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(71) Applicant: **Alpine Electronics, Inc.**
Tokyo (JP)

(72) Inventors:
- **OZAKI, Daisuke**
  Fukushima (JP)
- **TOMOYA, Hamaguchi**
  Fukushima (JP)

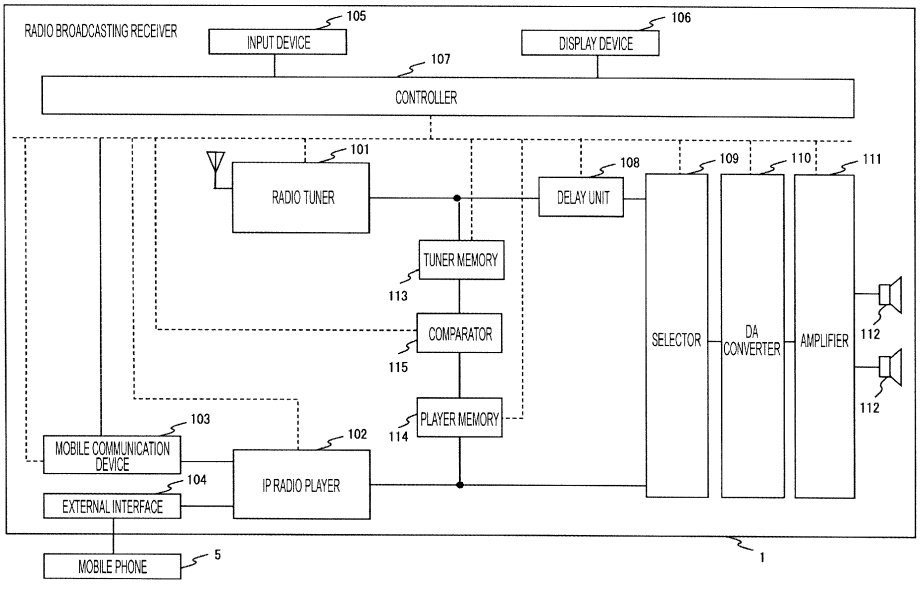
(74) Representative: **Schmitt-Nilson Schraud Waibel Wohlfrom**
Patentanwälte Partnerschaft mbB
Destouchesstraße 68
80796 München (DE)

(54) RADIO BROADCASTING RECEPTION APPARATUS AND SEAMLESS SWITCHING METHOD

(57) Provided is a radio broadcasting reception apparatus and seamless switching method" capable of appropriately setting a time point for start of reception of IP radio broadcasting in a case of seamlessly switching output sound from radio broadcasting to IP radio broadcasting.

A controller (107) updates a counter value with an update step (increase step or decrease step) corresponding to a quality range representing a range of reception quality including a reception quality, so as to come close to a range evaluation value registered in the quality range representing a range of reception quality including a reception quality at the time point. Here, the quality range is set to a smaller numerical value as the quality range indicates a range of smaller reception quality. Then, the controller (107) controls the start of the reception of the IP radio broadcasting when the counter value becomes less than a predetermined threshold value.

FIG. 2



EP 3 407 512 A1

Description

[0001] The present invention relates to a technique, employed in a radio broadcasting reception apparatus, of switching output sound from broadcasting that is outputting reception sound to reception sound of another broadcasting performing broadcasting having the same content as the broadcasting.

[0002] As a technique, employed in a radio broadcasting reception apparatus, of switching output sound from broadcasting that is outputting reception sound to reception sound of another broadcasting performing broadcasting having the same content as the broadcasting (that is, broadcasting having the relationship of simultaneous broadcasting with the broadcasting that is outputting reception sound), a broadcasting switching technique, employed in a radio broadcasting reception apparatus that receives FM broadcasting and IP radio broadcasting having the relationship of the simultaneous broadcasting with the FM broadcasting, of calculating a delay time of the sound received from the IP radio broadcasting with respect to the sound received from the FM broadcasting, delaying the sound received from the FM broadcasting by the calculated delay time by performing time stretch that expands the sound in a temporal axis direction, and switching output sound from the sound received from the FM broadcasting to the sound received from IP radio broadcasting, in the case of switching the output sound from sound received from FM broadcasting to the sound received from the IP radio broadcasting, thus seamlessly outputting reception sound (for example, JP 2013-201469 A) is known.

[0003] In the technique, the sound received from the IP radio broadcasting is compared with the sound received from the FM broadcasting and the delay time of the sound received from the IP radio broadcasting with respect to the sound received from the FM broadcasting is calculated.

[0004] In addition, as the technique of switching output sound from the broadcasting that is outputting reception sound to another reception sound having relationship of the simultaneous broadcasting with the broadcasting, there is known a technique, employed in a radio broadcasting reception apparatus that receives radio broadcasting and broadcasting having relationship of the simultaneous broadcasting with the radio broadcasting and distributed via a mobile communication network, of starting reception of the broadcasting distributed via the mobile communication network and switching output sound to reception sound of the broadcasting distributed via the mobile communication network, when a reception quality of the radio broadcasting that is outputting reception sound is deteriorated than a predetermined reference value (for example, JP 2003-169380 A).

[0005] In order to seamlessly switch output sound to reception sound of IP radio broadcasting having relationship of simultaneous broadcasting with FM broadcasting when reception quality of the FM broadcasting that is outputting reception sound deteriorates, it is necessary to start reception of the IP radio broadcasting at a time point earlier than a time point at which the FM broadcasting cannot be received normally by more than a time period needed for calculation processing of a delay time of the IP radio broadcasting with respect to the FM broadcasting and delay processing by time stretch of the reception sound of the FM broadcasting.

[0006] Then, when it is hard to appropriately set the time point at which reception of this IP radio broadcasting is started, the following problem occur.

[0007] That is, it is impossible to seamlessly switch broadcasting outputting reception sound in the case of starting reception of the IP radio broadcasting at a time point later than an appropriate time point. On the other hand, when the reception of the IP radio broadcasting is started at a time point earlier than the appropriate time point, the reception time of the IP radio broadcasting becomes redundant and the burden of the communication cost of the user unnecessarily increases in a case where the IP radio broadcasting is received using a communication service in which meter rate charging is performed. Further, even when the reception quality of the FM broadcasting is restored without failing to normally receive the FM broadcasting after the reception of the IP radio broadcasting is started, the unnecessary reception of IP radio broadcasting is performed, and the burden of communication cost on a user, which is originally unnecessary, occurs.

[0008] Accordingly, an object of the present invention is to appropriately set a reception start time point of IP radio broadcasting in a radio broadcasting reception apparatus which seamlessly switches output sound to reception sound of IP radio broadcasting having relationship of the simultaneous broadcasting with the broadcasting when a reception quality of the radio broadcasting that is outputting reception sound is deteriorated.

[0009] The present invention relates to a radio broadcasting reception apparatus and a seamless switching method according to the appended claims. According to an aspect, the present invention provides a radio broadcasting reception apparatus capable of receiving radio broadcasting and IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting. The radio broadcasting reception apparatus includes: a radio receiver configured to receive the radio broadcasting; an IP radio player configured to receive the IP radio broadcasting; an output unit configured to output one of reception sound of the radio receiver and reception sound of the IP radio player; a delay unit configured to delay the reception sound of the radio receiver output by the output unit; an evaluation value calculator configured to calculate an evaluation value representing a degree of quality; and a seamless switching controller configured to allow the IP radio player to start reception of the IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting that is outputting reception sound and allow the delay unit to

delay the reception sound of the radio receiver output by the output unit by a delay time of the IP radio broadcasting with respect to the radio broadcasting, and allow the output unit to switch output reception sound from the reception sound of the radio receiver to the reception sound of the IP radio player when the evaluation value represents that the degree of quality is worse than a predetermined degree, during a period of time for which the output unit is outputting reception sound of the radio receiver. Here, the evaluation value calculator calculates the evaluation value by changing the evaluation value by a predetermined update amount in a direction close to a working reference value that is a reference value corresponding to a current reception quality level that is the level of reception quality including reception quality of the radio broadcasting of the radio receiver according to a predetermined correspondence relationship between a level of reception quality and a plurality of reference values, at each time point. Further, the reference value represents a degree of specific quality, and the predetermined correspondence relationship is a relationship in which a level of better reception quality corresponds to a reference value representing the degree of better quality.

[0010] According to the radio broadcasting reception apparatus, when the evaluation value represents a reference value representing the degree of better quality than the working reference value, the evaluation value calculator uses, in the calculation of the evaluation value, an update amount determined such that the evaluation value varies increasingly as a current reception quality level is a level of worse reception quality, and when the evaluation value represents a reference value representing the degree of worse quality than the working reference value, the evaluation value calculator uses, in the calculation of the evaluation value, an update amount determined such that the evaluation value varies increasingly as a current reception quality level is a level of better reception quality.

[0011] According to an aspect, the present invention provides a radio broadcasting reception apparatus capable of receiving radio broadcasting and IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting. The radio broadcasting reception apparatus includes: a radio receiver configured to receive the radio broadcasting; an IP radio player configured to receive the IP radio broadcasting; an output unit configured to output one of reception sound of the radio receiver and reception sound of the IP radio player; a delay unit configured to delay the reception sound of the radio receiver output by the output unit; an evaluation value calculator configured to calculate an evaluation value; and a seamless switching controller configured to allow the IP radio player to start reception of the IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting that is outputting reception sound and allow the delay unit to delay the reception sound of the radio receiver output by the output unit by a delay time of the IP radio broadcasting with respect to the radio broadcasting, and allow the output unit to switch output reception sound from the reception sound of the radio receiver to the reception sound of the IP radio player when the evaluation value is less than a predetermined threshold value, during a period of time for which the output unit is outputting reception sound of the radio receiver. Here, the evaluation value calculator calculates the evaluation value by changing the evaluation value by a predetermined update amount in a direction close to a working reference value that is a reference value corresponding to a current reception quality range that is the range of reception quality including reception quality of the radio broadcasting of the radio receiver according to a predetermined correspondence relationship between a range of reception quality and a plurality of reference values, at each time point. Further, the predetermined correspondence relationship is a relationship in which a range of better reception quality corresponds to a larger reference value.

[0012] Here, according to the radio broadcasting reception apparatus, when the evaluation value is larger than the working reference value, the evaluation value calculator may use, in the calculation of the evaluation value, an update amount determined such that the evaluation value decreases increasingly as a current reception quality range is a range of worse reception quality, and when the evaluation value is smaller than the working reference value, the evaluation value calculator may use, in the calculation of the evaluation value, an update amount determined such that the evaluation value increases increasingly as a current reception quality range is a range of better reception quality.

[0013] Further, according to the radio broadcasting reception apparatus, when the evaluation value is larger than the working reference value, the evaluation value calculator may update the evaluation value in a range in which the evaluation value is not smaller than the working reference value, and when the evaluation value is smaller than the working reference value, the evaluation value calculator may update the evaluation value in a range in which the evaluation value is not larger than the working reference value.

[0014] Further, in the radio broadcasting reception apparatus, directions of magnitudes of the reference value and the evaluation value may be reversed.

[0015] That is, the seamless switching controller may allow the IP radio player to start reception of the IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting that is outputting reception sound, allow the delay unit to delay the reception sound of the radio receiver output by the output unit by a delay time of the IP radio broadcasting with respect to the radio broadcasting, and allow the output unit to switch output reception sound from the reception sound of the radio receiver to the reception sound of the IP radio player when the evaluation value is greater than a predetermined threshold value, and the predetermined correspondence relationship may be a relationship in which a

range of better reception quality corresponds to a smaller reference value.

[0016] Further, in this case, when the evaluation value is smaller than the working reference value, the evaluation value calculator may be configured to use, in the calculation of the evaluation value, an update amount determined such that the evaluation value increases increasingly as a current reception quality range is a range of better reception quality and when the evaluation value is larger than the working reference value, the evaluation value calculator may be configured to use, in the calculation of the evaluation value, an update amount determined such that the evaluation value decreases increasingly as a current reception quality range is a range of better reception quality.

[0017] Further, even in this case, when the evaluation value is larger than the working reference value, the evaluation value calculator may be configured to update the evaluation value in a range in which the evaluation value is not smaller than the working reference value, and when the evaluation value is smaller than the working reference value, the evaluation value calculator may be configured to update the evaluation value in a range in which the evaluation value is not larger than the working reference value.

[0018] Here, in the radio broadcasting reception apparatus as described above, the radio broadcasting may be at least one of a digital radio broadcasting and an analog radio broadcasting.

[0019] Further, the radio broadcasting reception apparatus as described above may be an in-vehicle radio broadcasting reception apparatus mounted in a car, and the IP radio player may receive IP radio broadcasting via mobile communication.

[0020] According to the radio broadcasting reception apparatus as described above, it is possible to calculate the evaluation value representing the quality tendency of reception quality up to the present and to determine the time point at which reception of the IP radio broadcasting is started using the evaluation value.

[0021] By considering the quality tendency of the quality of the reception quality, the reception of the IP radio broadcasting can be started at an appropriate time point rather than a case of starting reception of the IP radio broadcasting only according to the reception quality at the present time.

[0022] As described above, in the radio broadcasting reception apparatus according to the present invention, when the reception quality of a radio broadcasting that is outputting the reception sound deteriorates, the sound to be output is seamlessly transmitted to the reception sound of the IP radio broadcasting having the relationship between the broadcasting and the simultaneous broadcasting, and it is possible to appropriately set the reception start time point of the IP radio broadcasting.

Brief Description of Drawings

[0023]

Fig. 1 is a block diagram of a configuration of a radio broadcasting system according to an embodiment of the present invention.

Fig. 2 is a block diagram of a configuration of a radio broadcasting receiver according to an embodiment of the present invention.

Fig. 3 illustrates a counter control table according to an embodiment of the present invention.

Fig. 4 is a flowchart of a counter updating process according to an embodiment of the present invention.

Fig. 5 is a flowchart of a seamless switching process according to an embodiment of the present invention.

Fig. 6 is a diagram illustrating a processing example of delay processing according to an embodiment of the present invention.

Fig. 7 is a diagram illustrating relationship between counter values and reception quality, according to an embodiment of the present invention.

[0024] Embodiments of the present invention are described below.

[0025] Fig. 1 illustrates a configuration of a radio broadcasting system according to an embodiment.

[0026] As illustrated in Fig. 1, the radio broadcasting receiver 1 is a position-movable radio broadcasting receiver 1, such as a vehicle-mounted radio broadcasting receiver 1 or a portable radio broadcasting receiver, and performs reception of radio broadcasting by broadcasting waves from a radio broadcasting station 2. Further, examples of the radio broadcasting by broadcasting waves are digital radio broadcasting, such as Digital Audio Broadcasting (DAB) or DAB+, or analog radio broadcasting, such as FM radio broadcasting. Furthermore, the radio broadcasting receiver 1 is connected to a wide area network (WAN) 3, such as the Internet, through mobile communication so as to receive IP radio broadcasting from an IP radio server 4 on the WAN 3.

[0027] Hereinafter, for the sake of convenience, "radio broadcasting" will be described as referring to radio broadcasting by broadcasting waves, rather than IP radio broadcasting.

[0028] Here, the IP radio broadcasting performed by an IP radio server 4 includes IP radio broadcasting having the relationship of simultaneous broadcasting with radio broadcasting, that is, IP radio broadcasting having the same content as radio broadcasting.

[0029] Note that, in this embodiment, sound received from the IP radio broadcasting having the relationship of the simultaneous broadcasting with radio broadcasting delays relative to sound broadcasted by the radio broadcasting having the relationship of the simultaneous broadcasting with the IP radio broadcasting.

[0030] Next, a configuration of the radio broadcasting receiver 1 will be described with reference to Fig. 2

[0031] As illustrated in Fig. 2, the radio broadcasting receiver 1 includes a radio tuner 101 which receives radio broadcasting and reproduces and outputs received audio data, and an IP radio player 102 which receives IP radio broadcasting and outputs received audio data.

[0032] Here, the IP radio player 102 is connected to an IP radio server 4 on the WAN 3 through a mobile communication device 103 which performs mobile communication, receives an audio stream delivered from the IP radio server 4 through IP radio broadcasting, and reproduces and outputs audio data. Note that the radio broadcasting receiver 1 may include, instead of the mobile communication device 103, an external interface 104 to which a mobile phone 5 which performs mobile communication is connected. In this case, the IP radio player 102 may be connected to the IP radio server 4 on the WAN 3 through the mobile communication performed by the mobile phone 5, receive an audio stream delivered by the IP radio server 4 through IP radio broadcasting, and reproduce and output audio data.

[0033] In addition, the radio broadcasting receiver 1 includes an input device 105, a display device 106, and a controller 107.

[0034] Further, the radio broadcasting receiver 1 includes a delay unit 108 which delays audio data to be output from the radio tuner 101 by a set delay target time before outputting the audio data, a selector 109 which selects and outputs one of audio data output from the delay unit 108 and audio data output from the IP radio player 102, a DA converter 110 which converts the audio data output from the selector 109 into an analog sound signal and outputs the analog sound signal, an amplifier 111 which amplifies the analog sound signal output from the DA converter 110, and a speaker 112 which is driven by the sound signal amplified by the amplifier 111 and which outputs sound.

[0035] The radio broadcasting receiver 1 includes a tuner memory 113, a player memory 114, and a comparator 115.

[0036] With this configuration, when receiving an instruction for receiving radio broadcasting of a specific radio broadcasting station 2 from a user through the input device 105, the controller 107 starts reception of radio broadcasting of the radio broadcasting station 2 which is instructed to be received by the radio tuner 101, and output of the audio data. Further, the controller 107 outputs sound, received from the radio broadcasting station 2 by the radio tuner 101, from the speaker 112, by outputting the audio data, input to the selector 109 from the delay unit 108, to the DA converter 110.

[0037] On the other hand, the audio data output from the radio tuner 101 is stored in the tuner memory 113. Here, the storage in the tuner memory 113 is performed such that the latest audio data for a predetermined reproduction time is stored in the tuner memory 113 at all time. Furthermore, a reproduction time of the audio data stored in the tuner memory 113 at all-time is set to be equal to or longer than a period of time expected as a largest value of a delay time of the IP radio broadcasting having the relationship of simultaneous broadcasting with the radio broadcasting relative to the radio broadcasting.

[0038] In addition, the radio tuner 101 also performs a process of calculating a reception quality of the radio broadcasting being received in accordance with reception electric field strength of the radio broadcasting being received, an SN ratio, an error generation rate, or the like when the radio broadcasting is being received.

[0039] Here, the radio tuner 101 calculates the reception quality as a numerical value from 0 to 100. The numerical value represents that the reception quality is better as the value is larger.

[0040] Next, a counter updating process to be performed by the controller 107 is described.

[0041] First, a counter control table used for the counter updating process will be described.

[0042] As illustrated in Fig. 3, a decrease step, an increase step, and a range evaluation value are registered in the counter control table with respect to each of quality ranges respectively representing ranges obtained by dividing a range between 0 and 100 which are values of the reception quality of the radio broadcasting.

[0043] Here, 0 or a negative numerical value between 0 and -120 is registered in the decrease step of each quality range. In addition, in the decrease step of each quality range, a smaller numerical value is registered as the quality range represents a smaller reception quality range.

[0044] Also, 0 or a positive numerical value between 0 and +10 is registered in the increase step of each quality range. In addition, in the increase step of each quality range, a larger numerical value is registered as the quality range represents a larger reception quality range.

[0045] Further, a positive numerical value between 0 and 480 is registered in the range evaluation value of each quality range. In addition, in the range evaluation value of each quality range, a smaller numerical value is registered as the quality range represents a smaller reception quality range.

[0046] Next, a procedure of the counter updating process performed by the controller 107 using such a counter control table is illustrated in Fig. 4.

[0047] Here, the counter updating process is started when the radio tuner 101 starts receiving the radio broadcasting of the broadcasting station, or when the radio tuner 101 switches broadcasting stations that receive the radio broadcasting. When the radio tuner 101 has started receiving the radio broadcasting of the broadcasting station or when the radio tuner 101 has switched the broadcasting stations that receive the radio broadcasting, if the counter updating process has already been executed, the execution of the counter updating process is newly started after ending the executed counter updating process.

[0048] As illustrated in Fig 4, in the counter updating process, the controller 107 sets a counter value CV to 480 which is the maximum value of the range evaluation values registered in the counter control table (step 402).

[0049] Then, the reception quality Q calculated by the radio tuner 101 is acquired from the radio tuner 101 (step 404).

[0050] Next, the range evaluation value ReRQ, which is registered in the quality range RQ representing the range of the reception quality including the acquired reception quality Q, is acquired from the counter control table (step 406).

[0051] Then, it is determined whether the acquired range evaluation value ReRQ is smaller than the counter value CV (step 408) or whether the acquired range evaluation value ReRQ is larger than the counter value CV (step 410).

[0052] When the range evaluation value ReRQ is neither smaller nor larger than the counter value CV, that is, when the range evaluation value ReRQ is equal to the counter value CV, the process returns to step 404.

[0053] Subsequently, when the range evaluation value ReRQ is smaller than the counter value CV (step 408), the decrease step DSRQ, registered in the quality range RQ representing the range of reception quality including the acquired reception quality Q, is acquired from the counter control table (step 412). It is checked whether or not the value obtained by adding the decrease step DSRQ to the counter value CV is smaller than the range evaluation value ReRQ (step 414), and if so, the process returns to step 404.

[0054] Since the decrease step is 0 or a negative value as described above, the counter value CV is unchanged or is decreased due to the addition of the decrease step DSRQ.

[0055] On the other hand, when the value obtained by adding the decrease step DSRQ to the counter value CV is not smaller than the range evaluation value ReRQ (step 414), the counter value CV is updated to a value obtained by adding the decrease step DSRQ to the counter value CV (step 416).

[0056] Then, the process returns to step 404.

[0057] On the other hand, when the range evaluation value ReRQ is larger than the counter value CV (step 410), the increase step ISRQ, registered in the quality range RQ representing the range of reception quality including the acquired reception quality Q, is acquired from the counter control table (step 418). It is checked whether or not the value obtained by adding the increase step ISRQ to the counter value CV is larger than the range evaluation value ReRQ (step 420), and if so, the process returns to step 404.

[0058] Since the increase step is 0 or a negative value as described above, the counter value CV is unchanged or is increased due to the addition of the increase step ISRQ.

[0059] On the other hand, when the value obtained by adding the increase step ISRQ to the counter value CV is not larger than the range evaluation value ReRQ (step 420), the counter value CV is updated to a value obtained by adding the increase step ISRQ to the counter value CV (step 422).

[0060] Then, the process returns to step 404.

[0061] The counter updating process to be performed by the controller 107 has been described above.

[0062] According to the counter updating process described above, at each time point, the counter value CV is updated with an update step (increase step or decrease step) corresponding to the quality range RQ representing the range of the reception quality including the reception quality Q, so as to come close to the range evaluation value ReRQ registered in the quality range RQ representing a range of reception quality including a reception quality Q at the time point. Further, in the case of decreasing the counter value CV, the magnitude (absolute value) of the update step (decrease step) of the counter value CV increases as the reception quality Q decreases, and in the case of increasing the counter value CV, the magnitude (absolute value) of the update step (increase step) of the counter value CV increases as the reception quality Q increases.

[0063] Next, a seamless switching process of the controller 107 will be described which is performed in order to seamlessly switch sound output to the speaker 112 between sound received from the radio broadcasting and sound received from the IP radio broadcasting having the relationship of the simultaneous broadcasting with the radio broadcasting.

[0064] Fig. 5 illustrates a procedure of the seamless switching process. Note that the seamless switching process is activated when an instruction for receiving the radio broadcasting from a specific radio broadcasting station 2 is issued by the user.

As illustrated in Fig. 5, in this process, a state in which the radio broadcasting receiver 1 outputs the sound of the radio broadcasting from the speaker 112 is waited (step 502). Thereafter, when the state in which the sound of the radio broadcasting is output from the speaker 112 is entered, whether the counter value CV is less than a predetermined threshold value ThS (ThS is 220 for example, in the counter control table of Fig. 3) is monitored (step 504).

[0065] Subsequently, when the counter value CV is less than the predetermined threshold value ThS (step 504), start of reception of the IP radio broadcasting by the IP radio player 102 is instructed, the IP radio broadcasting having the relationship of the simultaneous broadcasting with the radio broadcasting that is outputting sound (step 506). The IP radio player 102 instructed to start reception accesses the WAN 3 via mobile communication and starts reception of IP radio broadcasting from the IP radio server 4. Thereafter, the IP radio player 102 outputs audio data received from the IP radio broadcasting to the selector 109 and stores the audio data in the player memory 114.

[0066] In addition, the controller 107 starts a delay

processing (step 508).

[0067] Here, in the delay processing, the controller 107 performs the following process.

[0068] Now, when the reproduction time of a predetermined time length (for example, 2 ms) is set as a unit time, rectangles in Fig. 6 surrounding numbers indicate audio data for unit time. Further, rectangles surrounding numbers without "'" indicate audio data received by the radio tuner 101 from the radio broadcasting, and rectangles surrounding numbers with "'" indicate audio data received by the IP radio player 102 from the IP radio broadcasting. Further, rectangles having the same numbers (for example, "4" and "4"') indicate audio data having the same content.

[0069] When the controller 107 has controlled the start of reception of the IP radio broadcasting at time point T1 in step 506, the controller 107 starts the delay processing and instructs the comparator 115 to calculate the delay time.

[0070] When the comparator 115 has been instructed to calculate the delay time, the comparator 115 waits for actual start of the reception of the audio data from the IP radio broadcasting at time point T2, calculates the delay time of the audio data of the IP radio broadcasting with respect to the audio data of the radio broadcasting by comparison with the audio data stored in the tuner memory 113 and the audio data stored in the player memory 114, and notifies the controller 107 of the calculated delay time.

[0071] Then, at time point T3, the controller 107, which has been notified of the delay time, sets the notified delay time as a delay target time in the delay unit 108 and instructs execution of time stretch.

[0072] The delay unit 108, which has been instructed to execute the time stretch, performs the time stretch on the audio data being output until the set delay target time coincides with the delay time of the audio data output from the delay unit 108 with respect to the audio data input to the delay unit 108. That is, as indicated by the output of the delay unit between the time point T3 and the time point T4, the delay unit 108 performs a time stretch operation of expanding and outputting the audio data in a temporal axis direction while maintaining pitch of sound of the audio data until the set delay target time coincides with the delay time of the audio data output from the delay unit 108 with respect to the audio data input to the delay unit 108.

[0073] The time stretch of the audio data is performed such that the length of the audio data in the temporal axis direction is not changed by a predetermined length (for example, 20% of the original length) or more with respect to the original length.

[0074] Thereafter, when the set delay target time coincides with the delay time of the audio data output from the delay unit 108 with respect to the audio data input to the delay unit 108, the delay unit 108 stops the time stretch, returns to the output of the audio data according to the normal reproduction speed, and reports the coincidence of the delay times to the controller 107.

[0075] When the coincidence of the delay times is reported, the controller 107 completes the delay processing.

[0076] Therefore, the delay processing started at time point T1 is completed at time point T4.

[0077] After the delay processing has been completed at the time point T4, as illustrated in Fig. 6, since no difference is caused in delay time between the audio data output by the IP radio player 102 and the audio data output by the delay unit 108, the selector 109 switches audio data to be output to the DA converter 110 between the audio data input from the IP radio player 102 and the audio data input from the delay unit 108, thereby enabling seamless switching of sound output from the speaker 112 between the sound of the audio data received from the radio broadcasting by the radio tuner 101 and the sound of the audio data received by the IP radio player 102.

[0078] Returning to Fig. 5, when the controller 107 starts the delay processing (step 508), the controller 107 monitors whether the counter value CV becomes greater than the threshold value ThR (ThR is for example, 360 in the counter control table of Fig. 3) (step 510), whether the counter value CV becomes less than the threshold value ThC (ThC is for example, 20 in the counter control table of Fig. 3) (step 512), and whether delay processing is completed (step 514).

[0079] It is noted that ThR, ThS, and ThC have a relationship of ThR > ThS > ThC.

[0080] When the counter value CV becomes greater than the threshold value ThR (step 510), the IP radio player 102 is instructed to stop the reception of the IP radio broadcasting (step 522), and the process returns to step 504. Here, in the case of stopping the reception of the IP radio broadcasting, the IP radio player 102 disconnects mobile communication with the WAN 3 of the mobile communication device 103 or the mobile phone 5.

[0081] On the other hand, when the counter value CV becomes greater than the threshold value ThC (step 512), the selector 109 switches the audio data output to the DA converter 110 to audio data output by the IP radio player 102 to switch sound output from the speaker 112 from sound of the audio data being received from the IP radio broadcasting by the IP radio player 102 (step 516) and the process proceeds to step 518. Here, in the case of proceeding from step 512 to step 516, the delay processing has not been completed at this time point, and therefore, switching from the sound of the audio data received from the radio broadcasting to the sound of the audio data received by the IP radio player 102 output from the speaker 112 is not seamlessly performed.

[0082] Even after the IP radio player 102 has switched the sound output to the speaker 112 to sound of the audio data being received from the IP radio broadcasting in step 516, the reception of the radio broadcasting being received is continued in radio tuner 101 as background.

[0083] On the other hand, when the delay processing

has completed (step 514), the selector 109 switches the audio data output to the DA converter 110 to audio data output by the IP radio player 102 to switch sound output from the speaker 112 from sound of the audio data being received from the IP radio broadcasting by the IP radio player 102 (step 516) and the process proceeds to step 518. Here, in this way, in the case of proceeding to step 516 from step 514, at this time point, the delay processing has been completed, and since the delay unit 108 delays the audio data received from the radio broadcasting by the delay time of the audio data received from the IP radio broadcasting with respect to the audio data received from the radio broadcasting and then outputs the audio data, so that the switching in step 516 enables the sound output from the speaker 112 to be seamlessly switched from the sound of the audio data received from the radio broadcasting to the sound of the audio data received by the IP radio player 102.

[0084] As described above, even after the IP radio player 102 has switched the sound output to the speaker 112 to sound of the audio data being received from the IP radio broadcasting, the reception of the radio broadcasting being received is continued in radio tuner 101 as background

[0085] Subsequently, when the IP radio player 102 switches the sound output to the speaker 112 to the sound being received from the IP radio broadcasting, whether the counter value CV exceeds the threshold value ThB is monitored (step 518).

[0086] Here, ThB is set such that ThB $\geq$ ThR.

[0087] When the counter value CV exceeds the threshold value ThB (step 518), the selector 109 switches the audio data output to the DA converter 110 to the audio data output by the delay unit 108, to switch sound output to the speaker 112 to the sound of the audio data received from the radio broadcasting from the radio tuner 101 (step 520). Here, at this time point, since the delay unit 108 delays the audio data received from the radio broadcasting by the delay time of the audio data received from the IP radio broadcasting with respect to the audio data received from the radio broadcasting and then outputs the audio data, the switching in step 520 enables the sound output from the speaker 112 to be seamlessly switched from the sound of the audio data received from the radio broadcasting to the sound of the audio data received by the IP radio player 102.

[0088] The IP radio player 102 is instructed to stop the reception of the IP radio broadcasting (step 522), and the process returns to step 504. Here, in the case of stopping the reception of the IP radio broadcasting, the IP radio player 102 disconnects mobile communication with the WAN 3 of the mobile communication device 103 or the mobile phone 5.

[0089] The seamless switching process performed by the controller 107 has been described above.

[0090] Relationship between the reception quality Q and the counter value CV is illustrated in Fig. 7.

[0091] Fig. 7b illustrates transition of the counter value CV updated by the counter updating process with respect to transition of the reception quality Q of Fig. 7a.

[0092] As described above, according to the counter updating process, at each time point, the counter value CV is updated with an update step (increase step or decrease step) corresponding to the quality range RQ representing the range of the reception quality including the reception quality Q, so as to come close to the range evaluation value ReRQ registered in the quality range RQ representing a range of reception quality including a reception quality Q at the time point. In addition, the range evaluation value ReRQ is smaller as it represents the range of the smaller reception quality Q.

[0093] Therefore, as also illustrated in the Fig. 7, the counter value CV is a value representing the quality tendency of the reception quality Q up to the present. There is a correlation between the quality tendency of the reception quality Q up to the present and a time point when the radio broadcasting cannot be normally received.

[0094] Therefore, by setting a time point at which reception of the IP radio broadcasting is started using the counter value CV, it is possible to start reception of the IP radio broadcasting at a more appropriate time point than the case of determining the time point of starting reception of the IP radio broadcasting according to only the reception quality at that time point.

[0095] That is, for example, when the radio broadcasting cannot be normally received, the quality tendency of the reception quality Q is gradually deteriorated before that time, but by using the counter value CV, it is possible to detect the tendency and to start reception of the IP radio broadcasting at an appropriate timing.

[0096] The above-described threshold values ThR and ThB are values of the counter value CV which represent the lower limits of the quality tendency of the reception quality Q which can be regarded as being able to sufficiently receive the radio broadcasting, and the above-described threshold value ThC is a value of the counter value CV which represents the upper limit of the quality tendency of the reception quality Q which can be regarded as being in a reception state in which the radio broadcasting cannot be received or a value obtained by adding some offset to the value.

[0097] The embodiments of the present invention have been described above.

[0098] Here, the above-described embodiments are equivalent even when the direction of magnitudes of the counter values of the range evaluation values is reversed.

[0099] In other words, in this case, the sign of each increase step and each decrease step in the counter control table is reversed, and a larger numerical value is set for the range evaluation value for a smaller range of reception quality Q.

[0100] In addition, in the counter updating process, step 402 is a process of setting the counter value CV to 0, step 408 is a process of determining whether the range evaluation value ReRQ is greater than the counter value

CV, and step 410 is a process of determining whether the range evaluation value ReRQ is smaller than the counter value CV.

[0101] Further, ThB ≤ ThR < ThS < ThC is set and, in the seamless switching process, step 504 is a process of monitoring whether the counter value CV becomes greater than the threshold value ThS, step 510 is a process of monitoring whether the counter value CV becomes less than the threshold value ThR, step 512 is a process of monitoring whether the counter value CV becomes greater than the threshold value ThC, and step 518 is a process of monitoring whether the counter value CV becomes less than the threshold value ThB.

Claims

1. A radio broadcasting reception apparatus capable of receiving radio broadcasting and IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting, the radio broadcasting reception apparatus comprising:

   a radio receiver configured to receive the radio broadcasting;
   an IP radio player (102) configured to receive the IP radio broadcasting;
   an output unit configured to output one of reception sound of the radio receiver and reception sound of the IP radio player (102);
   a delay unit (108) configured to delay the reception sound of the radio receiver output by the output unit;
   an evaluation value calculator configured to calculate an evaluation value; and
   a seamless switching controller configured to allow the IP radio player to start reception of the IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting that is outputting reception sound, allow the delay unit (108) to delay the reception sound of the radio receiver output by the output unit by a delay time of the IP radio broadcasting with respect to the radio broadcasting, and allow the output unit to switch output reception sound from the reception sound of the radio receiver to the reception sound of the IP radio player when the evaluation value is less than a predetermined threshold value, during a period of time for which the output unit is outputting reception sound of the radio receiver, **characterized in that**
   the evaluation value calculator is configured to calculate the evaluation value by changing the evaluation value by a predetermined update amount in a direction close to a working reference value that is a reference value corresponding to a current reception quality range that is the range of reception quality including reception quality of the radio broadcasting of the radio receiver at a time point according to a predetermined correspondence relationship between a range of reception quality and a plurality of reference values, at each time point, and
   the predetermined correspondence relationship is a relationship in which a range of better reception quality corresponds to a larger reference value.

2. The radio broadcasting reception apparatus according to claim 1, **characterized in that**, when the evaluation value is larger than the working reference value, the evaluation value calculator is configured to use, in the calculation of the evaluation value, an update amount determined such that the evaluation value decreases increasingly as a current reception quality range is a range of worse reception quality, and
   when the evaluation value is smaller than the working reference value, the evaluation value calculator is configured to use in the calculation of the evaluation value, an update amount determined such that the evaluation value increases increasingly as a current reception quality range is a range of better reception quality,

3. The radio broadcasting reception apparatus according to claim 1 or 2, **characterized in that**, when the evaluation value is larger than the working reference value, the evaluation value calculator is configured to update the evaluation value in a range in which the evaluation value is not smaller than the working reference value, and
   when the evaluation value is smaller than the working reference value, the evaluation value calculator is configured to update the evaluation value in a range in which the evaluation value is not larger than the working reference value,

4. The radio broadcasting reception apparatus according to any one of claims 1 to 3, **characterized in that**, the radio broadcasting is at least one of a digital radio broadcasting and an analog radio broadcasting.

5. The radio broadcasting reception apparatus according to any one of claims 1 to 4. **characterized in that** the radio broadcasting reception apparatus is an in-vehicle type radio broadcasting reception apparatus mounted on a vehicle, and the IP radio player (102) receives the IP radio broadcasting via mobile communication.

6. A seamless switching method for seamlessly switching output sound from reception sound of radio broadcasting to reception sound of IP radio broadcasting in a radio broadcasting reception apparatus

capable of receiving the radio broadcasting and the IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting, the method comprising:

an evaluation value calculation step of calculating, by the radio broadcasting reception apparatus, an evaluation value representing a degree of quality;

a seamless switching step of starting reception of the IP radio broadcasting having relationship of simultaneous broadcasting with the radio broadcasting that is outputting reception sound, delaying the reception sound of the radio receiver output by a delay time of the IP radio broadcasting with respect to the radio broadcasting, and switching output reception sound from the reception sound of the radio broadcasting to the reception sound of the IP radio player in a case where the evaluation value represents that a degree of quality is worse than a predetermined degree when the reception sound of the radio broadcasting is being output by the radio broadcasting reception apparatus, **characterized in that**

the evaluation value calculation step calculates the evaluation value by changing the evaluation value by a predetermined update amount in a direction close to a working reference value that is a reference value corresponding to a current reception quality level that is a level of the reception quality of the radio broadcasting in a time point according to a predetermined correspondence relationship between a level of reception quality and a plurality of reference values, at each time point, and

the reference value represents a degree of a specific quality, and the predetermined correspondence relationship is a relationship in which a level of better reception quality corresponds to a reference value representing a degree of better quality.

7. The seamless switching method according to claim 6, **characterized in that**, when the evaluation value represents degree of better quality than the working reference value, the evaluation value calculation step uses an update amount for the calculation of the evaluation value, the update amount being determined such that the evaluation value varies increasingly as a current reception quality level is a level of worse reception quality, and

when the evaluation value represents degree of worse quality than the working reference value, the evaluation value calculation step uses an update amount for the calculation of the evaluation value, the update amount being determined such that the evaluation value varies increasingly as a current reception quality level is a level of better reception quality.

FIG. 1

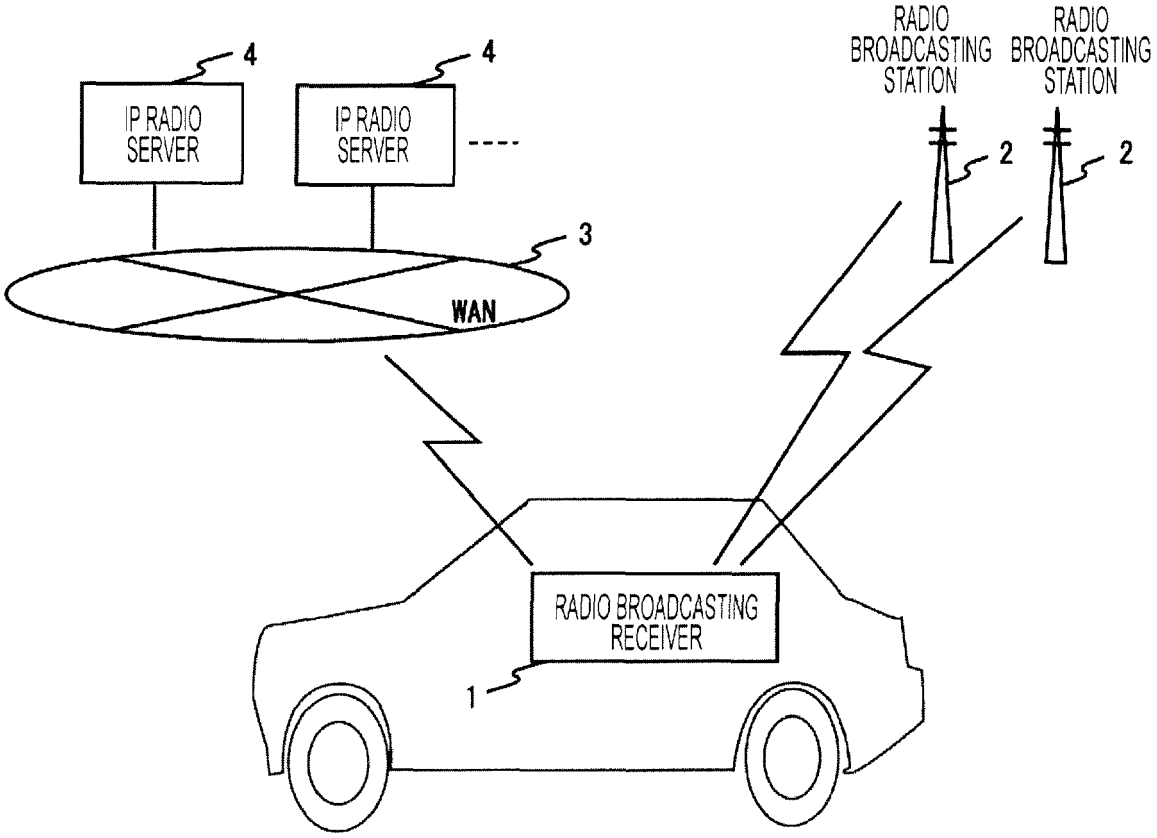

RADIO BROADCASTING STATION
RADIO BROADCASTING STATION
2
2
4
4
IP RADIO SERVER
IP RADIO SERVER
3
WAN
RADIO BROADCASTING RECEIVER
1

FIG. 2

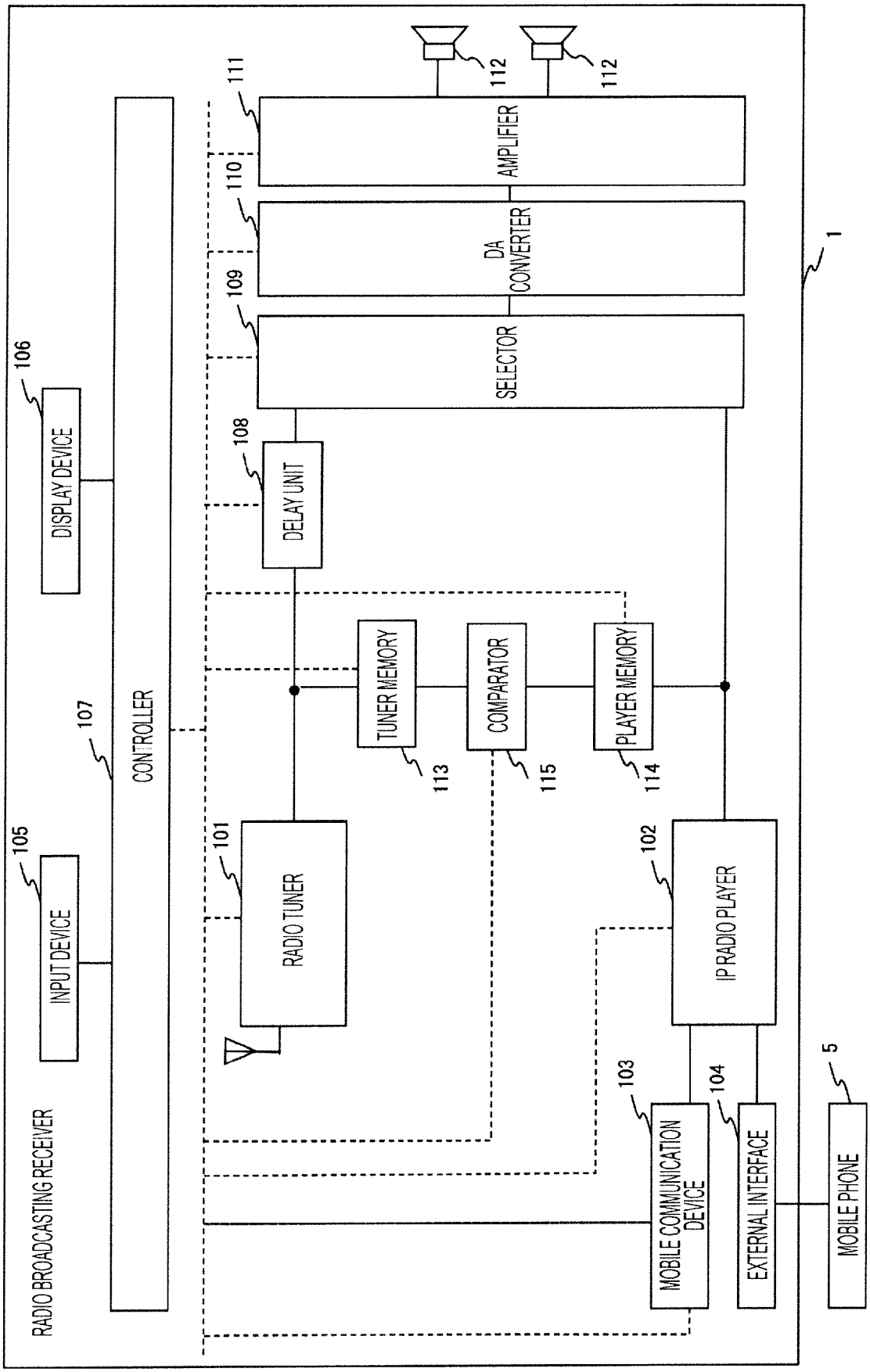

RADIO BROADCASTING RECEIVER
1
AMPLIFIER
111
112
112
DA CONVERTER
110
SELECTOR
109
DELAY UNIT
108
DISPLAY DEVICE
106
CONTROLLER
107
INPUT DEVICE
105
TUNER MEMORY
113
COMPARATOR
115
PLAYER MEMORY
114
RADIO TUNER
101
IP RADIO PLAYER
102
MOBILE COMMUNICATION DEVICE
103
EXTERNAL INTERFACE
104
MOBILE PHONE
5

FIG. 3

QUALITY RANGE	DECREASE STEP	INCREASE STEP	RANGE EVALUATION VALUE
91-100	0	+10	480
81-90	-1	+6	440
71-80	-2	+5	400
61-70	-4	+4	380
51-60	-6	+3	250
41-50	-10	+2	200
31-40	-20	+1	120
21-30	-30	+1	60
11-20	-60	0	0
00-10	-120	0	0

COUNTER CONTROL TABLE

FIG. 4

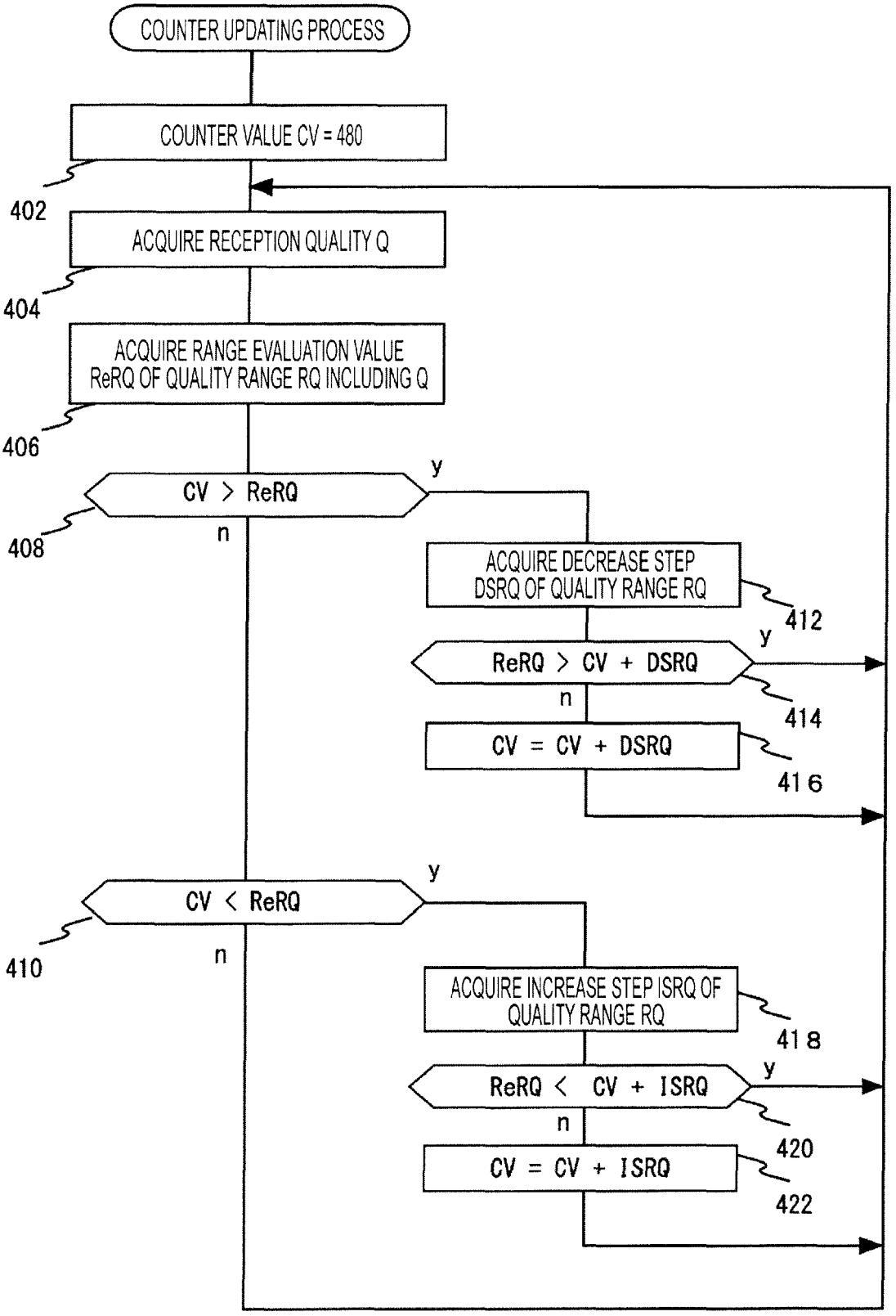

COUNTER UPDATING PROCESS
COUNTER VALUE CV = 480
402
ACQUIRE RECEPTION QUALITY Q
404
ACQUIRE RANGE EVALUATION VALUE ReRQ OF QUALITY RANGE RQ INCLUDING Q
406
CV > ReRQ
y
n
408
ACQUIRE DECREASE STEP DSRQ OF QUALITY RANGE RQ
412
ReRQ > CV + DSRQ
y
n
414
CV = CV + DSRQ
416
CV < ReRQ
y
n
410
ACQUIRE INCREASE STEP ISRQ OF QUALITY RANGE RQ
418
ReRQ < CV + ISRQ
y
n
420
CV = CV + ISRQ
422

FIG. 5

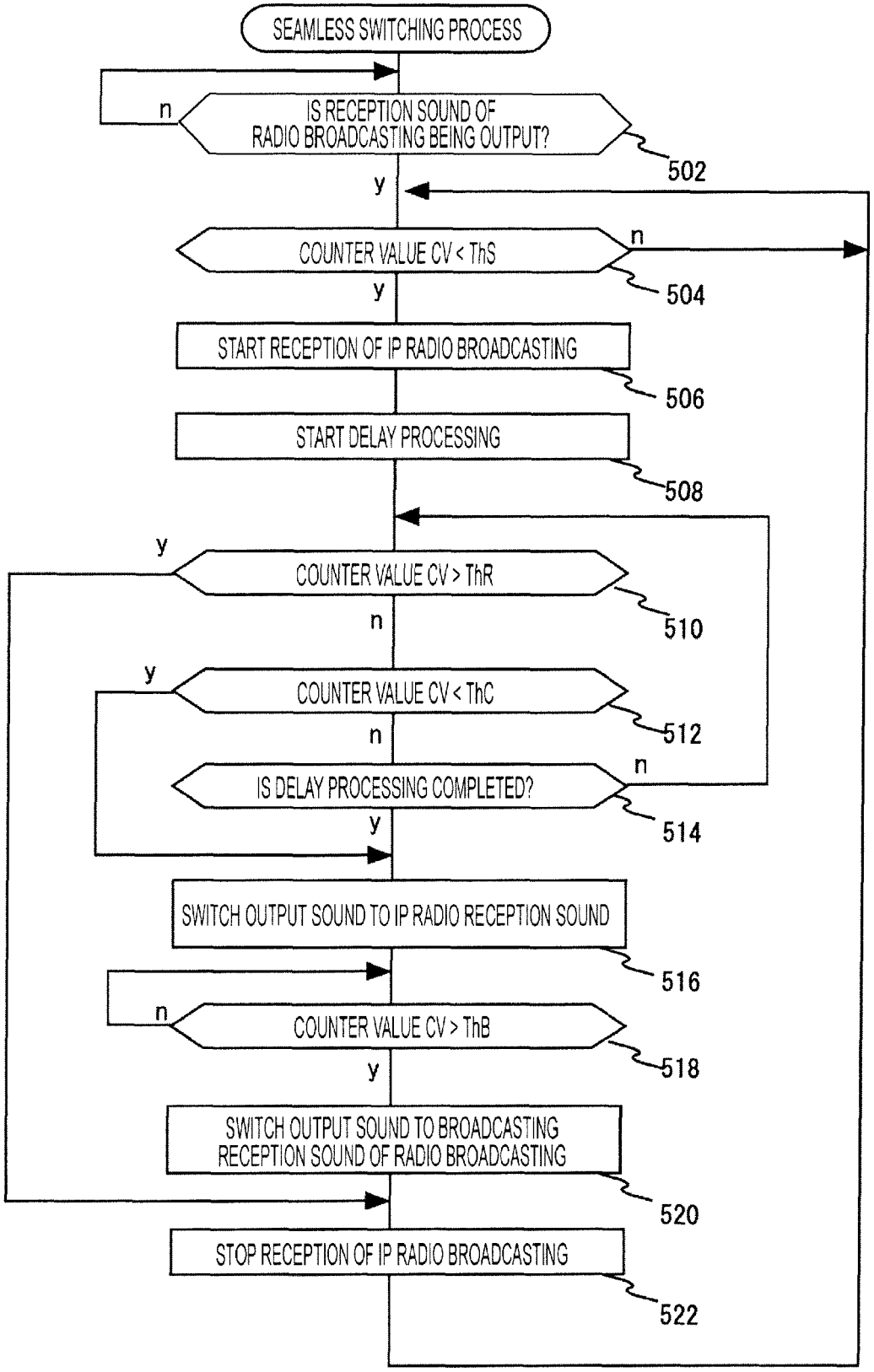

SEAMLESS SWITCHING PROCESS
IS RECEPTION SOUND OF RADIO BROADCASTING BEING OUTPUT?
502
n
y
COUNTER VALUE CV < ThS
504
n
y
START RECEPTION OF IP RADIO BROADCASTING
506
START DELAY PROCESSING
508
COUNTER VALUE CV > ThR
510
y
n
COUNTER VALUE CV < ThC
512
y
n
IS DELAY PROCESSING COMPLETED?
514
n
y
SWITCH OUTPUT SOUND TO IP RADIO RECEPTION SOUND
516
COUNTER VALUE CV > ThB
518
n
y
SWITCH OUTPUT SOUND TO BROADCASTING RECEPTION SOUND OF RADIO BROADCASTING
520
STOP RECEPTION OF IP RADIO BROADCASTING
522

FIG. 6

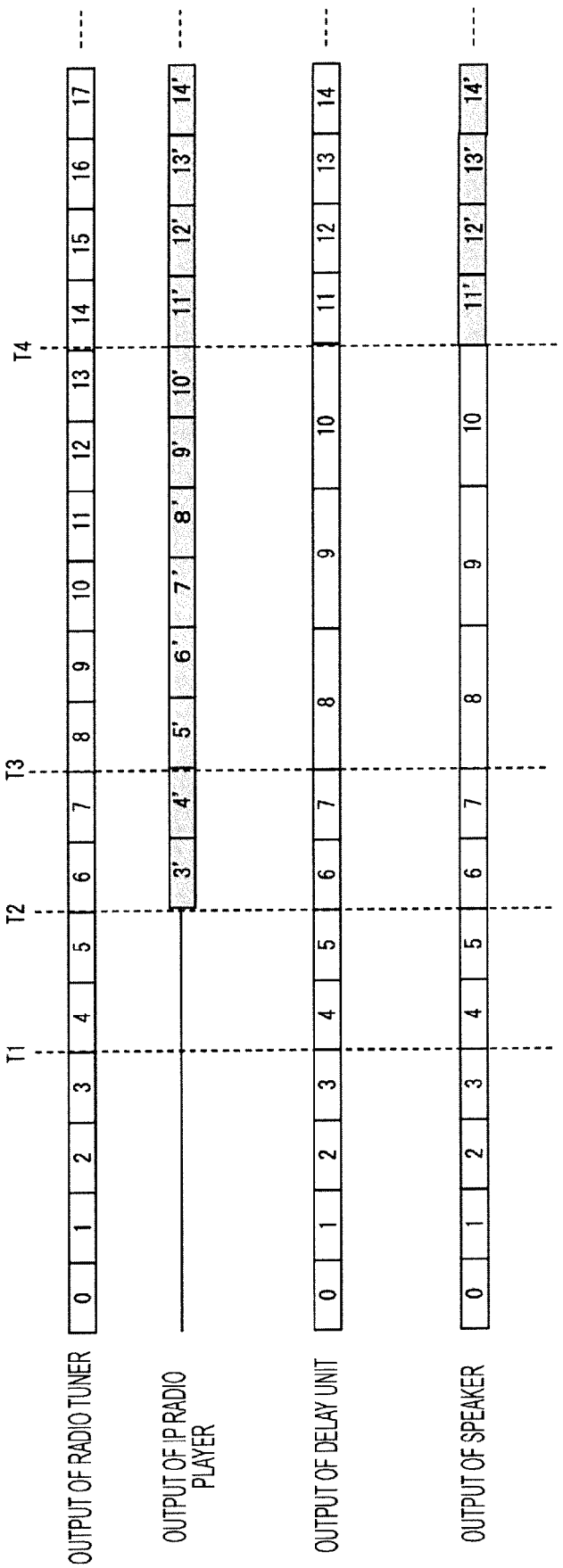

T1
T2
T3
T4
OUTPUT OF RADIO TUNER
OUTPUT OF IP RADIO PLAYER
OUTPUT OF DELAY UNIT
OUTPUT OF SPEAKER

FIG. 7A

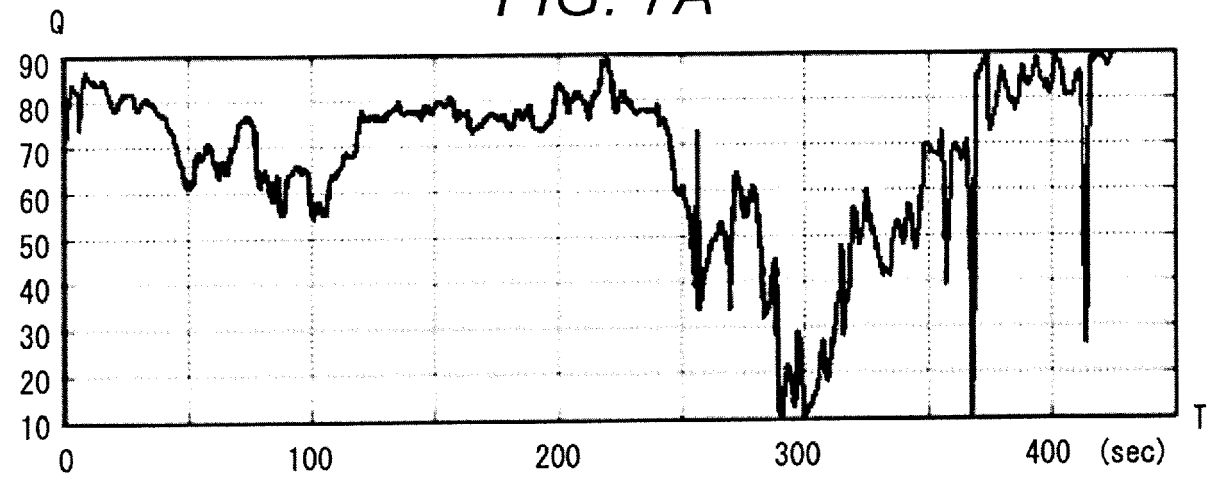
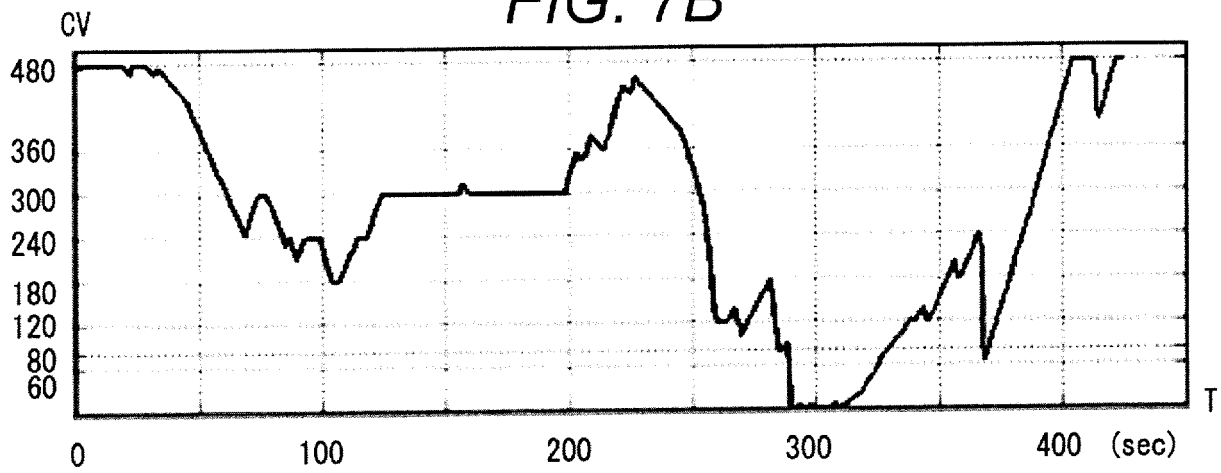

Q
90
80
70
60
50
40
30
20
10
0
100
200
300
400
(sec)
T

FIG. 7B


CV
480
360
300
240
180
120
80
60
0
100
200
300
400
(sec)
T

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EUROPEAN SEARCH REPORT

Application Number
EP 18 17 3517

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2016/119066 A1 (OLDEWURTEL FRANK [DE] ET AL) 28 April 2016 (2016-04-28) * paragraphs [0001] - [0002], [0012] - [0019], [0031]; figures 1-3 *	1-7	INV. H04H20/24 H04H20/26 H04H20/62
Y	EP 3 160 065 A1 (ALPINE ELECTRONICS INC [JP]) 26 April 2017 (2017-04-26) * paragraphs [0025], [0027] - [0028], [0055] - [0058] *	1-7	

TECHNICAL FIELDS SEARCHED (IPC)

H04H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	19 June 2018	Iovescu, Vladimir

CATEGORY OF CITED DOCUMENTS

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19-06-2018

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US 2016119066 A1	28-04-2016	CN 105284067 A	27-01-2016
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		EP 3005591 A1	13-04-2016
		US 2016119066 A1	28-04-2016
		WO 2014194970 A1	11-12-2014
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- JP 2003169380 A **[0004]**