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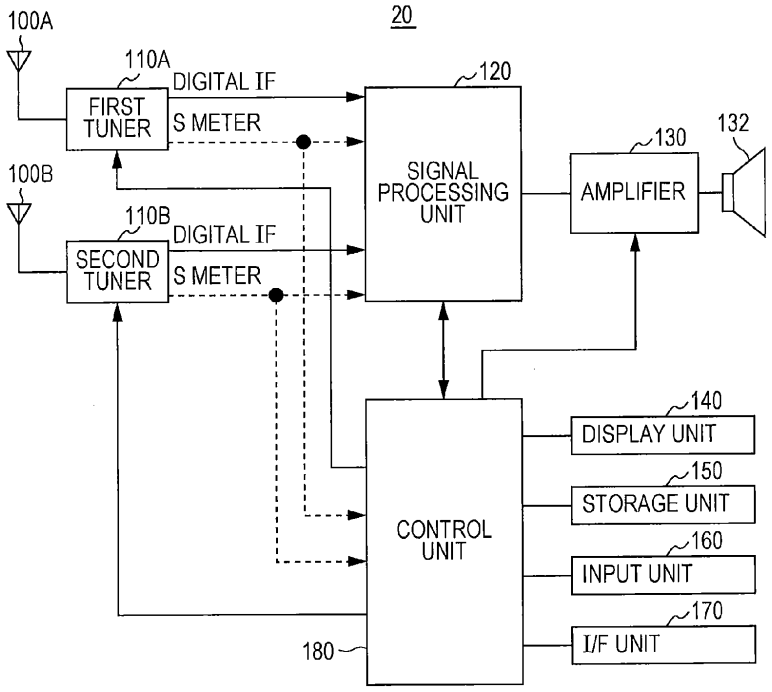
(54) Reception apparatus and method of displaying broadcasting station

(57) A radio reception apparatus (20) that receives an RDS broadcast scans a frequency band in a background operation with one tuner while outputting the radio broadcast with the other tuner to create a frequency table in which receivable frequencies are registered and display a broadcasting station list on the basis of the frequency table. A process (A) of extracting RDS data during the scanning, a process (B) of determining whether each frequency in the frequency table is receivable, and so on are performed in the radio reception apparatus. The broadcasting station corresponding to the frequency determined not to be receivable in the process (B) is immediately deleted from the broadcasting station list.

FIG. 1B



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Description

[0001] The present invention relates to a reception apparatus mounted in a vehicle, such as a movable body and, more particularly, to a radio reception apparatus capable of receiving a broadcast signal on which data is multiplexed.

[0002] Radio data system (hereinafter referred to as RDS) is a communications protocol standard, e.g. defined in IEC RDS standard version IEC 62106, for embedding small amounts of digital information in conventional FM radio broadcasts. Radio Broadcast Data System (RBDS), defined in NRSC-4-B, "United States RBDS Standard -- Specification of the Radio Broadcast Data System (RBDS)", is the official name used for the U.S. version of RDS; the two standards are only slightly different and the NRSC-4-B standard includes only those sections that differ from the European version of the Standard, IEC 62106, Specification of the Radio Data System (RDS) for VHF/FM sound broadcasting in the frequency range from 87.5 to 108.0MHz.

[0003] RDS/RBDS standardizes a variety of data that is multiplexed on radio broadcast signals and that are put into practical use in, for example, Europe or the U.S. For example, the data that is multiplexed includes information for identifying broadcast programs (Program Identification (PI)), information for identifying the genres of the broadcast programs (Program Type (PTY)), road traffic information using Traffic Message Channel (TMC) services, and so on.

[0004] A typical radio reception apparatus mounted in a vehicle is varied from time to time in its receiving sensitivity with the movement of the vehicle. If the receiving sensitivity of a broadcasting station that is currently listened to is degraded, it is necessary to switch the current broadcasting station to an alternative broadcasting station. Although the alternative broadcasting station having the same PI code as that of the broadcasting station that is currently listened to is generally searched for, one of two tuners in the radio reception apparatus can be operated in background in the search. In the background operation, frequency scanning of a reception bandwidth from a lower limit to an upper limit is periodically performed and a broadcasting station list in which broadcasting stations are arranged in alphabetical order or in descending order of electric field intensity is displayed to facilitate selection of a broadcasting station by a user (for example, refer to JP 2011-035883 A).

[0005] However, the creation of the broadcasting station list of receivable broadcasting stations by scanning the reception bandwidth from the lower limit to the upper limit, as disclosed in JP 2011-035883 A, has the following problems.

[0006] It takes a long time to scan the reception bandwidth from the lower limit to the upper limit in order to check the presence of the receivable broadcasting stations. In reception of an RDS/RBDS broadcast, such a scanning time is proportional to the number of receivable frequencies (broadcasting stations). For example, provided that 20 frequencies are receivable, it takes about two minutes to perform the scanning around the frequency band. This means that the broadcasting stations having the frequencies in the broadcasting station list reflect information that is acquired two minutes ago. In other words, the update cycle of the reception status of the broadcasting stations is up to about two minutes. For example, although a broadcasting station that was receivable two minutes ago may not currently be receivable, it is not possible to immediately delete the broadcasting station from the broadcasting station list even in such a case. Accordingly, even when the user refers to the broadcasting station list to select a broadcasting station, it is not possible for the user to receive the broadcast from the selected broadcasting station and results in audio output of only noise. In particular, when the vehicle is travelling in an area, such as a tunnel or an underground parking area, where the reception status is rapidly degraded, the number of broadcasting stations that are not receivable is increased to expose such a problem.

[0007] Therefore, it may be an object of the present invention to provide a reception apparatus and a broadcasting station displaying method that are capable of rapidly providing update information about broadcasting stations that are receivable and broadcasting stations that are not receivable to a user.

[0008] The afore-discussed problem is solved by the features of the independent claims. Further embodiments and developments are defined in the corresponding dependent claims. Further examples are provides for facilitating the understanding of the invention.

[0009] According to an embodiment of the present invention, a reception apparatus is capable of receiving a broadcast signal on which data is multiplexed. The reception apparatus includes at least first and second receiving units each capable of receiving the broadcast signal; a scanning unit that scans a frequency band with the second receiving unit while the broadcast signal received by the first receiving unit is being output; an extracting unit that extracts data from the broadcast signal received during the scanning by the scanning unit; a holding unit that holds a frequency table in which receivable frequencies within the frequency band scanned by the scanning unit are registered; a display unit that displays broadcasting stations corresponding to the frequency table held by the holding unit; a determining unit that determines whether each frequency in the frequency table is receivable during the scanning of the frequency band by the scanning unit; and a deleting unit that deletes the broadcasting station corresponding to the frequency determined not to be receivable by the determining unit from the display of the broadcasting stations.

[0010] If all alternative frequencies having the same program identification code as that of a frequency in the frequency table are not receivable, the determining unit preferably determines that the frequency is not receivable. The reception apparatus preferably further includes

a program identification code extracting unit that extracts the program identification code from the data extracted by the extracting unit and a creating unit that creates an alternative frequency table in which the frequencies having the same program identification code are registered on the basis of the extracted program identification code. The determining unit preferably refers to the alternative frequency table to determine whether each alternative frequency is receivable. If a receiving sensitivity of a certain frequency selected from the frequency table is lower than a threshold value and the receiving sensitivity of each alternative frequency registered in the alternative frequency table is lower than the threshold value, the determining unit preferably determines that the certain frequency is not receivable. If the receiving sensitivity of at least one alternative frequency in the alternative frequency table is higher than or equal to the threshold value, the determining unit preferably determines that the certain frequency is receivable.

[0011] The determining unit preferably determines in a time division manner whether each frequency in the frequency table is receivable while the scanning unit performs the scanning from a lower limit to an upper limit or from the upper limit to the lower limit of the frequency band. The determining unit preferably includes a unit that sets a flag in the frequency table if the determining unit determines that a certain frequency is not receivable, and the deleting unit preferably deletes the broadcasting station corresponding to the flag that is set from the display of the broadcasting stations. The reception apparatus preferably further includes a selecting unit that selects a broadcasting station from a list of the broadcasting stations displayed by the display unit and a control unit that controls selection of a broadcasting station by the first receiving unit on the basis of the broadcasting station selected by the selecting unit. The first and second receiving units preferably each receive an RDS broadcast. The first and second receiving units preferably each receive a digital broadcast.

[0012] According to another embodiment of the present invention, a method of displaying a broadcasting station in a reception apparatus capable of receiving a broadcast signal on which data is multiplexed includes scanning a frequency band for a receivable frequency with a second receiving unit while a broadcast signal received by a first receiving unit is being output; extracting data from the broadcast signal received during the scanning; holding a frequency table in which the receivable frequencies within the frequency band that is scanned are registered; displaying broadcasting stations corresponding to the frequency table that is held; determining whether each frequency in the frequency table is receivable during the scanning of the frequency band; and deleting the broadcasting station corresponding to the frequency determined not to be receivable by the determining from the display of the broadcasting stations.

[0013] According to the present invention, it is determined whether each frequency in the frequency table is receivable during the scanning of the frequency band and, if it is determined that the frequency is not receivable, the broadcasting station corresponding to the frequency is deleted from the display of the broadcasting stations.

[0014] Accordingly, by the invention, it is possible to immediately update the display of the broadcasting stations at a time when any non-receivable broadcasting station is found, unlike the related art in which the update of the display of the broadcasting stations in response to completion of the scanning of the entire frequency band is waited for. Consequently, it is possible to provide the up-to-date reliable display of the receivable broadcasting stations to the user. The probability that the user is not capable of receiving a broadcasting station when the user selects the broadcasting station from the list is reduced, compared with that in the related art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1A illustrates an example of the configuration of an in-vehicle electronic system according to an embodiment of the present invention;

Fig. 1B is a block diagram illustrating an example of the configuration of a radio reception apparatus according to an embodiment of the present invention;

Fig. 2 illustrates exemplary functional blocks included in a control unit illustrated in Fig. 1B;

Fig. 3 illustrates an example of a frequency table in which frequencies determined to be receivable are registered;

Fig. 4 illustrates an example of an alternative frequency table in which the relationship between PI codes and alternative frequencies is defined;

Fig. 5 illustrates an example of how a broadcasting station list is displayed;

Fig. 6 illustrates an example of the frequency table including a reception determination flag;

Fig. 7 is a graph describing exemplary processing in scanning in the radio reception apparatus according to the present embodiment;

Fig. 8 is a flowchart illustrating an exemplary operational process of creating the frequency table in the radio reception apparatus according to the present embodiment;

Fig. 9 is a flowchart illustrating an exemplary process of determining the receiving sensitivity of a frequency in the frequency table in the radio reception apparatus according to the present embodiment;

Fig. 10 is a flowchart illustrating an exemplary operational process of creating the broadcasting station list according to the present embodiment;

Fig. 11 is a flowchart illustrating an exemplary operational process of updating the broadcasting station list according to the present embodiment;

Fig. 12A illustrates update timing of the broadcasting

station list in a radio reception apparatus in related art;

Fig. 12B illustrates update timing of the broadcasting station list in the present embodiment;

Fig. 13A illustrates an example of how the broadcasting station list is displayed in the radio reception apparatus in the related art; and

Fig. 13B illustrates an example of how the broadcasting station list is displayed in the present embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0016] Embodiments of the present invention will herein be described with reference to the attached drawings. A radio reception apparatus mounted in an automobile, which is a movable body, is exemplified in the embodiments of the present invention. The radio reception apparatus is capable of receiving a radio broadcast signal on which data is multiplexed. The radio reception apparatus receives an RDS broadcast signal as an example here.

[0017] Fig. 1A illustrates an example of the configuration of an in-vehicle electronic system according to an embodiment of the present invention. Referring to Fig. 1A, an in-vehicle electronic system 10 includes a radio reception apparatus 20 mounted in a vehicle and a navigation apparatus 30. The radio reception apparatus 20 receives a radio broadcast signal selected by a user and supplies road traffic information included in data multiplexed on the radio broadcast signal to the navigation apparatus 30.

[0018] The radio reception apparatus 20 of the embodiment is a reception apparatus in accordance with the Radio Data System (hereinafter referred to as RDS) standard that is a communications protocol standard for embedding small amounts of digital information in conventional Frequency Modulation (FM) radio broadcasts in Europe. Alternatively or additionally, the radio reception apparatus 20 may be a receiver in accordance with the Radio Broadcast Data System (RBDS) standard that is the official name used for the U.S. version of RDS; both standards are only slightly different.

[0019] In the RDS broadcast signal, digital data (RDS data) is multiplexed on an analog FM broadcast signal. The RDS data includes, for example, a PI code for identifying each broadcast program, the name of the broadcast program, the genre of the broadcast program, and the road traffic information using the TMC service.

[0020] The road traffic information acquired by the radio reception apparatus 20 is supplied to the navigation apparatus 30. The navigation apparatus 30 is capable of displaying the acquired road traffic information on a road map or using the acquired road traffic information for audio guidance. An exemplary configuration of the in-vehicle electronic system 10 is illustrated in Fig. 1A. The in-vehicle electronic system 10 may include a television reception apparatus, a digital versatile disk (DVD)-Blu-ray disc playback apparatus, a multifunctional terminal (smartphone), etc. or may include only the radio reception apparatus.

[0021] Fig. 1B is a block diagram illustrating an example of the configuration of the radio reception apparatus 20 according to the present embodiment. Referring to Fig. 1B, the radio reception apparatus 20 includes a first antenna 100A, a first tuner 110A, a second antenna 100B, a second tuner 110B, a signal processing unit 120, an amplifier 130, a speaker 132, a display unit 140, a storage unit 150, an input unit 160, an interface (I/F) unit 170, and a control unit 180. The first tuner 110A receives a broadcast signal of a frequency (broadcasting station) selected via the first antenna 100A. The second tuner 110B receives a broadcast signal of a frequency (broadcasting station) selected via the second antenna 100B. The signal processing unit 120 receives the reception signals from the first and second tuners 110A and 110B to perform necessary processing for each reception signal. The amplifier 130 amplifies an audio signal processed in the signal processing unit 120. The speaker 132 outputs the audio signal amplified by the amplifier 130. The display unit 140 is capable of displaying data, etc. decoded in the signal processing unit 120. The input unit 160 receives an input from the user. The interface unit 170 is used to connect the radio reception apparatus 20 to an external device, such as the navigation apparatus 30. The control unit 180 controls the first and second tuners 110A and 110B, the signal processing unit 120, the amplifier 130, and so on.

[0022] The first tuner 110A includes, for example, an radiofrequency (RF) amplifier that receives an RF signal from the first antenna 100A to amplify the received RF signal; a tuning circuit that selects a signal having the frequency of a desired station from the amplified RF signal; a mixer that mixes a frequency signal from a local oscillator with the RF signal to generate an intermediate-frequency (IF) signal; and a signal strength meter (S meter) circuit that performs direct-current detection to the IF signal to extract a received electric field intensity signal (S meter signal), as widely known.

[0023] However, instead of the electric field intensity signal, a carrier-to-noise (C/N) value may be used to determine the receiving sensitivity.

[0024] In addition, the first tuner 110A converts the IF signal and the S meter signal into digital signals with an analog-to-digital converter (ADC) and supplies the digital signals to the signal processing unit 120 and the control unit 180. The second tuner 110B is configured in the same manner as in the first tuner 110A. The first and second tuners 110A and 110B are capable of selecting the same frequency or different frequencies in response to an instruction from the control unit 180. In the present embodiment, while a radio broadcast is being listened to with the first tuner 110A, the second tuner 110B scans the frequency band in the background operation to check receivable frequencies and extract the RDS data.

[0025] The signal processing unit 120 is, for example,

a digital signal processor (DSP).

[0026] The signal processing unit 120 is capable of performing signal processing including Fast Fourier Transform (FFT), digital filtering, signal synchronization, time-frequency deinterleave, audio decoding, data decoding, and phase diversity. The above signal processing can be controlled by using software stored in a program memory in the signal processing unit 120.

[0027] The signal processing unit 120 preferably includes a digital-to-analog converter (DAC). In this case, the signal processing unit 120 extracts an audio signal from the digital signal received from the first tuner 110A, converts the audio signal into an analog signal, and supplies the analog signal to the amplifier 130 for audio output.

[0028] In addition, the signal processing unit 120 extracts the RDS data from the signal received from the second tuner 110B to enable a variety of processing for the RDS data. For example, the signal processing unit 120 may extract the PI code, a program service name (Program Service (PS)), the road traffic information, etc. from the RDS data to supply the extracted information to the control unit 180.

[0029] The control unit 180 is, for example, a microcontroller.

[0030] The control unit 180 executes a program stored in a memory to control each component. The control unit 180 preferably causes the second tuner 110B to scan the frequency band in the background processing while causing the first tuner 110A to receive a radio broadcast to acquire the RDS data via the signal processing unit 120.

[0031] Fig. 2 illustrates exemplary functional blocks included in the control unit 180 in the present embodiment. Referring to Fig. 2, the control unit 180 includes a frequency scanner 200, an RDS data acquirer 202, a PI code extractor 204, an alternative broadcasting station creator 206, an alternative broadcasting station holder 208, a frequency table creator 210, a frequency table holder 212, a broadcasting station display block 214, a receiving sensitivity determiner 216, and a broadcasting station deleter 218.

[0032] The frequency scanner 200 causes the second tuner 110B to scan the entire frequency band at a certain frequency interval in the background processing.

[0033] The RDS data acquirer 202 acquires the RDS data extracted in the scanning of the frequency band via the signal processing unit 120.

[0034] The PI code extractor 204 extracts the PI code from the acquired RDS data.

[0035] The alternative broadcasting station creator 206 creates an alternative frequency table in which the frequencies having the same PI code are registered on the basis of the extracted PI code.

[0036] The alternative broadcasting station holder 208 holds the created alternative frequency table.

[0037] The frequency table creator 210 determines frequencies at which the electric field intensity signal received in the scanning of the frequency band is higher than or equal to a threshold value to create a frequency table in which such receivable frequencies are registered.

[0038] The frequency table holder 212 holds the created frequency table.

[0039] The broadcasting station display block 214 displays a list of the receivable broadcasting stations on the basis of the frequency table held by the frequency table holder 212.

[0040] The receiving sensitivity determiner 216 determines whether each frequency in the frequency table is receivable during the scanning of the frequency band.

[0041] The broadcasting station deleter 218 deletes the broadcasting station corresponding to the frequency that is determined not to be receivable by the receiving sensitivity determiner 216 from the broadcasting station list.

[0042] The frequency scanner 200 causes the second tuner 110B to scan a predetermined frequency band from an upper limit to a lower limit or from the lower limit to the upper limit at a certain frequency interval while a radio broadcast is being listened to with the first tuner 110A to check the receivable frequencies. Whether a frequency is receivable is based on the determination of whether the electric field intensity signal from the second tuner 110B is higher than or equal to the threshold value. If the electric field intensity signal from the second tuner 110B is higher than or equal to the threshold value, it is determined that the frequency is receivable. The result of the scanning in the frequency scanner 200 is sequentially supplied to the frequency table creator 210.

[0043] When the receivable frequency is detected by the frequency scanner 200, the RDS data multiplexed on the broadcast signal of the frequency is extracted by the signal processing unit 120 and the extracted RDS data is supplied to the RDS data acquirer 202. The PI code extractor 204 extracts the PI code, which is program identification information at the frequency that is being received, from the RDS data. The extracted PI code is supplied to the frequency table creator 210.

[0044] The frequency table creator 210 receives the frequency that is determined to be receivable by the frequency scanner 200 and the PI code extracted by the PI code extractor 204 to create the frequency table in which the frequency is paired with the PI code.

[0045] For example, when an FM broadcast in Europe is received, the second tuner 110B is caused to scan a frequency band from 108.0 MHz to 87.5 MHz at a frequency interval of 100 KHz in order to determine the receivable frequencies.

[0046] Fig. 3 illustrates an example of the frequency table in which frequencies determined to be receivable are registered. The relationship between the receivable frequencies and the PI codes corresponding to the frequencies is defined in the frequency table. The frequency table is updated such that a receivable broadcasting station is registered each time the broadcasting station is

found during the scanning of the entire frequency band. However, in the present embodiment, the receiving sensitivity of each frequency registered in the frequency table is determined during such normal scanning and the result of the determination is appropriately reflected in the frequency table, as described below.

[0047] The alternative broadcasting station creator 206 creates the alternative frequency table on the basis of the PI code extracted by the PI code extractor 204. The frequencies having the same PI code are registered in the alternative frequency table. In other words, the alternative frequency table is a table for identifying the broadcasting station that delivers the same broadcast program as that of the broadcasting station that is being received.

[0048] Fig. 4 illustrates an example of the alternative frequency table. For example, in an alternative frequency table 220 in Fig. 4, the current frequency is 98.5 MHz and the PI code of the frequency is D303 (refer to Fig. 3). The alternative frequencies having D303 as the PI code are 92.3 MHz, 94.3 MHz, 99.7 MHz, and 107.5 MHz represented by AF(1) to AF(4), respectively. The alternative frequency table 220 has "BAYERN 3" registered as the program service name (PS). Such alternative frequency tables are created at least for the frequencies included in the frequency table illustrated in Fig. 3.

[0049] The broadcasting station display block 214 refers to the frequency table illustrated in Fig. 3 and the PS of the alternative frequency table to display the broadcasting station list corresponding to the receivable frequencies.

[0050] Fig. 5 illustrates an example of how the broadcasting station list is displayed. This broadcasting station list includes a row 230 in which the program service name that is being received is displayed and a list row 240 below the row 230 in which a list of the program service names corresponding to the receivable frequencies is displayed. In the list row 240, identification indicator 242 is added to the broadcasting program that is being received. For example, the genres of the broadcasting programs and the frequencies of the broadcast programs may also be displayed in the broadcasting station list as information other than the program service names.

[0051] The receiving sensitivity determiner 216 determines whether each frequency included in the frequency table illustrated in Fig. 3 is receivable. The determination method is described in detail below. It is noted that the determination is performed in a time division manner during the scanning of the frequency band by the frequency scanner 200. The result of the determination by the receiving sensitivity determiner 216 is supplied to the broadcasting station deleter 218. The broadcasting station deleter 218 deletes the broadcasting station that is not receivable from the broadcasting station list.

[0052] The result of the determination by the receiving sensitivity determiner 216 is preferably represented by a reception determination flag associated with a frequency table illustrated in Fig. 6. Referring to Fig. 6, "1" denotes that the corresponding frequency is receivable. If the frequency is determined not to be receivable, the flag of the frequency is switched to "0." Upon switching of the reception determination flag to "0", the broadcasting station deleter 218 deletes the broadcasting station corresponding to the frequency from the broadcasting station list illustrated in Fig. 5.

[0053] An exemplary operation of the radio reception apparatus according to the present embodiment will now be described. Fig. 7 is a graph describing exemplary processing in the scanning performed by the second tuner 110B in the background operation.

[0054] Referring to Fig. 7, the vertical axis represents frequency and the horizontal axis represents time. The upper limit of the frequency band is set to 108.0 MHz and the lower limit thereof is set to 87.5 MHz. In the example in Fig. 7, the scanning from the upper limit to the lower limit is performed three times. A process A indicates extraction of the RDS data from an RDS broadcasting station. A process B indicates determination of the receiving sensitivity of a frequency registered in the frequency table. A process C indicates extraction of the road traffic information from a TMC broadcasting station.

[0055] Referring to Fig. 7, the scanning by the frequency scanner 200 is started. Upon determination of a frequency f1 to be receivable, a broadcast signal of the RDS broadcasting station is received and the process A of extracting the RDS data from the broadcast signal is performed.

[0056] The RDS data includes, for example, the PI code, the information (PTY) for identifying the genre of the program, the program service name, and traffic program identification (TP).

[0057] Although only the process A at the frequency f1 is indicated in the example in Fig. 7, the process A is similarly performed for the other receivable frequencies. Each time the receivable broadcasting station is found during the scanning of the frequency band, the corresponding frequency and the PI code are registered in, for example, the frequency table illustrated in Fig. 6 and the reception determination flag is set to "1." Upon completion of the scanning of the entire frequency band once, the frequency table illustrated in Fig. 3 or Fig. 6 is completed.

[0058] Fig. 8 is a flowchart illustrating an exemplary operational process of creating the frequency table by the frequency scanner 200. Referring to Fig. 8, in Step S101, the frequency scanner 200 varies the frequency of the second tuner 110B. In Step S102, the electric field intensity signal of the frequency received by the second tuner 110B is supplied to the control unit 180. In Step S103, the control unit 180 determines whether the electric field intensity signal is higher than or equal to a threshold value. If the electric field intensity signal is lower than the threshold value (NO in Step S103), the process goes back to Step S101. If the electric field intensity signal is higher than or equal to the threshold value (YES in Step S103), in Step S104, the control unit 180 determines that

the frequency is receivable. In Step S105, the control unit 180 determines whether the broadcasting station corresponding to the frequency is an RDS broadcasting station. If the broadcasting station corresponding to the frequency is not an RDS broadcasting station (NO in Step S105), the process goes back to Step S101. If the broadcasting station corresponding to the frequency is an RDS broadcasting station (YES in Step S105), in Step S106, the RDS data is extracted in the process A, as illustrated in Fig. 7. In Step S107, the frequency and the corresponding PI code are registered in the frequency table. In Step S108, it is determined whether the scanning reaches the upper limit or the lower limit of the frequency band. If the scanning does not reach the upper limit or the lower limit of the frequency band (NO in Step S108), the process goes back to Step S101. If the scanning reaches the upper limit or the lower limit of the frequency band (YES in Step S108), the scanning is terminated. Then, the next scanning is started.

[0059] Referring back to Fig. 7, upon completion of the process A, the process B of determining whether the frequency registered in the frequency table is receivable is performed. The determination may be started at any frequency in the frequency table. For example, when the scanning is started from higher frequencies, the check of the receiving sensitivity is performed for the frequencies in the frequency table in descending order. The receiving sensitivity of a frequency f7 registered in the frequency table is determined in the example in Fig. 7. The process B is performed by the receiving sensitivity determiner 216 in the time division manner during the scanning of the frequency band by the frequency scanner 200.

[0060] Fig. 9 is a flowchart illustrating an exemplary process of determining the receiving sensitivity of a frequency in the frequency table. Referring to Fig. 8, in Step S201, the receiving sensitivity determiner 216 selects one frequency from the multiple frequencies registered in the frequency table. In Step S202, the receiving sensitivity determiner 216 determines whether the electric field intensity signal of the frequency is higher than or equal to a threshold value. At this time, the second tuner 110B is tuned to the frequency to be subjected to the determination of the receiving sensitivity under the control of the control unit 180. If the electric field intensity signal of the frequency is higher than or equal to the threshold value (YES in Step S202), the process goes back to Step S201. Since the frequency is receivable when the electric field intensity signal of the frequency is higher than or equal to the threshold value, the next frequency is selected from the frequency table and the receiving sensitivity of the next frequency is determined. The determination of the next frequency is performed in the process B allocated to the next time division period.

[0061] If the electric field intensity signal of the frequency is lower than the threshold value (NO in Step S202), in Step S203, the alternative frequency table is searched on the basis of the PI code corresponding to the frequency. In Step S204, the alternative frequency registered in the alternative frequency table is selected. In Step S205, the receiving sensitivity of the alternative frequency is determined. For example, if it is determined that the electric field intensity signal of the frequency 98.5 MHz in the frequency table illustrated in Fig. 3 is lower than the threshold value, the alternative frequency table (refer to Fig. 4) corresponding to the PI code "D303" of the frequency is searched. Since the four alternative frequencies AF(1) to AF(4) are registered in the alternative frequency table, the receiving sensitivities of the four alternative frequencies are determined. The determination is based on the determination of whether the electric field intensity signal when the second tuner 110B is tuned to the alternative frequency is higher than or equal to the threshold value, as in the above manner.

[0062] In Step S206, it is determined whether the receiving sensitivities of all the alternative frequencies are degraded, that is, it is determined whether the electric field intensity signals of all the alternative frequencies are lower than the threshold value. If the receiving sensitivities of all the alternative frequencies are degraded, that is, the electric field intensity signals of all the alternative frequencies are lower than the threshold value (YES in Step S206), in Step S207, it is determined that the frequency selected from the frequency table is not receivable. In Step S208, the receiving sensitivity determiner 216 switches the reception determination flag of the frequency to "0." In response to the switching of the reception determination flag to "0", the broadcasting station list is updated. In Step S209, the broadcasting station deleter 218 deletes the broadcasting station corresponding to the flag "0" from the broadcasting station list. If the electric field intensity signal of any alternative frequency is higher than or equal to the threshold value (NO in Step S206), it is determined that the frequency selected from the frequency table is receivable and the process goes back to Step S201 to select the next frequency from the frequency table. In Step S210, it is determined whether an undetermined frequency exists in the frequency table. If an undetermined frequency exists in the frequency table (YES in Step S210), the process goes back to Step S201. If no undetermined frequency exists in the frequency table (NO in Step S210), the process is terminated. The process B of determining the receiving sensitivity of the frequency registered in the frequency table is performed in the time division manner in parallel to the scanning of the frequency band by the frequency scanner 200.

[0063] Referring back to Fig. 7 again, at a frequency f2, the process C of extracting the road traffic information (TMC data) transmitted from the TMC broadcasting station is performed. Then, at frequencies f6 and f7, the process B of determining the receiving sensitivity of the frequency registered in the frequency table is performed. Upon completion of the first scanning, the second tuner 110B starts the second scanning. When a larger number of receivable frequencies exist, it takes a longer time to perform the scanning once. For example, when about 20 receivable frequencies exist, it takes about two minutes

to perform the scanning once.

[0064] Fig. 10 is a flowchart illustrating an exemplary operational process of creating the broadcasting station list. Referring to Fig. 10, in Step S301, the broadcasting station display block 214 refers to the frequency table created by the frequency table creator 210 to extract the program service name (PS) corresponding to each frequency from the RDS data. In Step S302, the broadcasting station display block 214 creates the broadcasting station list, as illustrated in Fig. 5, which is a list of the broadcasting station name corresponding to the frequency that is being received and the receivable broadcasting station names.

[0065] In the process B illustrated in Fig. 7, if it is determined by the receiving sensitivity determiner 216 that the frequency in the frequency table is not receivable, the reception determination flag is set to "0." In Step S303, it is determined whether the reception determination flag set to "0" exists. If the reception determination flag set to "0" exists (YES in Step S303), in Step S304, the broadcasting station deleter 218 deletes the broadcasting station corresponding to the flag "0" from the broadcasting station list. If the reception determination flag set to "0" does not exist (NO in Step S303), the process skips Step S304.

[0066] Fig. 11 is a flowchart illustrating an exemplary operational process of updating the display of the broadcasting station list. Referring to Fig. 11, in Step S401, the broadcasting station display block 214 refers to the frequency table to display the broadcasting station list including the broadcasting station name that is being received and the receivable broadcasting station names. In Step S402, the scanning of the frequency band by the frequency scanner 200 is performed during the display of the broadcasting station list to determine whether the receivable frequency exists and, in parallel to the determination of the presence of the receivable frequency, the receiving sensitivity determiner 216 determines whether the frequency registered in the frequency table is receivable. The results of the determinations are reflected in the flag in the frequency table. In Step S403, it is determined whether the flag is switched to "0." If the flag is switched to "0" (YES in Step S403), in Step S404, the broadcasting station deleter 218 updates the display of the broadcasting station list. In other words, the broadcasting station deleter 218 deletes the broadcasting station corresponding to the frequency having the flag "0" from the broadcasting station list. If the flag is not switched to "0" (NO in Step S403), the process skips Step S404. When a new receivable frequency is found in the scanning of the frequency band, the frequency is registered in the frequency table.

[0067] Fig. 12A schematically illustrates an exemplary operation to display the broadcasting station list in related art.

[0068] Fig. 12B schematically illustrates an exemplary operation to display the broadcasting station list in the present embodiment.

[0069] In the related art, if it is determined that a frequency fc is receivable in the scanning of the frequency band, the broadcasting station corresponding to the frequency fc is displayed in the broadcasting station list at a time Tr1 in response to the determination. The reception state of the frequency fc is updated in the next scanning of the frequency band. Specifically, the frequency fc in the broadcasting station list is updated at a time Tr2. Even if the frequency fc is switched to a non-receivable state immediately after the time Tr1, the frequency fc is continued to be displayed in the receivable state in the broadcasting station list until the time Tr2. Provided that the time required for one scanning of the frequency band is denoted by Ts, an update time Td of the broadcasting station from the time Tr1 to the time Tr2 depends on the one scanning period Ts. When a larger number of receivable frequencies are found in one scanning, the scanning time Ts is increased in response to the increased number of receivable frequencies and the scanning period Ts of the frequency fc is also increased.

[0070] In contrast, in the present embodiment, the receiving sensitivities of the respective frequencies in the frequency table are repeatedly determined in the time division manner during the scanning of the frequency band. For example, when n-number frequencies (fa, fb, fc, ..., fn) are registered in the frequency table, the receiving sensitivities of the n-number frequencies are repeatedly determined during one scanning period and the results of the determinations are reflected in the flag in the frequency table. If the frequency fc is switched to the non-receivable state immediately after the time Tr1, the next determination of the receiving sensitivity of the frequency fc is performed in the scanning using the frequency table, unlike the related art in which the determination of the receiving sensitivity of the frequency fc is performed during the next scanning period of the frequency band.

[0071] Accordingly, an update period Tdx of the frequency fc in the broadcasting station list is much shorter than the update time Td in the related art. Consequently, if any frequency that is not receivable is found in the frequency table, the broadcasting station corresponding to the frequency is immediately deleted from the broadcasting station list.

[0072] As a result, it is possible to present the up-to-date accurate broadcasting station list to the user. The probability that the user is not capable of receiving a frequency when the broadcasting station corresponding to the frequency is selected from the broadcasting station list is reduced, compared with that in the related art.

[0073] Fig. 13A and Fig. 13B illustrate specific examples of how the broadcasting station list is displayed. Fig. 13A illustrates an example of how the broadcasting station list is displayed in the related art. Fig. 13B illustrates an example of how the broadcasting station list is displayed in the present embodiment. The display lists at a time T1, a time T2, and a time T3 are illustrated in the examples in Fig. 13A and Fig. 13B. It is assumed that a

vehicle enters an area, such as a tunnel or a underground parking area, where the reception environment of the radio waves is not good (the travelling distance is relatively long, for example, about one kilometer) at the time T2 and only "BAYERN 3" is receivable in the area where the reception environment of the radio waves is not good.

[0074] At the time T1, a program name "ARABERA" that is being received and multiple receivable program names are displayed in the broadcasting station list. At the time T2, the vehicle enters the area where the reception environment is not good. In the related art, since the update period of the broadcasting station list is long, the same broadcasting station list as the one at the time T1 is continued to be displayed at the time T2. In contrast, in the present embodiment, the receiving sensitivities of the frequencies in the frequency table are sequentially checked in the time division manner and it is determined that the program names other than "BAYERN 3" are not receivable. Only "BAYERN 3" is left in the broadcasting station list and all the other non-receivable program names are deleted. Accordingly, the user is capable of recognizing that only "BAYERN 3" is receivable from the broadcasting station list.

[0075] At the time T3, although the user, who has referred to the broadcasting station list in the related art, selects "HITRADIO" because "ARABERA" is inaudible, the user is not capable of listening to "HITRADIO" because the receiving sensitivity of "HITRADIO" is bad and only noise is output from the speaker. In contrast, the user, who has referred to the broadcasting station list in the present embodiment, is capable of switching to the reception of "BYAERN 3."

[0076] While the invention is described in terms of some specific examples and embodiments, it will be clear that this invention is not limited to these specific examples and embodiments and that many changes and modified embodiments will be obvious to those skilled in the art without departing from the scope of the invention as defined in the claims.

[0077] The present invention as described may be modified by at least one of the following modifications.

[0078] Although the electric field intensity signal is used in the determination of the receiving sensitivity of the frequency or the broadcasting station in the above embodiments, the error ratio of signals and/or the presence of a multi-path may be used as the determination condition, instead of the electric field intensity signal or in addition to the electric field intensity signal.

[0079] Although the receiving sensitivity determiner 216 sets the flag "0" for the frequency that is determined not to be receivable in the above embodiments, this setting is only an example. For example, the receiving sensitivity determiner 216 may delete such a frequency from the frequency table.

[0080] Although the radio reception apparatus is exemplified in the above embodiments as receiving the RDS broadcast, the radio reception apparatus may be configured to receive another radio broadcast in accordance to a communication protocol standard, other than the RDS broadcast communications protocol standard for embedding small amounts of digital information in conventional FM radio broadcasts, as long as data can be multiplexed on the radio broadcast. Further, the radio broadcast received by the radio reception apparatus is not also limited to the analog radio broadcast, e.g. conventional FM radio broadcast, and thus the radio reception apparatus may be alternatively or additionally configured to receive a digital radio broadcast, such as a digital audio broadcast (DAB), as well.

[0081] Although the radio reception apparatus including two tuners is exemplified in the above embodiments, the number of the tuners is not specifically limited. The radio reception apparatus may use a single tuner for reception of broadcast signals and extraction of data in the time division manner or may have three or more tuners.

Claims

1. A reception apparatus capable of receiving a broadcast signal on which data is multiplexed, the reception apparatus comprising:

   at least first and second receiving units (110A, 110B) each configured for receiving the broadcast signal;
   a scanning unit (200) that is configured to scan a frequency band with the second receiving unit (110B) while the broadcast signal received by the first receiving unit (110A) is being output;
   an extracting unit (202) that is configured to extract data from the broadcast signal received during the scanning by the scanning unit (200);
   a holding unit (212) that is configured to hold a frequency table in which receivable frequencies within the frequency band scanned by the scanning unit (200) are registered;
   a display unit (214) that is configured to display broadcasting stations corresponding to the frequency table held by the holding unit;
   a determining unit (216) that is configured to determine whether each frequency in the frequency table is receivable during the scanning of the frequency band by the scanning unit (200); and
   a deleting unit (218) that is configured to delete the broadcasting station corresponding to the frequency determined not to be receivable by the determining unit from the display of the broadcasting stations.

2. The reception apparatus according to Claim 1, wherein, if all alternative frequencies having the same program identification code as that of a frequency in the frequency table are not receivable, the determining unit (216) is configured to determine that the frequency is not receivable.

3. The reception apparatus according to Claim 2, further comprising:

a program identification code extracting unit (204) that is configured to extract the program identification code from the data extracted by the extracting unit (202); and
a creating unit (206) that is configured to create an alternative frequency table in which the frequencies having the same program identification code are registered on the basis of the extracted program identification code,
wherein the determining unit (216) is configured to refer to the alternative frequency table to determine whether each alternative frequency is receivable.

4. The reception apparatus according to Claim 3,
wherein, if a receiving sensitivity of a certain frequency selected from the frequency table is lower than a threshold value and the receiving sensitivity of each alternative frequency registered in the alternative frequency table is lower than the threshold value, the determining unit (216) is configured to determine that the certain frequency is not receivable.

5. The reception apparatus according to Claim 4,
wherein, if the receiving sensitivity of at least one alternative frequency in the alternative frequency table is higher than or equal to the threshold value, the determining unit (216) is configured to determine that the certain frequency is receivable.

6. The reception apparatus according to any of Claims 1 to 5,
wherein the determining unit (216) is configured to determine in a time division manner whether each frequency in the frequency table is receivable while the scanning unit (200) performs the scanning from a lower limit to an upper limit or from the upper limit to the lower limit of the frequency band.

7. The reception apparatus according to any of Claims 1 to 6,
wherein the determining unit (216) includes a unit that is configured to set a flag in the frequency table if the determining unit (216) determines that a certain frequency is not receivable, and
wherein the deleting unit (218) is configured to delete the broadcasting station corresponding to the flag that is set from the display of the broadcasting stations.

8. The reception apparatus according to any of Claims 1 to 7, further comprising:

a selecting unit that is configured to select a broadcasting station from a list of the broadcasting stations displayed by the display unit (214); and
a control unit that is configured to control selection of a broadcasting station by the first receiving unit (110A) on the basis of the broadcasting station selected by the selecting unit.

9. The reception apparatus according to any of Claims 1 to 8,
wherein the first (110A) and second (110B) receiving units each are configured to receive a Radio Data System broadcast.

10. The reception apparatus according to any of Claims 1 to 9,
wherein the first (110A) and second (110B) receiving units each are configured to receive a digital broadcast.

11. A method of displaying a broadcasting station in a reception apparatus capable of receiving a broadcast signal on which data is multiplexed, the methods comprising:

scanning a frequency table for a receivable frequency with a second receiving unit (110B) while a broadcast signal received by a first receiving unit (110A) is being output;
extracting data from the broadcast signal received during the scanning;
holding a frequency table in which the receivable frequencies within the frequency band that is scanned are registered;
displaying broadcasting stations corresponding to the frequency table that is held;
determining whether each frequency in the frequency table is receivable during the scanning of the frequency band; and
deleting the broadcasting station corresponding to the frequency determined not to be receivable by the determining from the display of the broadcasting stations.

12. The displaying method according to Claim 11,
wherein, if all alternative frequencies having the same program identification code as that of a frequency in the frequency table are not receivable, the determining determines that the frequency is not receivable.

13. The displaying method according to Claims 11 or 12, further comprising:

extracting the program identification code from the extracted data; and
creating an alternative frequency table in which the frequencies having the same program identification code are registered on the basis of the

extracted program identification code,
wherein the determining refers to the alternative frequency table to determine whether each alternative frequency is receivable.

14. The displaying method according to Claim 13,
wherein, if a receiving sensitivity of a certain frequency selected from the frequency table is lower than a threshold value and the receiving sensitivity of each alternative frequency registered in the alternative frequency table is lower than the threshold value, the determining determines that the certain frequency is not receivable.

15. The displaying method according to any of Claims 11 to 14,
wherein the determining determines in a time division manner whether each frequency in the frequency table is receivable while the scanning performs the scanning from a lower limit to an upper limit or from the upper limit to the lower limit of the frequency band.

FIG. 1A

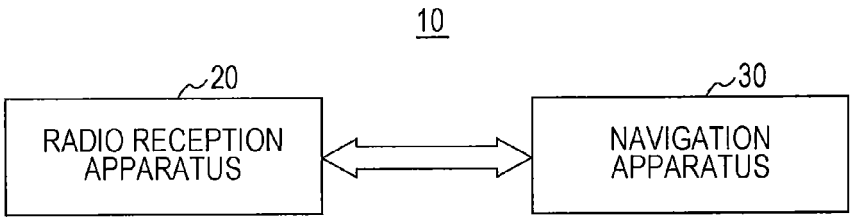

10
20
RADIO RECEPTION APPARATUS
30
NAVIGATION APPARATUS

FIG. 1B

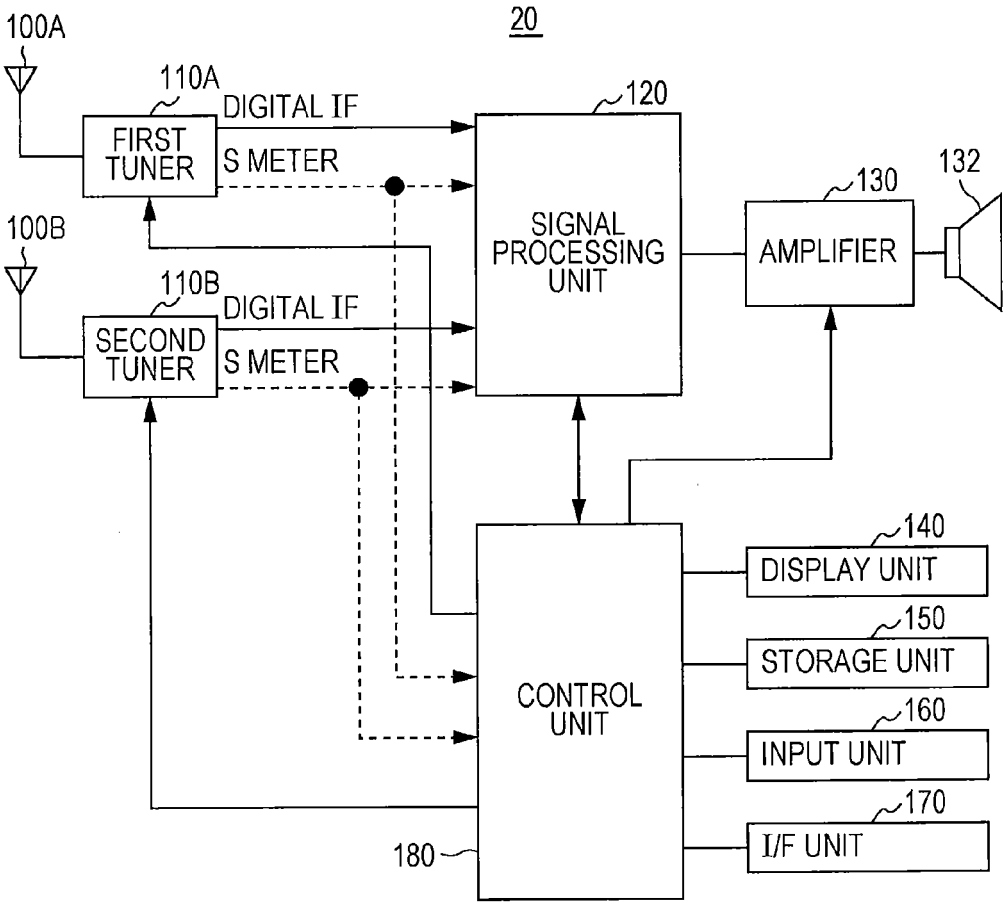

100A
20
110A
DIGITAL IF
FIRST TUNER
S METER
120
132
130
100B
SIGNAL PROCESSING UNIT
AMPLIFIER
110B
DIGITAL IF
SECOND TUNER
S METER
140
DISPLAY UNIT
150
STORAGE UNIT
CONTROL UNIT
160
INPUT UNIT
170
I/F UNIT
180

FIG. 2

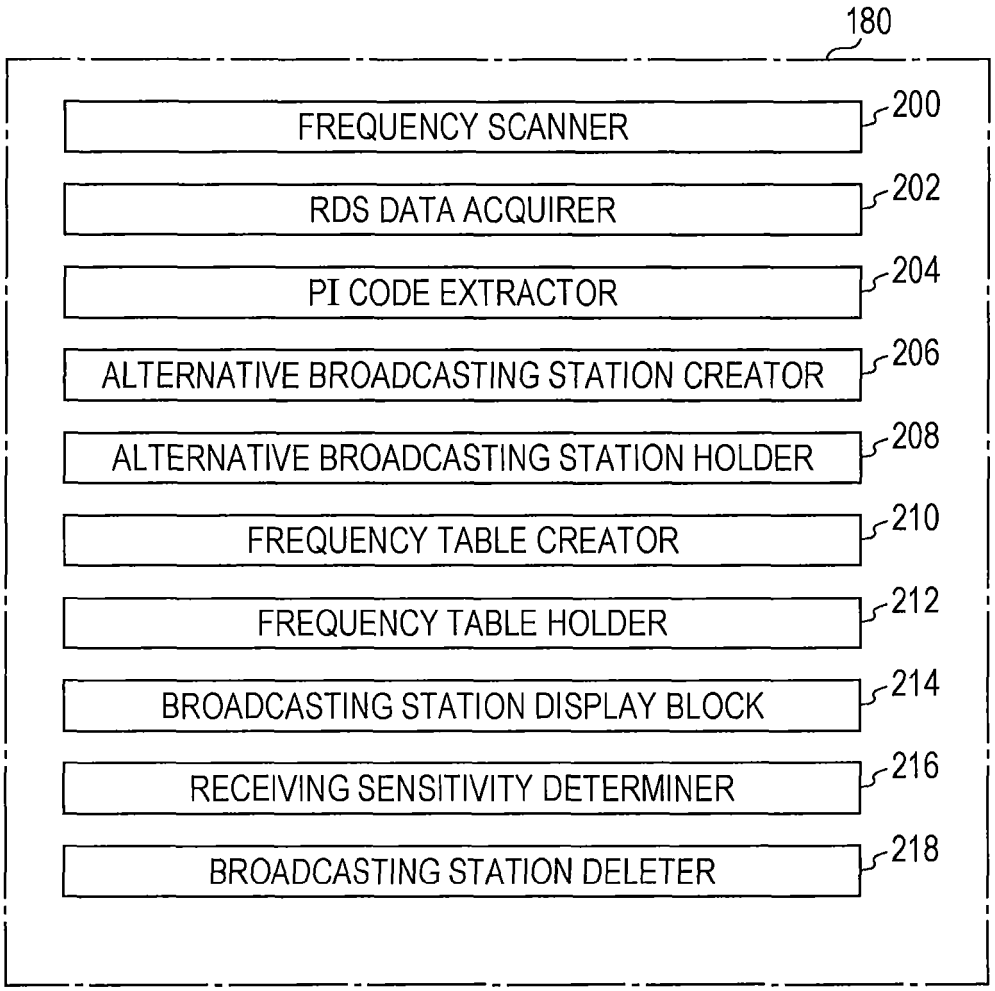

180
FREQUENCY SCANNER
200
RDS DATA ACQUIRER
202
PI CODE EXTRACTOR
204
ALTERNATIVE BROADCASTING STATION CREATOR
206
ALTERNATIVE BROADCASTING STATION HOLDER
208
FREQUENCY TABLE CREATOR
210
FREQUENCY TABLE HOLDER
212
BROADCASTING STATION DISPLAY BLOCK
214
RECEIVING SENSITIVITY DETERMINER
216
BROADCASTING STATION DELETER
218

FIG. 3

FREQUENCY TABLE

CURRENT RECEIVABLE FREQUENCY TBL	
FREQUENCY	PI
87.7	D711
89.0	D311
88.7	D301
90.3	D955
91.6	D304
93.7	D302
96.3	D951
96.7	D305
98.5	D303
100.7	D304
105.7	D305
106.3	D302
107.5	D301
107.9	D311

FIG. 4

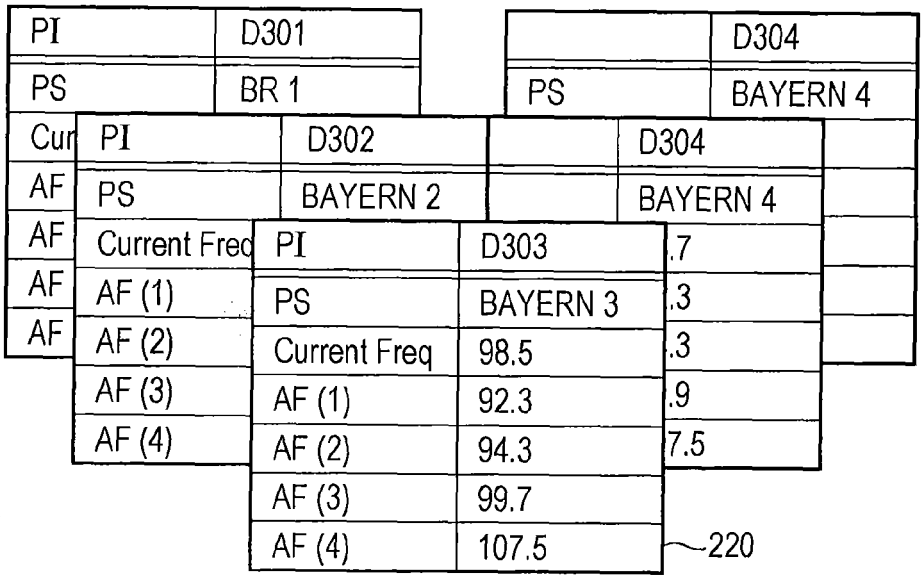


FIG. 5

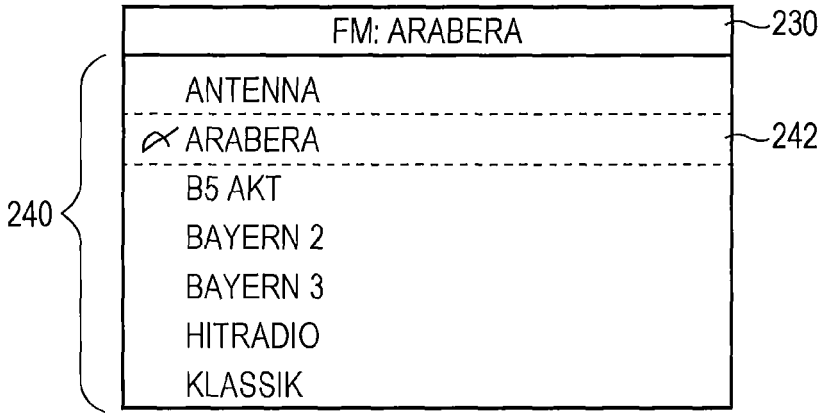


FIG. 6

CURRENT RECEIVABLE FREQUENCY TBL		
FREQUENCY	PI	RECEPTION DETERMINATION FLAG
87.7	D711	1
89.0	D311	1
88.7	D301	1
90.3	D955	1
91.6	D304	1
93.7	D302	1
96.3	D951	1
96.7	D305	1
98.5	D303	0
100.7	D304	1
105.7	D305	1
106.3	D302	1
107.5	D301	1
107.9	D311	1

FIG. 7

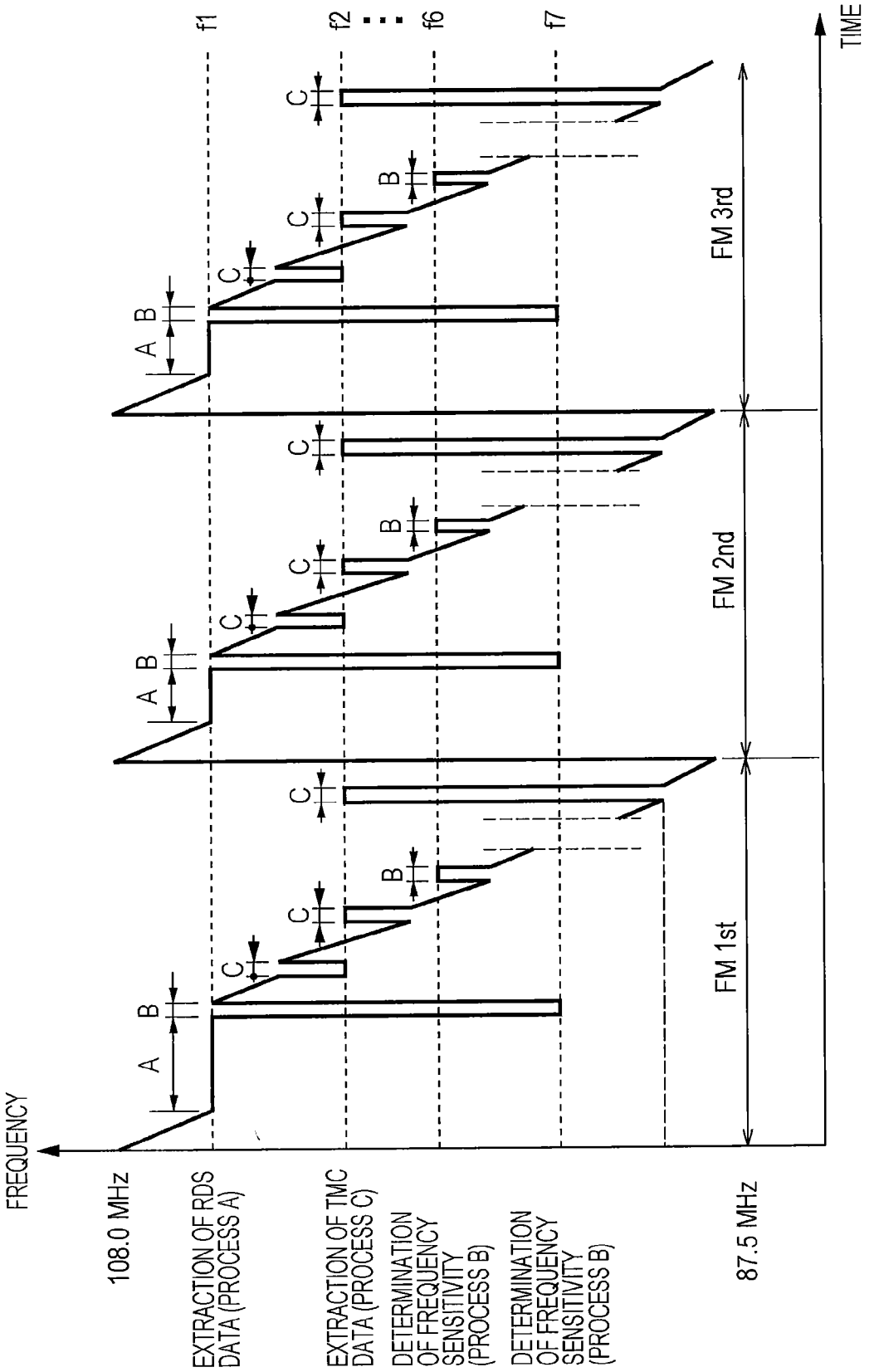

FREQUENCY
TIME
f1
f2
f6
f7
A
B
C
FM 1st
FM 2nd
FM 3rd
108.0 MHz
87.5 MHz
EXTRACTION OF RDS DATA (PROCESS A)
EXTRACTION OF TMC DATA (PROCESS C)
DETERMINATION OF FREQUENCY SENSITIVITY (PROCESS B)
DETERMINATION OF FREQUENCY SENSITIVITY (PROCESS B)

FIG. 8

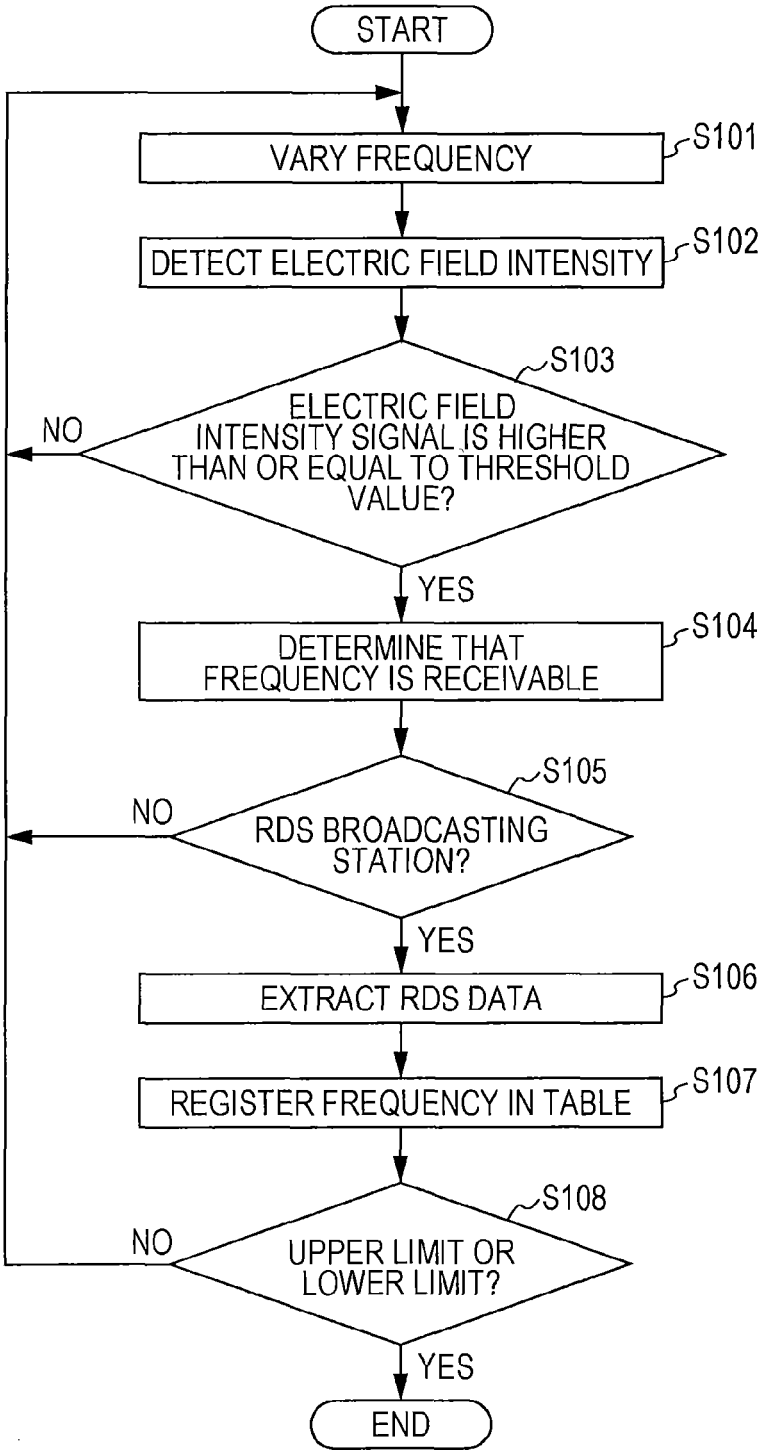

START
VARY FREQUENCY
S101
DETECT ELECTRIC FIELD INTENSITY
S102
S103
ELECTRIC FIELD INTENSITY SIGNAL IS HIGHER THAN OR EQUAL TO THRESHOLD VALUE?
NO
YES
DETERMINE THAT FREQUENCY IS RECEIVABLE
S104
S105
RDS BROADCASTING STATION?
NO
YES
EXTRACT RDS DATA
S106
REGISTER FREQUENCY IN TABLE
S107
S108
UPPER LIMIT OR LOWER LIMIT?
NO
YES
END

FIG. 9

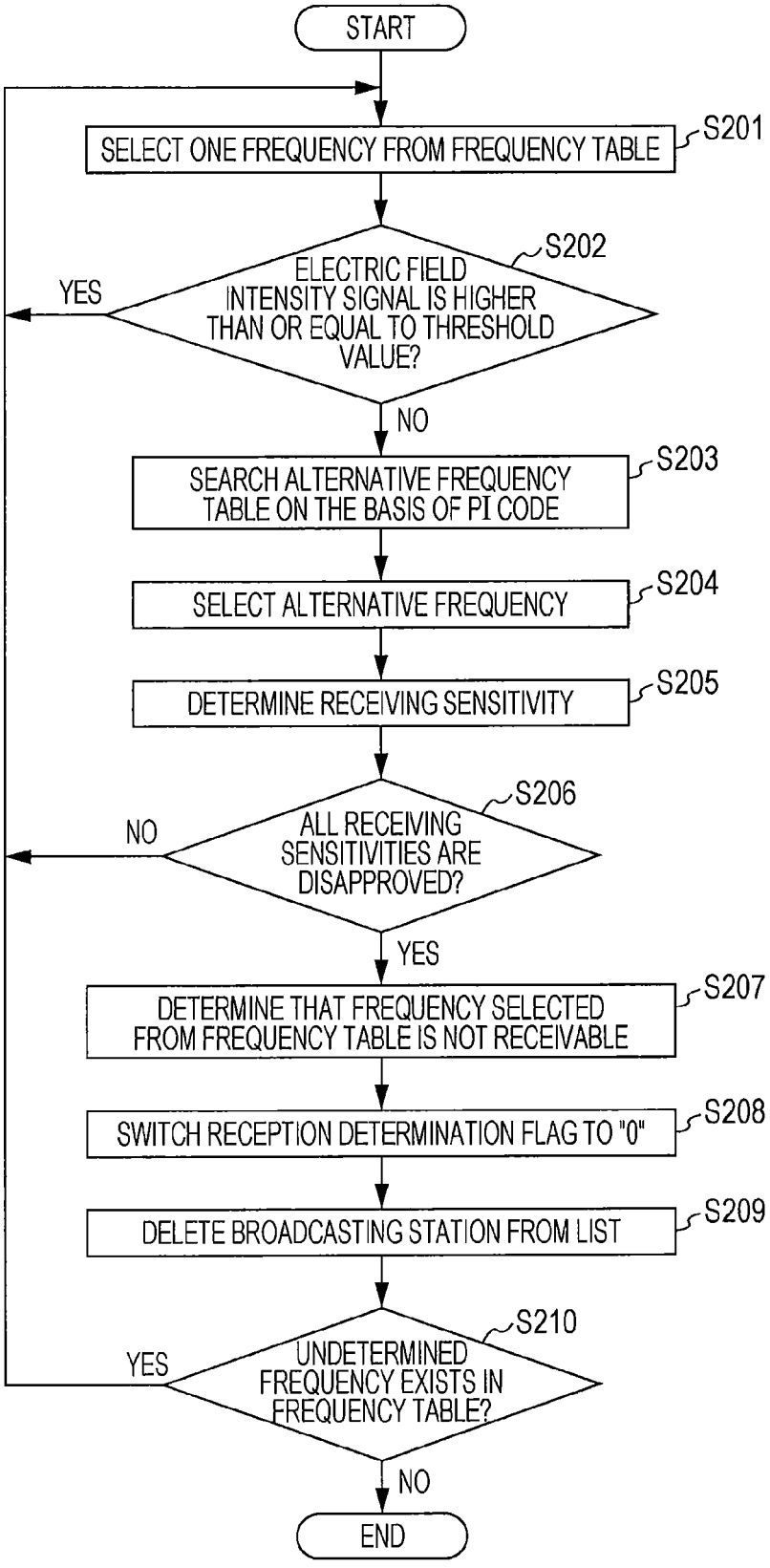

START
SELECT ONE FREQUENCY FROM FREQUENCY TABLE
S201
ELECTRIC FIELD INTENSITY SIGNAL IS HIGHER THAN OR EQUAL TO THRESHOLD VALUE?
S202
YES
NO
SEARCH ALTERNATIVE FREQUENCY TABLE ON THE BASIS OF PI CODE
S203
SELECT ALTERNATIVE FREQUENCY
S204
DETERMINE RECEIVING SENSITIVITY
S205
ALL RECEIVING SENSITIVITIES ARE DISAPPROVED?
S206
NO
YES
DETERMINE THAT FREQUENCY SELECTED FROM FREQUENCY TABLE IS NOT RECEIVABLE
S207
SWITCH RECEPTION DETERMINATION FLAG TO "0"
S208
DELETE BROADCASTING STATION FROM LIST
S209
UNDETERMINED FREQUENCY EXISTS IN FREQUENCY TABLE?
S210
YES
NO
END

FIG. 10

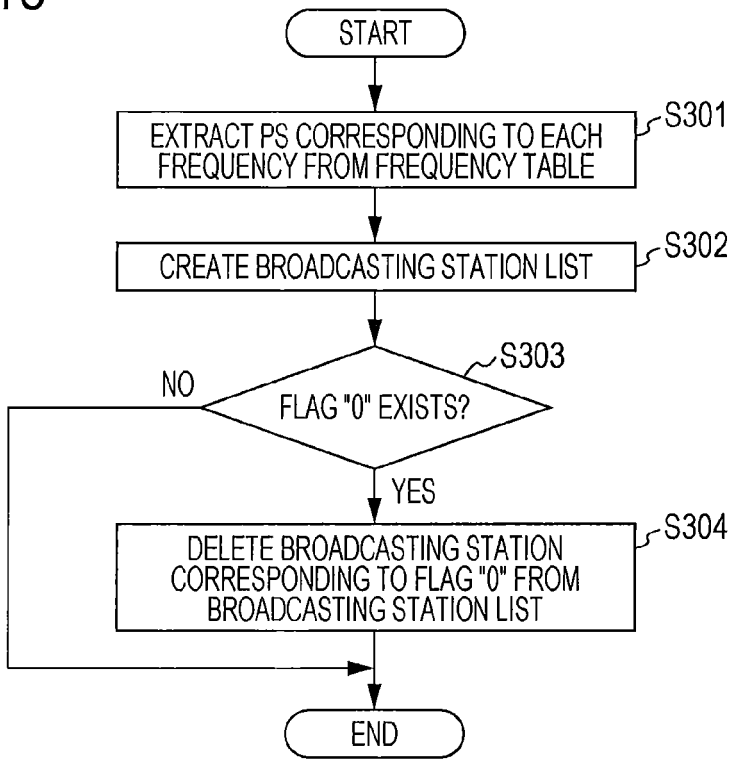

START
EXTRACT PS CORRESPONDING TO EACH FREQUENCY FROM FREQUENCY TABLE
S301
CREATE BROADCASTING STATION LIST
S302
S303
NO
FLAG "0" EXISTS?
YES
DELETE BROADCASTING STATION CORRESPONDING TO FLAG "0" FROM BROADCASTING STATION LIST
S304
END

FIG. 11

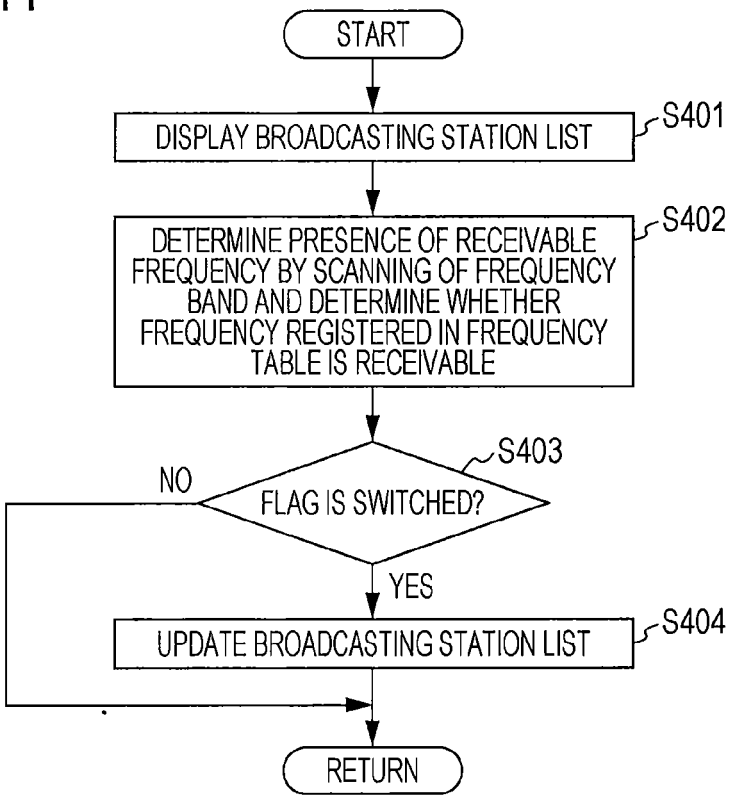

START
DISPLAY BROADCASTING STATION LIST
S401
DETERMINE PRESENCE OF RECEIVABLE FREQUENCY BY SCANNING OF FREQUENCY BAND AND DETERMINE WHETHER FREQUENCY REGISTERED IN FREQUENCY TABLE IS RECEIVABLE
S402
S403
NO
FLAG IS SWITCHED?
YES
UPDATE BROADCASTING STATION LIST
S404
RETURN

FIG. 12A

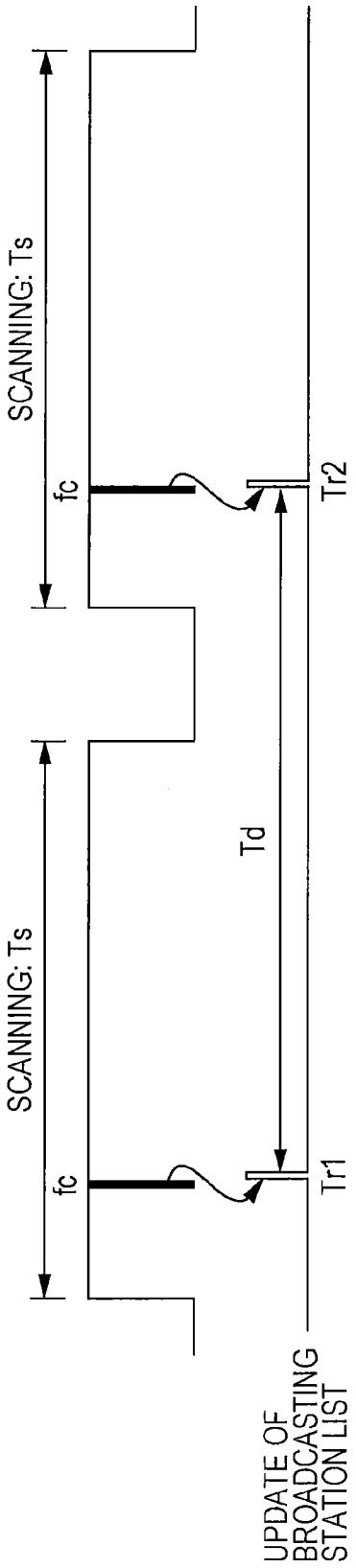


FIG. 12B

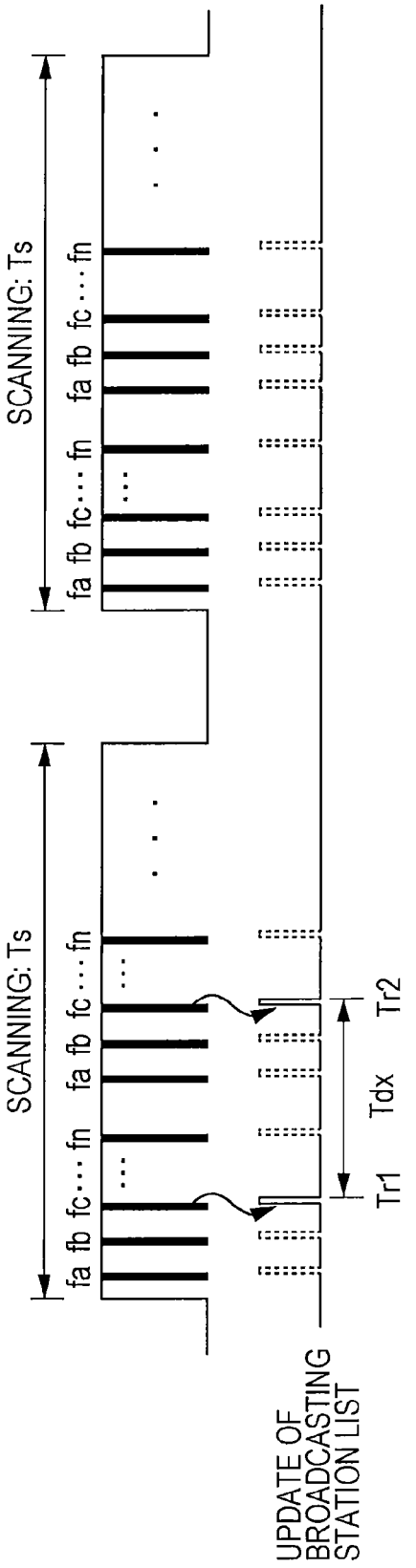


FIG. 13A

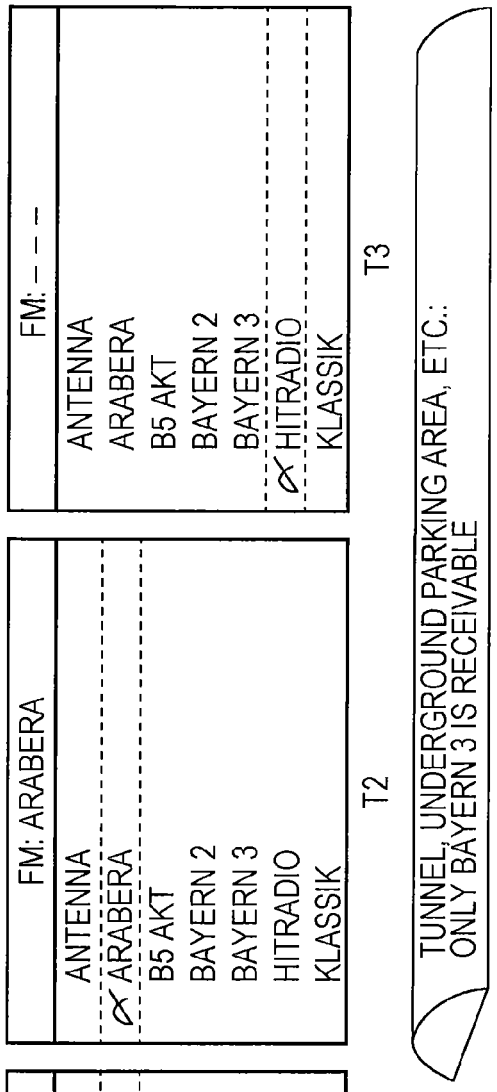
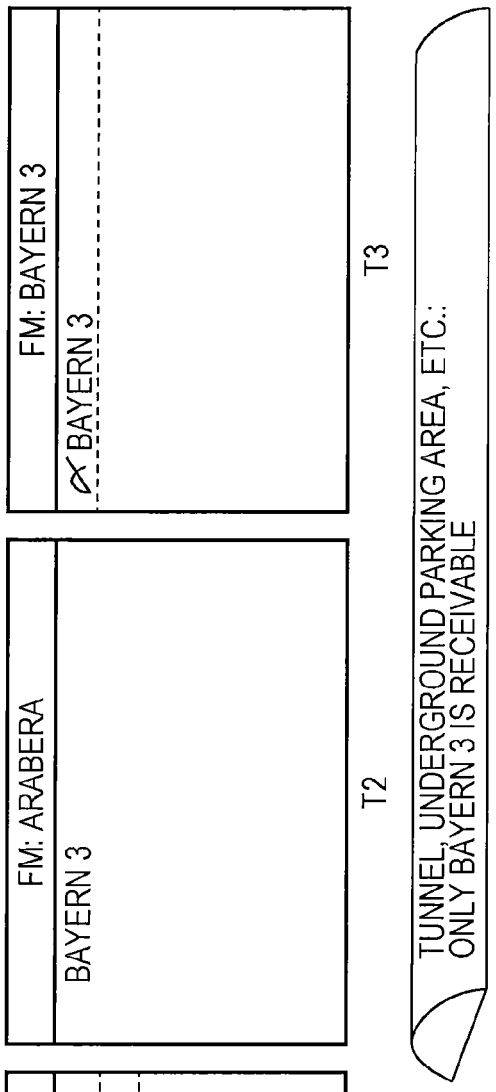


FIG. 13B



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011035883 A **[0004] [0005]**