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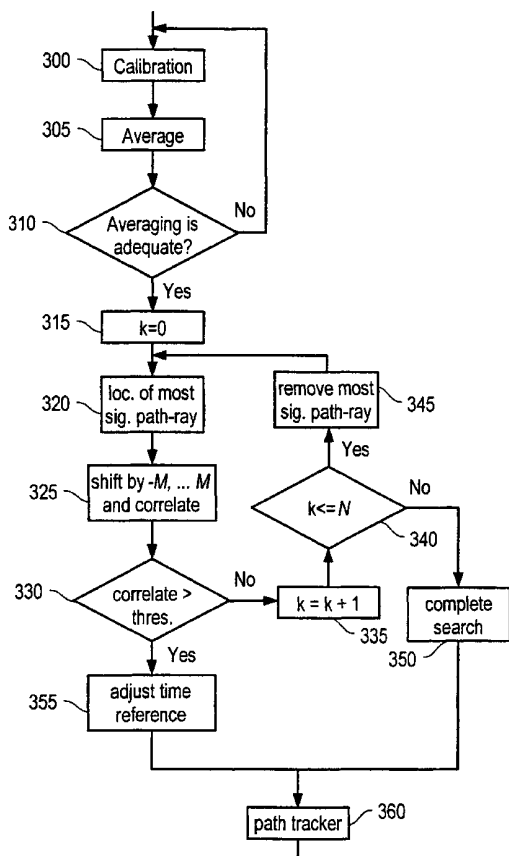
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[Continued on next page]

(54) Title: METHOD AND APPARATUS FOR FAST DETECTION OF LOCATIONS OF PATH RAYS IN A RAKE RECEIVER



(57) Abstract: Locations of path rays in a multi-path channel receiver having multiple time references are detected, e.g., when the receiver switches time references. Locations of received path rays are searched for and determined. The locations are tracked for a predetermined amount of time. If the locations are lost after a predetermined amount of time, a new search for the locations of the received path rays is initiated. The searching may include determining a probable location of a most significant path ray, shifting the location within a predetermined interval, analyzing each shifted location to determine whether the shifted location corresponds to the actual location of the received path ray, and depending on the analysis results, completing the search or determining a probable location of a next most significant ray. The analysis may be performed by correlating each shifted location with a pilot sequence and determining if the location results exceed a predetermined threshold. If the correlation results do not exceed the threshold, a determination is made whether all the most significant path rays have been analyzed, and if so, a complete search for the path ray location is initiated. When switching from a time reference of low accuracy to a time reference of high accuracy, the low accuracy time reference may be calibrated to the high accuracy time reference based on averaged measurements of the ration of clock cycles of the time reference of high accuracy to the clock cycles of the time reference of low accuracy.

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METHOD AND APPARATUS FOR FAST DETECTION OF LOCATIONS OF PATH RAYS IN A RAKE RECEIVER

5

BACKGROUND

This invention relates generally to a method and apparatus for detecting a received signal in a communication system. More particularly, this invention relates to a method and apparatus for detecting locations of path rays in a multi-path receiver having multiple time references.

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FIG. 1 is a block diagram of an exemplary cellular radiotelephone system, including an exemplary base station (BS) 110 and a mobile station (MS) 120. Although denoted a "mobile station", the station 120 may also be another type of remote station, e.g., a fixed cellular station. The BS includes a control and processing unit 130 which is connected to a mobile switching center (MSC) 140 which in turn is connected to a PSTN (not shown). General aspects of such cellular radiotelephone systems are known in the art. The BS 110 handles a plurality of voice channels through a voice channel transceiver 150, which is controlled by the control and processing unit 130. Also, each BS includes a control channel transceiver 160, which may be capable of handling more than one control channel. The control channel transceiver 160 is controlled by the control and processing unit 130. The control channel transceiver 160 broadcasts control information over the control channel of the BS or cell to mobiles locked to that control channel. It will be understood that the transceivers 150 and 160 can be implemented as a single device, like the voice and control transceiver 170, for use with control and traffic channels that share the same radio carrier.

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The MS 120 receives the information broadcast on a control channel at its voice and control channel transceiver 170. Then, the processing unit 180 evaluates the received control channel information, which includes the characteristics of cells that are candidates for the MS to lock on to, and determines on which cell the MS should lock.

Advantageously, the received control channel information not only includes absolute

information concerning the cell with which it is associated, but also contains relative information concerning other cells proximate to the cell with which the control channel is associated, as described for example in U.S. Patent No. 5,353,332 to Raith et al., entitled "Method and Apparatus for Communication Control in a Radiotelephone System".

5 Modern communication systems, such as a cellular radiotelephone system of the type described above and satellite radio systems, employ various modes of operation (analog, digital, dual mode, etc.) and access techniques such as frequency division multiple access (FDMA), time division multiple access (TDMA), code division multiple access (CDMA), and hybrids of these techniques.

10 In North America, a digital cellular radiotelephone system using TDMA is called the Digital Advanced Mobile Phone System (D-AMPS), some of the characteristics of which are specified in the TIA/EIA/IS-136 standard published by the Telecommunications Industry Association and Electronic Industries Association (TIA/EIA). Another digital communication system using direct sequence CDMA is
15 specified by the TIA/EIA/IS-95 standard. There are also frequency hopping TDMA and CDMA communication systems, one of which is specified by the EIA SP 3389 standard (PCS 1900). The PCS 1900 standard is an implementation of the GSM system, which is common outside North America, that has been introduced for personal communication services (PCS) systems.

20 Several proposals for the next generation of digital cellular communication systems are currently under discussion in various standards setting organizations, which include the International Telecommunications Union (ITU), the European Telecommunications Standards Institute (ETSI), and Japan's Association of Radio Industries and Businesses (ARIB).

25 Direct-sequence (DS) spread-spectrum modulation is commonly used in CDMA systems, in which each information symbol is represented by a number of "chips." Representing one symbol by many chips gives rise to "spreading," as the latter typically requires more bandwidth to transmit. The sequence of chips is referred to as the

spreading code or signature sequence. At a DS receiver, e.g., a Rake Receiver, the received signal is despread using a despreading code, which is typically the conjugate of the spreading code. IS-95 and J-STD-008 are examples of DS CDMA standards.

In the mobile radio channel, multi-path is created by reflection of the transmitted
5 signal from obstacles in the environment, e.g., buildings, trees, cars, etc. In general, the mobile radio channel is a time varying multi-path channel due to the relative motion of the structures that create the multi-path.

A characteristic of the multi-path channel is that each path through the channel may have a different phase. For example, if an ideal impulse is transmitted over a multi-
10 path channel, each pulse of the received stream of pulses generally has a different phase from the other received pulses. This can result in signal fading.

In a CDMA system, signal fading is combated by combining the pulses received over multiple paths using a Rake Receiver. Typically, the channel is modeled as discrete
15 MS. The locations of the received signal path rays are first found by using a searcher, and then these path rays are combined by using a maximum ratio combiner. A tracker is used to track the locations of the path rays.

FIG. 2A illustrates a typical DS-CDMA system including a Transmitter 200 and a Receiver 250. The Transmitter 200 includes a Spreader 210, a Modulator 220, and an antenna. The Spreader 210 spreads the signal to be transmitted, and the Modulator 220
20 modulates the spread signal on a carrier frequency. The modulated signal is then transmitted via the antenna in the Transmitter 200.

The Receiver 250 includes an antenna, an RF Pre-Processing unit 230, a Rake Receiver 240, and a Post-Processing unit 250. The transmitted signal is received via the antenna in the Receiver 250. The RF Pre-Processing unit 230 tunes to the desired band
25 and desired carrier frequency, then demodulates, amplifies, mixes, and filters the signal down to baseband.

The Rake Receiver 240 despreads the demodulated signal and detects the digital symbols that were transmitted. It may produce soft information as well, which gives information regarding the likelihood of the detected symbol values.

5 The Post-Processing unit 250 performs functions that depend highly on the particular communications application. For example, it may use the soft detected values to perform forward error correction decoding or error detection decoding. It may convert digital signals into speech using a speech decoder.

An MS, in the active mode, transmits and receives data. In the active mode, the MS uses a crystal oscillator with high accuracy and low phase noise as a reference clock. 10 For instance, in the Global System for Mobile Communications (GSM), it is proposed to use a 13 MHz crystal with high accuracy during the time the MS is awake. This crystal is synchronized with the BS to provide synchronous transmission and reception. This kind of crystal consumes a relatively large amount of current and is not necessary when the MS is, e.g., asleep in the idle mode, not receiving or transmitting data.

15 The MS only wakes up once in a while in the idle mode to listen to the Paging Channel (PCH) in order to receive paging messages from the BS. Hence, a crystal with low accuracy and low current consumption can be employed when the MS is asleep. An example of such a crystal is a Real Time Crystal (RTC), which is a 32 KHz crystal. An RTC has high phase noise and is much more sensitive to temperature variations than, e.g., 20 a 13 MHz crystal. Employing this crystal is feasible in the sleep mode since the MS needs only to have knowledge about the time.

When the MS wakes up to listen to the PCH, the crystal with high accuracy and also high current consumption can be used. Since the wake up time is only a small part of the total time (if the MS is not paged), by switching between these crystals the MS can 25 save power, thereby increasing its standby time.

It is known to use different clocks in different modes. For example, GB 232 4681 discloses a method for conserving energy by entering a lower power sleep mode. A clock with coarse resolution is used while the MS is in an idle mode. An offset between this

probable location of a most significant path ray, shifting the location within a predetermined interval, analyzing each shifted location to determine whether the shifted location corresponds to the actual location of the received path ray, and depending on the analysis results, completing the search or determining a probable location of a next most significant ray. The analysis of each shifted location may be performed by correlating each shifted location with a pilot sequence and determining if the correlation results exceed a predetermined threshold. If the correlation results do not exceed the threshold, a determination is made whether all the most significant path rays have been analyzed, and if so, a complete search for the path ray location is initiated. The steps may be initiated when the receiver switches from a time reference of low accuracy to a time reference of high accuracy. When switching from a time reference of low accuracy to a time reference of high accuracy, the low accuracy time reference may be calibrated to the high accuracy time reference based on averaged measurements of the ratio of clock cycles of the time reference of high accuracy to the clock cycles of the time reference of low accuracy.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of this invention will become apparent by reading this description in conjunction with the accompanying drawings, in which like reference numerals refer to like elements and in which:

FIG. 1 is a block diagram of an exemplary cellular radiotelephone communication system;

FIG 2A illustrates a typical DS CDMA system;

FIG. 2B illustrates a Rake Receiver in which the invention may be implemented;

FIG. 2C illustrates phase offset and the distance between different path rays;

FIG. 3 illustrates a method for detecting locations of path rays in a multi-path receiver according to an exemplary embodiment.

DETAILED DESCRIPTION

For illustrative purposes, the following description is directed to a cellular radio communication system, but it will be understood that this invention is not so limited and applies to other types of communication systems.

5 FIG. 2B illustrates an exemplary Rake Receiver in which the invention may be implemented. The Rake Receiver 240 comprises a Searcher 260, Rake Fingers 270, a Path Tracker 280, and a Combiner 290. The Searcher 260 detects the locations of the multi-path rays, and each Rake Finger 270 is assigned a path. The Rake Fingers 270 estimate the corresponding radio channel for the respective paths. The results are then
10 combined using the Combiner 290. The Searcher 260 may include, e.g., matched filters and a peak detector. Path rays are correlated with a certain pilot sequence, resulting in peaks which indicate the location of the path rays. These peaks are detected by the peak detector. The correlations and peak detections make the Searcher 260 computationally complex, and it is desirable to limit its duty cycle.

15 Conventionally, the locations of path rays are detected only once and then are tracked as long as possible by using the Path Tracker 280. This presents a problem if the path rays are lost, e.g., when changing from a low accuracy crystal to a high accuracy crystal when the MS wakes up to listen to the PCH.

 In order to avoid complete searching, the MS can calibrate the sleep mode crystal
20 by using the awake mode crystal when the MS wakes up. This calibration may be based on the measurement and comparison of clock cycles between the crystals. This calibration can take a long time due to the high phase noise of the crystal used in the sleep mode. This is not desirable since the MS should go back to sleep as soon as possible.

 According to an exemplary embodiment, the calibration time may be reduced by
25 averaging several short measurements of clock cycles. The averaging can be performed using, e.g., an Finite Impulse Response (FIR) filter in which a certain number of measurements is used or as an Infinite Impulse Response (IIR) filter, in which substantially all the measurements are used. The ratios of clock cycles for the high

accuracy clock to each low accuracy clock cycle can be measured and averaged, and the corresponding temperature can be measured. The averaged ratio and the corresponding temperature may be recorded in a temperature compensation table. The number of clock cycles of the low accuracy clock and the number of clock cycles of the high accuracy
5 clock that should elapse between paging periods are calculated from the ratio. Based on the measured temperature and by referring to the compensation table, the phase offsets caused by temperature variation may be accounted for.

According to exemplary embodiments, there are a number of phase offsets caused by the multi-path rays. The phase offsets are grouped, e.g., according to significance
10 based on signal-to-interference ratio (SIR), signal-to-noise ratio (SNR), or amplitude of the multi-path rays. It is assumed that the positions of these phase offsets do not significantly change in relation to each other within a certain short amount of time, for instance when the MS transitions from the wake up state to the sleep state and then back to the wake up state. Therefore, in each search window, there are several opportunities to
15 locate the phase offsets by locking on one of them, e.g., the most significant one, and then searching for the others in the expected locations.

FIG. 2C illustrates the locations of different path rays, with the horizontal axis representing time, and the vertical axis representing power. The solid lines represent the locations of path rays at time t_1 , e.g., during a wake up state, and the dashed lines
20 represent the locations of path rays at time t_2 , e.g., during a sleep state. As can be seen from FIG. 2C, after filtering, the distances between the different path rays are the same within a short period of time, but the inaccuracy of the low accuracy clock produces a phase offset. Thus, when a significant ray has been found, the locations of the other rays can be determined with high accuracy. To adjust for the small changes in the distances
25 between the rays, the path tracker is activated.

Having averaged an adequate number of measurements, the crystal with low accuracy can be calibrated so that the shift of the MS time reference is limited within a small number of path ray locations $+M$. One of the locations indicates the real shift of

the time reference. To determine the new time reference, the location of the most significant path-ray from previous observations is shifted within the interval $\{-M, -M + 1, \dots, M\}$ and analyzed to determine if a location within the interval corresponds to the actual location of the received most significant path ray.

5 If the time reference is found by finding one of the path rays, the locations of other path rays are found based on the relative distances between the found path ray and the other path rays. These relative distances are known and were available before the MS went into the sleep mode. The possible minor shifts of other path rays relative to the found path ray one can be adjusted by minor shifts of the correlator and comparing the
10 results.

 If the analysis fails, the location of the next most significant path-ray is analyzed. This task is repeated until the actual location of a path-ray is determined, indicating that the shift of the time reference of the MS is detected. Then, the time shift of the MS is adjusted, and the path tracker is then activated. However, if the analysis fails when
15 having studied the locations of the N most significant path rays, the MS time reference is considered to be lost, and a complete search for the ray locations is then activated.

 According to an exemplary embodiment, the most significant path-ray can be, e.g., the most significant one based on SIR, SNR, or amplitude. The analysis for determining the reference time shift can be, e.g., based on a correlation of the received
20 data to the known received pilot signals. The number N can be chosen in such a way that the correlators' complexity does not exceed that of the complete search.

 FIG. 3 illustrates a method for detecting a path ray in a receiver according to an exemplary embodiment. The method starts at step 300 at which the low accuracy crystal is calibrated with the high accuracy crystal. At step 305, measurements between time
25 references of the crystals are averaged. At step 310, a determination is made whether the averaging is adequate, depending, e.g., on a desired level of accuracy. If not, the process returns to step 300. If the averaging is adequate, a process variable k is set to zero at step 315. Then, at step 320, the location of the most significant path ray is determined. At

step 325, the path ray location is shifted by $-M$, ..., M , and each shifted location is analyzed. For example, the shifted path ray locations are correlated with a known pilot sequence. At step 330, a determination is made whether the correlation result is greater than a predetermined threshold. If not, k is incremented by 1 at step 335, and a
5 determination is made at step 340 whether k is less than or equal to N , i.e., a determination is made whether the N most significant path rays have been analyzed. If k is less than or equal to N , the most significant path ray is removed at step 345, and the process returns to step 320. If, at step 340 it is determined that k is not less than or equal to N , a complete search is initiated at step 350. If at step 330, the correlation is found to
10 be greater than the threshold, this means that the actual received path ray location has been found, and the time reference of the MS is accordingly adjusted at step 355. After the time reference is adjusted at step 355 or the search for the path ray location is completed at step 350, the process proceeds to step 360 at which the path tracker tracks the locations of the path rays.

15 This method can be implemented, e.g., in a microprocessor in the searcher or elsewhere in the multi-path receiver.

According to exemplary embodiments, a method and apparatus are provided for detecting a location of received path rays in a multi-path receiver having multiple time references.

20 It will be appreciated by those of ordinary skill in the art that this invention can be embodied in other specific forms without departing from its essential character. The embodiments described above should therefore be considered in all respects to be illustrative and not restrictive. For example, although described above with reference to a CDMA communication system, the invention is also applicable in other types of
25 communication systems.

WHAT IS CLAIMED IS:

1. A method for detecting locations of path rays in a multi-path channel receiver having multiple time references, the method comprising the steps of:
5 searching for locations of received path rays;
 determining the locations of the received path rays;
 tracking the locations of the received path rays for a predetermined amount of time; and
 if the locations are lost after the predetermined amount of time, initiating a
10 new search for the locations of the received path rays.

2. The method of claim 1, wherein the step of searching includes:
 determining a probable location of a most significant path ray;
 shifting the location within a predetermined interval;
15 analyzing each shifted location to determine whether the shifted location corresponds to the actual location of the received path ray; and
 depending on the analysis results, completing the search or determining a probable location of a next most significant ray.

- 20 3. The method of claim 2, wherein if the shifted location corresponds to the actual location of the received path ray, the step of completing the search comprises locating the other path rays based on the knowledge of relative distances between the located path ray and the other path rays.

- 25 4. The method of claim 2, wherein the step of analyzing includes:
 correlating each shifted location with a pilot sequence; and
 determining if the correlation results exceed a predetermined threshold.

5. The method of claim 4, further comprising, if the correlation results do not exceed the threshold:

determining whether all the significant path rays have been analyzed; and
if so, initiating a complete search for the path ray locations.

5

6. The method of claim 1, wherein the steps are initiated when the receiver switches from a time reference of low accuracy to a time reference of high accuracy.

7. The method of claim 6, further comprising, when switching from the time
10 reference of low accuracy to the time reference of high accuracy, a step of calibrating the
low accuracy time reference to the high accuracy time reference.

8. The method of claim 7, wherein the step of calibrating includes averaging
measurements of the ratio of clock cycles of the time reference of high accuracy to the
15 clock cycles of the time reference of low accuracy.

9. The method of claim 1, wherein the receiver is a cellular radio.

10. An apparatus for detecting locations of path rays in a multi-path receiver, the
20 apparatus comprising:

a tracker for tracking the path rays for a predetermined amount of time; and

a searcher for locating the path rays when the predetermined amount of time
expires and the locations are lost.

25 11. The apparatus of claim 10, wherein the searcher determines a probable
location of a most significant path ray, shifts the location within a predetermined interval,
and analyzes each shifted location to determine whether the shifted location corresponds
to the actual location of the received path ray, wherein depending on the analysis results,
the search is completed or a probable location of next most significant ray is determined.

12. The apparatus of claim 11, wherein if the shifted location corresponds to the actual location of the received path ray, the searcher locates the other path rays based on the knowledge of relative distances between the located path ray and the other path rays.

5 13. The apparatus of claim 11, wherein the searcher analyzes each shifted location by correlating each shifted location with a pilot sequence and determining if the correlation results exceed a predetermined threshold.

10 14. The apparatus of claim 13, wherein if the correlation results do not exceed the threshold, the searcher determines whether all the significant path rays have been analyzed, and if so, initiates a complete search for the path ray locations.

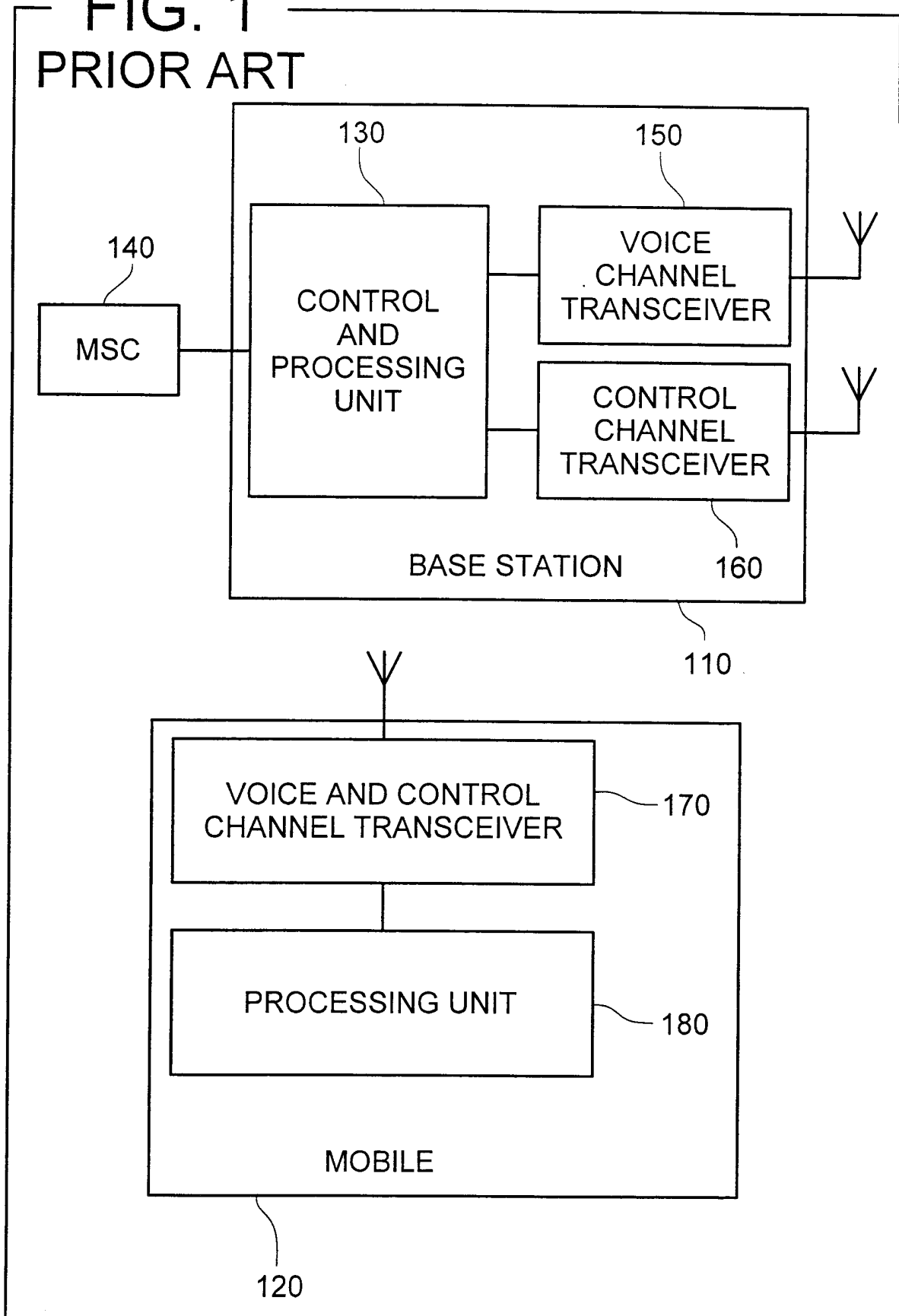
15 15. The apparatus of claim 10, wherein the tracking and searching are performed when switching from a time reference of low accuracy to a time reference of high accuracy.

20 16. The apparatus of claim 15, wherein when switching from the time reference of low accuracy to a time reference of high accuracy, the time reference of low accuracy is calibrated to the time reference of high accuracy.

 17. The apparatus of claim 16, wherein the calibration includes averaging measurements of the ratio of clock cycles of the time reference of high accuracy to the clock cycles of the time reference of low accuracy.

25 18. The apparatus of claim 10, wherein the receiver is a cellular radio.

FIG. 1
PRIOR ART



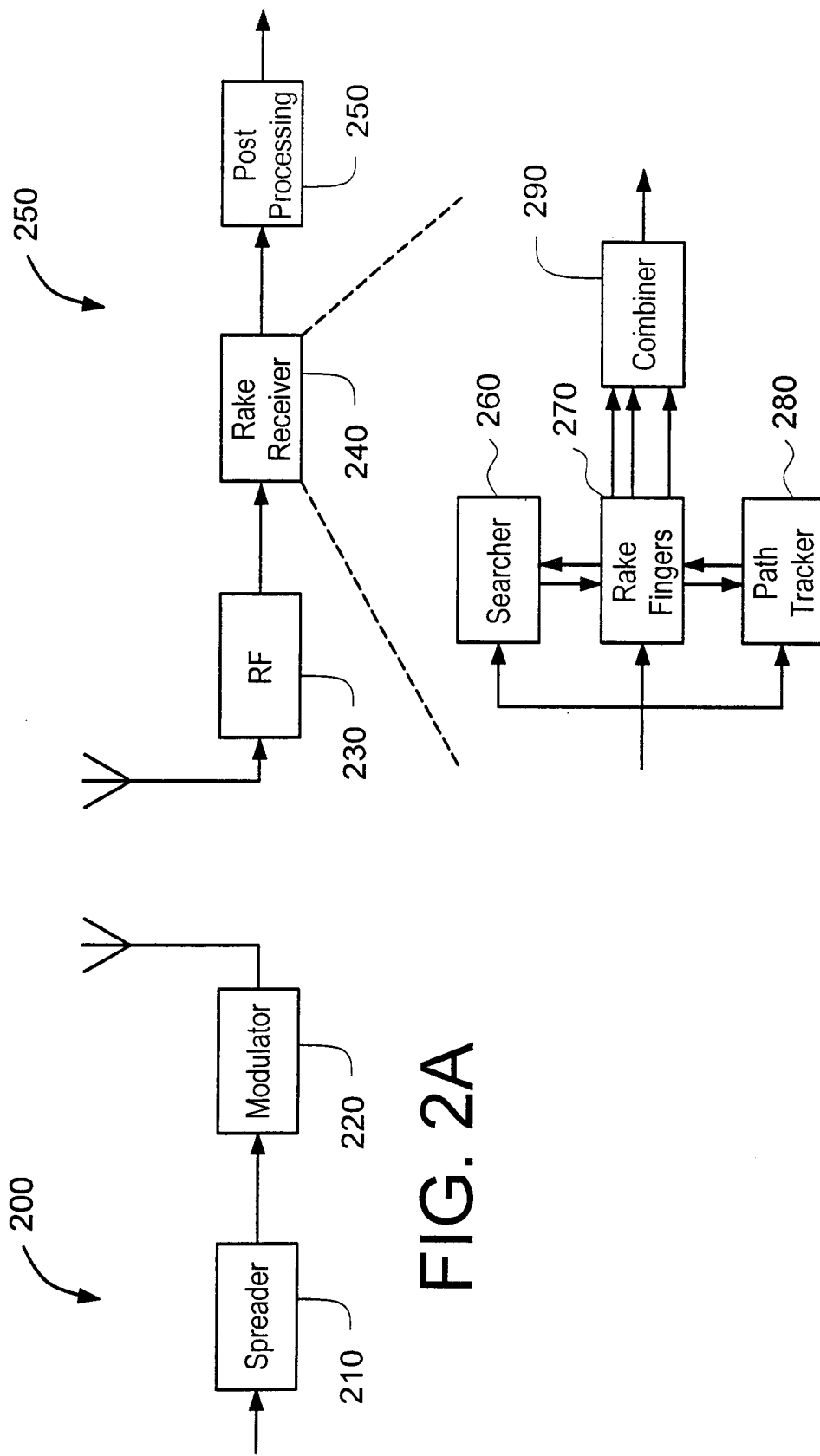


FIG. 2A

FIG. 2B

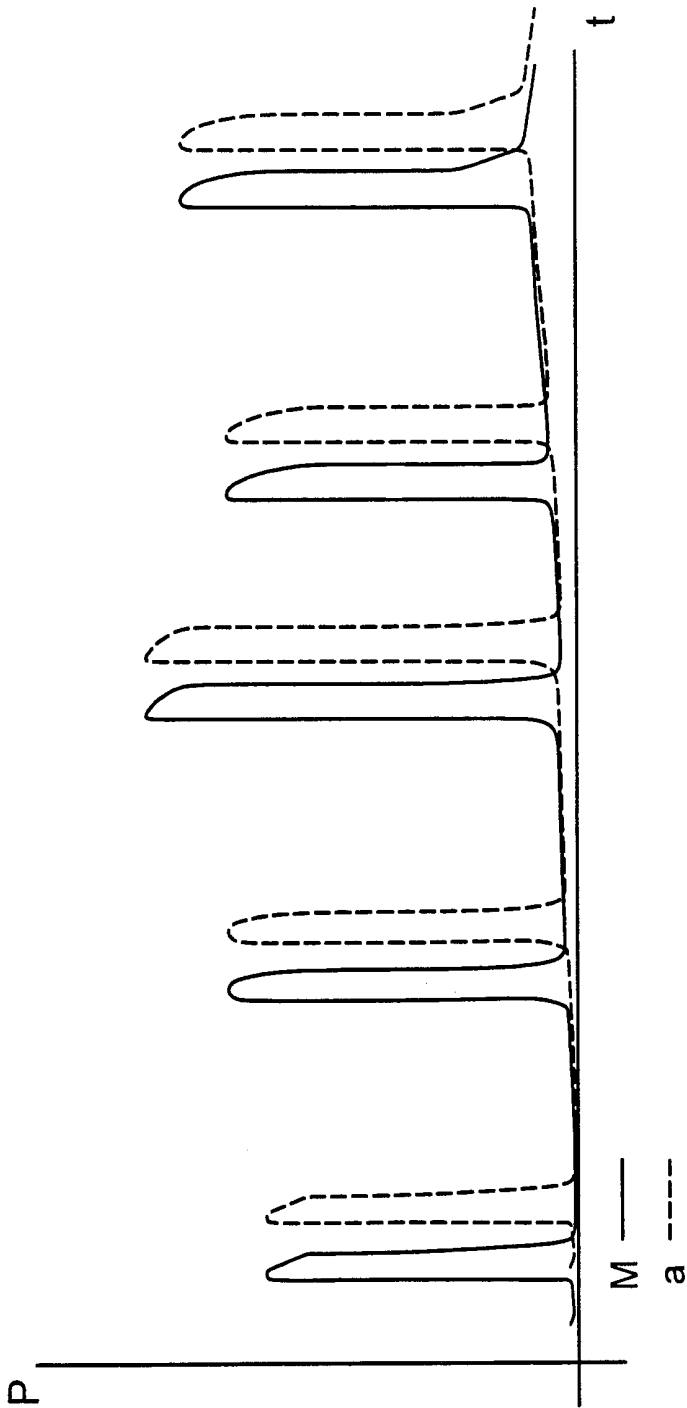


FIG. 2C

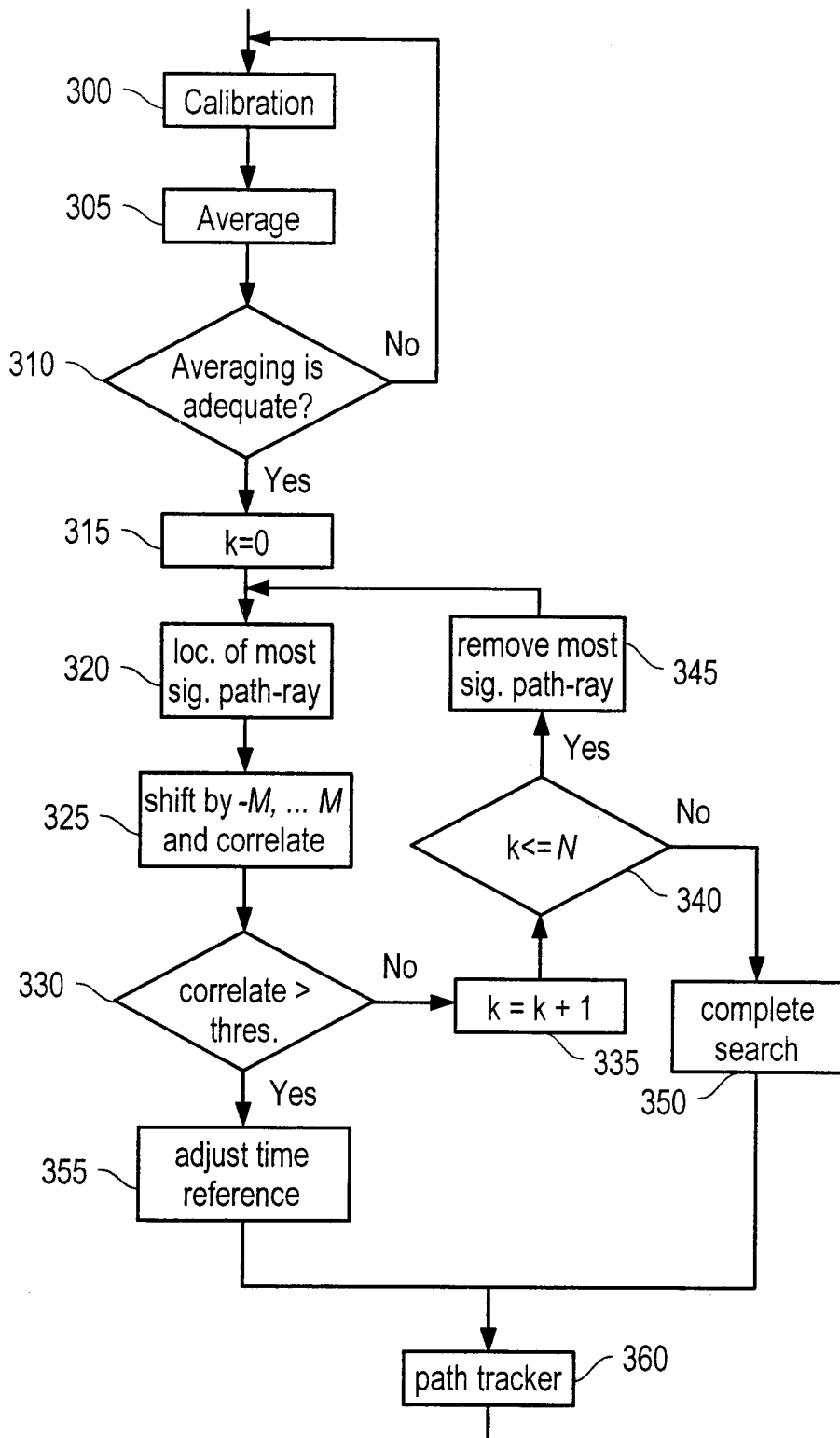


FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No

PC 1/EP 01/02247

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 H04B1/707				
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) IPC 7 H04B				
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 practical, search terms used) EPO-Internal, PAJ, INSPEC, WPI Data				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
Y A Y A	EP 0 877 493 A (NIPPON ELECTRIC CO) 11 November 1998 (1998-11-11) column 2, line 11 -column 3, line 4 column 5, line 17 -column 7, line 45; figures 4,5 column 9, line 52 -column 10, line 11 --- WO 97 19522 A (NOKIA TELECOMMUNICATIONS OY ;STAAHLE LAURI (FI)) 29 May 1997 (1997-05-29) page 10, line 5 - line 28; claims 1,4,8 --- US 5 490 165 A (WEAVER JR LINDSAY A ET AL) 6 February 1996 (1996-02-06) column 6, line 38 - line 45 column 9, line 22 -column 10, line 13 -----	1,2,4, 9-11,13, 18 3,6,7, 12,15,16 1,2,4, 9-11,13, 18 1,4,5,9, 13,14,18		
<input type="checkbox"/> Further documents are listed in the continuation of box C.				
<input checked="" type="checkbox"/> Patent family members are listed in annex.				
* Special categories of cited documents :				
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none; vertical-align: top;"> <ul style="list-style-type: none"> *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which 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 </td> <td style="width: 50%; border: none; vertical-align: top;"> <ul style="list-style-type: none"> *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. *Z* document member of the same patent family </td> </tr> </table>			<ul style="list-style-type: none"> *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which 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 	<ul style="list-style-type: none"> *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. *Z* document member of the same patent family
<ul style="list-style-type: none"> *A* document defining the general state of the art which is not considered to be of particular relevance *E* earlier document but published on or after the international filing date *L* document which may throw doubts on priority claim(s) or which 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 	<ul style="list-style-type: none"> *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. *Z* document member of the same patent family 			
Date of the actual completion of the international search <div style="text-align: center; font-size: large;">25 July 2001</div>		Date of mailing of the international search report <div style="text-align: center; font-size: large;">31/07/2001</div>		
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl. Fax: (+31-70) 340-3016		Authorized officer <div style="text-align: center; font-size: large;">Nilsson, M</div>		

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 01/02247

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0877493 A	11-11-1998	JP 2853705 B	03-02-1999
		JP 10308689 A	17-11-1998
		BR 9802069 A	15-06-1999
		US 6222834 B	24-04-2001
WO 9719522 A	29-05-1997	FI 955585 A	21-05-1997
		AU 715532 B	03-02-2000
		AU 7574896 A	11-06-1997
		CN 1202993 A	23-12-1998
		EP 0862817 A	09-09-1998
		JP 2000500938 T	25-01-2000
		NO 982274 A	16-07-1998
US 5490165 A	06-02-1996	AU 685869 B	29-01-1998
		AU 8096394 A	22-05-1995
		BR 9405888 A	26-12-1995
		CA 2150932 A	04-05-1995
		EP 0676107 A	11-10-1995
		FI 953210 A	28-08-1995
		IL 111432 A	10-03-1998
		JP 2938573 B	23-08-1999
		JP 8508152 T	27-08-1996
		RU 2138918 C	27-09-1999
		WO 9512262 A	04-05-1995
		ZA 9407841 A	18-05-1995