(54) **Production management system and method of transmitting data**

(57) A production line such as an automobile assembling line includes a plurality of slave computers 18 for controlling (for instance) assembling robots RB in assembling stations ST, and a host computer 16. When common information required by the slave computers is to be modified, e.g. due to a change in the robots, common information stored in the host computer 16 (at 52h) is modified and transmitted to the slave computers.

As described, workpieces, eg car bodies W, carry identifying bar codes which are read to initiate the transmission of corresponding workstation command data from a store 50 of the host computer 16.

Also as described, the slave computers 18 add serial numbers to the data they receive. On subsequent transmission, the host computer 16 checks the serial numbers and requests the host computers 18 to transmit any missing data.
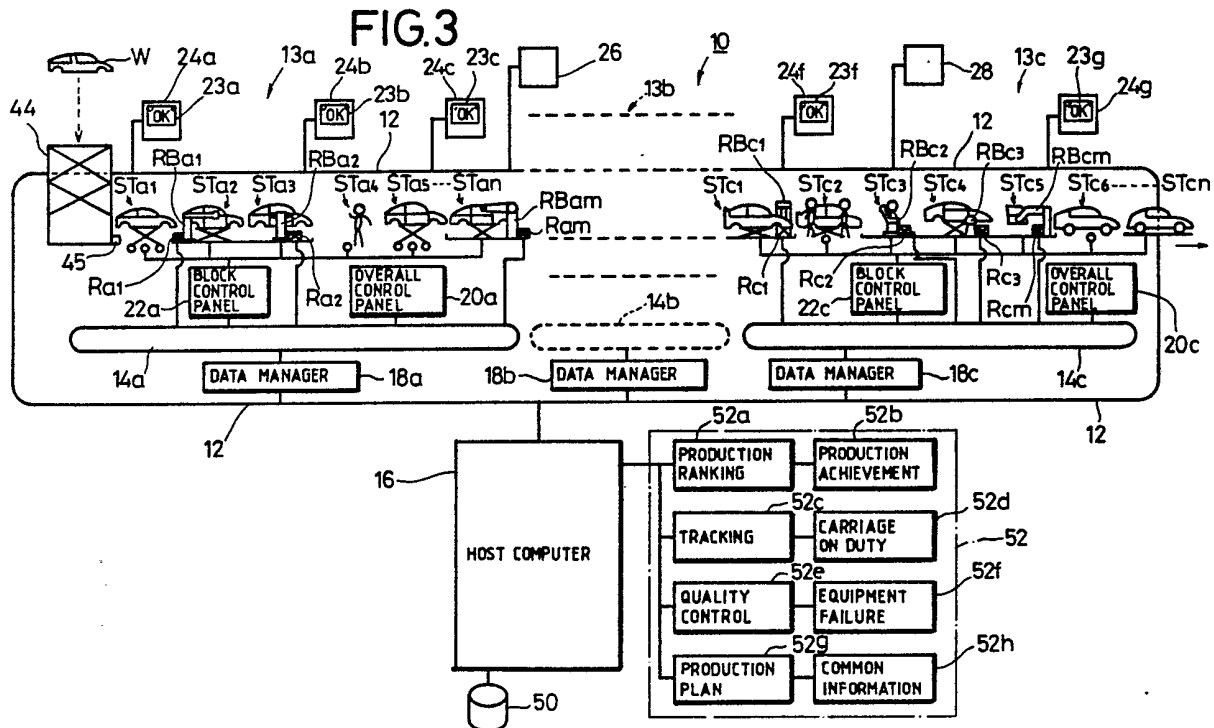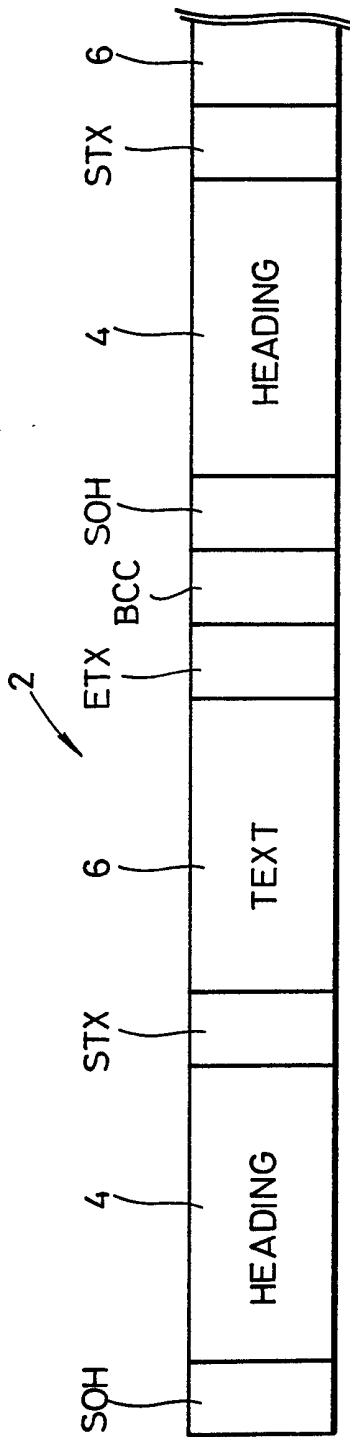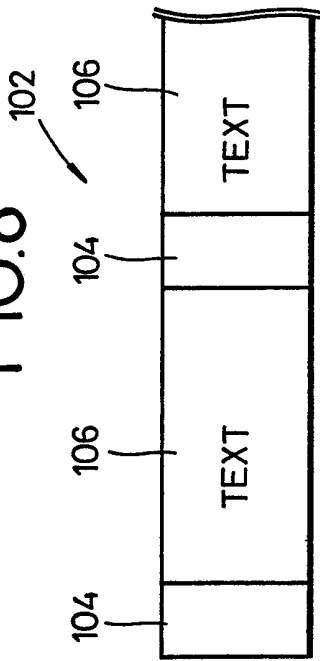
FIG.3

GB 2 239 325 A

FIG.1

SOH | HEADING `4` | STX | TEXT `6` | ETX | BCC | SOH | HEADING `4` | STX | `6`

`2`

FIG.8

`102`

`104` | TEXT `106` | `104` | TEXT `106`

FIG.2

FIG.3

Components shown in the diagram:

- W
- 44
- 45
- 24a, 23a
- OK
- RBa1
- STa1, STa2, STa3, STa4, STa5...STan
- 24b, 23b, 12
- OK
- RBa2
- 13a
- 24c, 23c
- OK
- 26
- 13b
- Ra2
- RBam, Ram
- 22a
- BLOCK CONTROL PANEL
- 20a
- OVERALL CONTROL PANEL
- 14a
- 18a
- DATA MANAGER
- 12
- 14b
- 18b
- DATA MANAGER
- 10

- 24f, 23f
- OK
- STc1, STc2, STc3, STc4, STc5, STc6...STcm...STcn
- Rc1
- RBc1
- Rc2, RBc2
- 28
- 13c
- 23g, 24g
- OK
- RBc3, RBcm
- Rc3, Rcm
- 22c
- BLOCK CONTROL PANEL
- 20c
- OVERALL CONTROL PANEL
- 14c
- 12
- 18c
- DATA MANAGER

- 16
- HOST COMPUTER
- 50

- 52
- 52a PRODUCTION RANKING
- 52b PRODUCTION ACHIEVEMENT
- 52c TRACKING
- 52d CARRIAGE ON DUTY
- 52e QUALITY CONTROL
- 52f EQUIPMENT FAILURE
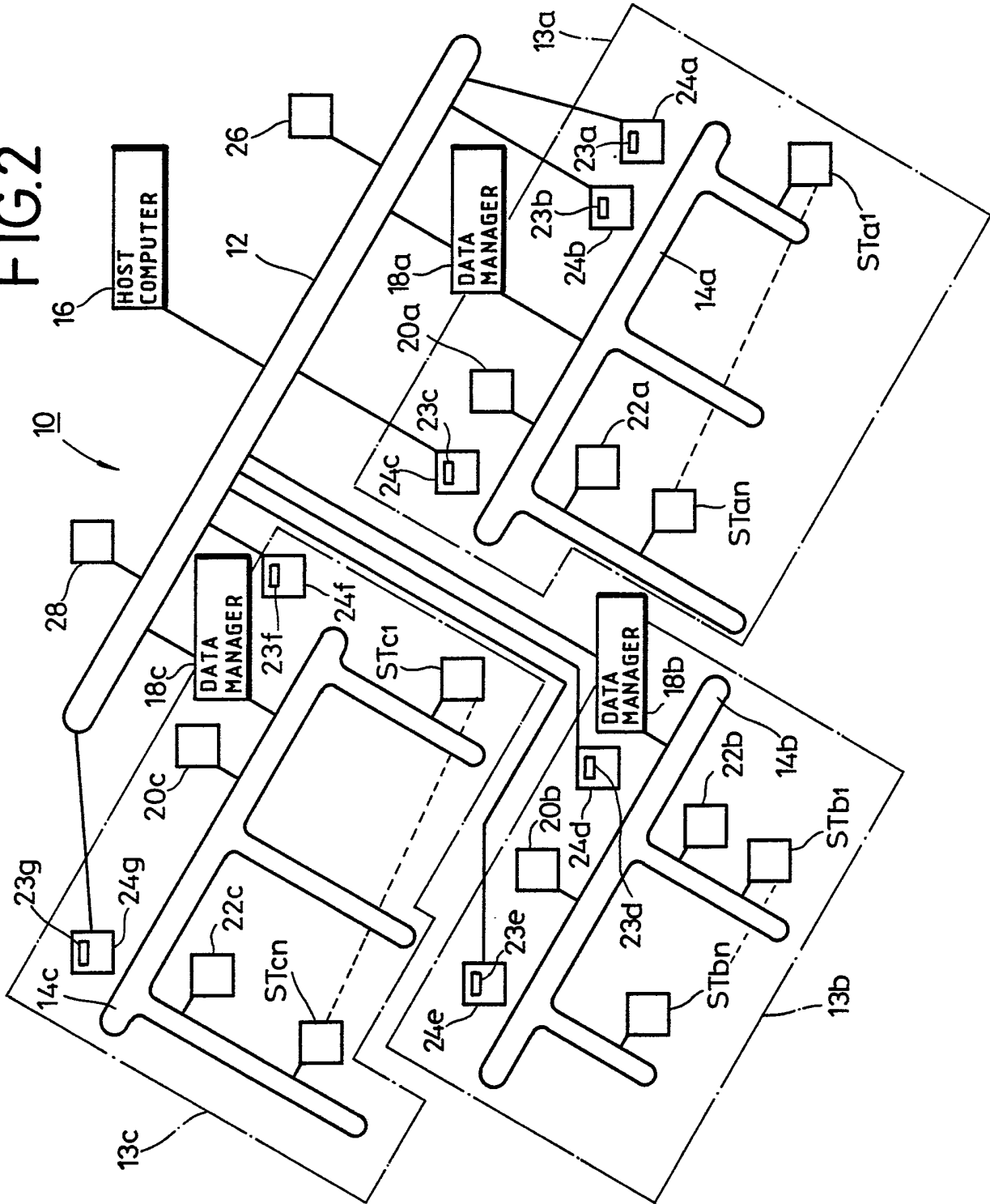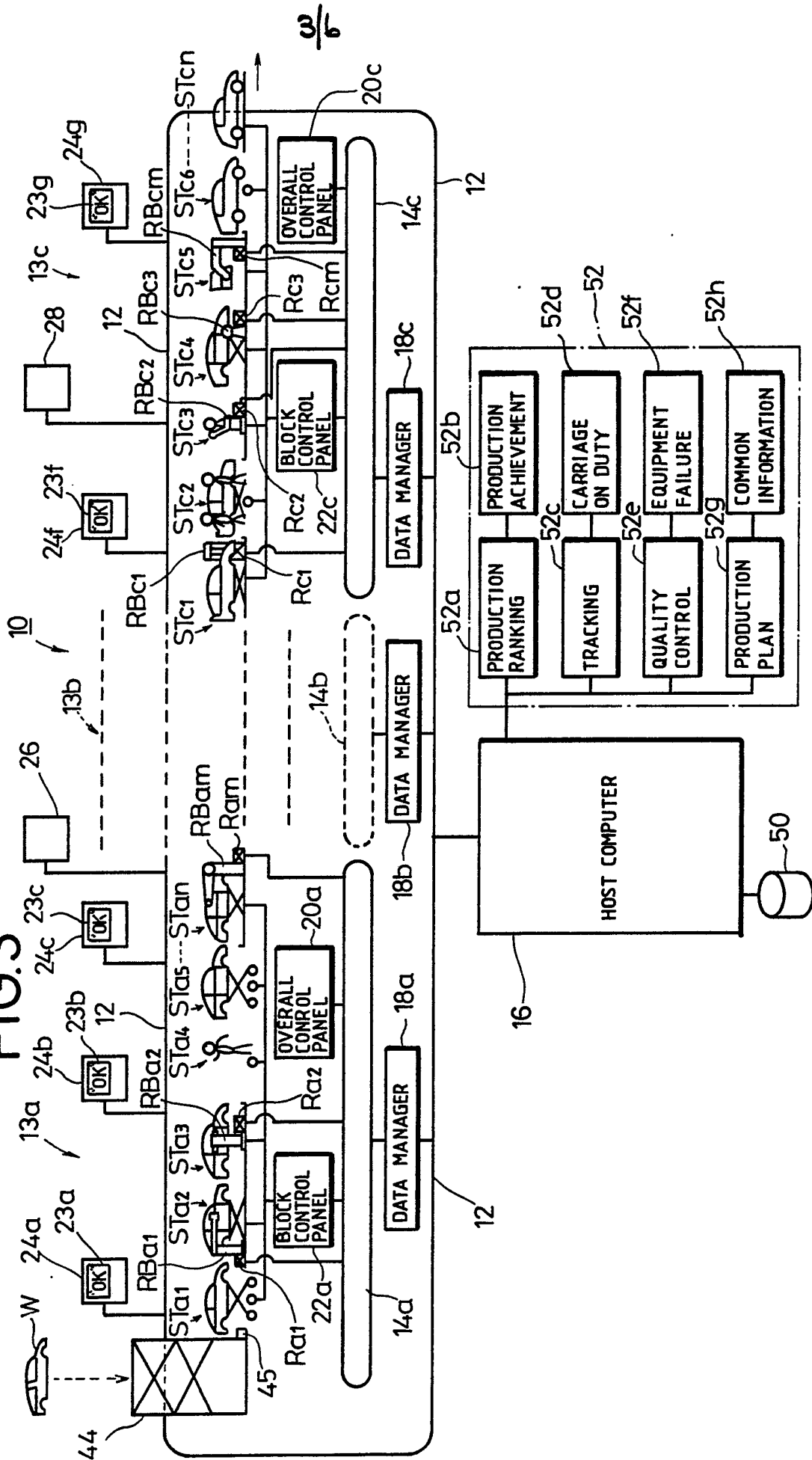- 52g PRODUCTION PLAN
- 52h COMMON INFORMATION

FIG.4

XE

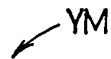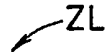| TYPE DATA XE	TYPE NUMBER INFORMATION α1A	SECONDARY INFORMATION α2B	OPTIONAL SPECIFICATIONS α3C	COLOR SPECIFICATIONS α4D
X	α11	α21	α31	α41
X	α11	α22	α31	α42
X	α12	α21	α32	α42
X	α12	α22	α31	α41

FIG.5

YM

TYPE DATA XE	OPERATION PATTERN DATA ZL
X1	Z1 : 1 0 0 0 1 0 0 0 1 · · · · · · 1 0 1 0
X2	Z2 : 0 0 1 0 0 0 0 0 1 · · · · · · 0 0 1 0
X3	Z3 : 1 0 0 1 0 0 0 1 1 · · · · · · 0 1 0 1
X4	Z4 : 1 0 1 0 0 0 0 0 1 · · · · · · 1 0 1 0

FIG.6

ZL

DP=D1	DP=D2	DP=D3	DP=D4
1000100010101001	1000100010000001	1100010100010101	1000100010001110

FIG.7

SERIAL NUMBER	TEXT						
A—1	CARRIAGE NUMBER						
A—2	TYPE DATA						
	ROBOT NUMBER	AXIS NUMBER	TIGHTENING TORQUE	TIGHTENING TIME	FRAME NUMBER	RESULT OF CHECK	
A—3	RBa_1	3	5.0	2	F-12	OK	
A—4	RBa_1	2	5.5	2	F-12	OK	
A—5	RBa_1	1	5.5	3	F-12	OK	
A—6	RBa_2	1	12.0	2	F-11	OK	
A—7	RBa_2	2	12.0	2	F-11	OK	
A—8	RBa_2	3	12.5	4	F-10	OK	
A—9	RBa_3	4	12.0	2	F-10	OK	
A—10	RBa_3	5	8.0	0	F-10	OK	

100

PRODUCTION MANAGEMENT SYSTEM

AND METHOD OF TRANSMITTING DATA

The present invention relates to a production management system and a method of transmitting data, for use with an automatic production line for manufacturing products such as automobiles, and more particularly to a production management system having a host computer for centralized management of common data required by slave computers which are associated with pieces of production equipment such as various robots of an automobile production line and control or manage these pieces of production equipment, and a method of transmitting data in the production management system.

As more useful electronic devices are developed in recent years, production lines for manufacturing various products are being automatized to improve the quality of the manufactured products. Modern production lines include a plurality of machining stations combined with numerically controlled machine tools and automatic machines such as robots. These machining stations are coupled with an automatic warehouse or a material handling system including self-propelled carriages so that various workpieces such as parts to be machined and assembled can be automatically supplied to the machining stations. Such a combined system is known as an FA (Factory Automation) system, which includes a

production management computer that controls the machining and assembling operation in each of the machining stations and controls or manages the flow or distribution of workpieces between the machining stations. The FA system is also employed to control automobile assembling lines.

To meet diverse consumer needs, some automobile assembling lines of today are each designed to assemble automobiles of many different kinds based on desired combinations of types, grades, geographical regions of use, and options. It is therefore necessary on an automobile assembling line to change automatic machines or actuators frequently in all or some of the machining stations depending on the type of automobiles to be produced. Usually, the pieces of production equipment such as automatic machines of the assembling line have multiple functions and are highly complex. In order to process data to be supplied to the automatic machines and quickly recover any of the automatic machines from malfunctioning conditions, the assembling line should be controlled by a centralized production management system which manages such data processing and recovery from failures under centralized control. Highly efficient, complex data processing for an assembling line controlled by a centralized production management system preferably requires production management computers to be associated with respective pieces of production equipment in the machining (or assembling) stations for managing these pieces of production equipment under decentralized control.

On a production line such as an automobile assembling line where pieces of production equipment and actuators need to be frequently changed, however, the production management computers of such a decentralized production management system need to be separately supplied with common information such as production equipment type information, actuator type information, and abnormal code information. When certain pieces of production equipment or certain actuators are changed or removed, therefore, corresponding common information must be modified, i.e., changed in or removed from the respective associated production management computers. As a result, the maintenance of the decentralized production management system is highly complicated.

Even if the pieces of production equipment on an automobile assembling line are not changed, operation pattern data for the automatic machines in the respective machining stations must be changed each time a different automobile type is to be assembled.

The process of changing operation pattern data for the respective automatic machines on an automobile assembling line depending on the type of automobiles to be manufactured is very tedious and time-consuming, resulting in an increase in the cost of production.

The production management computers of the decentralized system are governed by a host computer. Data should be reliably and quickly transmitted between the pro-

duction management computers and also between these comput-
ers and the host computer for high-speed operation of the
assembling line.

FIG. 1 of the accompanying drawings shows a text
format for data, which has heretofore been employed in such
data transmission. The text format, generally denoted at 2,
comprises a heading 4 that contains auxiliary information
such as a transmission route, priority, and a message
number, required to process a text, a text 6 containing an
information message, transmission characters SOH (start of
heading), STX (start of text), and ETX (end of text), and a
block check character BCC.

The transmission control characters SOH, STX, ETX
are defined by JISC 6220, and have the following functions:
The transmission control character SOH is a character for
starting the heading 4 of the information message. The
transmission control character STX is a character used at
the end of the heading 4 and prior to the text 6. The
transmission control character ETX is a character used at
the end of the text 6. When a data item is transmitted from
a transmitting end to a receiving end, the receiving end
transmits an acknowledge signal each time one of the trans-
mission control characters SOH, STX, ETX and the block check
character BCC (hereinafter referred to as transmission con-
trol characters TCC) is received, while at the same time the
receiving end receives the heading 4 and the text 6.

The data transmission system in which an acknowledge signal is transmitted from the receiving end to the transmitting end each time a transmission control character TCC is received is also employed in an automobile assembling line. More specifically, data supplied to a host computer include, for example, quality control data such as tightening torque data and tightening time data from a nut runner as an automatic machine, or operation end data. Based on the supplied data, the host computer displays such quality control data on a display unit. Workpieces assembled on an automobile assembling line having a plurality of machining stations are operated upon at a large number of locations. Therefore, a vast amount of data must be transmitted and received within a short period of time.

The conventional data transmission system employing the text format 2 shown in FIG. 1 requires the transmitting and receiving ends to confirm each of the transmission control characters TCC. The time needed to confirm the transmission control characters TCC is long, and hence the time required to transmit desired data is also long. The long data transmission time tends to affect the processing time of the assembling line.

The present invention provides
a production management system for controlling a pro-
duction line having a plurality of working stations,
comprising a slave computer for controlling pieces of pro-
duction equipment in the working stations, and a host com-
puter for supervising common information required by the
slave computer, the arrangement being such that when the
common information is to be modified due to a change in the
pieces of production equipment, the common information
stored in the host computer is modified into corrected com-
mon information, and the corrected common information is
transmitted from the host computer to the slave computer, so
that the common information stored in the slave computer can
be modified by the corrected common information.

Preferably,
the production management system further includes a
main network by which the host computer and the slave com-
puter are interconnected, and a subnetwork by which the

slave computer and the pieces of production equipment are interconnected.

Preferably, each of the pieces of production equipment includes a sequencer and/or a robot controller, and an automatic machine controllable by the sequencer and/or the robot controller.

The present invention also provides a production management system for controlling a production line having a plurality of working stations having respective automatic machines controllable by sequencers and/or robot controllers, comprising read-out means for reading type data applied to workpieces delivered to the production line, and computer means having memories for storing type data and operation pattern data composed of bit trains, the arrangement being such that when a workpiece is delivered to the production line, the type data of the delivered workpiece are read by the read-out means and transmitted to the computer means, and the computer means transmits operation pattern data corresponding to the transmitted type data to the sequencers and/or the robot controllers for controlling the automatic machines.

Preferably, the computer means comprises a plurality of slave computers for controlling the sequencers and/or robot controllers, and a

host computer for controlling the slave computers, the arrangement being such that the type data read by the read-out means are transmitted through the host computer to the slave computers, and the slave computers select operation pattern data corresponding to the transmitted type data.

The present invention also provides a method of transmitting data for a production line including a host computer, a slave computer controllable by the host computer, and pieces of production equipment controllable by the slave computer, comprising the steps of adding consecutive serial numbers to respective data in the slave computer when the data are transmitted from the host computer through the slave computer to the pieces of production equipment or when the data are transmitted from the pieces of production equipment through the slave computer to the host computer, and storing the data with the serial numbers added thereto in the slave computer and transmitting the data with the serial numbers added thereto to the pieces of production equipment or the host computer.

Preferably, the method further includes the steps of, after the data have been stored and transmitted, determining whether a serial number lacks among the serial numbers added to the data received by the pieces of production equipment or the host computer, and, if there is a lacking serial number, requesting the slave computer to transmit the data relative to the lacking serial number.

An embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:-

FIG. 1 is a diagram of a text format used in a conventional method of transmitting data;

FIG. 2 is a schematic view of a production line in which a production management system according to the present invention is incorporated;

FIG. 3 is a detailed view of the production line shown in FIG. 2;

FIG. 4 is a diagram showing type data corresponding to workpieces delivered to the production line;

FIG. 5 is a diagram of an operation pattern table stored in data managers of the production line;

FIG. 6 is a diagram showing operation pattern data in the operation pattern table illustrated in FIG. 5;

FIG. 7 is a diagram of data transmitted and received by the data managers of the production line shown in FIGS. 2 and 3; and

FIG. 8 is a diagram showing a text format used in a data transmission method according to the present invention.

FIG. 2 schematically shows a production line incorporating a production management system according to the present invention. In the illustrated embodiment, the production line is shown as an automobile assembling line by way of example.

The production line, generally designated by the reference numeral 10, includes a main network 12 having optical fiber cables or the like, and subnetworks 14a through 14c associated respectively with a plurality of separate assembly lines 13a through 13c. To the main network 12, there is a connected a host computer 16 for controlling or managing the production on the production line 10. Slave computers (hereinafter referred to as "data managers") 18a through 18c are connected between the main network 12 and the subnetworks 14a through 14c for transmitting and receiving data therebetween. The data managers 18a through 18c receive data, add predetermined serial numbers to all the received data, and transmit the data with the serial numbers, and have respective memories (not shown) for storing all the data with the serial numbers which are transmitted.

Self-propelled carriages run along the assembly lines 13a through 13c. The subnetworks 14a through 14c are associated with machining (or assembling) stations STa1 through STan, STb1 through STbn, and STc1 through STcn (hereinafter referred to as "machining stations STa1 through

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STcn"), respectively. The subnetworks 14a through 14c are also associated with respective control panels (hereinafter referred to as "overall control panels") 20a through 20c in the form of sequencers for supervising the positions and speeds of the self-propelled carriages and controlled actions to be carried out in the respective machining stations STa1 through STcn under centralized control. To the subnetworks 14a through 14c, there are also connected respective sequencers (hereinafter referred to as "block control panels") 22a through 22c for distributing control information to various pieces of production equipment in the respective machining stations STa1 through STcn depending on the travel of the self-propelled carriages, i.e., in synchronism with the introduction of workpieces.

The pieces of production equipment referred to above include the overall control panels 20a through 20c, the block control panels 22a through 22c, robot controllers Ra1 through Ram, Rb1 through Rbm, Rc1 through Rcm (hereinafter referred to as "robot controllers Ra1 through Rcm"), and robots RBa1 through RBam, RBb1 through RBbm, RBc1 through RBcm (hereinafter referred to as "robots RBa1 through RBcm"), as shown in FIG. 3.

The assembly lines 13a through 13c are combined with line side computers 24a through 24g arranged along the assembly lines 13a through 13c and having respective display units 23a through 23g. The line side computers 24a through

- 11 -

24g are used as quality monitors or type checking monitors for monitoring how workpieces are assembled in the machining stations STa1 through STcn. The line side computers 24a through 24g are connected directly to the main network 12. The main network 12 is connected to supervising computers 26, 28 serving as supervising monitors for monitoring the degree to which the assembly lines 13a through 13c operate on duty and the total number of automobiles assembled.

The production line incorporating the production management system of the invention is basically constructed as described above. Operation and advantages of the production line and the production management system will be described below.

FIG. 3 shows in detail the production line 10 shown in FIG. 2. As illustrated in FIG. 3, the host computer 16 is associated with a type data file 50 for storing type data corresponding to workpieces W to be delivered onto the production line 10. The workpieces W (i.e., automobile bodies in the illustrated embodiment) have labels printed with bar codes indicative of type number information $\alpha 1A$ (A = 1, 2, ...) of the workpieces W. When a workpiece W is delivered from a drop lifter 44 into the first machining station STa1 of the production line 10, the type number information $\alpha 1A$ on the label is read by an input device 45 such as a bar code reader and applied therefrom to the host computer 16 through the main network 12. In response to the applied

type number information α1A, the host computer 16 reads, from the data file 50, type data XE (E = 1, 2, ···) corresponding to the type number information α1A and composed of secondary information α2B (B = 1, 2, ···) such as of a type grade, a geographical region of use, etc., optional specifications α3C (C = 1, 2, ···) such as a power steering function, a sun roof specification, etc., and color specifications α4D (D = 1, 2, ···) of automobiles, as shown in FIG. 4. The host computer 16 then sends the type data XE through the main network 12 to the line side computer 24a which stores the supplied type data XE.

The host computer 16 is also associated with a group 52 of production management tables 52a through 52h. These production management tables 52a through 52g store production ranking data, production achievement data, tracking data, self-propelled carriage on-duty data, quality control data, equipment failure data, and production plan data, respectively. The production management table 52h stores common information indicative of the arrangements of the assembly lines 13a through 13c corresponding to the sub-networks 14a through 14c, the arrangements of the pieces of production equipment such as automatic machines installed in the machining stations STa1 through STcn, operation pattern information of the pieces of production equipment, and the types of actuators used. The tracking data referred to above are data for controlling the self-propelled carriages

based on the self-propelled carriage on-duty data so that they will smoothly run on the assembly lines 13a through 13c without a collision. The tracking data are delivered to the overall control panels 20a through 20c.

The common information stored in the production management table 52h is supplied from the host computer 16 through the main network 12 to the data managers 18a through 18c which then stores the received data in their memories.

One form of such common information stored in the memory of each of the data managers 18a through 18c is an operation pattern table YM (M = 1, 2, $\cdots$) for operating the robots RGBa1 through RBcm. FIG. 5 shows the operation pattern table YM in detail. As shown in FIG. 5, the operation pattern table YM is composed of the type data XE and operation pattern data ZL (L = 1, 2, $\cdots$). The operation pattern data ZL are in the form of 64-bit data comprising four series of 16-bit data, as shown in FIG. 6. The 16-bit data DP (P = 1, 2, $\cdots$) of the operation pattern data ZL are assigned to the robot controllers Ra1 through Rcm, which then read only those 16-bit data DP corresponding thereto and actuate the robots RBa1 through RBcm based on the data thus read.

The bits of which the operation pattern data ZL are composed are representative of optional specifications such as a power steering, a sun roof, an automatic transmission, etc., geographical region specifications including domestic,

U.S.A., and Europe specifications, and performance specifications such as engine displacements, radiator capacities, etc.

The common information including the operation pattern data ZL is supplied through the data managers 18a through 18c and the subnetworks 14a through 14c to the overall control panels 20a through 20c and the block control panels 22a through 22c in which the common information is stored, and also supplied through the main network 12 to the supervising computers 26, 28 in which the common information is stored. The common information is also stored in the data managers 18a through 18c.

When the common information is to be modified, i.e., changed or removed due to a change in the arrangement of the assembly lines resulting from different type grades, geographical regions, and options of automobiles assembled on the production line 10, or due to modification or removal of the pieces of assembling equipment and their operation pattern information, or due to a change in the types of the actuators used, only the common information stored in the management table 52h associated with the host computer 16 is changed, added, or deleted, and the corrected common information is then supplied through the main network 12, the data managers 18a through 18c, and the subnetworks 14a through 14c to the control panels 20a through 20c, 22a through 22c, and the computers 26, 28. Accordingly, the common information can be modified with ease.

After the common information has been prepared, a workpiece W supplied from the drop lifter 44 is placed on a self-propelled carriage which is then moved to carry the workpiece W to the first machining station STa1. Upon arrival of the workpiece W at the first machining station STa1, the identification data indicating the carriage number are read from the self-propelled carriage which carries the workpiece W, and sent to the overall control panel 20a which stores the received identification data. The text composed of the identification data indicative of the carriage number is transmitted as data 100 from the overall control panel 20a through the subnetwork 14a, the data manager 18a, and the main network 12 to the line side computer 24a. At this time, a serial number A-1 is added to the text by the data manager 18a before the data 100 are transmitted to the line side computer 24a. The transmitted data 100 with the serial number A-1 added are also stored in the memory of the data manager 18a.

Upon reception of the transmitted data 100 with the serial number A-1 added thereto, the line side computer 24a checks the received data 100 up with carriage identification data which have previously been transmitted from the host computer 16 and stored in the line side computer 24a. If the data 100 agree with the stored carriage identification data, then the line side computer 24a transmits an agreement signal to the host computer 16. In response to the agree-

ment signal, the host computer 16 supplies the type data XE corresponding to the workpiece W carried on the carriage having the above carriage number, e.g., the type data X1 (see FIG. 5), through the main network 12 to the data manager 18a. The data manager 18a then refers to the operation pattern table YM stored in the memory thereof, and transmits the operation pattern data ZL = Z1 corresponding to the type data XE = X1 to the overall control panel 20a and the block control panel 22a. The type data X1 include a frame number (body number) for identifying the workpiece W, i.e., the automobile. The data manager 18a adds a serial number A-2 to the type data X1, transmits the type data X1 with the serial number A-2 as data 100 to the overall control panel 20, and stores the data 100 in its memory (see FIG. 7).

The overall control panel 20a has as many storage areas as the number of the machining stations STa1 through STcn. The first storage area of the overall control panel 20a stores the carriage number and the type data XE as a data pair. This data pair is transferred successively through the second storage area, the third storage area, and so on in synchronism with the movement of the self-propelled carriage. The type data XE transmitted to the block control panel 22a are supplied to the robot controllers Ra1 through Ram associated with the respective robots RBa1 through RBam in the machining stations STa1 through STan.

The robot controllers Ra1 through Ram select an operation pattern program corresponding to the type of the

workpiece W and prepared according to the 16-bit data DP
(see FIG. 5) of their own among the operation pattern data
ZL = Z1 from the block control panel 22a, and control the
robots RBa1 through RBam, respectively, to perform works
assigned to the respective machining stations STa1 through
STan. Then, the block control panel 22a sends operating
condition signals in the processing time from the robot con-
trollers Ra1 through Ram through the data manager 18a of the
subnetwork 14 and the main network 12 to the host computer
16. Each of the operating condition signals has a text
which, as shown in FIG. 7, includes the reference mark rela-
tive to the robot RBa1, for example, which is a nut runner,
the axis number of the robot RBa1, for example, the tighten-
ing torque value, the tightening time, the frame number
given to the workpiece W, and data indicative of whether the
nut is tightened properly ("OK") or improperly ("NG"). At
this time, serial numbers A-3 through A-10 are added to the
operating condition signals, respectively, by the data man-
ager 18a before the signals are sent as data 100 to the host
computer 16.

The host computer 16 determines whether the serial
numbers A-3 through A-10 in the transmitted data 100 are
consecutive or not. If any serial number lacks, then the
host computer 16 requests the data manager 18a to transmit
the data 100 relative to the lacking serial number, so that
the host computer 16 can obtain the complete data 10

relative to the lacking serial number which are stored in the data manager 18a. The data 100 relative to the serial numbers A-3 through A-10 are quality control data which are recorded in the management table 52e in the table group 52 (FIG. 3).

When the block control panel 22a receives operation completion signals from the robot controllers Ra1 through Ram, these signals are sent to the overall control panel 20a. The overall control panel 20a controls all carriages running on the assembly line 13a corresponding to the subnetwork 14a, and also carriages moving between the machining stations at all times. The overall control panel 20a transmits movement permit signals to self-propelled carriages through the block control panel 22a.

The above operation is repeated to move the self-propelled carriages and distribute the type data XE to the machining stations STa1 through STan. The robots RB1a through RBam disposed in the respective machining stations STa1 through STan effect given operations according to the operation pattern data ZL corresponding to the type data XE.

The assembly lines 13b, 13c corresponding to the respective subnetworks 14b, 14c are of the same construction as that of the assembly line 13a of the subnetwork 14a. The functions of the overall control panels 20b, 20c and the block control panels 22b, 22c are also the same as those of the overall control panel 20a and the block control panel

22a. The data managers 18b, 18c are structurally and func-

tionally identical to the data manager 18a. More

specifically, the data managers 18b, 18c add serial numbers

to the data to be transmitted and received, and store the

data with the serial numbers in their respective memories.

The serial numbers to be added by the data managers 18b, 18c

are different from those to be added by the data manager

18c, e.g., they are B-1, B-2, ··· and C-1, C2, ···,

respectively, so that the networks from which these data

have been transmitted can be identified. The serial numbers

are however not limited to the above numbers, but may have

initial values of 1, 10001, 20001 to be added by the data

managers 18a through 18c, respectively.

The serial numbers may be added such that they are

successively added from the first serial number in either

every working day, or every week if involved data are few.

According to the data transmission method of the

present invention, as shown in FIG. 8, a text format 102 is

composed of only an inherent serial number area 102 and a

text 106. Therefore, the text format 102 is much simpler

than the conventional text format 2 shown in FIG. 1.

In the illustrated embodiment, automobile bodies

are assembled on the assembly line 13a corresponding to the

subnetwork 14a, suspensions are assembled on the assembly

line 13b corresponding to the subnetwork 14b, and engines

are assembled on the assembly line 13c corresponding to the

subnetwork 14c. However, the assembly lines 13a through 13c may be employed to assemble automobile parts in different combinations.

With the present invention, as described above, the production management system comprises data managers or slave computers for controlling pieces of production equipment in the respective machining stations and a host computer for supervising common information required by the slave computers. When the common information is to be modified or removed due to a change in the pieces of production equipment, only the common information stored in the host computer is modified or removed so that the common information stored in each of the slave computers can be modified or removed. Therefore, the data can easily be modified or removed and any process for confirming such data modification or removal can easily be performed. The time required to effect the maintenance of the production management system can thus be shortened. As a consequence, the production management system of the present invention has the advantages of both a decentralized control system having a plurality of slave computers and a centralized control system having a host computer. Since the production management system of the invention can easily modify or remove data to be stored in the slave computers depending on the types of products to be produced, the production management system is particularly useful in combination with the production mode

in which products of many kinds are manufactured on one production line.

Moreover, the automatic machining or assembling devices such as robots are controlled by the operation pattern data composed of bit trains that are shared by these automatic machining or assembling devices. When workpieces or products of different specifications are to be machined or assembled by the automatic machining or assembling devices, the bit trains or data of the operation pattern data are changed thereby changing the operation of the automatic machining or assembling devices. The time required to change the data for the automatic machining or assembling devices is thus greatly shortened. Where the production management system is used in combination with a production line for producing many different kinds of products, the cost of the products manufactured by the production line can be lowered.

Accordingly, the production management system of the invention is useful in combination with the production mode in which products of many kinds are manufactured on one production line.

Furthermore, the data managers or slave computers having memories are connected between the pieces of production equipment in the machining or working stations and the host computer. Data are transmitted between the pieces of production equipment and the host computer according a text

format in which inherent serial numbers are added to the data by the data managers. Therefore, the response time required to confirm the data is reduced. Consequently, the data can be transmitted at high speed.

The preferred embodiments of the present invention can provide a production management system including slave computers for controlling pieces of production equipment in respective working or machining stations and a host computer for controlling the slave computers, the production management system being capable of efficiently and flexibly coping with changes of the pieces of production equipment or the types of workpieces, and of transmitting data quickly and accurately between the computers.

Although a certain preferred embodiment has been shown and described, it should be understood that many changes and modifications may be made therein without departing from the scope of the appended claims.

CLAIMS.

1. A production management system for controlling a production line having a plurality of working stations, comprising:

a slave computer for controlling pieces of production equipment in the working stations;

a host computer for supervising common information required by said slave computer; and

the arrangement being such that when said common information is to be modified due to a change in said pieces of production equipment, the common information stored in said host computer is modified into corrected common information, and the corrected common information is transmitted from said host computer to said slave computer, so that the common information stored in said slave computer can be modified by said corrected common information.

2. A production management system according to claim 1, further including a main network by which said host computer and said slave computer are interconnected, and a subnetwork by which said slave computer and said pieces of production equipment are interconnected.

3. A production management system according to claim 2, wherein each of said pieces of production equipment includes a sequencer and/or a robot controller, and an automatic machine controllable by said sequencer and/or said robot controller.

4. A production management system for controlling a production line having a plurality of working stations having respective automatic machines controllable by sequencers and/or robot controllers, comprising:

read-out means for reading type data applied to workpieces delivered to the production line;

computer means having memories for storing type data and operation pattern data composed of bit trains; and

the arrangement being such that when a workpiece is delivered to the production line, the type data of the delivered workpiece are read by said read-out means and transmitted to said computer means, and said computer means transmits operation pattern data corresponding to the transmitted type data to the sequencers and/or the robot controllers for controlling the automatic machines.

5. A production management system according to claim 4, wherein said computer means comprises a plurality of slave computers for controlling the sequencers and/or robot controllers, and a host computer for controlling said slave computers, the arrangement being such that the type data read by said read-out means are transmitted through said host computer to said slave computers, and said slave computers select operation pattern data corresponding to the transmitted type data.

6. A method of transmitting data for a production line including a host computer, a slave computer controlla-

ble by said host computer, and pieces of production equipment controllable by said slave computer, comprising the steps of:

adding consecutive serial numbers to respective data in the slave computer when the data are transmitted from the host computer through the slave computer to the pieces of production equipment or when the data are transmitted from the pieces of production equipment through the slave computer to the host computer; and

storing the data with the serial numbers added thereto in the slave computer and transmitting the data with the serial numbers added thereto to the pieces of production equipment or the host computer.

7. A method according to claim 6, further comprising the steps of:

after the data have been stored and transmitted, determining whether a serial number lacks among the serial numbers added to the data received by the pieces of production equipment or the host computer; and

if there is a lacking serial number, requesting the slave computer to transmit the data relative to the lacking serial number.

8. A production management system substantially as hereinbefore described with reference to Figures 2 to 8 of the accompanying drawings.

9. A method of transmitting data substantially as hereinbefore described with reference to Figures 2 to 8 of the accompanying drawings.