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(54) **TRANSMISSION POWER CONTROL METHOD AND TRANSMISSION/RECEPTION APPARATUS**

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(57) **ABSTRACT**
Slot quality detector **121** detects a reception level, and power controller inversely corresponding to reception quality **122** outputs power control information indicative of increasing transmission power in the case where the detected reception level is higher than a threshold value and of decreasing the transmission power in the case where the detected quality is lower than the threshold value. Transmission power setter **108** performs the setting of transmission power corresponding to the power control information and provides a control to transmit by the set power. That allows improving of a battery saving and moderating of the specification of amplifiers in a transmission/reception apparatus, thereby resulting in decreased interference to signals of other users in the CDMA communication.

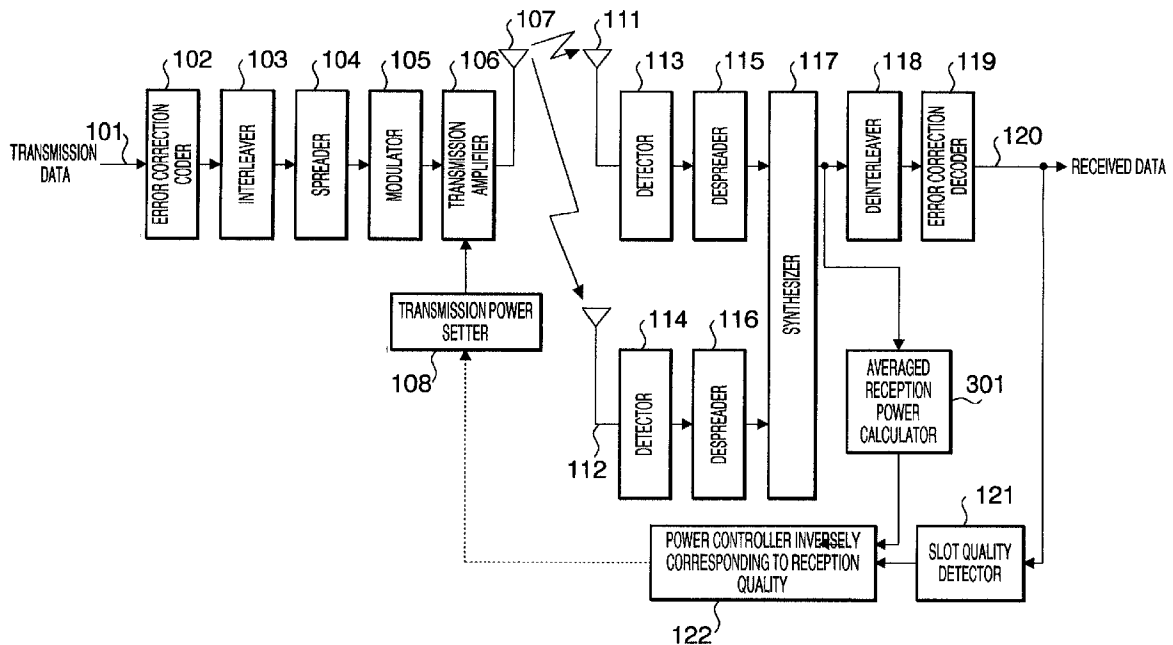


FIG. 1
PRIOR ART

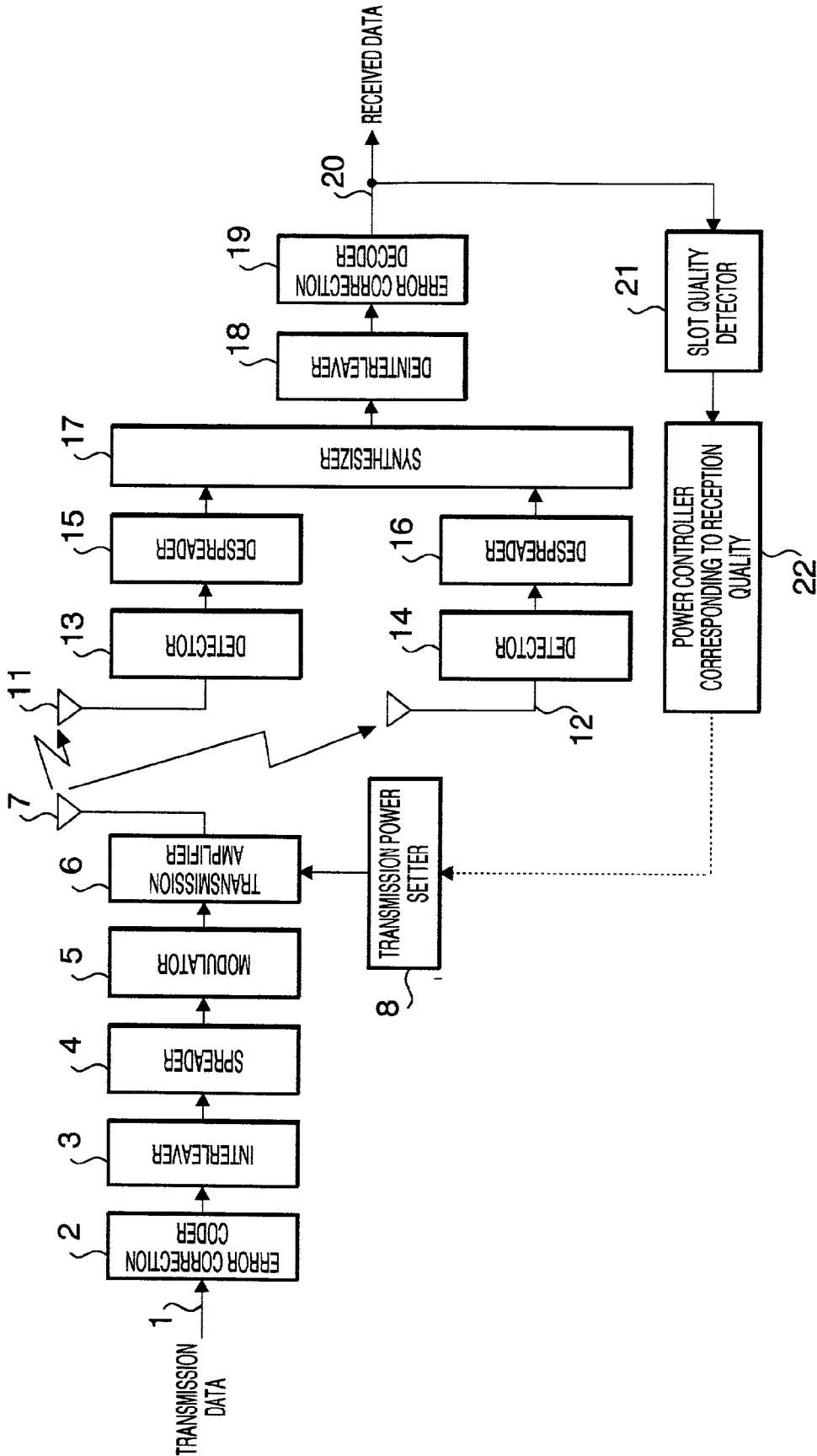


FIG. 2

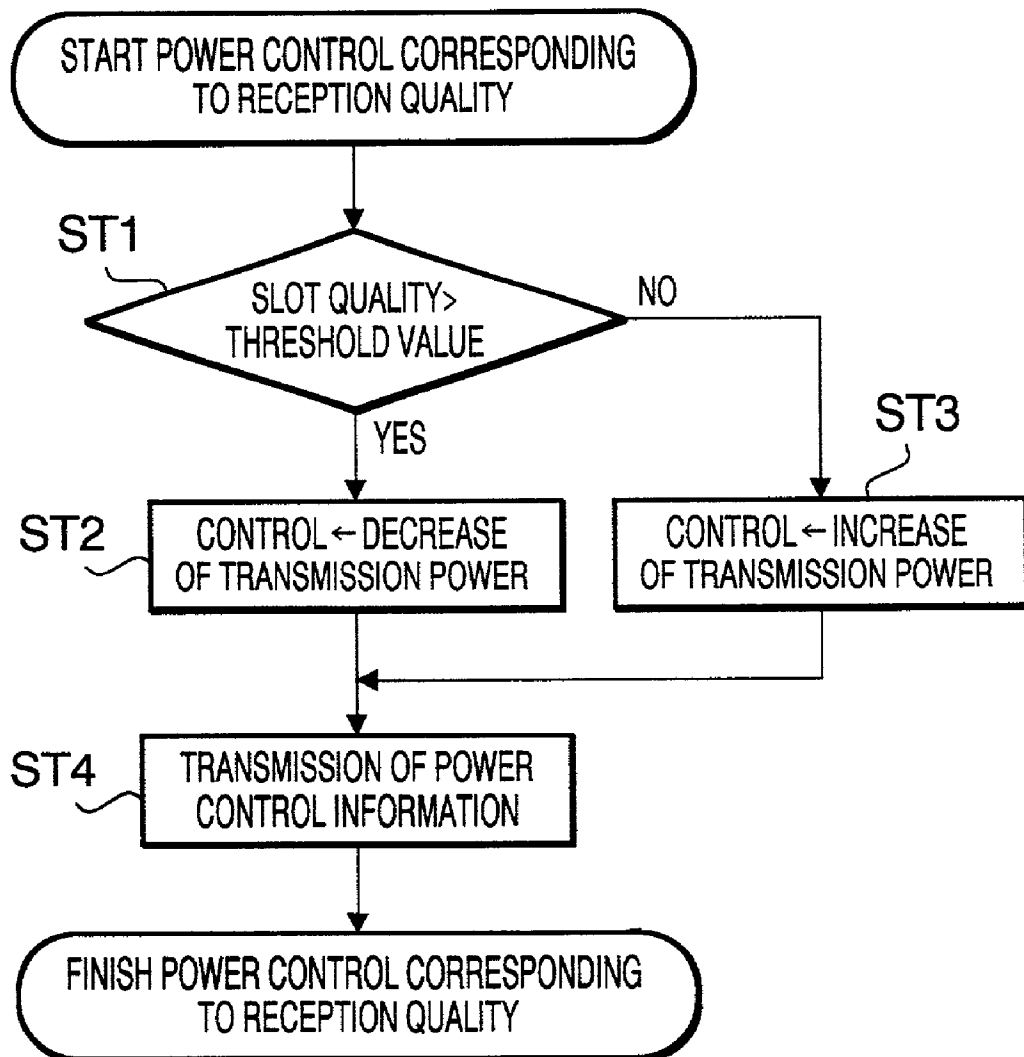


FIG. 3

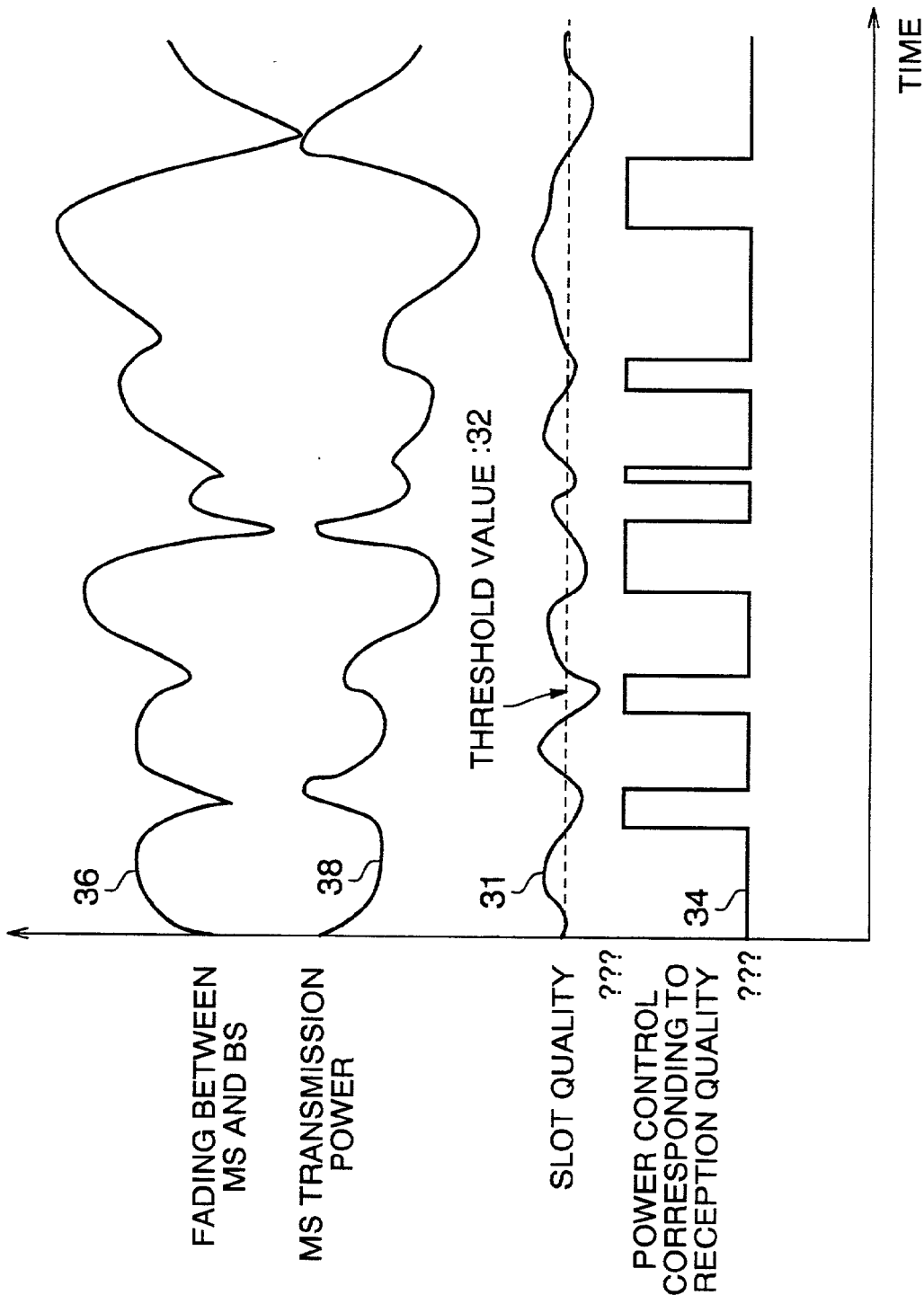


FIG. 4

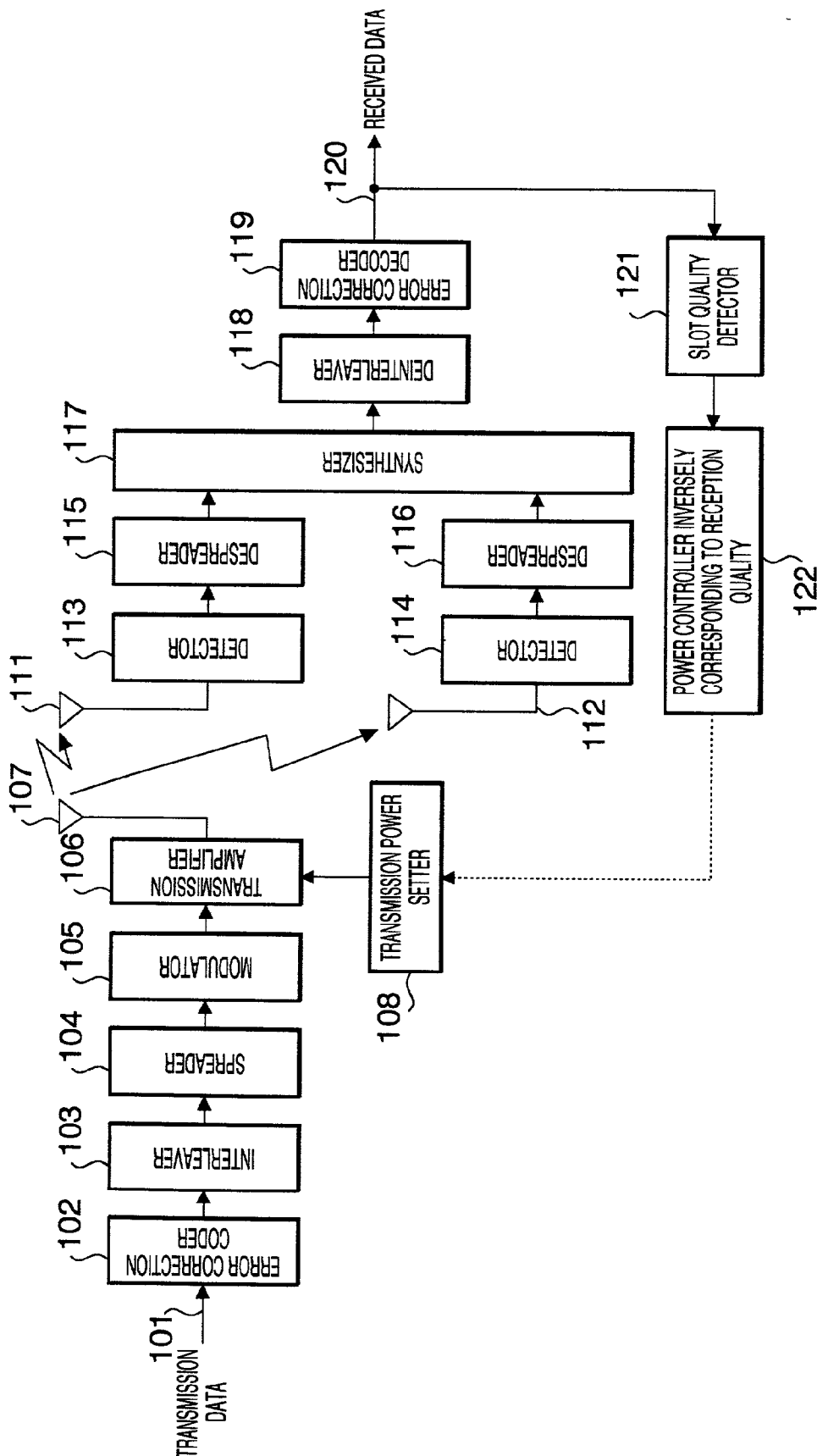


FIG. 5

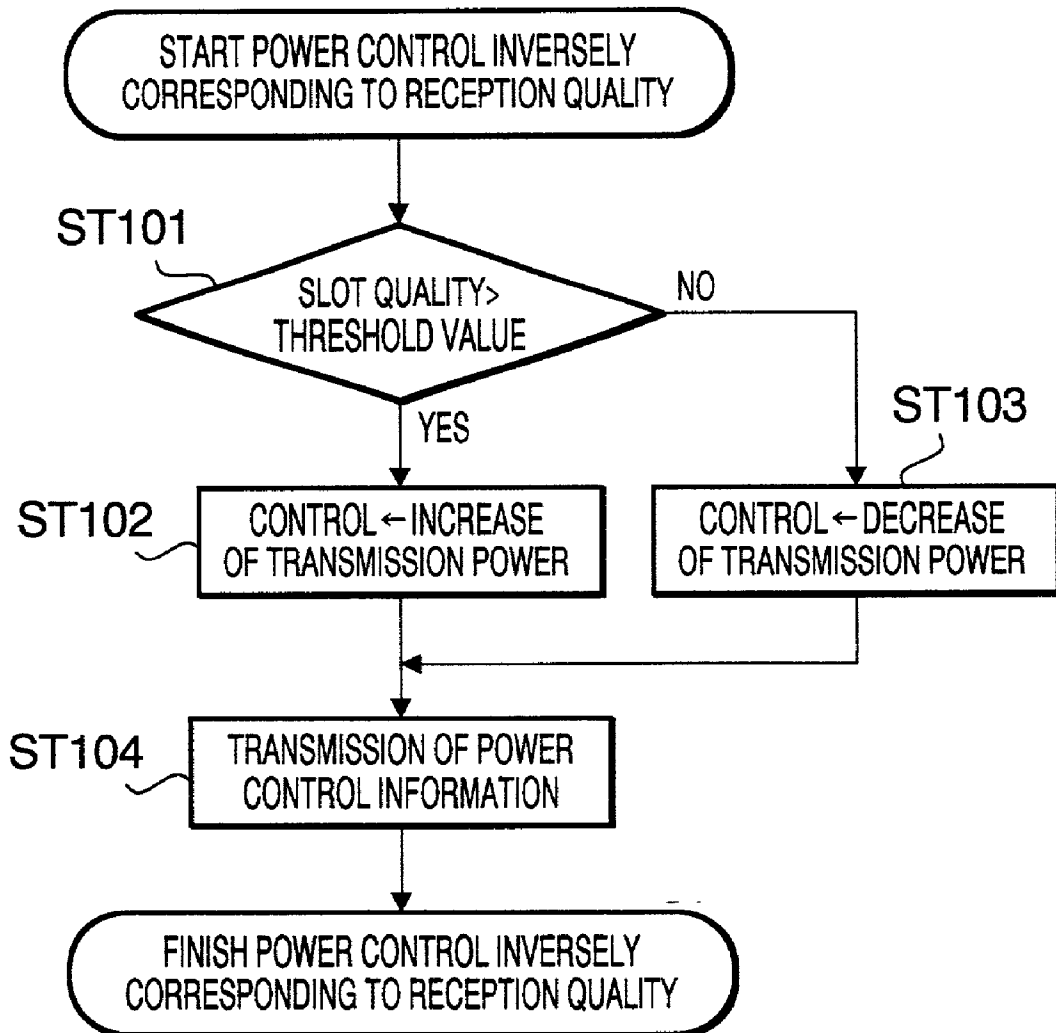


FIG. 6

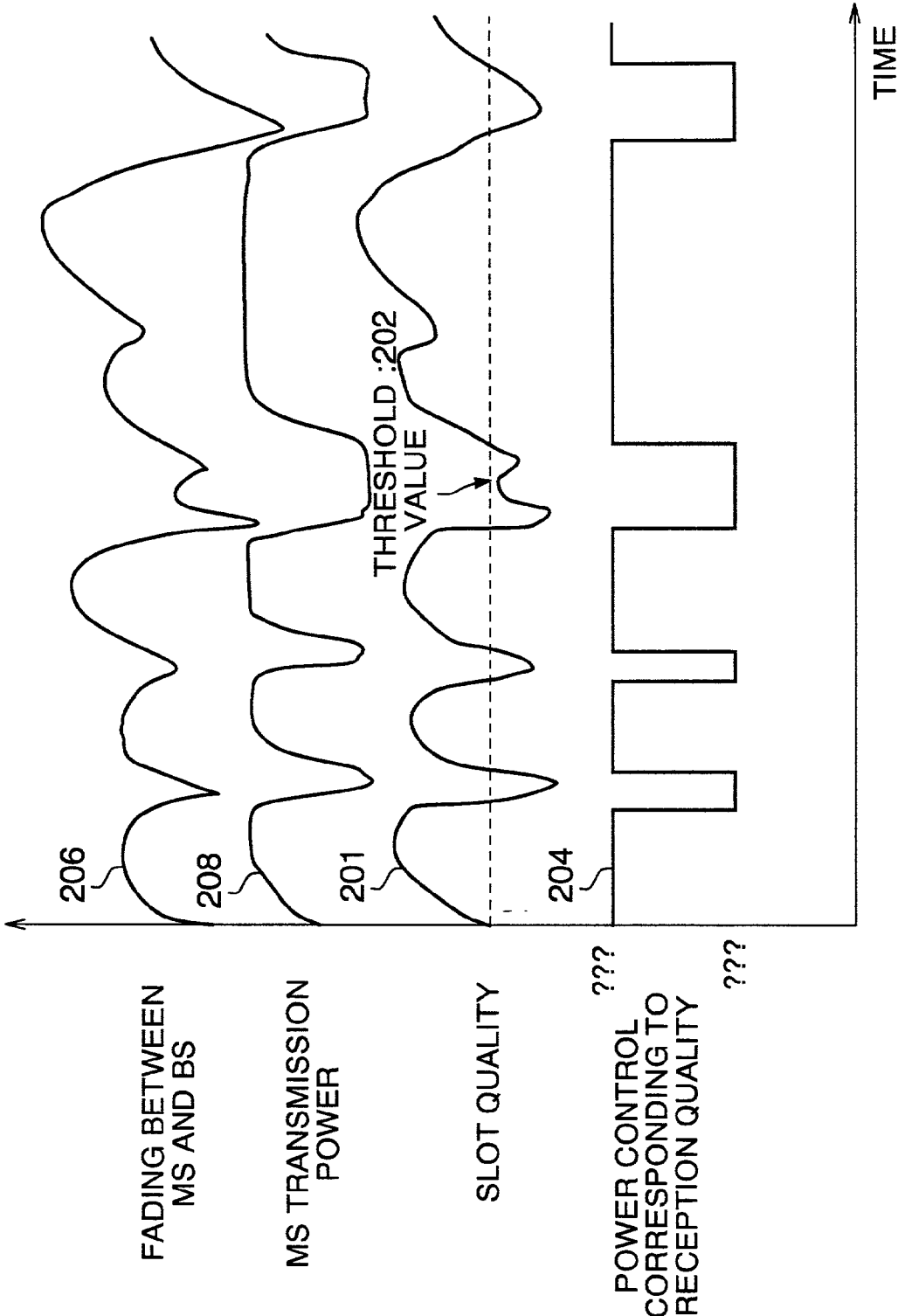


FIG. 7

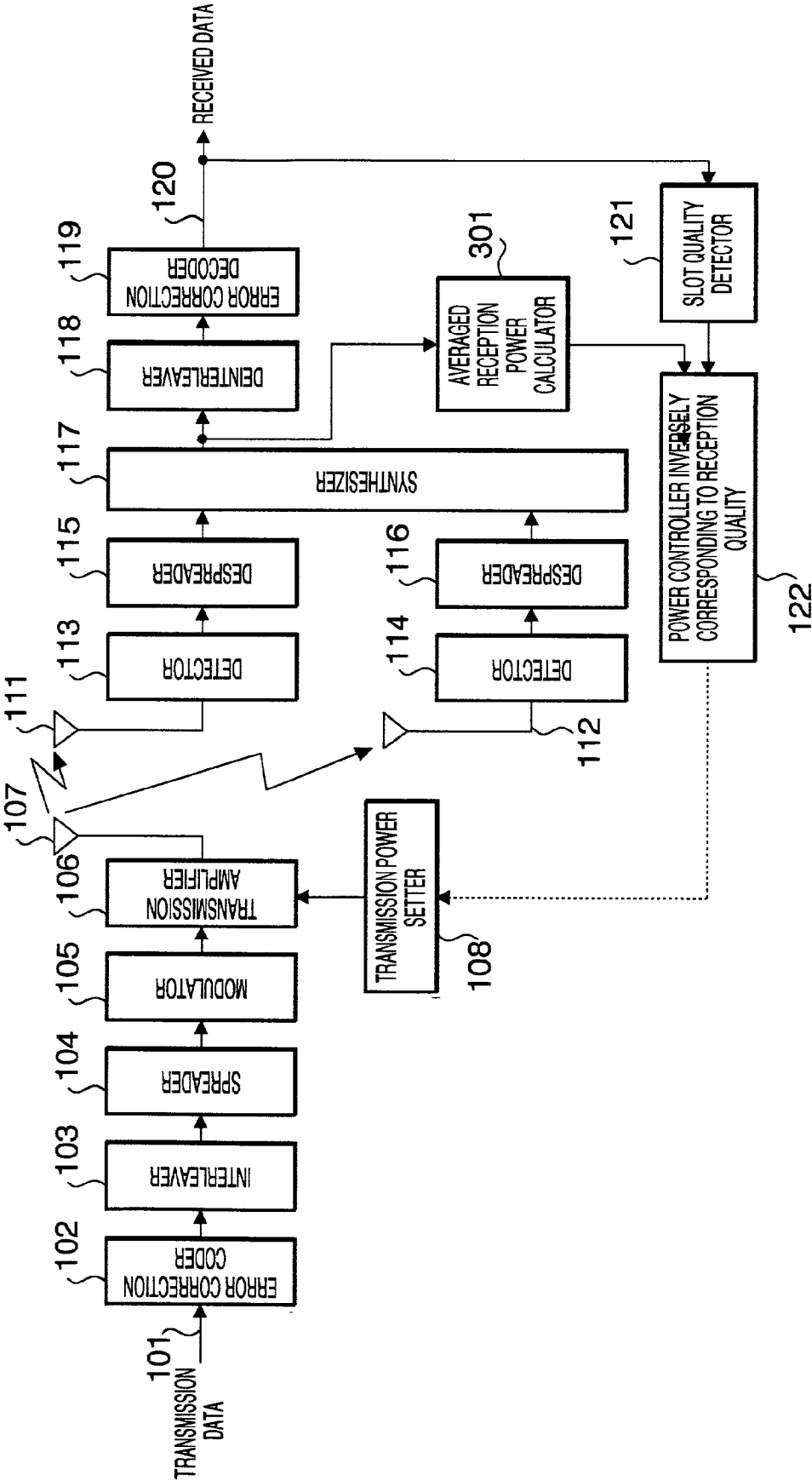


FIG. 8

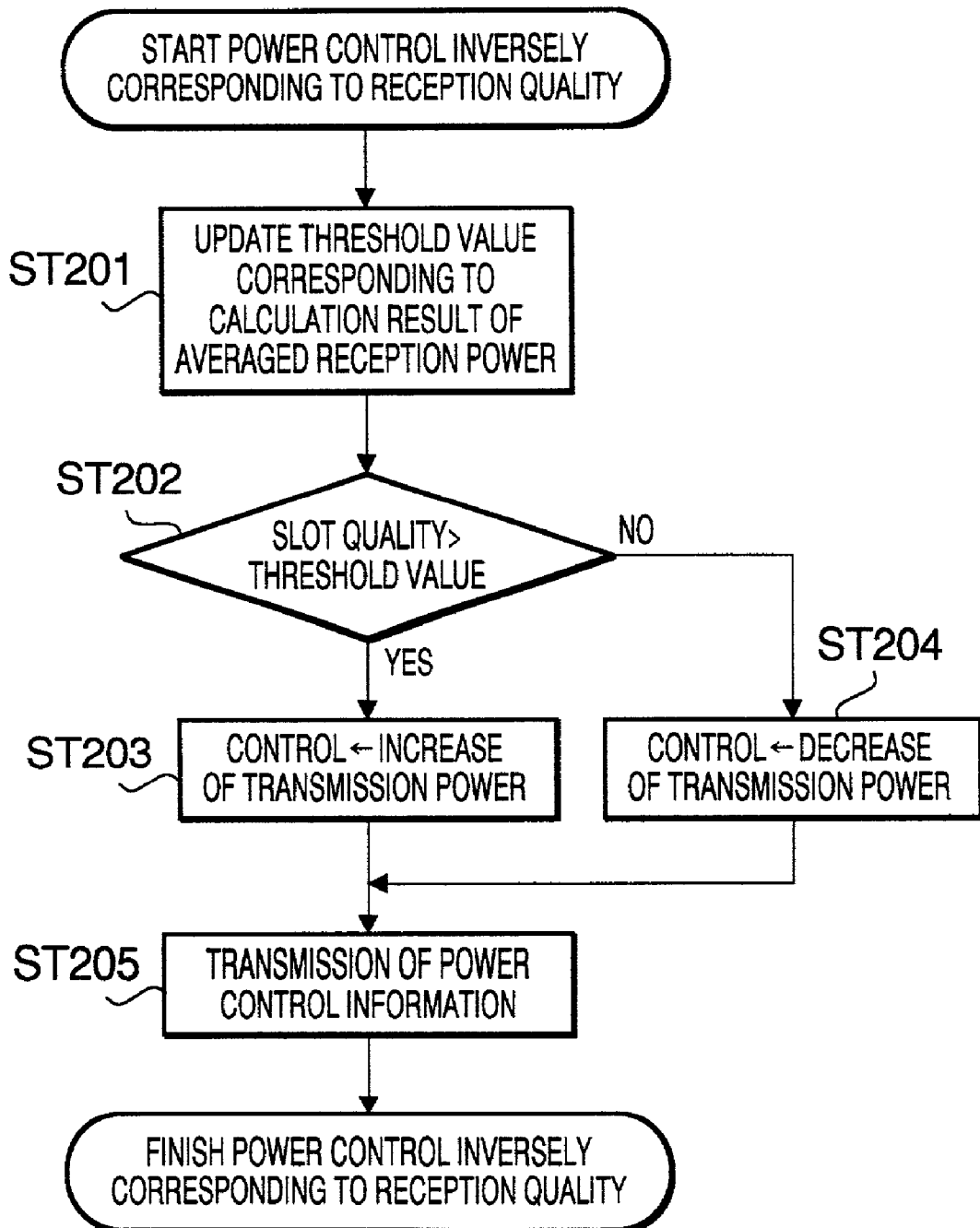
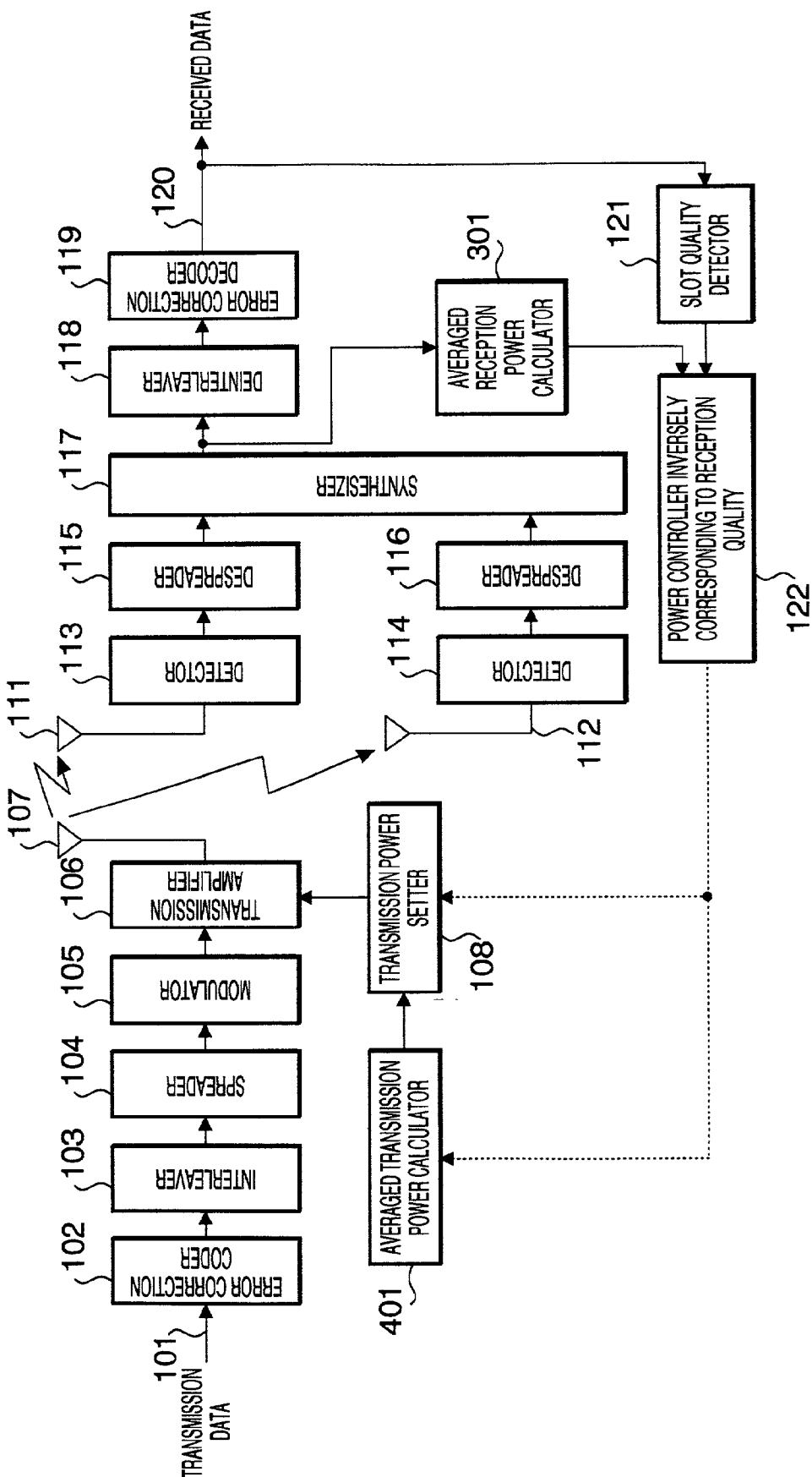


FIG. 9



TRANSMISSION POWER CONTROL METHOD AND TRANSMISSION/RECEPTION APPARATUS

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a transmission power control method and a transmission/reception apparatus, which are used in a CDMA (Code Division Multiple Access) that is a digital radio communication and so on, capable of controlling transmission power optimally for a battery saving in a mobile station apparatus and so on.

[0003] 2. Description of the Related Art

[0004] In a conventional transmission/reception apparatus using a transmission power control, the transmission power is controlled to be increased in the case where a reception quality decreases by a decrease of a reception level due to fading, or the like, and to be decreased in the case of a good reception quality.

[0005] FIG. 1 is a block diagram illustrating a schematic configuration of a conventional CDMA transmission/reception apparatus. In FIG. 1, transmission data 1 is subjected to error correction coding in error correction coder 2, and interleaved in interleaver 3. Then the data is spread with a predetermined spreading code in spreader 4, demodulated in demodulator 5, amplified in transmission amplifier 6, and transmitted from transmission antenna 7.

[0006] At this time, transmission amplifier 6 amplifies the transmission power to the level set by transmission power setter 8. This example illustrates an example of diversity reception. Therefore, in a receiver, signals are received in first reception antenna 11 and in second reception antenna 12, detected in first detector 13 and in second detector 14 respectively, despread in first despreaders 15 and in second despreaders 16 respectively, then synthesized in synthesizer 17.

[0007] In the case where a plurality of paths present in a communication link due to the effect of delayed versions and so on, RAKE combining is also performed in synthesizer 17. The synthesized data are deinterleaved in deinterleaver 18, subjected to error correction in error correction decoder 19 to obtain reception data 20.

[0008] In the receiver, slot quality detector 21 detects a slot quality of reception data 20. In detail, at step ST1 of a flow chart illustrated in FIG. 2, the quality of the slot (a block of data with a certain length) is detected. At this step, as illustrated in FIG. 3, it is decided whether or not the slot quality (reception quality) 31 is higher than threshold value 32.

[0009] Based on the decision result, power controller corresponding to reception quality 22 (hereinafter abbreviated as power controller-CRQ 22) controls the transmission power to be decreased at step ST2 in the case where reception quality (reception level) 31 is higher (better) than threshold value 32. On the other hand, power controller-CRQ 22 controls the transmission power to be increased at step ST3 in the case where the reception quality is lower than the threshold value. In detail, power controller-CRQ 22 provides a control as illustrated by rectangle line 34 in FIG. 3. Then, at step ST4, transmits power control information is transmitted to transmission power setter 8 in a transmitter.

[0010] FIG. 3 is a diagram illustrating the control of power controller-CRQ 22 for reverse link signals (signals transmitted from mobile station MS to base station BS). In FIG. 3, the fading between transmission side MS and reception side BS illustrated by curve 36 and the transmission power of mobile side MS illustrated by curve 38 are almost in inverse proportion.

[0011] Thus, it is possible to keep the reception quality almost constant, thereby allowing the improvement of the error correction ability in the case of using the error correction code having high resistance to random errors, such as convolutional code. However, there is a factor that a transmission power control error or interference volume changes, interleaving are performed to make errors further random.

[0012] According to the manner described above, the transmission power control corresponding to the reception quality always allows using of the minimum level of transmission power needed to keep the quality constant, thereby resulting in a battery saving of the mobile station. In addition, that also allows improving of system capacity because the interference volume is decreased by suppressing an unnecessary transmission power in the CDMA communication system.

[0013] However, in the conventional reception/transmission apparatus described above, the transmission power is controlled to be increased in the case where the reception quality decreases by the decrease of the reception level due to the fading, or the like, and to be decreased in the case of the good communication quality. In the case where the reception level decreases due to the fading, it is necessary to increase the transmission level to tens of dB to transmit, which requires a transmission amplifier to have a large dynamic range. However, especially in the mobile station, the requirements for a battery life and specification on amplifiers have become severe, which makes it difficult to use an amplifier with the large dynamic range. In addition, the increase of the level makes the instant interference (to signals of other users) high in the CDMA communication.

SUMMARY OF THE INVENTION

[0014] The object of the present invention is to provide a transmission power control method and a transmission/reception apparatus capable of satisfying severe requirements for a better life and specification on amplifiers, and of decreasing interference to signals of other users in a CDMA communication.

[0015] The present inventor was interested in the fact that an increase of transmission power did not improve a quality to an expected degree when a power level was decreased depending on level variations due to fading, and found the fact that an excess increase of the transmission power can be prevented by decreasing the transmission power to abandon such portion of communications in the case of level variations due to the fading, thus resulting in the present invention.

[0016] That is, the principle of the present invention is as follows. The transmission/reception apparatus in the reception side detects the reception level and provides the power control to the transmission side to increase the transmission power in the case where the detected reception level is higher than a threshold value, and decrease the transmission

power in the case where the detected reception level is lower than the threshold value, and the transmission side thus performs a transmission by the power according to the power control.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. 1 is a block diagram of a conventional CDMA transmission/reception apparatus;

[0018] FIG. 2 is a flow chart to explain an operation of the conventional CDMA transmission/reception apparatus;

[0019] FIG. 3 is a diagram to explain a power control corresponding to reception quality in the conventional CDMA transmission/reception apparatus;

[0020] FIG. 4 is a block diagram of a CDMA transmission/reception apparatus according to the first embodiment of the present invention;

[0021] FIG. 5 is a flow chart to explain an operation of the CDMA transmission/reception apparatus according to the above embodiment;

[0022] FIG. 6 is a diagram to explain a power control inversely corresponding to reception quality in the CDMA transmission/reception apparatus according to the above embodiment;

[0023] FIG. 7 is a block diagram of a CDMA transmission/reception apparatus according to the second embodiment of the present invention;

[0024] FIG. 8 is a flow chart to explain an operation of the CDMA transmission/reception apparatus according to the above embodiment; and

[0025] FIG. 9 is a block diagram of a CDMA transmission/reception apparatus according to the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0026] In a transmission power control method of the present invention, a transmission/reception apparatus in a reception side detects a reception level, and provides a power control to the transmission side to increase the transmission power in the case where the detected reception level is higher than a threshold value, and decrease the transmission power in the case where the detected reception level is lower than the threshold value, and the transmission side thus performs a transmission by the power according to the power control.

[0027] According to this method, since the transmission power control inversely corresponding to the reception quality is performed, an averaged transmission power can be decreased, thereby resulting in more battery saving of the transmission/reception apparatus than conventional apparatuses and the suppressed peak transmission power. That allows moderating of the specification of amplifiers, especially allows reducing of a cost and power consumption of the transmission/reception apparatus.

[0028] In addition, in this transmission power control method, it is preferable in the reception side to calculate a long-term reception power average and determine the threshold value corresponding to the calculation result. By

this manner, it is possible to obtain the same effect as the manner described above, and prevents the transmission power from decreasing according to an attenuation due to a long-term variation, by reflecting the calculation result of the averaged reception power.

[0029] In addition, in this transmission power control method, it is preferable in the transmission side to calculate an average of transmission power control information and determine the transmission power corresponding to the calculation result. By this manner, it is possible to obtain the same effect as the manner described above, and perform further effective transmission power control by calculating the averaged transmission power.

[0030] In addition, the transmission/reception apparatus of the present invention comprises a receiver having a reception quality detecting section for detecting the reception quality and a power control inversely corresponding to reception quality section for outputting power control information of increasing the transmission power in the case where the detected reception level is higher than the threshold value and decreasing the transmission power in the case where the reception level is lower than the threshold value, and also comprises a transmitter having a transmission power setting section for setting the transmission power corresponding to the power control information and providing a control to transmit according to the set power.

[0031] According to the constitution, since the transmission power control inversely corresponding to reception quality is performed, the averaged transmission power can be decreased, thereby resulting in more battery saving of the transmission/reception apparatus than conventional apparatuses and the suppressed peak transmission power. That allows moderating of the specification of amplifiers, especially allows reducing of a cost and power consumption of the transmission/reception apparatus.

[0032] In addition, in this transmission/reception apparatus, the receiver comprises an averaged reception power calculating section for calculating the long-term reception power average, and the power control inversely corresponding to reception quality section determines the threshold value corresponding to the calculation result.

[0033] According to this manner, it is possible to obtain the same effect as the manner described above, and prevents the transmission power from decreasing according to the attenuation due to the long-term variation, by reflecting the calculation result of the averaged reception power.

[0034] In addition, in the transmission/reception apparatus, the transmitter comprises an averaged transmission power calculating section for obtaining an average of the power control information, and the transmission power setting section determines the transmission power corresponding to the calculation result. According to the constitution, it is possible to obtain the same effect as the manner described above, and perform further effective transmission power control by calculating the averaged transmission power.

[0035] In addition, it is preferable in the transmission/reception apparatus that the transmitter and the receiver comprise the constitutions to perform the CDMA communication. According to the constitution, in the CDMA communication, it is possible to improve the system capacity

more than the conventional constitution because the decrease of the averaged transmission power results in the decrease of interference volume.

[0036] Hereinafter, the embodiments of the present invention are explained with reference to attached drawings in detail.

[0037] First Embodiment

[0038] FIG. 4 illustrates a block diagram of a CDMA transmission/reception apparatus in the first embodiment of the present invention. In FIG. 4, transmission data 101 is subjected to error correction coding in error correction coder 102, and interleaved in interleaver 103. Then the data are spread with a spreading code in spreader 104, demodulated in demodulator 105, amplified in transmission amplifier 106, and transmitted from transmission antenna 107.

[0039] At this time, transmission amplifier 106 amplifies the transmission power to the level set by transmission power setter 108. This example illustrates an example of diversity reception. Therefore, in a receiver, signals are received in first reception antenna 111 and in second reception antenna 112, detected in first detector 113 and in second detector 114 respectively, despread in first despreader 115 and in second despreader 116 respectively, then synthesized in synthesizer 17.

[0040] In the case where a plurality of paths present in a communication link due to the effect of delayed versions and so on, RAKE combining is also performed in synthesizer 117. The synthesized data are deinterleaved in deinterleaver 118, subjected to error correction in error correction decoder 119 to obtain reception data 120.

[0041] In the receiver, slot quality detector 121 detects a slot quality of reception data 120. In detail, at step ST101 of a flow chart illustrated in FIG. 5, the quality of the slot (a block of data with a certain length) is detected. At this step, it is decided whether or not the slot quality (reception quality) 201 is higher than threshold value 202.

[0042] Based on the decision result, power control inversely corresponding to reception quality section 122 (hereinafter abbreviated as power control-ICRQ 122) generates the power control information so as to increase the transmission power at step ST2 as illustrated by rectangle line 204 in FIG. 6 in the case where reception quality (reception level) 201 is higher (better) than threshold value 202 and to decrease the transmission power at step ST103 in the case where the reception quality is lower than threshold value 202. Then at step ST104, the power control information is transmitted to transmission power setter 108 in the transmitter.

[0043] A logic diagram of power control-ICRQ section 122 illustrated in FIG. 6 shows an example of reverse link signals (signals transmitted from mobile station MS to base station BS). The transmission power in mobile side MS illustrated by curve 208 indicates almost similar variations with the fading between transmission side MS and reception side BS illustrated by curve 206.

[0044] Two kinds of reception qualities thus are available, i.e., extremely good reception quality and extremely poor reception quality. In the case of using the error correction code having high resistance to random errors, such as

convolutional code, the correction ability is held by interleaving to make errors random.

[0045] When the transmission power control illustrated in FIG. 6 is performed, it is not necessary to transmit by high power in the case where the reception level more than a certain level is kept by the level variation due to fading. Therefore, transmission power setter 108 controls the transmission power (under a certain power level) not to transmit in the receiver by higher power than a certain power level after the power level reaches the certain power level even in the case where power control-ICRQ section 122 instructs to increase the transmission power.

[0046] The maximum MS transmission power thus is controlled under the power level that is too high. On the other hand, in the case where the level is under the certain level by the level variation due to fading (the level variation due to fading is under the certain level) it is not reasonable to transmit by compulsory high transmission power because good enough quality may not be obtained. In such case, the transmission power is decreased to abandon such poor quality, thereby reducing the transmission power.

[0047] In this case, error correction decoder 119 extremely lowers the likelihood of soft decision decoding. The case of performing the error correction and interleaving is equivalent to the case of puncture, and a correct demodulation is performed in the case of a low degree of the error correction and the interleaving. Thus, by setting in transmission power setter 108 the transmission power with the transmission power value controlled by power controller-ICRQ 122, the averaged transmission power and the peak transmission power is reduced.

[0048] In a transmission of packets and so on, the packet that could not be transmitted is retransmitted. It is supposed that the effect of decreasing the entire transmission power is more effective than the effect of increasing the transmission power to retransmit, and also supposed that FER (Frame Error Rate) is less than random errors by not performing the interleaving.

[0049] Thus, according to the first embodiment, since the transmission power control inversely corresponding to reception quality is performed along with interleaving, error correction and so on, the averaged transmission power can be reduced. Therefore, the battery saving of the mobile station is achieved more than the conventional apparatuses and the peak transmission power is suppressed. That allows moderating of the specification of amplifiers, further reducing of the cost and power consumption of the transmission/reception apparatus. In addition, it is possible to improve the system capacity more than the conventional constitution because the decrease of the averaged transmission power results in the decrease of interference (volume) in the CDMA system.

[0050] Second Embodiment

[0051] FIG. 7 illustrates a block diagram of a CDMA transmission/reception apparatus according to the second embodiment of the present invention. In addition, in the second embodiment of the present invention illustrated in FIG. 7, a section corresponding to each section in the first embodiment illustrated in FIG. 4 is assigned the same symbol to omit the explanation.

[0052] The second embodiment illustrated in FIG. 7 is characterized by having averaged reception power calculator 301 for calculating a long-term variations of the reception level caused by an attenuation of communication distance to be reflected in a threshold value in power controller-ICRQ 302 so that the appropriate transmission power control is performed.

[0053] That is, in the receiver, at step ST201 illustrated in the operation flow chart of the power control inversely corresponding to reception quality in FIG. 8, averaged reception power calculator 301 calculates, using data output from synthesizer 117, the long-term variations of the reception level caused by the attenuation of communication distance and so on, and updates the threshold value of power controller-ICRQ 122 corresponding to the calculation result. The update is performed to increase the threshold value when the calculation value is high, which is assumed that the attenuation is low, and to decrease the threshold value when the calculation value is low.

[0054] Then, slot quality detector 121 detects a slot quality based on reception data 120 at step ST202, and decides whether or not the slot quality is higher than the threshold value.

[0055] Based on the decision result, power controller-ICRQ 122 generates the power control information indicative of increasing the transmission power at step ST203 in the case where the reception quality is higher (better) than the threshold value, and of decreasing the transmission power at step ST204 in the case where the reception quality is lower than the threshold value. Then, at step ST205, the power control information is transmitted to transmission power setter 108 in the transmitter.

[0056] When a cell radius is large, it is supposed that the long-term level variation generates by a difference of communication distance and shadowing. In such case, the transmission power decreases as the attenuation of the long-term variation if the threshold value of power controller-ICRQ 122 is fixed in the same way as the first embodiment.

[0057] However, the above problem that the transmission power decreases as the attenuation of the long-term variation is solved in the same way as the second embodiment, where averaged reception power calculator 301 obtains the long-term averaged reception level to update the threshold value. The more effective transmission control than the first embodiment is thus performed.

[0058] As described above, according to the second embodiment, it is possible to obtain the same effect as the first embodiment, and also cancel the effect of decreasing the transmission power as the attenuation of the long-term variation by reflecting the calculation result of the averaged reception power.

[0059] Third Embodiment

[0060] FIG. 9 illustrating a block diagram of a CDMA transmission/reception apparatus according to the third embodiment of the present invention. In addition, in the third embodiment of the present invention illustrated in FIG. 9, a section corresponding to each section in the second embodiment illustrated in FIG. 7 is assigned the same symbol to omit the explanation.

[0061] The third embodiment illustrated in FIG. 9 is characterized by having averaged transmission power calculator 401 for deciding an averaged transmission power not to incline the control corresponding to the power control information from power controller-ICRQ 122 to transmit to transmission power setter 108 so that the upper limit of the transmission power is decided.

[0062] That is, in the receiver, slot quality detector 121 detects a slot quality of reception data 120. According to the result, power controller-ICRQ 122 generates the power control information indicative of increasing the transmission power in the case where the reception quality is higher (better) than a threshold value, and of decreasing the transmission power in the case where the reception quality is lower than the threshold value, and transmits the power control information to transmission power setter 108 and averaged transmission power calculator 401 in the transmitter.

[0063] Thus, averaged transmission power calculator 401 decides the averaged transmission power not to incline the control from power controller-ICRQ 122 to transmit to transmission power setter 108, thereby deciding the upper limit of the transmission power.

[0064] That is, in the transmitter, averaged transmission power calculator 401 detects the incline of the control from power controller-ICRQ 122, then increases the upper limit of the transmission power of transmission power setter 108 by deciding that the communication distance is getting bigger in the case of (inclining to increase the power) the continuous controls indicative of increasing the power level from power controller-ICRQ 122, and decreases the upper limit of the transmission power of transmission power setter 108 by deciding that the communication distance is getting smaller in the case of (inclining to decrease the power) the continuous controls indicative of decreasing the power level from power controller-ICRQ 122. The more effective transmission power control is thus performed than the second embodiment.

[0065] As described above, according to the third embodiment, it is possible to obtain the same effect as the second embodiment, and to perform further effective transmission power control than the second embodiment by calculating the averaged transmission power.

[0066] The apparatuses according to the first embodiment to the third embodiment described above are applicable to communication terminal apparatuses as mobile station apparatuses and base station apparatuses in a radio communication system. In addition, the first embodiment to the third embodiment described above explain about the case of applying the transmission/reception apparatus of the present invention in the CDMA communication system, however the transmission/reception apparatus of the present invention is applicable to the other communications besides the CDMA. In addition, the first embodiment to the third embodiment described above explain about the case of using the reception level as the reception quality, however in the present invention, SNR (Signal to Noise ratio), CNR (Carrier to Noise ratio), SIR (Signal to Interference ratio), FER (Frame Error Rate), BER (Bit Error Rate), etc. are applicable as the reception quality.

[0067] As appeared in the above-mentioned explanation, it is possible in the reception/transmission apparatus to

improve the battery life and moderate the specification on amplifiers, thereby decreasing interference to signals of other users in the CDMA communication.

What is claimed is:

1. A transmission power control method comprising the steps of:

detecting a quality of a received signal;

generating power control information indicative of increasing transmission power in the case where the detected quality is higher than a threshold value and of decreasing said transmission power in the case where said detected quality is lower than said threshold value; and

transmitting the power control information.

2. The transmission power control method according to claim 1, said method further comprises a step of calculating an average of reception power for a predetermined interval and deciding the threshold value corresponding to the calculation result.

3. A radio communication apparatus comprising:

quality detecting means for detecting a quality of a received signal;

power control inversely corresponding to quality means for outputting power control information indicative of increasing transmission power in the case where the detected quality is higher than a threshold value and of decreasing said transmission power in the case where said detected quality is lower than said threshold value.

4. The radio communication apparatus according to claim 3, said apparatus further comprises averaged reception power calculating means for calculating an average of reception power for a predetermined interval, wherein said power control inversely corresponding to quality means decides the threshold value corresponding to the calculation result.

5. A radio communication apparatus comprising:

reception means for receiving power control information indicative of increasing transmission power in the case where a quality is higher than a threshold value and of decreasing said transmission power in the case where said quality is lower than said threshold value;

transmission power setting means for performing the setting of transmission power corresponding to said power control information; and

transmission means for performing a transmission by the set power.

6. The radio communication apparatus according to claim 5, said apparatus further comprises averaged reception power calculating means for obtaining an average of said power control information, wherein said transmission power setting means decides the transmission power corresponding to said calculation result.

7. A transmission/reception apparatus comprising:

a receiver having quality detecting means for detecting a quality of a received signal, and power control inversely corresponding to quality means for outputting power control information indicative of increasing

transmission power in the case where the detected quality is higher than a threshold value and of decreasing said transmission power in the case where said detected quality is lower than said threshold value; and

a transmitter having reception means for receiving said power control information, transmission power setting means for performing the setting of transmission power according to corresponding to said power control information, and transmission means for performing a transmission by the set power.

8. The transmission/reception apparatus according to claim 7, said apparatus further comprises averaged reception power calculating means for calculating an average of reception power for a predetermined interval, wherein said power control inversely corresponding to quality means decides the threshold value corresponding to the calculation result.

9. The transmission/reception apparatus according to claim 7, said apparatus further comprises averaged transmission power calculating means for obtaining an average of said power control information, wherein said transmission power setting means decides the transmission power corresponding to said calculation result.

10. A base station apparatus having a transmission/reception apparatus, said transmission/reception apparatus comprising:

a receiver having quality detecting means for detecting a quality of a received signal, and power control inversely corresponding to quality means for outputting power control information indicative of increasing transmission power in the case where the detected quality is higher than a threshold value and of decreasing said transmission power in the case where said detected quality is lower than said threshold value; and

a transmitter having reception means for receiving said power control information, transmission power setting means for performing the setting of transmission power corresponding to said power control information, and transmission means for performing a transmission by the set power.

11. A communication terminal apparatus having a transmission/reception apparatus, said transmission/reception apparatus comprising:

a receiver having quality detecting means for detecting a quality of a received signal, and power control inversely corresponding to quality means for outputting power control information indicative of increasing transmission power in the case where the detected quality is higher than a threshold value and of decreasing said transmission power in the case where said detected quality is lower than said threshold value; and

a transmitter having reception means for receiving said power control information, transmission power setting means for performing the setting of transmission power corresponding to said power control information, and transmission means for performing a transmission by the set power.

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