

# WIRELESS TRANSMISSION SYSTEM AND WIRELESS TRANSMISSION METHOD

## FIELD

Embodiments described herein relate generally to a  
5 wireless transmission system and a wireless transmission method.

## BACKGROUND

Generally, an elevator is provided with a device  
for controlling the elevator overall which is called a  
10 control board (hereinafter referred to as an elevator control device).

The elevator control device drives a hoisting  
mechanism to control the ascending and descending  
operation of a car in an elevator shaft, and also  
15 transmits, for example, a control signal for  
controlling the opening and closing of a car door of  
the car which has arrived at a predetermined hall.

Meanwhile, a control signal called a car call  
which is output in accordance with an operation on a  
20 destination floor button provided in the car is  
transmitted to the elevator control device from the  
car.

Transmitting a control signal between the elevator  
control device and the car is carried out via a  
25 transmission cable called a travelling cable which  
connects the elevator control device and the car.

When a travel of the elevator (car) to run becomes  
long, the length of the above-mentioned travelling  
cable must be increased.

30 When the length of the travelling cable is  
increased, the weight of the same increases. Since the  
travelling cable is connected to the car, in accordance  
with the increase in the weight of the travelling  
cable, the capacity of the hoisting mechanism for  
35 ascending and descending the car must be increased.

For this reason, a mechanism for transmitting a  
control signal between the elevator control device and

the car wirelessly without using a travelling cable is desired.

Further, by transmitting a control signal called a hall call which is output in accordance with an  
5 operation on a hall call button installed in each hall on the floor wirelessly, wiring (a cable) or the like necessary for transmitting the control signal may be simplified.

#### SUMMARY

10 According to one aspect, there is provided a wireless transmission system comprising a plurality of wireless apparatuses corresponding to a plurality of components of an elevator, respectively, the plurality of components outputting signals used for controlling the  
15 elevator, each of the plurality of wireless apparatuses comprising:

a transmitter configured to transmit a first signal, which is output by a corresponding component, to other wireless apparatuses wirelessly;

20 a receiver configured to receive a second signal output by each of components corresponding to the other wireless apparatuses from each of the other wireless apparatuses wirelessly; and

a counter configured to maintain a value which is  
25 updated every time the first signal is transmitted or the second signal is received, wherein

the transmitter is configured to transmit the first signal when the value maintained by the counter agrees with a value determined in advance with respect  
30 to the wireless apparatus comprising the transmitter, and

values determined in advance with respect to the plurality of wireless apparatuses, respectively, are different from one another,

35 the transmitter comprised in a predetermined wireless apparatus of the plurality of wireless apparatuses is configured to transmit a third signal,

which is a substitute of the second signal, when the value maintained by the counter does not agree with a value determined in advance with respect to the predetermined wireless apparatus, and the second signal  
5 is not received for a certain period,

the plurality of components comprise an elevator control device configured to control at least ascending and descending operation of a car;

the predetermined wireless apparatus is a wireless  
10 apparatus corresponding to the elevator control device; and

the wireless apparatus corresponding to the elevator control device further comprises a notification module configured to notify the elevator  
15 control device that the second signal is not received for a certain period.

According to another aspect, there is provided a wireless transmission method executed by a wireless  
20 transmission system comprising a plurality of wireless apparatuses corresponding to a plurality of components of an elevator, respectively, the plurality of components outputting signals used for controlling the elevator, the wireless transmission method comprising:

25 maintaining, by each of the wireless apparatuses, a value which is updated every time a first signal output by a corresponding component is transmitted to other wireless apparatuses wirelessly, or a second signal output by each of components corresponding to  
30 the other wireless apparatuses which is transmitted from the other wireless apparatuses wirelessly is received; and

transmitting, by each of the wireless apparatuses, the first signal when the maintained value agrees with  
35 a value determined in advance with respect to each of the wireless apparatuses, wherein

values determined in advance with respect to

the plurality of wireless apparatuses, respectively,  
are different from one another,

transmitting a third signal using a predetermined  
wireless apparatus of the plurality of wireless  
5 apparatuses, the third signal being a substitute of the  
second signal, when the value maintained by the counter  
does not agree with a value determined in advance with  
respect to the predetermined wireless apparatus, and  
the second signal is not received for a certain period,  
10 controlling at least ascending and descending  
operation of a car using an elevator control device,  
the plurality of components comprising the elevator  
control device, and  
notifying the elevator control device, using the  
15 wireless apparatus corresponding to the elevator  
control device, that the second signal is not received  
for a certain period.

#### BRIEF DESCRIPTION OF THE DRAWINGS

20 FIG. 1 is an illustration showing a structure of  
an elevator according to an embodiment.

FIG. 2 is a diagram for describing an example of a  
functional configuration of each of wireless  
apparatuses which constitute a wireless transmission  
25 system according to the present embodiment.

FIG. 3 is a flowchart showing an example of a  
procedure of a process executed in a wireless apparatus  
operating as a parent node.

30 FIG. 4 is a flowchart showing an example of a  
procedure of a process executed in a wireless apparatus  
operating as a child node.

FIG. 5 is a diagram for describing a specific  
example of an operation of the wireless transmission  
system according to the present embodiment.

DETAILED DESCRIPTION

Embodiments will be described hereinafter with reference to the accompanying drawings.

5 In general, according to one embodiment, a wireless transmission system includes a plurality of wireless apparatuses corresponding to a plurality of components of an elevator which output signals used for controlling the elevator, respectively. Each of the wireless apparatuses includes a transmitter, a  
10 receiver, and a counter. The transmitter transmits a first signal, which is output by a corresponding component, to other wireless apparatuses wirelessly. The receiver receives a second signal output by each of

components corresponding to the other wireless apparatuses from each of the other wireless apparatuses wirelessly. The counter maintains a value which is updated every time the first signal is transmitted or the second signal is received. The transmitter is configured to transmit the first signal when the value maintained by the counter agrees with a value determined in advance with respect to the wireless apparatus including the transmitter. Values determined in advance with respect to the plurality of wireless apparatuses, respectively, are different from one another.

FIG. 1 is a diagram showing the structure of an elevator 10 according to the present embodiment. In the elevator 10 shown in FIG. 1, an elevator control device 11 configured to control the elevator 10 overall, which is called a control board, is provided at the upper part of an elevator shaft 20.

In the elevator 10, a car 12 and a counterweight 13 are provided within the elevator shaft 20, and are each supported on a guide rail (not shown) so that they can ascend and descend.

Also, a hoisting mechanism 14 which is connected to the elevator control device 11 is provided in the upper part of the elevator shaft 20. A main rope 15 whose one end is connected to the car 12 and the other end is connected to the counterweight 13 is wound around the hoisting mechanism 14.

In the elevator 10, the car 12 and the counterweight 13 connected to respective ends of the main rope 15 move in directions opposite to each other, i.e., ascend and descend relative to each other, as the hoisting mechanism 14 is driven based on the control of the elevator control device 11.

A car controller for controlling opening and closing of a car door of the car 12 which has arrived at, for example, halls 31 to 34 is provided on the

upper part of the car 12, although this is omitted in FIG. 1.

Further, a destination floor button is provided inside the car 12. The destination floor button is for  
5 registering a destination floor of a user who has got on the car 12. When an operation on the destination floor button is performed by the user, a signal representing the destination floor registered by the user (hereinafter referred to as a car call) is output.

Also, hall call buttons are installed in halls 31  
10 to 34 on the respective floors at which the car arrives. The hall call button is for registering a position of the hall from which the user gets on the car 12 (i.e., a registration floor). When an operation  
15 on the hall call button is performed by the user in halls 31 to 34, a signal representing the position of the hall registered by the user and the direction of destination (up or down) (hereinafter referred to as a hall call) is output.

In the present embodiment, at places near  
20 components of the elevator 10 which output signals for controlling the elevator 10 described above (hereinafter referred to as control signals), wireless apparatuses corresponding to the respective components  
25 are provided.

The components of the elevator 10 include, for example, the elevator control device 11, the car 12 (destination floor button), and the hall call buttons installed in halls 31 to 34 on the respective floors.  
30 That is, the control signals for controlling the elevator 10 of the present embodiment include, for example, various control signals for controlling the elevator 10 overall which are output from the elevator control device 11, the car call output in accordance  
35 with the operation on the destination floor button provided inside the car 12, and the hall call output in accordance with the operation on each of the hall cal

buttons installed in halls 31 to 34 on the respective floors.

Note that the components of the elevator 10 in the present embodiment may be ones other than the elevator control device 11, the car 12 (destination floor button), and the hall call buttons installed in halls 31 to 34 on the respective floors as described above as long as they output control signals used for controlling the elevator 10. Further, it suffices that the control signal for controlling the elevator 10 in the present embodiment is a signal (data) that needs to be transmitted and received among the components of the elevator 10.

FIG. 1 shows a wireless apparatus 16a as a wireless apparatus corresponding to the elevator control device 11. A wireless apparatus 16b are shown as a wireless apparatus corresponding to the car 12. Further, wireless apparatuses 16c to 16f are shown as wireless apparatuses corresponding to the hall call buttons installed in halls 31 to 34 of the respective floors.

A plurality of wireless apparatuses including wireless apparatuses 16a to 16f shown in FIG. 1 constitute a wireless transmission system which enables wireless transmission of a control signal in the elevator 10.

With reference to FIG. 2, a functional configuration of each of wireless apparatuses 16a to 16f which constitute the wireless transmission system according to the present embodiment will be described. For convenience sake, a functional configuration of wireless apparatus 16a of wireless apparatuses 16a to 16f will be described referring to FIG. 2.

As shown in FIG. 2, wireless apparatus 16a includes a storage 161, a transmitter-receiver 162, a counter 163, and a controller 164.

The storage 161 stores, for example, a control

signal output from the component of the elevator 10 corresponding to wireless apparatus 16a (i.e., the elevator control device 11 in this case).

5       The transmitter-receiver 162 transmits the control signal stored in the storage 161 (that is, the control signal output from the elevator control device 11 corresponding to wireless apparatus 16a) wirelessly to wireless apparatuses 16b to 16f other than wireless apparatus 16a itself.

10       Also, the transmitter-receiver 162 receives a control signal transmitted from each of the other wireless apparatuses 16b to 16f. Control signals transmitted from the other wireless apparatuses 16b to 16f, respectively, are those output from the components  
15       corresponding to these wireless apparatuses 16b to 16f.

      The counter 163 maintains a value updated every time a control signal is transmitted from the transmitter-receiver 162 or a control signal is received by the transmitter-receiver 162. In other  
20       words, the counter 163 has the function of counting the number of times of transmission/reception of the control signal in wireless apparatus 16a.

      The controller 164 is a functional part which controls the entire wireless apparatus 16a. The  
25       controller 164 has the function of controlling the transmission timing of the control signal in wireless apparatus 16a in order to avoid collision of signals among wireless apparatuses 16a to 16f which constitute the wireless transmission system according to the  
30       present embodiment. More specifically, the controller 164 transmits the control signal in a case where a value maintained by the counter 163 agrees with a value determined in advance with respect to wireless apparatus 16a.

35       While the functional configuration of wireless apparatus 16a has been described referring to FIG. 2, since the functional configurations of the other

wireless apparatuses 16b to 16f are similar to that of wireless apparatus 16a, a detailed explanation of them will be omitted.

Also, although no detailed explanation will be  
5 given, wireless apparatuses 16a to 16f include, as a hardware configuration, a wireless communication antenna, a PHY circuit which executes a process of a physical layer in an OSI reference model, a micro control unit (MCU) which executes a process (MAC  
10 process) of a data link layer in the OSI reference model, a ROM, a RAM, an I/O module which handles transfer of the control signal carried out with a component corresponding to this wireless apparatus, etc.

15 In the present embodiment, in the wireless communication (transmission) of the control signal by wireless apparatuses 16a to 16f, it is assumed that a frequency band of 1 GHz or less, for example, 920 MHz band (Sub-GHz band) is used. The above-mentioned  
20 920 MHz band is superior in a radio wave reachability (that is, easily connected) as compared to the other frequency band (2.4 GHz band, for example). Accordingly, a control signal transmitted from one of wireless apparatuses 16a to 16f (for example, wireless  
25 apparatus 16a) is received by all the other wireless apparatuses (for example, wireless apparatuses 16b to 16f).

As the wireless communication antenna provided in each of wireless apparatuses 16a to 16f, a diversity  
30 antenna, for example, can be used. When this is used, the communication quality and reliability among wireless apparatuses 16a to 16f and can be improved.

Next, the operation of the wireless transmission system according to the present embodiment will be  
35 described. In the wireless transmission system according to the present embodiment, one of the above-described wireless apparatuses 16a to 16f operates as a

parent node. Meanwhile, each of the wireless apparatuses other than the wireless apparatus operating as the parent node operates as a child node.

5 In the wireless transmission system according to the present embodiment, a process to be executed by the wireless apparatus operating as the parent node differs from a process to be executed by the wireless apparatus operating as the child node. Hereinafter, each of a process executed in the wireless apparatus operating as the parent node and a process executed in the wireless  
10 apparatus operating as the child node will be described. It is assumed that the wireless apparatus operating as the parent node and the wireless apparatus operating as the child node are determined in advance  
15 in the wireless transmission system. Here, it is assumed that wireless apparatus 16a is a wireless apparatus operating as the parent node, and wireless apparatuses 16b to 16f are wireless apparatuses operating as child nodes.

20 First, referring to the flowchart of FIG. 3, an example of a procedure of a process executed in wireless apparatus 16a operating as the parent node will be described. The process shown in FIG. 3 is executed continuously while the elevator 10 is being  
25 operated.

When the driving (operation) of the elevator 10 is started, the transmitter-receiver 162 included in wireless apparatus 16a transmits a signal for starting transmission of control signals among wireless  
30 apparatuses 16a to 16f (hereinafter referred to as a start frame) (step S1).

When the start frame is transmitted by the transmitter-receiver 162, the counter 163 resets the value maintained by the counter 163 (hereinafter referred to as a counter value) (step S2). More  
35 specifically, the counter value is reset to zero, for example.

By referring to the counter value, the controller 164 determines whether it is the transmission timing of wireless apparatus 16a in the wireless transmission system (step S3). In this case, the controller 164  
5 determines whether the counter value agrees with a value determined in advance with respect to wireless apparatus 16a (hereinafter referred to as a transmission determination value of wireless apparatus 16a). When the counter value agrees with the  
10 transmission determination value of wireless apparatus 16a, the controller 164 determines that it is the transmission timing of wireless apparatus 16a. Meanwhile, when the counter value does not agree with the transmission determination value of wireless  
15 apparatus 16a, the controller 164 determines that it is not the transmission timing of wireless apparatus 16a. It is assumed that the transmission determination value of wireless apparatus 16a is already held in wireless apparatus 16a.

20 Here, a case where the transmission determination value of wireless apparatus 16a is zero is assumed. In this case, since the counter value after execution of the process of steps S2 is zero, in step S3, it is determined that the transmission timing of wireless  
25 apparatus 16a has come.

When it is determined that the transmission timing of wireless apparatus 16a has come (YES in step S3), the controller 164 acquires a control signal stored in the storage 161. Here, a control signal acquired by  
30 the controller 164 is that output by the elevator control device 11 corresponding to wireless apparatus 16a, and includes, for example, a control signal for (the car controller which is provided in) the car 12 (i.e., a signal for controlling the opening and closing  
35 of the car door).

The transmitter-receiver 162 transmits the control signal (frame) acquired by the controller 164 (step

S4).

The counter 163 updates the counter value in accordance with the transmission of the control signal by the transmitter-receiver 162. More specifically,  
5 the counter 163 adds 1 to the counter value (step S5).

When the process of step S5 is executed, the flow returns to step S3 described above and the process is repeated.

When it is determined that the transmission timing  
10 does not apply to wireless apparatus 16a in step S3 (NO in step S3), the controller 164 refers to the counter value and determines whether the counter value needs to be reset (step S6). In this case, the controller 164 determines whether the counter value agrees with the  
15 upper limit value (hereinafter referred to as a reset determination value) defined by the number of wireless apparatuses provided in the wireless transmission system, for example, (that is, whether the counter value has reached the reset determination value). If  
20 the counter value agrees with the reset determination value, the controller 164 determines that the counter value needs to be reset. Meanwhile, if the counter value does not agree with the reset determination value, the controller 164 determines that the counter  
25 value does not need to be reset.

If it is determined that the counter value does not need to be reset (NO in step S6), the controller 164 determines whether a control signal (a carrier wave of a frame) transmitted by (one of) the other wireless  
30 apparatuses 16b to 16f is received by the transmitter-receiver 162 (step S7).

When it is determined that a control signal is not received (NO in step S7), the process of step S7 is repeated. In other words, wireless apparatus 16a waits  
35 until a control signal is received from the other wireless apparatuses 16b to 16f.

Meanwhile, when it is determined that a control

signal is received (YES in step S7), the process of step S5 described above is executed.

5 If it is determined that the counter value needs to be reset in step S6 (YES in step S6), the flow returns to step S1 described above, and the process is repeated.

10 After the counter value has been reset as a start frame is transmitted by executing the process shown in FIG. 3, when the counter value agrees with the transmission determination value of wireless apparatus 16a, wireless apparatus 16a operating as the parent node transmits a control signal output by the elevator control device 11 corresponding to this wireless apparatus 16a to the other wireless apparatuses 16b to 15 16f.

Various signals (the start frame and the control signal) transmitted by wireless apparatus 16a in the process shown in FIG. 3 are received by all the other wireless apparatuses 16b to 16f, which are the 20 apparatuses other than wireless apparatus 16a, by way of transmission in the Sub-GHz band mentioned above.

Next, referring to the flowchart of FIG. 4, an example of a procedure of a process executed in a wireless apparatus operating as the child node will be 25 described. Here, a case where the process shown in FIG. 4 is executed by wireless apparatus 16b of wireless apparatuses 16b to 16f operating as the child nodes will be described. Likewise the process shown in FIG. 3, the process shown in FIG. 4 is executed 30 continuously while the elevator 10 is being operated. In the description of FIG. 4, a functional configuration of wireless apparatus 16b (i.e., a storage, a transmitter-receiver, a counter, and a controller) is described with the same reference 35 numbers as those used in FIG. 2.

First, when a start frame is transmitted by wireless apparatus 16a in the process shown in FIG. 3

as described above, a transmitter-receiver 162 included in wireless apparatus 16b can receive this start frame.

Hence, a controller 164 included in wireless apparatus 16b determines whether the start frame is received by the transmitter-receiver 162 (step S11).

When it is determined that the start frame is received (YES in step S11), a counter 163 included in wireless apparatus 16b resets the counter value maintained by the counter 163 (step S12). More specifically, the counter value is reset to zero, for example.

By referring to the counter value, the controller 164 determines whether it is the transmission timing of wireless apparatus 16b in the wireless transmission system (step S13). In this case, the controller 164 determines whether the counter value agrees with a value determined in advance with respect to wireless apparatus 16b (hereinafter referred to as a transmission determination value of wireless apparatus 16b). If the counter value agrees with the transmission determination value of wireless apparatus 16b, the controller 164 determines that it is the transmission timing of wireless apparatus 16b. Meanwhile, if the counter value does not agree with the transmission determination value of wireless apparatus 16b, the controller 164 determines that it is not the transmission timing of wireless apparatus 16b. It is assumed that the transmission determination value of wireless apparatus 16b is already held in wireless apparatus 16b.

When it is determined that the transmission timing of wireless apparatus 16b has come (YES in step S13), the controller 164 acquires a control signal stored in the storage 161 included in wireless apparatus 16b. Here, the control signal acquired by the controller 164 is that output by the car 12 which is the component corresponding to wireless apparatus 16b, and includes,

for example, a control signal for the elevator control device 11 (i.e., a car call representing the destination floor registered by the operation on the destination floor button installed inside the car 12).

5           The transmitter-receiver 162 transmits the control signal (frame) acquired by the controller 164 (step S14).

          The counter 163 updates the counter value in accordance with the transmission of the control signal  
10       by the transmitter-receiver 162. More specifically, the counter 163 adds 1 to the counter value (step S15).

          When the process of step S15 is executed, the flow returns to step S13 described above and the process is repeated.

15           When it is determined that a start frame is not received in step S11 described above (NO in step S11), and that the transmission timing does not apply to wireless apparatus 16b in step S13 (NO in step S13), the controller 164 determines whether a control signal  
20       (a carrier wave of a frame) transmitted by (one of) the other wireless apparatuses 16a and 16c to 16f is received by the transmitter-receiver 162 (step S16).

          When it is determined that a control signal is not received (NO in step S16), the flow returns to step S11  
25       and the process is repeated. In other words, wireless apparatus 16b waits until a start frame or a control signal transmitted from the other wireless apparatuses 16a and 16c to 16f is received.

          Meanwhile, when it is determined that a control  
30       signal is received (YES in step S16), the process of step S15 described above is executed.

          After the counter value has been reset as the start frame is received by executing the process shown in FIG. 4, when the counter value agrees with the  
35       transmission determination value of wireless apparatus 16b, wireless apparatus 16b operating as the child node transmits a control signal output by the car 12

corresponding to this wireless apparatus 16b to the other wireless apparatuses 16a and 16c to 16f.

Although it has been described that the process shown in FIG. 4 is executed by wireless apparatus 16b, the process of FIG. 4 is similarly executed in the other wireless apparatuses 16c to 16f operating as the child nodes. More specifically, in each of wireless apparatuses 16c to 16f, after the counter value has been reset as the start frame is received, when the counter value agrees with a value determined in advance with respect to these wireless apparatuses 16c to 16f (i.e., the transmission determination value of these wireless apparatuses 16c to 16f), wireless apparatuses 16c to 16f each transmit a control signal output by the components corresponding to wireless apparatuses 16c to 16f (the hall call buttons installed in the halls on the respective floors) to the other wireless apparatuses.

As described above referring to FIGS. 3 and 4, counters 163 included in wireless apparatuses 16a to 16f update (increment) their respective counter values as a control signal is transmitted from the corresponding wireless apparatuses and a control signal is received from the wireless apparatuses other than themselves. In other words, the counter value of counter 163 included in a certain wireless apparatus which transmitted the control signal, for example, is incremented by the transmission of this control signal, and the counter value of counter 163 included in the wireless apparatus other than the aforementioned wireless apparatus is incremented by the reception of this control signal. Accordingly, in the present embodiment, the counter values of the counters 163 included in wireless apparatuses 16a to 16f, respectively, become the same in all of wireless apparatuses 16a to 16f (that is, become synchronized).

Further, the transmission determination values of

wireless apparatuses 16a to 16f are different from one another. By this feature, in the present embodiment, only one wireless apparatus whose transmission determination value agrees with the counter value,  
5 which is the same value in all of wireless apparatuses 16a to 16f, is allowed to send the control signal.

The control signal received in wireless apparatuses 16a to 16f is handed to components corresponding to wireless apparatuses 16a to 16f,  
10 respectively, and a process according to the control signal is executed in the components.

Next, referring to FIG. 5, a specific example of an operation of the wireless transmission system according to the present embodiment will be described.

15 Here, it is assumed that a plurality of wireless apparatuses which constitute the wireless transmission system are wireless apparatuses 16a to 16f. It is assumed that the wireless apparatus operating as the parent node is wireless apparatus 16a, and the wireless  
20 apparatuses operating as the child nodes are wireless apparatuses 16b to 16f. It is assumed that the transmission determination value of wireless apparatus 16a is 0, the transmission determination value of wireless apparatus 16b is 1, the transmission  
25 determination value of wireless apparatus 16c is 2, the transmission determination value of wireless apparatus 16d is 3, the transmission determination value of wireless apparatus 16e is 4, and the transmission determination value of wireless apparatus 16f is 5.

30 Here, the reset determination value is a value defined by the number of wireless apparatuses provided in the wireless transmission system, and may be a value derived by, for example, adding 1 to the maximum value of the transmission determination value of wireless  
35 apparatuses 16a to 16f (i.e., 5 in this case). Accordingly, in FIG. 5, descriptions will be given assuming that the reset determination value is 6.

Note that in FIG. 5, TX represents transmission of a signal by each of wireless apparatuses 16a to 16f. RX represents reception of a signal in each of wireless apparatuses 16a to 16f.

5           In the following, the counter value maintained by the counter 163 included in each of wireless apparatuses 16a to 16f is referred to as the counter value of each of wireless apparatuses 16a to 16f for convenience.

10           First, in step S21, a case where a start frame (ST) is transmitted by wireless apparatus 16a operating as the parent node is assumed. In this case, the counter value of wireless apparatus 16a is reset to zero by the transmission of the start frame (ST).

15           Meanwhile, wireless apparatuses 16b to 16f operating as the child nodes receive the start frame (ST) transmitted by wireless apparatus 16a. The counter values of wireless apparatuses 16b to 16f are reset to zero by the reception of the start frame (ST).

20           That is, in step S21, the counter values of wireless apparatuses 16a to 16f all become zero.

          Here, as described above, the transmission determination value of wireless apparatus 16a is zero. In this case, the counter value of wireless apparatus  
25   16a agrees with the transmission determination value of wireless apparatus 16a. Therefore, in step S22, wireless apparatus 16a transmits a control signal (DT1) output by the elevator control device 11. The control signal (DT1) transmitted by wireless apparatus 16a  
30   includes, for example, a control signal for (the car controller provided in) the car 12 (for example, a control signal for controlling the opening and closing of the car door). The counter value of wireless apparatus 16a is updated to 1 by the transmission of  
35   the control signal (DT1).

          Meanwhile, wireless apparatuses 16b to 16f receive the control signal (DT1) transmitted by wireless

apparatus 16a. The counter value of each of wireless apparatuses 16b to 16f is updated to 1 by the reception of the control signal (DT1).

5 That is, in step S22, the counter values of wireless apparatuses 16a to 16f all become 1.

Further, when the control signal (DT1) transmitted by wireless apparatus 16a includes a control signal for controlling the opening and closing of the car door, for example, the car 12 (the car controller)  
10 corresponding to wireless apparatus 16b executes the control (opening and closing control of the car door) based on this control signal. The component corresponding to each of wireless apparatuses 16b to 16f in this case may execute control based on a control  
15 signal necessary for the components only when it is received in the wireless apparatus corresponding to the component. The same applies to a case where a wireless apparatus other than wireless apparatus 16a transmits the control signal.

20 Next, as described above, the transmission determination value of wireless apparatus 16b is 1. In this case, the counter value of wireless apparatus 16b agrees with the transmission determination value of wireless apparatus 16b. Therefore, in step S23,  
25 wireless apparatus 16b transmits a control signal (DT2) output by the car 12. The control signal (DT2) transmitted by wireless apparatus 16b includes, for example, a control signal for the elevator control device 11 (for example, a car call representing the  
30 destination floor registered by the operation on the destination floor button installed in the car 12). The counter value of wireless apparatus 16b is updated to 2 by the transmission of the control signal (DT2).

35 Meanwhile, wireless apparatuses 16a and 16c to 16f receive the control signal (DT2) transmitted by wireless apparatus 16b. The counter value of each of wireless apparatuses 16a and 16c to 16f is updated to 2

by the reception of the control signal (DT2).

That is, in step S23, the counter values of wireless apparatuses 16a to 16f all become 2.

Further, when the control signal (DT2) transmitted  
5 by wireless apparatus 16b includes a car call, for  
example, the elevator control device 11 corresponding  
to wireless apparatus 16a executes the control  
(ascending and descending operation control of the car  
12) based on this control signal. More specifically,  
10 the elevator control device 11 executes the control of  
moving (landing) the car 12 to the destination floor  
registered by the user based on the car call.

Next, as described above, the transmission  
determination value of wireless apparatus 16c is 2. In  
15 this case, the counter value of wireless apparatus 16c  
agrees with the transmission determination value of  
wireless apparatus 16c. Here, in step S24, a case  
where a control signal (for example, a hall call which  
is output in accordance with the operation on the hall  
20 call button installed in hall 31) in (the storage 161  
included in) wireless apparatus 16c does not exist is  
assumed. In this case, wireless apparatus 16c  
transmits a signal (NA) representing that a control  
signal does not exist. The counter value of wireless  
25 apparatus 16c is updated to 3 by the transmission of  
the signal (NA).

Meanwhile, wireless apparatuses 16a, 16b, and 16d  
to 16f receive the signal (NA) transmitted by wireless  
apparatus 16c. The counter value of each of wireless  
30 apparatuses 16a, 16b, and 16d to 16f is updated to 3 by  
the reception of the signal (NA).

That is, in step S24, the counter values of  
wireless apparatuses 16a to 16f all become 3.

Note that the signal (NA) transmitted by wireless  
35 apparatus 16c is not one used for controlling the  
elevator 10. For this reason, when the signal (NA) is  
received by wireless apparatuses 16a, 16b, and 16d to

16f, this signal (NA) does not need to be handed to the components corresponding to wireless apparatuses 16a, 16b, and 16d to 16f, respectively.

5       Next, as described above, the transmission determination value of wireless apparatus 16d is 3. In this case, the counter value of wireless apparatus 16d agrees with the transmission determination value of wireless apparatus 16d. Therefore, in step S25, wireless apparatus 16d transmits a control signal (DT4)  
10       which is output in accordance with the operation on the hall call button installed in hall 32. The control signal (DT4) transmitted by wireless apparatus 16d includes, for example, a control signal for the elevator control device 11 (for example, a hall call  
15       representing the position of the hall and the direction of destination registered by the operation on the hall call button installed in hall 32). The counter value of wireless apparatus 16d is updated to 4 by the transmission of the control signal (DT4).

20       Meanwhile, wireless apparatuses 16a to 16c, 16e, and 16f receive the control signal (DT4) transmitted by wireless apparatus 16d. The counter value of each of wireless apparatuses 16a to 16c, 16e, and 16f is updated to 4 by the reception of the control signal  
25       (DT4).

That is, in step S25, the counter values of wireless apparatuses 16a to 16f all become 4.

30       Further, when the control signal (DT4) transmitted by wireless apparatus 16d includes a hall call, for example, the elevator control device 11 corresponding to wireless apparatus 16a executes the control (ascending and descending operation control of the car 12) based on this control signal. More specifically, the elevator control device 11 executes the control of  
35       landing the car 12 at (the position of) the hall registered by the user based on the hall call.

Next, as described above, the transmission

determination value of wireless apparatus 16e is 4. In this case, the counter value of wireless apparatus 16e agrees with the transmission determination value of wireless apparatus 16e. Here, in step S26, a case  
5 where wireless apparatus 16e which has come to the transmission timing cannot transmit a signal is assumed. When wireless apparatus 16e is operating properly, a control signal from this wireless apparatus 16e (i.e., a control signal output in accordance with  
10 the operation on the hall call button installed in hall 33) or a signal representing that such a control signal does not exist is transmitted. However, when a trouble such as a temporary communication failure has occurred near wireless apparatus 16e, there is a possibility  
15 that a signal from wireless apparatus 16e will not be transmitted. When a signal from wireless apparatus 16e cannot be transmitted as in the above case, since the counter values of the respective wireless apparatuses 16a to 16f are not updated, none of wireless  
20 apparatuses 16a to 16f can transmit a signal, and the operation of the elevator 10 is delayed.

Hence, in the present embodiment, a wireless apparatus (which will hereinafter be indicated as a substitute wireless apparatus) which transmits a signal  
25 on behalf of the wireless apparatus that is unable to transmit the signal as described above is to be determined in advance from among wireless apparatuses 16a to 16f. Here, it is assumed that wireless apparatus 16a operating as the parent node is  
30 determined in advance as the substitute wireless apparatus. In this case, wireless apparatus 16a transmits a signal (DY), which is a substitute of a signal to be transmitted from another wireless apparatus, when it is not the transmission timing of  
35 wireless apparatus 16a (that is, when the counter value does not agree with the transmission determination value of wireless apparatus 16a) and a signal from the

other wireless apparatuses 16b to 16f is not received for a certain period. In this case, the counter value of wireless apparatus 16a is updated to 5 by the transmission of the signal (DY).

5           Meanwhile, when the above-described state of wireless apparatus 16e not being able to transmit a signal is temporary, and the state is recovered, wireless apparatuses 16b to 16f receive the signal (DY) transmitted from wireless apparatus 16a. The counter  
10 value of each of wireless apparatuses 16b to 16f is updated to 5 by the reception of the signal (DY).

          That is, in step S26, even if a signal from wireless apparatus 16e which has come to the transmission timing, for example, is not transmitted,  
15 because wireless apparatus 16a (the substitute wireless apparatus) on behalf of wireless apparatus 16e transmits a signal, the counter values of wireless apparatuses 16a to 16f all become 5.

          However, if the state that a signal from wireless  
20 apparatus 16e cannot be transmitted is brought by a breakdown, etc., of wireless apparatus 16e, not by a temporary communication failure, etc., the wireless transmission system is structured such that only wireless apparatuses 16a to 16d and 16f other than  
25 wireless apparatus 16e operate. Here, it is assumed that the transmission determination values of the respective wireless apparatuses 16a to 16f are managed within wireless apparatus 16a which is determined in advance as the substitute wireless apparatus.  
30 According to this structure, wireless apparatus 16a can specify the wireless apparatus which did not transmit a signal despite its transmission timing based on the counter value of wireless apparatus 16a and the transmission determination values of the respective  
35 wireless apparatuses 16a to 16f. In this case, it is also possible to structure wireless apparatus 16a such that it notifies a manager, etc., of the elevator 10

that a control signal from the specified wireless apparatus is not received for a certain period (that is, the specified wireless apparatus is not operating properly) via the elevator control device 11, for example.

Also, when wireless apparatus 16a, which is determined in advance as the substitute wireless apparatus, cannot transmit a signal, there may be a situation where none of wireless apparatuses 16a to 16f can transmit the signal as described above. In order to avoid such a situation, another wireless apparatus which transmits the signal in place of the substitute wireless apparatus when this substitute wireless apparatus cannot transmit the signal may further be determined.

Further, in order to reduce a load on one wireless apparatus which is determined in advance as the substitute wireless apparatus, the wireless apparatus assigned as the substitute wireless apparatus may be changed dynamically. More specifically, a wireless apparatus having a transmission determination value corresponding to a value obtained by adding (or subtracting) 1 to (or from) the counter value of wireless apparatus 16a to 16f may be allowed to operate as the substitute wireless apparatus. Alternatively, a structure in which a wireless apparatus other than wireless apparatuses 16a to 16f is prepared as a substitute wireless apparatus may be employed.

Next, as described above, the transmission determination value of wireless apparatus 16f is 5. In this case, the counter value of wireless apparatus 16f agrees with the transmission determination value of wireless apparatus 16f. Therefore, in step S27, wireless apparatus 16f transmits a control signal (DT6) which is output in accordance with the operation on the hall call button installed in hall 34. The control signal (DT6) transmitted by wireless apparatus 16f

includes, for example, a control signal for the elevator control device 11 (for example, a hall call representing the position of the hall and the direction of destination registered by the operation on the hall call button installed in hall 34). The counter value of wireless apparatus 16f is updated to 6 by the transmission of the control signal (DT6).

Meanwhile, wireless apparatuses 16a to 16e receive the control signal (DT6) transmitted by wireless apparatus 16f. The counter value of each of wireless apparatuses 16a to 16e is updated to 6 by the reception of the control signal (DT6).

That is, in step S27, the counter values of wireless apparatuses 16a to 16f all become 6.

Here, as described above, the reset determination value is 6. In this case, the counter value of wireless apparatus 16a operating as the parent node agrees with the reset determination value. As described above, when the counter value of wireless apparatus 16a agrees with the reset determination value, wireless apparatus 16a determines that the counter values of the respective wireless apparatuses 16a to 16f have reached the upper limit. In this case, in order to continue transmission of a signal by each of wireless apparatuses 16a to 16f (that is, in order to resume the transmission of signals), the counter values of wireless apparatuses 16a to 16f must be reset. For this reason, in step S28, as in step S21, wireless apparatus 16a transmits a start frame (ST). The counter value of wireless apparatus 16a is reset to zero by the transmission of the start frame (ST). Similarly, the counter values of wireless apparatuses 16b to 16f are reset to zero by the reception of the start frame (ST). After step S28, the wireless transmission system operates in a way similar to the way in which it operated in step S22 onward described above.

Further, since the elevator control device 11, for example, of a plurality of components of the elevator 10 controls the elevator 10 overall, the elevator control device 11 has more opportunity to transmit the control signal as compared to the other components. Accordingly, by defining multiple values (transmission determination values) with respect to wireless apparatus 16a corresponding to the elevator control device 11, it is also possible to allow the opportunity to transmit the control signal from wireless apparatus 16a to be set multiple times until a start frame (ST) is transmitted again, for example. Also, a structure in which a period of transmitting the control signal by wireless apparatus 16a is set longer than a period of transmitting the control signal by each of the other wireless apparatuses 16b to 16f may be employed.

As described above, the wireless transmission system according to the present embodiment includes wireless apparatuses 16a to 16f corresponding to the components of the elevator 10, respectively, that output signals for controlling the elevator 10. Each of wireless apparatuses 16a to 16f includes counter 163 that maintains a counter value which is updated every time a control signal (a first signal) output by a corresponding component (a component corresponding to the wireless apparatus including this counter 163) is transmitted from the wireless apparatus or a control signal (a second signal) output by each of components corresponding to the other wireless apparatuses from each of the other wireless apparatuses is received. Each of wireless apparatuses 16a to 16f transmits a control signal when the counter value maintained by counter 163 agrees with the transmission determination value set for the wireless apparatus including the counter 163. Note that the transmission determination values of wireless apparatuses 16a to 16f are different from one another.

In the present embodiment, since each of wireless apparatuses 16a to 16f can transmit a control signal at an appropriate transmission timing because of this structure, it becomes possible to transmit control  
5 signals in the elevator 10 wirelessly while avoiding collision of signals among wireless apparatuses 16a to 16f. In other words, according to the present embodiment, by transmitting a control signal by an implicit token passing method using the Sub-GHz band  
10 frequency, it is possible to resolve a problem called a hidden node problem in a wireless LAN, and realize efficient transmission of the control signal with a relatively short latency time as compared to, for example, CSMA/CA.

Also, in the present embodiment, wireless  
15 apparatus 16a (a predetermined wireless apparatus) operating as the parent node transmits a start frame (a third signal) representing that signal transmission will be started. The counter value of wireless  
20 apparatus 16a is reset when the start frame is transmitted. The counter values of wireless apparatuses 16b to 16f operating as the child nodes are reset when the start frame is received. With this structure, it is possible to reset the counter value  
25 for determining the transmission timing of each of wireless apparatuses 16a to 16f, and start wireless transmission of a control signal in the wireless transmission system.

Also, in the present embodiment, wireless  
30 apparatus 16a operating as the parent node transmits a start frame when the counter value agrees with the upper limit value defined by the number of wireless apparatuses 16a to 16f. According to such a structure, wireless transmission of control signals in the  
35 wireless transmission system can be carried out continuously and efficiently. Note that a structure in which the start frame is transmitted periodically may

be adopted.

Further, in the present embodiment, when it is not the transmission timing of wireless apparatus 16a (that is, when the counter value does not agree with the transmission determination value of wireless apparatus 16a) and a control signal from the other wireless apparatuses 16b to 16f is not received for a certain period, wireless apparatus 16a (a predetermined wireless apparatus) determined as the substitute wireless apparatus transmits a signal (a third signal), which is a substitute of the control signal. According to such a structure, even if (one of) the other wireless apparatuses 16b to 16f, for example, is unable to transmit a control signal, wireless transmission of control signals in the wireless transmission system can be continued. Also, in the present embodiment, it is possible to notify the elevator control device 11, for example, that a control signal from the other wireless apparatuses 16b to 16f is not received for a certain period.

In the present embodiment, when a control signal which should be transmitted at a transmission timing of the apparatus does not exist, a signal (a third signal) representing that the control signal does not exist is transmitted. In this way, wireless transmission of control signals in the wireless transmission system can be carried out efficiently without waiting for a control signal to be output from the corresponding component.

Also, in the present embodiment, by defining multiple values (transmission determination values) with respect to wireless apparatus 16a corresponding to the elevator control device 11, for example, it becomes possible to secure more opportunity for wireless apparatus 16a to transmit a control signal which is output by the elevator control device 11 as compared to the other components of the elevator 10 and thus

wireless transmission of control signals output by the elevator control device 11 can be carried out more efficiently.

5 While certain embodiments have been described, these embodiments have been presented by way of example only, and are not intended to limit the scope of the inventions. Indeed, the novel embodiments described herein may be embodied in a variety of other forms; furthermore, various omissions, substitutions and  
10 changes in the form of the embodiments described herein may be made without departing from the spirit of the inventions. The accompanying claims and their equivalents are intended to cover such forms or modifications as would fall within the scope and spirit  
15 of the inventions.

## WHAT IS CLAIMED IS:

1. A wireless transmission system comprising a plurality of wireless apparatuses corresponding to a plurality of components of an elevator, respectively,  
5 the plurality of components outputting signals used for controlling the elevator, each of the plurality of wireless apparatuses comprising:
  - a transmitter configured to transmit a first  
10 signal, which is output by a corresponding component, to other wireless apparatuses wirelessly;
  - a receiver configured to receive a second signal output by each of components corresponding to the other wireless apparatuses from each of the other wireless apparatuses wirelessly; and
  - 15 a counter configured to maintain a value which is updated every time the first signal is transmitted or the second signal is received, wherein
    - the transmitter is configured to transmit the  
20 first signal when the value maintained by the counter agrees with a value determined in advance with respect to the wireless apparatus comprising the transmitter, and
    - values determined in advance with respect to the  
25 plurality of wireless apparatuses, respectively, are different from one another,
  - the transmitter comprised in a predetermined  
wireless apparatus of the plurality of wireless  
apparatuses is configured to transmit a third signal,  
which is a substitute of the second signal, when the  
30 value maintained by the counter does not agree with a value determined in advance with respect to the predetermined wireless apparatus, and the second signal is not received for a certain period,
  - the plurality of components comprise an elevator  
35 control device configured to control at least ascending and descending operation of a car;
  - the predetermined wireless apparatus is a wireless

apparatus corresponding to the elevator control device;  
and

the wireless apparatus corresponding to the  
elevator control device further comprises a  
5 notification module configured to notify the elevator  
control device that the second signal is not received  
for a certain period.

2. The wireless transmission system of Claim 1,  
wherein:

10 the transmitter comprised in a predetermined  
wireless apparatus of the plurality of wireless  
apparatuses is configured to transmit a third signal  
for starting transmission of a signal among the  
plurality of wireless apparatuses;

15 the counter comprised in the predetermined  
wireless apparatus is configured to reset the value  
maintained by the counter when the third signal is  
transmitted;

the receiver comprised in a wireless apparatus  
20 other than the predetermined wireless apparatus is  
configured to receive the transmitted third signal; and

the counter comprised in the wireless apparatus  
other than the predetermined wireless apparatus is  
configured to reset the value maintained by the counter  
25 when the third signal is received.

3. The wireless transmission system of Claim 2,  
wherein the transmitter comprised in the predetermined  
wireless apparatus is configured to transmit the third  
signal when the value maintained by the counter agrees  
30 with an upper limit value defined by the number of  
wireless apparatuses.

4. The wireless transmission system of Claim 1,  
wherein the transmitter is configured to transmit a  
third signal representing that the first signal is  
35 nonexistent when the value maintained by the counter  
agrees with the value determined in advance with  
respect to the wireless apparatus comprising the

transmitter, and the first signal to be output by the component corresponding to the wireless apparatus does not exist.

5         5. The wireless transmission system of Claim 1, wherein:

        a plurality of values are defined with respect to a wireless apparatus corresponding to the elevator control device.

10         6. A wireless transmission method executed by a wireless transmission system comprising a plurality of wireless apparatuses corresponding to a plurality of components of an elevator, respectively, the plurality of components outputting signals used for controlling the elevator, the wireless transmission method  
15         comprising:

        maintaining, by each of the wireless apparatuses, a value which is updated every time a first signal output by a corresponding component is transmitted to other wireless apparatuses wirelessly, or a second  
20         signal output by each of components corresponding to the other wireless apparatuses which is transmitted from the other wireless apparatuses wirelessly is received; and

        transmitting, by each of the wireless apparatuses,  
25         the first signal when the maintained value agrees with a value determined in advance with respect to each of the wireless apparatuses, wherein

        values determined in advance with respect to the plurality of wireless apparatuses, respectively, are  
30         different from one another,

        transmitting a third signal using a predetermined wireless apparatus of the plurality of wireless  
apparatuses, the third signal being a substitute of the second signal, when the value maintained by the counter  
35         does not agree with a value determined in advance with respect to the predetermined wireless apparatus, and the second signal is not received for a certain period,

controlling at least ascending and descending operation of a car using an elevator control device, the plurality of components comprising the elevator control device, and

- 5 notifying the elevator control device, using the wireless apparatus corresponding to the elevator control device, that the second signal is not received for a certain period.