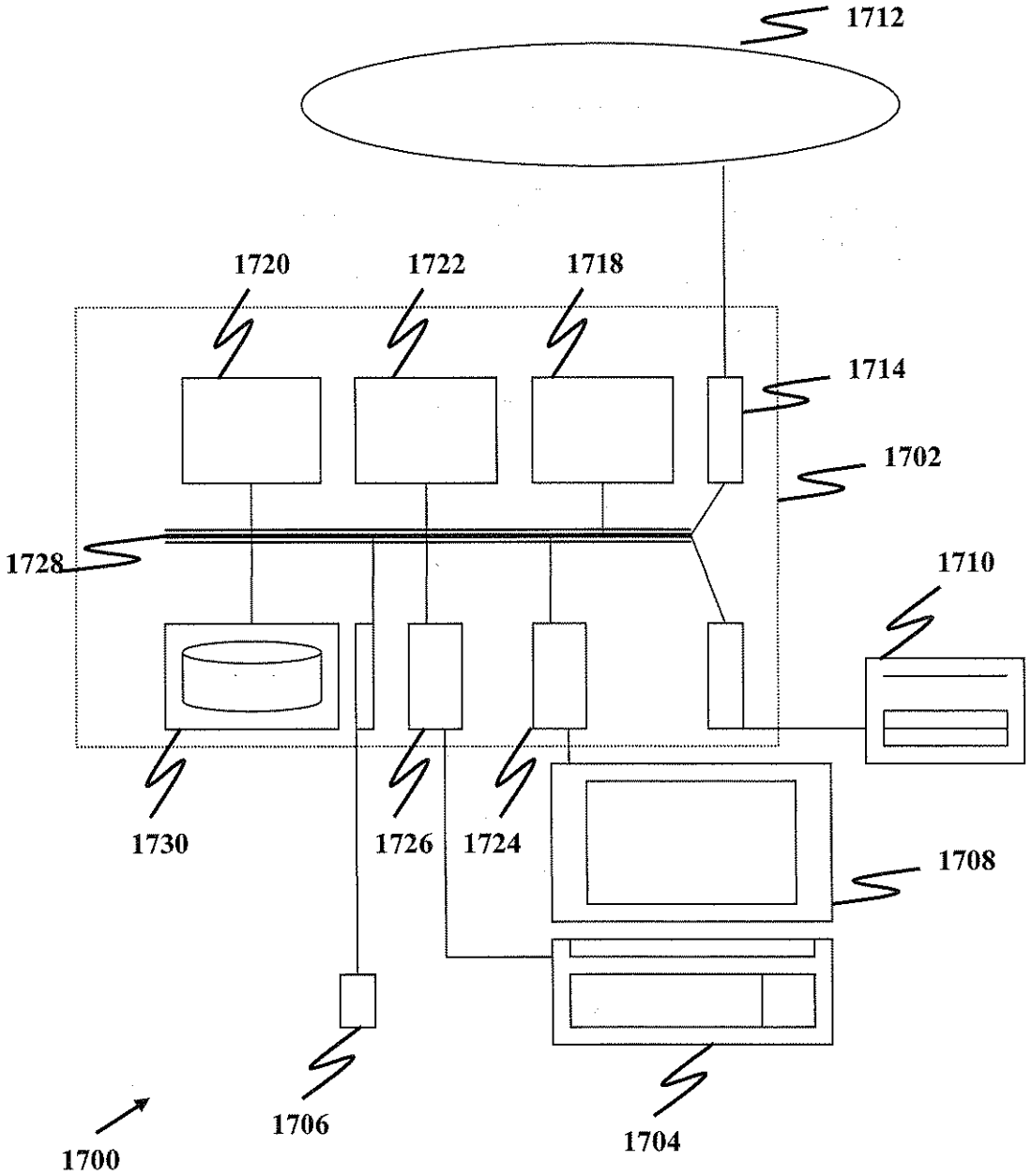

1712
1720
1722
1718
1714
1702
1728
1710
1730
1726
1724
1708
1706
1704
1700

Fig. 10