US009270531B2

(12) **United States Patent**
Fujii

(10) **Patent No.: US 9,270,531 B2**
(45) **Date of Patent: Feb. 23, 2016**

(54) **COMMUNICATION APPARATUS, CONTROL METHOD, AND PROGRAM**

(75) Inventor: **Kenichi Fujii**, Tokyo (JP)

(73) Assignee: **CANON KABUSHIKI KAISHA**, Toyko (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 627 days.

(21) Appl. No.: **13/125,952**

(22) PCT Filed: **Nov. 4, 2009**

(86) PCT No.: **PCT/JP2009/005839**
§ 371 (c)(1),
(2), (4) Date: **Apr. 25, 2011**

(87) PCT Pub. No.: **WO2010/052894**
PCT Pub. Date: **May 14, 2010**

(65) **Prior Publication Data**

US 2011/0206029 A1 Aug. 25, 2011

(30) **Foreign Application Priority Data**

Nov. 5, 2008 (JP) 2008-284512

(51) **Int. Cl.**
H04B 7/00 (2006.01)
H04L 12/24 (2006.01)
H04W 84/18 (2009.01)

(52) **U.S. Cl.**
CPC ***H04L 41/0893*** (2013.01); *H04W 84/18* (2013.01)

(58) **Field of Classification Search**
CPC H04W 84/18; H04W 28/021
USPC 370/252, 254, 270, 390, 432, 465, 370/310–350
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,240,464 B1 * 5/2001 Fijolek et al. 709/250
2004/0019668 A1 1/2004 Kakadia

(Continued)

FOREIGN PATENT DOCUMENTS

JP 2006-352281 A 12/2006
JP 2006-352282 A 12/2006

(Continued)

OTHER PUBLICATIONS

IEEE Std. 802.15.3-2003, Part 15.3: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for High Rate Wireless Personal Area Networks (WPANs), pp. 1-315.*

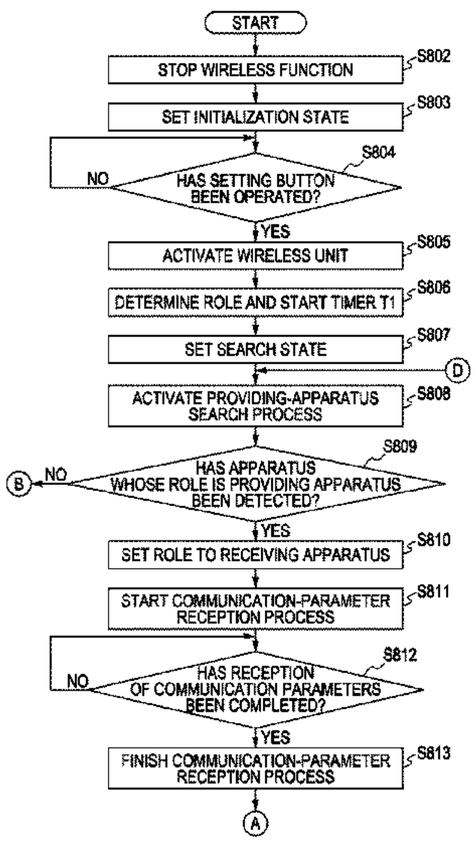
(Continued)

Primary Examiner — Andrew Chriss
Assistant Examiner — Kenan Cehic
(74) *Attorney, Agent, or Firm* — Carter, DeLuca, Farrell & Schmidt, LLP

(57) **ABSTRACT**

The convenience of users is improved for a case in which a network is structured by way of performance of a process of sharing communication parameters with other apparatuses. A process of providing, so that an upper limit number of communication partners is M which is a plural number, communication parameters to a communication partner is performed in accordance with a predetermined operation performed by a user. When the predetermined operation is performed by the user again after the process has been performed, the communication parameters are provided to a communication partner so that an upper limit number of communication partners is one.

17 Claims, 10 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

2005/0021855	A1*	1/2005	Wang et al.	709/245
2005/0096080	A1*	5/2005	Choi et al.	455/522
2005/0143129	A1	6/2005	Funk et al.	
2005/0213512	A1*	9/2005	Konuma	H04L 12/40136 370/252
2007/0274341	A1*	11/2007	Rodriguez	370/473

FOREIGN PATENT DOCUMENTS

WO	2004/058403	A2	7/2004
WO	2006/134772	A1	12/2006

OTHER PUBLICATIONS

U.S. Appl. No. 13/131,581, filed May 26, 2011, Hideaki Tachibana.
U.S. Appl. No. 13/061,124, filed Feb. 25, 2011, Tatsuhiko Sakai.
U.S. Appl. No. 13/124,203, filed Apr. 14, 2011, Fumihide Goto.
U.S. Appl. No. 13/122,619, filed Apr. 5, 2011, Fumihide Goto.
U.S. Appl. No. 13/122,558, filed Apr. 4, 2011, Tatsuhiko Sakai.
U.S. Appl. No. 13/120,535, filed Mar. 23, 2011, Fumihide Goto.
Wi-Fi Certified (unregistered trademark) for Wi-Fi Protected Setup: Easing the User Experience for Home and Small Office Wi-Fi (registered trademark) Networks, http://www.wi-fi.org/wp/wifi-protected-setup.
U.S. Appl. No. 13/124,203, filed Apr. 14, 2011.
U.S. Appl. No. 13/122,619, filed Apr. 5, 2011.
U.S. Appl. No. 13/122,558, filed Apr. 4, 2011.
U.S. Appl. No. 13/120,535, filed Mar. 23, 2011.
Japanese Office Action issued in corresponding application No. 2008-284512 on May 14, 2013.

* cited by examiner

FIG. 1

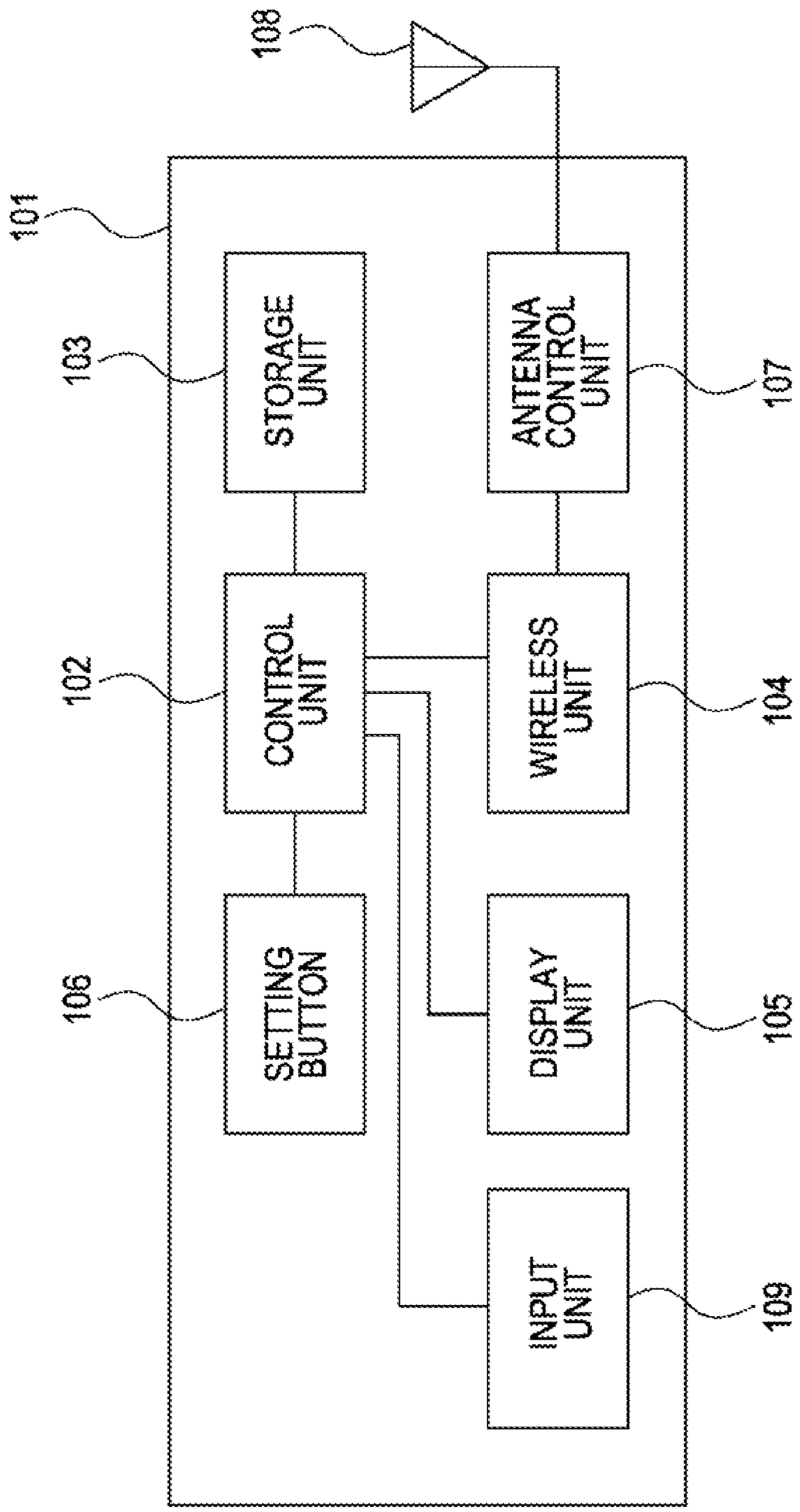

108
101
103
STORAGE UNIT
ANTENNA CONTROL UNIT
107
102
CONTROL UNIT
WIRELESS UNIT
104
106
SETTING BUTTON
DISPLAY UNIT
105
INPUT UNIT
109

FIG. 2

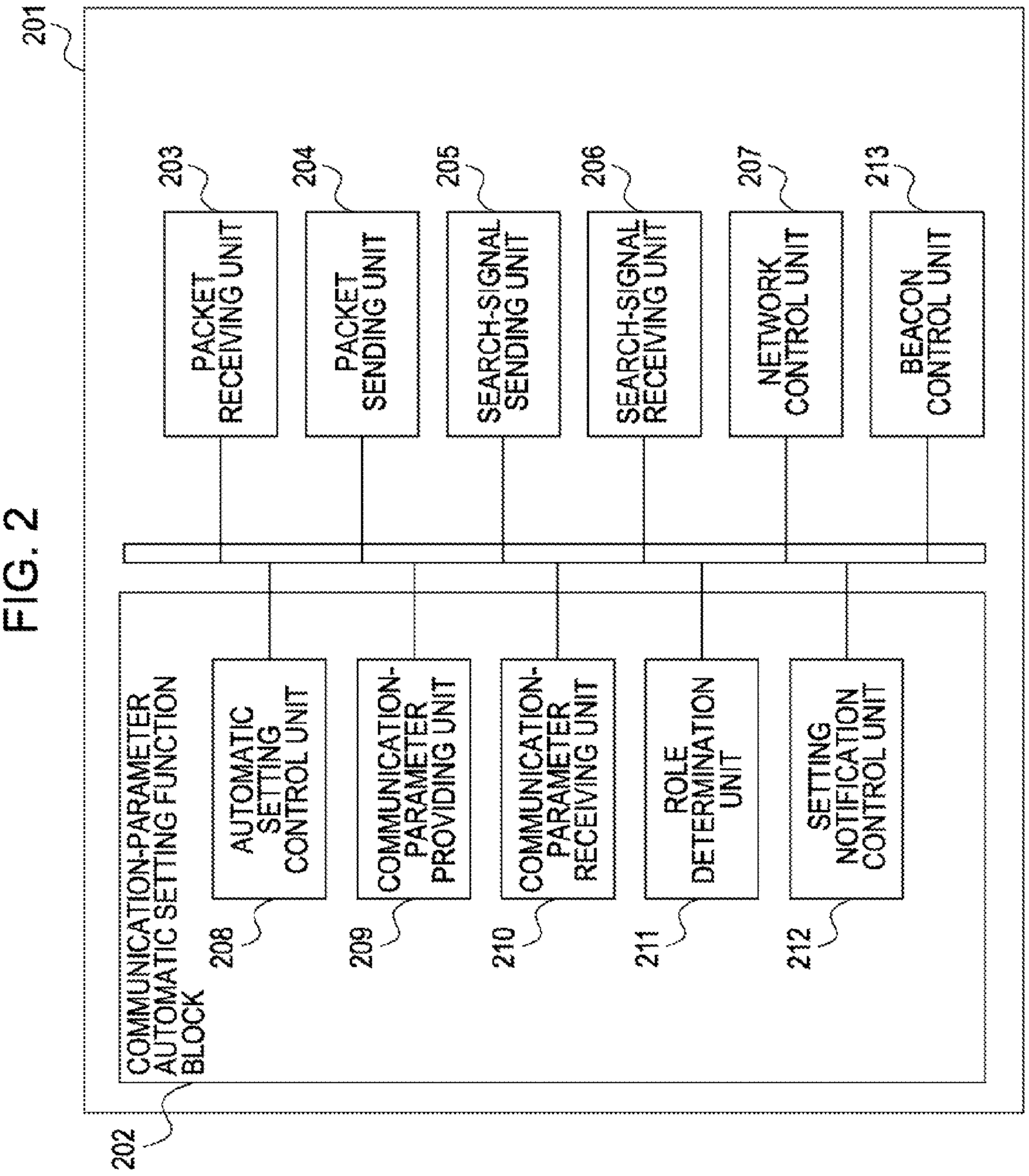

201
203
PACKET RECEIVING UNIT
204
PACKET SENDING UNIT
205
SEARCH-SIGNAL SENDING UNIT
206
SEARCH-SIGNAL RECEIVING UNIT
207
NETWORK CONTROL UNIT
213
BEACON CONTROL UNIT
COMMUNICATION-PARAMETER AUTOMATIC SETTING FUNCTION BLOCK
208
AUTOMATIC SETTING CONTROL UNIT
209
COMMUNICATION-PARAMETER PROVIDING UNIT
210
COMMUNICATION-PARAMETER RECEIVING UNIT
211
ROLE DETERMINATION UNIT
212
SETTING NOTIFICATION CONTROL UNIT
202

FIG. 3

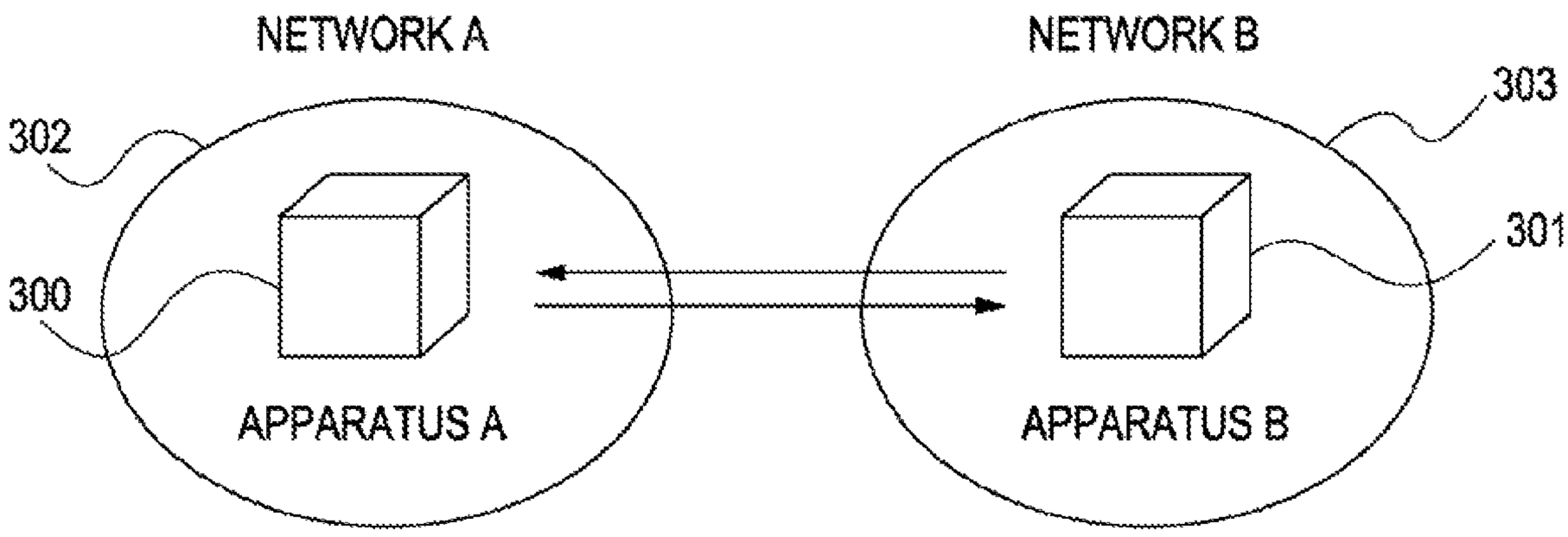


FIG. 4

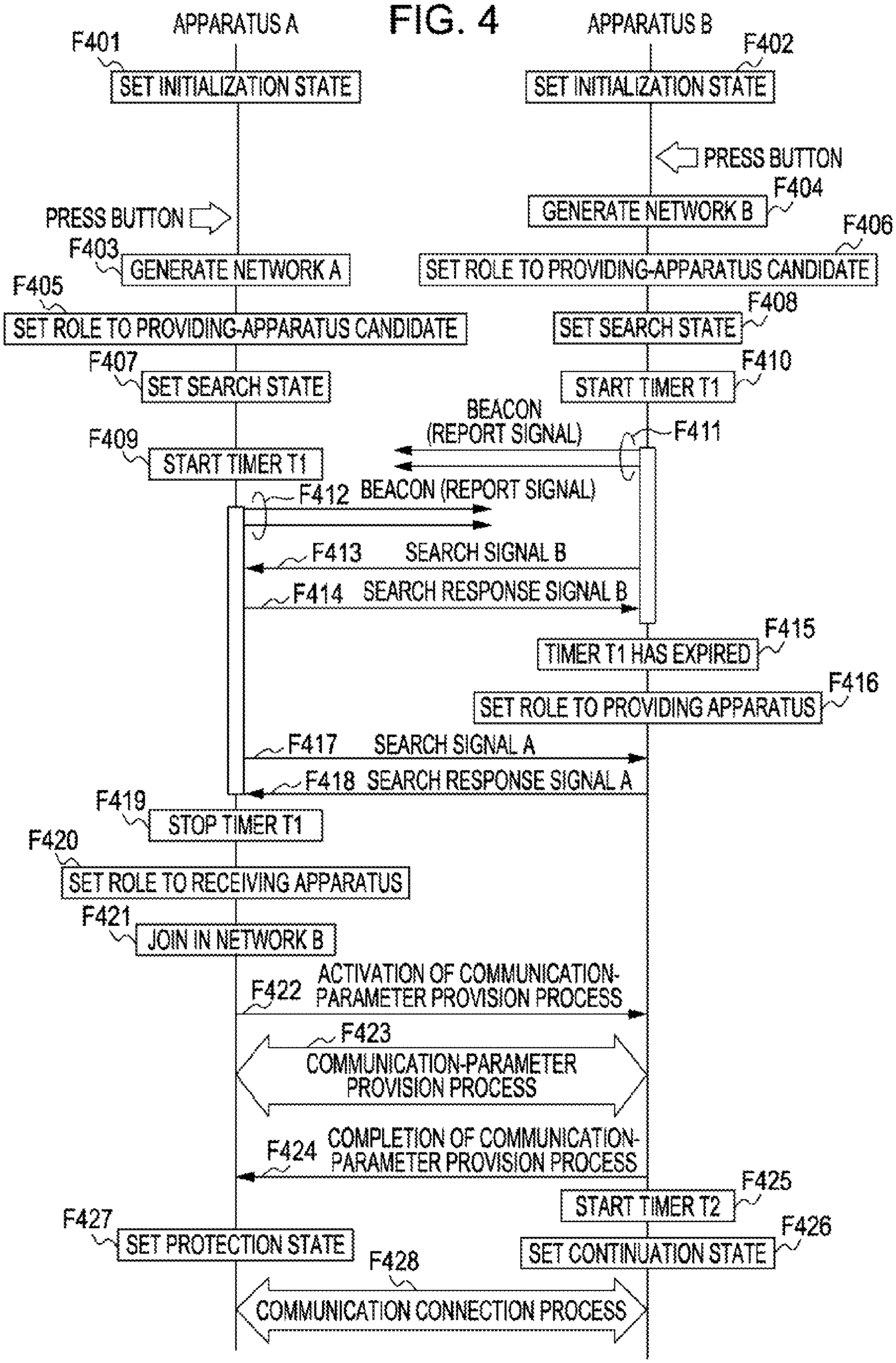
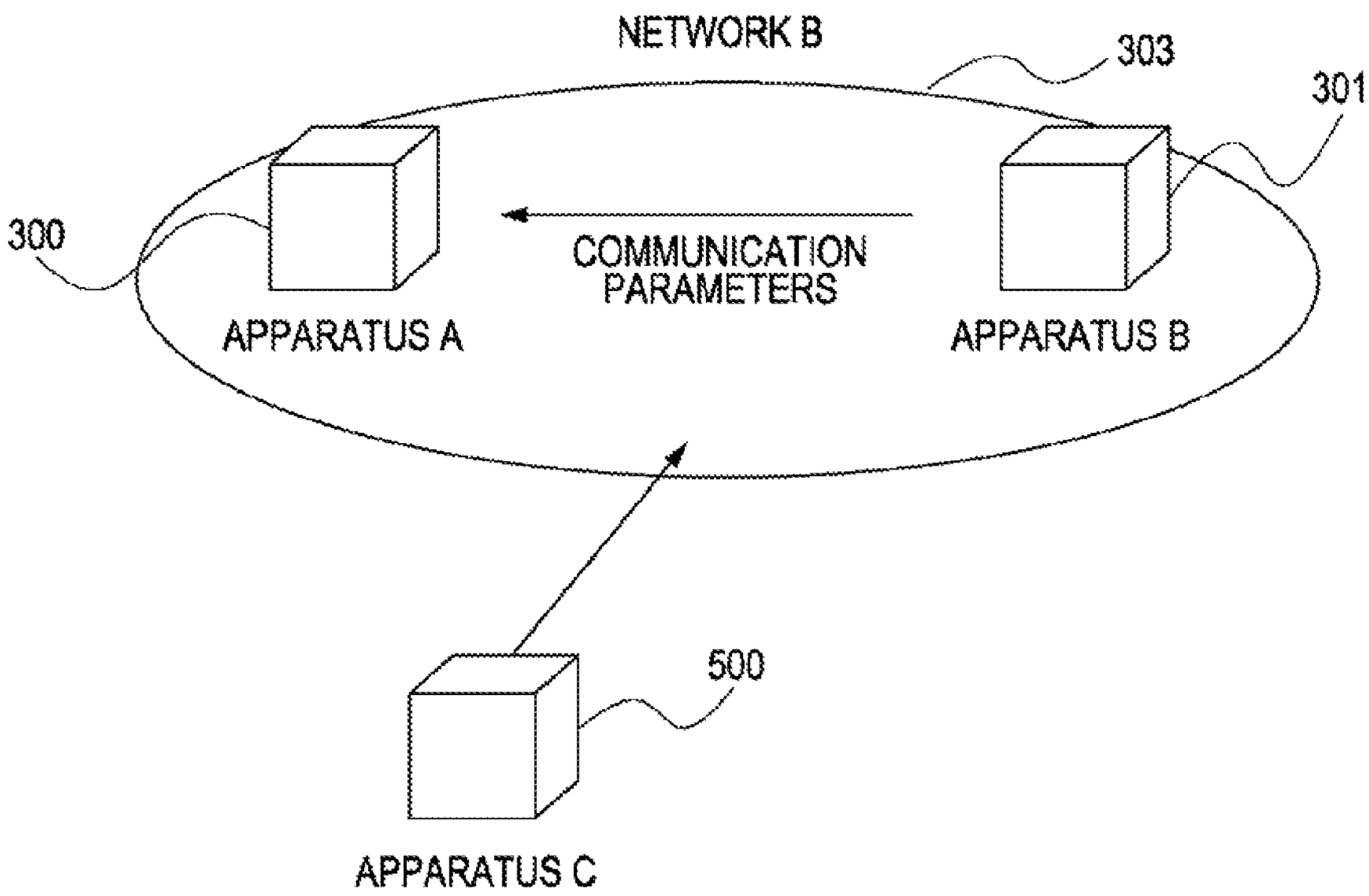

APPARATUS A
APPARATUS B
F401
SET INITIALIZATION STATE
F402
SET INITIALIZATION STATE
PRESS BUTTON
PRESS BUTTON
F404
GENERATE NETWORK B
F403
GENERATE NETWORK A
F406
SET ROLE TO PROVIDING-APPARATUS CANDIDATE
F405
SET ROLE TO PROVIDING-APPARATUS CANDIDATE
F408
SET SEARCH STATE
F407
SET SEARCH STATE
F410
START TIMER T1
BEACON
(REPORT SIGNAL)
F411
F409
START TIMER T1
F412 BEACON (REPORT SIGNAL)
F413 SEARCH SIGNAL B
F414 SEARCH RESPONSE SIGNAL B
F415
TIMER T1 HAS EXPIRED
F416
SET ROLE TO PROVIDING APPARATUS
F417 SEARCH SIGNAL A
F418 SEARCH RESPONSE SIGNAL A
F419
STOP TIMER T1
F420
SET ROLE TO RECEIVING APPARATUS
F421
JOIN IN NETWORK B
F422 ACTIVATION OF COMMUNICATION-PARAMETER PROVISION PROCESS
F423
COMMUNICATION-PARAMETER PROVISION PROCESS
F424 COMPLETION OF COMMUNICATION-PARAMETER PROVISION PROCESS
F425
START TIMER T2
F427
SET PROTECTION STATE
F426
SET CONTINUATION STATE
F428
COMMUNICATION CONNECTION PROCESS

FIG. 5


NETWORK B
303
301
300
COMMUNICATION PARAMETERS
APPARATUS A
APPARATUS B
500
APPARATUS C

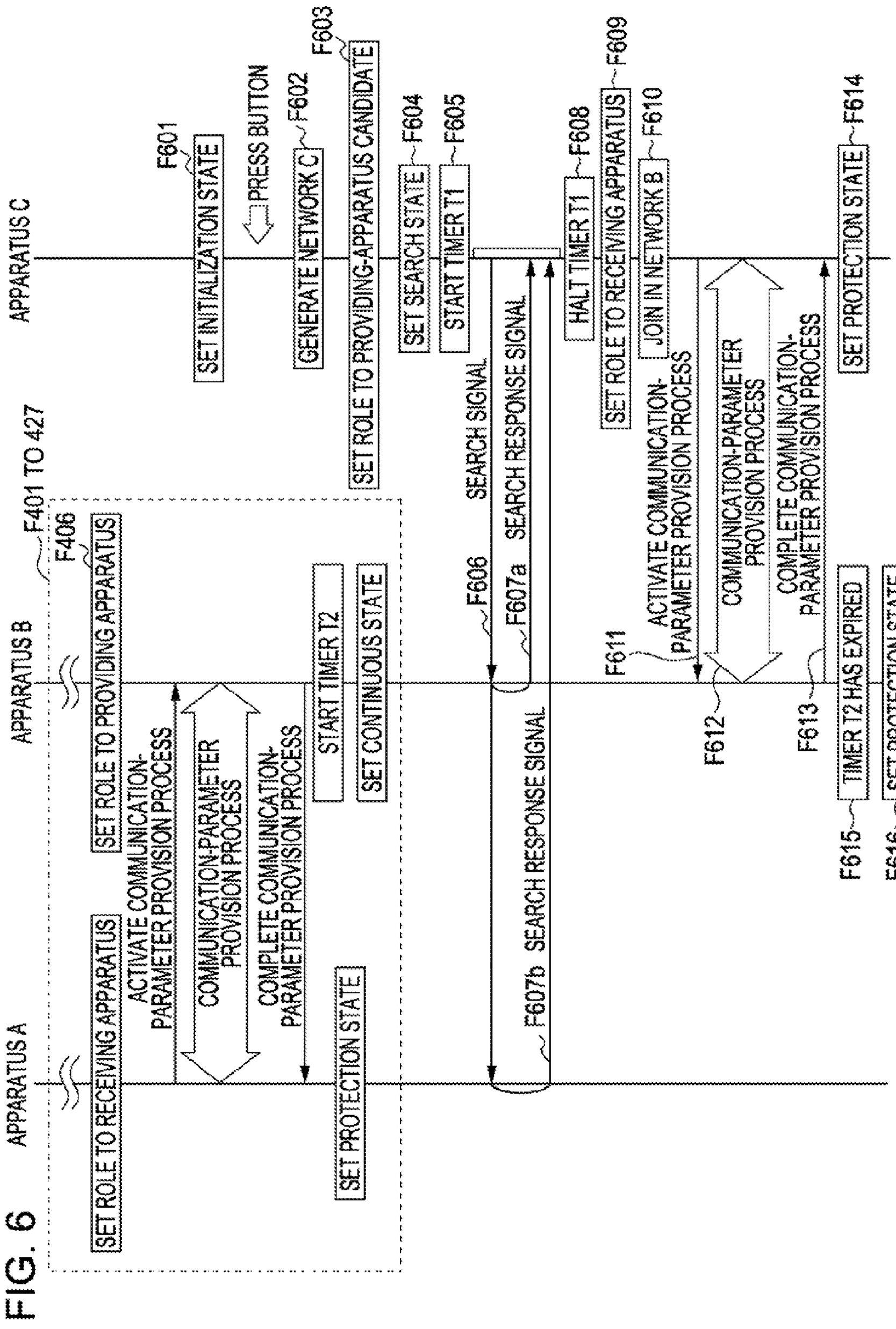

APPARATUS C
F601
SET INITIALIZATION STATE
PRESS BUTTON
F602
GENERATE NETWORK C
F603
SET ROLE TO PROVIDING-APPARATUS CANDIDATE
F604
SET SEARCH STATE
F605
START TIMER T1
SEARCH SIGNAL
F608
HALT TIMER T1
F609
SET ROLE TO RECEIVING APPARATUS
F610
JOIN IN NETWORK B
F614
SET PROTECTION STATE
APPARATUS B
F401 TO 427
F406
SET ROLE TO PROVIDING APPARATUS
START TIMER T2
SET CONTINUOUS STATE
F606
F607a SEARCH RESPONSE SIGNAL
F611
ACTIVATE COMMUNICATION-PARAMETER PROVISION PROCESS
F612
COMMUNICATION-PARAMETER PROVISION PROCESS
F613
COMPLETE COMMUNICATION-PARAMETER PROVISION PROCESS
F615
TIMER T2 HAS EXPIRED
F616
SET PROTECTION STATE
APPARATUS A
SET ROLE TO RECEIVING APPARATUS
ACTIVATE COMMUNICATION-PARAMETER PROVISION PROCESS
COMMUNICATION-PARAMETER PROVISION PROCESS
COMPLETE COMMUNICATION-PARAMETER PROVISION PROCESS
SET PROTECTION STATE
F607b SEARCH RESPONSE SIGNAL

FIG. 6

FIG. 7

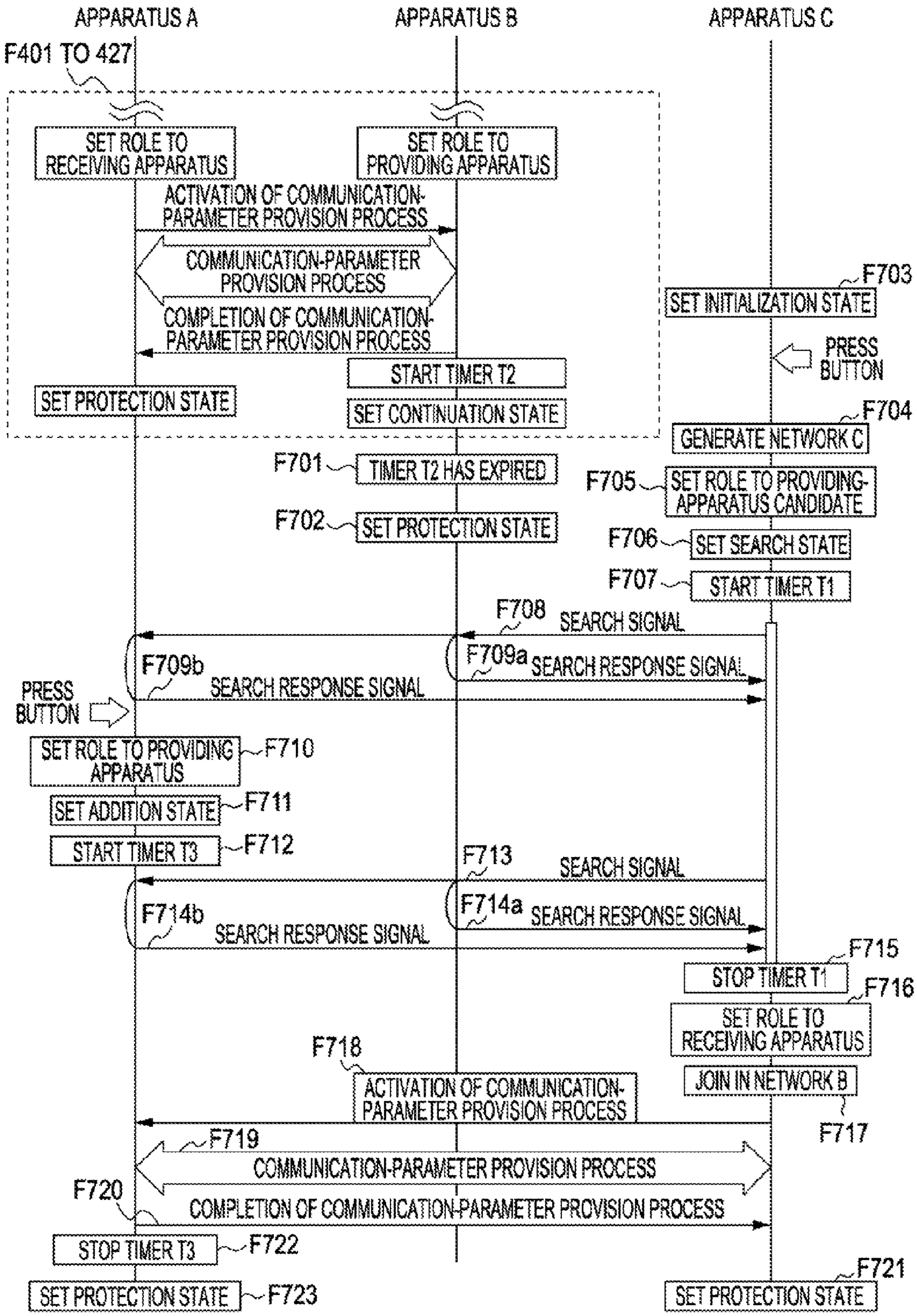

APPARATUS A
APPARATUS B
APPARATUS C
F401 TO 427
SET ROLE TO RECEIVING APPARATUS
SET ROLE TO PROVIDING APPARATUS
ACTIVATION OF COMMUNICATION-PARAMETER PROVISION PROCESS
COMMUNICATION-PARAMETER PROVISION PROCESS
COMPLETION OF COMMUNICATION-PARAMETER PROVISION PROCESS
START TIMER T2
SET PROTECTION STATE
SET CONTINUATION STATE
F703
SET INITIALIZATION STATE
PRESS BUTTON
F704
GENERATE NETWORK C
F701
TIMER T2 HAS EXPIRED
F705
SET ROLE TO PROVIDING-APPARATUS CANDIDATE
F702
SET PROTECTION STATE
F706
SET SEARCH STATE
F707
START TIMER T1
F708
SEARCH SIGNAL
F709a
SEARCH RESPONSE SIGNAL
F709b
SEARCH RESPONSE SIGNAL
PRESS BUTTON
SET ROLE TO PROVIDING APPARATUS
F710
SET ADDITION STATE
F711
START TIMER T3
F712
F713
SEARCH SIGNAL
F714a
SEARCH RESPONSE SIGNAL
F714b
SEARCH RESPONSE SIGNAL
F715
STOP TIMER T1
F716
SET ROLE TO RECEIVING APPARATUS
F718
ACTIVATION OF COMMUNICATION-PARAMETER PROVISION PROCESS
JOIN IN NETWORK B
F717
F719
COMMUNICATION-PARAMETER PROVISION PROCESS
F720
COMPLETION OF COMMUNICATION-PARAMETER PROVISION PROCESS
STOP TIMER T3
F722
F721
SET PROTECTION STATE
F723
SET PROTECTION STATE

FIG. 8A

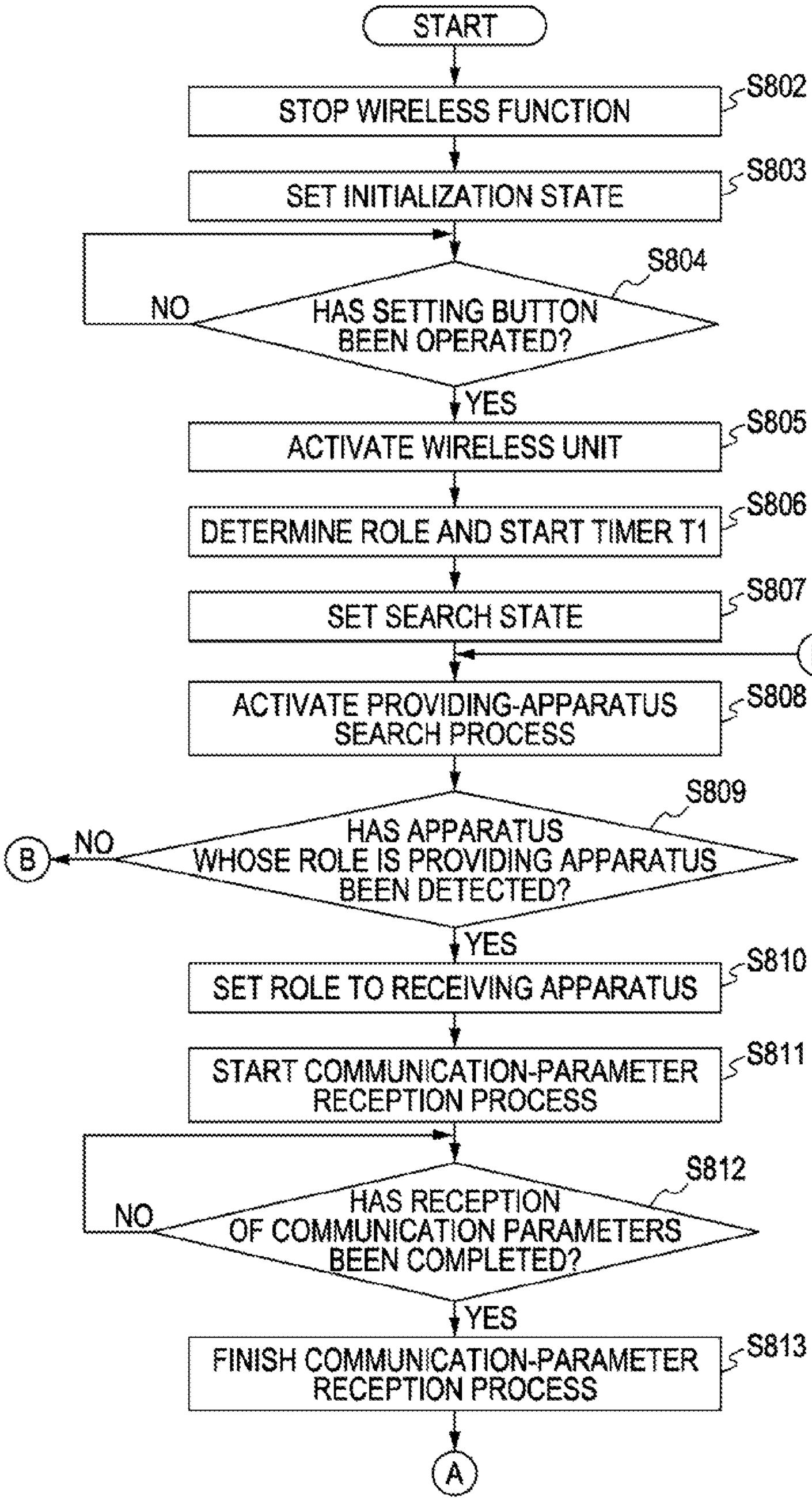

START
STOP WIRELESS FUNCTION
S802
SET INITIALIZATION STATE
S803
S804
NO
HAS SETTING BUTTON BEEN OPERATED?
YES
ACTIVATE WIRELESS UNIT
S805
DETERMINE ROLE AND START TIMER T1
S806
SET SEARCH STATE
S807
D
ACTIVATE PROVIDING-APPARATUS SEARCH PROCESS
S808
S809
B
NO
HAS APPARATUS WHOSE ROLE IS PROVIDING APPARATUS BEEN DETECTED?
YES
SET ROLE TO RECEIVING APPARATUS
S810
START COMMUNICATION-PARAMETER RECEPTION PROCESS
S811
S812
NO
HAS RECEPTION OF COMMUNICATION PARAMETERS BEEN COMPLETED?
YES
FINISH COMMUNICATION-PARAMETER RECEPTION PROCESS
S813
A

FIG. 8B

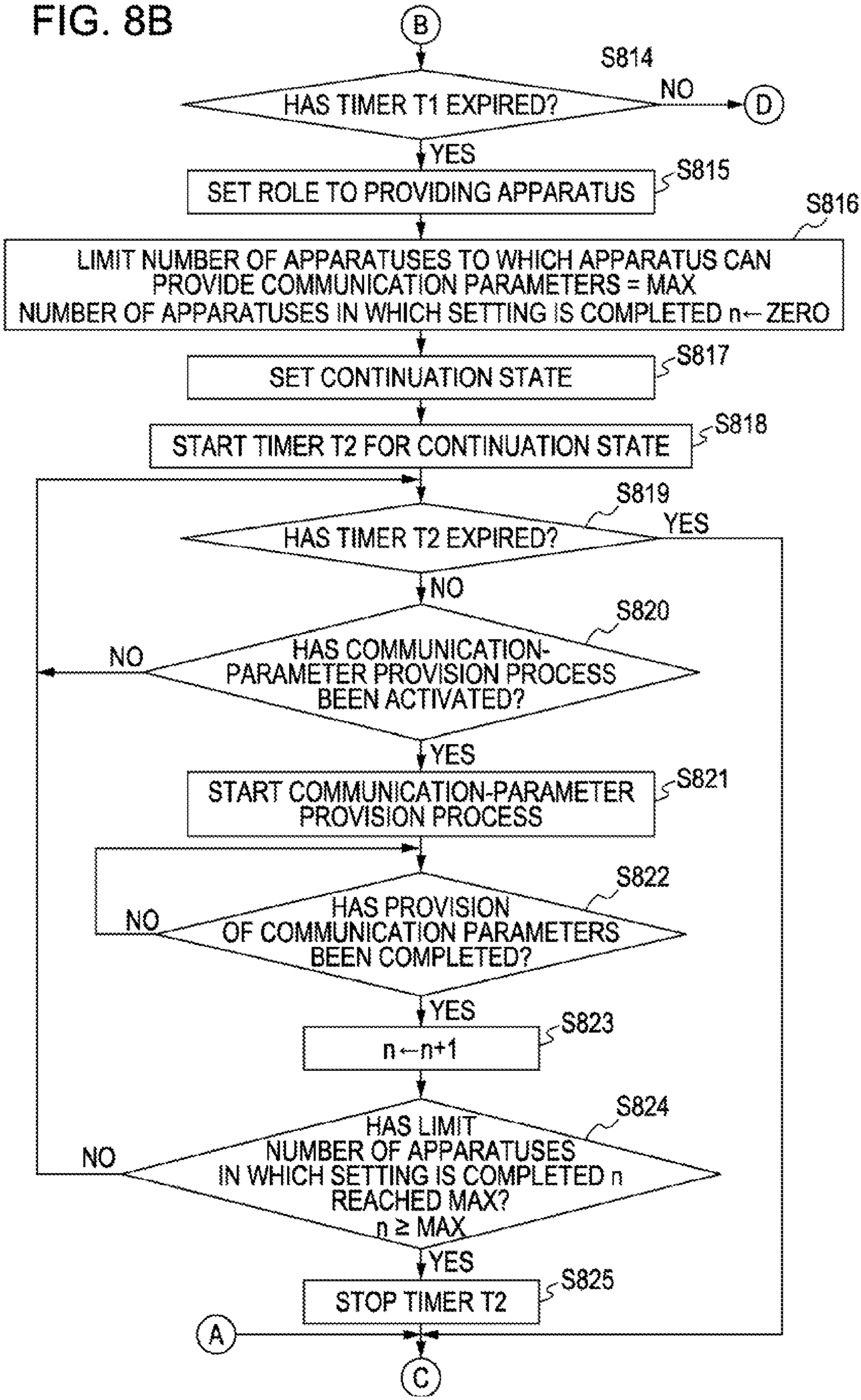
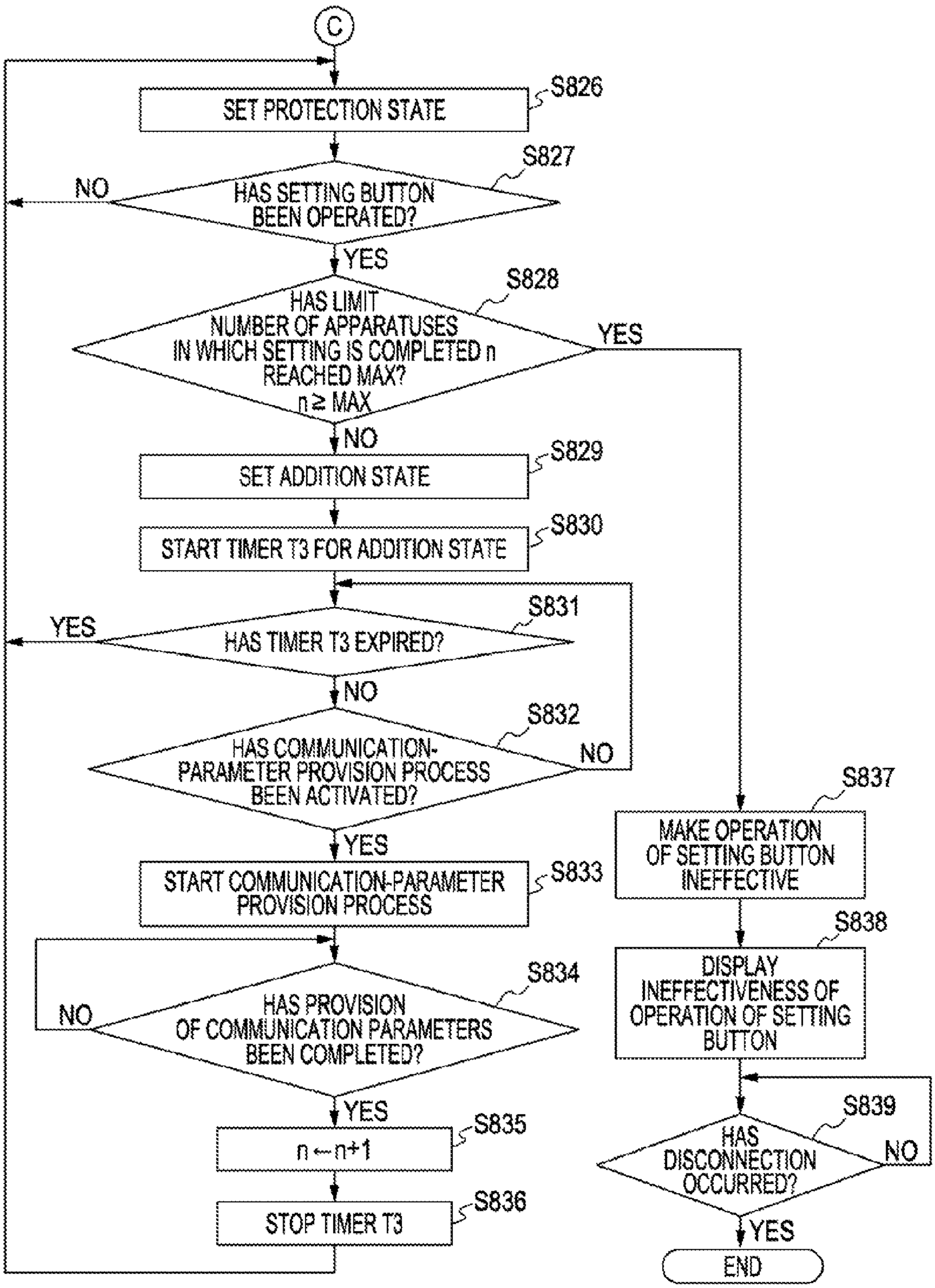

B
S814
HAS TIMER T1 EXPIRED?
NO
D
YES
S815
SET ROLE TO PROVIDING APPARATUS
S816
LIMIT NUMBER OF APPARATUSES TO WHICH APPARATUS CAN PROVIDE COMMUNICATION PARAMETERS = MAX
NUMBER OF APPARATUSES IN WHICH SETTING IS COMPLETED n ← ZERO
S817
SET CONTINUATION STATE
S818
START TIMER T2 FOR CONTINUATION STATE
S819
HAS TIMER T2 EXPIRED?
YES
NO
S820
HAS COMMUNICATION-PARAMETER PROVISION PROCESS BEEN ACTIVATED?
NO
YES
S821
START COMMUNICATION-PARAMETER PROVISION PROCESS
S822
HAS PROVISION OF COMMUNICATION PARAMETERS BEEN COMPLETED?
NO
YES
S823
n ← n+1
S824
HAS LIMIT NUMBER OF APPARATUSES IN WHICH SETTING IS COMPLETED n REACHED MAX?
n ≥ MAX
NO
YES
S825
STOP TIMER T2
A
C

FIG. 8C


C
SET PROTECTION STATE
S826
HAS SETTING BUTTON BEEN OPERATED?
S827
NO
YES
HAS LIMIT NUMBER OF APPARATUSES IN WHICH SETTING IS COMPLETED n REACHED MAX? n ≥ MAX
S828
YES
NO
SET ADDITION STATE
S829
START TIMER T3 FOR ADDITION STATE
S830
HAS TIMER T3 EXPIRED?
S831
YES
NO
HAS COMMUNICATION-PARAMETER PROVISION PROCESS BEEN ACTIVATED?
S832
NO
YES
START COMMUNICATION-PARAMETER PROVISION PROCESS
S833
HAS PROVISION OF COMMUNICATION PARAMETERS BEEN COMPLETED?
S834
NO
YES
n←n+1
S835
STOP TIMER T3
S836
MAKE OPERATION OF SETTING BUTTON INEFFECTIVE
S837
DISPLAY INEFFECTIVENESS OF OPERATION OF SETTING BUTTON
S838
HAS DISCONNECTION OCCURRED?
S839
NO
YES
END

COMMUNICATION APPARATUS, CONTROL METHOD, AND PROGRAM

TECHNICAL FIELD

The present invention relates to a communication apparatus that can share communication parameters with other apparatuses, a control method, and a program.

BACKGROUND ART

In wireless communication typified by wireless local area networks (LANs) conforming to the Institute of Electrical and Electronics Engineers (IEEE) 802.11 standard series, there are many setting items that must be prior to use.

For example, as the setting items, there are communication parameters that are necessary to perform wireless communication, such as a service set identifier (SSID) which is a network identifier, an encryption method, an encryption key, an authentication method, and an authentication key. It is very complicated for a user to manually enter and set these communication parameters.

For this reason, various manufacturers have devised automatic setting methods for easily setting communication parameters in wireless apparatuses. In these automatic setting methods, using a procedure and messages that are determined in advance between apparatuses to be connected to each other, communication parameters are provided from one of the apparatuses to the other apparatus, and setting of the communication parameters is automatically performed.

In NPL, an example of automatic setting of communication parameters is disclosed.

In the automatic setting of communication parameters that is disclosed in NPL, a setting process is started by pressing a setting start button that is provided on an apparatus. While the setting process is being performed, automatic setting is performed between the apparatus and another apparatus in which the setting process is also started.

Furthermore, in PTL, an example of automatic setting of communication parameters among three or more apparatuses is disclosed. Furthermore, in PTL, a configuration is disclosed, in which one apparatus that is to provide communication parameters (hereinafter, referred to as a "providing apparatus") is determined among apparatuses joining in a network, and in which the providing apparatus provides the communication parameters to the other apparatuses (hereinafter, referred to as "receiving apparatuses").

CITATION LIST

Patent Literature

PTL 1: Japanese Patent Laid-Open No. 2006-352282

Non Patent Literature

NPL 1: Wi-Fi CERTIFIED (unregistered trademark) for Wi-Fi Protected Setup: Easing the User Experience for Home and Small Office Wi-Fi (registered trademark) Networks, http://www.wi-fi.org/wp/wifi-protected-setup

SUMMARY OF INVENTION

Technical Problem

Here, a case is considered, in which automatic setting of communication parameters is performed among three or more apparatuses, and in which communication is performed on the same network.

In this case, when three apparatuses start automatic setting of communication parameters using button operations, first, the automatic setting of communication parameters is performed between two of the apparatuses. Then, the automatic setting of communication parameters is performed on the third apparatus. However, in order to continually perform the automatic setting of communication parameters on the third apparatus, another button operation needs to be performed on either one of the two apparatuses in which setting has been completed.

Furthermore, regarding apparatuses such as game machines, when a user plays a game utilizing communication with unspecified partners, when and how many partner apparatuses will request the user to perform setting (for joining in the game) are unknown. More particularly, when a user starts a game, a plurality of apparatuses simultaneously join in the game often. In such a case, if a button operation is necessary every time one apparatus is added, this causes a user to perform the button operation in a complicated manner.

The present invention aims to improve the convenience of users for a case in which a network is structured by way of performance of a process of sharing communication parameters with other apparatuses.

Solution to Problem

A communication apparatus according to an aspect of the present invention includes the following elements: a first provision means for providing, so that the number of communication partners to which a communication parameter is to be provided is limited to M that is a plural number, the communication parameter to a communication partner in accordance with a predetermined operation performed by a user; and a second provision means for providing, so that an upper limit number of communication partners is one, the communication parameter to a communication partner in accordance with the predetermined operation performed by the user. When the predetermined operation is performed by the user again after a communication-parameter provision process performed by the first provision means has finished, the communication-parameter provision process is performed by the second provision means.

Furthermore, a communication apparatus according to another aspect of the present invention includes the following elements: a first provision means for providing a communication parameter to a plurality of communication partners during a period of time ending with a predetermined time limit in accordance with a predetermined operation performed by a user; and a second provision means for providing, so that an upper limit number of communication partners is one, the communication parameter to a communication partner in accordance with the predetermined operation performed by the user. When the predetermined operation is performed by the user again after a communication-parameter provision process performed by the first provision means has finished, the communication-parameter provision process is performed by the second provision means.

Moreover, a method for controlling a communication apparatus according to another aspect of the present invention includes controlling a communication apparatus to: perform a process of providing, so that an upper limit number of communication partners is M which is a plural number, a communication parameter to a communication partner in accordance with a predetermined operation performed by a user; and provide, when the predetermined operation is performed by the user again after the process has been performed, the

communication parameter to a communication partner so that an upper limit number of communication partners is one.

Advantageous Effects of Invention

According to the aspects of the present invention, the convenience of users can be improved for a case in which a network is structured by way of performance of a process of sharing communication parameters with other apparatuses.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a configuration diagram of a communication apparatus according to a first embodiment of the present invention.

FIG. **2** is a diagram of a software function block of the communication apparatus according to the first embodiment of the present invention.

FIG. **3** is a diagram of a network configuration in the first embodiment of the present invention.

FIG. **4** is a sequence diagram illustrating operations of apparatuses A and B according to the first embodiment of the present invention.

FIG. **5** is a diagram of a network configuration in the first embodiment of the present invention.

FIG. **6** is a sequence diagram illustrating operations of the apparatuses A and B and an apparatus C according to the first embodiment of the present invention.

FIG. **7** is a sequence diagram illustrating operations of the apparatuses A, B, and C according to the first embodiment of the present invention.

FIG. **8**A is a first part of a flowchart of an operation of the communication apparatus according to the first embodiment of the present invention.

FIG. **8**B is a second part of the flowchart of an operation of the communication apparatus according to the first embodiment of the present invention.

FIG. **8**C is a third part of the flowchart of an operation of the communication apparatus according to the first embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

First Embodiment

Hereinafter, a communication apparatus according to a first embodiment will be described in detail with reference to the accompanying drawings. Hereinafter, examples in which a wireless LAN system conforming to IEEE 802.11 series is used are described. However, a communication form is not necessarily limited to a wireless LAN conforming to IEEE 802.11 series.

An exemplary hardware configuration in the first embodiment will be described.

FIG. **1** is a block diagram showing an example of a configuration of each apparatus, which is described below, according to the first embodiment of the present invention. FIG. **1** illustrates the entirety of an apparatus **101**. A control unit **102** controls the entire apparatus **101** by executing a control program that is stored in a storage unit **103**. The control unit **102** also performs various types of control when the apparatus **101** performs a communication-parameter automatic setting process between the apparatus **101** and another apparatus. The storage unit **103** stores the control program that is executed by the control unit **102**, and various types of information items such as communication parameters. Various types of operations described below are performed by executing, with the control unit **102**, the control program that is stored in the storage unit **103**.

A wireless unit **104** is used to perform wireless communication. A display unit **105** performs various types of displays. The display unit **105** has a function of capable of outputting visually recognizable information, such as a liquid crystal display (LCD) or a light-emitting diode (LED), or a function of capable of outputting a sound, such as a speaker.

A setting button **106** is used to supply a trigger for starting the communication-parameter automatic setting process. When the control unit **102** detects an operation of the setting button **106** that is performed by a user, the control unit **102** performs a process described below.

An antenna control unit **107** and an antenna **108** are provided. An input unit **109** is used by the user to input various types of inputs.

FIG. **2** is a diagram showing an example of a software function block that is used by each apparatus to perform an operation of setting communication parameters which is described below.

FIG. **2** illustrates the entirety of an apparatus **201**. The apparatus **201** includes a communication-parameter automatic setting function block **202**. In the first embodiment, the communication-parameter automatic setting process of automatically setting communication parameters that are necessary to perform wireless communication, such as an SSID which is a network identifier, an encryption method, an encryption key, an authentication method, and an authentication key, is performed.

A packet receiving unit **203** receives packets that are associated with various types of communication. Reception of a beacon (a report signal/broadcast signal) is performed by the packet receiving unit **203**. A packet sending unit **204** sends packets that are associated with various types of communication. Sending of a beacon is performed by the packet sending unit **204**. Note that an information item for structuring and maintaining a network, an information item for joining of an apparatus in a network, various type of information items concerning an apparatus that is a sender, and so forth are added to a beacon.

A search-signal sending unit **205** controls sending of an apparatus search signal, such as a probe request. A probe request may be called a network search signal for searching for a desired network. Sending of a probe request is performed by the search-signal sending unit **205**. Furthermore, sending of a probe response, which is a response signal that is in response to a received probe request, is also performed by the search-signal sending unit **205**.

A search-signal receiving unit **206** controls reception of an apparatus search signal, such as a probe request, from another apparatus. Reception of a probe request is performed by the search-signal receiving unit **206**. Furthermore, reception of a probe response is also performed by the search-signal receiving unit **206**. Note that various types of information items concerning an apparatus that is a sender are added to an apparatus search signal and a response signal that is in response to the apparatus search signal.

A network control unit **207** controls connection to a network. A process of connection to a wireless LAN ad-hoc network or the like is performed by the network control unit **207**.

In the communication-parameter automatic setting function block **202**, an automatic-setting control unit **208** controls various types of protocols in the communication-parameter automatic setting process.

A communication-parameter providing unit **209** provides communication parameters to a partner apparatus. A commu-

nication-parameter provision process included in the communication-parameter automatic setting process, which is described below, is performed by the communication-parameter providing unit **209** in accordance with control that is performed by the automatic setting control unit **208**. Furthermore, the communication-parameter providing unit **209** performs a first provision process of providing communication parameters to a plurality of communication partners, and a second provision process of providing the communication parameters to one communication partner so that an upper limit number of communication partners is one. A communication-parameter receiving unit **210** receives communication parameters from a partner apparatus. A communication-parameter reception process included in the communication-parameter automatic setting process, which is described below, is performed by the communication-parameter receiving unit **210** in accordance with control that is performed by the automatic setting control unit **208**.

In addition, the automatic-setting control unit **208** also determines whether a time that has elapsed after the communication-parameter automatic setting process started has exceeded a time limit of the communication-parameter automatic setting process. Furthermore, when it is determined that the time that has elapsed after the communication-parameter automatic setting process started has exceeded the time limit, the communication-parameter automatic setting process is discontinued in accordance with control that is performed by the automatic setting control unit **208**.

Furthermore, whether or not the number of apparatuses in which a setting process is performed within the time limit of the communication-parameter automatic setting process after the communication-parameter automatic setting process started has exceeded a limit number of apparatuses is also determined by the automatic setting control unit **208**. Additionally, when it is determined that the number of apparatuses in which the communication-parameter automatic setting process is performed within the time limit has exceeded the limit number of apparatuses, the communication-parameter automatic setting process is discontinued in accordance with control that is performed by the automatic setting control unit **208**.

A role determination unit **211** determines a role (a providing apparatus or a receiving apparatus) in the communication-parameter automatic setting process. A role determination process, which is described below, is performed by the role determination unit **211**.

A setting notification control unit **212** controls a process that is associated with notification of the start and end of the communication-parameter automatic setting process. A process of sending/receiving a start notification message, a start notification response message, and a completion notification message to/from a providing apparatus, which is described below, is performed by the setting notification control unit **212**.

A beacon control unit **213** controls timing at which a beacon (a report signal) is sent.

FIG. **3** is a diagram showing a communication apparatus A**300** (hereinafter, referred to as an "apparatus A") and a communication apparatus B**301** (hereinafter, referred to as an "apparatus B"). These apparatuses have the configurations shown in FIGS. **1** and **2**, which are described above.

Each of the apparatuses A and B operates as a providing apparatus that provides communication parameters or a receiving apparatus that receives communication parameters. Alternatively, the apparatuses A and B generate a network A**302** (hereinafter, referred to as a "network A") and a network B**303** (hereinafter, referred to as a "network B"), respectively, in a state in which the roles of the apparatuses A and B have not been determined.

The apparatuses A and B find each other, and perform arbitration to determine which apparatus will serve as a providing apparatus. As a result, communication parameters are provided from an apparatus serving as a providing apparatus to an apparatus serving as a receiving apparatus.

Furthermore, the networks A and B are ad-hoc networks that are structured by the apparatuses A and B, respectively. An ad-hoc network is called an independent basic service set (MSS). Individual ad-hoc networks are distinguished from one another using basic service set identifiers (BSSIDs) that are network identifiers.

FIG. **4** is a diagram illustrating an example of a process sequence in a case in which users press the setting buttons **106** of the apparatuses A and B, and in which the communication-parameter automatic setting process is performed between the apparatuses A and B.

First, the apparatuses A and B are set to be in an initialization state (F**401** and F**402**). Next, the setting buttons **106** are pressed. The apparatus A generates the unique network A (F**403**), and the apparatus B also generates the unique network B (F**404**). When the setting buttons **106** are pressed, the apparatuses A and B start the communication-parameter automatic setting process. In the communication-parameter automatic setting process, roles are determined using the role determination process, and the communication-parameter provision process of providing communication parameters from a providing apparatus to a receiving apparatus is performed. The communication-parameter provision process can be realized using a communication protocol process that is defined in a communication-parameter setting process whish is an industry standard as described in NPL. Furthermore, the communication-parameter provision process can also be realized using a unique communication protocol process if the apparatuses support the communication protocol process.

Next, each of the apparatuses A and B sets an operation role (hereinafter, referred to as a "role") thereof to a providing-apparatus candidate indicating that whether the apparatus will serve as a providing apparatus or a receiving apparatus has not been determined (F**405** and F**406**). Furthermore, the apparatuses A and B set the states the states thereof to a search state (F**407** and F**408**), and start timers T**1** (F**409** and F**410**). Each of the timers T**1** indicates an arbitration time for an operation role, and is used to set the operation role of an apparatus whose timer T**1** has first expired to a providing apparatus. Accordingly, when no providing apparatus has been detected before the timer T**1** expires, an apparatus whose timer T**1** has first expired will serve as a providing apparatus. Furthermore, when an apparatus has detected a providing apparatus before the timer T**1** of the apparatus expires, the apparatus sets the role thereof to a receiving apparatus.

Each of the apparatuses A and B sends, after a corresponding one of the timers T**1** has started, a beacon (a report signal) (F**411** and F**412**). The beacon includes an information element indicating that the apparatus has a function of the communication-parameter automatic setting process. Note that the information element may be an information element indicating that the communication-parameter automatic setting process is being performed. Furthermore, the beacon may include an information element indicating a providing-apparatus candidate that is the current role.

In the beacon, a BSSID is included. The BSSID of the network A is different from the BSSID of the network B.

Accordingly, an apparatus that has received the beacon can recognize a network to which an apparatus that sent the beacon belongs.

Then, the apparatus B sends a search signal B (F**413**). In the search signal B, as in the beacon, an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed, and an information element indicating a providing-apparatus candidate that is the current role are included.

When the apparatus A receives the search signal B that was sent from the apparatus B, the apparatus A sends a search response signal B to the apparatus B (F**414**). Also in the search response signal B, as in the beacon and as in the search signal A, an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed, and an information element indicating a providing-apparatus candidate that is the current role are included.

It is supposed that the timer T**1** of the apparatus B, which indicates the arbitration time for an operation role, has expired earlier than the timer T**1** of the apparatus A (F**415**). When the timer T**1** of the apparatus B has expired, the apparatus B sets the operation role thereof to a providing apparatus (F**416**).

Next, the apparatus A sends a search signal A (F**417**). Also in the search signal A that is sent from the apparatus A, an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed, and an information element indicating a providing-apparatus candidate that is the current role are included.

When the apparatus B receives the search signal A that was sent from the apparatus A, the apparatus B sends a search response signal A to the apparatus A (F**418**). Also in the search response signal A, as in the beacon and as in the search signal A, an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed is included. However, for the current role, an information element indicating a providing apparatus is included. Here, in addition to the information element indicating a providing apparatus as a role, an information element indicating that the apparatus is in a state in which the apparatus can provide communication parameters may be added.

When the apparatus A receives the search response signal A that was sent from the apparatus B, the apparatus A verifies that the role of the apparatus B is a providing apparatus, and that the apparatus B is in a state in which the apparatus can provide communication parameters. Then, the apparatus A stops the timer T**1** for arbitration (F**419**), sets the role thereof to a receiving apparatus (F**420**), and joins in the network B that the apparatus B generated (F**421**). In other words, the receiving apparatus joins in the network of the providing apparatus. Accordingly, the apparatuses A and B join together in the same network B, and communication messages that should be exchanged in the communication-parameter automatic setting process can be mutually sent/received between the apparatuses A and B. Up to this point, the process sequence from the beginning to the role determination process is completed. Furthermore, for joining of the apparatus A in the network B in F**421**, the apparatus A has not formally received communication parameters from the apparatus B. Accordingly, in this state, data communication in a formal manner (encrypted communication or the like) cannot be performed in the network B. Only communication using a special control packet can be performed. The communication-parameter provision process is performed utilizing this special packet.

Here, when arbitration for a role that is a providing apparatus which provides communication parameters or a receiving apparatus which receives communication parameters is performed between the apparatuses A and B, a search signal and a search response signal are used. However, search for a partner apparatus and arbitration for determination of a role may be performed using a passive scan in which a beacon is mutually sent/received between apparatuses without sending/receiving a search signal and a search response signal.

The apparatus A that joins in the network B sends, to the apparatus B, a message for an instruction for activating the communication-parameter provision process (F**422**). The communication-parameter provision process is performed between the apparatus A serving as a receiving apparatus and the apparatus B serving as a providing apparatus (F**423**). As a result, communication parameters are sent (provided) from the apparatus B to the apparatus A. When the communication-parameter provision process normally finishes, the apparatus B sends, to the apparatus A, a message concerning a completion of the communication-parameter provision process (F**424**). Accordingly, the communication-parameter provision process is completed. Note that the communication parameters that the apparatus B provides may be communication parameters for the network B or communication parameters other than the communication parameters for the network B.

After the apparatus B sent the communication parameters to the apparatus A, the apparatus B serving as a providing apparatus starts a timer T**2** indicating a first predetermined time limit for continuously accepting a new apparatus (F**425**). The apparatus B sets the state thereof to a continuation state (F**426**). On the other hand, the apparatus A sets the state thereof to a protection state, thereby entering a state in which the communication-parameter automatic setting process is not activated (F**427**). In other words, the providing apparatus continues the communication-parameter automatic setting process, and holds a state in which the apparatus serving as a providing apparatus can provide the communication parameters to further another apparatus. When the receiving apparatus receives the communication parameters from the providing apparatus, the receiving apparatus finishes the communication-parameter automatic setting process.

Then, the apparatuses A and B perform a communication connection process using the communication parameters that are shared as a result of the communication-parameter automatic setting process (F**428**). Communication at this stage is performed in a state in which the communication parameters are shared. Accordingly, the state is different from the state in F**421**, and encrypted communication that is defined using the shared communication parameters or the like can also be performed.

Note that, when the communication-parameter provision process finishes, the communication connection process immediately starts, whereby the apparatuses A and B can communicate with each other without forcing a user to perform another operation. In this case, a connection request signal clearly indicating that an apparatus has started the communication connection process may be sent. By utilizing the connection request signal that is sent from an apparatus which joins in the network in which the provided communication parameters are necessary, the apparatus B can recog-

nize that the apparatus has requested connection to the network, and can also easily grasp the number of apparatuses that join in the network. Furthermore, before the communication connection process starts, the apparatus B is instructed, by a user operation, to check the start of connection, whereby the apparatus B may start the communication connection process. Furthermore, the apparatus B starts, using a detection of another apparatus on the network as a trigger, the communication connection process, whereby an unnecessary connection process can be prevented.

FIG. **5** is a diagram showing the first communication apparatus A**300** (the apparatus A), the second communication apparatus B**301** (the apparatus B), a third communication apparatus C**500** (hereinafter, referred to as an "apparatus C"), and a network B**303**. The apparatuses A, B and C have the configurations shown in FIGS. **1** and **2**, which are described above.

The apparatuses A and B join in the ad-hoc network B using the process illustrated in FIG. **4**. A process for joining of the apparatus C in the ad-hoc network B will be described. Note that the apparatus B provided the communication parameters for the network B to the apparatus A, and the apparatuses A and B are in a state in which the apparatuses join in the network B. Hereinafter, the following two cases will be described: a case in which only the setting button **106** of the apparatus C is operated, and in which the apparatus C joins in the network B: and a case in which the setting buttons **106** of the apparatuses A and C are operated, and in which the apparatus C joins in the network B.

FIG. **6** is a sequence diagram for explaining an operation of each of the apparatuses.

FIG. **6** illustrates a sequence in a case in which only the setting button **106** of the apparatus C is operated.

A process that is similar to the process which is described above with reference to FIG. **4** is performed. More specifically, the communication parameters for the network B are provided from the apparatus B serving as a providing apparatus to the apparatus A serving as a receiving apparatus. The apparatus A sets the state thereof to the protection state. The apparatus B starts the timer T**2**, and sets the state thereof to the continuation state.

In the apparatus C, the state thereof is set to the initialization state (F**601**). When a user operates the setting button **106** of the apparatus C, the apparatus C starts the communication-parameter automatic setting process. When the apparatus C has started the communication-parameter automatic setting process, the apparatus C structures a network C (F**602**). Furthermore, the apparatus C sets the operation role thereof to a providing-apparatus candidate indicating that whether the apparatus will serve as a providing apparatus or a receiving apparatus has not been determined (F**603**). Next, the apparatus C sets the state thereof to the search state (F**604**), and starts a timer T**1** indicating the arbitration time for an operation role (F**605**).

After the apparatus C has started the timer T**1**, the apparatus C sends a search signal (F**606**). The search signal includes an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed, and an information element indicating a providing-apparatus candidate that is the current role.

When the apparatuses A and B receive the search signal that was sent from the apparatus C, the apparatuses A and B send back search response signals (F**607***a* and F**607***b*).

In a case in which the apparatus A that has already been in the protection state sends back a search response signal, the apparatus A sends back a search response signal not indicating that the apparatus A activates the communication-parameter automatic setting process (F**607***b*). Alternatively, the apparatus A may send back a search response signal indicating that the apparatus A does not activate the communication-parameter automatic setting process.

Additionally, in a case in which the apparatus B in the continuation state sends back a search response signal, the apparatus B stores, in a search response signal, an information element indicating that the apparatus B serves as a providing apparatus, and sends back the search response signal (F**607***a*). Here, in addition to the information element indicating a providing apparatus as a role, an information element indicating that the apparatus is in a state in which the apparatus can provide communication parameters may be added.

The apparatus C receives the search response signal from the apparatus B (F**607***a*), thereby detecting existence of a providing apparatus. The apparatus C sets the role thereof to a receiving apparatus (F**609**). Furthermore, the apparatus C stops the timer T**1** (F**608**).

Next, the apparatus C joins in the network B in which the providing apparatus exists (F**610**), and sends, to the apparatus B, a message for an instruction for activating the communication-parameter provision process (F**611**).

The communication-parameter provision process is performed between the apparatus C serving as a receiving apparatus and the apparatus B serving as a providing apparatus (F**612**). As a result, the communication parameters are sent (provided) from the apparatus B to the apparatus C. Here, because the apparatus B provided the communication parameters for the network B to the apparatus A, the apparatus B also provides the communication parameters for the network B to the apparatus C. In other words, the apparatus C receives, from the apparatus B serving as a providing apparatus, the communication parameters that are necessary for communication in the network B (F**613**).

After the apparatus B has provided the communication parameters to the apparatus C, the apparatus B sends a completion notification message (F**613**).

When the apparatus C receives the completion notification message, the apparatus C sets the state thereof to the protection state, thereby entering a state in which the apparatus does not activate the communication-parameter automatic setting process (F**614**).

On the other hand, the apparatus B waits until the timer T**2**, which indicates the time limit for continuously performing the communication-parameter automatic setting process between the apparatus and another apparatus, expires. When the setting button **106** of another apparatus has been pressed before the timer T**2** of the apparatus B expires, the apparatus B provides the communication parameters for the network B to the apparatus as in the case of the apparatus C. When the timer T**2** expires (F**615**), the apparatus B sets the state thereof from the continuation state to the protection state in which the apparatus does not activate the communication-parameter automatic setting process (F**616**).

As described above, without an operation of the setting button **106** being performed by the user who uses the apparatus B, the communication-parameter automatic setting process between the apparatus B and another apparatus is continuously enabled for the fixed time. Thus, this can allow the apparatus C to automatically join in the network B. Furthermore, regarding communication parameters that are provided when the apparatus B is in the continuation state, communication parameters that are the same as the communication parameters that have already been provided to another apparatus are provided. Thus, this can allow a plurality of appa-

ratuses to join in the same network. FIG. **7** is a sequence diagram for explaining an operation of each of the apparatuses in a case in which the setting buttons of the apparatuses A and C are operated, and in which the apparatus C joins in the network B.

A process that is similar to the process which is described above with reference to FIG. **4** is performed. More specifically, the communication parameters for the network B are provided from the apparatus B serving as a providing apparatus to the apparatus A serving as a receiving apparatus. The apparatus A sets the state thereof to the protection state. The apparatus B starts the timer T**2**, and sets the state thereof to the continuation state.

After that, the timer T**2**, which indicates the time limit for continuation of the communication-parameter automatic setting process, of the apparatus B expires (F**701**). The apparatus B sets the state thereof to the protection state indicating that the communication-parameter automatic setting process is not activated (F**702**).

In this state, when the setting button **106** of the apparatus C in the initialization state (F**703**) is operated by the user, the apparatus C starts the communication-parameter automatic setting process. When the apparatus C starts the communication-parameter automatic setting process, the apparatus C structures a network C (F**704**). The apparatus C sets the role thereof to a providing-apparatus candidate (F**705**). Then, the apparatus C sets the state thereof to the search state (F**706**), and starts the tinier T**1** of the apparatus C (F**707**). In this state, even when the apparatus C sends a search signal (F**708**), because the apparatuses A and B are in the protection state, the apparatuses A and B send back search response signals not indicating that the apparatuses A and B activate the communication-parameter automatic setting process (F**709***a* and F**709***b*). Alternatively, the apparatuses A and B send back search response signals indicating that the apparatuses A and B do not activate the communication-parameter automatic setting process (F**709***a* and F**709***b*).

On the other hand, the setting button **106** of the apparatus A is operated. Here, because the apparatus A has already completed the communication-parameter automatic setting process between the apparatus A and B, the apparatus A sets the role thereof to a providing apparatus simultaneously with the operation of the setting button **106** performed by a user (F**710**).

Next, the apparatus A sets the state thereof to an addition state in which the apparatus A can perform the communication-parameter automatic setting process between the apparatus A and one different apparatus (F**711**). The apparatus A starts a timer T**3** indicating a second predetermined time limit (F**712**). When the apparatus A has not received any request for providing the communication parameters from another apparatus before the timer T**3** expires, the apparatus A sets the state thereof to the protection state, and finishes the communication-parameter automatic setting process. When the apparatus A has received a request for providing the communication parameters from another apparatus before the tinier T**3** expires, the apparatus A provides the communication parameters that were provided from the apparatus B (the communication parameters for the network in which the apparatus A is joining).

Here, the apparatus C sends the search signal again because the timer T**1** has not expired (F**713**). In the search signal, an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed, and an information element indicating a providing-apparatus candidate that is the current role are included.

For the search signal that was sent from the apparatus C, the apparatus A or B sends back a search response signal (F**714***a* or F**714***b*).

In a case in which the apparatus B sends back a search response signal, the apparatus B sends back a search response signal not indicating that the apparatus B does not activate the communication-parameter automatic setting process (F**714***a*). Furthermore, in a case in which the apparatus A sends back a search response signal, the apparatus A stores, in a search response signal, an information element indicating that the apparatus A serves as a providing apparatus, and sends back the search response signal (F**714***b*).

The apparatus C receives the search response signal from the apparatus A, thereby detecting existence of a providing apparatus. The apparatus C sets the role thereof to a receiving apparatus (F**716**). Furthermore, the apparatus C stops the timer T**1** (F**714**).

The apparatus C that set the role thereof to a receiving apparatus joins in the network B in which the providing apparatus exists (F**717**), and activates the communication-parameter reception process. The apparatus C that activated the communication-parameter reception process sends, to the apparatus A, a message for an instruction for activating the communication-parameter provision process (F**718**). The apparatus C receives, from the apparatus A serving as a providing apparatus, the communication parameters that are necessary for communication in the network B (F**719**). Furthermore, the apparatus A provides, to the apparatus C, the communication parameters, which were provided from the apparatus B, for the network B in which the apparatus A joins (F**719**).

After the apparatus A has provided the communication parameters to the apparatus C, the apparatus A sends a completion notification message (F**720**).

When the apparatus C receives the completion notification message, the apparatus C sets the state thereof to the protection state, thereby entering a state in which the communication-parameter automatic setting process is not activated (F**721**).

On the other hand, after the apparatus A have provided the communication parameters to the apparatus C, the apparatus A stops the timer T**3** (F**722**). The apparatus A sets the state thereof from the addition state to the protection state in which the communication-parameter automatic setting process is not activated (F**723**).

As described above, the operation of the setting button **106** of the apparatus A serving as a receiving apparatus that receives communication parameters can also allow the apparatus C to join in the network B.

Furthermore, referring to FIG. **7**, a case is described, in which the setting button **106** of the apparatus C is operated after the timer T**2** of the apparatus B has expired. However, in a case in which the setting button **106** of the apparatus A is operated while the timer T**2** of the apparatus B is operating, i.e., while the apparatus B is being in the continuation state, the apparatus C can perform the communication-parameter automatic setting process between the apparatus C and both the apparatuses A and B.

Additionally, regarding the state of the apparatus B, only a case in which the state of the apparatus B changes from the continuation state in which the timer T**2** is operating to the protection state that is set after the timer T**2** has expired is described. However, the apparatus B that has been in the protection state can also be set, using the operation of the

setting button **106**, to be in the addition state, and can provide the communication parameters as in the above-described case of the apparatus A.

Moreover, when the apparatus B is in the continuation state and the setting button **106** of the apparatus B is pressed, the time indicated by the timer T**2** may be extended. Alternatively, the apparatus B may immediately enter the addition state.

In addition, in the above description, a providing apparatus starts the timer T**2** after the providing apparatus provides communication parameters to a receiving apparatus. However, an apparatus may start the timer T**2** thereof after it is determined that the role of the apparatus is a providing apparatus. In this manner, during a predetermined period of time from when it is determined that the role of an apparatus is a providing apparatus to when the timer T**2** of the apparatus expires, the apparatus can provide communication parameters to a plurality of receiving apparatuses. Furthermore, the number of receiving apparatuses to which a providing apparatus can provide communication parameters may be limited. In this manner, even during a period of time until the timer T**2** of a providing apparatus expires, the providing apparatus can provide communication parameters only to a predetermined number, which is determined in advance, of receiving apparatuses.

Hereinafter, an apparatus starts the timer T**2** thereof after it is determined that the role of the apparatus is a providing apparatus, and further, the number of apparatuses to which the providing apparatus can provide communication parameters is also limited in advance.

FIGS. **8**A to **8**B are parts of a flowchart showing an example of an operation flow in a case in which the setting button **106** of the apparatus A or B is operated, and in which the communication-parameter automatic setting process is performed. This flowchart can be applied to any of the apparatuses A and B.

First, in each of the apparatuses, a wireless function is stopped (S**802**). The state of the apparatus is set to the initialization state (S**803**).

In order to activate the communication-parameter automatic setting process for sharing communication parameters with a communication partner, the setting button **106** is operated by a user. When the control unit **102** determines that the setting button **106** has been operated (S**804**), the control unit **102** activates the wireless unit **104** (S**805**). When the wireless unit **104** is activated, the apparatus structures a network, and starts sending a beacon. In addition, the apparatus starts the timer T**1** for determination of a role (S**806**). Furthermore, at this state, the apparatus sets the role thereof to a providing-apparatus candidate. The apparatus sets the state thereof to the search state (S**807**), and activates a providing-apparatus search process (S**808**).

Herein, the providing-apparatus search process is performed by sending/receiving a beacon (a report signal), by sending/receiving a search signal (a probe request), and by sending/receiving a search response signal (a probe response). In each of the signals, an information element indicating that the apparatus has the function of the communication-parameter automatic setting process or indicating that the communication-parameter automatic setting process is being performed, an information element indicating a role, and an information element indicating whether or not a provision function is being activated are included on an as needed basis.

Next, the apparatus determines whether or not the apparatus has detected an apparatus whose role is a providing apparatus (S**809**). When the apparatus has detected a providing apparatus, the apparatus sets the role thereof to a receiving apparatus (S**810**), and starts the communication-parameter reception process (S**811**). The apparatus that activates the communication-parameter reception process sends, to the providing apparatus, a message for an instruction for activating the communication-parameter provision process, and receives communication parameters from the providing apparatus. When reception of communication parameters is completed (S**812**), the apparatus finishes the communication-parameter reception process (S**813**). The apparatus proceeds to S**826**. In contrast, when the apparatus has not detected a providing apparatus (S**809**), the apparatus repeats the providing-apparatus search process while the timer T**1** is operating (S**814**). When the timer T**1** has expired without detection of a providing apparatus, the apparatus sets the role thereof to a providing apparatus (S**815**). Next, the apparatus sets a limit number of apparatuses to which the apparatus can provide communication parameters to M that is a plural number (sets an upper limit number of apparatuses to which the apparatus can provide communication parameters to MAX), and sets the current number of apparatuses in which setting is completed n to zero (S**816**).

Then, the apparatus sets the state thereof to the continuation state, in which the apparatus can continuously perform the communication-parameter automatic setting process between the apparatus and another apparatus (S**817**). The apparatus starts the timer T**2** indicating the time limit of the continuation state (S**818**). When the apparatus has been instructed by a receiving apparatus to activate the communication-parameter provision process while the apparatus is being in the continuation state before the timer T**2** expires, the apparatus activates the communication-parameter provision process (S**820**). Then, the apparatus starts the communication-parameter provision process (S**821**). When provision of communication parameters is completed (S**822**), the apparatus increments the number of apparatuses in which setting is completed n by one (S**823**). The apparatus determines whether or not the number of apparatuses in which setting is completed n has reached the limit number of apparatuses to which the apparatus can provide communication parameters MAX (S**824**). When the number of apparatuses in which setting is completed n has not reached the limit number of apparatuses to which the apparatus can provide communication parameters MAX, the apparatus waits until the apparatus is instructed to activate the communication-parameter provision process (S**820**), while the timer T**2** is operating (S**819**).

When the timer T**2** has expired, the apparatus finishes functioning as a providing apparatus, and finishes the communication-parameter automatic setting process. The apparatus proceeds to S**826**. Furthermore, even when the timer T**2** has not expired, in a case in which the number of apparatuses in which setting is completed n has reached the limit number of apparatuses to which the apparatus can provide communication parameters MAX, the apparatus stops the timer T**2** (S**825**). The apparatus finishes functioning as a providing apparatus, and finishes the communication-parameter automatic setting process. The apparatus proceeds to S**826**.

In a case in which the apparatus finishes the communication-parameter reception process (S**813**), or in a case in which the apparatus finishes functioning as a providing apparatus (S**819** or S**825**), the apparatus sets the state thereof to the protection state in which the communication-parameter automatic setting process is not activated (S**826**). Then, the apparatus checks whether or not the setting button **106** has been operated again (S**827**). When the apparatus detects that the setting button **106** has been operated (S**827**), the apparatus checks whether or not the number of apparatuses in which

setting is completed n has already reached the limit number of apparatuses to which the apparatus can provide communication parameters MAX (S**828**). When the number of apparatuses in which setting is completed n has reached the limit number of apparatuses to which the apparatus can provide communication parameters MAX, the apparatus makes the operation of the setting button **106** ineffective or ignores the operation of the setting button **106** (S**837**). Then, the apparatus notifies the user of ineffectiveness of the operation of the setting button **106** using a pattern or color display, a virtually recognizable information output, or a sound output (S**838**). The pattern or color display can be realized by causing an LED to blink or by illuminating an LED. The virtually recognizable information output can be realized, for example, by displaying a message on an LCD. The sound output can be realized, for example, using a speaker. In this case, the apparatus may notify the user of the fact that the number of apparatuses to which the apparatus has provided communication parameters has reached the limit number of apparatuses to which the apparatus can provide communication parameters together with the ineffectiveness of the operation of the setting button **106**. Here, determination in S**828** may be performed only by the apparatus that has functioned as a providing apparatus. Alternatively, when the setting button **106** of an apparatus that has functioned as a receiving apparatus is operated, the apparatus that has functioned as a receiving apparatus may inquires, of the apparatus that has functioned as a providing apparatus, the number of apparatuses in which setting is completed and the limit number of apparatuses to which the providing apparatus can provide communication parameters. The apparatus that has functioned as a receiving apparatus may perform determination in S**828** on the basis of a response to the inquiry. Then, the apparatus continues communication until disconnection occurs (S**839**). In contrast, in a case in which an operation of the setting button **106** is detected (S**827**), and in which the number of apparatuses in which setting is completed n has not reached the limit number of apparatuses to which the apparatus can provide communication parameters MAX (S**828**), the apparatus sets the state thereof to the addition state in which the apparatus can perform the communication-parameter provision process (S**829**). Note that, in a case in which the apparatus does not perform determination in S**828**, when an operation of the setting button **106** is detected (S**827**), the apparatus sets the state thereof to the addition state in which the apparatus can perform the communication-parameter provision process (S**829**).

The apparatus starts the timer T**3** for holding the addition state (S**830**). As described above, the addition state is a state in which the apparatus can provide the communication parameters to one different apparatus. Then, when the apparatus is instructed by a receiving apparatus to activate the communication-parameter provision process (S**832**), the apparatus starts the communication-parameter provision process (S**833**). After that, provision of the communication parameters is completed (S**834**), the apparatus increments the number of apparatuses in which setting is completed n by one (S**835**). The apparatus stops the timer T**3**, and the apparatus returns to S**826**. Furthermore, in a case in which the apparatus has not been instructed to activate the communication-parameter provision process (S**832**), and in which the timer T**3** has expired (S**831**), the apparatus returns to S**826**.

Then, the apparatus sets the role thereof to the protection state again (S**826**), and waits until the user operates the setting button **106** (S**827**).

Note that, in the above description, when the setting button **106** is operated again after the apparatus has set the state thereof to the protection state, the apparatus sets the state thereof to the addition state, and provides the communication parameters to an additional apparatus. The apparatus may be designed so that the apparatus does not enter the addition state even when the setting button **106** is operated after the apparatus set the state thereof to the protection state and a predetermined time has elapsed. With the above-designed apparatus, the following configuration can be realized: during a predetermined period of time after the apparatus provides or receives communication parameters, joining of another apparatus in the network using the communication-parameter automatic setting process is allowed; and, however, after the predetermined period of time elapses, joining of another apparatus in the network using the communication-parameter automatic setting process is not allowed.

Furthermore, because joining of a plurality of communication apparatuses can be accepted using only one button operation, an operation of accepting joining in the same network is simplified. Additionally, even when the role of an apparatus in the communication-parameter automatic setting process that is performed using a first button operation is a providing apparatus or a receiving apparatus, joining of one new communication apparatus is accepted using each of the subsequent button operations. Thus, all communication apparatuses can allow the second and subsequent button operations to be performed regardless of the roles of the communication apparatuses, whereby convenience for automatic setting of communication parameters can be improved.

Moreover, even in a case in which a first communication-parameter automatic setting process finishes, if the setting button is operated again, an apparatus that is to join in the network can be added. Additionally, because the number of additional apparatuses is one, joining of a plurality of unexpected partner apparatuses in the network can be reduced. In other words, although the button operation is a simple operation, the network can be extended while the security thereof is being maintained.

Note that, the first embodiment of the present invention is described above using wireless LANs conforming to IEEE 802.11 series as examples. However, the present invention may be implemented in other wireless media such as media using wireless universal serial bus (USB), media using MBOA, media using Bluetooth (registered trademark), media using ultra wide band (UWB), or media using ZigBee. The present invention may be implemented in wired communication media such as wired LANs.

Here, MBOA stands for Multi Band OFDM alliance. Furthermore, UWB includes wireless USB, wireless 1394, WINET, and so forth.

Additionally, a network identifier, an encryption method, an encryption key, an authentication method, and an authentication key are used as examples of communication parameters. However, as a matter of course, other information may be used, or other information may be included in the communication parameters.

A recording medium on which a computer program code of software that realizes the above-described functions is recorded is provided in a system or apparatus, and a computer (a central process unit (CPU) or a micro processing unit (MPU)) of the system or apparatus reads and executes the computer program code stored on the recording medium, whereby the present invention can also be implemented.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be

accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2008-284512, filed Nov. 5, 2008, which is hereby incorporated by reference herein in its entirety.

The invention claimed is:

1. A communication apparatus comprising:

a communication-parameter providing unit configured to:

perform a first communication-parameter provision process for providing a communication parameter to one or more communication partners in response to a predetermined operation performed by a user, an upper limit number of the communication partners being M, which is a plural number; and

perform a second communication-parameter provision process for providing the communication parameter to a communication partner in response to the predetermined operation performed by the user, an upper limit number of the communication partner being one,

wherein, when time has exceeded a predetermined time limit before provision of the communication parameter to M communication partners is completed in the first communication-parameter provision process, and when it is detected that the predetermined operation is performed by the user again, the communication-parameter providing unit performs the second communication-parameter provision process without performing the first communication-parameter provision process.

2. A method for controlling a communication apparatus, the method comprising controlling the communication apparatus to:

perform a first communication-parameter provision process for providing a communication parameter to one or more communication partners in response to a predetermined operation performed by a user, an upper limit number of the communication parameters being M, which is a plural number; and

perform a second communication-parameter provision process for providing the communication parameter to a communication partner in response to the predetermined operation performed by the user, an upper limit number of the communication partner being one,

wherein, when time has exceeded a predetermined time limit before provision of the communication parameter to M communication partners is completed in the first communication-parameter provision process, and when it is detected that the predetermined operation is performed by the user again, the second communication-parameter provision process is performed without performing the first communication-parameter provision process.

3. A non-transitory computer readable medium storing a program for controlling a communication apparatus, wherein the program, when executed by a computer, controls a communication apparatus to:

perform a first communication-parameter provision process for providing a communication parameter to one or more communication partners in response to a predetermined operation performed by a user, an upper limit number of the communication parameters being M, which is a plural number; and

perform a second communication-parameter provision process for providing the communication parameter to a communication partner in response to the predetermined operation performed by the user, an upper limit number of the communication partner being one,

wherein, when time has exceeded a predetermined time limit before provision of the communication parameter to M communication partners is completed in the first communication-parameter provision process, and when it is detected that the predetermined operation is performed by the user again, the second communication-parameter provision process is performed without performing the first communication-parameter provision process.

4. The communication apparatus according to claim **1**, wherein the communication parameter is used for wireless communication.

5. The communication apparatus according to claim **1**, wherein the communication parameter includes at least one of a network identifier, an encryption method, an encryption key, an authentication method, and an authentication key.

6. The communication apparatus according to claim **1**, wherein the communication parameter includes a network identifier, an encryption method, an encryption key, an authentication method, and an authentication key.

7. The communication apparatus according to claim **1**, wherein the communication-parameter providing unit is further configured to set the state of the communication apparatus to a protection state in which the first and second communication-parameter provision processes are not activated.

8. The communication apparatus according to claim **1**, wherein the second communication-parameter provision process is performed depending on whether the communication parameter is provided to the M communication partners in the first communication-parameter provision process.

9. The communication apparatus according to claim **8**, wherein, even when the predetermined operation is performed by the user after the communication parameter is provided to the M communication partners in the first communication-parameter provision process, the second communication-parameter provision process is not performed.

10. The communication apparatus according to claim **1**, wherein the communication apparatus performs LAN communication conforming to a wireless protocol with the one or more communication partners to which the communication parameter is provided.

11. The communication apparatus according to claim **1**, wherein the communication parameter provided in the first communication-parameter provision process is identical to the communication parameter provided in the second communication-parameter provision process.

12. The communication apparatus according to claim **1**, further comprising:

a role determination unit configured to:

send a beacon signal indicating a capability of functioning as a communication parameter providing apparatus;

send a search signal to the one or more communication partners to search for an external providing apparatus; and

set the communication apparatus as a providing apparatus.

13. The communication apparatus according to claim **12**, wherein the role determination unit is further configured to receive a search response signal from the one or more communication partners indicating that the one or more communication partners are not an external providing apparatus.

14. The communication apparatus according to claim **12**, wherein the beacon signal includes a network identifier of a network created by the communication apparatus.

15. The communication apparatus according to claim **12**, wherein the search signal includes a network identifier and an

indication that the communication apparatus has a capability of functioning as a communication-parameter providing apparatus.

16. The communication apparatus according to claim **12**, wherein the search signal includes an indication that the first communication-parameter provision process is being performed by the communication apparatus.

17. The communication apparatus according to claim **12**, wherein the search signal includes an indication that the second communication-parameter provision process is being performed by the communication apparatus.

* * * * *