

POWER SUPPLY SYSTEM AND POWER SUPPLY METHOD

Field

[0001]

The present invention relates to a technique for controlling supply of power during a power failure.

Background

[0002]

In recent years, business continuity planning (hereinafter, BCP) has become increasingly important to corporations, and in consideration of greater demands for BCP from tenants moving into multi-tenant buildings as well, BCP measures are now being developed for new buildings from early stages of their planning. In addition, government offices and municipalities have announced provision of subsidies, as well as development guidelines, in order to support BCP measures which focus on accepting people who are unable to return home in the event of a disaster. Recent development of BCP and BCP measures are attributable to the fact that, among 5.15 million people who were unable to return home in the Tokyo metropolitan area in the wake of the Great East Japan Earthquake, public and private facilities were only capable of temporarily accepting a number of people as small as less than a hundred thousand, and attributable also to the planned blackouts after the earthquake which affected business planning of corporations.

[0003]

At present, as a result of the almost total lack of empty space

in metropolitan areas preventing the number of buildings on which BCP measures are implemented from increasing rapidly and renovation work for implementing BCP measures on existing buildings being problematic in terms of execution and duration of construction, BCP measures are not being advanced swiftly.

[0004]

Incidentally, the Fire Service Act, the Building Standard Law, the Electrical Facility Technical Reference, and the like require private power generation equipment such as a safety power supply, an emergency power supply, and a backup power supply capable of supplying power during a power failure of a commercial power supply or an occurrence of a fire accompanied by a power failure of a commercial power supply, to be installed in buildings. A calculation formula is defined for a power supplying capacity of an emergency power supply capable of supplying power to fire-fighting equipment and the like. A power supplying capacity is calculated based mainly on power used by a load required by fire-fighting equipment and the like during a fire such as fire-fighting/smoke removal equipment, a sprinkler pump, an indoor fire hydrant (hereinafter, referred to as an "emergency load") and power used by a load required by an emergency elevator, emergency lighting, and the like (hereinafter, referred to as a "safety load"). A safety power supply refers to the "safety power supply" or the "business power supply" which is specified in the Electrical Facility Technical Reference and which is used to maintain functionality of electric equipment owned by a consumer when supply

of commercial power from a power company is interrupted. A safety power supply is not a power supply used for evacuation or fire-fighting activities but is regarded as a power supply used for the continuation of business and safety purposes. An emergency power supply is the "emergency power supply" specified in the Fire Service Act and is used when supply of power to fire-fighting equipment and the like is interrupted. An emergency power supply is a piece of equipment which is connected to a fire hydrant, a sprinkler, fire-fighting/smoke removal equipment, and the like and which supplies power so that the fire-fighting equipment and the like can operate in an appropriate manner even when a commercial power supply is interrupted. The Fire Service Act specifies how long power must be supplied to each piece of fire-fighting equipment. Specifically, it is specified that an emergency power supply must be continuously operational for 60 minutes or longer at a rated load, a fuel oil capacity of 2 hours or longer is provided, and voltage can be established within 40 seconds. A backup power supply is the "backup power supply" specified in the Building Standard Law and is used as a power supply of emergency lighting, smoke removal equipment, and the like. In a similar manner to an emergency power supply of fire-fighting equipment and the like, a backup power supply is designed so that emergency lighting and the like can operate for a certain period of time even when a commercial power supply is interrupted. Hereinafter, private power generation equipment represented by these safety power supply, emergency power supply, and backup power supply will be

referred to as a "private power supply".

[0005]

To address the problems described above, PTL 1 discloses a technique which enables supply of power to a load to be continued using a private power supply by integrating power lines, even in the event of a power failure of a commercial power supply. According to this document, loads are classified into a group of loads whose standby power can be cut and a group of loads whose standby power should not be cut. In addition, with respect to the group of loads whose standby power can be cut, power from an integrated system trunk line is branched via a service panel board and an expansion panel board. In this case, the service panel board is constituted by a master circuit breaker connected to the system trunk line and a plurality of branch circuit breakers connected to the loads. In addition, the expansion panel board is constituted by a plurality of remote-controlled circuit breakers. A remote-controlled circuit breaker is capable of remotely interrupting a line in accordance with an instruction from an external controller. The external controller determines, either automatically or by a manual operation, a remote-controlled circuit breaker to interrupt the line or the number of remote-controlled circuit breakers according to the circumstances. In this case, the "circumstances" include whether or not a power failure of a commercial power supply has occurred, a remaining fuel amount of a private power supply, power usage by loads, and the like. According to this document, during a power failure of a commercial power supply, power of a private

power supply can be continuously supplied by an integrated system to loads for which the need to supply power is high while avoiding power from being wastefully supplied to loads for which the need to supply power is low. Furthermore, since the supply of power to loads in a standby state can be interrupted even when a power failure of the commercial power supply has not occurred, energy conservation and cost reduction can also be achieved by cutting standby power.

[0006]

Examples of other proposed conventional systems include a system which uses a combination of detection of a power failure by a power failure detector and the presence or absence of detection of a fire by a fire detector to switch power supplying lines and supply power to equipment that require power (for example, PTL 2) and a system which switches power lines depending on a remaining fuel amount of an emergency generator and supplies power (for example, PTL 3).

[Citation List]

[Patent Literature]

[0007]

[PTL 1] Japanese Patent Application Laid-open No. 2012-075216

[PTL 2] Japanese Patent Application Laid-open No. 2005-020879

[PTL 3] Japanese Patent Application Laid-open No. 2010-142076

[0008]

However, the cost to enhance a private power supply in order to ensure power supplying capability in the event of an emergency is high. In addition, even when a private power supply has

sufficient power supplying capability during an emergency, since the power supplying capability and loads to which power is to be supplied change depending on a state of a commercial power supply, a state of the private power supply, a state of a fire, and the like, it is difficult to appropriately distribute power to a plurality of loads in a building.

SUMMARY

[0009]

In order to solve the problems described above, a power supply system according to one aspect of the present invention includes: a plurality of panel boards connected via a circuit breaker and a power line to a commercial power supply and another power supply; and a control apparatus connected via a communication line to the plurality of panel boards. Each of the plurality of panel boards includes: a specific current sensor configured to output a measured value obtained by measuring a current flowing to a specific load from the power line; a specific remote-controlled circuit breaker which is a remote-controlled circuit breaker provided between the power line and the specific load; and a control unit which is connected via a signal line to the specific current sensor and the specific remote-controlled circuit breaker. The control apparatus is configured to receive fire occurrence information indicating whether or not a fire occurs, power failure occurrence information indicating whether or not a power failure of the commercial power supply occurs, and private power supply information indicating a

remaining energy amount of the private power supply, determine an operation of the plurality of panel boards based on state information including the fire occurrence information, the power failure occurrence information, and the power supply information, and transmit an operation instruction indicating the determined operation to the plurality of panel boards. A control unit in a specific panel board among the plurality of panel boards is configured to determine a threshold for the measured value based on the operation instruction and control the specific remote-controlled circuit breaker to a connected state or interrupted state based on the operation instruction. The control unit in the specific panel board is configured to determine whether or not the measured value exceeds the threshold and controls, when it is determined that the measured value exceeds the threshold, the specific remote-controlled circuit breaker to the interrupted state.

[0010]

In accordance with states of a fire, a commercial power supply, and a private power supply, power from the commercial power supply and the private power supply can be appropriately and variably distributed to a plurality of loads inside a building by setting remote-controlled circuit breakers and thresholds.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 illustrates a functional configuration of a power

supply system according to an embodiment of the present invention;

FIG. 2 illustrates a configuration of a power supply system;

FIG. 3 illustrates a configuration of a divided panel board PB;

FIG. 4 illustrates configurations of a master board, a branch board, and a control board when an existing panel board exists;

FIG. 5 illustrates an installation method of a master board, a branch board, and a control board;

FIG. 6 illustrates an arrangement of a power supply system inside a building;

FIG. 7 illustrates a configuration of an area energy management system;

FIG. 8 illustrates mode determination;

FIG. 9 illustrates a registration method of an RB set value table;

FIG. 10 illustrates an RB set value table;

FIG. 11 illustrates a configuration of a panel board according to a modification;

FIG. 12 illustrates an RB set value table of a panel board according to a modification;

FIG. 13 illustrates operations of a power supply system in the event of a power failure;

FIG. 14 illustrates operations of a power supply system in the event that a power failure has occurred but a fire has not occurred;

FIG. 15 illustrates operations of a power supply system after

a BCP mode;

FIG. 16 illustrates operations of a power supply system when a fire has occurred during a BCP mode; and

FIG. 17 illustrates operations of a power supply system in the event that a power failure occurs after a fire has occurred.

DESCRIPTION OF EMBODIMENTS

[0012]

Hereinafter, an outline of embodiments of the present invention will be described.

[0013]

With an emergency power supply specified in the Fire Service Act, the Fire Service Act specifies that the time from detection of a power failure of a commercial power supply to establishment of voltage must be 40 seconds or less. However, a power failure is not always associated with a fire as exemplified by a rolling blackout or a blackout caused by an insufficient supply of commercial power. In this case, power supplied from an emergency power supply is directed to a safety load and a power supplying capacity for an emergency load remains as surplus power. The surplus power can be effectively utilized to supply power to some of important equipment such as a server.

[0014]

Usually, implementing a BCP measure to a building requires work for installing or enhancing a private power supply apparatus and work for installing or renovating a power line. The lack of

advancement of BCP measures is mainly due to cost, duration of construction, and installation space. Specific examples thereof are as follows.

- The cost of private power supply equipment is high. In particular, in the case of an existing building, there is no available space to install or add private power supply equipment.

- The enhancement of private power supply equipment requires reinforcement of a floor of the building due to an increase in equipment weight and renovation of walls for sound-proofing. In addition, the cost of incidental work such as securing a flue for discharging smoke to the outside of the building and installing cooling equipment of a private power supply is high. The same applies to enhancing auxiliary equipment such as a fuel tank.

- With an existing building, since tenants are at work during the daytime on weekdays, construction work is to be mainly performed over the weekends and during the night. As a result, the duration of construction increases. Generally, since premium rates apply to work cost for weekends and the nighttime, the duration of construction must be shortened as much as possible.

- An existing line that supplies power from an existing private power supply must be renovated or a new line must be added.

[0015]

Since surplus power of a private power supply is subjected to a usable upper limit (a range of an emergency load), there is a problem in that load equipment to use the surplus power must be subjected to a power use limit. In addition, with some buildings

such as an office building, power supply from a private power supply to a plurality of users must be controlled and concentration of a power supply range in a usage space must be accommodated. Specific examples of the problems include the following.

- When surplus power of an emergency load set when calculating the capacity described earlier is exceeded, an emergency stop of the private power supply occurs.

- When using the surplus power or when interruption occurs, an emergency stop of the private power supply occurs due to an inrush current or the like.

- Control for supplying the surplus power only to important devices such as a server must be performed to limit power usage.

- When a fire breaks out during use of the surplus power, the use of the surplus power must be stopped and an emergency load must be established.

- In order to supply power to fire-fighting equipment for two hours or more as specified by the Fire Service Act, a remaining operable time of a private power supply must be determined and use of the surplus power must be stopped by setting a threshold or the like.

- In order to supply the surplus power to a plurality of users inside the building or supply the surplus power in a concentrated manner to a portion of spaces such as disaster control headquarters of respective companies, a system must be constructed which enables a power supplying capacity of the entire building to be controlled and a power supplying capacity of each space to be varied.

[0016]

Since the power supply system proposed in PTL 1 does not enable control upon detection of a fire, using an emergency load of an emergency power supply as surplus power is not appropriate. In addition, this system remotely interrupts supply of power to loads in the event of a power failure or when conserving power in units of branch circuit breakers of an existing panel board. In other words, a control section installed in each panel board controls switching on or off of remote-controlled circuit breakers installed in units of branch circuit breakers. Therefore, when there are a plurality of existing panel boards, a control section installed in each of the plurality of panel boards and a control section that controls the plurality of control sections in a centralized manner are required. Furthermore, a corresponding number of remote-controlled circuit breakers are required. While the number of remote-controlled circuit breakers is not too large in the case of a general household or a small-scale consumer, the number of panel boards in the case of a large-scale consumer normally ranges from several tens to several hundreds and the number of branch circuit breakers per one panel board is normally also around several tens. Therefore, the number of remote-controlled circuit breakers of separately-installed panel boards as a whole becomes significantly large and, since a size of a remote-controlled circuit breaker itself is larger than that of a branch circuit breaker, installation space increases.

[0017]

For example, the Fire Service Act requires that an emergency generator holds enough fuel to stay operational for two hours or more. Since an uninterruptible system utilizing the emergency generator proposed in PTL 2 does not enable control for automatically stopping a load due to a threshold of a remaining fuel amount when a remaining operable time reaches two hours or for manually stopping a load after somehow confirming the remaining fuel amount, an emergency load of the emergency generator cannot be appropriately used as surplus power. Furthermore, a power supplying capacity of the entire building cannot be controlled or a power supplying capacity of each space cannot be varied in order to supply power to a plurality of users inside the building or to supply power in a concentrated manner to a portion of spaces such as disaster control headquarters of respective companies.

[0018]

An autonomous operation system utilizing the power storage/emergency generator and power apparatus proposed in PTL 3 is premised on being equipped with power supplying equipment that is sufficient with respect to general loads and a first load and on installing a dedicated line for supplying power to the first load, and is unable to solve the problems of cost, duration of construction, and installation space.

[0019]

On the other hand, when power is obtained from a commercial power supply, the power supply system according to the present embodiment supplies power to a general load and a load set in advance

(hereinafter, a BCP load) and enables power intended for an emergency load from a private power supply to be restrictively supplied to a BCP load under conditions such as during a power failure of the commercial power supply when a fire has not occurred. Furthermore, by simplifying construction for enhancing a private power supply apparatus or a skeleton or simplifying line construction, the power supply system enables a BCP measure of a building to be performed while reducing cost, duration of construction, and installation space. In addition, assuming that a plurality of users are present inside the building, supply of power to BCP loads of the plurality of users is controlled as a whole and a power supplying capacity for each user, centralization and averaging of power supply spaces, and the like can be variably set.

[0020]

The building is an office building, a factory, a hospital, or the like which includes a commercial power supply and a private power supply apparatus such as an emergency generator or a battery and which includes a service line connected to a general load and an emergency line connected to a safety load and an emergency load. The power supply system according to the present embodiment has a function of supplying power from a private power supply in the event of an emergency such as a power failure and, by installing a plurality of circuit breakers on the emergency line and the service line, establishing a power supply line to the general load by integrating trunk lines.

[0021]

When using surplus power, since a determination of whether or not the surplus power is usable must be made by ascertaining the circumstances such as whether an emergency has occurred and whether a fire has not occurred, a centralized management control apparatus has a function of receiving state signals such as a power failure detection signal, a fire occurrence signal, and a state signal regarding a state of the private power supply or the like from detectors or a central monitoring apparatus or an equipment control board of a monitoring system provided inside the building in order to manage the building and determining whether or not the surplus power is usable by a logical operation based on a combination of the respective state signals.

[0022]

The centralized management control apparatus has a function of performing opening/closing operations of the plurality of circuit breakers and selecting a suitable mode from a plurality of modes set in advance and outputting a signal of the selected mode to a control unit that controls a panel board when the centralized management control apparatus determines that the surplus power is usable based on a result of the logical operation. In addition, the centralized management control apparatus can be connected to a terminal apparatus to cause the terminal apparatus to display information and warnings regarding the entire system and enable set numerical values to be input to the terminal apparatus.

[0023]

The control unit controls a circuit of a panel board that supplies power from a service line to a general load. In addition to the control unit, the panel board includes a current sensor, a plurality of remote-controlled circuit breakers (remote circuit breakers), and a branch circuit that distributes power to the general load and the BCP load. The panel board may further include an electricity meter connected to a communication network. The electricity meter is a sensor which is connected, via the communication network, to a system such as an x-Energy Management System (xEMS, where x denotes a building, a factory, a cluster, a community, or the like) or a Meter Data Management System (MDMS) and which measures a current, electricity, or the like supplied to the panel board.

[0024]

The control unit is connected to a current sensor and has a function of constantly measuring a current inside the panel board and a function of causing an opening/closing operation of a remote-controlled circuit breaker. Furthermore, the control unit has a function of receiving an RB set value table indicating an opening/closing set value and an interrupting current set value of each mode from the centralized management control apparatus and storing the RB set value table. A mode indicates one of a plurality of values such as a normal mode, a BCP accommodating mode, an interrupt mode, a maintenance mode, and a manual mode. An opening/closing set value and an interrupting current set value

are registered for each mode. The opening/closing set value and the interrupting current set value can be varied in accordance with the needs of each user by a terminal apparatus connected to the centralized management control apparatus.

[0025]

The control unit has a function of causing an opening operation of a remote-controlled circuit breaker to interrupt a circuit when the current inside the panel board exceeds the interrupting current set value in the RB set value table. The control unit has a function of limiting demand power of the panel board by opening/closing operations of remote-controlled circuit breakers respectively arranged in a circuit that supplies power to a general load and a circuit that supplies power to a BCP load in the panel board.

[0026]

For example, if a mode that is instructed by the centralized management control apparatus to the control unit is the BCP mode, the panel board only supplies power to the BCP load, and if the mode is the interrupt mode, the panel board interrupts all general loads and BCP loads and avoids using surplus power when a fire occurs or when an operating time of the private power supply reaches a time limit. Furthermore, the centralized management control apparatus has a function of setting an opening/closing set value and an interrupting current set value of each mode with respect to each of a plurality of control units.

[0027]

The centralized management control apparatus has a function of differentiating a timing at which a mode signal is output to each control unit. When the centralized management control apparatus outputs a mode signal for simultaneously starting supply of power to all control units, since power is simultaneously supplied to all panel boards, an emergency stop of a private power supply may occur due to an excessive inrush current. In addition, when the centralized management control apparatus outputs a mode signal for simultaneously stopping supply of power to all control units, an emergency stop of a private power supply whose maintenance is incomplete may occur due to an overrun or a UPS that supplies power to remote-controlled circuit breakers may be subjected to a large load due to the instantaneous use of a significant amount of power when simultaneously interrupting several tens of remote-controlled circuit breakers causing a phenomenon where a current increases abruptly and subsequently decreases abruptly. In order to prevent these effects, the centralized management control apparatus has a function of selecting a priority or an order of outputting mode signals to individual control units and has a function of setting an output time interval (output time) that is a time interval of output to an arbitrary time and outputting mode signals to all control units within an arbitrary completion time. These functions are enabled when outputting mode signals to the respective control units.

[0028]

The centralized management control apparatus has a function

of constantly monitoring a state signal of a remaining fuel amount of a private power supply, a state signal of a power storage amount of a battery, or the like and a function of computing a remaining operating time of the private power supply. In addition, the centralized management control apparatus has a function of stopping supply of power from the private power supply and interrupting remote-controlled circuit breakers of all panel boards when the remaining operating time reaches a remaining operating time threshold set in advance. These functions are provided to ensure that fuel or a power storage amount corresponding to a period of time for which power must be supplied to an emergency load as specified by the Fire Service Act and the like is retained.

[0029]

A panel board may be constituted by a plurality of boards including a master board that receives supply of power from a power line, a branch board that supplies power to circuits such as power outlets, and a control board that controls the panel board. Accordingly, the panel board may be installed in a divided or integrated manner.

[0030]

Each of the plurality of panel boards inside the building is controlled using modes, an opening/closing set value, and an interrupting current set value. For example, in the BCP mode, by interrupting a remote-controlled circuit breaker arranged in a general load supply circuit connected to a general load and setting an interrupting current set value of a remote-controlled circuit

breaker arranged in a BCP load supply circuit connected to a BCP load to 10 amperes, the general load is interrupted and only the BCP load can use power up to 10 amperes. Since the centralized management control apparatus can calculate maximum power usage based on an integrated value of interrupting current set values of respective BCP modes registered and set in the centralized management control apparatus, a BCP load in accordance with the surplus power of the private power supply can be set and power demand in the BCP mode can be limited. Accordingly, an effect such as an occurrence of an emergency stop of the private power supply caused by the power demand in the BCP mode exceeding the power supplying capacity can be reduced and the power supplying capacity for an emergency load can be used as surplus power.

[0031]

Since an adjustment of differentiating output timings can be made when the centralized management control apparatus outputs mode signals to a plurality of control units, the effect of an inrush current to the private power supply can be reduced as compared to simultaneously outputting the mode signals.

[0032]

Since the centralized management control apparatus can output mode signals to control units in accordance with a priority set in advance for each panel board, power demands of panel boards can be reduced in an ascending order of their priorities in accordance with conditions such as an operating time of the private power supply. As a result, the operating time of the private power supply

can be extended.

[0033]

Since surplus power is supplied to loads from a service line and circuits inside the panel board, a conventionally-required dedicated line for the private power supply is no longer necessary. In addition, since the number of installed dedicated panel boards is reduced, installation space and the number of parts are reduced and a construction period is shortened.

[0034]

The use of surplus power eliminates the need to enhance a private power supply or perform auxiliary work on a building and an existing private power supply can be used. For example, a large private power supply that exceeds a planned power supplying capacity is not required as the private power supply. In addition, a transformer or the like is not required for the private power supply. Accordingly, installation space and the number of parts are reduced and a construction period is shortened.

[0035]

By supplying power from a BCP load circuit of the panel board to BCP loads such as a server and other important devices or power outlets in an office, power need not be supplied to the office from the private power supply when a power failure of a commercial power supply occurs in the event of a disaster or the like and people who are unable to return home can also be accommodated.

[0036]

The centralized management control apparatus may interrupt

a remote-controlled circuit breaker connected to a load in a standby power state set in advance in a time slot set in advance regardless of whether or not a power failure of a commercial power supply has occurred. Accordingly, since standby power of loads such as air conditioning equipment, office automation (OA) equipment, and manufacturing equipment which do not operate during the night or on weekends can be cut, power saving is achieved.

[0037]

By installing a system interconnection protection apparatus, the power supply system according to the present embodiment is capable of constructing a line in which systems of a service line and an emergency line are interconnected and can supply power to all loads. As a result, in the event where a power failure of the commercial power supply has not occurred and a fire of the building has not occurred, when power usage of all loads as determined based on a measured value of a current sensor almost exceeds contracted power, the centralized management control apparatus can perform a peak cut by activating the private power supply or by interrupting unnecessary general loads. For example, the centralized management control apparatus can acquire information indicating power usage of a commercial power supply, and when the power usage exceeds a power usage threshold set in advance, the centralized management control apparatus can reduce power usage by activating the private power supply. The power usage threshold is, for example, a value obtained by subtracting a margin set in advance from contracted power.

[0038]

Generally, power supplied from a panel board to a load is determined by a fixed ampere trip such as 50 amperes, 75 amperes, and 100 amperes of a sub-circuit breaker (distribution circuit breaker, molded case circuit breaker, branch circuit breaker, manual circuit breaker) of each branched wiring in the panel board. Therefore, when the power supply system according to the present embodiment is not used, by manually controlling a sub-circuit breaker, power from the panel board is distributed to loads. In addition, power distribution cannot be controlled in units smaller than the ampere trip of a sub-circuit breaker. In the present embodiment, the use of a current sensor and a remote-controlled circuit breaker enables an arbitrary ampere trip to be set. Accordingly, power supplying capacities of a commercial power supply and a private power supply can be thoroughly supplied to tenants.

[0039]

When the private power supply is being used and a fire has occurred in the building, the centralized management control apparatus interrupts supply of power to loads other than an emergency load and a safety load. Accordingly, power can be supplied to an emergency load and a safety load such as fire-fighting equipment in preference to general loads and BCP loads.

[0040]

The centralized management control apparatus constantly computes a remaining operating time of the private power supply,

and performs control for stopping supply of power to BCP loads when a result of the computation is equal to or less than a remaining operating time threshold set in advance. Accordingly, a period of time for which power is supplied to an emergency load as specified by the Fire Service Act and the like can be maintained. Since the computation enables the centralized management control apparatus to recognize a timing at which supply of power to a BCP load is to be stopped, for example, the remaining operating time threshold may be set higher than a limit and notification may be performed by sounding an alarm from a speaker before (for example, 10 minutes before the limit) stopping the supply of power. Accordingly, tenants can turn off a power supply of an important device such as a server through a normal process.

[0041]

A panel board may be divided into a plurality of pieces. Accordingly, the panel board can be carried into and installed at locations accessed via a narrow carry-in route and at locations with limited installation space which are commonly found in existing buildings.

[0042]

When there is an existing panel board, the panel board may be installed in proximity of the existing panel board. Accordingly, since renovation work of the existing panel board can be completed in a short period of time, even when a period of time for which a whole building blackout can be performed in an existing building is limited to about one day a year, renovation work of

all panel boards in the building can be completed within a limited period of time.

[0043]

Hereinafter, embodiments of the present invention will be described with reference to the drawings.

[0044]

FIG. 1 illustrates a functional configuration of a power supply system according to an embodiment of the present invention.

[0045]

While a power supply system applied to an office building will be described in the present embodiment, the power system can also be applied to a logistic facility, a factory, a hospital, and the like. The power supply system includes a centralized management control apparatus 10, a plurality of panel boards PB1, PB2, ..., PBn (where n is an integer), a terminal apparatus 111, a speaker 112, circuit breakers CB1, CB2, ..., CBk (where k is an integer), and a uninterruptible power supply (UPS) 115. Although elements are distinguished from each other by numerals attached to alphabetical character in reference symbols, when elements need not be distinguished from each other, the numerals in reference symbols may be omitted.

[0046]

As functions, the centralized management control apparatus 10 includes a monitoring process 101, a logical operation process 102, and a control output process 103. The centralized management control apparatus 10 is, for example, a computer and, as illustrated

in FIG. 2, includes a memory 121, a central processing unit (CPU) 122, and a communication interface (I/F) 123. The memory stores programs and data. In accordance with the programs stored in the memory, the CPU functions as the monitoring process 101, the logical operation process 102, and the control output process 103.

[0047]

A panel board PB_n includes a control unit CUn, a current transformer CT_n, a meter Mn, and remote-controlled circuit breakers RB_{n1}, RB_{n2}, ..., RB_{nm} (where n and m are integers). Moreover, the panel board PB may only include one remote-controlled circuit breaker RB.

[0048]

The terminal apparatus 111 is installed in a disaster control center inside a building or the like. The terminal apparatus 111 is, for example, a computer and includes a memory, a CPU, a communication interface, an input device, and a display device. The memory stores programs and data. The CPU executes an input/output function in accordance with a program stored in the memory. The input device accepts an input from a manager. The display device displays information from the centralized management control apparatus 10. Moreover, an input device and a display device connected to the centralized management control apparatus 10 may be used instead of the terminal apparatus 111.

[0049]

The speaker 112 is connected to the terminal apparatus 111 and generates an alarm sound via the terminal apparatus 111 in

accordance with an instruction from the centralized management control apparatus 10.

[0050]

The UPS 115 is installed in a disaster control center inside a building or the like and supplies power to the centralized management control apparatus 10, the terminal apparatus 111, the control unit CU, and the remote-controlled circuit breaker RB.

[0051]

The centralized management control apparatus 10 is installed in a disaster control center inside a building or the like and can receive a state signal of a device of the present system via a communication network and perform a monitoring process 101 of the state signal. When a problem occurs in a result of the monitoring process 101, the centralized management control apparatus 10 causes the speaker 112 to generate an alarm sound and causes the terminal apparatus 111 to display a warning. The terminal apparatus 111 has a role as a user interface for displaying a monitoring state of the centralized management control apparatus 10, inputting a set value, displaying a current mode, and the like and also has a role of storing data.

[0052]

The monitoring process 101 uses a database area 14. Signals subjected to the monitoring process 101 include a state signal 11 of each detector output from a power failure detector of a commercial power supply, a fire warning board of the building, and the like, a state signal 12 of each piece of equipment output from a control

board or a circuit breaker of a private power supply 54 such as an emergency generator or a battery, and a state signal 13 of a panel board PB output from a control unit CU arranged in the panel board PB, and are stored in the database area 14. As state information, the database area 14 stores power failure information of a commercial power supply, fire information of the building, voltage establishment information of the private power supply 54, power recovery information of the commercial power supply, fire recovery information, supplied power values, current values, and power amounts of the commercial power supply and the private power supply 54, a fuel amount of the private power supply 54, an RB open/close state of each remote-controlled circuit breaker RB, a CB open/close state of each circuit breaker CB, a power storage amount of the private power supply 54, and the like.

[0053]

The logical operation process 102 performs a logical operation of each state signal registered in the database area 14. The logical operation process 102 constantly performs a mode determination 15 based on a combination of respective state signals. When a change in modes occurs as a result of the mode determination 15, the logical operation process 102 can perform an opening/closing determination 16 of the circuit breaker CB according to the mode, output CB opening/closing signals 17 of the circuit breakers CB1, CB2, CB3, ..., CBn connected to a power line, and perform an opening/closing operation of the circuit breaker CB according to the mode to switch power lines. Furthermore, the logical operation

process 102 performs an interlock 36 under certain conditions such as an occurrence of a fire.

[0054]

Based on an output destination priority process 18 on a plurality of control units CU in a plurality of panel boards PB in the logical operation process 102 and an output order process 19 of the control units CU, the control output process 103 performs output 20 of mode signals indicating a mode to the plurality of control units CU. At this point, the control output process 103 can reduce an inrush current to the power supply by performing a delayed output 21 in which the mode signals are sequentially output to the plurality of control units CU at timings that have been staggered by intervals set in advance such that output to all control units CU is completed within a completion time set in advance.

[0055]

The control unit CU has a storage area such as a memory. An RB set value table 22 having been set and registered in the centralized management control apparatus 10 by the terminal apparatus 111 is output by the centralized management control apparatus 10 and registered in the storage area. An opening/closing set value defining an opening/closing operation of a remote-controlled circuit breaker RB connected to the control unit CU and an interrupting current set value defining a current that interrupts the remote-controlled circuit breaker RB are set and registered in the RB set value table 22.

[0056]

Based on an input 23 of a mode signal from the centralized management control apparatus 10, the control unit CUn can control opening/closing of a circuit inside the panel board PB by updating 24 interrupting current set values of the remote-controlled circuit breakers RBn1, RBn2, ..., RBnm connected to the control unit CUn by referring to the RB set value table 22, performing an opening/closing determination 25 based on opening/closing set values, and performing a delayed output 27 of opening/closing signals 26 of the remote-controlled circuit breakers RBn1, RBn2, ..., RBnm to perform an opening/closing operation 28 of each remote-controlled circuit breaker RB according to the mode.

[0057]

In addition, the control unit CU is connected by a network to a meter M housed inside the panel board PB in order to measure a current value 29 and a power amount 30 inside the panel board PB, and constantly performs a table reference 31 for determining whether or not the current value 29 exceeds the interrupting current set value registered in the RB set value table 22. The meter M is connected to a current transformer CT and converts a current detected by the current transformer CT into a measured value. For example, in the case of a three-phase AC wire, the current transformer CT includes a three-phase current transformer and the meter M calculates a current based on an output of the three-phase current transformer. Hereinafter, the current transformer CT and the meter M will be collectively referred to as a current sensor. When the current value 29 exceeds the interrupting current set

value, the control unit CU can perform an RB opening/closing determination 25, output 26 an RB opening signal to perform an opening operation 28 of the remote-controlled circuit breaker RB, and interrupt a circuit.

[0058]

Accordingly, control of power lines and panel boards PB centered on the centralized management control apparatus 10 can be realized.

[0059]

A period of time for which power is to be supplied to an emergency load by the private power supply 54 is specified by the Fire Service Act and the like. For this reason, the centralized management control apparatus 10 performs a remaining operating time computation 32 in which a state signal of a remaining fuel amount of the private power supply 54, a state signal of a power storage amount of a battery, and the like are constantly monitored and a remaining operating time of the private power supply 54 is calculated, and when a result of the logic operation satisfies conditions set in advance, the centralized management control apparatus 10 outputs a mode signal for interrupting all remote-controlled circuit breakers RB of all panel boards PB to the control unit CU in order to stop the supply of power from the private power supply 54 to the panel board PB and interrupts the supply of power to general loads and BCP loads. For example, the centralized management control apparatus 10 receives an accumulated power amount, an accumulated operating time, an oil level signal,

a remaining fuel amount, and the like of the private power supply 54 and calculates the remaining operating time based on the received information. Alternatively, a remaining energy amount or the like of the private power supply 54 may be used in place of a remaining operating time. For example, the centralized management control apparatus 10 may acquire information indicating a remaining operating time, and when the remaining operating time equals or falls below a time threshold set in advance, cause the terminal apparatus 111 to display a warning, and transmit a mode signal for controlling the remote-controlled circuit breaker RB to an interrupted state to a plurality of panel boards PB.

[0060]

The private power supply 54 may also supply power to other equipment not controlled by the present invention such as fire-fighting/smoke removal equipment and emergency elevators, and a power supplying capability of each power supply may differ according to the performance of the power supply. When a phenomenon occurs in which a shortage or a surplus of a power supply amount of the private power supply 54 is created because the private power supply 54 is unable to accommodate a change in load when power demands of equipment abruptly increases or decreases in a short period of time, and a control apparatus of the private power supply 54 (a private power supply control section 55) determines that the increase or decrease in the power supply amount exceeds a permissible range of the performance of the private power supply 54, the private power supply 54 may take an emergency stop measure

or may interrupt a line using a circuit breaker that connects the private power supply 54 to the power line in order to prevent a failure of the private power supply 54. In order to prevent the private power supply 54 from exceeding a permissible range of an increase or decrease in the power supply amount due to an increase or decrease in power demand caused by the output 20 of a mode signal, a threshold indicating a power supplying capability of the private power supply 54 is set to the centralized management control apparatus 10. The centralized management control apparatus 10 constantly monitors and determines supplied power. Moreover, in addition to a determination based on a threshold, a determination may be made based on a voltage drop signal, an overcurrent signal, or the like input from the control section of the private power supply 54. Specifically, by monitoring supplied power of the private power supply 54 that accompanies a change in power demand that occurs when performing a delayed output 21 of a mode signal and predicting 33 an amount of change per unit time, when the centralized management control apparatus 10 determines that a permissible range (a range of an amount of change set in advance) of the private power supply 54 is exceeded, the centralized management control apparatus 10 performs a process 34 of stopping the delayed output 21 of the mode signal, or when power demand including other equipment not controlled by the present invention increases in a state where the private power supply 54 is supplying power and the centralized management control apparatus 10 determines that the supplied power of the private power supply 54

exceeds the permissible range, in order to preferentially supply power to specific important equipment such as a safety apparatus, the centralized management control apparatus 10 outputs 35 an interrupt mode to a specific panel board whose priority set to the centralized management control apparatus 10 is low to interrupt a remote-controlled circuit breaker and, consequently, reduce the power demand and the like.

[0061]

FIG. 2 illustrates a configuration of a power supply system.

[0062]

A service line 50 is connected to a commercial power supply 51 outside of a building. A power failure detector 52 that detects a power failure of the commercial power supply 51, a fire detector 56 that detects a fire of the building, a private power supply 54 connected to an emergency line 53, and a private power supply control section 55 that controls the private power supply 54 are provided in the building. The centralized management control apparatus 10 is connected to the power failure detector 52, the private power supply control section 55, and the fire detector 56 via a network of signal lines and is capable of receiving a state signal of each piece of equipment.

[0063]

The private power supply 54 may be a generator using a diesel engine, a gas turbine engine, or the like or may be a battery. Moreover, the private power supply 54 may be connected in plurality to the emergency line 53 via a circuit breaker or to a low voltage

line on a secondary side of a transformer TR.

[0064]

When detecting a fire in the building, the fire detector 56 enables a fire detection signal. When detecting a power failure of the commercial power supply 51, the power failure detector 52 enables a power failure detection signal. The private power supply control section 55 controls the private power supply 54 and outputs a state of the private power supply 54 such as activation, voltage establishment, and a remaining energy amount. Moreover, the fire detector 56, the power failure detector 52, the private power supply control section 55, and the circuit breaker CB may be connected to the centralized management control apparatus 10 via a central monitoring apparatus that is provided in a monitoring system of the building.

[0065]

A plurality of panel boards PB capable of supplying power to general loads and BCP loads and a circuit breaker CB1 that can be opened or closed by the centralized management control apparatus 10 are connected to the service line 50 to create a state where the service line 50 can be controlled. In a similar manner, a circuit breaker CB2 which is capable of supplying power to a safety load 113 and an emergency load 114 and which can be opened or closed by the centralized management control apparatus 10 is connected to the emergency line 53 to create a state where the emergency line 53 can be controlled.

[0066]

In addition, CB3 capable of connecting the service line 50 and the emergency line 53 with each other by an opening/closing operation can be opened or closed by a signal output from the centralized management control apparatus 10. Therefore, power supplied from the private power supply 54 can be fed to the service line 50. In addition, power supplied from the commercial power supply 51 can be fed to the safety load and the emergency load.

[0067]

The plurality of panel boards PB connected to the service line 50 have a circuit capable of branching and supplying power to a general load circuit and a BCP load circuit. Remote-controlled circuit breakers RB1 and RB2 are respectively arranged in the general load circuit and the BCP load circuit. The remote-controlled circuit breakers RB1 and RB2 perform opening/closing operations in accordance with a signal output by a control unit CU arranged inside the panel board PB. The general load circuit includes a plurality of sub-circuit breakers which are respectively connected to a plurality of general loads L1. The BCP load circuit includes a plurality of sub-circuit breakers which are respectively connected to a plurality of BCP loads L2. Moreover, when the plurality of general loads L1 and the plurality of BCP loads L2 respectively corresponding to a plurality of usage spaces are connected to one panel board PB, the panel board PB may include three or more remote-controlled circuit breakers RB.

[0068]

Each of the control units CU1, CU2, ..., CUn can change an

interrupting current set value by referring to the RB set value table 22 set and registered in advance for each mode when a mode signal is input by the centralized management control apparatus 10 and by performing opening/closing operations of the remote-controlled circuit breakers RB1 and RB2 in accordance with opening/closing set values.

[0069]

In addition, the control unit CU constantly monitors a current value inside the panel board PB using the current transformer CT and the meter M and constantly refers to an interrupting current set value in the RB set value table 22 stored in a storage area inside the control unit CU by the centralized management control apparatus 10, and when the measure current value exceeds the interrupting current set value, the control unit CU can interrupt the remote-controlled circuit breaker RB1 or the remote-controlled circuit breaker RB2.

[0070]

Since the centralized management control apparatus 10 can set an interrupting current set value for each mode with respect to all control units CU in advance based on an input from the terminal apparatus 111, the centralized management control apparatus 10 can set power supplied to the panel board PB so that the supplied power does not exceed a power supplying capacity of the private power supply 54 for an emergency load.

[0071]

Accordingly, the centralized management control apparatus 10

establishes supply of power to the panel board PB so that the supplied power does not exceed a power supplying capacity of the private power supply 54 for an emergency load by issuing a command for an opening operation to CB1 upon receiving a power failure signal from the power failure detector 52 to interrupt the service line 50 from the commercial power supply 51 and issuing a command for a closing operation to CB2 after receiving an activation signal and a voltage establishment signal of the private power supply 54 from the private power supply control section 55 to establish supply of power to the emergency line 53 from the private power supply 54 and by issuing a command for a closing operation to CB3 in a state where there is no fire signal from the fire detector 56 to supply power to the service line 50 and outputting a mode signal to the respective control units CU to adjust power supplied to the panel board PB. In the case of an existing building, an existing panel board 65 may be connected to the remote-controlled circuit breaker RB21 to supply power to the general load L21 that is connected to the existing panel board 65.

[0072]

Hereinafter, a method of dividing the panel board PB will be described.

[0073]

FIG. 3 illustrates a configuration of a divided panel board PB.

[0074]

In FIG. 3, a left side illustrates a front view of the divided

panel board PB and a right side illustrates a right side view of the divided panel board PB. The panel board PB may be divided into a master board 60 for receiving supply of power from a power line, a branch board 61 for supplying power to a BCP load, and a control board 62 for controlling a remote-controlled circuit breaker. Accordingly, a person installing the panel board PB can carry in and install the panel board PB in pieces. When installing the power supply system in an existing building, spaces in the existing building such as an internal wall surface of an electric pipe space (EPS) are often limited in size due to the existing panel board 65 and existing equipment 66 illustrated in FIG. 5 being already installed therein, and conditions such as a door constituting a carry-in route being small may also exist. In consideration thereof, the panel board PB is designed so that the panel board PB can be installed after being divided. The master board 60, the branch board 61, and the control board 62 are provided with a lid 63 and a lock 64 and can be locked.

[0075]

FIG. 4 illustrates configurations of the master board 60, the branch board 61, and the control board 62 when an existing panel board exists.

[0076]

The master board 60 includes a terminal board TBa, a manual circuit breaker (sub-circuit breaker) MCBa, a current transformer CT, a remote-controlled circuit breaker RB1, a terminal board TBb, a meter M, and a case 160 (first case) that houses these components.

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The terminal board TBa is connected to the service line 50. The circuit breaker MCBa and the current transformer CT are sequentially connected, via a power line (panel board wire), to the terminal board TBa. The power line connected to the manual circuit breaker MCBa branches into two power lines (branch wires). The remote-controlled circuit breaker RB1 and the terminal board TBb are connected to one of the power lines. The branch board 61 is connected to the other power line. The existing panel board 65 is connected to the terminal board TBb. The meter M is connected by a signal line (denoted by a dashed line in the drawing) to the current transformer CT. The manual circuit breaker MCBa prevents an overcurrent.

[0077]

The branch board 61 includes a remote-controlled circuit breaker RB2, a plurality of manual circuit breakers MCBb, and a case 161 (second case) that houses these components. The remote-controlled circuit breaker RB2 is connected to a power line extending from the manual circuit breaker MCBa of the master board 60. A power line extending from the remote-controlled circuit breaker RB2 branches into a plurality of power lines to which the plurality of manual circuit breakers MCBb are connected. A plurality of BCP loads are respectively connected to the plurality of manual circuit breakers MCBb.

[0078]

The control board 62 includes a voltage regulator AVR, a manual circuit breaker MCBc, a control unit CU, and a case 162 (third

case) that houses these components. The voltage regulator AVR is connected to a power line extending from the UPS 115. A plurality of manual circuit breakers MCBc are connected to the voltage regulator AVR. The control unit CU, the meter M, the remote-controlled circuit breaker RB1, and the remote-controlled circuit breaker RB2 are respectively connected via power lines to the plurality of manual circuit breakers MCBc. Accordingly, even in the event of a power failure, power is supplied to the control unit CU, the meter M, the remote-controlled circuit breaker RB1, and the remote-controlled circuit breaker RB2. In addition, the control unit CU, the meter M, the remote-controlled circuit breaker RB1, and the remote-controlled circuit breaker RB2 are connected by signal lines (denoted by dashed lines in the diagram) and are in a state where various signals can be input and output.

[0079]

The existing panel board 65 includes a terminal board TBe and a plurality of manual circuit breakers MCBc. The terminal board TBe is connected to a power line extending from the terminal board TBb of the master board 60. A plurality of manual circuit breakers MCBc are connected to the terminal board TBe. A plurality of general loads are respectively connected to the plurality of manual circuit breakers MCBc. When the number of manual circuit breakers MCBc in the existing panel board 65 is larger than the number of manual circuit breakers MCBb in the branch board 61, dimensions of the branch board 61 can be set smaller than those of the existing panel board 65.

[0080]

FIG. 5 illustrates a method of installing the master board 60, the branch board 61, and the control board 62.

[0081]

In the diagram, an upper side is a front view illustrating an EPS internal wall surface. Prior to installing the panel board PB, the existing panel board 65, existing equipment 66, and the like are installed on the EPS internal wall surface.

[0082]

In the diagram, a lower side is a plan view illustrating a floor plan of the building. The master board 60 is installed in proximity of the existing panel board 65. The branch board 61 and the control board 62 may be installed in available space inside the EPS or may be locked and installed in a space such as an office.

[0083]

Basically, the master board 60, the branch board 61, and the control board 62 are installed on a same floor. Since wiring such as power lines and signal lines that interconnect the master board 60, the branch board 61, and the control board 62 are finer than the service line 50, work for connecting the wiring is simplified and shortened as compared to work on the service line 50 in which wiring is performed in a height direction along the EPS of the building. In addition, since connection of the service line 50 to the master board 60 is performed last, the commercial power supply 51 need not be placed in a blackout state during installation work of the master board 60, the branch board 61, and the control board

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62 and the installation work can be performed without having to stop important devices in the building such as a server. Therefore, connection work can be performed even on weekdays on which tenants are present in the building, and duration of the work can be reduced as compared to work on a power line which necessitates a blackout and which is limited to the nighttime and weekends.

[0084]

Work for connecting the master board 60 and the service line 50 to each other can be performed after the master board 60, the branch board 61, and the control board 62 are installed on a whole building blackout day or the like which is necessary about once a year for the purpose of building maintenance. Since this work involves connecting the master board 60 and the existing panel board 65 to each other by disconnecting the service line 50 connected to the existing panel board 65, reconnecting the service line 50 to the master board 60 installed in proximity, and connecting a power line 67 prepared in advance, the work can be completed in a short period of time.

[0085]

Hereinafter, a relationship between a structure of the building and the power supply system will be described.

[0086]

FIG. 6 illustrates an arrangement of the power supply system inside a building.

[0087]

The terminal apparatus 111, the centralized management

control apparatus 10, and the UPS 115 are installed in a disaster control center inside the building or the like. The panel board PB is installed in the EPS of each floor or the like. A signal line is extended from the centralized management control apparatus 10 to each panel board. A power line for supplying power necessary for operation is arranged from the UPS 115 to the terminal apparatus 111, the centralized management control apparatus 10, and the panel board PB and the UPS 115 can operate for a certain amount of time even when a power failure of the commercial power supply 51 occurs. As a result, even when a power failure occurs, the centralized management control apparatus 10 can perform control for interrupting remote-controlled circuit breakers arranged inside the panel board PB or the like.

[0088]

The centralized management control apparatus 10 can allocate an interrupting current set value of each panel board PB within a range of surplus power in accordance with an input to the terminal apparatus 111 by a manager. Therefore, the power supply system can supply surplus power of the entire building to a specific floor in a concentrated manner. For example, by supplying surplus power in a concentrated manner to a floor on which disaster control headquarters are located or to a server room or the like, the power supply system can effectively utilize limited power.

[0089]

One floor may be divided into a plurality of usage spaces and the panel board PB may be installed in each usage space. In this

case, the power supply system can supply power in a concentrated manner to a local point that is a unit smaller than a floor.

[0090]

Hereinafter, a case where the power supply system is applied to an area energy management system will be described.

[0091]

In recent years, area energy management businesses that accommodate power or thermal energy between buildings in an area such as collective receiving commercial power in the area are being developed. By applying the power supply system according to the present embodiment to an area energy management system, supply of power to a plurality of buildings can be controlled from an energy center.

[0092]

FIG. 7 illustrates a configuration of an area energy management system.

[0093]

Buildings B1, B2, ..., B5 and an energy center EC1 are provided in an area C1. Buildings B6, B7, ..., B10 and an energy center EC2 are provided in an area C2. An area power supply system controls supply of power to a plurality of buildings B in the areas C1 and C2. The centralized management control apparatus 10 is installed in the energy center EC of each area C. The centralized management control apparatus 10 is connected to the panel board PB installed in each of the plurality of buildings B in a same area via wired communication or wireless communication.

[0094]

The centralized management control apparatus 10 is connected to a cloud server 116 outside of the areas C1 and C2 via the Internet. Functions, set values, and stored data of the centralized management control apparatus 10 are backed up by the cloud server 116. Due to the power supply system adopting such a duplex system, in addition to becoming disaster resistant, remote response can be carried out by a manager of another area when responding to an emergency such as a disaster. For example, when the area C1 is impacted by a disaster, a manager of the energy center of the area C2 not affected by the disaster can provide support to the area C1 as an emergency response. Examples of an emergency response include monitoring a state of the panel board PB and preparing for unforeseen circumstances such as equipment failure, adjusting an interrupting current set value in order to reduce unnecessary power, and arranging for procurement and delivery of fuel when a shortage of fuel used by a private power supply occurs.

[0095]

Hereinafter, information used by the power supply system will be described.

[0096]

The mode determination 15 in the logical operation process 102 will now be described.

[0097]

FIG. 8 illustrates the mode determination 15.

[0098]

The mode determination 15 includes condition information for each mode. The condition information of one mode includes a mode name, a mode number, and mode conditions. The mode name indicates a name of the mode. Examples of mode names include a normal mode, an interrupt mode, a BCP mode, a manual mode, and a maintenance mode. The interrupt mode can be further divided into during power failure, during power failure and during fire, at limit of remaining amount, and during power recovery. The mode number is an identifier indicating the mode and is transmitted as a mode signal from the centralized management control apparatus 10 to the control unit CU. Moreover, the device state after control in FIG. 8 indicates an operating state after each mode is applied under conditions where the present system controls the devices of the circuit breaker CB1, the circuit breaker CB2, the circuit breaker CB3, the remote-controlled circuit breaker RB1, and the remote-controlled circuit breaker RB2.

[0099]

The mode conditions refer to conditions for making or enabling a transition to the mode. The mode conditions are defined by a power failure detection signal indicating a state of the commercial power supply 51, a fire occurrence signal indicating a state of a building, a private power supply voltage establishment signal indicating a state of the private power supply 54, circuit breaker CB3 connection information related to an emergency line which indicates a state of the emergency line 53, and a remaining amount warning indicating a determination result of a remaining operating time of the private

power supply 54. The power failure detection signal is enabled (ON) when a power failure of the commercial power supply 51 is detected by the power failure detector 52. The fire occurrence signal is enabled when a fire of a building is detected by the fire detector 56. The voltage establishment signal is enabled when the private power supply control section 55 detects that voltage of the private power supply 54 has been established and is within a voltage range set in advance. The emergency line connection information is enabled when the circuit breaker CB3 is in a connected state (ON) and the panel board PB is connected to the emergency line 53 by the centralized management control apparatus 10 or when the safety load and the emergency load are connected to the service line 50 by the centralized management control apparatus 10. The remaining amount warning is enabled when the private power supply control section 55 or the centralized management control apparatus 10 detects that the remaining operating time of the private power supply 54 has equaled or fallen below a remaining operating time threshold set in advance. The remaining operating time threshold is a value obtained by, for example, adding a margin to an operating time of a legal emergency load 114. Alternatively, a remaining energy amount of the private power supply 54 may be used in place of the remaining operating time. The remaining amount warning may be enabled when it is detected that the remaining energy amount has fallen outside of a remaining amount range set in advance (for example, equal to or under a remaining energy amount threshold set in advance).

[0100]

The logical operation process 102 can cause the mode to make a transition to the normal mode when the power failure detection signal is off, the fire occurrence signal is off, and the connection information of the circuit breaker CB3 is on. The logical operation process 102 can determine that a power failure has occurred and cause the mode to make a transition to the interrupt mode when the power failure detection signal is on, the fire occurrence signal is off, the voltage establishment signal is off, and the connection information of the circuit breaker CB3 is off. The logical operation process 102 can determine that a power failure accompanied by a fire has occurred and cause the mode to make a transition to the interrupt mode when the power failure detection signal is on, the fire occurrence signal is on, and the voltage establishment signal is on. The logical operation process 102 can determine that fuel level is low and cause the mode to make a transition to the interrupt mode when the power failure detection signal is on, the voltage establishment signal is on, and the remaining amount warning is on. In addition, in response to an input indicating power recovery to the terminal apparatus 111 made by the manager, the logical operation process 102 can cause the mode to make a transition to the interrupt mode when the power failure detection signal is off and the voltage establishment signal is on. The logical operation process 102 can cause the mode to make a transition to the BCP mode when the power failure detection signal is on, the fire occurrence signal is off, the voltage establishment signal

is on, the connection information of the circuit breaker CB3 is on, and the remaining amount warning is off. Furthermore, in response to an input indicating the manual mode to the terminal apparatus 111 made by the manager, the logical operation process 102 can cause the mode to make a transition to the manual mode when the fire occurrence signal is off. In addition, in response to an input indicating the maintenance mode to the terminal apparatus 111 made by the manager, the logical operation process 102 can cause the mode to make a transition to the maintenance mode.

[0101]

Accordingly, the centralized management control apparatus 10 can cause a transition to be made to an appropriate mode in accordance with states of a fire of the building, the commercial power supply 51, and the private power supply 54.

[0102]

FIG. 9 illustrates a registration method of an RB set value table.

[0103]

The opening/closing set value and the interrupting current set value of each of the plurality of modes are registered as an RB set value table in the centralized management control apparatus 10 based on input to the terminal apparatus 111 made by the manager. The centralized management control apparatus 10 transmits the opening/closing set values and the interrupting current set values to a plurality of control units CU. The plurality of control units CU receive the respective opening/closing set values and the

interrupting current set values and store the values as the RB set value table 22.

[0104]

FIG. 10 illustrates an RB set value table.

[0105]

The RB set value table 22 has an entry field for each mode. The entry field of one mode includes a value of a mode signal, an opening/closing set value of each remote-controlled circuit breaker RB, and an interrupting current set value. An opening/closing set value is represented by either opened (interrupted) or closed (connected) for each remote-controlled circuit breaker RB. The interrupting current set value is represented by a current [A].

[0106]

Upon receiving a mode signal from the centralized management control apparatus 10, each control unit CU causes the remote-controlled circuit breaker RB to operate by outputting a signal of an opening/closing operation in accordance with an opening/closing set value corresponding to the mode signal and, by updating and setting the interrupting current set value corresponding to the mode signal, constantly compares a current measured value of the meter M with the interrupting current set value. When the control unit CU determines that the current measured value has exceeded the interrupting current set value, the control unit CU controls the remote-controlled circuit breaker RB in a connected state to an interrupted state. For example, the control unit CU1 of the panel board PB1 controls the

remote-controlled circuit breaker RB11 to an interrupted state and the remote-controlled circuit breaker RB12 to a connected state in the BCP mode, and when the control unit CU1 determines that a sum of currents flowing through the remote-controlled circuit breakers RB exceeds 15 [A] that is the interrupting current set value, the control unit CU1 controls the remote-controlled circuit breaker RB12 in a connected state to an interrupted state.

Accordingly, the panel board PB1 can supply power up to 40 [A] to the general load L11 and the BCP load L12 in the normal mode and can supply power up to 15 [A] to the BCP load L12 in the BCP mode. For example, the control unit CU2 of the panel board PB2 controls the remote-controlled circuit breaker RB21 and the remote-controlled circuit breaker RB22 to a connected state in the BCP mode, and when the control unit CU2 determines that a sum of currents flowing through the remote-controlled circuit breakers RB exceeds 30 [A] that is the interrupting current set value, the control unit CU2 controls the remote-controlled circuit breaker RB21 and the remote-controlled circuit breaker RB22 in a connected state to an interrupted state. Accordingly, the panel board PB2 can supply power up to 60 [A] to the general load L21 and the BCP load L22 in the normal mode and can supply power up to 30 [A] to the general load L21 and the BCP load L22 in the BCP mode. In this case, in the BCP mode, the panel board PB2 can supply half the power to the same loads as in the normal mode. For example, the control unit CU3 of the panel board PB3 controls the remote-controlled circuit breaker RB31 and the remote-controlled circuit breaker RB32

to an interrupted state in the BCP mode. Accordingly, the panel board PB3 can supply power up to 60 [A] to the general load L31 and the BCP load L32 in the normal mode. The panel board PB3 does not supply power to the loads in the BCP mode. For example, the control unit CU4 of the panel board PB4 controls the remote-controlled circuit breaker RB41 to an interrupted state and the remote-controlled circuit breaker RB42 to a connected state in the BCP mode, and when the control unit CU4 determines that a sum of currents flowing through the remote-controlled circuit breakers RB exceeds 30 [A] that is the interrupting current set value, the control unit CU4 controls the remote-controlled circuit breaker RB42 in a connected state to an interrupted state.

Accordingly, the panel board PB4 can supply power up to 40 [A] to the general load L41 and the BCP load L42 in the normal mode and can supply power up to 30 [A] to the BCP load L42 in the BCP mode. By setting the interrupting current set value of the BCP mode in the RB set value table 22 of the control unit CU4 to be larger than the interrupting current set value of the BCP mode in the RB set value table 22 of the control unit CU1, a larger distribution of power than the power supplied to the BCP load L12 can be supplied to the BCP load L42. In addition, in the RB set value table 22 of the control unit CU1, the RB12 opening/closing set value in the BCP mode may indicate a connected state and the interrupting current set value may indicate 0. In this case, RB12 enters an interrupted state in the BCP mode. Furthermore, in the RB set value table 22 of the control unit CU2, respective set values of the normal mode

may be equal to respective set values of the BCP mode. In this case, the panel board PB2 performs the same control in the normal mode and the BCP mode.

[0107]

Accordingly, when a condition of a sum of all interrupting current set values being equal to or less than the power supplying capability is satisfied, the centralized management control apparatus 10 can freely set the plurality of remote-controlled circuit breakers RB of the plurality of panel boards PB and can supply power without waste regardless of capacities of sub-circuit breakers. For example, the centralized management control apparatus 10 can distribute the power supplying capability to a plurality of floors in the normal mode and concentrate the power supplying capability to the panel boards PB on a specific floor, in a specific usage space, or the like in the BCP mode.

[0108]

Moreover, instead of transmitting a mode signal, the centralized management control apparatus 10 may transmit an opening/closing set value and an interrupting current set value corresponding to a mode to the control unit. In this case, the control unit CU stores the received opening/closing set value and interrupting current set value instead of storing the RB set value table 22.

[0109]

Hereinafter, a panel board according to a modification will be described.

[0110]

FIG. 11 illustrates a configuration of a panel board according to a modification.

[0111]

In FIG. 11, an upper diagram illustrates an example where parts, circuits, and functions constituting the master board 60, the branch board 61, and the control board 62 are housed in one case. The panel board PB1 includes three current transformers CT11, CT12, and CT13, three meters M11, M12, and M13, three remote-controlled circuit breakers RB11, RB12, and RB13, and the control unit CU1. A power line extending from the service line 50 branches into three power lines (branch wires) to which the three current transformers CT11, CT12, and CT13 are respectively connected. The three meters M11, M12, and M13 are respectively connected to the three current transformers CT11, CT12, and CT13. The general load L11 and the BCP loads L12 and L13 are respectively connected to the three remote-controlled circuit breakers RB11, RB12, and RB13. The control unit CU1 is connected to the three meters M11, M12, and M13 and the three remote-controlled circuit breakers RB11, RB12, and RB13. Moreover, as illustrated in a lower diagram, the CU1 may be installed outside of the panel board PB and may control a plurality of panel boards PBn. In addition, the numbers of current transformers CT, meters M, remote-controlled circuit breakers RB, and loads in the panel board PB are not limited to three.

[0112]

In a similar manner to the dividing method described earlier, the panel board PB1 according to the present modification can be divided into and installed as one master board 60, two branch boards 61, and one control board 62. In this case, the master board 60 includes the current transformer CT11, the meter M11, and the remote-controlled circuit breaker RB11. A first branch board 61 includes the current transformer CT12, the meter M12, and the remote-controlled circuit breaker RB12. A second branch board 61 includes the current transformer CT13, the meter M13, and the remote-controlled circuit breaker RB13. The control board 62 includes the control unit CU1.

[0113]

Due to the configuration described above, the meters M11, M12, and M13 respectively measure currents flowing through the remote-controlled circuit breakers RB11, RB12, and RB13.

[0114]

FIG. 12 illustrates an RB set value table of the panel board according to the modification.

[0115]

An entry field of one mode in the RB set value table 22 according to the modification includes a value of a mode signal, an opening/closing set value of each remote-controlled circuit breaker RB, and an interrupting current set value of each remote-controlled circuit breaker RB.

[0116]

The control unit CU1 in the panel board PB1 controls the

remote-controlled circuit breaker RB11 to an interrupted state when a measured value of the meter M11 exceeds the interrupting current set value of the remote-controlled circuit breaker RB11. In a similar manner, the control unit CU1 controls the remote-controlled circuit breaker RB12 to an interrupted state when a measured value of the meter M12 exceeds the interrupting current set value of the remote-controlled circuit breaker RB12. In a similar manner, the control unit CU1 controls the remote-controlled circuit breaker RB13 to an interrupted state when a measured value of the meter M13 exceeds the interrupting current set value of the remote-controlled circuit breaker RB13. Accordingly, the centralized management control apparatus 10 can set an interrupting current set value for each remote-controlled circuit breaker RB. [0117]

Hereinafter, operations of the power supply system in the event of a power failure will be described.

[0118]

FIG. 13 illustrates operations of the power supply system in the event of a power failure.

[0119]

When a remaining fuel amount or a power storage amount of the private power supply is sufficient and a power failure has occurred but a fire has not occurred, the centralized management control apparatus 10 performs control in the BCP mode. Moreover, in a state where the remaining fuel amount or the power storage amount of the private power supply has been depleted or is insufficient, the BCP

mode is not executed due to the private power supply remaining operating time computation 32. However, generally, such a state is rare.

[0120]

The centralized management control apparatus 10 receives a power failure detection signal from the power failure detector 52 (step S10). When there is no power failure detection signal, the centralized management control apparatus 10 repeats step S10 (step S10: no). When there is a power failure detection signal, the centralized management control apparatus 10 starts control of the circuit breakers CB on the power lines (step S10: yes). The centralized management control apparatus 10 controls the circuit breaker CB1 between the commercial power supply 51 and the service line 50 and the circuit breaker CB3 between the service line 50 and the emergency line 53 to an interrupted state (step S11), and performs the logical operation process 102. When a fire detection signal is received from the fire detector 56 (step S12: yes), the centralized management control apparatus 10 determines that the mode is to make a transition to the interrupt mode (step S13), and when there is no fire detection signal (step S12: no), the centralized management control apparatus 10 determines that the mode is to make a transition to the BCP mode (step S31, step S41).

[0121]

Since the private power supply 54 is activated when the mode makes a transition to the interrupt mode, the centralized management control apparatus 10 receives a private power supply activation

signal from the private power supply control section 55 (step S13). Since the private power supply control section 55 outputs a voltage establishment signal when necessary voltage is established after the private power supply 54 is activated, the centralized management control apparatus 10 receives the voltage establishment signal (step S14). By controlling the circuit breaker CB2 between the private power supply 54 and the emergency line 53 to a connected state (step S15), the centralized management control apparatus 10 supplies power to the safety load 113 and the emergency load 114 (step S16). Furthermore, the centralized management control apparatus 10 outputs an interrupt mode signal to each control unit CU (step S17). At this point, the centralized management control apparatus 10 performs an optimization process of priorities of control units CU that are output destinations and an output order (step S18), and performs the delayed output 21 in which the mode signals are output at timings that have been staggered by output time intervals set in advance for each control unit CU (step S19). Moreover, the output time interval can be arbitrarily set. Upon receiving the interrupt mode signal, each control unit CU reads the opening/closing set value in the RB set value table 22 stored in a storage area of the control unit CU and outputs a signal that causes the remote-controlled circuit breaker RB to perform an opening/closing operation (step S20). In the case of the interrupt mode, the control unit CU controls all remote-controlled circuit breakers RB to the interrupted state (step S21).

[0122]

When it is determined that the mode is to make a transition to the BCP mode (step S12: no), since the private power supply 54 is activated, the centralized management control apparatus 10 receives a private power supply activation signal from the private power supply control section 55 (step S31). Since the private power supply control section 55 outputs a voltage establishment signal when necessary voltage is established after the private power supply 54 is activated, the centralized management control apparatus 10 receives the voltage establishment signal (step S32). By controlling the circuit breaker CB2 between the private power supply 54 and the emergency line 53 to a connected state (step S33) and connecting the circuit breaker CB3 between the service line 50 and the emergency line 53 (step S34), the centralized management control apparatus 10 creates a state that enables power to be supplied to the panel board PB from the private power supply 54 via the service line 50. In this case, the emergency load 114 is not operated and does not consume power.

[0123]

The centralized management control apparatus 10 performs the logical operation process 102 and, in order to reduce the effect of an inrush current from the private power supply 54 on the loads, outputs an interrupt mode signal to each control unit CU (step S41) to control all remote-controlled circuit breakers RB (RB11, RB12, RB21, RB22, ..., RBn1, RBn2) in all panel boards RB to an interrupted state, and interrupts all loads connected to all panel boards RB (step S42). This interruption operation is performed in a similar

manner to steps S19 to S21.

[0124]

The centralized management control apparatus 10 performs the logical operation process 102 upon receiving a signal indicating that the circuit breaker CB3 has been connected, and based on a result of a computation of surplus power or a remaining operating time of the private power supply 54, the centralized management control apparatus 10 performs an optimization process of priorities of control units CU that are output destinations of a BCP mode signal and an output order (step S44). For example, a high importance of a BCP load connected to a certain panel board PB means that the priority of the panel board PB is high. Accordingly, in order to preferentially supply power to the panel board PB, based on the surplus power or the remaining operating time of the private power supply 54, the centralized management control apparatus 10 performs a process of not supplying power to a panel board PB connected to an unnecessary load. Once the centralized management control apparatus 10 determines control units CU that are output destinations, the centralized management control apparatus 10 selects control units CU in a descending order of priority as output destinations, and performs the delayed output 21 in which the BCP mode signal is output to the selected output destinations at output timings that have been staggered by output time intervals (step S45).

[0125]

Upon receiving the BCP mode signal from the centralized

management control apparatus 10, each control unit CU outputs a signal that causes the remote-controlled circuit breaker RB to perform an opening/closing operation in accordance with the opening/closing set value in the RB set value table 22 stored in a storage area of the control unit CU (step S46) and updates the interrupting current set value (step S47). In the example of the present flow, the control unit CU connects the remote-controlled circuit breakers RB12, RB22, ..., RBn2 (step S48).

[0126]

Since power has already been supplied from the private power supply 54 to the panel board PB in step S34 and the remote-controlled circuit breaker RBn2 is connected in step S48, power is supplied to the BCP load L2 connected to the remote-controlled circuit breaker RBn2 (step S49).

[0127]

When the central monitoring apparatus described earlier is provided for the purpose of building management, based on a power failure detection signal, the central monitoring apparatus may interrupt the service line 50 by controlling the circuit breakers CB1 and the like and may activate the private power supply 54 by controlling the private power supply control section 55.

[0128]

According to the operations described above, when a power failure has occurred and a fire has not occurred, the power supply system can supply power from the private power supply 54 to the safety load 113 and the BCP load L2. In addition, when a power

failure has occurred and a fire has also occurred, the power supply system can supply power from the private power supply 54 to the safety load 113 and the emergency load 114.

[0129]

Hereinafter, several specific examples of operations of the power supply system in the event of an emergency will be described.

[0130]

First, a case where a power failure has occurred but a fire has not occurred will be described.

[0131]

FIG. 14 illustrates operations of the power supply system when a remaining fuel amount or a power storage amount of the private power supply is sufficient and a power failure has occurred but a fire has not occurred.

[0132]

The diagram illustrates cooperative operations among the power failure detector 52, the fire detector 56, monitoring control devices such as the private power supply control section 55, the terminal apparatus 111, the centralized management control apparatus 10, the circuit breakers CB, the control units CU, and the remote-controlled circuit breakers RB.

[0133]

The power failure detector 52 enables a power failure detection signal when a power failure of the commercial power supply 51 is detected (step S101). When the power failure detection signal is enabled (step S102), the centralized management control

apparatus 10 interrupts the circuit breaker CB1 and the circuit breaker CB3 (step S103) and causes the terminal apparatus 111 to display the occurrence of a power failure (step S104). In this case, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. When the fire detector 56 has disabled a fire detection signal (step S105), the centralized management control apparatus 10 recognizes that a fire has not occurred (step S106), and since a logical operation process reveals that a power failure has occurred, a fire has not occurred, voltage of the private power supply has not been established, and the circuit breaker CB3 is in an interrupted state, the centralized management control apparatus 10 causes the mode to make a transition to an interrupt mode (during power failure) (step S107) and causes the terminal apparatus 111 to display that the present mode is the interrupt mode (step S108). Subsequently, the centralized management control apparatus 10 reads an output destination order setting (step S109) and performs a delayed output of the interrupt mode signal in accordance with the output destination order setting (step S110). For example, when the output destination order setting indicates an order of the control units CU1, CU2, and CU3 and the output time interval is 2 seconds, the centralized management control apparatus 10 outputs the interrupt mode signal to the control unit CU1, after 2 seconds, outputs the interrupt mode signal to the next control unit CU2, and after 2 seconds, outputs the interrupt mode signal to the next control unit CU3.

[0134]

Upon receiving the interrupt mode signal (step S111), the control unit CU outputs an interrupt signal to all connected remote-controlled circuit breakers (step S112). Upon receiving the interrupt signal, the remote-controlled circuit breakers interrupt circuits (step S113).

[0135]

The private power supply control section 55 activates the private power supply 54 in response to a power failure detection signal and enables a private power supply activation signal indicating the activation of the private power supply 54 (step S114). When the private power supply activation signal is enabled (step S115), the centralized management control apparatus 10 causes the terminal apparatus 111 to display that the private power supply 54 has been activated (step S116).

[0136]

The private power supply 54 establishes voltage within an activation time (for example, 40 seconds) set in advance from the power failure detection signal, and enables a voltage establishment signal (step S117). When the voltage establishment signal is enabled (step S118), the centralized management control apparatus 10 causes the terminal apparatus 111 to display that the voltage of the private power supply 54 has been established (step S119).

[0137]

The centralized management control apparatus 10 connects the private power supply 54 and the emergency line 53 to each other by connecting the circuit breaker CB2 (step S120). Subsequently,

the centralized management control apparatus 10 enables emergency line connection information (step S121) and causes the terminal apparatus 111 to display that the emergency line 53 is the system to be used (step S122). In addition, the centralized management control apparatus 10 connects the emergency line 53 and the service line 50 to each other by connecting the circuit breaker CB3 (step S123), enables connection information of the circuit breaker CB3 (step S124), and causes the terminal apparatus 111 to display that the emergency line 53 and the service line 50 have been connected to each other (step S125). Moreover, the central monitoring apparatus may interrupt the circuit breakers and the like.

[0138]

Since a logical operation process reveals that a power failure has occurred, a fire has not occurred, the circuit breaker CB3 is in a connected state, voltage of the private power supply 54 has been established, and a remaining operating time of the private power supply 54 is greater than a limit value, the centralized management control apparatus 10 causes the mode to make a transition to a BCP mode (step S126) and causes the terminal apparatus 111 to display that the present mode is the BCP mode (step S127). Subsequently, the centralized management control apparatus 10 reads an output destination order setting (step S128) and performs a delayed output of a BCP mode signal in accordance with the output destination order setting (step S129). At this point, the centralized management control apparatus 10 may select control units CU that are output destinations by the output destination

priority process 18.

[0139]

Upon receiving the BCP mode signal (step S130), the control unit CU reads the interrupting current set value of the BCP mode (step S131) and outputs an interrupt signal to the remote-controlled circuit breaker RB1 (step S132). Upon receiving the interrupt signal, the remote-controlled circuit breaker RB1 interrupts a general load circuit (step S133). Subsequently, the control unit CU outputs a connect signal to the remote-controlled circuit breaker RB2 (step S134). Upon receiving the connect signal, the remote-controlled circuit breaker RB2 connects a BCP load circuit (step S135). Output of interrupt signals and connect signals to the remote-controlled circuit breakers RB1 and RB2 is performed at an operating time interval set in advance (for example, 2 seconds).

[0140]

Subsequently, the control unit CU constantly acquires a current measured value of the meter M, and when the control unit CU determines that the current measured value has exceeded the interrupting current set value for a period of time set in advance (for example, 10 seconds) (step S136), the control unit CU outputs a interrupt signal to the remote-controlled circuit breaker RB2 (step S137). Upon receiving the interrupt signal, the remote-controlled circuit breaker RB2 interrupts the BCP load circuit (step S138).

[0141]

Subsequently, the control unit CU outputs an RB state signal indicating that the remote-controlled circuit breaker RB2 is interrupted (step S139). Upon receiving the RB state signal (step S140), the centralized management control apparatus 10 causes the terminal apparatus 111 to display an interruption warning indicating that the remote-controlled circuit breaker RB2 is interrupted (step S141). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound.

[0142]

Subsequently, the manager confirms usage of the BCP load, and when the load is large, performs adjustment in order to lower power demand (current). Subsequently, when the terminal apparatus 111 receives an input of a reset operation of the remote-controlled circuit breaker RB2 made by the manager (step S142), the centralized management control apparatus 10 outputs a reset command to the control unit CU (step S143). Upon receiving the reset command, the control unit CU outputs a connect signal to the remote-controlled circuit breaker RB2 (step S144). Upon receiving the connect signal, the remote-controlled circuit breaker RB2 once again connects the BCP load circuit (step S145).

[0143]

FIG. 15 illustrates operations of the power supply system at a remaining amount limit of the private power supply or during power recovery of the commercial power supply after the BCP mode.

[0144]

Subsequently, the centralized management control apparatus 10 receives power supply information indicating a state of the private power supply 54 from the private power supply control section 55 (step S153), calculates a remaining operating time of the private power supply 54 based on the received information, and when it is determined that the remaining operating time is equal to or less than a limit value, the centralized management control apparatus 10 enables a remaining amount warning (step S154). Subsequently, by performing a logical operation process, the centralized management control apparatus 10 causes the mode to make a transition to the interrupt mode (at limit of remaining amount) (step S156). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. Subsequent operations (steps S157 to S163) of the interrupt mode are similar to operations (steps S108 to S113) of the interrupt mode described earlier. The centralized management control apparatus 10 interrupts the circuit breaker CB3 (step S164), enables interruption information of the circuit breaker CB3 (step S165), and causes the terminal apparatus 111 to display that the emergency line 53 and the service line 50 have been interrupted (step S166). [0145]

When the commercial power supply 51 recovers, the power failure detector 52 disables the power failure detection signal (step S167). When the power failure detection signal is disabled (step S168), the centralized management control apparatus 10 interrupts the circuit breaker CB3 (step S169) and causes the

terminal apparatus 111 to display that power has recovered (step S170). Subsequently, by performing a logical operation process, the centralized management control apparatus 10 causes the mode to make a transition to the interrupt mode (during power recovery) (step S171). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. Subsequent operations (steps S172 to S177) of the interrupt mode are similar to operations (steps S108 to S113) of the interrupt mode described earlier.

[0146]

Subsequently, the centralized management control apparatus 10 interrupts the circuit breaker CB2 to interrupt the emergency line 53 and the service line 50 (step S178), enables interruption information of the circuit breaker CB2 (step S179), and causes the terminal apparatus 111 to display that the emergency line 53 has been interrupted (step S180). In addition, by connecting the circuit breaker CB1 and the circuit breaker CB3 (step S181), the centralized management control apparatus 10 switches the system supplying power to the panel board PB from the emergency line 53 to the service line 50. Alternatively, the central monitoring apparatus may connect the circuit breaker CB1 and the circuit breaker CB3 and the like.

[0147]

When the centralized management control apparatus 10 switches the system to the service line 50 by controlling the circuit breakers CB (step S181), the centralized management control apparatus 10

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disables the emergency line connection information (step S182) and causes the terminal apparatus 111 to display that the emergency line 53 is no longer the system used (step S183).

[0148]

Subsequently, the manager prepares for the normal mode. When the terminal apparatus 111 accepts an input of a normal mode operation made by the manager (step S184), the centralized management control apparatus 10 reads an output destination order setting (step S185) and performs a delayed output of a normal mode signal in accordance with the output destination order setting (step S186).

[0149]

Upon receiving the normal mode signal (step S187), the control unit CU reads the interrupting current set value of the normal mode (step S188) and outputs a connect signal to all connected remote-controlled circuit breakers (step S189). Upon receiving the connect signal, the remote-controlled circuit breakers connect circuits (step S190). When the control unit CU outputs an RB state signal indicating a state of the remote-controlled circuit breakers to the centralized management control apparatus 10, the centralized management control apparatus 10 causes the terminal apparatus 111 to display that the present mode is the normal mode (step S191).

[0150]

Next, a case where a fire occurs during the BCP mode will be described.

[0151]

FIG. 16 illustrates operations of the power supply system when a fire has occurred during the BCP mode.

[0152]

Upon detecting that a fire has occurred, the fire detector 56 enables a fire detection signal (step S202). When the fire detection signal is enabled (step S203), the centralized management control apparatus 10 causes the terminal apparatus 111 to display that a fire has occurred (step S204). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. By causing the mode to make a transition to the interrupt mode (during power failure and during fire) due to a logical operation process (step S206), the centralized management control apparatus 10 interrupts all remote-controlled circuit breakers, stops supply of power to the BCP loads, and enables surplus power to be used by the emergency load. Subsequent operations (steps S207 to S213) of the interrupt mode are similar to operations (steps S108 to S113) of the interrupt mode described earlier. Subsequently, the centralized management control apparatus 10 interrupts the circuit breaker CB3 to interrupt the emergency line 53 and the service line 50 (step S214), enables interruption information of the circuit breaker CB3 (step S215), and causes the terminal apparatus 111 to display that the emergency line 53 and the service line 50 have been interrupted (step S216). Moreover, the central monitoring apparatus may perform interruption of the circuit breakers and the like.

[0153]

The centralized management control apparatus 10 sets an interlock (step S217).

[0154]

Subsequently, upon detecting that a fire has not occurred, the fire detector 56 disables the fire detection signal (step S218). When the fire detection signal is disabled (step S219), the centralized management control apparatus 10 causes the terminal apparatus 111 to display that a fire has not occurred (step S220). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. The manager confirms the state of the system. When the terminal apparatus 111 accepts input of a fire recovery operation made by the manager (step S221), the centralized management control apparatus 10 releases the interlock (step S222).

[0155]

Subsequently, the centralized management control apparatus 10 connects the emergency line 53 and the service line 50 to each other by connecting the circuit breaker CB3 (step S223), enables connection information of the circuit breaker CB3 (step S224), and causes the terminal apparatus 111 to display that the emergency line 53 and the service line 50 have been connected to each other (step S225). Subsequent operations (steps S226 to S235) of the BCP mode are similar to operations (steps S126 to S135) of the BCP mode described earlier.

[0156]

Next, a case where a power failure occurs after a fire has

occurred will be described.

[0157]

FIG. 17 illustrates operations of the power supply system in the event that a power failure occurs after a fire has occurred.

[0158]

First, operations (steps S301 to S303) during the occurrence of a fire are similar to operations (steps S202 to S204) during the occurrence of a fire described earlier.

[0159]

Subsequently, operations (steps S304 to S307) during the occurrence of a power failure of a commercial power supply are similar to operations (steps S101 to S104) during the occurrence of a power failure of a commercial power supply described earlier. Operations (steps S308 to S313) for activating the private power supply and establishing voltage of the private power supply after the power failure of the commercial power supply are similar to operations (steps S114 to S119) for activating the private power supply described earlier.

[0160]

By performing a logical operation process, the centralized management control apparatus 10 causes the mode to make a transition to the interrupt mode (during power failure and during fire) (step S314). Subsequent operations (steps S315 to S320) of the interrupt mode are similar to operations (steps S108 to S113) of the interrupt mode described earlier. In addition, an interlock is performed until recovery from the fire is performed (step S321).

Hereinafter, due to the interlock, the centralized management control apparatus 10 does not change modes until a fire recovery operation is performed. Moreover, while timings of the occurrence of a fire and the occurrence of a power failure of the commercial power supply may vary, since the centralized management control apparatus 10 adopts conditions that enable a transition to the interrupt mode during power failure and during fire to be made based on a combination of the fire detection signal, the power failure detection signal, and the voltage establishment signal, the conditions are satisfied even if the signals are input at different timings.

[0161]

The centralized management control apparatus 10 connects the private power supply 54 and the emergency line 53 to each other by connecting the circuit breaker CB2 (step S322). Subsequently, the centralized management control apparatus 10 enables emergency line connection information (step S323) and causes the terminal apparatus 111 to display that the emergency line 53 is the system to be used (step S324). Moreover, the central monitoring apparatus may perform connection of the circuit breaker CB2.

[0162]

Once recovery from the fire is made, the fire detector 56 disables the fire detection signal (step S325). Subsequent operations (steps S326 to S342) for fire recovery are similar to operations (steps S219 to S235) for fire recovery described earlier. When the commercial power supply 51 recovers, the power failure

detector 52 disables the power failure detection signal (step S343). When the power failure detection signal is disabled (step S344), the centralized management control apparatus 10 interrupts the circuit breaker CB3 (step S345) and causes the terminal apparatus 111 to display that power has recovered (step S346). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. Subsequently, by performing a logical operation process, the centralized management control apparatus 10 causes the mode to make a transition to the interrupt mode (during power recovery) (step S347). At this point, the centralized management control apparatus 10 may cause the speaker 112 to generate an alarm sound. Subsequent operations (steps S348 to S353) of the interrupt mode are similar to operations (steps S108 to S113) of the interrupt mode described earlier. Subsequent operations (steps S354 to S367) for power recovery are similar to operations (steps S178 to S191) for power recovery described earlier.

[0163]

According to the operations described above, the power supply system can determine an appropriate mode and control the panel board PB based on states of a fire of a building, the commercial power supply 51, the private power supply 54, the circuit breakers CB1, CB2, CB3, and the like. The manager can confirm a state or a mode of the power supply system by a display on the terminal apparatus 111 and can make an input to the power supply system by an operation on the terminal apparatus 111.

[0164]

Terms used in the expressions of the present invention now will be described. As the power supply, a private power supply and the like may be used. As the private power supply, private power generation equipment such as a safety power supply, an emergency power supply, and a backup power supply may be used. As the power line, the service line 50 or the like may be used. As the control apparatus, the centralized management control apparatus 10 or the like may be used. As the specific load, the BCP loads L12, L22 or the like may be used. As the remote-controlled circuit breaker, the remote-controlled circuit breakers RB12, RB22, RBn2 or the like may be used. As the designated remote-controlled circuit breaker, the remote-controlled circuit breakers RB11, RB21, RBn1 or the like may be used. As the fire occurrence information, a fire occurrence signal or the like may be used. As the power failure occurrence information, a power failure occurrence signal or the like may be used. As the power supply information, a private power supply activation signal, a voltage establishment signal, emergency line connection information, a remaining amount warning, a remaining operating time, and the like may be used. As the operation instruction, a mode signal or the like may be used. As the emergency operation, a BCP mode or the like may be used. As the interruption operation, an interrupt mode or the like may be used. As the normal operation, the normal mode or the like may be used. As the operation information, the RB set value table 22 or the like may be used. As the specific panel board, the panel board PB selected by the

output destination priority process 18 or the like may be used.

[0165]

10: centralized management control apparatus,

11: state signal of each detector,

12: state signal of each piece of equipment,

13: state signal of CU,

14: database area of centralized management control apparatus,

15: mode determination,

16: CB opening/closing determination,

17: CB opening/closing signal,

18: output destination priority process,

19: output order process,

20: mode signal output,

21: delayed output,

22: RB set value table,

23: mode signal input,

24: interrupting current set values update,

25: RB opening/closing determination,

26: RB opening/closing signal output,

27: RB delayed output,

28: RB opening/closing operation,

29: current value,

30: power amount,

31: table reference,

32: remaining operating time computation,

33: supplied power change prediction,

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34: output stopping process,
35: specific panel board interrupt mode signal,
50: service line,
51: commercial power supply,
52: power failure detector,
53: emergency line,
54: private power supply,
55: private power supply control section,
56: fire detector,
60: master board,
61: branch board,
62: control board,
63: lid,
64: lock,
65: existing panel board,
66: existing equipment,
67: power line,
111: terminal apparatus,
112: speaker,
113: safety load,
114: emergency load,
115: UPS,
116: cloud server,
121: memory,
122: CPU,
123: communication interface,

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160-162: case,

CB: circuit breaker,

CT: current transformer,

CU: control unit,

M: meter,

PB: panel board,

RB: remote-controlled circuit breaker,

TR: transformer,

C: area,

B: building,

EC: energy center

What is Claimed is:

1. A power supply system, comprising:
 - a plurality of panel boards connected via a circuit breaker and a power line to a commercial power supply and another power supply; and
 - a control apparatus connected via a communication line to the plurality of panel boards, wherein
 - each of the plurality of panel boards includes:
 - a specific current sensor configured to output a measured value obtained by measuring a current flowing to a specific load from the power line;
 - a specific remote-controlled circuit breaker provided between the power line and the specific load; and
 - a control unit connected via a signal line to the specific current sensor and the specific remote-controlled circuit breaker,
 - the control apparatus is configured to receive fire occurrence information indicating whether or not a fire occurs, power failure occurrence information indicating whether or not a power failure of the commercial power supply occurs, and power supply information indicating a remaining energy amount of the power supply, determine an operation of the plurality of panel boards based on state information including the fire occurrence information, the power failure occurrence information, and the power supply information, and transmit an operation instruction

indicating the determined operation to the plurality of panel boards,

a control unit in a specific panel board among the plurality of panel boards is configured to determine a threshold for the measured value based on the operation instruction and control the specific remote-controlled circuit breaker to a connected state or interrupted state based on the operation instruction, and

the control unit in the specific panel board is configured to determine whether or not the measured value exceeds the threshold and controls, when it is determined that the measured value exceeds the threshold, the specific remote-controlled circuit breaker to the interrupted state.

2. The power supply system according to claim 1, wherein the specific panel board includes:

a panel board wire connected to the power line;

a plurality of branch wires which respectively provide, for a plurality of loads including the specific load, connection between the panel board wire and the plurality of loads; and

a plurality of remote-controlled circuit breakers which include the specific remote-controlled circuit breaker and which are respectively provided on the plurality of branch wires,

a specific current sensor in the specific panel board is configured to measure a current flowing through the panel board wire, and

the control unit in the specific panel board is connected via a signal line to the plurality of remote-controlled circuit breakers

and configured to control the plurality of remote-controlled circuit breakers based on the operation instruction.

3. The power supply system according to claim 2, wherein the plurality of remote-controlled circuit breakers include a designated remote-controlled circuit breaker,

when the control apparatus determines based on the state information that a power failure of the commercial power supply occurs, a fire does not occur, voltage of the power supply is within a predetermined voltage range, and an remaining energy amount of the power supply is within a predetermined remaining amount range, the control apparatus determines an emergency operation as the operation, and

when the operation instruction indicates the emergency operation, the control unit in the specific panel board controls the designated remote-controlled circuit breaker to the interrupted state and controls the specific remote-controlled circuit breaker to the connected state.

4. The power supply system according to claim 3, wherein

in any of the case where the control apparatus determines based on the state information that a power failure of the commercial power supply occurs and voltage of the power supply is not established, the case where the control apparatus determines based on the state information that a fire occurs, or the case where the control apparatus determines based on the state information that the remaining energy amount is outside of the remaining amount range, the control apparatus determines an interruption operation

as the operation, and

when the operation instruction indicates the interruption operation, the control unit in the specific panel board controls the plurality of remote-controlled circuit breakers to the interrupted state.

5. The power supply system according to claim 4, wherein

when the control apparatus determines, based on the state information, that a power failure of the commercial power supply does not occur, the control apparatus determines a normal operation as the operation, and

when the operation instruction indicates the normal operation, the control unit in the specific panel board controls at least the designated remote-controlled circuit breaker to the connected state, and

when it is determined that the measured value exceeds the threshold, the control unit in the specific panel board controls the designated remote-controlled circuit breaker to the interrupted state.

6. The power supply system according to claim 1, wherein

the control apparatus is configured to transmit a plurality of pieces of operation information that differ from each other to the plurality of panel boards respectively,

each of the plurality of pieces of operation information indicates control of the specific remote-controlled circuit breaker, and

each control unit in the plurality of panel boards is

configured to receive corresponding operation information and perform control indicated in the corresponding operation information on the specific remote-controlled circuit breaker in accordance with the operation instruction.

7. The power supply system according to claim 1, wherein the specific panel board includes a plurality of remote-controlled circuit breakers including the specific remote-controlled circuit breaker, and

a load is connected to the specific remote-controlled circuit breaker via a panel board different from the specific panel board.

8. The power supply system according to claim 1, wherein the specific panel board includes:

a first case housing the specific current sensor;

a second case housing the specific remote-controlled circuit breaker; and

a third case housing the control unit.

9. The power supply system according to claim 1, wherein

the control apparatus is configured to receive input information inputted to an input device, generate, based on the input information, operation information indicating the specific remote-controlled circuit breaker corresponding to each of a plurality of operations and the threshold corresponding to each of a plurality of operations, and transmit the operation information to the plurality of panel boards, and

the control unit is configured to store the operation information and select, from the operation information, the

specific remote-controlled circuit breaker and the threshold corresponding to an operation indicated by the operation instruction.

10. The power supply system according to claim 1, wherein after determining the operation, the control apparatus transmits the operation instruction every time a predetermined output time lapses to the plurality of panel boards in a predetermined order.

11. The power supply system according to claim 1, wherein the control apparatus is configured to cause a display device to display information indicating any of the state information or the operation.

12. The power supply system according to claim 1, further comprising
an uninterruptible power supply configured to supply power to the control unit, the specific current sensor, and the specific remote-controlled circuit breaker.

13. The power supply system according to claim 1, wherein the plurality of panel boards are arranged in a plurality of buildings.

14. The power supply system according to claim 1, wherein the control apparatus is configured to acquire information indicating power usage of the commercial power supply, and when the power usage exceeds a predetermined power usage threshold, the control apparatus activate the power supply to reduce the power usage.

15. The power supply system according to claim 1, wherein the specific panel board includes:

a plurality of branch wires which respectively provide, for a plurality of loads including the specific load, connection between the power line and the plurality of loads;

a plurality of current sensors which include the specific current sensor and which are respectively provided on the plurality of branch wires; and

a plurality of remote-controlled circuit breakers which include the specific remote-controlled circuit breaker and which are respectively provided on the plurality of branch wires,

the plurality of current sensors in the specific panel board are configured to measure currents flowing through the plurality of branch wires respectively, and

the control unit in the specific panel board is connected via a signal line to the plurality of current sensors and the plurality of remote-controlled circuit breakers and is configured to control the plurality of remote-controlled circuit breakers based on the operation instruction.

16. The power supply system according to claim 1, wherein

the control apparatus acquires information indicating power of the power supply in response to the determination of the operation, is configured to calculate an amount of change in the power of the power supply, and when the control apparatus determines that the amount of change is outside of a range of a predetermined amount of change, the control apparatus transmits an instruction

for stopping the transmission of the operation instruction to the plurality of panel boards.

17. The power supply system according to claim 1, wherein the control apparatus acquires information indicating power of the power supply in response to the determination of the operation, and when the power of the power supply exceeds a predetermined power threshold, the control apparatus transmits an instruction for controlling the specific remote-controlled circuit breaker to the interrupted state to the specific panel board.

18. The power supply system according to claim 1, wherein the control apparatus is configured to acquire information indicating a remaining operating time of the power supply, and when the remaining operating time equals or falls below a predetermined time threshold, the control apparatus causes a display device to display a warning and transmits an instruction for controlling the specific remote-controlled circuit breaker to the interrupted state to the plurality of panel boards.

19. A power supply method, comprising:
receiving, using a control apparatus, fire occurrence information indicating whether or not a fire occurs, power failure occurrence information indicating whether or not a power failure of a commercial power supply occurs, and power supply information indicating a remaining energy amount of a power supply, the control apparatus being connected via a communication line to a plurality of panel boards, the plurality of panel boards being connected via a circuit breaker and a power line to the commercial power supply

and the power supply, each of the plurality of panel boards including a specific current sensor being configured to output a measured value obtained by measuring a current flowing to a specific load from the power line, a specific remote-controlled circuit breaker being provided between the power line and the specific load, and a control unit being connected via a signal line to the specific current sensor and the specific remote-controlled circuit breaker;

determining, using the control apparatus, an operation of the plurality of panel boards based on state information including the fire occurrence information, the power failure occurrence information, and the power supply information;

transmitting, using the control apparatus, an operation instruction indicating the determined operation to the plurality of panel boards;

determining, using a control unit in a specific panel board among the plurality of panel boards, a threshold with respect to the measured value based on the operation instruction;

controlling, using the control unit in the specific panel board, the specific remote-controlled circuit breaker to a connected state or interrupted state based on the operation instruction;

determining, using the control unit in the specific panel board, whether or not the measured value exceeds the threshold;
and

when it is determined that the measured value exceeds the threshold, controlling, using the control unit in the specific panel

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board, the specific remote-controlled circuit breaker to an interrupted state.