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"REMOTE MONITOR AND DIAGNOSIS APPARATUS"

1 The present invention provides a remote monitor
and diagnosis apparatus for elevator or the like, which
continuously monitors the running history and the running
state of a plurality of elevators, escalators or the
5 like, which, upon detection of an abnormality, analyzes
the cause of the abnormality and directs restoration work
at the maintenance center of the elevators or the like,
and which performs suitable preventive maintenance on
the basis of the running history and the running state.

10 A conventional system for elevator or the
like has such configuration that a maintenance center is
informed about an abnormality when it has been detected
on the basis of continuously monitoring the running
state of the elevator or the like. Therefore, the
15 time taken until the detection of an abnormality can
be shortened. However, work such as abnormality cause
analysis and restoration from the abnormality is not
started till a maintenance man goes to the spot where the
elevator or the like is installed. An example of such
20 prior art is described in JP-B-63-20749.

In a configuration proposed as that taking a
step forward, the running state at the time when an
abnormality is detected is taken in to make a diagnosis
of a failure location and a maintenance directive corre-
25 sponding to this failure is outputted as described in

1 JP-A-59-22869 and U.S. Patent No.4,622,538.

In such prior art, when an abnormal situation occurs in an elevator or the like, the maintenance center makes a diagnosis of cause location of this
5 abnormal situation and indicates the failure location and the repair location in order to cope with this situation. At such a stage that any failure does not occur in an elevator or the like, therefore, any preventive action is not taken. It is thus difficult
10 to prevent occurrence of a failure or a trouble due to aged deterioration.

In view of the above described prior art, the present invention has been made. An object of the present invention is to provide a remote monitor and
15 diagnosis apparatus of elevator or the like capable of preventing a situation resulting in running stop or at least removing a primary factor causing a serious failure by always monitoring age-based running history and current running state of elevators or the like, in
20 addition to the conventional function of judging a failure location and generating a maintenance command at the maintenance center upon occurrence of a failure in an elevator or the like, by monitoring an omen of occurrence of a failure before a failure occurs in an elevator
25 as a concrete phenomenon, and by preventing occurrence of a failure in advance as quickly as possible.

Another object of the present invention is to provide an apparatus which, even when an abnormality

1 in an elevator or the like is detected, gives consideration to not only abnormality detection terms of the elevator or the like but also the running state of the elevator or the like, which has emitted an informing
5 trigger, and the running history up to occurrence of an abnormality and judges the failure cause more precisely and directs restoration work rapidly at the maintenance center on the basis of monitor and diagnosis program.

In order to achieve the above described object,
10 in accordance with the present invention, an elevator unit or the like comprises an elevator or the like and a monitor terminal for monitoring a control unit of the elevator or the like; a general apparatus comprises a plurality of elevator units or the like
15 thus configured and a maintenance center for remotely monitoring those elevator units or the like; the monitor terminal unit is so configured as to output to the maintenance center the running history and the running state obtained by monitoring the elevator or the like
20 and the control unit as well as an informing trigger upon detection of an abnormal situation; on the other hand, the maintenance center has a monitor and diagnosis program for receiving the running history, the running state and the informing trigger from the monitor terminal
25 unit and for monitoring and making a diagnosis upon the elevator unit or the like; a failure diagnosis is made by this monitor and diagnosis program when the informing trigger is outputted; and necessary preventive maintenance

1 can be performed on the basis of analysis of the
running history and the running state.

The present invention will be apparent from
the following detailed description taken in conjunction
5 with the accompanying drawings, in which:

Fig. 1 is a whole configuration diagram showing
an embodiment of the present invention;

Fig. 2 is the detailed block configuration
diagram of a monitor terminal unit shown in Fig. 1;

10 Fig. 3 is the detailed block configuration
diagram of a maintenance center similarly shown in
Fig. 1; and

Fig. 4 is a flow chart of monitor and
diagnosis program used in the maintenance center.

15 The present invention will hereafter be
described by referring to an illustrated preferred embodi-
ment. In this embodiment, the present invention will
be described by taking an elevator as an example of
the elevator or the like.

20 Fig. 1 shows a whole configuration diagram of
a remote monitor and diagnosis apparatus for elevator
according to the present invention. Monitor terminal
units 10, 11 and 12 respectively included in a plurality
of elevator units 21, 22 and 23 are connected to a
25 maintenance center 20 via telephone lines 1c. For
each of the monitor terminal units 10, 11 and 12, one
or more elevator control units 30 and 31 as well as
and an elevator controlled thereby are disposed. For

1 brevity, only an elevator connected to the elevator
control unit 30 is illustrated and its configuration
will be roughly described. A cage 1 of the elevator
and a counterweight 2 are hung on a sheave 4 via a
5 rope 3 in a well-bucket form. A brake device 5, a motor
M and a tachometer generator G are attached to the axis
of the sheave 4 via reduction gears. The rotation
direction and speed of the motor M are controlled by
the output of a power control unit 9 having a thyristor
10 control device and a disconnecter to control power
supplied from three-phase AC power supply. The thyristor
included in the power control unit 9 is controlled by
the output of a speed control circuit 8 supplied with the
output of the tachometer generator G and the output of
15 a microcomputer 6. Control signals of the power
control unit 9 comprise signals fed from various safety
devices installed in the elevator and a signal fed
from a safety circuit 7 supplied with a signal fed
from the microcomputer 6. The power control unit 9
20 controls the traveling direction of the elevator and
the brake device 5. Cage information supplied via a
traveling cable connected to the cage 1, information
regarding the elevator hall, information fed from the
tachometer generator G, and information SS fed from the
25 safety device are inputted to the microcomputer 6,
which controls the elevator by using such information.

Further, interphones 40 and 41 disposed in
the elevator cage 1 are connected to the monitor terminal

1 unit 10. The monitor terminal unit 10 is connected to
the elevator control units 30-31 by an elevator communi-
cation signal line 1a of common line type electrically
isolated via a pulse transformer PT. Electrical
5 isolation using this pulse transformer prevents failure
of any unit connected to the elevator communication
signal line 1a from affecting other units. Further, by
using this elevator communication signal line 1a, the
monitor terminal unit 10 can periodically take in the
10 internal operation states of the elevator control
units 30-31. To be concrete, necessary data can be
taken in by configuring a transmission control circuit
connected from the monitor terminal unit 10 to a bus
line of the elevator control unit so that the trans-
15 mission control circuit may periodically send out the
elevator control state.

Further, interphones 40-41 for elevator cage
are used for performing voice talk between the inside
of the elevator cage 1 and the maintenance center 20
20 via the telephone line 1c. The interphones 40 and 41
are also connected to the monitor terminal unit 10
via an interphone signal line 1b of common line type
electrically isolated by a line transformer LT. The
monitor terminal device 10 monitors the operation state
25 of the elevator control unit 30. Upon detecting an
abnormality, the monitor terminal unit 10 transmits
the abnormality of the elevator control unit 30 to the
maintenance center 20 via the telephone line 1c as the

1 informing trigger. In addition to transmission of
this informing trigger, the same telephone line can be
used in a time division scheme, in response to a talk
request fed from an interphone, for talk between the
5 inside of the elevator cage 1 and a head set installed
in the maintenance center 20 as described later.

Fig. 2 is a detailed block configuration
diagram showing the internal configuration of the
monitor terminal unit 10. The monitor terminal unit
10 10 comprises an elevator control unit communication
circuit 101, a data control circuit 100, a memory
circuit 102, a data modem circuit 103, a telephone line
network control circuit 104 and an interphone control
circuit 105. The data control circuit 100 comprises a
15 microcomputer and controls operation of the whole
monitor terminal unit 10. Under the control of the data
control circuit 100, the elevator control unit communi-
cation circuit 101 is activated to periodically take
in the operation state of the elevator control unit 30
20 via the elevator communication signal line 1a. Data
items taken in comprise the traveling direction of
the cage 1, input such as pushbutton input for causing
this operation, the operation command of the control
circuit responsive to this input, the response, the
25 start time of its actual operation, elapsed time and
the response state responsive to the manipulation input.
The memory circuit 102 stores therein past and current
age-based running state of the elevator control unit 10

1 as the running history and stores the current state in
operation as the running state. The data modem circuit
103 modulates the informing trigger outputted by the
elevator control unit 30 upon occurrence of an abnormality
5 as well as information regarding the current running
state and the past running history into analog data or
demodulates signals fed from the maintenance center 20.
Thus the data modem circuit 103 is a communication
circuit for interchanging signals over the telephone
10 line network 1c as signals belonging to the same
frequency band as that of voice signals. The telephone
line network control circuit 104 connects the monitor
terminal unit 10 to the telephone line network 1c and
controls transmission/reception of a telephone call.
15 The interphone control circuit 105 connects the inter-
phones 40-41 installed within the elevator cage to the
monitor terminal unit 10. Data indicating the running
history and the running state stored in the memory
circuit 102 are periodically transmitted from this
20 monitor terminal unit 10 toward the maintenance center
20. When the informing trigger is generated as a result
of detection of an elevator control abnormality by the
monitor terminal unit 10, the data indicating the running
history and the running state may be transmitted to the
25 maintenance center together with this informing
trigger.

Fig. 3 shows the configuration of the maintenance center 20. This maintenance center 20 comprises

1 an information processing circuit 200, a data modem
circuit 201, a telephone line network control circuit
202, a large-capacity data base circuit 203, a terminal
204 with display, a printer 205, a talk circuit 206
5 and a head set 207. The information processing circuit
200 comprising a minicomputer or a work station
analyzes data such as the running history, the running
state and the informing trigger transmitted from the
elevator control units 30-31 via the monitor terminal
10 units 10-12. Thus the information processing circuit
200 makes a failure diagnosis to find the abnormality
cause, predicts an abnormality, and makes a diagnosis
for preventive maintenance with respect to the
abnormality thus predicted. Further, the information
15 processing circuit 200 performs man-machine control
upon the display 204 and the printer 205 of the mainte-
nance center 20. The data modem circuit 201 performs
mutual conversion between digital data and analog data
by using the same scheme as that of data modulation and
20 demodulation performed in the monitor terminal units
10-12. In the same way as the telephone line network
control circuit 104 of each of the monitor terminal
units 10-20, the telephone line network control circuit
202 controls transmission/reception of a telephone
25 call between the maintenance center 20 and the telephone
line 1c. The talk circuit 206 is a control circuit
within the maintenance center for performing voice talk
with respect to the interphones 40-41 installed in the

1 elevator cage 1. The head set 207 is connected to the
talk circuit 206. An operator in the maintenance
center can talk with the interphones 40-41 installed
in the elevator cage 1 while manipulating the terminal
5 204 with display and the printer 205. The large-capacity
data base circuit 203 is an external storage device
which stores therein a remote diagnosis program file
for judging the running history and the running state
of each of the elevator control units 30 and 31 and for
10 making a remote diagnosis to find the cause of the
abnormality wherefore the informing trigger has been
outputted. That external storage device stores therein
running history, running state record, informing trigger
record, a failure history file and a maintenance command
15 file of each of the elevator control units 30 and 31 as
well.

Further, in the terminal with display, arbitrary
contents of the large-capacity data base circuit 203
and the processing progress in the information processing
20 circuit 200 can be printed on the printer 205 and indicated
on the display as occasion demands. In the terminal with
display, necessary control input can be performed.

Operation performed by the apparatus of this
embodiment will now be described.

25 In order to monitor the running state of the
elevator control units 30-31, the monitor terminal units
10, 11 and 12 periodically read out data of running
state. As a result, running state signals of confinement,

1 the start device system, the safety device system, the
power supply system and the door system of the elevator
control units 30 and 31 are detected by various
sensors and switches. These running state signals
5 are stored in the memory circuit 102 as running history
for respective systems. These running history and
running state are periodically outputted to the maintenance
center and stored into the large-capacity data base 203.
When the monitor terminal unit 10-20 detects an abnormality
10 of a specific elevator control unit, the monitor terminal
unit 10 corresponding to that elevator control unit
outputs an informing trigger indicating the abnormality.
In addition, that monitor terminal unit 10 outputs the
running history, which has not been transmitted yet at
15 that stage, and the running state which has been judged
abnormal.

Upon receiving them, the maintenance center
20 reads out the remote diagnosis program, which is
based upon the configuration of the elevator control
unit, the operation flow and empirical law of maintenance,
20 from the large-capacity data base circuit 203 on
the basis of the running history obtained until then and
transmitted from the monitor terminal units 10 to 12
as well as the current running state which has resulted
25 in the abnormal situation. The maintenance center 10
then puts the remote diagnosis program into operation,
analyzes the cause of occurrence of the failure,
generates a maintenance command corresponding to that

1 cause, and display the maintenance command together with
indication of the failure location on the display 204
or prints them on the printer 205 as occasion demands.

By referring to a flow chart shown in Fig. 4,
5 the case where a door failure occurs and the monitor
terminal unit 10-12 judges the situation abnormal and
outputs an informing trigger will now be described
as an example.

In case it is judged that a confinement state
10 has been caused due to a door failure (step 400), i.e.,
in case the door is closed but the cage is not started,
or in case the cage has moved to a desired floor with
the door closed once and thereafter the door does not
open (so-called confinement state), a call is originated
15 from the maintenance center 20 to the interphones 40-41
installed in the cage 1 and rescue dispatch is performed
(step 405). Here, the monitor and diagnosis program
advances analysis processing along steps on the basis
of the past running history and the running state obtained
20 when the abnormality has occurred. For example, the
control state obtained when a passenger in the cage 1
operates a door opening button or a door closing button is
judged. That is to say, it is judged whether the door
open/close command output is present or not irrespective
25 of the button operation (step 410). If the closing
command is not outputted here, judgment of the control
system is begun (step 415). In the state judgment of
the control system, it is first judged whether an

1 abnormality exists in the microcomputer 6 included in
the elevator control unit 30 or in the door drive system.
If the control system is judged abnormal, the safety
device is checked (step 425) and the result of its
5 analysis is outputted. If it is judged that the control
system is normal (i.e., the door drive system is
abnormal), the door drive system is checked (step 430)
and the result of its analysis is outputted. If the
door does not move in spite of the door opening command
10 at step 410, it is judged whether mechanical lock
is present or not (step 420). If it is judged that the
lock is not mechanical, items such as electrical
insufficiency, fusing and motor fault are checked and
analyzed (step 440). If it is judged that the lock
15 is mechanical, check on surrounding of the door
including check on abnormality of link coupling device
and check on alien substance nipped by the door as well
as the result of the analysis are outputted. It
is a matter of course that besides the running state
20 directly appearing as phenomenon at that time, running
history such as the fact that the door which had
not closed once restored to the normal state by automatic
execution of door closing control is used for judgment
of a failure location at each of the steps heretofore
25 described. On the basis of the running history resulting
in abnormality detection by the elevator control units
30 and 31 and the concrete operation state of the
elevator at the time of detection, a diagnosis is thus

1 made to know what state the elevator assumes when the
elevator is judged abnormal. A diagnosis for checking
whether the stop position of the elevator is largely
shifted from the prescribed cage stop position or not
5 or whether the door is closed or not is advanced in
accordance with procedure of a flow chart as exempli-
fied in Fig. 4. Suitable restoration directive is given
to the maintenance man dispatched for restoration
from the abnormality.

10 Further, by making a self-diagnosis of a
failure of the elevator control units 30 and 31, the
failure location such as the elevator control relay,
the power supply unit, the microcomputer within the
elevator control unit, or the communication line can
15 be concretely specified. At the same time, the failure
generating mechanism can be presumed. Thereby components
for substitution and measuring instruments required
for restoration from abnormality can be concretely
specified.

20 Further, in this embodiment, the running
history and the running state of each elevator are
periodically transmitted from the monitor terminal units
10, 11 and 12 to the maintenance center 20. Before
abnormal situation occurs and an informing trigger
25 is issued, therefore, it is possible to precisely grasp
the wear and decline of each constituent device caused
by age-based changes and generate commands for preventive
maintenance.

1 Data adopted as examples of study items for preventive maintenance and items of preventive maintenance obtained by analyzing those data are as follows.

- 5 ① The number of times of stop at each floor classified by up/down movement:

 Grasping frequency of use by passengers

 Directing the floor whereon devices of door system should be inspected with priority.

- 10 ② The number of times of excess of time required for each of opening/closing operation *:

 Detecting a failure sign of a door-system device

- 15 ③ The number of times of detection of shock caused by each of opening/closing operation *:

 Detecting a failure sign of a door-system device

- ④ The number of times and time of lighting of ceiling illumination:

20 Grasping the illumination substitution time

- ⑤ Landing control error data *:

 Detecting abnormality in control system/elongation of rope

- ⑥ Measurement of dynamic/static characteristics of elevator stop brake:

 Measuring abnormality of brake system

- 25 ⑦ Measurement of elevator up/down speed data:

 Detecting abnormality of control/drive system

1 (Data indicated * are stored into the failure history
file, whereas other data are stored into the running
history file.)

In case of the prior art, an abnormality
5 cannot be judged unless a maintenance man goes to the
spot where the elevator is installed when a failure has
occurred. However, the present invention makes it
possible to give precise and concrete instructions for
restoration work, before dispatch of a maintenance man
10 for restoration from the abnormality, on the basis
of the current running state and the running history
obtained until then. As a result, the maintenance
efficiency is improved, and the unavailable time of
elevators can be shortened. Further, before abnormal
15 situation occurs, preventive maintenance can be
performed with respect to portions, which tend to be
faulty due to age-based changes, on the basis of the
running history and the running state at that time.
Therefore, the probability of occurrence of abnormal
20 situation can be lowered and unavailable time of the
elevator can be further reduced. Periodical transmission
of the running history and the running state can be
performed by using the time of answer back with respect
to the operation confirming signal transmitted from the
25 maintenance center 20 to each of the monitor terminals
10, 11 and 12 once a day, for example, as commonly
performed in such remote monitor apparatuses.

By periodically transmitting the running history

1 and the running state of each elevator control unit
from the monitor terminal unit beforehand as in this
embodiment, preventive maintenance in advance can be
performed. In making a diagnosis of a failure as well,
5 the problem of transmission capacity of the telephone
line network and the hindrance caused by insufficient
memory capacity of the monitor terminal unit are also
mitigated.

As a matter of course, it is also possible
10 to adopt such a configuration that data of running
history and running states are transmitted when a
failure has occurred, depending upon the design of the
entire apparatus. It is also possible to consider the
entire past running history at that time in addition to
15 making a failure diagnosis.

In this embodiment, an elevator is taken as
an example of the elevator or the like. As a matter
of course, however, the present invention is not limited
to elevators; but is applicable to escalators or the
20 like requiring periodical maintenance and administration
in the same way as elevators.



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CLAIMS:-

1. A remote monitor and diagnosis apparatus comprising a plurality of elevator units or the like each including an elevator or the like, a control unit of said elevator or the like and a monitor terminal of said control unit, and comprising a maintenance center so connected to such a plurality of elevator units or the like as to remotely monitor said elevator unit or the like, characterized in that:

said monitor terminal unit outputs a running state and running history obtained by monitoring said elevator unit or the like and an informing trigger indicating an abnormal situation of said elevator unit or the like to said maintenance center; and

said maintenance center has a monitor and diagnosis program for receiving the running state, the running history and the informing trigger from said monitor terminal unit and for monitoring and making a diagnosis upon said elevator unit or the like.

2. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that data communication between said monitor terminal unit and said maintenance center is performed via an analog communication line.

3. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 2, characterized in that said analog communication line comprises a commercial telephone line.



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4. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said monitor terminal unit monitors a plurality of said control units of the elevators.

5. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said monitor terminal unit transmits said running state and running history to said maintenance center beforehand, and when said monitor terminal unit senses an abnormality of said elevator unit or the like and generates said informing trigger, a failure diagnosis is made upon said elevator unit on the basis of said running state and running history already transmitted to said maintenance center.

6. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 5, characterized in that said monitor terminal unit periodically transmits said running state and running history to said maintenance center at predetermined time intervals.

7. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said monitor terminal unit comprises memory means and senses said running history and running state to store them into said memory means, and when said monitor terminal unit senses an abnormality of said elevator unit or the like and transmits an informing



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trigger to said maintenance center, said monitor terminal unit transmits said running history and running state stored in said memory means to said maintenance center.

8. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said maintenance center makes a diagnosis of a failure of said elevator unit or the like and issues a predetermined maintenance command depending upon the failure diagnosis.

9. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 8, characterized in that upon input of said informing trigger, said maintenance center makes a diagnosis of the failure of said elevator unit or the like.

10. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 8, characterized in that said maintenance center makes a diagnosis of said inputted running history and running state, and issues a predetermined maintenance command depending upon said running history and running state.

11. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said elevator or the like comprises a talk unit, said maintenance center also comprises a talk unit, and talk between said elevator or the like and said maintenance center via both talk units is possible.



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12. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said maintenance center comprises printing means, which is capable of arbitrarily or periodically printing the running history and running state of an arbitrary elevator or the like.

13. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 13, characterized in that said maintenance center comprises a display device, which is capable of arbitrarily or periodically displaying the running history and running state of an arbitrary elevator or the like.

14. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 1, characterized in that said maintenance center comprises memory means, and the running history, the running state and informing trigger for each elevator or the like as well as contents of the failure diagnosis and maintenance command are recorded into said memory means.

15. A remote monitor and diagnosis apparatus for elevator unit or the like according to Claim 14, characterized in that remote diagnosis processing program for making a remote diagnosis of said running history, running state and informing trigger is incorporated into said memory means.

16. A remote monitor and diagnosis apparatus constructed substantially as herein described with reference to and as illustrated in the accompanying drawings.