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GB 1520647
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(71) Applicant
Sumikin Coke Company Limited,
(Japan),
1850 Minato,
Wakayama City,
Wakayama Prefecture,
Japan
(72) Inventors
Minoru Ikeda,
Yasuyuki Higashigawa
(74) Agent and/or address for service
Hyde, Heide and O'Donnell,
146 Buckingham Palace Road,
London,
SW1W 9TR

(54) Automatic control system for operation of cokery machinery

(57) The running operations of a quenching car, and optionally also a pusher machine, a charging car and a coke guide, are controlled through transposed-pair-type inductive radio lines, capable of data transmission, which are arranged over the whole length of the running path of the respective travelling machine(s). The absolute addresses of the working machine(s) are continuously transmitted to a main control system and instructions to effect the running, stopping and working operations of the travelling machine(s) are generated on the basis of the control programmes stored in the main controller, and on the basis of the speed and work data-fed from the working machines, and the positions and working states of the same machines. Also disclosed is a fixed position stop control apparatus for the automatic control method.

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FIG. 1A

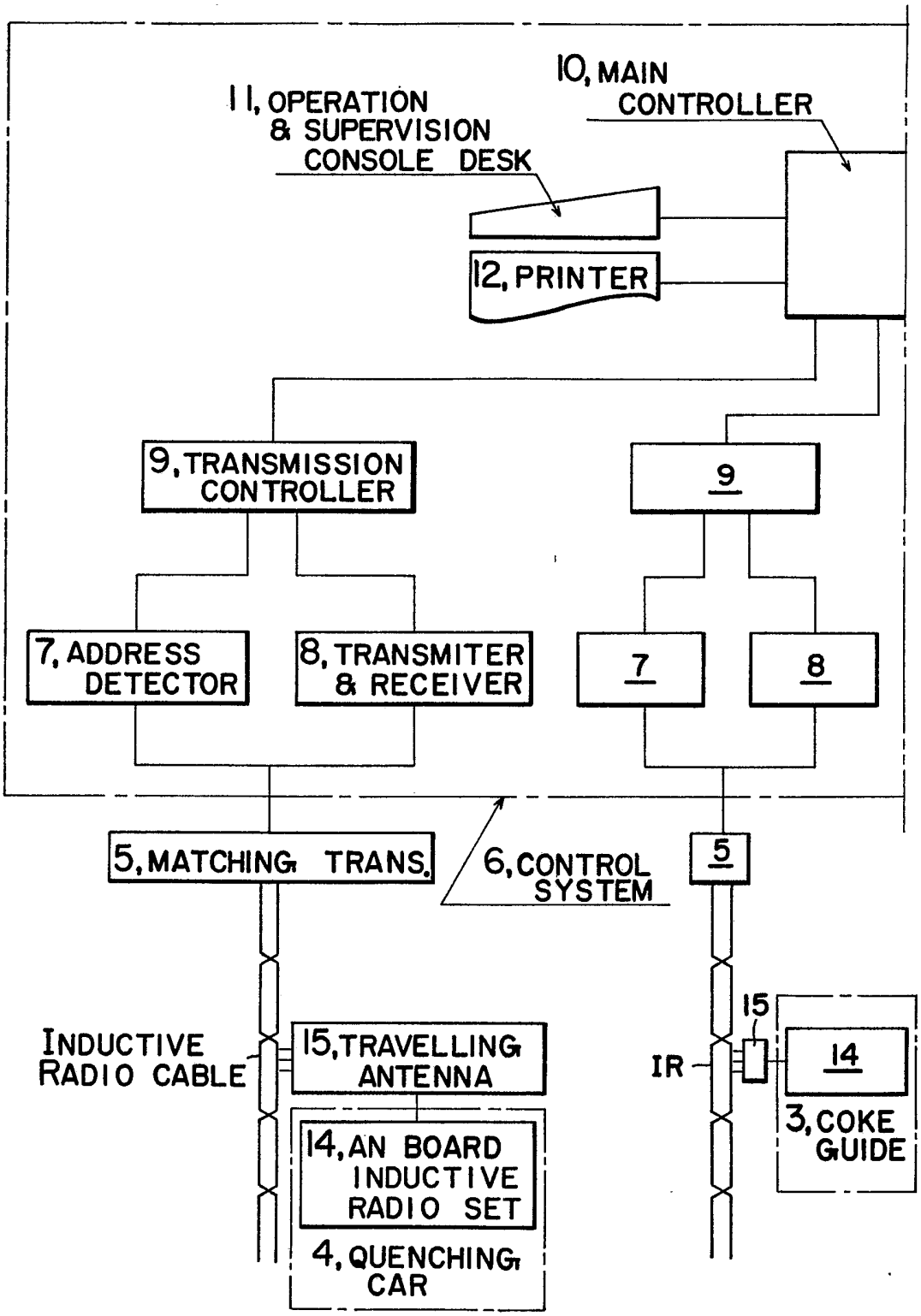
10, MAIN CONTROLLER
11, OPERATION & SUPERVISION CONSOLE DESK
12, PRINTER
9, TRANSMISSION CONTROLLER
9
7, ADDRESS DETECTOR
8, TRANSMITER & RECEIVER
7
8
5, MATCHING TRANS.
6, CONTROL SYSTEM
5
INDUCTIVE RADIO CABLE
15, TRAVELLING ANTENNA
14, AN BOARD INDUCTIVE RADIO SET
4, QUENCHING CAR
IR
15
14
3, COKE GUIDE

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FIG. 1B

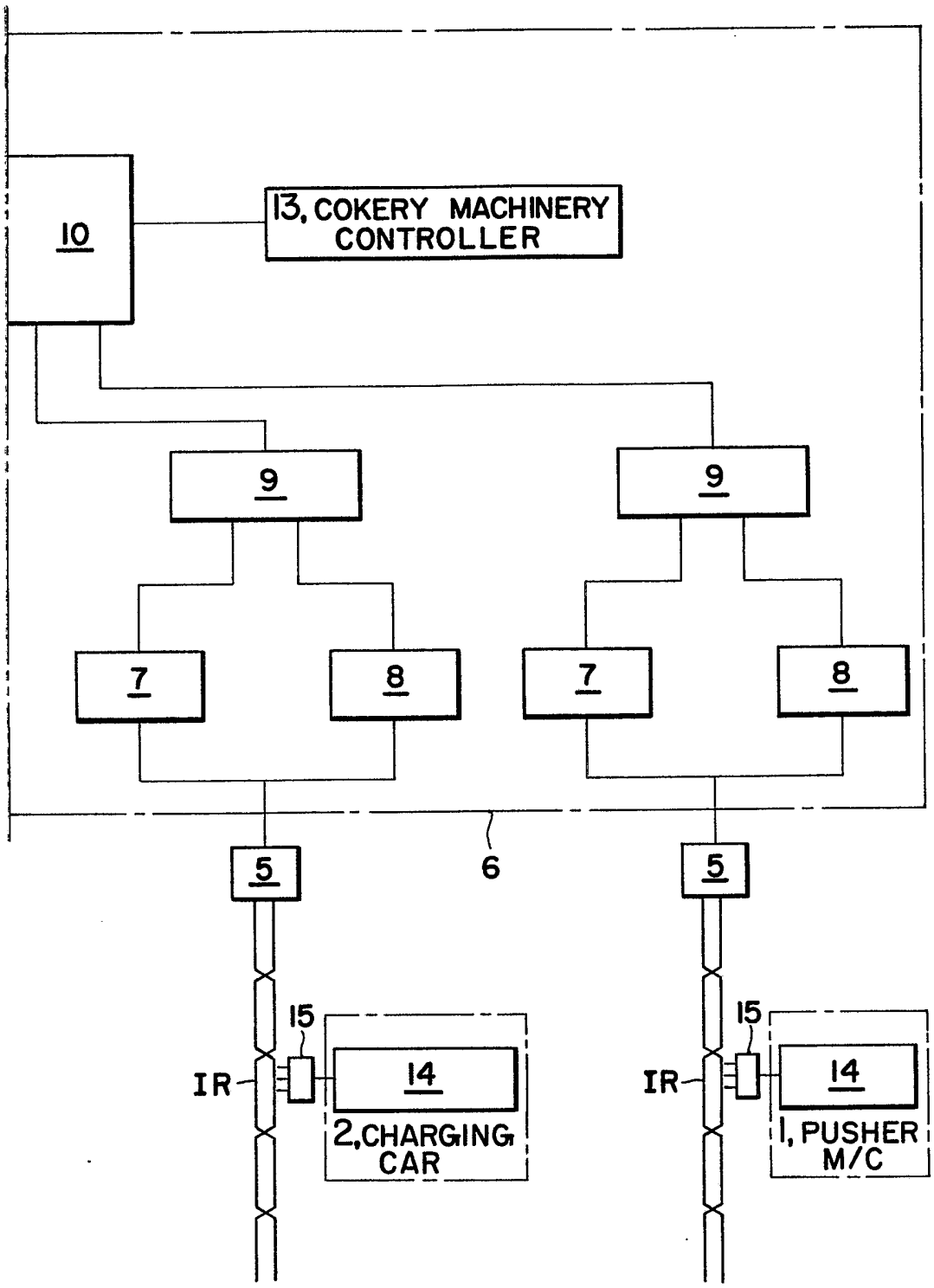

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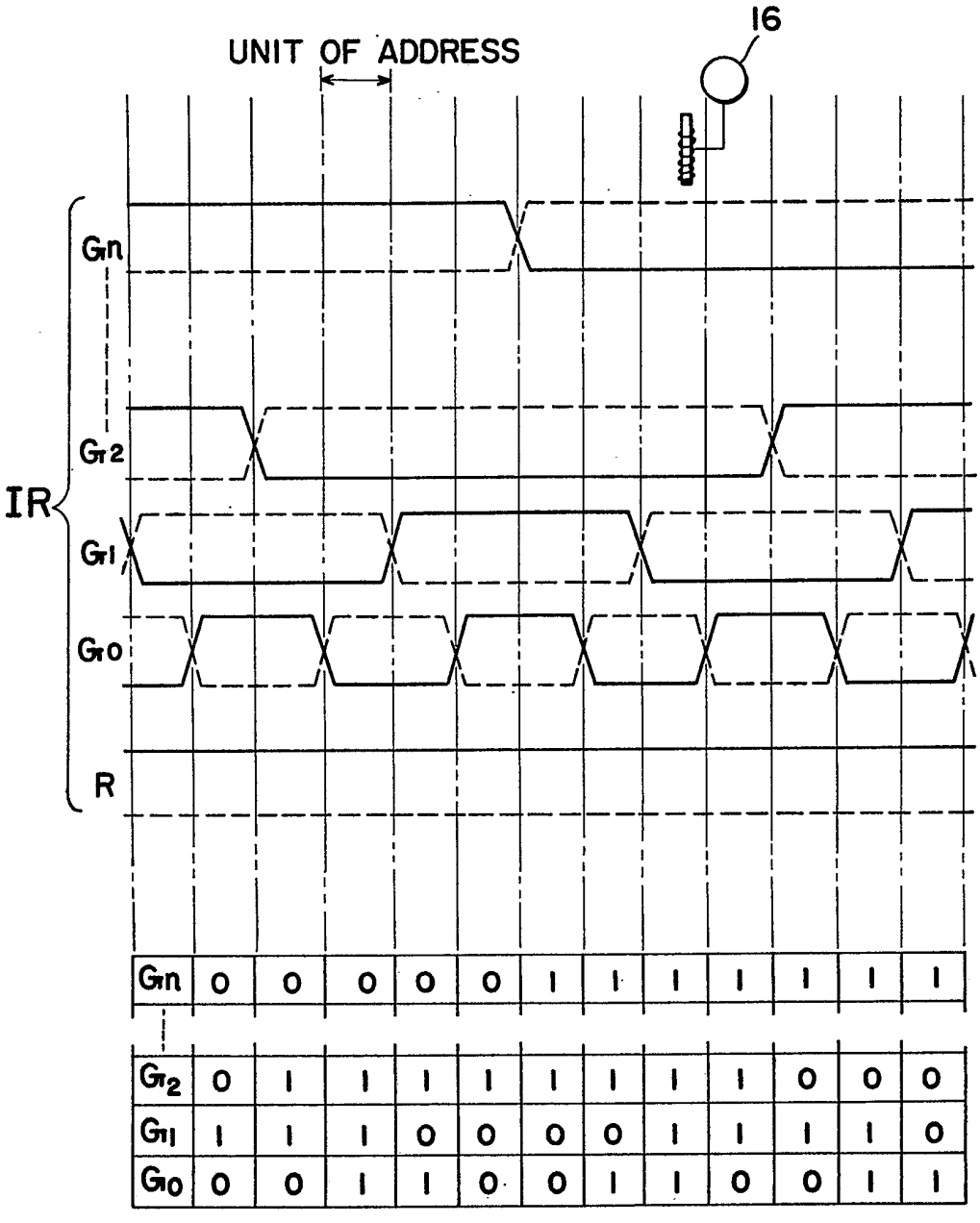
FIG. 2



Gn	0	0	0	0	0	1	1	1	1	1	1	1
G2	0	1	1	1	1	1	1	1	1	0	0	0
G1	1	1	1	0	0	0	0	1	1	1	1	0
G0	0	0	1	1	0	0	1	1	0	0	1	1

4B

FIG. 3

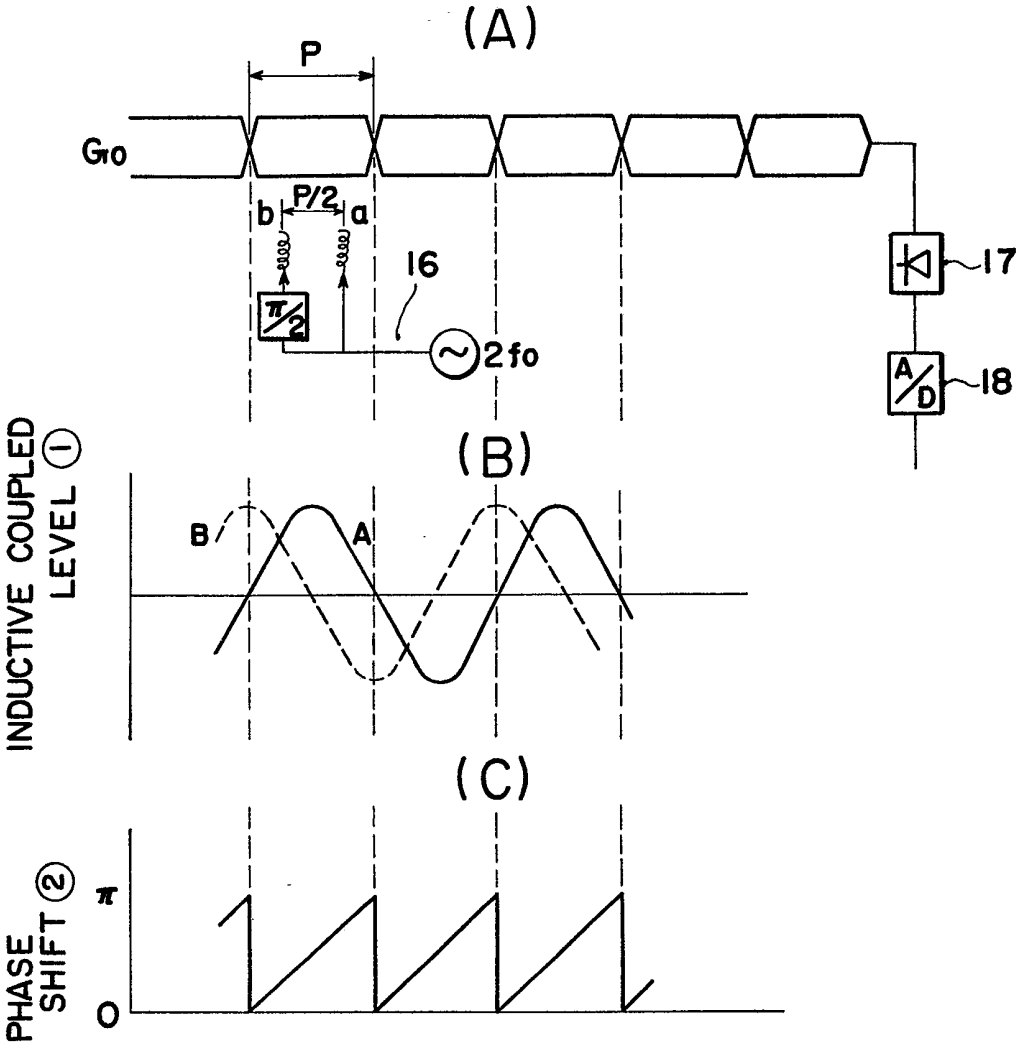

(A)
P
Go
b
P/2
a
16
π/2
2fo
17
A/D
18
(B)
INDUCTIVE COUPLED LEVEL ①
B
A
(C)
PHASE SHIFT ②
π
0

FIG. 4

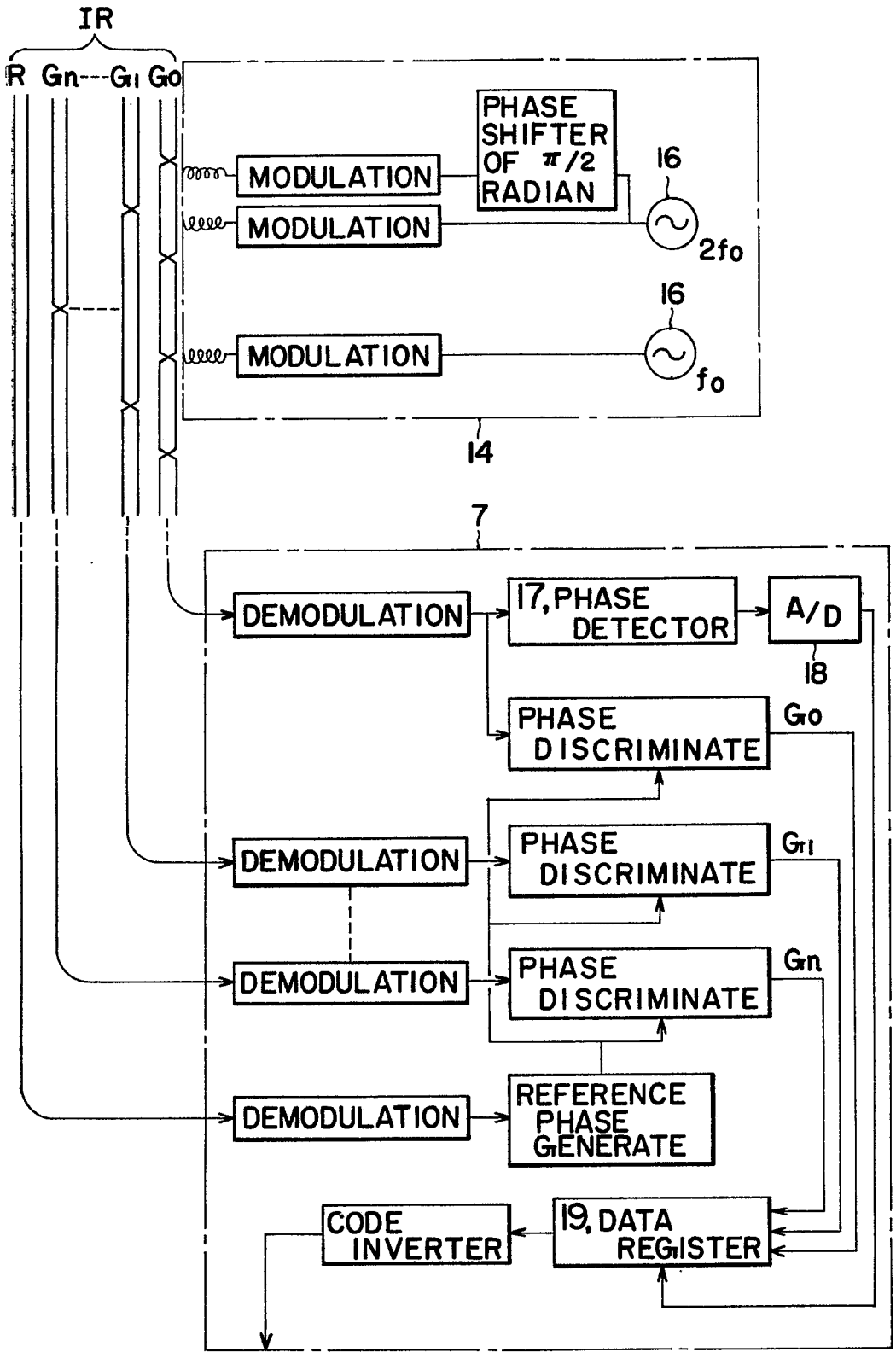
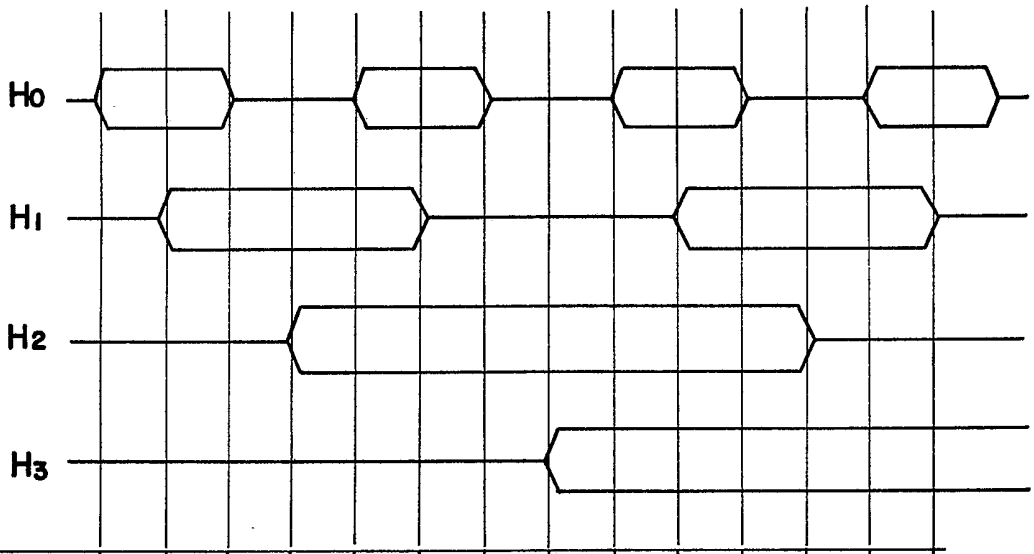

IR
R
Gn
G1
Go
MODULATION
MODULATION
PHASE SHIFTER OF π/2 RADIAN
16
2fo
16
MODULATION
fo
14
7
DEMODULATION
17, PHASE DETECTOR
A/D
18
PHASE DISCRIMINATE
Go
DEMODULATION
PHASE DISCRIMINATE
G1
DEMODULATION
PHASE DISCRIMINATE
Gn
DEMODULATION
REFERENCE PHASE GENERATE
CODE INVERTER
19, DATA REGISTER

FIG. 5



H_0	1	1	0	0	1	1	0	0	1	1	0	0	1
H_1	0	1	1	1	1	0	0	0	0	1	1	1	1
H_2	0	0	0	1	1	1	1	1	1	1	1	0	0
H_3	0	0	0	0	0	0	0	1	1	1	1	1	1

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FIG. 6A

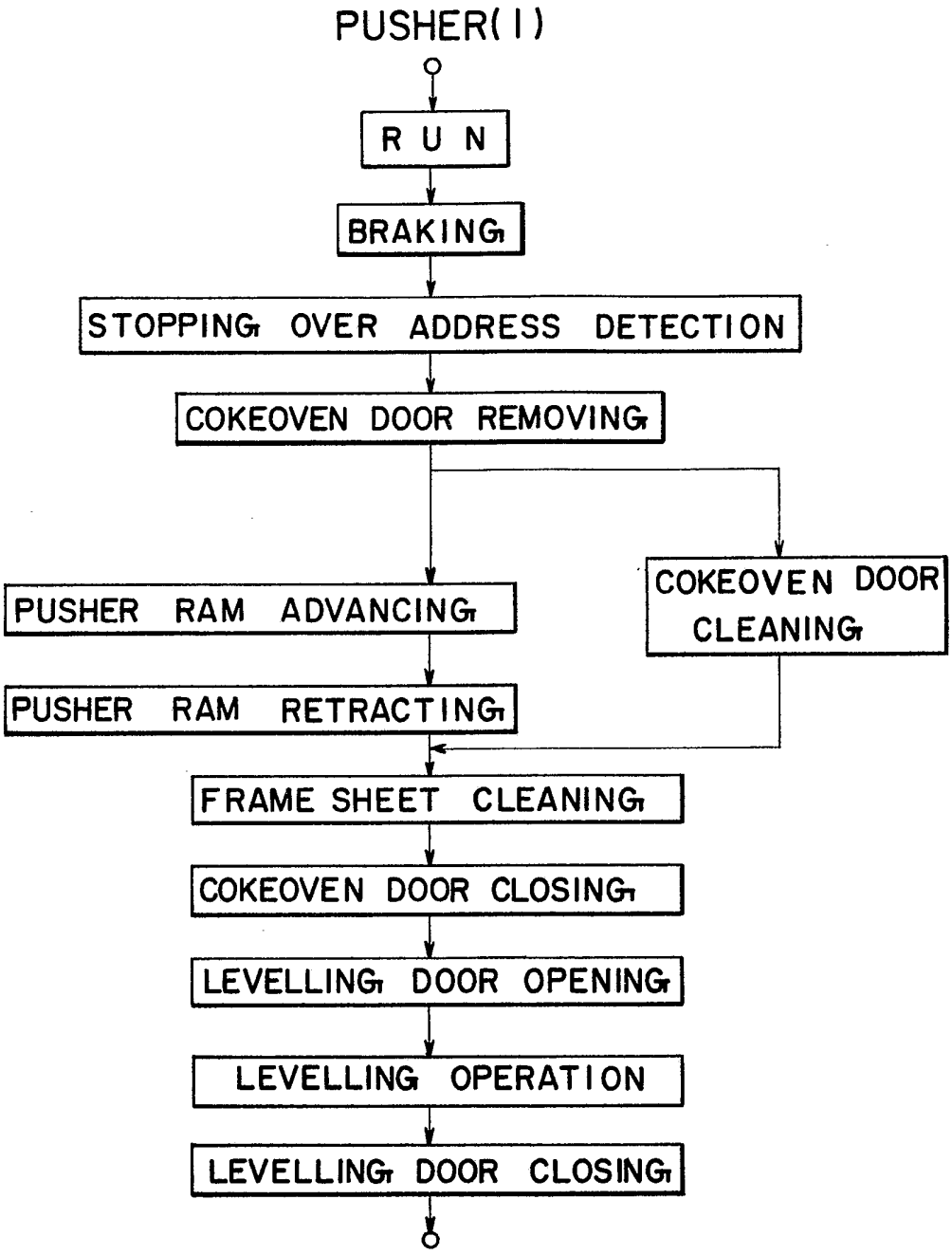

FIG. 6B

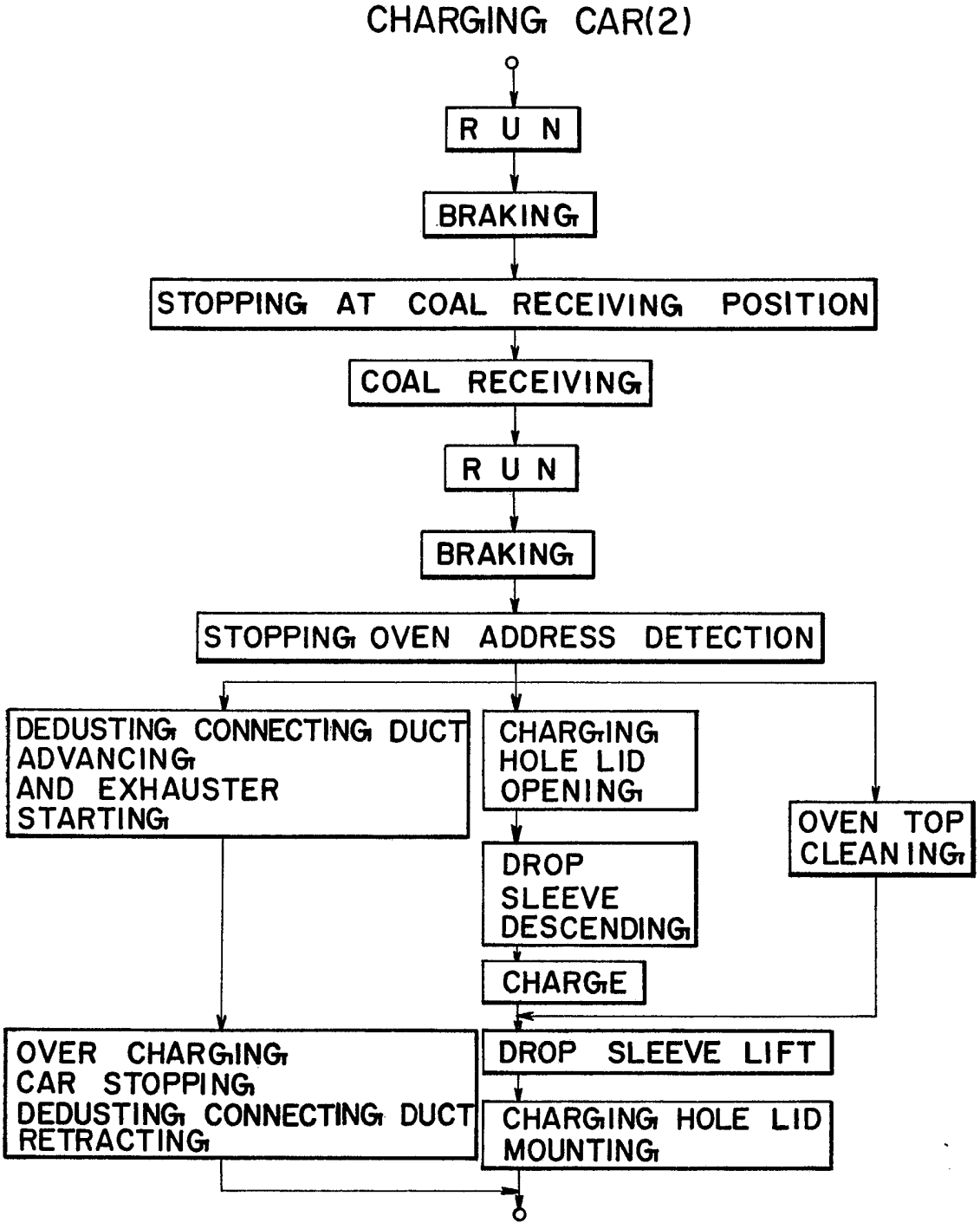
CHARGING CAR(2)
RUN
BRAKING
STOPPING AT COAL RECEIVING POSITION
COAL RECEIVING
RUN
BRAKING
STOPPING OVEN ADDRESS DETECTION
DEDUSTING CONNECTING DUCT ADVANCING AND EXHAUSTER STARTING
CHARGING HOLE LID OPENING
OVEN TOP CLEANING
DROP SLEEVE DESCENDING
CHARGE
OVER CHARGING CAR STOPPING
DEDUSTING CONNECTING DUCT RETRACTING
DROP SLEEVE LIFT
CHARGING HOLE LID MOUNTING

FIG. 6C

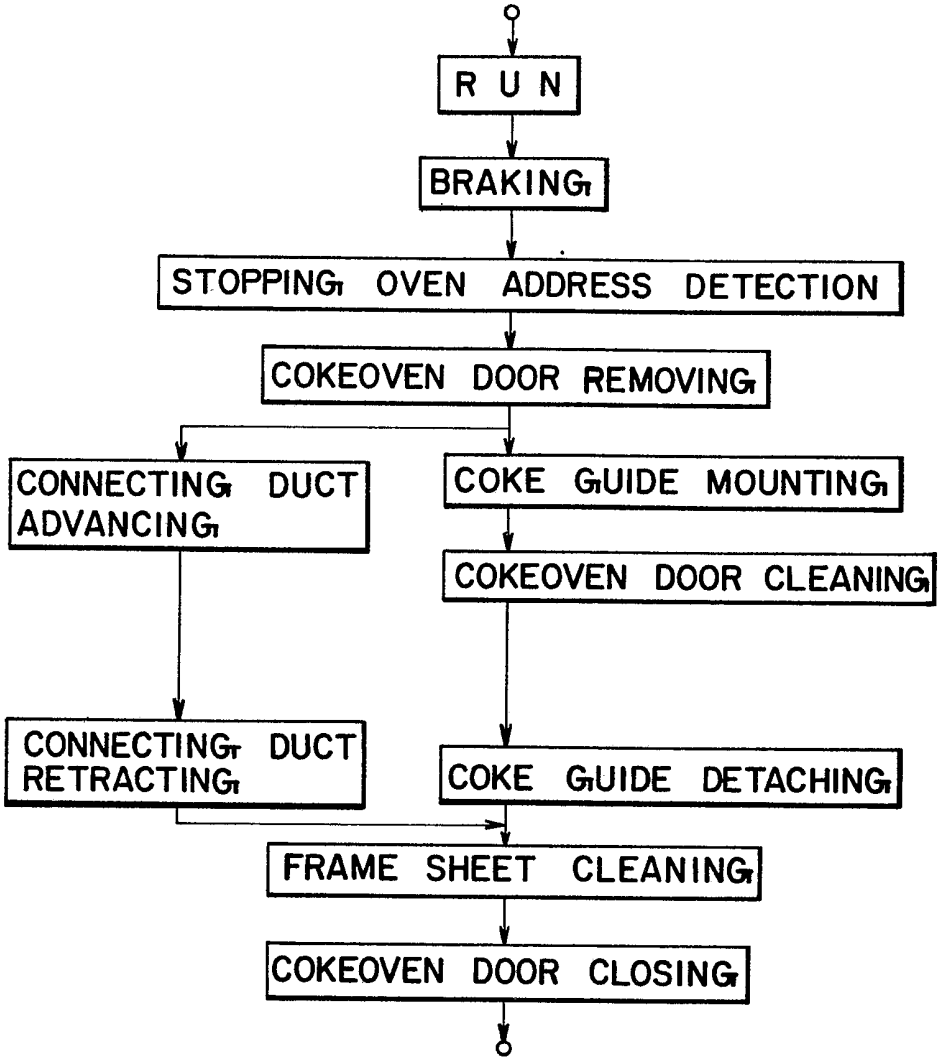
COKE GUIDE(3)
RUN
BRAKING
STOPPING OVEN ADDRESS DETECTION
COKEOVEN DOOR REMOVING
CONNECTING DUCT ADVANCING
COKE GUIDE MOUNTING
COKEOVEN DOOR CLEANING
CONNECTING DUCT RETRACTING
COKE GUIDE DETACHING
FRAME SHEET CLEANING
COKEOVEN DOOR CLOSING

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FIG. 6D

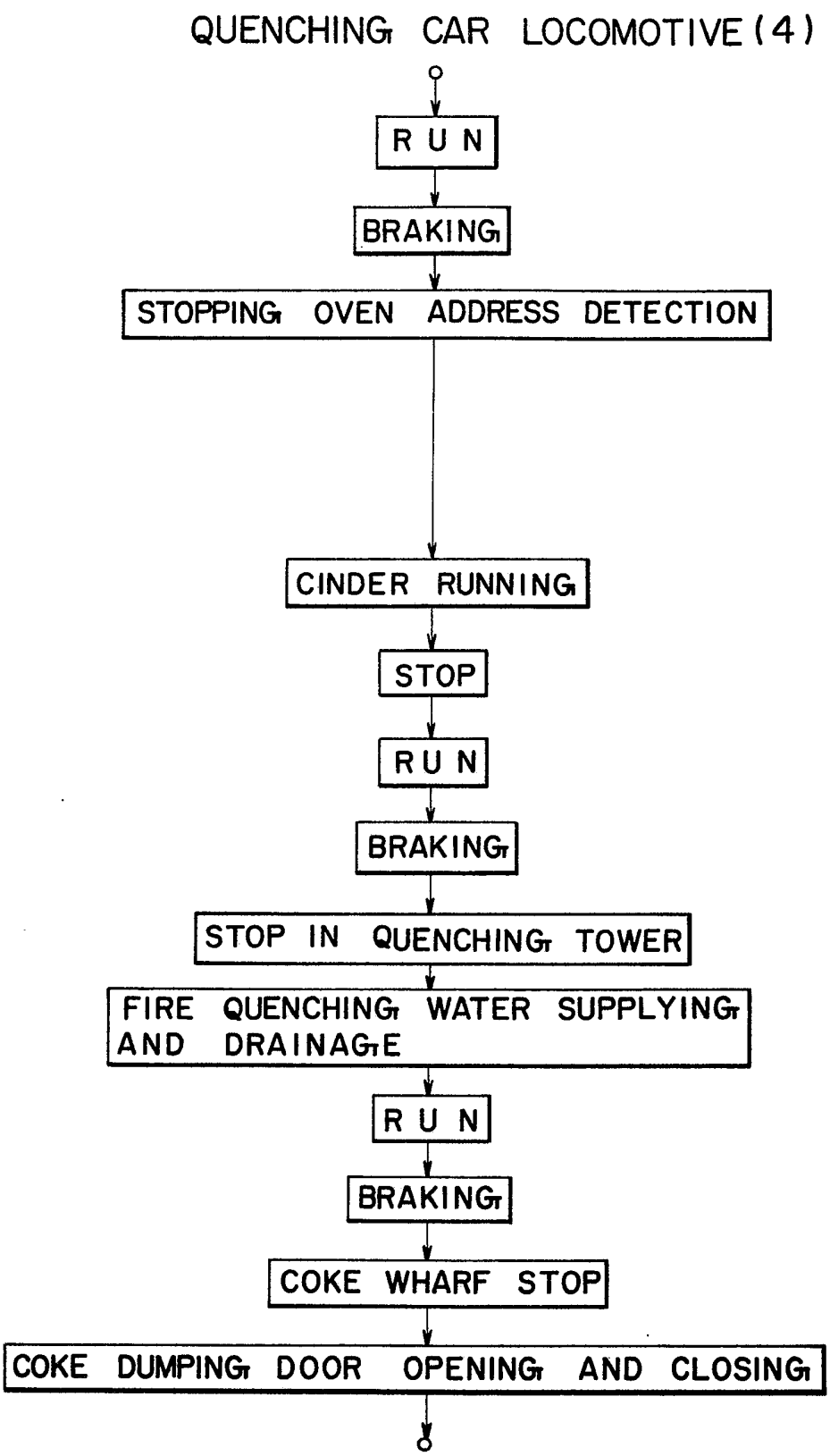


FIG. 6E

QUENCHING TOWER

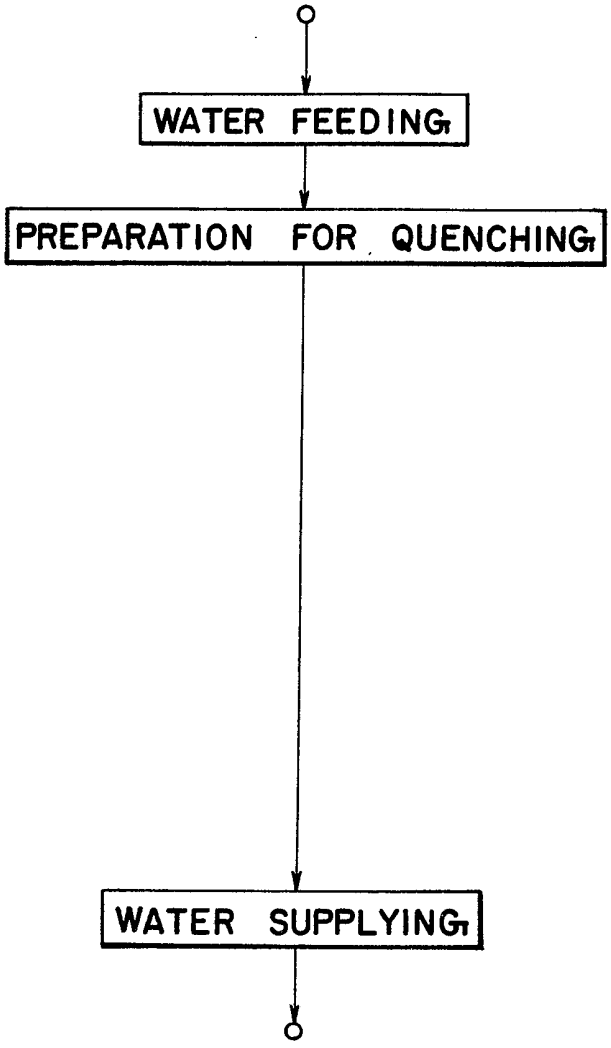


FIG. 7

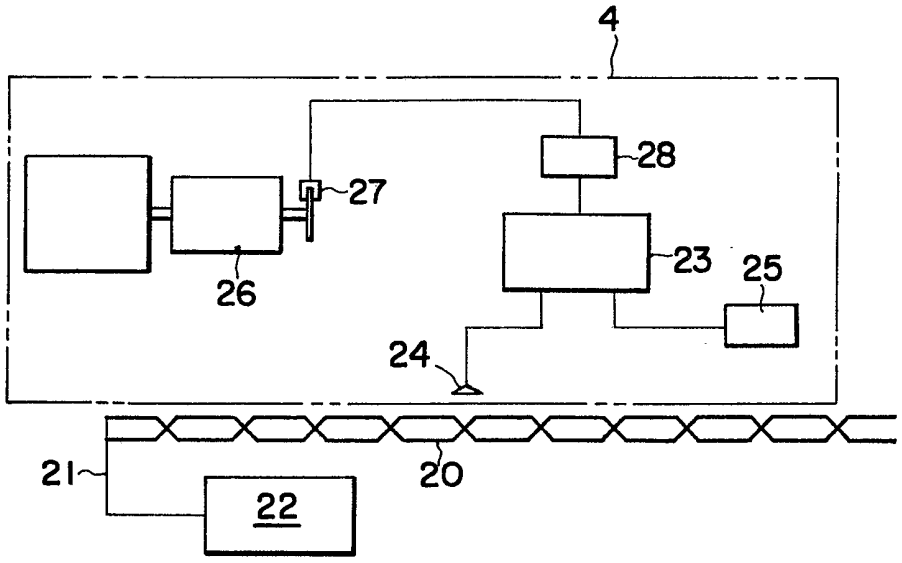

4
28
27
23
25
26
24
21
20
22

FIG. 8

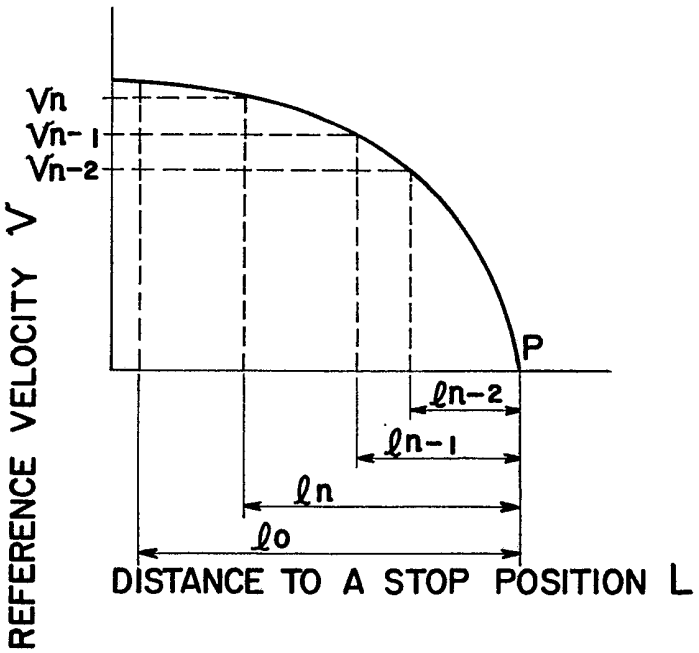

Vn
Vn-1
Vn-2
REFERENCE VELOCITY V
P
ℓn-2
ℓn-1
ℓn
ℓo
DISTANCE TO A STOP POSITION L

FIG. 9

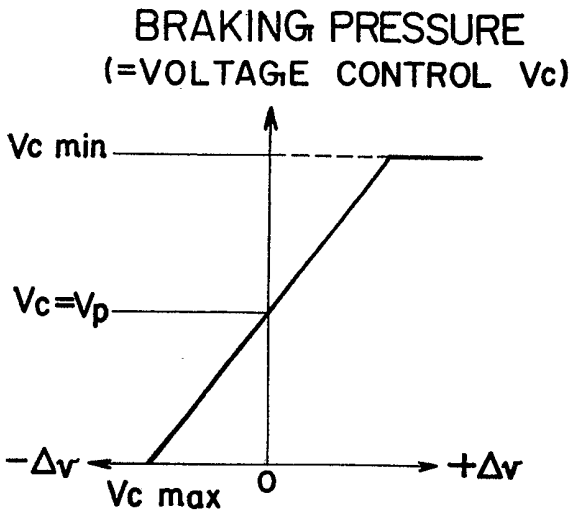
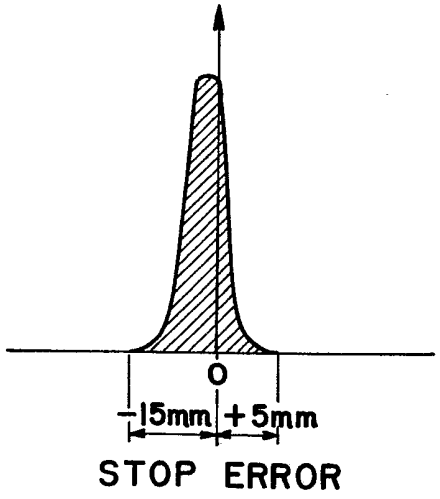

BRAKING PRESSURE
(=VOLTAGE CONTROL Vc)
Vc min
Vc=Vp
−Δv
+Δv
Vc max
0

FIG. 10


0
−15mm
+5mm
STOP ERROR

SPECIFICATION

Automatic control system for operation of cokery machinery

Background of the invention

The present invention relates to an automatic control system for operations of cokery machinery, in particular running, stopping and working operation of travelling machines including a pusher machine, a charging car, a coke guide and a quenching car; operation of a stop control apparatus for stopping the said travelling machines with a high degree of accuracy at predetermined positions; and control of auxiliary cokery machinery including quenching tower, coke wharf and exhausters of dust removers, etc.

The discharging of red hot coke from oven chamber is accomplished by repeating predetermined working steps by the consecutive operations of travelling machines to the oven chamber according to a predetermined working schedule. When the respective travelling machines are thus operating, they are required to communicate with one another to confirm their relative operations and positions.

In the prior art, the mutual communications and confirmations of such travelling machines have been effected either by eye or by the use of telephone or radio lines. According to such communication methods however, a false report is liable to occur, and the confirmation of the relative positions cannot then be completely ensured.

In an attempt to overcome such difficulties a number of remote controls for the run of a coke quenching car locomotive have been tried, including a method in which the runs of a series of travelling machines are automatically controlled.

However such automatic control is generally directed to a method in which the travelling machines equipped with transmitters and receivers are controlled by giving through a relay, an instruction from one of the travelling machines to another, or a method in which the positions of the travelling machines are confirmed and the working states of the same are controlled by a ground based detector. This makes it remarkably difficult to automatically control in safety and without fail the discharging operations which is located in hot and severe conditions amidst much dust and water vapor.

If the remote control of the quenching locomotive car is taken as an example, more specifically the quenching locomotive is stopped a predetermined relative position to a coke guide, then started in synchronism with the pusher ram speed of a pusher machine, and is then towards a quenching tower after the red hot coke is loaded in the quenching car and stopped at a predetermined position in the quenching tower, in which it contacted with water. After the quenching operation, the quenching car locomotive is moved to an empty coke wharf to dump the quenched coke into the coke wharf, and is again run toward the coke guide for re-loading with coke. After a series of such automatic operations, the quenching car locomotive detects during its steps a number of fixed points to conduct appropriate decelerating and stopping operations. Since the method is dependent upon track conditions which may for example cause slipping, it is difficult to accurately control the run of the quenching car locomotive and to stop it accurately.

This difficulty is caused by the following: Since the track of the quenching car locomotive fluctuates horizontally and vertically more than 200 mm with respect to the relative distance from the vertical and a horizontal reference line, the distance between ground based detectors indicating the fixed points and an on-board detector carried on the quenching car locomotive for detecting the fixed points when it passes over the ground based detectors, is changing without any interruption so that the accuracy of detection cannot be sustained.

In a coking plant which is designed to plan the remote control of the quenching car locomotive therefore, the track is made sufficiently firm to maintain the detection accuracy. Thus it is necessary to prepare a strong foundation which is very costly. Reinforcement of existing coking plant is in practice impossible.

Even if the detecting accuracy of the ground based and the on-board detector is maintained the control by the mutual detections of the on-board detectors of the coke guide and the quenching car locomotive cannot provide the desired accuracy because of short braking distances.

As a method of eliminating the difficulties described, the so called "relative address detecting method" has been suggested in which the running distance of the quenching car is determined to locate the position. In this method, however, the idle wheels of the quenching car locomotive turn on the track so that the running distance is expressed in terms of the number of wheel turns. This inevitably results in errors arising from the slippage or the like of the idle wheels. Therefore, the ground-based detectors are disposed at several positions over the whole length of the running path of the quenching car so that the errors from the absolute positions may be remedied when such ground based detectors are passed over.

The said method has succeeded in reducing the number of the ground based detectors over other methods of the prior art but has failed to provide a basic solution for the problem which exists between the ground based detectors and the on-board detector.

Further if the electric power is interrupted, the quenching car locomotive cannot be located because of the running distance during the power interruption. It therefore becomes necessary to run the quenching car locomotive to a reference point by manual operation and to renew the running operation from that reference point.

Also, the travelling machines used generally use an A.C. electric motor as their drive source. However, travelling machines using the A.C. electric motors cannot have their speeds controlled because the rate of revolutions of the electric motor is determined in accordance with the frequency of the power source.

In the prior art a braking device adapted to stop the travelling machines is for example a wheel tread brake operated by means of a brake shoe braking means for the rotary shaft of a drive mechanism using a thrust brake.

With such brake devices, the travelling machines are stopped at their destinations by manually interrupting the braking forces while visually confirming the destinations.

However, with automatically controllers introduced in recent years, such braking systems are unable easily to effect stoppages accurately at each destination.

If a braking force is applied at a predetermined point before the destination the wheels may slip after their rotations are stopped. As a result, the distance from a braking point to a stopping point is not constant and automatic control is difficult due to the track conditions such as arising from rain or oil, differences of the track.

In an endeavour to avoid such difficulties it has been proposed to use a D.C. electric motor as the drive source of the travelling machines in which the rate of revolutions of the electric motor is stepwise reduced from a predetermined point before the destination and a breaking force is applied after the speed is dropped to a predetermined low level and at a point where the distances to the destination reaches a predetermined value. However, such means still failed to overcome the difficulties that although error in the distance from a braking point to a stopping point is reduced it does not achieve a constant value with varying track conditions. Moreover, the cycle times required for the discharging are lengthened, because the speed is stepwise reduced. Also reconstructing the drive mechanism and installing a rectifier is an expensive operation.

Summary of the invention

It is, therefore, an object of the present invention to mitigate the problems described, namely to automatically control the cokery machinery, and to stop the travelling machines with a high degree of accuracy at predetermined positions without major reconstruction of existing travelling machines and tracks of coke oven plant, and to provide both a method for automatically controlling the working steps of the various travelling machines by the use of an inductive radio line system and a fixed position stopping control apparatus.

According to one feature of the present invention there is provided an automatic control system for coke oven works comprising; arranging transposed-pair-type inductive radio lines capable of data transmissions over the working steps of various travelling machines including a pusher machine, a charging car, a coke guide and a quenching car locomotive or more specifically the working steps of at least the quenching car; detecting the absolute positions of said respective travelling machines continuously in time and space at a central control system by means of a continuous address detecting mechanism resorting to an absolute address detecting method; and instructing consecutively to effect the running, stopping and working operations of travelling machines by grasping the positions and working states of said respective travelling machines, or specifically only said quenching car locomotive, on the basis of the control programmes of the respective working steps and centre addresses of the respective coke oven chamber which are stored in said central control system, the speed and work data fed from said respective travelling machines, and the positions and working states of said travelling machines. According to another feature of the present invention, there is provided a fixed position stop control apparatus in the travelling machines including a continuous absolute address detector and a speed detector, said apparatus comprising: a hydraulic disc brake mounted on the driving mechanism of said travelling machine; a controller for detecting and feeding difference between an actual speed and a predetermined speed by comparing both the distance to a stop position and the actual speed, which are continuously detected and fed by said continuous absolute address detector and said speed detector, respectively, with reference deceleration pattern which is determined from said predetermined speed and a distance to a stop position, and a hydraulic controller for continuously controlling the braking force of the said disc brake in response to the output signal of the said controller.

The drive mechanism of the travelling machines includes the electric driving motor and a reduction gear mechanism, both of which are mounted on the cars of the said machines.

Description of the drawings

Other objects, features and advantages of the present invention will become more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1A and 1B are block diagrams showing one embodiment of the automatic control system for coke oven plant according to the present invention;

Fig. 2 is a diagram illustrating the principle of an absolute address location by a phase discrimination method;

Fig. 3 is a diagram illustrating the principle of a continuous position detection;

Fig. 4 is a block diagram showing a continuous address detector;

Fig. 5 is a diagram illustrating the principle of

an absolute address location by a level discriminations method;

Figs. 6A to 6E are block diagrams illustrating the working programs of respective travelling machines;

Fig. 7 is a block diagram showing one example of a fixed position stop controller;

Fig. 8 is a chart illustrating a reference deceleration curve which is obtained from a reference velocity *v* and a distance to a stop position L;

Fig. 9 is a diagram illustrating change in the brake pressure control voltage (v) and velocity difference (Av) between the actual velocities (v) and reference velocities (v) and

Figure 10 is a diagram illustrating the braked result in terms of a stop error.

Description of the preferred embodiments

The automatic controls of respective travelling machines will be described in the following.

As shown in Figs. 1A and 1B there are arranged transposed-pair-type inductive radio cables (IR cables) which are capable of conducting data transmissions over the whole length of running path of the respective travelling machines which include a pusher machine 1, a charging car, a coke guide 3 and a quenching car locomotive 4. The radio cables (IR cable) have their matching transes 5 connected with address detectors 7, and transmitter-receivers 8 of central control system 6 for the respective travelling machines. The address detectors 7 and transmitter-receivers 8 are respectively connected through a transmission controller 9 with a main controller 10. This main controller 10 is connected with an operation and supervision console desk 11, a printer 12 and an auxiliary coking machinery controller 13.

On the pusher 1, the charging car 2, the coke guide and the quenching car locomotive 4 there are respectively mounted on-board inductive radio sets 14 so that data and instructions can be transmitted through a travelling antenna 15 between the radio sets 14 and the main controller 10 and so that the absolute addresses of the respective travelling machines 1 to 4 can be continuously located by the action of the continuous position detecting mechanism resorting to the absolute address location.

The continuous address detecting mechanism resorting to that absolute address detection is composed of an absolute address detector and a continuous address detector.

Fig. 2 illustrates the principle of the absolute address detection by the phase discrimination method. The signals, which are to be received by both phase reference pairs R having no transposition and paired lines G_0 to G_n transposed with different pitches, both belonging to the transposed-pair-type inductive radio cables (IR, cable), are binary designated so that their portions in phase with the phase reference parts R are expressed by "0" whereas their portions in opposite phase to the pairs R are expressed by "1", so that the addresses can be located by a 2^n over the whole length of the running passages of the travelling machines 1 to 4. This location is combined with a method by which the minimum transposed pitches are further continuously resolved by the continuous position detection shown in Fig. 3 because its minimum unit for the address detection is about 100mm.

Figs. 3(A) to 3(C) illustrate the principle of continuous position detection. The received levels of the minimum transposed pair lines G_0 intersecting at a predetermined period P takes their minimum at the intersection of the paired lines G_0 and their maximum at intermediate portions, and their level fluctuations can be made to take a generally sinusoidal shape by properly selecting the interval P between the intervals, the shape of the antenna and the distance between the IR cables and the travelling antenna. As illustrated in Fig. 3(A), one of the signals from an oscillator 16 is subjected to an electrical phase shift of $\pi/2$ radian. Subsequently such inductively coupled level patterns A and B as have their inductive radio line intersecting interval shifted by P/2, as shown in Fig. 3(B), are transmitted from two antennas a and b. The aforementioned signals received by the paired line G_0 are fed through a phase detector 17. As a result there can be attained such a phase shift as is proportional to the distance from the intersection, as shown in Fig. 3(C).

This change in the phase shift is converted by an A/D converter 18 to continuously generate the distances from the intersection of the antennas.

Fig. 4 is a block diagram showing one example of the present address locator. By an oscillator 16 of the inductive radio set 14 on each of the travelling machines 1 to 4, there are transmitted modulated reference pulses having a frequency f_0 for the phase reference pairs R and a frequency $2f_0$ for the respective pairs G_0 to G_n. At the respective address detectors 7 of the central control system 6 installed on the ground, the pulse signals $2f_0$ received by the respective paired lines G_0 to G_n transposed are demodulated and are discriminated whether they are in phase with or in opposite phase to the pulse signal f_0, having been received and demodulated by the reference pairs until they are stored in a data register 19.

Moreover, the distances from the intersection, which are discriminated from the phase shift in the transposed pitches P of the minimum transposed paired lines G_0 by the aforementioned continuous address location are simultaneously stored in the data register 19. The absolute addresses of the respective travelling machines over the whole length are located continuously in time and space from those composed distances, and are transmitted to and stored in the central controller 10 through the respective communication controller 9.

By using a plurality of transposed-pair-type cables H_0 to H_n which are composed of portions opened at a predetermined width and portions

densely transposed, as shown in Fig. 5, the absolute address location of 2^n can be realised by detecting the signals which are inductively coupled with the antenna at the opened portions but not at the dense portions and which correspond to the binary values "1" and "0".

Although the foregoing description has been limited to the address locations on the ground, the address of the quenching car locomotive can also be located by a similar method on the quenching car locomotive itself.

The main controller 10 serves to transmit and receive through the auxiliary cokery machinery controller 13 the instructions and data for the level of water in a reservoir, the opening and closing operations of quenching water value, and the starting and stopping operations of a quenching water supply pump with a quenching tower, the instructions and the data for full and/or empty states of the code wharf, the start and stop of a coke feeder, and troubles with the coke wharf, in addition to the instructions and data necessary for ascension pipes, coal bunker and dust remover and to store all of them.

Moreover, the main controller 10 thus far described is sorted with the control programmes of the various working steps of the travelling machines 1 to 4 shown in Fig. 6, and with the central addresses of the ovens chambers and is designed in response to data fed through the auxiliary cokery machinery controller 13, the working oven chamber data fed from the operation and supervision console desk 11, and data from the respective travelling machines 1 to 4; to transmit the starting, stopping and working instructions of the respective travelling machines 1 to 4 to the radio sets 14 of the respective travelling machines 1 to 4 through the transmission controllers 9, the transmission-receivers 8 and the transposed-pair-type radio cables (IR cable) thereby to control the respective travelling machines 1 to 4 and to receive and store the date of the working states thereby to send out the necessary data through a printer or typewriter 12.

If the main controller 10 is fed with a predetermined oven chamber number designation in accordance with the working schedule from the console desk 11, it transmits the running instructions toward a first oven chamber discharge to the pusher machine 1, the guide car 3 and the quenching car locomotive 4 in accordance with the control programmes of the working steps of the pusher machine 1, coke guide 3 and quenching car locomotive 4 stored therein, thereby to start their respective driving motors. When the pusher machine 1, the coke guide 3 and the quenching car locomotive 4 start their runs, the corresponding address locators 7 continuously locate the respective absolute addresses of the pusher machine 1, the coke guide 3 and the quenching car locomotive 4 and feed them to the main controller 10. This main controller 10 is further fed with the respective velocity signals of the pusher machine 1, the coke guide 3 and the quenching car locomotive from the respective radio sets 14 thereon through the respective transmitter-receivers 8, so that they compare and arithmetically operate without any interruption, the central address of the predetermined oven chamber, the speed data of the pusher machine 1, the coke guide 3 and the quenching car locomotive 4, and the respective braking programs of the present positions, all of which are stored therein, thereby to determine brake instructing positions. When these brake instructing positions are reached, the central controller 10 transmits the respective braking instructions in response to the respective braking programmes stored in advance, to actuate the respective brakes of the pusher machine 1, the coke guide 3 and the quenching car locomotive 4 so that they may be stopped at the centre address of the first oven chamber.

When the main controller 10 confirms, from the comparisons with the absolute addresses fed from the respective address detector 7, so that the pusher machine 1, the coke guide 3 and the quenching car locomotive 4 have been stopped at the centre address of the predetermined oven chamber it transmits a coke oven door-removing instruction to the pusher machine 1 and the coke guide 3 in response to the control programme of the working steps to actuate the door lifting machine of the pusher machine 1 and the guide car 3 thereby to remove the coke oven door.

When these coke oven door removing operations have been completed, an end signal is transmitted through the radio sets 14 of the pusher machine 1 and the coke guide 4. The main controller 10 then transmits a guide mounting instruction and a connecting duct advancing instruction for dust removal to the coke guide 3 so that guide mounting cylinder and a connecting duct actuating cylinder are operated to mount the guide and to advance the connecting duct until the latter is connected to a main duct.

The main controller 10 transmits a coke oven door cleaning instruction to the pusher machine/and coke guide 3 so that a door cleaning machine may be actuated to clean the coke oven door. When the guide mounting and connecting duct advancing are ended, an end signal is fed from the radio set 14 of the coke guide 3 to the main controller 10.

Simultaneously with the aforementioned collecting duct-advancing instruction, the main controller 10 transmits ground based, blower starting instruction for a guiding operation to the auxiliary cokery machinery controller 13 so that the ground blower may be started.

When the main controller 10 confirms that the operations thus far described have been completed, it transmits both a pusher ram advancing instruction to the pusher machine 1 so that the pusher ram may be advanced and a starting instruction to the quenching car locomotive 4 so that the quenching car locomotive 5 may be run in synchronism with the advancing speed of the pusher ram.

The main controller 10 receives from the pusher machine 1 at the advanced end of the pusher ram a signal of completion of the pushing and then transmits a stopping instruction to the quenching car locomotive 4 so as to stop it and simultaneously transmits a retracting instruction to the pusher ram so as to retract it.

Subsequently, when the main controller 10 transmits a running instruction to the quenching car locomotive 4 so that the quenching car locomotive 4 starts its run to the quenching tower, the central controller 10 compares and arithmetically operates the address of the quenching car locomotive 4, which is continuously fed from the locator 7 of the address of the quenching car locomotive 4, the speed data, which are fed from the quenching car locomotive 4, and the address of the stop position in the quenching tower and the braking programme, which are stored therein, thereby to determine a braking instruction address. When this braking instruction position is reached, the main controller 10 transmits the braking instruction on the basis of the braking programme so that the quenching car locomotive 4 is accurately stopped at the stop position in the quenching tower in accordance with a predetermined deceleration value.

The main controller 10 transmits to the auxiliary cokery machinery controller 13 a quench water supplying instruction to the quenching tower after it has confirmed that the quenching car locomotive 4 has been stopped at a predetermined address.

When fed with a drainage ending signal, after the coke quenching operation, the main controller 10 transmits such a running instruction to the quenching car locomotive 4 as to run to the coke wharf. When the quenching car locomotive 4 starts its run to the coke wharf, the main controller 10 selects an appointed coke wharf on the basis of the data fed from the coke wharf and arithmetically determines a braking instructing address on the basis of the quenching car locomotive 4, which is fed from the address detector 7, the speed data which is fed from the quenching car locomotive and the central address of the coke wharf selected as well as on the basis of the braking programme. When the quenching car locomotive 4 reaches the instructed braking address, the main controller 10 transmits a braking instruction on the basis of the braking programme so that the quenching car locomotive 4 is stopped at the central address of the coke wharf selected in accordance with the predetermined deceleration value.

After having confirmed that the quenching car locomotive 4 was stopped, the main controller 10 transmits a coke dumping instruction to the quenching car locomotive 4 so that the coke unloading door of quenching car is opened and closed to dump the coke to the coke wharf.

When fed with the pusher ram ending signal from the pusher machine 1, the main controller 10 transmits both a guide-retracting instruction and a connecting duct-retracting instruction to the coke guide 3 and ground exhauster stopping for the guide operation to the auxiliary cokery machinery controller 13 thereby partly to retract the coke guide and the connecting duct and partly to stop the earth exhauster.

When fed with coke guide and connecting duct retraction completing signals, the main controller 10 transmits a frame sheet cleaning instruction to the pusher machine 1 and coke guide 3 after it has confirmed that an oven door cleaning completing signal from the pusher machines and the guide 3, so that the sheet cleaning machine is advanced to clean the frame sheet.

When fed with the frame sheet cleaning completing signal from the pusher machine 1 and the coke guide 3, the main controller 10 transmits a coke oven door closing instruction to the pusher machine 1 and the coke guide 3 so that lifting machine is advanced to attach the coke oven door.

When fed with a coke oven door attachment-completing signal from the pusher machine 1 and the coke guide 3, the main controller 10 transmits such a running signal to the pusher machine 1, the coke guide 3 and the quenching car locomotive 4 as to run to a second oven chamber to be discharged and subsequently provides instructions similar to the aforementioned ones.

The charging car 2 starts its running operations in response to the running instruction to coal bunker at the time when the main controller 10 transmits such running instruction to the pusher machine 1, the coke guide 3 and the quenching car locomotive 4 as to run the first oven to be discharged. The main controller 10 determines a braking instruction address by comparing and arithmetically operating the central address of a coal receiving position, which is selected on the basis of both the address data fed from continuously the address locator 7 of the charging car and the data fed from a coal bunker, the speed data fed from the charging car 2, and the braking programme stored. When the charging car 2 reaches the brake instructing address, the main controller 10 transmits a braking instruction in response to the braking programme so that the charging car 2 is stopped accurately at the central address of the coal receiving position selected in accordance with a predetermined deceleration value.

After it has been confirmed that the charging car 2 was stopped at the coal receiving address, the main controller 10 transmits a coal receiving instruction to the charging car so that a coal tower cutting gate is opened and closed to load a predetermined quantity of coal.

When fed with a coal reception completing signal from the charging car 2, the main controller 10 transmits a running instruction to an oven to be charged, i.e. the first oven to be discharged so that the charging car 2 is run.

When the charging car 2 starts its run, the main controller 10 determines a brake instructing address by executing the comparisons and

arithmetic operations in response to the address data fed from the address detector 7 of the charging car 2, the speed data fed from the charging car 2, and the central address of the oven chamber to be charged and the braking programme both stored therein. When the charging car 2 reached the brake instruction address, the main controller 10 transmits on the basis of the braking programme so that the charging car 2 is stopped accurately at the central position of the oven chamber to be charged in accordance with a predetermined deceleration value.

After having confirmed that the charging car 2 has stopped at the central address of the oven of the number to be charged, that it is fed with a coke oven door attachment completing signal from the pusher machine 1 and the coke guide 3, and that the pusher machine 1 has stopped at the address of the second oven chamber to be discharged, the main controller 10 transmits an ascension pipe edging instruction, a high-pressure gas liquor injecting instruction and a ground based exhauster starting instruction for the charging operation to the auxiliary cokery machinery controller 13 thereby to close a top cover and to open a dish-shaped valve, to open a high pressure gas liquor valve and to start a ground based blower for the charging operation.

When fed with an ascension pipe edging completing signal, a high pressure gas liquor valve opening completing signal and a ground based exhauster start completing signal for the charging operation, the main controller 10 transmits a charging hole lid-opening instruction, an oven top-cleaning instruction, a dust removal connecting duct advancing instruction and a preduster on the charging car 2 starting signal to the charging car 2 to actuate a lifting magnet thereby to open a charging hole lid, to start an oven top cleaner, to connect a dust removal connecting duct, and to start a pre duster on the charging car.

When fed with a charging hole lid-opening completing signal, dust removal connecting duct-connection completing signal and a pre-duster on the charging car start completing signal, the main controller 10 transmits a drop sleeve descending signal to the charging car 2 so that the drop sleeve is mounted in a charging hole. When a drop sleeve mount-completing signal is received, the main controller 10 transmits a charge-starting instruction to the charging car 2 so that a table feeder is drained to start the charging operation. At the time a predetermined amount of coal is charged, a levelling door opening instruction is transmitted from the main controller 10 to the pusher machine 1 so that the levelling drop opening and closing device of the pusher machine 1 is actuated to open a levelling door and to mount a levelling chute in a levelling hole.

When fed with a levelling door opening-completing signal from the pusher machine 1 and a levelling starting signal from the charging car 2, the main controller 10 transmits a levelling operation starting instruction to the pusher machine 1 so that a leveller is reciprocated to conduct its levelling operation.

When fed with a charge completing signal from the charging car 2, the main controller 10 transmits a leveller retracting instruction to the pusher machine 1 to retract both the leveller and the levelling chute. Meanwhile, the main controller 10 has already beed fed with the oven top cleaning completing signal.

When fed with a levelling operation completing signal from the pusher machine 1, the main controller 10 transmits both a levelling door closing instruction to the pushing machine 1 to close the levelling door and a drop sleeve lifting instruction to the charging car 2.

When fed with a drop sleeve lift completing signal, the main controller 10 transmits a charging hole lid mounting instruction to the charging car 2 so that the lifting magnet is actuated to mount the charging hole lid.

When fed with a lifting magnet mount completing signal, the main controller 10 transmits a pre duster on the charging car stopping instruction and connecting duct retraction instruction to the charging car 2 to stop the hover of preduster and to retract and transmit a ground based exhauster collecting blower stopping instruction for the charging car and a high pressure gas liquor valve closing instruction to the auxiliary coking machinery controller 13 to stop a ground exhauster for the charging operation and to close a high pressure gas liquor valve.

When fed with a preduster on the charging car stop completing signal, a connecting duct retraction-completing signal, a ground based exhauster stopping signal and a high pressure gas liquor valve closing signal, the main controller 10 transmits the charging car 2 to run to its coal receiving address.

Meanwhile, the pusher machine 1, the coke guide 3 and quenching car locomotive 4 are being instructed to discharge works of the second oven chamber.

The various travelling machines are automatically controlled by repeating the steps described.

As hereinbefore described, according to the present invention, since the transposed pair-type inductive radio cables are arranged over the whole length of the running paths of the respective travelling machines, and since the absolute addresses of the travelling machines are continuously located at the central control system by the continuous address detecting mechanism resorting to the absolute address detecting method, the addresses can be located accurately in steps of 10mm for example, with no requirement for any mechanical contact mechanism such as the idle wheel rotating system or any error due to slippage or the like. Although the present invention is directed to the contactless address detection it can sufficiently cope with the changes in the relative positions

between 1R cables and travelling antenna as large as 300mm in the vertical and horizontal directions.

For the breaking decelerations and the stops of the respective travelling machines, proper braking operations can be ensured in accordance with the deceleration values stored in advance in the computer by comparing without interruption the signal of the speed detector carried on the travelling machines and the present addresses detected by the inductive radio address detection so that the travelling machines can be stopped with remarkable accuracy at fixed positions.

While the foregoing description is directed to the automatic control of the working operations of all the travelling machines, the present invention is also effective in the automatic control of the quenching car only, i.e. the remote control of the run of the quenching car, which is made coactive with the pusher machine to conduct the loading operation of red-hot coke. In this instance it is sufficient to arrange transposed-pair-type inductive radio cables which are capable of data transmissions over the whole length of the running path of the quenching car; to continuously locate the absolute address of the quenching car at an on-board controller for quenching car controller in place of the foregoing main control system by means of a continuous address detecting mechanism resorting to the absolute address detection, and to instruct the running and stopping operations of the quenching car and the loading and dumping operations of coke consecutively in accordance with the working steps in response to the working step control programme, the central addresses of the respective oven chamber, the quenching tower stopping position addresses, and the central addresses of the respective coke wharfs, all of which are stored in the said controller, and in response to the speed data and working step data of the pusher machine. The specific explanations of the operations referred to above are similar to those of the whole working steps, and they are accordingly have not been included.

When the central addresses of the respective oven chambers are to be stored in the on-board controller for quenching car controller, the displacement in the relative positions of the respective central oven addresses due to the extension and contraction of the coke oven is corrected by adding a function to correct the central oven addresses in accordance with the season and weather conditions so that the detecting accuracy can be maintained.

If the power supply is interrupted, it is possible to detect the present address thereby to continue the works, due to the advantage of the present invention at the instant when the power supply is restored.

An embodiment of an apparatus for controlling the stops of the travelling machines at fixed position will now be described.

The following description is directed to a coke oven plant equipped with an absolute address detector having transposed-pair-type cables of a detection unit of 10mm.

The said detector is made operative partly to detect the positions as addresses of 2^n over the whole length of the running path of the quenching car by designating the signals, which are received by the untransposed phase reference pairs and the respective pairs transposed at different pitches in the transposed-pair-type cables, their portions in phase with the phase reference pairs being designated "0" whereas their portions in opposite phase are designated "1" and partly to locate the addresses at a unit not exceeding 5mm by detecting the phases of the signals which are received by the minimum transposed pairs.

As shown more specifically in Fig. 7 transposed-pair-type inductive radio cables 20 are arranged along the tracks of the quenching car locomotive 4 and are connected through an approach cable 21 with an oscillator 22 installed on the ground. On the quenching car locomotive 4, on the other hand, there are carried a controller 23 having a built-in address detector, a travelling antenna 24, and a speed detector 25. To an A.C. electric motor 26 for driving the quenching car locomotive 4, moreover, there is attached a hydraulic disc brake 27 to which a hydraulic controller 28 connected to the on-board controller 23 is connected.

As shown in Fig. 8, on the other hand, the controller 23 is fed and stored with a reference distance-velocity pattern relative to a stopping target position P.

Thus the signals transmitted from the oscillator 22 are received through the transposed-pair-type inductive radio cables 20 by a travelling antenna 24. When the distances of the addresses of the quenching car locomotive 4 located by the on-board controller 23 relative to the target position P are changed as indicated at l_n, l_{n-1}, l_{n-2}, and so one, the on-board controller 23 transmits the control signals V_v, which are computed by the following equation, as shown in Fig. 9 in accordance with the difference Δv between the actual velocities v'_n, v'_{n-1}, v'_{n-2} and so on at the respective instants, which are fed from the speed oscillator 25 to the on-board controller 23, and the reference velocities v_n, v_{n-1}, v_{n-2}, and so on so that the oil pressure of the hydraulic disc brake 27 may be controlled to regulate the braking pressure thereby to stop the quenching car 4 accurately at the stopping target P:

$$V_c = V_p - K_1 \Delta v - K_2 \int \Delta v dt$$

wherein:

V_p: the reference voltage at the reference deceleration;

K_1 and K_2: control constants; and

V_c: brake pressure control voltage.

In this instance the hydraulic disc brake 27 has little self-boosting action, because it is constructed so that it applies a pad to the surface of the rotating disc, whereby the brake torque

obtained is proportional to the brake controlling oil pressure. Since an equal brake is ensured for either forward or backward due to the lack of a self-boosting force, the quenching car locomotive 4 can be stopped with great accuracy at the stopping target point P.

The result in the present invention is applied to the quenching car locomotive 4 which is equipped with the absolute address detecting method having the herein before described transposed-pair-type inductive radio lines and which is controlled in a notched manner by the drive of an A.C. electric motor, is illustrated in Fig. 10. From this Figure, it is to be understood that the present invention has succeeded in stopping the quenching car locomotive correctly with an accuracy within a range of +5mm to −15mm with respect to the stopping target position.

As hereinbefore described, according to the present invention the hydraulic disc brakes are incorporated as the drive mechanisms of the travelling machines, and the continuously detected actual velocities are compared with the reference velocity curve, which has been determined from the predetermined velocity and from the distance to the stop position, so that the braking pressure is adjusted for the deceleration continuously on the basis of the compared difference. As a result it is possible to stop the travelling machines at the predetermined addresses within a shorter period that has hitherto been possible, in which the deceleration is stepwise effected with no delay in the oven unloading time period. Thus the practice of present invention makes a significant contribution to the operation of coke oven plant.

In its broadest aspect the invention comprises a travelling machine including a continuous address detector and a speed detector: a fixed position stop control apparatus comprising

a) a hydraulic disc brake mounted on the drive mechanism of said working machine;

b) a controller for detecting and feeding a difference between an actual velocity and a predetermined running velocity curve by comparing both the distance to a stop position and the actual velocity, which are continuously detected and fed by said continuous address detector and said speed detector, respectively, with the reference deceleration pattern which is determined from said predetermined running velocity and a distance to a stop position; and

c) hydraulic controller for continuously controlling the braking force of said disc brake on the basis of the output signal of said controller.

Claims

1. An automatic control system for cokery machinery comprising:

a) arranging transposed-pair-type inductive radio lines capable of data transmissions over the whole length of the running path of travelling machines including a pusher machine, a charging car, a coke guide and a quenching car locomotive;

b) detecting the absolute addresses of said travelling machines continuously in time and space at a main control system by means of a continuous position detecting mechanism resorting to an absolute address detecting method; and

c) instructing consecutively to effect the running, stopping and working operations of said travelling machines by grasping the positions and working states of the said respective travelling machines on the basis of the control programmes of the respective central addresses and the respective working steps which are stored in the said main controller, the speed and work data fed from the said respective travelling machines, and the positions and working states of said respective travelling machines.

2. An automatic run control method for automatically controlling the quenching car locomotive of a coke oven plant which is operative to receive red hot coke from a oven chamber in cooperation with a pusher machine and a coke guide, comprising the steps

a) arranging transposed-pair-type inductive ratio lines capable of data transmissions over the whole length of the running path of the said quenching car locomotive;

b) detecting the absolute position of the said quenching car continuously in time and space at an on-board controller for quenching car locomotive controller by means of a continuously position-detecting mechanism resorting to an absolute address detecting method; and

c) instructing to consecutively effect the running, stopping, loading and dumping operations of the said quenching car locomotive and quenching car in accordance with the working steps on the basis of a working step control programmes of each oven centering address, quenching tower stop position address and each coke wharf central position address which are stored in the said on-board controller for quenching car locomotive, the speed data fed from said quenching car locomotive and the working data of said pusher machine.

3. A travelling machine including a continuous address detector and a speed detector; a fixed position stop control apparatus comprising

a) a hydraulic disc brake mounted on the drive mechanism of said working machine;

b) a controller for detecting and feeding a difference between an actual velocity and a predetermined running velocity curve by comparing both the distance to a stop position and the actual velocity, which are continuously detected and fed by said continuous address detector and said speed detector, respectively, with the reference deceleration pattern which is determined from said predetermined running velocity and a distance to a stop position; and

c) hydraulic controller for continuously controlling the braking force of said disc brake on the basis of the output signal of said controller.

4. An automatic control system for coking installations as claimed in claim 1 or claim 2, substantially as hereinbefore described and with particular reference to the accompanying drawings.

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