



G00002

MOTOR-DRIVEN MOVABLE RACK SYSTEM

FIELD OF THE INVENTION

This invention relates to a motor-driven movable rack system comprising a plurality of motor-driven racks which are controlled by a monitoring unit at a remote location when there is any problem with such racks.

DESCRIPTION OF RELATED ART

A plurality of movable racks housing books, documents or various objects are installed in a packed state and are released from the packed state whenever necessary. Specifically, a vacant space can be prepared in front of a particular movable rack in order to load or unload objects, so that a limited storage space can be effectively used. Some movable racks are driven by a motor.

In a movable rack system, a vacant space should be available in front of a particular movable rack where objects are loaded or unloaded. In the case of a motor-driven movable rack system, it is possible to prepare a vacant space at a desired position. Particular movable racks to be moved and a direction in which they should be moved are determined on the basis of the vacant space to be prepared and a positional relationship between movable racks. The movement of the movable racks is controlled in accordance with the determined results.

Each movable rack is very heavy. When such a movable rack starts moving with books and various objects loaded thereon, it tends to produce a large kinetic energy. It is therefore very dangerous if a worker is caught between such movable racks. In order to overcome this problem, the movable rack system is usually provided with a variety of safety units. For example, once a working space is prepared at the specified position, the movable racks are interlocked, and cannot be moved in order to form a new working space at a different position until a resetting operation is performed. Further, if any movable rack is moved to narrow the working space where the worker is present, the worker manually or bodily touches a safety bar switch



horizontally attached on the frontage of the movable rack with which he or she is working. The moving movable rack is immediately stopped. The foregoing safety bar switch is also useful when a foreign object is left in the working space. In such a case, the safety bar switch is operated to stop a particular movable rack, which is made to move in a reverse direction by the operation of an emergency switch, thereby enabling the worker to leave from the working space between movable racks or the foreign object to be removed therefrom. Thereafter, an emergency mode will be reset, and a normal operation mode will be resumed.

In a further example, there is a motor-driven movable rack system in which a double-command suspending function is provided in order to stop a rack that is being moved in accordance with a first command, if a second command is issued to prepare a working space at a different position.

Some motor-driven movable rack systems emit alarm sound under particular situations, e.g. the chimes are rung when movable racks are being moved. There is some movable rack system in which a bell rings or a buzzer sounds when emergency measures such as moving racks backward in order to release a worker or remove an object sandwiched between adjacent movable racks, or when a safety bar switch is operated in order to stop the moving racks. In the case of the double command, either a bell or buzzer will be operated in some movable rack system. Alternatively, visual indications will be given by lamps or on a monitor display, in place of the foregoing acoustic alarms. Further, both acoustic and visual alarms will be given when there is a problem related to an overheated motor and other problems.

The motor-driven movable rack system usually has a number of complicated functions as described above. Therefore, it may be difficult for the worker to make full use of such complicated functions. For example, the worker may be at a loss for coping with a case where movable racks are suddenly stopped due to the operation of a safety switch or where an alarm is emitted.

Sometimes, the worker cannot resume the ordinary operation mode even if there is no problem. Needless to say, the ordinary operation cannot be resumed until a problem is overcome.

With a conventional movable rack system, the user may call a maintenance person, who will advise how to cope with the problem using a telephone, and then will be dispatched to the user's site in order to deal with the problem, if necessary.

When the maintenance person comes to the user and inspects the movable rack system in response to the user's request, most of problems can be usually found to be easily dealt by the user in accordance with the maintenance person's instructions. In many cases, a lot of time and money are consumed on trifles. If the user adequately understands an operating state of the movable rack system, and accurately informs the maintenance person of such a state over a telephone network, the maintenance person can instruct the user how to deal with the problem. Then the user can easily overcome the problem in accordance with the instructions. However, it is impossible to expect the user to exactly understand the operating state of the movable rack system. Even if the user correctly understands the operating state of the movable rack system and reports it to the maintenance person, the maintenance person sometimes needs further details of the operating state. In such a case, the maintenance person has to come to the user's site.

This invention is contemplated in order to overcome the foregoing problems of the related art, and is intended to provide a motor-driven movable rack system that enables a maintenance person and so on at a remote place to grasp operating status of the movable rack system and to overcome problems without actually coming to a site where the movable rack system is installed, and to which control signals can be transmitted if necessary.

SUMMARY OF THE INVENTION

According to a first feature of the invention, there is provided a motor-driven movable rack system comprising: a plurality of motor-driven movable racks arranged side by side

at a user's site; a control section for controlling the movement of the movable racks and forming a working space necessary for loading or unloading objects between desired movable racks; and a monitoring unit installed at a remote place and collecting, via a telephone network, data on operating status of the movable racks that are under control of the control section. This arrangement relieves a maintenance person from coming to the user's site in order to overcome any problem in the movable rack system.

In accordance with a second feature, the telephone network may be a radio telephone network. This enables the movable rack system to be connected to the terminal at the remote place using the radio telephone network at a reduced cost. No telephone line will be necessary for this purpose.

According to a third feature, the movable rack system further includes a transmitter for transmitting control data of the movable racks via the telephone network, and another monitoring unit attached to the movable racks for the purpose of collecting the control data of the movable racks. When there is any problem, the user can determine a kind or type of the problem, and cope with it without any assistance of the maintenance person. Further, the user can overcome the problem while observing data displayed on the monitor, and communicating with the maintenance person who observes the data displayed at the remote location. Still further, the maintenance person dispatched to the user's site can quickly and appropriately identify the problem and overcome it while observing the monitoring unit at the user's site.

In a fourth feature of the invention, the control data from the transmitter may contain data concerning abnormal states of the movable racks, which are received by the monitoring unit for the purpose of identifying a problem in the movable rack system.

With a fifth feature, the monitoring unit at the remote place may include a terminal unit for transmitting control signals to the movable rack system via the telephone network.

This enables the movable rack system to be controlled via the terminal equipment at the remote place on the basis of control data received therefrom.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view showing the configuration of a motor-driven movable rack system according to the invention.

Fig. 2 shows the configuration of a movable rack maintenance telecommunication system which serves as a main part in the motor-driven movable rack system.

Fig. 3 is a block diagram showing a control system of the motor-driven movable rack system.

Fig. 4 schematically shows the main part of the movable rack maintenance telecommunication system.

Fig. 5 shows the sequence of one operation mode.

Fig. 6 shows the sequence of another operation mode.

Fig. 7 shows the sequence of a further operation mode.

Fig. 8 shows distribution of target data in each of the operation modes.

Fig. 9 shows examples of data on a monitor display.

Fig. 10 schematically shows communications between the movable rack system and a remote monitoring unit.

Fig. 11 shows hardware constituting the motor-driven movable rack system.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The configuration of a motor-driven movable rack system 3 will be described with reference to Figs. 10 and 11. Referring to Fig. 10, the motor-driven movable rack system 3 is connected, via an adapter 2, to a terminal equipment 1 provided at a manufacturer's or dealer's site (called the "remote terminal equipment 1" hereinafter). A variety of data can be exchanged between the movable rack system 3 and the remote terminal equipment 1, using a telephone network.

The movable rack system 3 includes a plurality of well-known movable racks that are juxtaposed and actuated by a motor. In response to a command signal, movable racks are moved in order to form a working space therebetween, and load

and unload objects.

A communication controller 4 stores general data on the movable rack system 3, and a variety of data concerning problems, history of problems and so on. These data are transferred to the remote terminal equipment 1 via the telephone network.

The remote terminal equipment 1 includes a data processing unit 5 and a monitor 6 which displays a variety of received data. The maintenance person and so on can understand how the movable rack system 3 is controlled, on the basis of the control data from the communication controller 4. Then a verbal communication is established between a user's telephone set 8 and a telephone set 7 at the remote terminal equipment 1, which enables the user to inform the maintenance person of a problem or an operating state of the movable rack system 3, and the maintenance person to advise how to cope with the current problem. Further, the maintenance person can analyze the informed operating state, predict a probable problem, and instruct the user how to deal with the current state before such a problem occurs.

Fig. 11 shows hardware constituting the movable rack system in order to clearly indicate the concept shown in Fig. 10. The remote terminal equipment 1 includes a personal computer 5 as a data processing unit, a printer 9 connected to the personal computer 5, and a modem 10 for transmitting and receiving data signals via the telephone network. The personal computer 5 also includes the monitor 6 (shown in Fig. 10), and constitutes a monitoring unit together with a printer 9.

Referring to Fig. 11, the user has a plurality of blocks of the movable rack system 3. Each block of the movable rack system 3 is controlled as a unit, and a vacant space is formed between movable racks in each block. A dedicated communication module 15 is provided for each block of the movable rack system 3. Therefore, a plurality of communication modules 15 are connected to the communication controller 4 via a communication network. The data stored in the communication controller 4 are transmitted to the remote terminal equipment 1 via the modem

11 and the telephone network. The communication modules 15, communication controller 4 and modem 11 constitute an adapter 2 at the user's site.

A preferred embodiment of the invention will be described with reference to Figs. 1 to 9.

The embodiment shown in Fig. 1 is constituted by a movable rack control system 30, a movable rack maintenance telecommunication system 40 (called the "maintenance telecommunication system 40"), and a network system 50.

The movable rack control system 30 includes a motor-driven movable rack system 3 which is composed of a plurality of motor-driven movable racks 32 and stationary racks 31. In response to a command signal for forming a working space between certain movable racks or other command signals, the movable rack system 3 is operated under control of a control unit.

In the embodiment shown in Fig. 1, a fork-lift truck 35 is used in order to load or unload objects onto or from a movable rack. A radio terminal 36 is operated on the fork-lift truck 35 in order to transmit various command signals using a radio communication.

The maintenance telecommunication system 40 includes the monitoring unit described with reference to Figs. 10 and 11, uses a radio telephone network, and also has a data unit 41, a radio telephone set 42, a radio repeater 43, a personal computer 5, and a monitor 6.

The movable rack control system 30 transfers data to the data unit 41. The data are then transferred to the personal computer 5 via the radio telephone 42 such as a personal handy phone (PHS) or a portable digital phone that can transmit digital data, the radio repeater 43 and an ordinary telephone network. The personal computer 5 and monitor 6 constitute the monitoring unit.

The fork lift truck 35 is provided with a terminal 37 for a radio LAN (Local Area Network). The terminal 37 transmits and receives data to and from a terminal processor 51 in the network system 50. The network system 50 comprises the terminal

processor 51 (e.g. a personal computer), and a central processing unit 52 (e.g. a personal computer) connected to the terminal processor 51 via a telephone network.

The terminal processor 51 and the movable rack control system 30 are usually installed in a warehouse 20. The network system 50 is mainly applied to inventory control of objects stored in the warehouse 20.

Fig. 2 shows a specific example of the movable rack control system 30 and the maintenance telecommunication system 40. In this example, an ordinary telephone network is utilized. The movable rack control system 30 comprises a plurality of blocks of motor-driven movable rack systems 3. Each block includes a plurality of movable racks 31, 32, 33, arranged side by side. Each movable rack 31 is provided with a main control panel 21, and is called the "main movable rack". The remaining movable racks 32, 33 and so on in each block are called the "sub-movable racks".

Each of the movable racks 31, 32, 33, ... has a control module constituted by a circuit board, which controls the operation of each movable rack. The main movable racks 31 respectively include communication modules 15, which constitute a communication network. The communication network is connected to the communication controller 4 in the adapter 2 shown in Figs. 10 and 11. The communication controller 4 collects and stores general data on the movable rack systems 3, control data, trouble data, and so on.

These data are transferred to the remote terminal equipment 1 via the telephone network. In other words, the adapter 2 transmits the control data of the movable rack systems 3 to the remote terminal equipment 1 via the telephone network.

The remote terminal equipment 1 constitutes the monitoring unit including the personal computer 5, monitor 6 and printer 9, as shown in Fig. 11. The remote terminal equipment 1 and the adapter 2 have telephone sets 7 and 8, respectively. The main movable racks 31 may be motor-driven racks, or stationary racks as shown in Fig. 1.

The movable racks constituting the movable rack system are controlled by control systems configured as shown in Fig. 3. Each main movable rack 31 has a main control panel 21 and a decentralized control panel 25. Each of the sub-movable rack 32, 33, ... is provided with a decentralized control panel 25. The main control panel 21 has a main control unit 24 (i.e. a CPU or a micro-processor), a monitor 14 realized by a liquid crystal display or the like, and a CNV module 15 as an interface.

An AC power is supplied to the main control unit 24 from a power source via a circuit breaker and a power switch, and is then supplied to the decentralized control panels 25 via a power relay contact which is opened or closed by the main control unit 24.

The main control panel 21 receives signals from various switches and sensors such as a gangway switch, a stop sensor, an advance confirming sensor, and a safety bar switch, and is connected with an illumination light, a light indicating the operation of movable racks, a reset switch, and the power switch.

Each decentralized control panel 25 includes, as a main component, a control module 22 constituted by a CPU or a micro-processor, receives signals from switches and sensors such as a gangway switch, a stop sensor, an advance confirming sensor and a safety bar switch, and is connected with the illumination light, a motor, an emergency stop switch and so on. Further, each decentralized control panel 25 is connected to the main control unit 24 via the CNV module 15.

Fig. 4 shows an example of the maintenance telecommunication system 40. Each main movable rack 31 includes the main control unit 24 and the monitor 14, which are connected via an adapter 18. The main control unit 24 and monitor 14 constitutes a monitoring unit for the movable rack system. The monitor 14 displays various data supplied by the main control unit 24 via the adapter 18.

Watching the monitor 14, the maintenance person can recognize how the movable racks are being controlled. Various

data from the main control unit 24 are also transferred to the personal computer 5 via the adapter 18, data unit 41, radio telephone 42 such as a PHS or a portable digital phone, the repeater 43 and the modem 10. The data unit 41 and radio telephone 42 are used to transmit the control data of the movable racks to the personal computer 5.

The control data arriving from the data unit 41 via the radio telephone 42 are inputted into the personal computer 5 via the repeater 43, telephone network and modem 10. In the maintenance center, the maintenance personnel watches the control data displayed on the monitor 6, and understands the situation of the movable rack system at the remote location. The control data also contain information concerning abnormal states of the movable rack system. Therefore, the maintenance person watches the monitoring unit (including the personal computer 5), and can know problems occurring in the movable rack system.

If there is a problem in the movable rack system, the maintenance person gives appropriate instructions to the user using a two-way communication function or using a suitable telephone network. When the two-way communication function is provided, the personal computer 5 can send a control signal to the movable rack system using the telephone network.

The movable rack system operates in modes shown in Figs. 5 to 7. Fig. 5 shows an automatic reporting mode (called "the mode 1") when there is trouble in the movable rack system; Fig. 6 shows a data collecting mode (called "the mode 2"); and Fig. 7 shows a data updating mode (called "the mode 3"). In these drawing figures, "M terminal" denotes a terminal equipment installed at the manufacturer or dealer of the movable rack system. "U adapter" denotes the adapter 2 at the user's site. "AEX system" denotes the control system of the motor-driven movable rack system 3.

First of all, the mode 1 will be described with reference to Fig. 5. In the movable rack system 3, particular movable racks are moved and stopped in accordance with a specific

command signal. In this state, operation status signals indicative of a current operation state of movable racks, an operation mode and so on are transmitted to the adapter 2, so that a status of the movable rack system 3 is monitored. Once the operation status data are recognized to contain abnormal data indicating a problem in the movable rack system 3, internal data of the movable rack system 3 are temporarily stored in the main control panel 21 of the adapter 2.

The foregoing abnormal data cover the following: a signal indicative of the operation of the safety bar switch; a signal indicative of issuance of a double command; a signal indicative of abnormal torque; and an abnormal timer signal indicating that a specified working space is not formed within a predetermined period of time after the issuance of a space forming command.

The adapter 2 is connected to the remote terminal equipment 1 via the telephone network. The stored data are transferred to the personal computer 5 in the remote terminal equipment 1. Then the adapter 2 is disconnected from the telephone network. The transferred data are displayed on the monitor 6, and will be reviewed by the maintenance person who analyzes the control status of the movable rack system 3. The maintenance person then instructs the user on how to solve the problem using the two-way communication or using a different telephone line. Following the instructions, the user can solve the problem.

In the mode 2 shown in Fig. 6, the remote terminal equipment 1 connects to the movable rack system 3 via the telephone network, and requests the latter to send data. In response to the request, the user's adapter 2 causes the movable rack system 3 to further output the internal data, collects and temporarily stores the data, and provides them to the remote terminal equipment 1. Receiving the data, the remote terminal equipment 1 disconnects itself from the telephone network, and displays them on the monitor 6. The maintenance person analyzes the displayed data, reviews the necessity of maintenance work, and studies how to maintain the movable rack system 3. Once

a maintenance method is determined, the maintenance person communicates with the user using the two-communication function or via another telephone network, thereby helping the user maintain the movable rack system 3.

In the mode 3 shown in Fig. 7, the existing data of the movable rack system 3 to be monitored are updated if necessary. The data mainly comprise: the number of movable racks; the number of gangways between the movable racks; and parameters related to a timer limit, an acceleration rate, a deceleration rate, and starting torque. When a plurality of blocks of the movable rack system 3 are provided, data of a desired block of the movable rack system 3 can be updated.

First of all, data to be updated are input at the remote terminal equipment 1, and are then transferred to the user's adapter 2 via the telephone network. The telephone network will be disconnected after the data transfer. At the adapter 2, the received data are over-written on the existing data. As a result, the data stored in the movable rack system 3 are updated. Thereafter, the movable rack system 3 will be operated on the basis of the updated data.

In the example shown in Figs. 5 to 7, trouble shooting, request for data, and updating of the data are performed in an off-line mode while only data transfer is performed using the telephone network. Alternatively, the data request and updating of the data can be performed with the telephone network connected. If necessary, the movable rack system 3 may be in continuous connection with the telephone network.

Fig. 8 specifically shows data which are processed by the remote terminal equipment 1 at the manufacture's or dealer's premises. They are general data, trouble data, operation parameters, trouble history data, torque information data, movable rack control data, and operation status data. The general data include date/time, block addresses, the number of movable racks, a version of current software, a total power supplying time, the number of operations of the movable rack system, a total value of back light illumination time. The

truck control data include received and transmitted data.

The trouble data represent details of alarms or problems, and include block numbers of the movable rack system, kinds or types of alarms or errors, and an identification number of each movable rack in each block.

The trouble history data represent history of problems occurring in each block of movable racks, and include dates, a kind of an error, and the identification code of each movable rack.

The torque data represent loads applied to each movable rack.

The foregoing data are respectively transferred and displayed in the modes 1, 2 and 3 in different manners. As shown in Fig. 8, the trouble data are transferred and displayed only in the mode 1. The operation parameters are transferred and displayed in all of the modes 1, 2 and 3. The remaining data are transferred and displayed in the modes 1 and 2.

Fig. 9 shows how the foregoing data of Fig. 8 are displayed on the monitor. However, any data can be displayed as desired, and are not limited to those shown in Figs. 8 and 9. No detailed description will be made on Fig. 9.

When the movable rack system is provided with the two-way communication function, and if there is any problem in the movable rack system 3, it is more preferable that the remote terminal equipment 1 transmits the data to the movable rack system 3 and controls the movable rack system 3 on the basis of data returned therefrom. In such a case, the remote terminal equipment 1 performs the control operation in order to overcome the problem.

In the foregoing embodiment, the monitoring unit is installed at the manufacturer's or dealer's site in order to know how the movable rack system 3 is controlled by the control unit thereof, on the basis of control status data received via the telephone network. Therefore, the maintenance person can quickly solve problems or overcome inconvenience in the movable rack system 3 without coming to the user's site. If necessary,

the remote terminal equipment 1 sends control signals to the movable rack system 3 in order to update existing parameters thereof.

Further, if a radio telephone system is used in place of the telephone network, the maintenance person can know controlled status of the movable rack system 3 using a digital radio telephone such as a PHS. This arrangement enables the movable rack system 3 to be connected with the remote terminal equipment 1 at a reduced cost, without using an additional telephone line.

As shown in Fig. 4, the monitoring unit including the main control unit 24, monitor 14 and so on is also provided at the user's site so that the user can observe the controlled status of the movable rack system 3. Therefore, if there is any problem in the movable rack system 3, the user can identify a kind of the problem, and cope with it without the maintenance person's assistance. Further, in such a case, the user observes indications on the monitoring unit and copes with the problem while communicating, via the telephone network, with the maintenance person who is observing indications on the monitoring unit and instructing the user how to deal with the problem. In addition, the maintenance person dispatched to the user's site observes the monitoring unit, and copes with the problem quickly and appropriately.

WHAT IS CLAIMED IS:

1. A motor-driven movable rack system comprising: a plurality of motor-driven movable racks arranged side by side at a user's site; a control section for controlling the movement of the movable racks and forming between desired movable racks a working space necessary for loading or unloading objects; and a monitoring unit installed at a remote place and collecting, via a telephone network, data on operating status of the movable racks that are under control of the control section.
2. The movable rack system according to claim 1, wherein the telephone network is a radio telephone network.
3. The movable rack system according to claim 1, further comprising, at the user's site, a transmitter for transmitting control data of the movable racks via the telephone network, and another monitoring unit attached to the movable racks for the purpose of collecting the control data of the movable racks.
4. The movable rack system according to claim 1 or 3, wherein the control data from the transmitter contain data concerning abnormal states of the movable racks, which are received by the monitoring unit at the remote place for the purpose of identifying problems in the movable rack system.
5. The movable rack system according to claim 1, wherein the monitoring unit at the remote place includes a terminal unit for transmitting control signals to the movable rack system via the telephone network.