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(71) Applicant: INTERDIGITAL TECHNOLOGY CORPORATION [US/US]; Suite 525, 300 Delaware Avenue, Wilmington, DE 19801 (US).

(72) Inventor: OZLUTURK, Fatih, M.; 70 Willowdale Avenue, Port Washington, NY 11050 (US).

(74) Agents: VOLPE, Anthony, S. et al.; Volpe and Koenig, P.C., 400 One Penn Center, 1617 John F. Kennedy Boulevard, Philadelphia, PA 19103 (US).

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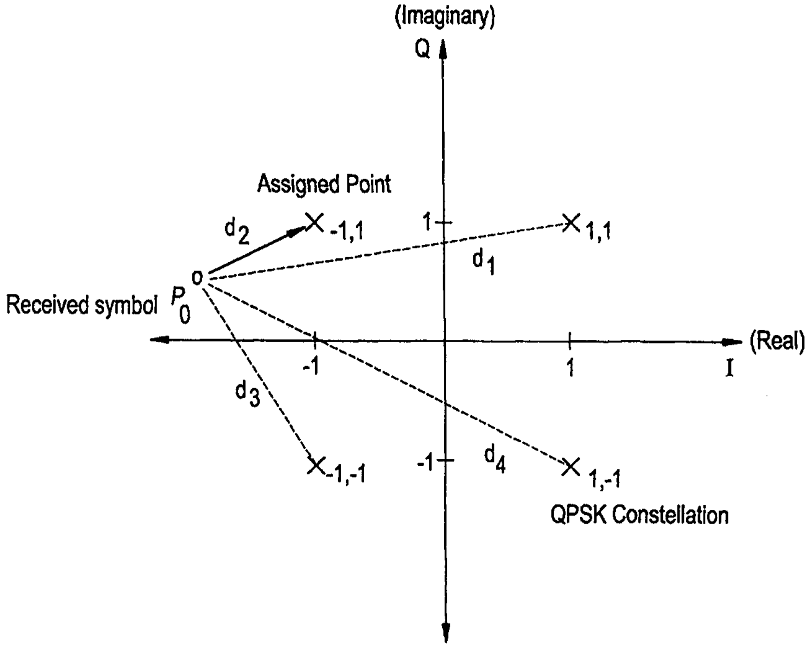


(57) Abstract

A global pilot (61) and unwanted traffic (115i) signal canceler for a spread spectrum communication system receiver that reduces their contributive noise effects (149). The present invention effectively cancels the global pilot and unwanted, active traffic signals prior to decoding a desired traffic signal at the receiver. The system and method decreases the bit error rate (BER) yielding an increased signal–to–noise ratio.

CANCELLATION OF PILOT AND UNWANTED TRAFFIC SIGNALS IN A CDMA SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to digital communications. More specifically, the invention relates to a system and method which cancels the global pilot signal and unwanted traffic signals from a received code division multiple access signal thereby removing them as interferers prior to decoding.

Description of the Prior Art

Advanced communication technology today makes use of a communication technique in which data is transmitted with a broadened band by modulating the data to be transmitted with a pseudo-noise (pn) signal. The technology is known as digital spread spectrum or code divisional multiple access (CDMA). By transmitting a signal with a bandwidth much greater than the signal bandwidth, CDMA can transmit data without being affected by signal distortion or an interfering frequency in the transmission path.

Shown in **Figure 1** is a simplified, single channel CDMA communication system. A data signal with a given bandwidth is mixed with a spreading code generated by a pn sequence generator producing a digital spread spectrum signal. The signal which carries data for a specific channel is known as a traffic signal. Upon reception, the data is reproduced after correlation with the same pn sequence used to transmit the data. Every other signal within the transmission bandwidth appears as noise to the signal being despread.

For timing synchronization with a receiver, an unmodulated traffic signal known as a pilot signal is required for every transmitter. The pilot signal allows respective receivers to synchronize with a given transmitter, allowing despreading of a traffic signal at the receiver.

In a typical communication system, a base station communicates with a plurality of individual subscribers fixed or mobile. The base station which transmits many signals, transmits a global pilot signal common to the plurality of users serviced by that particular base station at a higher power level. The global pilot is used for the initial acquisition of an individual user and for the user to obtain signal-estimates for coherent reception and for the combining of multipath components during reception. Similarly, in a reverse direction, each subscriber transmits a unique assigned pilot for communicating with the base station.

Only by having a matching pn sequence can a signal be decoded, however, all signals act as noise and interference. The global pilot and traffic signals are noise to a traffic signal being despread. If the global pilot and all unwanted traffic signals could be removed prior to despreading a desired signal, much of the overall noise would be reduced, decreasing the bit error rate and in turn, improve the signal-to-noise ratio (SNR) of the despread signal.

Some attempts have been made to subtract the pilot signal from the received signal based on the relative strength of the pilot signal at the receiver. However, the strength value is not an accurate characteristic for calculating interference due to the plurality of received signals with different time delays caused by reflections due to terrain. Multipath propagation makes power level estimates unreliable.

There is a need to improve overall system performance by removing multiple noise contributors from a signal prior to decoding.

SUMMARY OF THE INVENTION

The present invention reduces the contributive noise effects of the global pilot signal and unwanted traffic signals transmitted in a spread spectrum communication system. The present invention effectively cancels the global pilot and unwanted traffic signal(s) from a desired traffic signal at a receiver prior to decoding. The resulting signal has an increased signal-to-noise ratio.

Accordingly, it is an object of the present invention to provide a code division multiple access communication system receiver which reduces the contributive noise effects from the pilot and active, unwanted traffic signals.

It is another object of the present invention to improve the desired traffic signal SNR by eliminating the noise effects of the global pilot and active traffic signals.

Other objects and advantages of the system and method will become apparent to those skilled in the art of advanced telecommunications after reading the detailed description of the preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a simplified block diagram of a prior art, CDMA communication system.

Figure 2A is a detailed block diagram of a B-CDMA™ communication system.

Figure 2B is a detailed system diagram of a complex number multiplier.

Figure 3A is a plot of an in-phase bit stream.

Figure 3B is a plot of a quadrature bit stream.

Figure 3C is a plot of a pseudo-noise (pn) bit sequence.

Figure 4 is a block diagram of a global pilot signal cancellation system according to the present invention.

Figure 5 is a block diagram of an unwanted traffic signal(s) cancellation system according to the present invention.

Figure 6 is a diagram of a received symbol p_o on the QPSK constellation showing a hard decision.

Figure 7 is a block diagram of a combined pilot and unwanted traffic signal cancellation system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments will be described with reference to the drawing figures where like numerals represent like elements throughout.

A B-CDMA™ communication system **17** as shown in **Figure 2** includes a transmitter **19** and a receiver **21**, which may reside in either a base station or a mobile user receiver. The transmitter **19** includes a signal processor **23** which encodes voice and nonvoice signals **25** into data at various bit rates.

By way of background, two steps are involved in the generation of a transmitted signal in a multiple access environment. First, the input data which can be considered a bi-phase modulated signal is encoded using forward error-correcting coding (FEC) **27**. One signal is designated the in-phase channel I **33x**. The other signal is designated the quadrature channel Q **33y**. Bi-phase modulated I and Q signals are usually referred to as quadrature phase shift keying (QPSK).

In the second step, the two bi-phase modulated data or symbols **33x**, **33y** are spread with a complex, pseudo-noise (pn) sequence **35I**, **35Q** using a complex number multiplier **39**. The operation of a complex number multiplier **39** is shown in **Figure 2B** and is well understood in the art. The spreading operation can be represented as:

$$(x+jy) \times (I+jQ) = (xI-yQ) + j(xQ+yI) \qquad \textbf{Equation (1)}$$

$$= a+jb.$$

A complex number is in the form $a+jb$, where a and b are real numbers and $j^2=-1$. Referring back to **Figure 2a**, the resulting I **37a** and Q **37b** spread signals are combined **45a**, **45b** with other spread signals (channels) having different spreading codes, multiplied (mixed) with a carrier signal **43**, and transmitted **47**. The transmission **47** may contain a plurality of individual signals.

The receiver **21** includes a demodulator **49a**, **49b** which mixes down the transmitted broadband signal **47** with the transmitting carrier **43** into an intermediate carrier frequency **51a**, **51b**. A second down conversion reduces the signal to baseband. The QPSK signal **55a, 55b** is then filtered **53** and mixed **56** with the locally generated complex pn sequence **35I**, **35Q** which matches the conjugate of the transmitted complex code. Only the original signals which were spread by the same code will be despread. All other signals will appear as noise to the receiver **21**. The data **57x**, **57y** is coupled to a signal processor **59** where FEC decoding is performed on the convolutionally encoded data.

As shown in **Figures 3A** and **3B**, a QPSK symbol consists of one bit each from both the in-phase (I) and quadrature (Q) signals. The bits may represent a quantized version of an analog sample or digital data. It can be seen that symbol duration t_s is equal to bit duration.

The transmitted symbols are spread by multiplying the QPSK symbol stream by the complex pn sequence. Both the I and Q pn sequences are comprised of a bit stream generated at a much higher frequency, typically 100 to 200 times the symbol rate. One such pn sequence is shown in **Figure 3C**. The complex pn sequence is mixed with the symbol bit stream producing the digital spread signal (as previously discussed).

The components of the spread signal are known as chips having a much smaller duration t_c.

When the signal is received and demodulated, the baseband signal is at the chip level. When the I and Q components of the signal are despread using the conjugate of the pn sequence used during spreading, the signal returns to the symbol level.

The embodiments of the present invention are shown in **Figures 4, 5** and **7**. The global pilot signal cancellation system **61** embodiment is shown in **Figure 4**. A received signal r is expressed as:

Equation (2)

$$r = \propto c_p + \beta c_t + n$$

where the received signal r is a complex number and is comprised of the pilot strength $\propto$ multiplied with the pilot code c_p, summed with the traffic strength β multiplied with the traffic code c_t, summed with random noise n. The noise n includes all received noise and interference including all other traffic signals. To cancel the global pilot signal from the received signal r, the system **61** must derive the signal strength of the pilot code $\propto$ where:

Equation (3)

$$\propto \neq \beta$$

since the global pilot is transmitted at a higher power level than a traffic signal.

When the received signal r is summed over time, **Equation (2)** becomes:

$$\Sigma r = \propto \Sigma c_p + \beta \Sigma c_t + \Sigma n. \qquad \textbf{Equation (4)}$$

Referring to **Figure 4**, the received baseband signal r is input **63** into the pilot signal cancellation system **61** and into a pilot despreader **65** which despreads the pilot signal from the received signal r. First mixer **67** despreads the received signal r by multiplying with the complex conjugate c_p^* **69** of the pilot pn code used during spreading yielding:

$$\Sigma r c_p^* = \propto \Sigma c_p c_p^* + \beta \Sigma c_t c_p^* + \Sigma n c_p^*. \qquad \textbf{Equation (5)}$$

A complex conjugate is one of a pair of complex numbers with identical real parts and with imaginary parts differing only in sign.

The despread pilot signal **71** is coupled to a first sum and dump processor **73** where it is summed over time. The first sum and dump **73** output O_{sd1} is:

$$O_{sd1} = \propto L + \beta \Sigma c_t c_p^* + \Sigma n c_p^* \qquad \textbf{Equation (6)}$$

where L is the product of the pilot spreading code c_p and the complex conjugate of the pilot spreading code c_p^* summed over L chips.

The sum and dump **73** output O_{sd1} is coupled to a low pass filter **75**. The low pass filter **75** determines the mean value for each signal component. The mean value for pilot-traffic cross-correlation is zero and so is the mean value of the noise n. Therefore, after filtering **75**, the second and third terms in **Equation (6)** become zero. The low pass filter **75** output O_{lpf} over time is:

Equation (7)

$$O_{lpf} = \propto L.$$

The low pass filter **75** output O_{lpf} is coupled to a processing means **77** to derive the pilot code strength $\propto$. The processing means **77** calculates $\propto$ by dividing the low pass filter **79** output O_{lpf} by L. Thus, the processing means **77** output O_{pm} is:

$$O_{pm} = \propto.$$ **Equation (8)**

The pilot spreading code c_p^* complex conjugate generator **69** is coupled to a complex conjugate processor **79** yielding the pilot spreading code c_p. The pilot spreading code c_p is input to a second mixer **81** and mixed with the output of a traffic spreading code c_t^* complex conjugate generator **83**. The resulting product from the second mixer **81** output is coupled to a second sum and dump processor **85**. The output O_{sd2} of the second sum and dump processor **85** is $\sum c_p c_t^*$ and is combined with $\propto$ at a third mixer **87**. The third mixer **87** output **89** is $\propto\sum c_p c_t^*$.

The received signal r is also despread by traffic despreader **91**. The traffic despreader **91** despreads the received signal r by mixing the received signal r with the traffic code c_t^* complex conjugate generator **83** using a fourth mixer 93 yielding:

Equation (9)

$$\Sigma r c_t^* = \propto\Sigma c_p c_t^* + \beta\Sigma c_t c_t^* + \Sigma n c_t^*.$$

The traffic despreader **91** output **95** is coupled to a third sum and dump **97**. The third sum and dump **97** output O_{sd3} over time is:

Equation (10)

$$O_{sd3} = \Sigma r c_t^* = \beta L + \propto\Sigma c_p c_t^* + \Sigma n c_t^*$$

where L is the product of the traffic spreading code c_t and the complex conjugate of the traffic spreading code c_t^* summed over L chips.

The third sum and dump **97** output O_{sd3} is coupled to an adder **99** which subtracts the third mixer **87** output **89**. The adder **99** output O_{add} is:

Equation (11)

$$O_{add} = \beta L + \propto\Sigma c_p c_t^* + \Sigma n c_t^* - \propto\Sigma c_p c_t^*.$$

Thus, the pilot canceler **61** output O_{add} is equal to the received signal r minus the pilot signal simplified below:

$$O_{add} = \beta L + \Sigma n c_t^* . \qquad \textbf{Equation (12)}$$

The invention uses a similar approach to cancel unwanted traffic signal(s) from a desired traffic signal. While traffic signals are interference to other traffic signals just as the global pilot signal is, unwanted traffic signal cancellation differs from global pilot signal cancellation since a traffic signal is modulated by the data and is therefore dynamic in nature. A global pilot signal has a constant phase, whereas a traffic signal constantly changes phase due to data modulation.

The traffic signal canceler system **101** embodiment is shown in **Figure 5**. As above, a received signal r is input **103** to the system:

Equation (13)

$$r = \psi d c_d + \beta c_t + n$$

where the received signal r is a complex number and is comprised of the traffic code signal strength ψ multiplied with the traffic signal data d and the traffic code c_d for the unwanted traffic signal to be canceled, summed with the desired traffic code strength β multiplied with the desired traffic code c_t, summed with noise n. The noise n includes all received noise and interference including all other traffic signals and the global pilot signal. To cancel the unwanted traffic signal(s) from the received signal r, the system **101** must derive the signal strength of the unwanted traffic code ψ to be subtracted and estimate the data d, where:

$$\psi \neq d \neq \beta. \qquad \textbf{Equation (14)}$$

When the received signal r is summed over time, **Equation 13** can be expressed as:

$$\Sigma r = \psi d \Sigma c_d + \beta \Sigma c_t + \Sigma n. \qquad \textbf{Equation (15)}$$

Referring to **Figure 5**, the received baseband signal r is input **103** into the desired traffic signal despreader **91** which despreads the desired traffic signal from the received signal r. Desired traffic signal mixer **93** mixes the received signal r with the complex conjugate c_t^* of the desired traffic pn code used during spreading. The despread traffic signal is coupled to a sum and dump processor **97** and summed over time. The sum and dump **97** output O_{sd3} is:

$$O_{sd3} = \Sigma r c_t^* = \beta L + \psi \, d \Sigma c_d c_t^* + \Sigma n c_t^*. \qquad \textbf{Equation (16)}$$

The traffic signal canceler system **101** shown in **Figure 5** includes n unwanted traffic signal cancelers **115_1-115_n**. An exemplary embodiment includes 10 (where n=10) unwanted traffic signal cancelers **115_1-115_{10}**.

Each unwanted traffic signal canceler **115_1-115_n** comprises: an unwanted traffic signal despreader **139_1-139_n** that includes a first mixer **117_1-117_n** and an unwanted traffic signal code generator **119_1-119_n**; second **133_1-133_n** mixer, first **121_1-121_n** and second **123_1-123_n** sum and dump processors, a hard decision processor **125_1-125_n**, a low pass filter **127_1-127_n**, a processing means **129_1-129_n**, third mixer **131_1-131_n**, a conjugate processor **135_1-135_n**, an adjustable amplifier **137_1-137_n**, and a desired traffic signal code generator **83**.

As above, the received signal r is input **103** into each unwanted traffic canceler **115_1-115_n**. The unwanted traffic signal despreader **139_1-139_n** is coupled to the input **103** where the received signal r is mixed **117_1-117_n** with the complex conjugate c_{d1}^*-c_{dn}^* of the traffic pn sequence for each respective unwanted signal. The despread **139_1-139_n** traffic signal is coupled to a first sum and dump processor **121_1-121_n** where it is summed over time. The first sum and dump **121_1-121_n** output O_{sd1n} is:

$$O_{sd1n} = \Sigma r c_{dn}^* = \psi \, dL + \beta \Sigma c_t c_{dn}^* + \Sigma n c_{dn}^* . \qquad \textbf{Equation (17)}$$

where L is the product of the unwanted traffic signal spreading code c_{dn} and c_{dn}^* is the complex conjugate of the unwanted traffic signal spreading code.

The first sum and dump **121_1-121_n** output O_{sd1n} is coupled to the hard decision processor **125_1-125_n**. The hard decision processor **125_1-125_n** determines the phase shift ϕ in the data due to modulation. The hard decision processor **125_1-125_n** also determines the QPSK constellation position d that is closest to the despread symbol value.

As shown in **Figure 6**, the hard decision processor **125_1-125_n** compares a received symbol p_o of a signal to the four QPSK constellation points $x_{1,1}$, $x_{-1,1}$, $x_{-1,-1}$, $x_{1,-1}$. It is necessary to examine each received symbol p_o due to corruption during transmission **47** by noise and distortion, whether multipath or radio frequency. The hard decision processor computes the four distances d_1, d_2, d_3, d_4 to each quadrant from the received symbol p_o and chooses the shortest distance d_2 and assigns that symbol d location $x_{-1,1}$. The hard decision processor also derotates (rotates back) the original signal coordinate p_o by a phase amount ϕ that is equal to the phase corresponding to the selected symbol location $x_{-1,1}$. The original symbol coordinate p_o is discarded.

The hard decision processor **125_1-125_n** phase output ϕ is coupled to a low pass filter **127_1-127_n**. Over time, the low pass filter **127_1-127_n** determines the mean value for each signal component. The mean value of the traffic-to-traffic cross-correlation and also the mean value of the noise n are zero. Therefore, the low pass filter **127_1-127_n** output O_{lpfn} over time is:

$$O_{lpfn} = \psi L. \qquad \textbf{Equation (18)}$$

The low pass filter **127_1-127_n** output O_{lpfn} is coupled to the processing means **129_1-129_n** to derive the unwanted traffic signal code strength ψ. The processing means **129_1-129_n** estimates ϕ by dividing the filter **127_1-127_n** output O_{lpfn} by L.

The other hard decision processor **125_1-125_n** output is data d. This is the data point d corresponding to the smallest of the distances d_1, d_2, d_3, or d_4 as shown in **Figure 6**. Third mixer **131_1-131_n** mixes the unwanted traffic signal strength ψ with each date value d.

The unwanted traffic signal spreading code complex conjugate generator c_{d1}^*-c_{dn}^* is coupled to the complex conjugate processor **135_1-135_n** yielding the unwanted traffic signal spreading code c_{d1}-c_{dn} and is input to the second mixer **133_1-133_n** and mixed with the output of desired traffic signal spreading code complex conjugate generator c_t^*. The product is coupled to the second sum and dump processor **123_1-123_n**. The second sum and dump processor **123_1-123_n** output O_{sd2n} is $\sum cd_n c_t^*$ and is coupled to variable amplifier **137_1-137_n**. Variable amplifier **137_1-137_n** amplifies the second sum and dump processor **123_1-123_n** output O_{sd2n} in accorance with the third mixer **131_1-131_n** output which is the determined gain.

The variable amplifier **137_1-137_n** output **141_1-141_n** is coupled to an adder **143** which subtracts the output from each variable amplifier **137_1-137_n** from the output of the desired traffic signal despreader **105**. The output O is:

$$O = \beta L + \psi d \Sigma c_d c_t^* + \Sigma n c_t^* - \psi d \Sigma c_d c_t^* . \qquad \textbf{Equation (19)}$$

The adder **143** output O (also the unwanted traffic canceler system **101** output) is equal to the received signal r minus the unwanted traffic signals simplified below:

$$O = \beta L + \Sigma n c_t^* \qquad \textbf{Equation (20)}$$

where the noise n varies depending on the amount of traffic signals subtracted from the received signal.

Another embodiment **145** cancelling the global pilot signal and unwanted traffic signals is shown in **Figure 7**. As previously discussed, the unwanted traffic cancellation system **101** includes the desired traffic signal despreader **91** and a plurality of unwanted traffic signal cancelers **115_1-115_n**. The traffic cancellation system is coupled in parallel with the pilot cancellation system **61** previously described, but without a desired traffic singal despreader. A common input **147** is coupled to both systems **101, 61** with a common adder **149** which is coupled to the outputs O, O_{add} from both systems **101, 61**. The pilot and unwanted traffic signals are subtracted from the desired traffic signal yielding an output **151** free of interference contributions by the pilot and plurality of transmitted traffic signals.

While specific embodiments of the present invention have been shown and described, many modifications and variations could be made by one skilled in the art without departing from the spirit and scope of the invention. The above description serves to illustrate and not limit the particular form in any way.

* * *

WE CLAIM:

1. A cancellation system for use in a receiver that receives communication signals from a transmitter over a CDMA air interface that removes selective signals from a desired traffic signal prior to decoding, the system comprising:

an input for receiving the communication signals;

said input coupled to a desired traffic signal despreader having an output;

said input coupled to a selective signal canceler having an output;

said selective signal canceler output subtracted from said desired traffic signal output as the cancellation system output; and

said output is the desired traffic signal free from the selective signals.

2. The cancellation system according to claim 1 wherein said selective signal canceler further comprises at least one selective signal canceler.

3. The cancellation system according to claim 2 wherein said selective signal canceler is an unwanted traffic signal canceler.

4. The cancellation system according to claim 3 wherein said unwanted traffic signal canceler further comprises:

an unwanted traffic signal despreader having an input coupled to said input and a summed output;

said unwanted traffic signal canceler output coupled to a hard decision processor having a phase output and a data output;

said hard decision processor phase output coupled to a low pass filter, said low pass filter having an output;

said low pass filter output coupled to an input of a processor that filters and removes the product of the unwanted traffic signal to desired traffic signal cross-correlation outputting the unwanted traffic signal strength;

said processor output multiplied with said hard decision data output with a first multiplier having an output;

said unwanted traffic code generator output coupled to an input of a complex conjugate processor having an output;

said complex conjugate output mixed with a complex conjugate of the desired traffic signal code, said first mixer having an output;

said first mixer output coupled to an input of a first sum and dump processor having an output;

said first sum and dump processor coupled to an input of an amplifier having an adjustable gain controlled by said first multiplier output; and

said output of said amplifier is the unwanted traffic signal strength.

5. The cancellation system according to claim 4 wherein said selective signal canceler further includes a global pilot signal canceler.

6. The cancellation system according to claim 5 wherein said global pilot signal canceler comprises:

a global pilot despreader coupled to said input having a summed output;

a desired traffic signal and global pilot cross-correlation means;

said global pilot despreader output coupled to a pilot strength determining means, said determining means having an output;

said pilot strength determining means output multiplied with said cross-correlation means output; and

said multiplied product is said selective signal canceler output.

7. The cancellation system according to claim 6 wherein said cross-correlation means comprises:

a global pilot signal code generator;

a desired traffic signal complex conjugate code generator;

a second mixer for cross-correlating said global pilot signal code and said desired traffic signal complex conjugate code; and

a second sum and dump processor for summing over time said cross-correlation product.

8. The cancellation system according to claim 7 wherein said means to derive said global pilot signal strength further comprises:

a low-pass filter having an output; and

a processor coupled to said low-pass filter deriving and outputting the global pilot signal strength.

9. The cancellation system according to claim 1 wherein said selective signal canceler is a global pilot signal canceler.

10. The cancellation system according to claim 9 wherein said global pilot signal canceler comprises:

a global pilot despreader coupled to said input having a summed output;

a desired traffic signal and global pilot cross-correlation means;

said global pilot despreader output coupled to a pilot strength determining means, said determining means having an output;

said pilot strength determining means output multiplied with said cross-correlation means output; and

said multiplied product is said selective signal canceler output.

11. The cancellation system according to claim 10 wherein said cross-correlation means comprises:

a global pilot signal code generator;

a desired traffic signal complex conjugate code generator;

a mixer for cross-correlating said global pilot signal code and said desired traffic signal complex conjugate code; and

a sum and dump processor for summing over time said cross-correlation product.

12. The cancellation system according to claim 11 wherein said means to derive said global pilot signal strength further comprises:

a low-pass filter having an output; and

a processor coupled to said low-pass filter deriving and outputting the global pilot signal strength.

13. A global pilot signal cancellation system for use in a receiver that receives communication signals from a transmitter over a CDMA air interface that removes the global pilot signal from a desired traffic signal prior to decoding, the system comprising:

an input for receiving the communication signals and a system output;

said input coupled to a global pilot despreader and a desired traffic signal despreader each having a summed output;

a desired traffic signal and global pilot cross-correlation means;

said global pilot despreader output coupled to a pilot strength determining means, said determining means having an output;

said pilot strength determining means output multiplied with said cross-correlation means output; and

said multiplied product subtracted from said desired traffic signal despreader output outputting the desired traffic signal free from the global pilot signal.

14. The global pilot signal cancellation system according to claim 13 wherein said cross-correlation means comprises:

a global pilot signal code generator;

a desired traffic signal complex conjugate code generator;

a mixer for cross-correlating said global pilot signal code and said desired traffic signal complex conjugate code; and

a sum and dump processor for summing over time said cross-correlation product.

15. The global pilot signal cancellation system according to claim 14 wherein said means to derive said global pilot signal strength further comprises:

a low-pass filter having an output; and

a processor coupled to said low-pass filter deriving and outputting the global pilot signal strength.

16. A traffic signal canceler system for use in a receiver that receives communication signals from a transmitter over a CDMA air interface that removes at least

one unwanted traffic signal from a desired traffic signal prior to decoding, the system comprising:

an input for receiving the communication signals and a system output;

said input coupled to a desired traffic signal despreader having a summed output;

at least one unwanted traffic signal processors, having an input coupled to said input and each having an output; and

each of said plurality of unwanted traffic signal processors output subtracted from said desired traffic signal despreader output outputting said desired traffic signal free from the plurality of unwanted traffic signals.

17. The traffic signal cancellation system according to claim 16 wherein said unwanted traffic signal canceler processor further comprises:

an unwanted traffic signal despreader having an input coupled to said input and a summed output;

said unwanted traffic signal canceler output coupled to a hard decision processor having a phase output and a data output;

said hard decision processor phase output coupled to a low pass filter, said low pass filter having an output;

said low pass filter output coupled to an input of a processor that filters and removes the product of the unwanted traffic signal to desired traffic signal cross-correlation outputting the unwanted traffic signal strength;

said processor output multiplied with said hard decision data output with a multiplier having an output;

said unwanted traffic code generator output coupled to an input of a complex conjugate processor having an output;

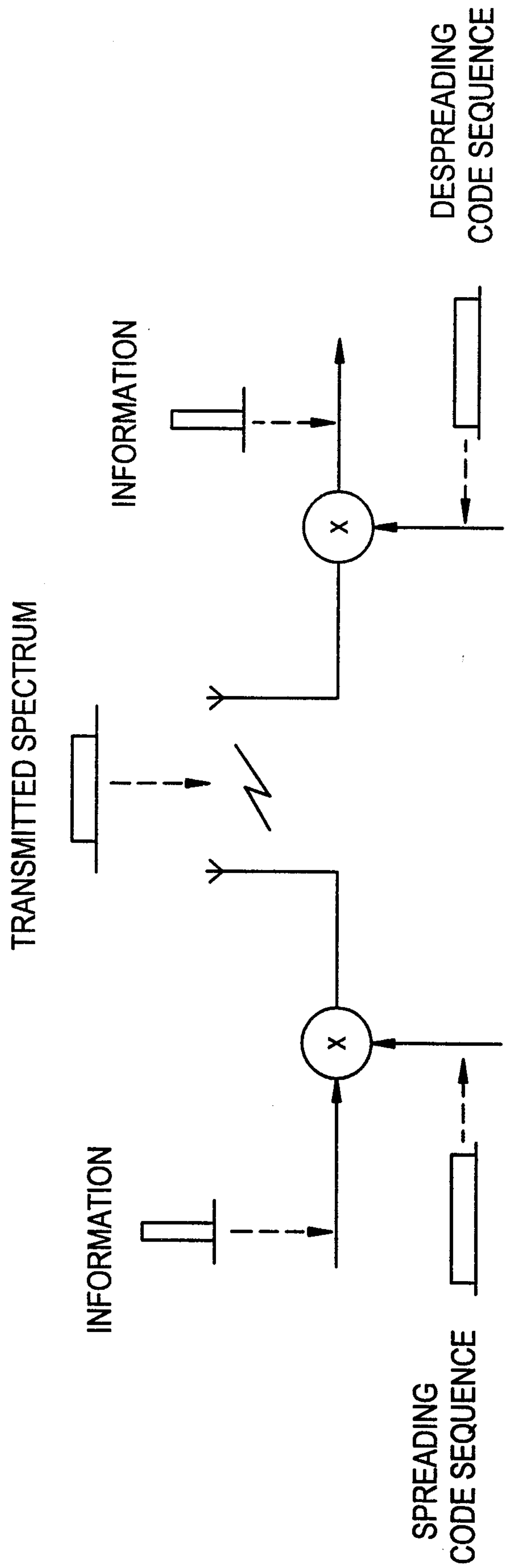
said complex conjugate output mixed with a complex conjugate of the desired traffic signal code, said mixer having an output;

said mixer output coupled to an input of a second sum and dump processor having an output;

said sum and dump processor coupled to an input of an amplifier having an adjustable gain controlled by said multiplier output; and

said output of said amplifier is the unwanted traffic signal strength.

FIG. 1
PRIOR ART



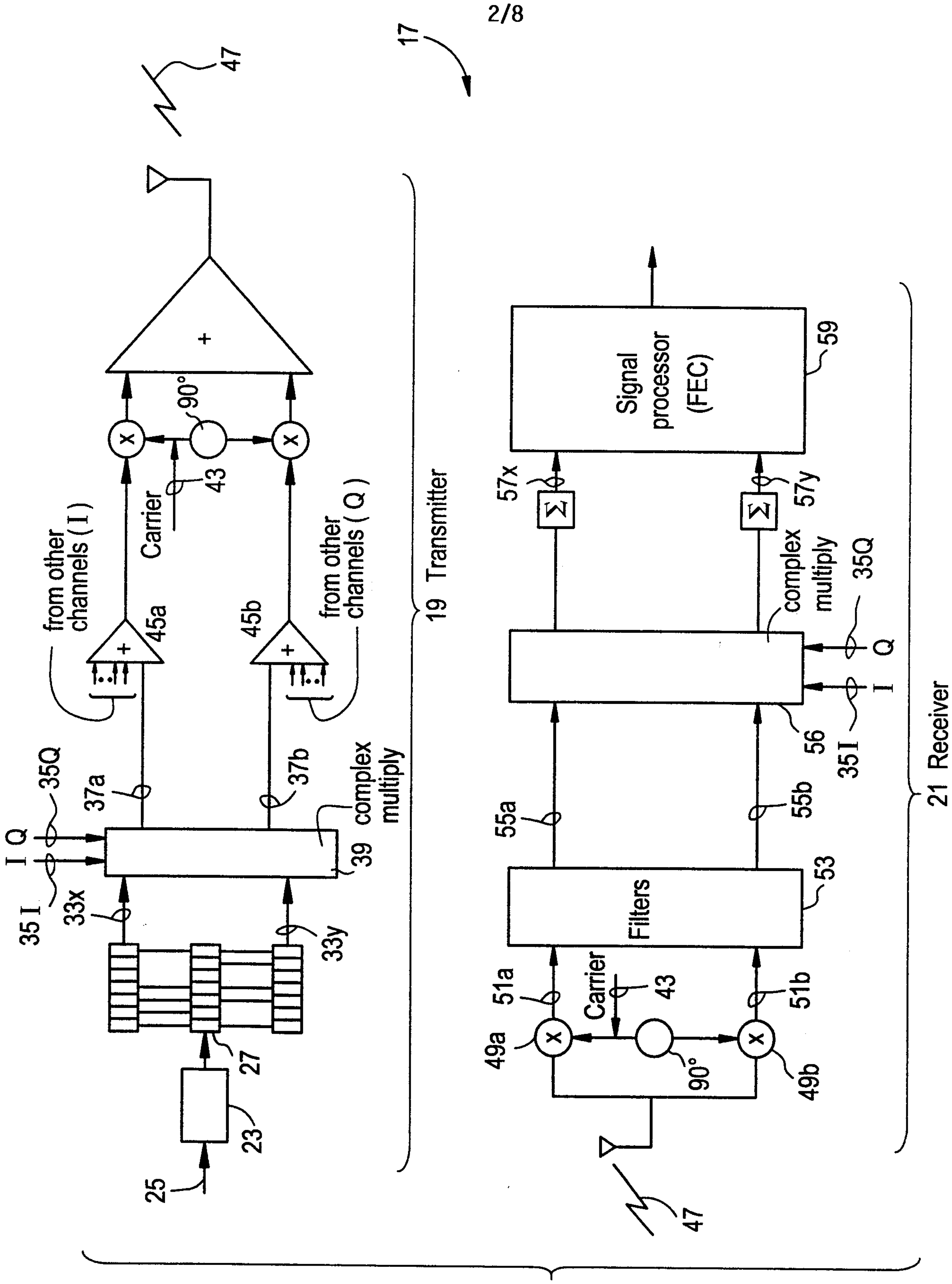

17
47
25
23
27
33x
33y
35 I
35Q
I
Q
39
complex multiply
37a
37b
from other channels (I)
from other channels (Q)
45a
45b
Carrier
43
90°
19 Transmitter
47
49a
49b
51a
51b
Filters
53
55a
55b
56
complex multiply
57x
57y
Signal processor (FEC)
59
21 Receiver

FIG.2A

FIG. 2B

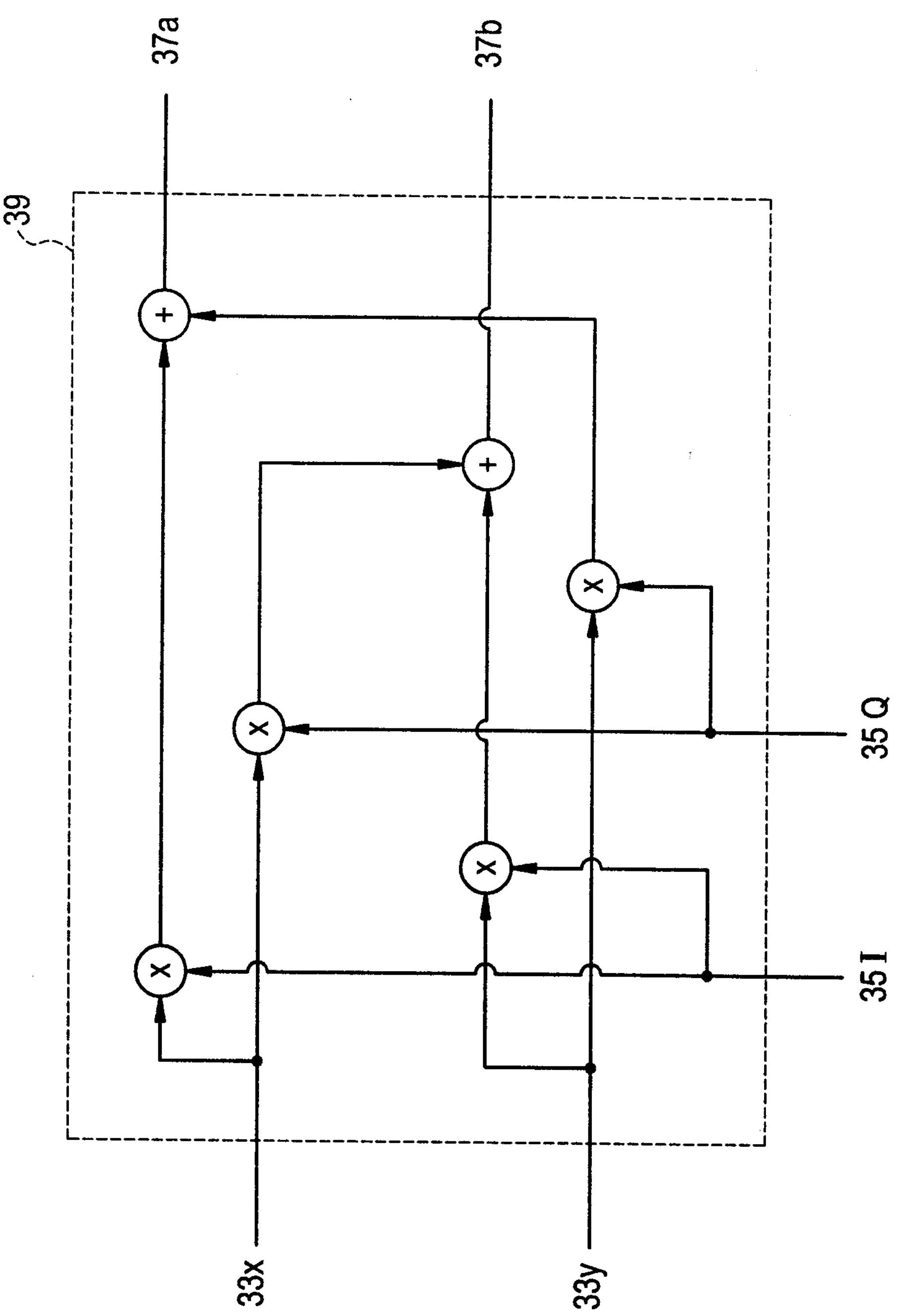


FIG. 3A

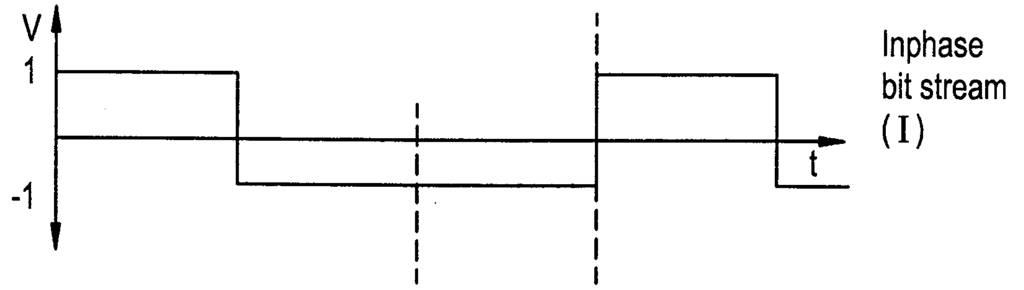


FIG. 3B

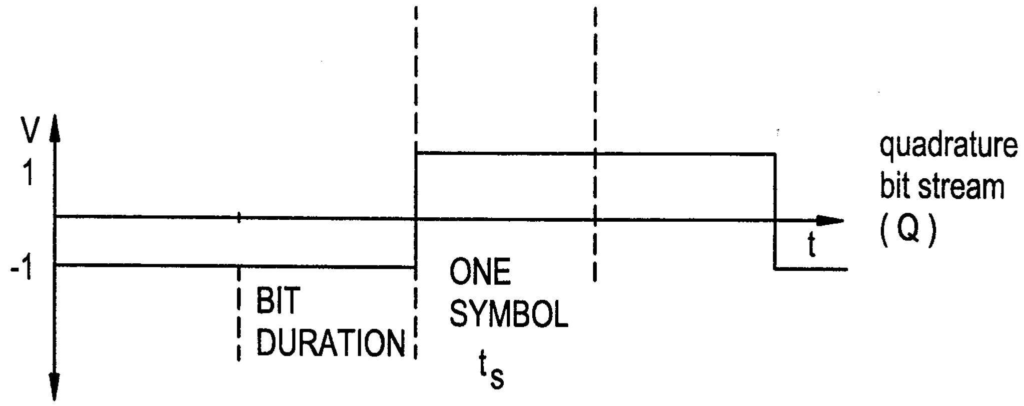


FIG. 3C

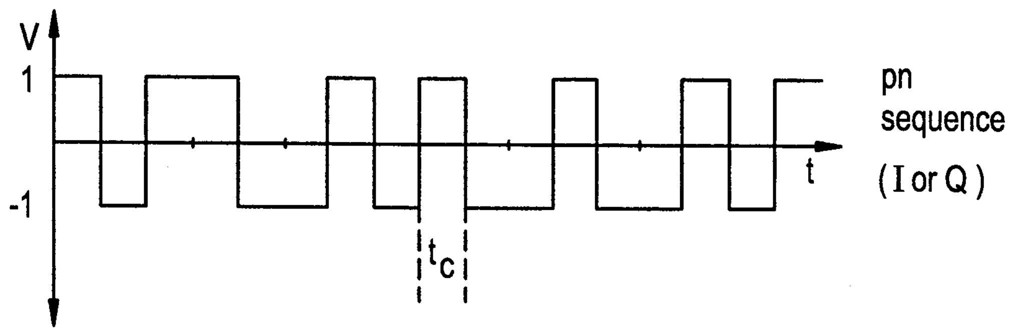
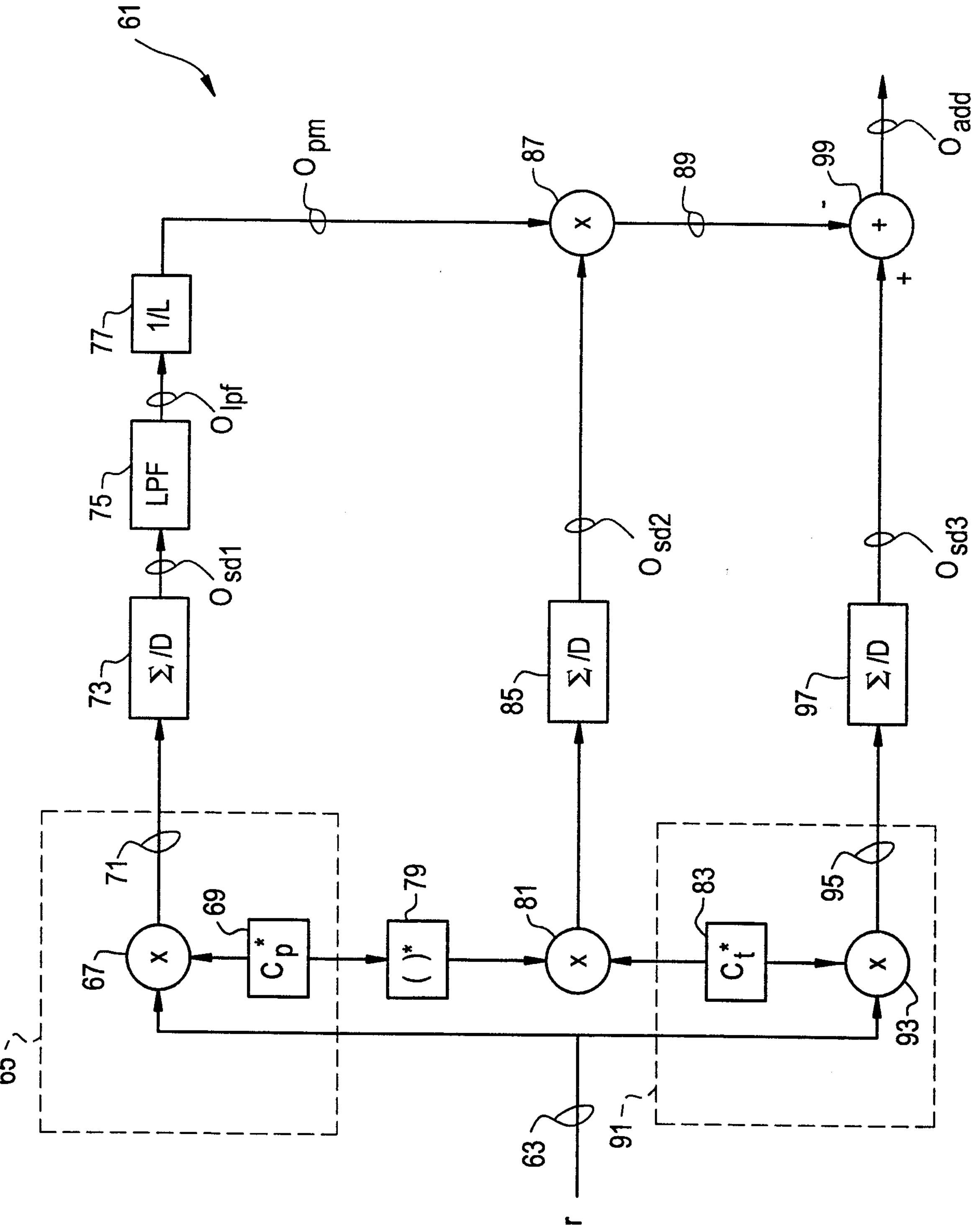


FIG. 4


61
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79
81
83
85
87
89
91
93
95
97
99
63
r
Σ/D
Σ/D
Σ/D
LPF
1/L
( )*
C_p^*
C_t^*
O_{sd1}
O_{lpf}
O_{pm}
O_{sd2}
O_{sd3}
O_{add}
-
+

FIG. 5

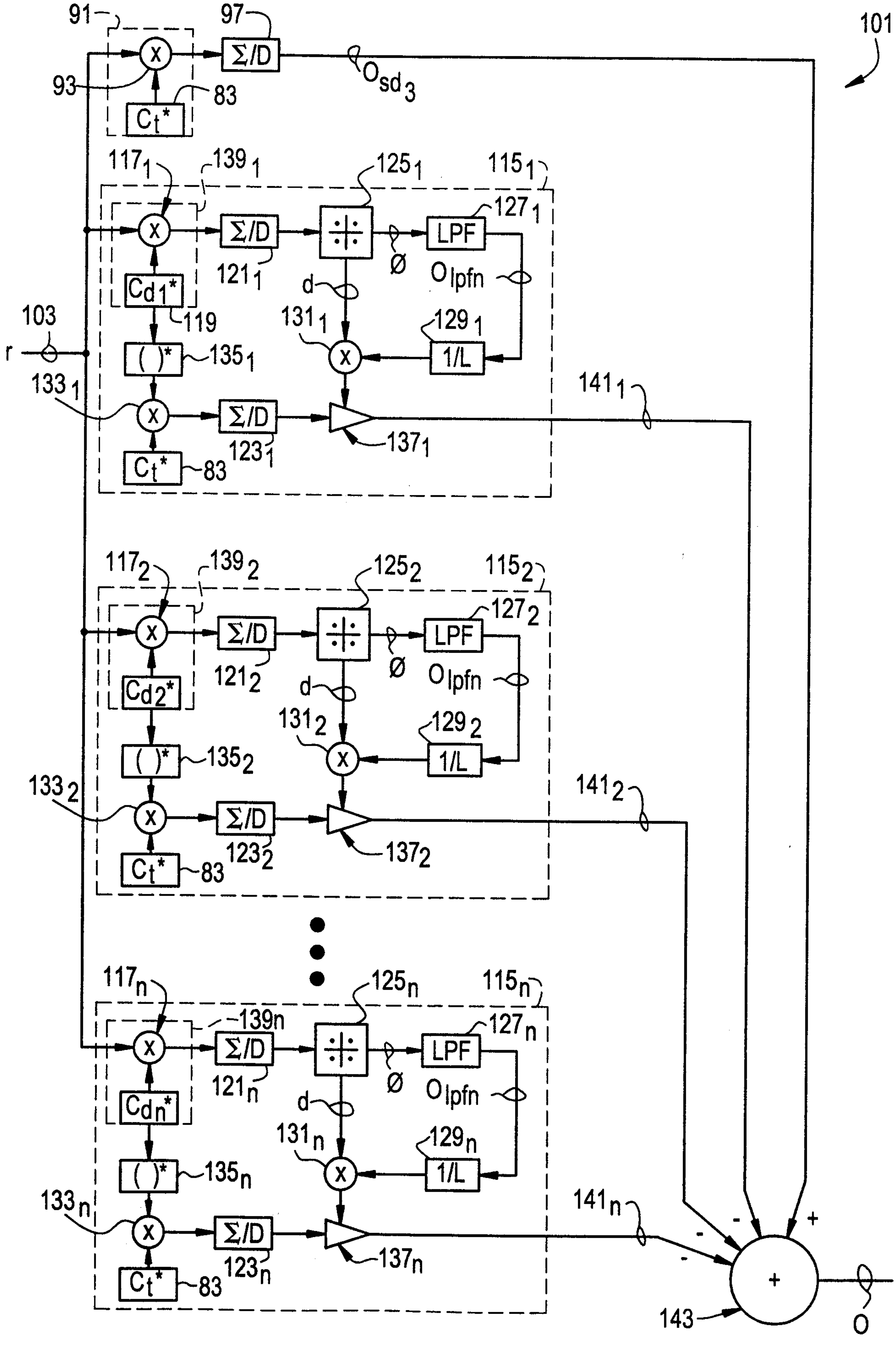

91
97
Σ/D
X
93
Ct*
83
O_{sd3}
101
117_1
139_1
125_1
115_1
127_1
LPF
Σ/D
121_1
Ø
O_{lpfn}
d
$Cd1^*$
119
103
r
131_1
129_1
1/L
( )*
135_1
133_1
123_1
137_1
141_1
117_2
139_2
125_2
115_2
127_2
$Cd2^*$
121_2
131_2
129_2
135_2
133_2
123_2
137_2
141_2
117_n
139n
125_n
115_n
127_n
Cdn^*
121_n
131_n
129_n
135_n
133_n
123_n
137_n
141_n
143
O

FIG.6

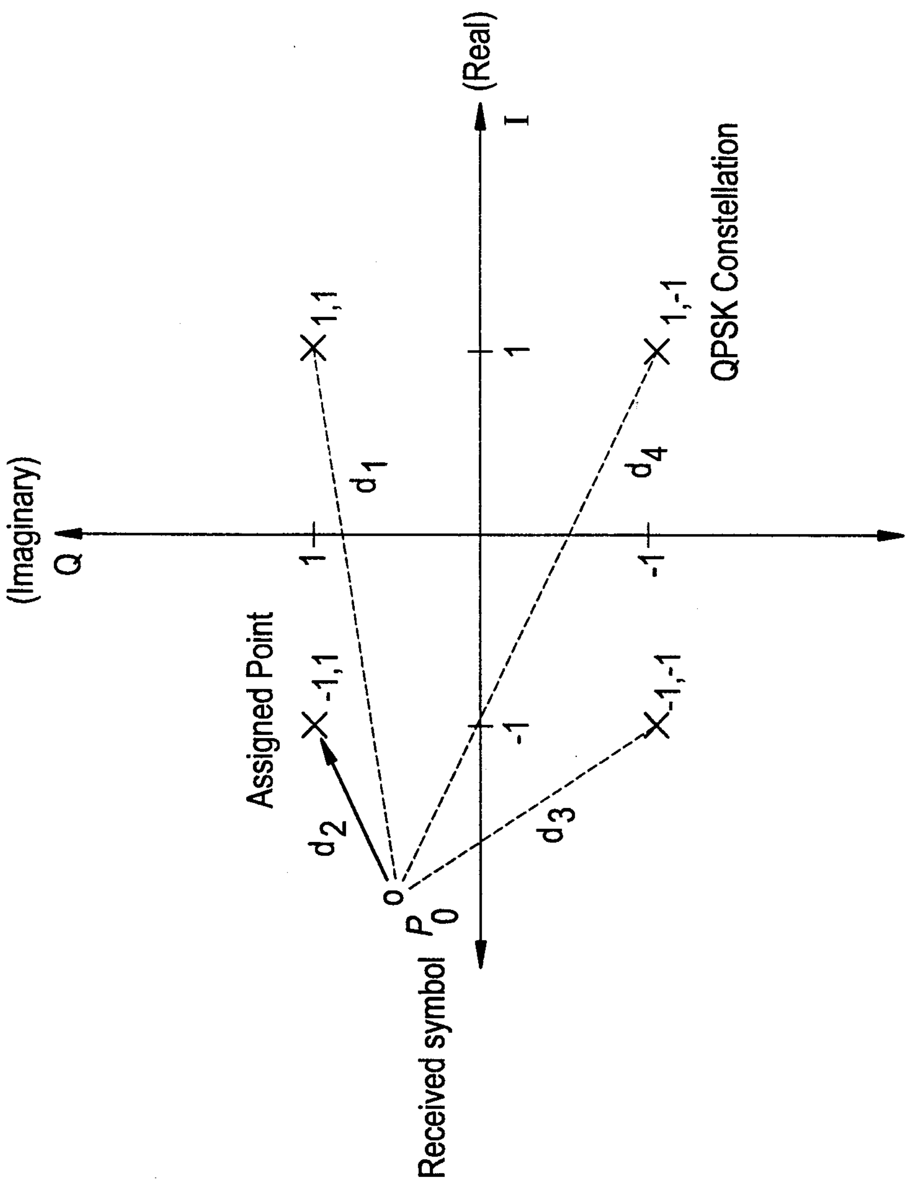
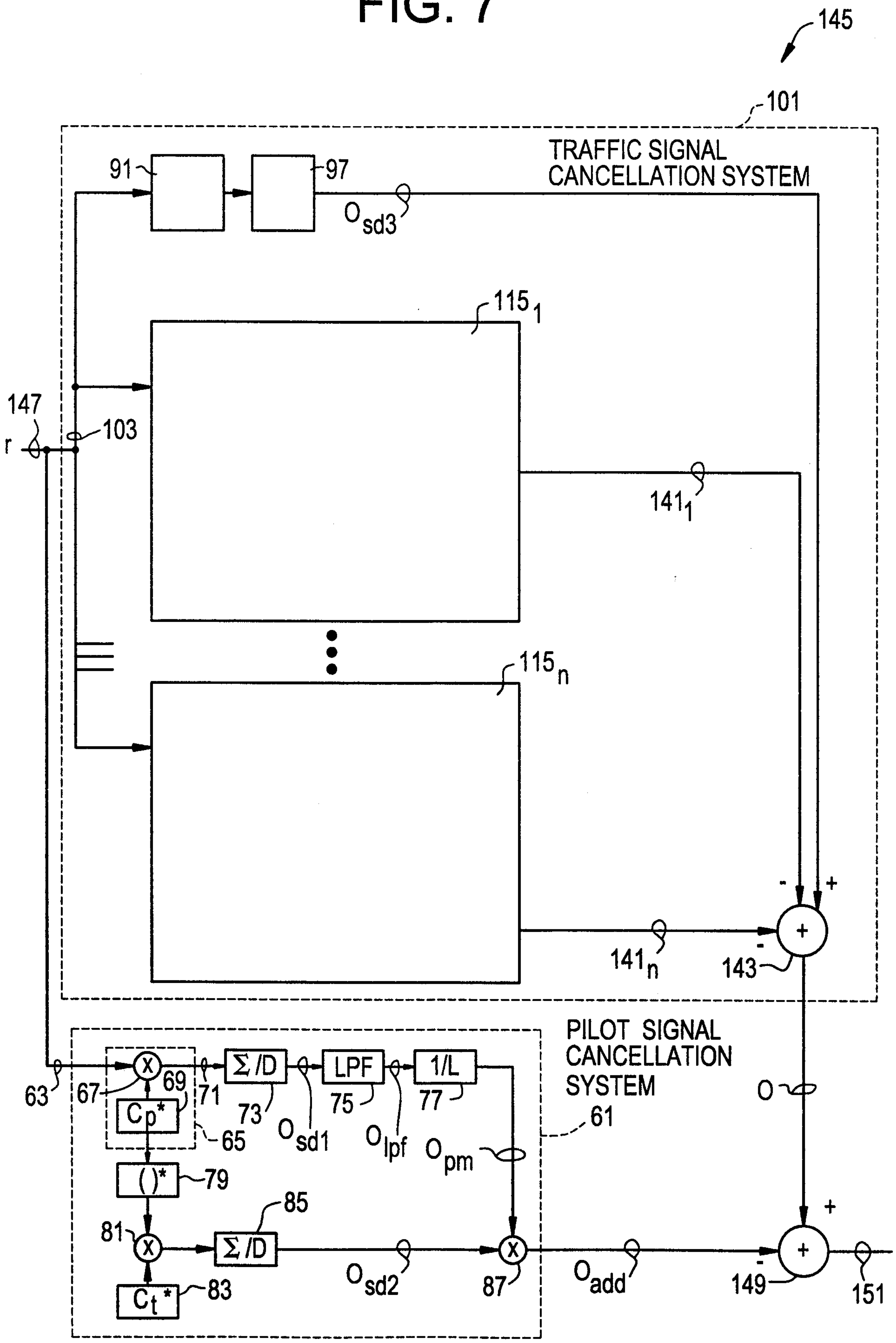

(Imaginary)
Q
(Real)
I
1
-1
1
-1
1,1
-1,1
1,-1
-1,-1
d1
d2
d3
d4
Assigned Point
Received symbol
P0
QPSK Constellation

FIG. 7


145
101
TRAFFIC SIGNAL CANCELLATION SYSTEM
91
97
Osd3
115 1
147
r
103
141 1
115 n
141 n
143
PILOT SIGNAL CANCELLATION SYSTEM
X
Σ/D
LPF
1/L
63
67
69
71
73
75
77
Cp*
65
Osd1
Olpf
Opm
61
O
()*
79
85
81
X
Σ/D
X
Osd2
87
Oadd
149
151
Ct*
83

INTERNATIONAL SEARCH REPORT

Intern. ..al Application No
PCT/US 99/01883

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 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 6 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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 43362 A (YELLIN DANIEL ;DSPC ISRAEL LTD (IL)) 1 October 1998	1-3, 13-15
Y	see abstract	16
A	see page 12, line 11 - page 13, line 10 see page 14, line 7 - page 15, line 3 see figures 1,2,4,5 ---	5-12
Y	US 5 719 852 A (KOWALSKI JOHN ET AL) 17 February 1998	1-3,16
A	see abstract see figures 1,3 see column 1, line 57 - column 2, line 31 see column 4, line 45 - line 55 --- -/--	4,17

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
2 June 1999	14/06/1999

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, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lustrini, D

2

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 99/01883

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 5 224 122 A (BRUCKERT EUGENE) 29 June 1993	1-3
A	see abstract	5,6,9, 10,13-16
	see figure 2 see column 8, line 68 - column 9, line 12 see column 9, line 53 - column 10, line 38 see column 11, line 63 - column 12, line 24 see column 12, line 57 - column 13, line 29 see column 15, line 1 - line 32 -----	

2

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 99/01883

Patent document cited in search report		Publication date	Patent family member(s)			Publication date
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