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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 July 2013 (04.07.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/097005 Al

(51) International Patent Classification:
F04B 39/00 (2006.01)

(21) International Application Number:
PCT/BR20 12/000473

(22) International Filing Date:
23 November 2012 (23.1 1.2012)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PI1 105380-1 26 December 201 1 (26. 12.201 1) BR

(71) Applicant: **WHIRLPOOL S.A.** [BR/BR]; Avenida das Naçoes Unidas, n° 12.995, 32 ° andar, Brooklin Novo, CEP-04578-000 Sao Paulo, SP (BR).

(72) Inventors: **PORTO, Leandro Lucas Rodrigues;** Rua Rui Barbosa, n° 1020, Costa e Silva, CEP-892 19-901 Joinville, SC (BR). **STUMPF, Cristiano;** Rua Joao Pio Duarte, n° 864, Corrego Grande, CEP-88037-001 Florianopolis, SC (BR). **PIROVANO, Moacir;** Rua Americo Vespiicio, n° 1235, Nova Brasilia, CEP-89213-401 Joinville, SC (BR). **PELLEGRINI, Claudio de;** Rua Dom Pedro I, n° 206, Apto. 604, America, CEP-89204-170 Joinville, SC (BR). **VENDRAMI, Carlos Eduardo;** Rua Servidao Augusto Rohden, n° 41, Apto. 103, Rom Retiro, CEP-89222-323 Joinville, SC (BR). **GUESSER, Thiago Mannes;** Rua Guia Lopes, n° 346, CEP-892 18-060 Joinville, SC (BR).

(74) Agent: **RODRIGUES, Carina, S.;** Daniel Advogados, Rua Joaquim Floriano, 413, 13° andar, Itaim Bibi, CEP-04534-01 1 Sao Paulo, SP (BR).

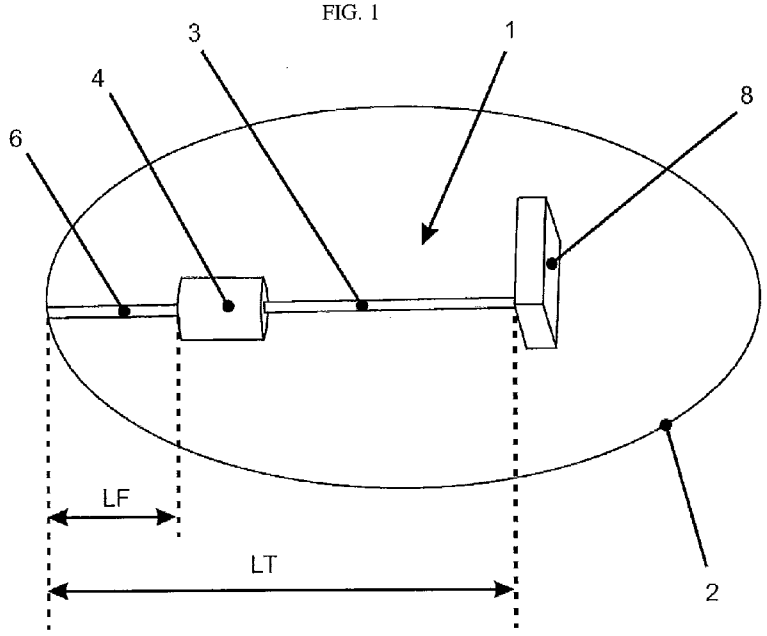
(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, 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, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

[Continued on nextpage]

(54) Title: DISCHARGE LINE OF COMPRESSOR

FIG. 1



(57) Abstract: Hermetic reciprocating compressor includes a discharge line compris¬ ing at least one pipeline (1) which is placed in the interior of the com¬ pressor shell (2). Said pipeline (1) is composed of at least one initial pipeline segment (3), at least one ex - pansion chamber (4), and at least one final pipeline segment (5). The final pipeline segment (6) is func^ tionally arranged between the shell (2) and the expansion chamber (4) and has a length (LF) that is equivalent to approximately 5% to 20% of the length (LT) of the pipeline (1).

WO 2013/097005 A1

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

"DISCHARGE LINE OF COMPRESSOR"

Field of the Invention

The present invention refers to a discharge line of compressor and, in special, to a discharge line which comprises at least one expansion chamber.

More specifically, the present invention reveals the development of a discharge line of compressor whose expansion chamber is arranged so as to attenuate, in a substantially optimized manner, the variations of pressure related to the pulsation due to the discharge cycles of the compressor.

Background of the Invention

As already known by the skilled in the art, the compressors comprise devices that are capable of altering the pressure of a working fluid that circulates in a system into which the same is inserted. In the case of alternative compressors, the pressure of a working fluid is altered by the cyclical shift and controlled by the volume of a compression chamber, which is normally defined by a chamber, that is able to receive the working fluid, and a movable piston, wherein said piston is capable of presenting an alternative shift in the interior of the already mentioned compression chamber.

Thus, most movable elements of a compressor, as well as the reactions exerted by these elements, are responsible for the generation of vibrations and noises. Consequently, the current prior art comprises an infinity of solutions related to the mitigation of such vibrations and noises.

Within this context, there are expansion chambers, which are specifically employed to attenuate the variations of pressure that are transmitted through the discharge lines of the alternative compressors.

Generally, the current expansion chambers comprise a kind of chamber and/or cavity placed in the proper discharge line. It shall be mentioned that such discharge expansion chambers are commonly of reactive type, in which the attenuation of sound results from the return of sound reflection to the source. Optionally, and also in accordance with the prior art, the discharge expansion chambers can also be of dissipative type. The constructive features (layout) of the discharge lines (piping arrangement and volumes) causes the appearance of concentrated parameter "models", whose theory makes an analogy with the vibration of a mass-spring system, considering the gas in the pipeline as mass and the cavities as pneumatic springs.

In this context, the current prior art provides conventional concretizations of discharge lines whose expansion chamber is placed next to the initial segment of the discharge line. Moreover, and considering the structural point-of-view, it is noted that the expansion chamber is normally placed in the interior of the hermetic shell of the compressor and, in special, in a position immediately next to the head of the compressor.

However, the restrictions of physical space block the increase in volume of said expansion chamber. On the other hand, it is noted that the current tendency is the reduction of the sizes of the hermetic shells of the compressors, and this tendency potentially prejudices the total sizing of the expansion chamber of the discharge line of the current hermetic compressors.

In order to overcome such limitations, the current prior art further provides concretizations in which the acoustic filters of the discharge are composed of expansion chambers that are externally placed in relation the hermetic shell of the compressor. Examples of such type of concretization can be noted in documents US 6,935,848 and US 5,596,879.

However, it is noted that the use of discharge acoustic filters that are placed externally in relation to the hermetic shell of the compressor presents other undesirable aspects, such as, for example, the noise generated due to the flow and the variations of pressure of the gas that circulates in the interior of such parts, the structural brittleness (the discharge expansion chamber, normally brittle, is not protected by the hermetic shell), and the physical adaptability of the compressor in any system (the area occupied by the compressor is greater when the discharge expansion chamber is placed externally in relation to the hermetic shell).

The present invention arises from the above-mentioned scenario.

Objectives of the Invention

Thus, one of the objectives of the present invention is the provision of a discharge line of compressor without containing the above-mentioned limitations. In this sense, it is also one of the objectives of the invention that the discharge line of compressor is specially free of sizing limitations that exist in the discharge lines of the current prior art compressors.

Another objective of the present invention is the provision of a discharge line of compressor which is capable of attenuating the variations of pressure that are transmitted through the discharge line by utilizing exclusively internal means in relation to the hermetic shell of the compressor.

Still another objective of the present invention is the utilization of the proper discharge line and the acoustic filter to set the desired value of frequency of the concentrated parameter model.

Summary of the Invention

These and other objectives of the instantly revealed invention are totally achieved by means of the discharge line of compressor, which is the object of the present invention.

Said discharge line of compressor comprises at least one pipeline which is placed in the interior of the shell of the compressor and which is composed of at least one initial pipeline segment, at least one expansion chamber, and at least one final pipeline segment.

According to the present invention, the expansion chamber includes the last expansion chamber of the pipeline, and the final pipeline segment is functionally arranged between at least one place of the shell and the expansion chamber. In this sense, it is noted that, in accordance with the present invention, the final pipeline segment has a length that is equivalent to approximately 5% to 20% of the length of the pipeline. Preferably, the "final" expansion chamber is functionally arranged between the initial pipeline segment and the final pipeline segment.

Optionally, the pipeline further comprises at least one intermediate pipeline segment and at least one additional intermediate expansion chamber, and, in this case, the "final" expansion chamber is functionally arranged between the last intermediate pipeline segment and the final pipeline segment.

Short Description of the Drawings

The present invention will be detailed with basis on the figures described below.

Figure 1 illustrates a simplified concretization of the discharge line of compressor, in accordance with the present invention; and

Figure 2 illustrates an optional concretization of the discharge line of compressor, in accordance with the present invention.

Detailed Description of the Invention

According to the previously revealed context, the main objective of the present invention is the provision of a discharge line of compressor that is specifically placed in the interior of the shell of the compressor and which is free of limitations and negative aspects of the prior art discharge lines.

Thus, the present discharge line has its expansion chamber (at least one expansion chamber) placed next to the outlet of the compressor, in other words, next to (but still in the interior of) the hermetic shell of the compressor. This new arrangement enables that all, or almost all, the length of the discharge line can be utilized to set the desired value of frequency of the concentrated parameter model.

Before detailing the concretizations of the present invention, the following technical definitions shall be disclosed:

Expansion chamber: volume or cavity that is arranged in series in a discharge line.

Discharge system: assemblage of pipelines and volumes (expansion chamber) that are placed between the valve(s) that discharge the compressed fluid in the cylinder and hermetic shell.

Discharge line: assemblage of pipelines and volumes that are placed between the discharge chamber of the compressor and the hermetic shell.

Discharge chamber: first volume wherein the gas is discharged from the cylinder, common volume generated by the cap of the cylinder.

Figures 1 and 2 enable a better visualization of the instantly claimed discharge line.

In figure 1, it is schematized the internal environment of the hermetic shell of an alternative compressor. In such internal environment, more precisely between the discharge chamber 8 and the shell 2, it is included a discharge line, which has the objective of establishing the outlet circuit of the already compressed working fluid, in other words, interconnecting the discharge chamber 8 to any system (not illustrated) that is normally placed outside in relation to the cited shell 2.

Moreover and still referring to figure 1, it is noted that the discharge line is fundamentally composed of a pipeline 1 that begins in the discharge chamber 8, and extends up to an outlet point (not illustrated) of the shell 2. The pipeline can be divided into an initial segment 3 and a final segment 5, wherein both segments 3 and 5 are connected by an expansion chamber 4.

In this context, it shall be mentioned that the expansion chamber 4 is a discharge expansion chamber which is already known by the skilled in the art.

The great development of the present invention refers to the location of the cited expansion chamber 4, or, from another point of view, the great development of the present invention refers to the length of the final segment 5.

In this sense, it shall be mentioned that, in accordance with the present invention, the expansion chamber 4 is considered the "last" expansion chamber of the pipeline 1, in other words, the expansion chamber that comes immediately before the final segment 5. Consequently, the final segment 5 is considered the "last" segment of the pipeline 1, which comes immediately before the shell 2. Evidently, the employment of the term "last" is based on the fluid flow in the discharge line (flow which begins in the discharge chamber 8 and ends in the shell 2).

More specifically, the main novelty of the present invention addresses in the fact the final segment 5 of the pipeline 1 has a length LF that is equivalent to approximately 5% to 20% of the length LT of the pipeline 1. In other terms, the main novelty of the present invention addresses in the fact the expansion chamber 4 is placed next to the outlet of the shell 2 (i.e., substantially distant from the discharge chamber 8, in accordance with the arrangement for the prior art discharge lines).

The length (or extension) of the final segment 5 of the pipeline 1, and the consequent location of the expansion chamber 4, allow the theory of concentrated parameter models to be much more explored, since the whole length of the initial segment 3 of the pipeline 1 can be used to form the concentrated parameter "model" with a great length of wave (low frequency) between the volume of the expansion chamber 4 and the volume of the discharge chamber 8 (what is physically impossible when an expansion chamber is placed

immediately forwards a discharge chamber, and considering a gas having the same thermodynamic conditions).

As a result, the expansion chamber 4, in accordance with the concepts revealed in the present invention, can be composed of a chamber and/or cavity of lower volume (when compared to the volumes of the prior art similar items), and with a greater or equivalent efficiency.

It shall be further emphasized that the length LF of the final segment 5 of the pipeline 1 is equivalent to approximately 5% to 20% of the length LT of the pipeline 1. This percentage range generated especially interesting results in compressors of refrigeration systems with its functioning in frequencies of 50 Hz and 60 Hz.

Optionally, and as illustrated in figure 2, the discharge line, in accordance with the present invention, can be further composed of intermediate segments 6 of the pipeline 1, besides intermediate acoustic filters 7.

In any way, and independently from the eventual existence and/or amount of intermediate segments 6 and intermediate acoustic filters 7, the main feature of the present invention is the final segment 5 of the pipeline 1 with a length LF that is equivalent to approximately 5% to 20% of the length LT of the pipeline 1.

In a more generally context, It shall be mentioned that the length of the pipeline 1 and the location of the filter 4 also interfere in the value of the natural frequencies that are formed in discharge systems and internal diameters of pipelines and filters, shape of the components, acoustical barriers placed in the interior of the filters or pipelines (perforated panels, pipelines, orifices, etc) and also the fluid, considering its thermodynamic conditions (temperature and pressure). Therefore, since the compressors usually have functioning frequencies of 50 Hz and 60 Hz, i.e. values of low frequency, and that, in such values and its harmonics, there will be great pulsation amplitudes, it is considered important the decrease of the natural frequency values of discharge systems, so as to attenuate the pulsation from low frequencies, and, whether possible, before those related to the functioning of the compressor.

Although it has been described an example of preferable concretization of the present invention, it shall be understood that the scope of the same includes other possible variations, being only limited by the content of the claims, in which are included such possible equivalent means.

CLAIMS

1. A discharge line of compressor comprising at least one pipeline (1) which is placed in the interior of the shell (2) of the compressor and which is composed of at least one initial pipeline segment (3), at least one expansion chamber (4), and at least one final pipeline segment (5), CHARACTERIZED in that:

said expansion chamber (4) includes the last expansion chamber of the pipeline (1);

said final pipeline segment (5) is functionally arranged between at least one place of the shell (2) and the expansion chamber (4); and

said final pipeline segment (5) has a length (LF) that is equivalent to approximately 5% to 20% of the total length (LT) of the pipeline (1).

2. The discharge line of compressor, in accordance with Claim 1, CHARACTERIZED in that said expansion chamber (4) is functionally arranged between the initial segment (3) of the pipeline (1) and the final segment (5) of the pipeline (1).

3. The discharge line of compressor, in accordance with Claim 1, CHARACTERIZED in that said pipeline (1) further comprises at least one intermediate segment (6) and at one intermediate expansion chamber (7).

4. The discharge line of compressor, in accordance with Claim 3, CHARACTERIZED in that said expansion chamber (4) is functionally arranged between the last intermediate segment (6) of the pipeline (1) and the final segment (5) of the pipeline (1).

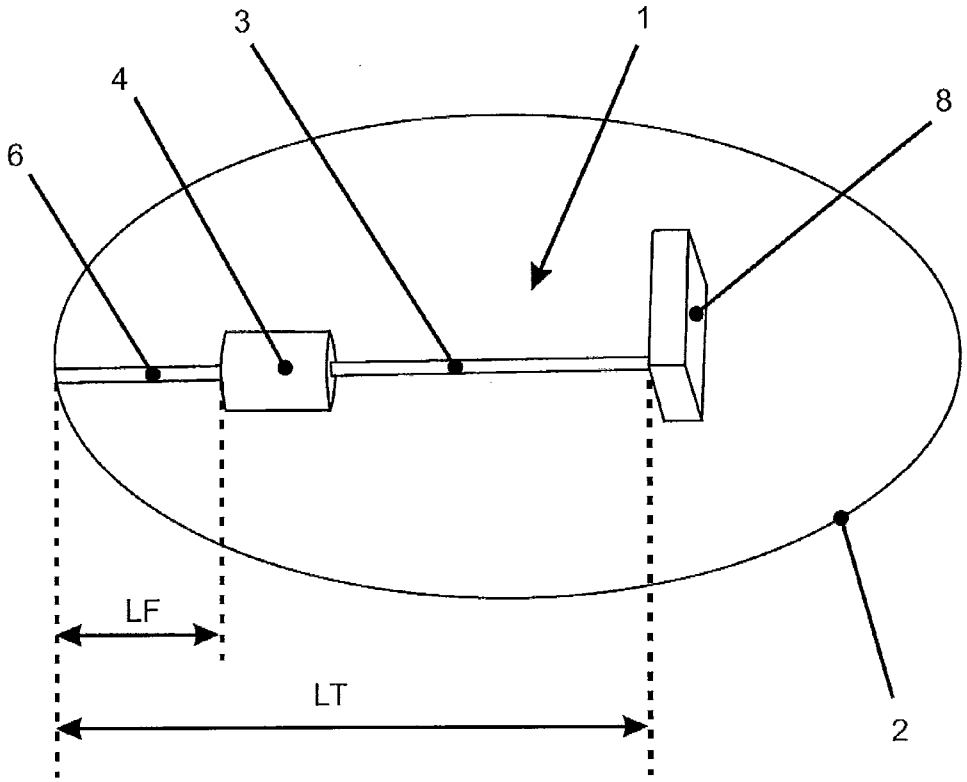


FIG. 1

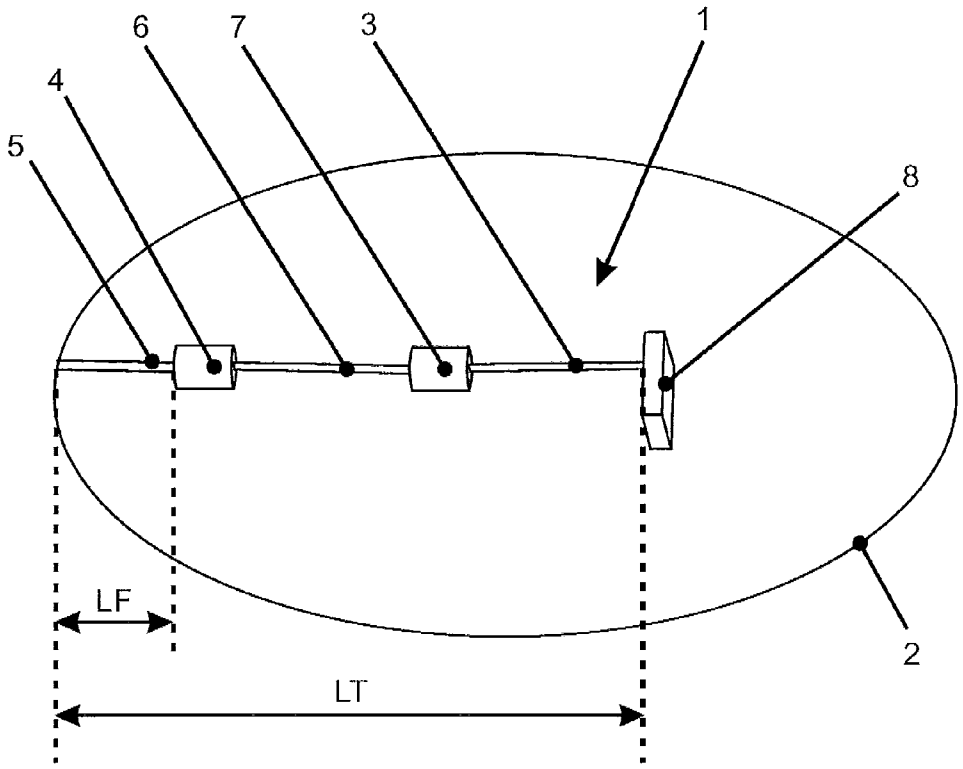


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/BR2012/000473

A. CLASSIFICATION OF SUBJECT MATTER
INV. F04B39/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010/166586 A1 (KWON DAE IL [KR] ET AL) 1 July 2010 (2010-07-01)	1,2
Y	paragraphs [0007] , [0008] , [0009] , [0011], [0033], [0034]; figures 2,4,5	3,4
Y	US 2006/018778 A1 (SE0 CHE0L [KR]) 26 January 2006 (2006-01-26) paragraph [0027]; figure 7	3,4
A	US 5 596 879 A (BURKHART LARRY J [US] ET AL) 28 January 1997 (1997-01-28) cited in the application the whole document	1-4
A	US 6 935 848 B2 (MARSHALL STEVE EDWIN [US] ET AL MARSHAL STEVE EDWIN [US] ET AL) 30 August 2005 (2005-08-30) cited in the application the whole document	1-4

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" documentwhich may throw doubts on priority claim(s) orwhich is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 February 2013	19/02/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Olona Laglera, C

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/BR2012/000473

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010166586 A1	01-07-2010	NONE	
US 2006018778 A1	26-01-2006	BR PI0501353 A	07-03-2006
		CN 1724866 A	25-01-2006
		JP 2006029322 A	02-02-2006
		US 2006018778 A1	26-01-2006
US 5596879 A	28-01-1997	NONE	
US 6935848 B2	30-08-2005	US 2004234387 A1	25-11-2004
		US 2005276711 A1	15-12-2005
		WO 2004104495 A2	02-12-2004