

United States Patent

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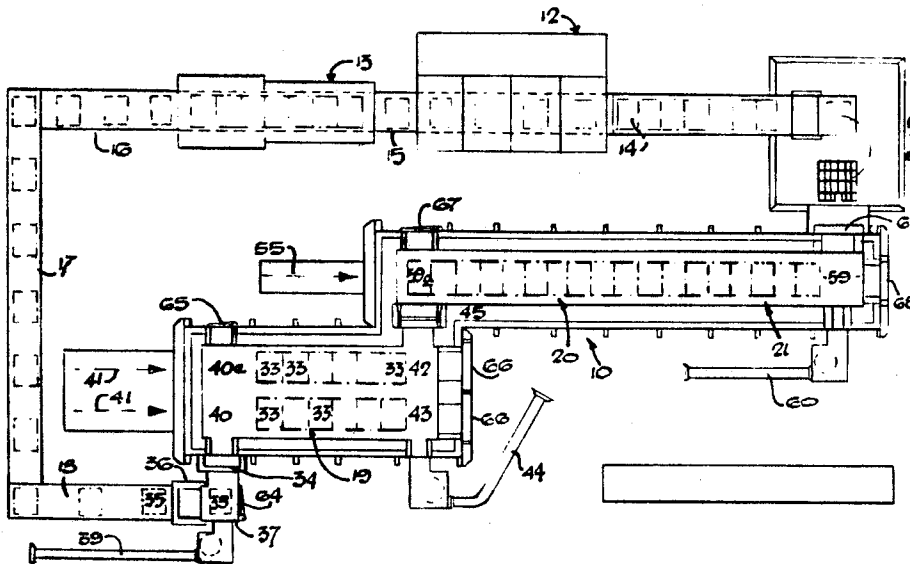
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[54] CONTINUOUS CARBURIZING FURNACE 10 Claims, 7 Drawing Figs.

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148/16.5, 263/8
[51] Int. Cl. C21d 9/00
[50] Field of Search. 266/5, 5 T,
5 E, 24; 148/16.5; 263/36, 37, 38, 6, 8

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ABSTRACT: A continuous carburizing furnace comprising a heating chamber having inlet door means through which, when open, work can be fed into the chamber, a carburizing chamber, interconnecting door means between the chambers through which, when open, work can be fed from the heating chamber to the carburizing chamber, first feeding means for feeding work fed into the heating chamber into a transfer position within said chamber, second feeding means for feeding work from the transfer position through the interconnecting door means when open to a feed position in the carburizing chamber, third feeding means for feeding work from the feed position towards outlet door means of the furnace and means for operating the interconnecting door means when at least the inlet door means are closed.



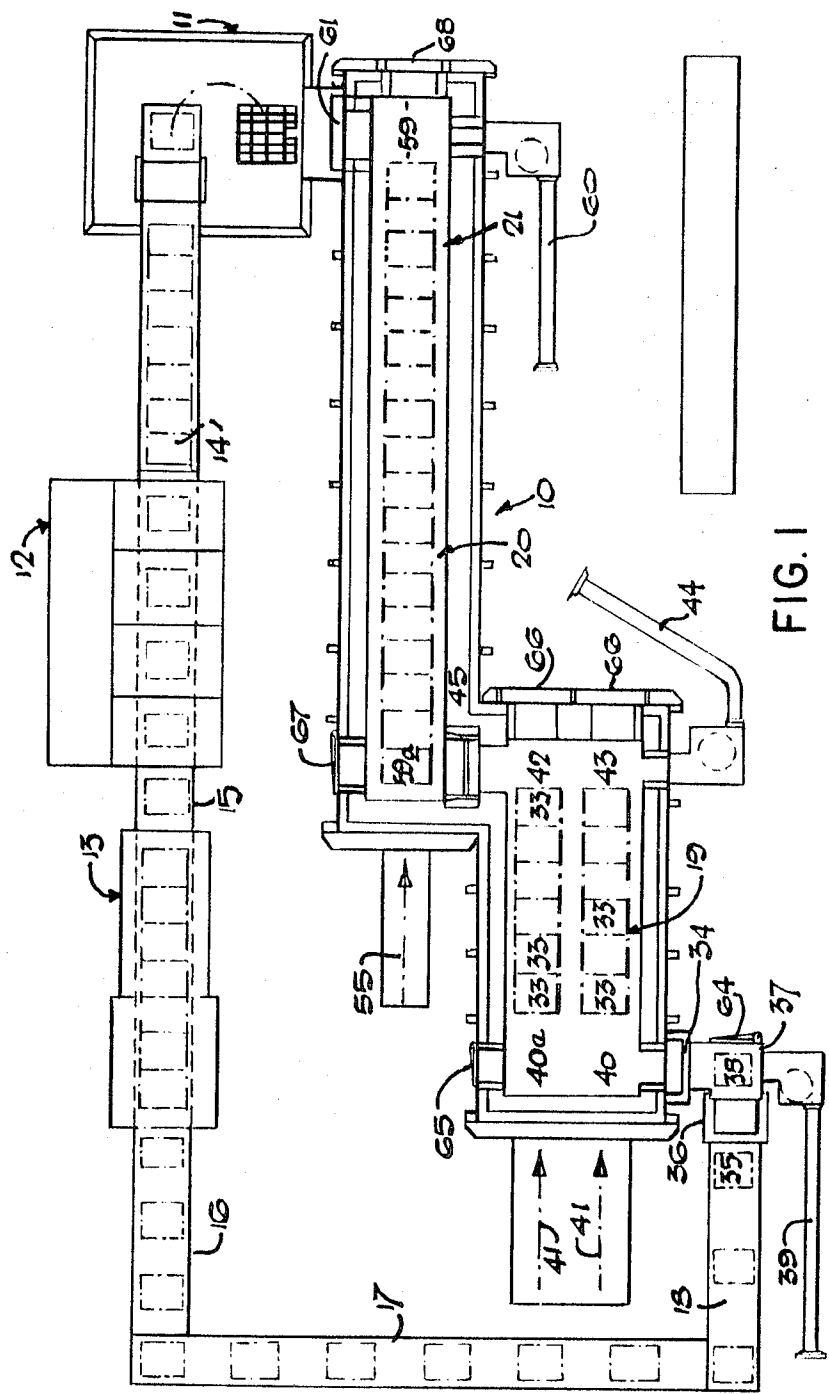
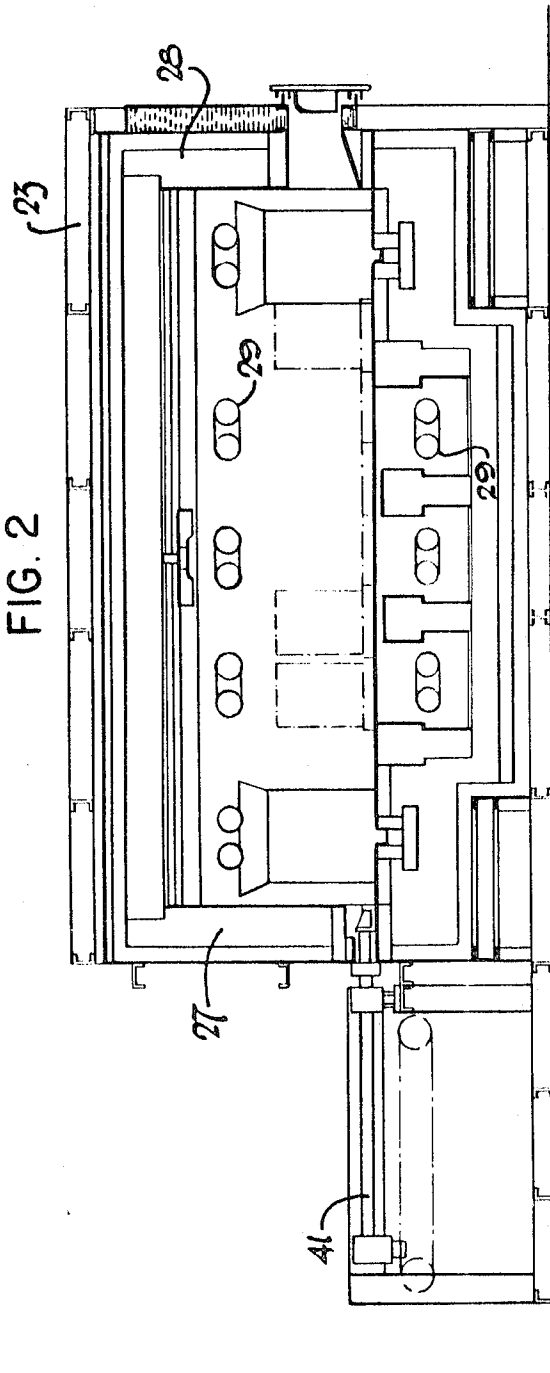


FIG. 1

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FIG. 2



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FIG. 5

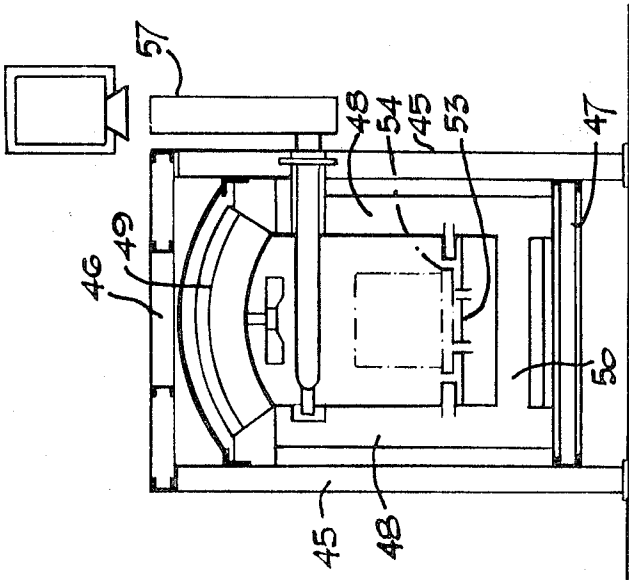
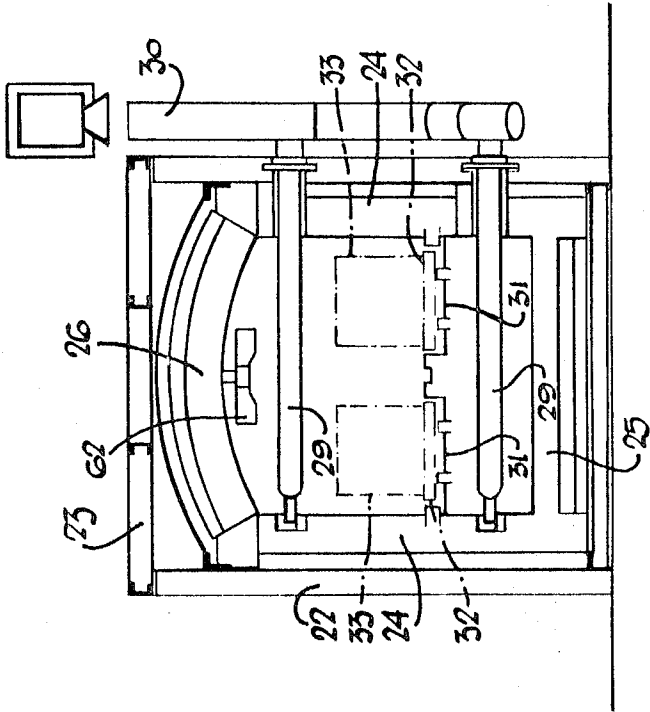


FIG. 3

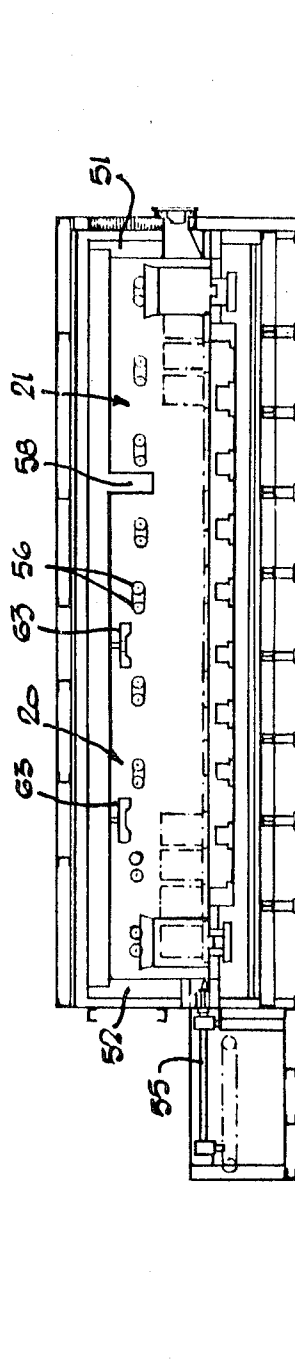


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FIG. 4



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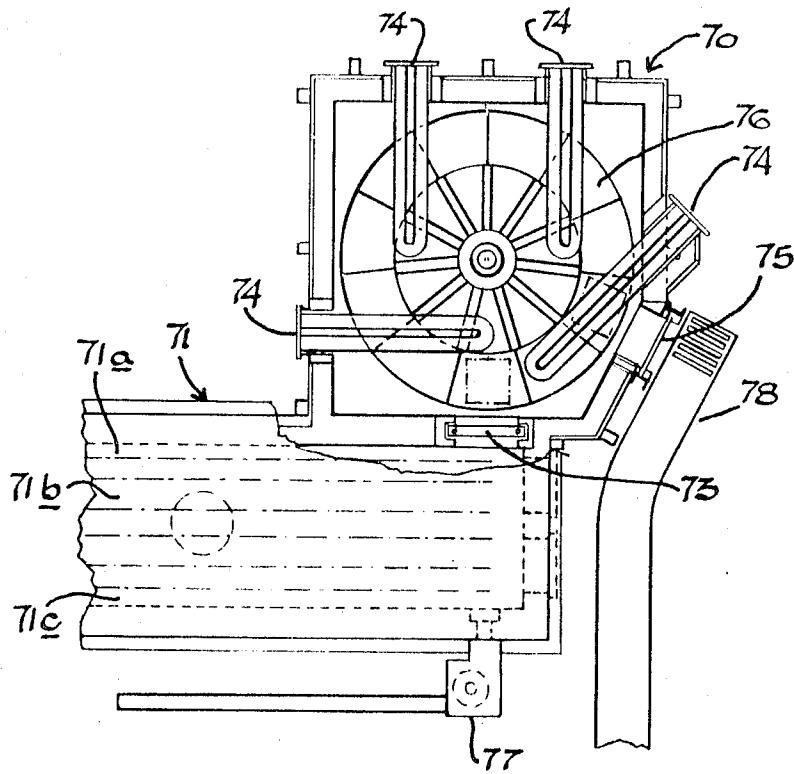


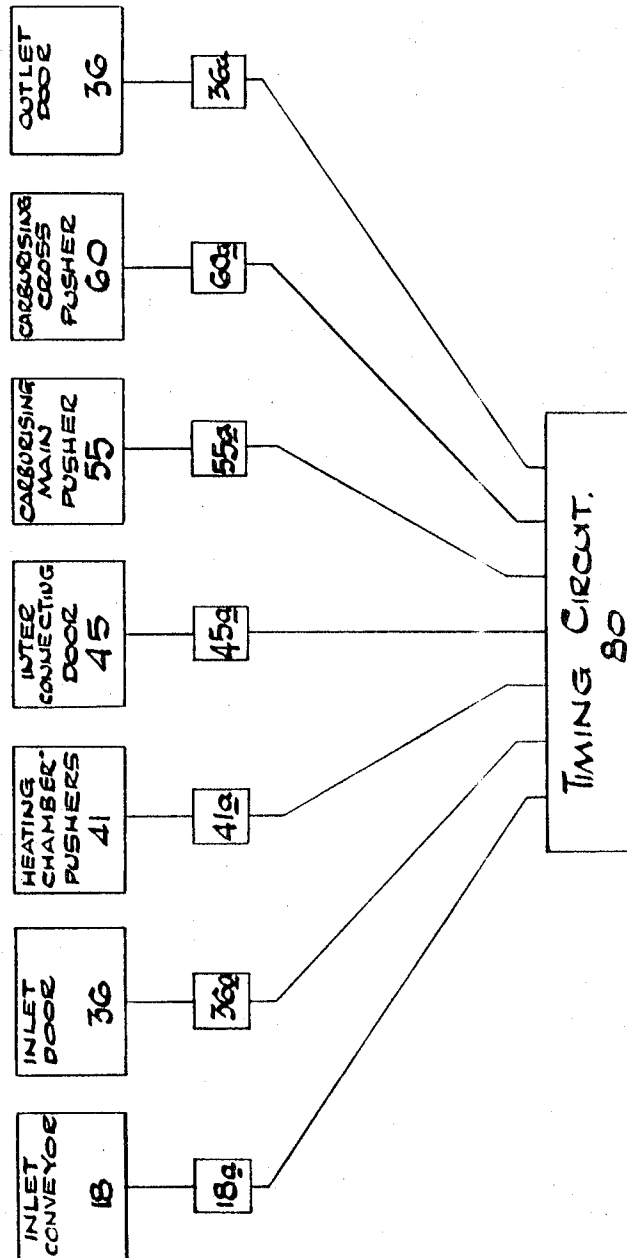
FIG. 6

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FIG. 7



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CONTINUOUS CARBURIZING FURNACE

BACKGROUND OF THE INVENTION

The invention relates to heat treating furnaces, particularly to continuous carburizing. The invention also relates to the method of heat treating, especially carburizing. In this specification, the word carburizing is intended to include carbonitriding.

Continuous carburizing is carried out using the gas carburizing method and the carburizing is carried out in three stages. Firstly, the work is heated to carburizing temperature in a gaseous atmosphere which prevents scaling or decarburization. Secondly, the work is heated in an atmosphere which has been carbon enriched which causes carbon to penetrate into the work. The length of time which the work is exposed to the carbon enriched atmosphere controls the depth of penetration of the carbon. Thirdly, the work is subjected to a diffusion period during which the carbon content of the atmosphere is adjusted to be in equilibrium with the desired carbon content in the surface of the work. The diffusion period allows the high surface carbon which is produced during the carburizing period to diffuse to produce a case upon the work which has the required carbon gradient from the interior of the work to the external surface thereof.

In previously known continuous carburizing furnaces, all three of these stages are carried out in what amounts to a single chamber. This is usually an elongated chamber in which the work is fed in at one end and is removed at the other. Since the chamber is usually full of work, inlet and outlet doors at the ends of the chamber have to be open at the same time to enable new work to be fed in and carburized work to be removed and as a result the atmosphere in the chamber migrates from one section to another.

It is thus difficult, in prior known furnaces, precisely to determine the boundaries of the heating, carburizing and diffusing zones. Since the degree of carburization depends on the time which the work is in the carburizing atmosphere and since this is determined in turn by the rate of feed of work through the chamber, migration of the carburizing atmosphere from the carburizing zone has an effect on the rate at which carburization is effected. This makes it difficult, inter alia, to control the carburizing depth in components of different section passing through the furnace, and even in different parts of the same component presenting different sections respectively.

Prior furnaces are controlled by controlling the carbon enrichment of the atmosphere in the various sections of the furnace but since the atmosphere can migrate from one section to another it is difficult to maintain entirely the desired atmosphere in each section. It is therefore necessary, to some extent, to run prior art furnaces on a trial and error basis.

The object of the present invention is to enable closer control to be obtained over the carburizing process.

According to one aspect of the invention, we provide a continuous carburizing furnace comprising a heating chamber having inlet door means through which, when open, work can be fed into the chamber a carburizing chamber, interconnecting door means between the chambers through which, when open, work can be fed from the feeding chamber to the carburizing chamber, first feeding means for feeding work fed into the heating chamber into a transfer position within said chamber, second feeding means for feeding work from the transfer position through the interconnecting door means when open to a feed position in the carburizing chamber, third feeding means for feeding work from the feed position towards outlet door means of the furnace and means for operating the interconnecting door means when at least the inlet door means are closed.

By this arrangement, the interconnecting door means can be closed when it is desired to feed new work into the feeding chamber. The inlet door means can then be opened and the work can be fed in. Since the interconnecting door means are

closed, there will be no migration of atmosphere from the heating chamber to the carburizing chamber. When the work is in the heating chamber, the inlet door means can be closed and the interconnecting door means can be opened and work can be fed from the heating chamber to the carburizing chamber. There may be a small migration of atmosphere from one chamber to the other, but since the inlet door means is closed, there will be no air or gas flow tending to cause such migration.

According to a further aspect of the invention, we provide a continuous method of carburizing comprising passing work into a heating chamber in which the work is heated in a non-carburizing atmosphere, passing the work from the heating chamber to a carburizing chamber in which the work is heated in a carburizing atmosphere, passing the work from the carburizing chamber into a diffusing chamber and subsequently out of the diffusing chamber, characterized in that migration of the atmosphere between the heating and carburizing chambers is controlled by cutting off communication between the heating and carburizing chambers during the time that work is fed into the heating chamber.

Where the carburizing chamber and the diffusing chamber are in communication, the heating and carburizing chambers will be put out of communication also while the work is removed from the diffusing chamber. This may occur simultaneously with the feed of work into the heating chamber. Alternatively, feed of work into the heating chamber may be effected at a different (nonoverlapping) time with feed of work out of the diffusing chamber.

The invention will now be described in detail by way of example with reference to the accompanying drawings in which:

FIG. 1 is a plan view of a complete carburizing plant including a carburizing furnace embodying the invention.

FIG. 2 is a longitudinal vertical section through the heating section of the furnace shown in FIG. 1.

FIG. 3 is a transverse section of the heating section of the furnace.

FIG. 4 is a longitudinal, vertical section of the carburizing section of the furnace.

FIG. 5 is a transverse cross section of the carburizing section of the furnace.

FIG. 6 is a fragmentary view of a modification in which a rotary hearth diffuser is provided, and

FIG. 7 is a schematic circuit diagram of a control system for the door and feed means of the furnace.

Referring to FIG. 1, the carburizing furnace is indicated generally at 10. The carburizing plant also includes a quench tank 11 which is conveniently of the type described in patent specification No. 987,338; a washer 12 and a tempering furnace 13 which may be electric. A conveyor 14 conveys the work from the quench tank to the washer, a conveyor 15 which conveys the work from the washer to the tempering furnace and a conveyor 16 conveys the work from the tempering furnace. The conveyor 16 leads to a length of conveyor 17 from which the work can be unloaded and onto which fresh work is loaded. The work is supported in jigs and the jigs are mounted on trays. The jigs are so arranged that the whole of the surface of the work which is required to be carburized is open to the carburizing atmosphere when the work is in the carburizing chamber. A further length of conveyor 18 leads from the conveyor 17 to introduce new work into the furnace.

The furnace comprises a heating section indicated generally at 19, a carburizing section indicated generally at 20, and a diffusing section indicated generally at 21. The carburizing section 20 and the diffusing section 21 form parts of the same chamber.

Referring first to the heating section 19 and thus to FIGS. 1, 2, and 3, the section comprises a supporting framework having vertical side members 22 and an upper horizontal frame 23. A chamber is formed within the framework having sidewalls 24 of refractory material, a base 25 and a roof 26 also of refractory material. End walls 27 and 28 are also provided and are likewise formed of refractory material. Extending between the

sidewalls 24 are a number of pairs of radiant tube burners some of which are indicated at 29 and which exhaust into duct work indicated generally at 30. The heating chamber includes two spaced tracks 31 to receive work which is indicated in FIG. 3 by two trays 32 carrying work loads occupying positions indicated at 33. Some of the radiant tube burners 29 are above the work and some below as is clearly seen from FIGS. 2 and 3.

The work may be arranged in one or more rows and typically as seen in FIG. 1 is arranged in two rows, each of the rows being supported on one of the tracks 31. The work is introduced into the heating chamber through inlet door means indicated at 34 in FIG. 1. A tray of work occupying a position indicated at 35 in FIG. 1 is fed through a door 36 into a vestibule 37 so that it assumes the position 38. From this position it is pushed by means of a pusher 39 through the inlet door means 34 to the interior of the heating chamber to assume a position indicated at 40a or 40.

Mounted at the bottom of the end wall 27 is a first feed means comprising two pushers 41 which may be mechanically linked, and are arranged side by side so that one of the pushers can engage a tray in the position 40. The pushers then push the tray into the appropriate row shown in FIG. 1 and push the row to the right in that figure.

When a tray reaches a transfer position 42 or 43 in the heating chamber, it is then advanced by a second feed means comprising a pusher 44 movable transversely of the rows in the heating chamber through interconnecting door means 45 into the carburizing chamber 20. Although, again, the work can be arranged in more than one row in the carburizing chamber, it is shown in FIG. 1 arranged in a single row. After displacement by pusher 44 each tray will then be in the position 59a ready for movement along the carburizing chamber.

The carburizing chamber is constructed in a similar manner to heating chamber having a steel framework with uprights 45 and an upper and lower horizontal frame 46 and 47 respectively. The chamber has sidewalls 48, a roof 49, a base 50 and end walls 51 and 52. These walls are all formed with refractory material. A track 53 is shown in FIG. 5 is provided for a single row of trays.

Adjacent to the base of the end wall 52 is a third feed means comprising a pusher 55 which can be operated to advance the trays along the carburizing chamber. The carburizing chamber had radiant tube burners such as indicated at 56 arranged above the work and these radiant tube burners exhaust into duct means 57.

Part way along the carburizing chamber there is a baffle 58 extending from the roof of the chamber to adjacent the top of the work on the trays and this baffle divides the chamber into the carburizing section 20 and the diffusing section 21.

Upon arrival at the position 59, each tray can be pushed by means of a pusher 60 through outlet door means 61 into the quench tank 11 lowerator platform.

The heating chamber is provided with a central roof fan 62 and the carburizing chamber with two such fans 63. Various access doors are provided, thus there is a first access door 64 in the vestibule 37, an access door 65 in the heating chamber opposite to the inlet door means 34, access doors 66 in the heating chamber in the end wall 28, an access door 67 in the carburizing chamber opposite to the interconnecting door means 45 and an access door 68 in the end wall 51 of the carburizing chamber.

In the modification illustrated in FIG. 6, a diffusing chamber 70 is provided at the downstream end of the carburizing chamber 71 in laterally offset relation thereto. The diffusing chamber is not permanently in communication with the carburizing chamber, such communication being controlled by a second interconnecting door means 73.

The carburizing chamber itself is equipped with heating elements in the form of radiant tube burners 74, and the feed means provided in the diffusing chamber for advancement of the work trays to an outlet door means 75 comprises a rotary hearth or platform 76 which may be driven continuously or intermittently as required.

In this modification the carburizing chamber includes three trackways 71a 71b 71c for rows of work trays advanced in this case by a feed means similar to that shown at 55 in FIG. 1, but including three separate pusher devices, one for each of the trackways.

A discharge pusher device operating laterally of the trackways is provided at 77 and operates in a manner similar to the pusher device 60 already mentioned.

Upon emergence from the outlet door means 75, the work supporting trays are moved along a conveyor 78 which may be a roller conveyor.

For effecting operation of each of the door means and the feeding means in the required sequence, each of these means is provided with an individually energized operating device which may be either pneumatic or electrical.

Conveniently the door means are operated by pneumatic piston and cylinder units, and the feed means, that is to say each pusher device, is operated by means of an electric motor.

The arrangement is illustrated schematically in FIG. 7, wherein the various doors, conveyors, and pushers are shown connected to respective operating devices designated by a like numeral of reference with a suffix a.

An electrical timing circuit 80 provides the requisite output signals to control operation of each operating device at the required time.

Where the operating devices are pneumatic piston and cylinder units, the requisite control may be effected by means of a solenoid valve controlled by an electrical signal from the timing circuit, and in the case where the operating device is an electric motor, the timing circuit can supply the requisite signal to operate switch means for the electric motor.

The operation of the furnace is as follows:

It is assumed that the outlet door means 61 has just closed after the pusher 60 has moved the tray containing the work load from the position 59 onto the platform of the quench tank 11 preparatory to lowering said platform. All other door means of the furnace at this time will be closed, the positions 38, 39, 40, 42, 43, 59a and 59 will all be vacant.

To effect advancement of the work through the furnace the inlet door means 36 is opened and a tray containing a work load is moved from the position 35 to the position 38 in the inlet vestibule 37 by a beam and pawl feeding means incorporated in the conveyor 18.

The inlet door means 36 then closes and upon arrival at the closed position the inlet door means 34 is opened. The tray containing or supporting the work load is then moved, at right angles to its direction of advancement by the conveyor 18 through the opening afforded by the open door means 34 into either the position 39, or the position 40, according to which of the two rows of trays in the heating section 19 of the furnace is due for advancement (that is to say the track which was not advanced in the preceding cycle of operations). In some cases, however, both rows of trays may be advanced together where the carburizing section has tracks for accommodating same.

The twin pusher 41 is then operated, and that driving element thereof which is aligned with the position 39 or 40 into which the tray has been delivered, will thereby cause the end tray of the associated track to be delivered into the position 42 or 43 as the case may be.

The interconnecting door means 45 is then opened and the pusher 44 is operated to move the tray occupying the position 42, or the position 43, through the opening afforded by the door means 45 into the position 59a. It will be noted that the direction of movement of the tray in this direction is at right angles in its direction of advancement through the heating section 19 and through the carburizing and diffusing sections 20 and 21 of the furnace.

The interconnecting door means 45 now closes, and the pusher 55 is operated to advance all the trays and work loads situated in the sections 20 and 21 to bring the foremost and its work load into the position 59, leaving a vacant space at the position 59a upon retraction of this pusher. The outlet door means 61 is then opened and the pusher 60 operated to move

the tray and work load occupying the position 59 to the platform of the quench tank 11 after which the outlet door means 61 closes to complete the cycle of operation.

The interconnecting door means 45 is opened only when the inlet door means 34 and outlet door means 61 are both closed.

In the modified form of furnace illustrated in FIG. 6, a suitable connection would be provided from the timing circuit to operate the second interconnecting door means 73 and the outlet door means 75 in the required timed relationship, with the other door means and with the feeding means of the furnace. In this case, the second interconnecting door means may be open concurrently with the first interconnecting door means, provided that the outlet door means 75 is closed. Alternatively, if the outlet door means 75 is open concurrently with the first interconnecting door means between the heating and carburizing chambers, then the second interconnecting door means 73 should be closed at this time.

In any of the foregoing arrangements there is less tendency for the atmosphere of one of the sections to migrate into the successive section. The atmosphere in the heating section 19 is thus maintained as a noncarburizing atmosphere. The atmosphere in the carburizing section is maintained as a carburizing atmosphere. Consequently, each work load is subjected to carburizing for a precisely determined time and in precisely determined atmospheric conditions, namely, those in the carburizing section 20. The carburizing time is a predetermined fraction of a fixed cycle time determined by the timing circuit.

This enables greater accuracy than heretofore to be attained in respect of the depth of carburizing of the work.

Off setting of the sections 19, 20 and possibly 21 in directions transverse to the direction of advancement of the trays and work loads through each of these sections and the provision of feeding means such as a pusher operating at right angles at its direction of advancement, enables the interconnecting door means to close without requiring any longitudinal spacing to be maintained between successive trays. This is an advantage in the feeding means in effecting longitudinal displacement through each section of the furnace can be in the form of a pusher, and the provision of spacing between successive trays is not necessary.

It will be understood that although, as illustrated, it is convenient in many cases in successive sections of the furnace to be offset from each other horizontally, it would be within the scope of the invention to adopt some other arrangement where this is found to be necessary or advantageous in any particular case. For example, such sections can be offset vertically, or both vertically and horizontally.

A further improvement in control as to the depth of gradient of carburization can be achieved by employment of automatic means for controlling the atmosphere primarily in the carburizing section 20 but also if desired in the heating and diffusing sections.

If in the event of a breakdown of the furnace, only the work in the carburizing chamber 20 will be affected, and even in respect of this work the extent of carburization will be known through knowledge of its residence time in the carburizing section before breakdown. This permits the selected carburizing treatment to be achieved in respect of this work upon restoration of the furnace to operable conditions.

Although the foregoing description to the drawings and for the construction of furnace shown therein, advancement of the trays and work loads has been effected by means of pushers it will be understood that the invention may be applied to constructions of furnace wherein advancement is effected by other forms of feed means, for example, such feed means may comprise one or more belt or slat conveyors. Alternatively one or more of the sections of the furnace may comprise a rotary chamber mounted for rotation about longitudinally extending axis and provided internally with a helical formation, such as a rib, to effect advancement of a tray carrying a work load axially through the chamber in response to rotation thereof.

What we claim as our invention is:

1. A continuous carburizing furnace comprising a heating chamber containing a noncarburizing gaseous atmosphere which prevents scaling or decarburization, inlet door means through which, when open, work can be fed into said heating chamber, a carburizing chamber containing a carburizing atmosphere, a diffusion chamber at the outlet end of said carburizing chamber containing an atmosphere adjusted to be in equilibrium with the desired carbon content in the surface of the work, interconnecting door means between the chambers through which when open, work can be fed from the heating chamber to the carburizing chamber, first feeding means for feeding work fed into the heating chamber into a transfer position within said chamber, second feeding means for feeding work from the transfer position through the interconnecting door means when open to a feed position in the carburizing chamber, third feeding means for feeding work from the feed position towards outlet door means of the furnace and means for operating the interconnecting door means when at least the inlet door means are closed, said feeding means and said door-operating means being automatically operable at predetermined times throughout a treatment cycle.

2. A furnace according to claim 1 wherein said outlet door means are situated at an outlet of said diffusing chamber which is in constant communication with said carburizing chamber, the operating means for said interconnecting door means being operable when both said inlet and said outlet door means are closed.

3. A furnace according to claim 1 wherein the outlet door means are situated at the outlet of a diffusing chamber which is separated from the carburizing chamber by a second interconnecting door means, the latter being provided with operating means operable when the outlet door means are closed, and when either one or both of the first said interconnecting door means and the inlet door means are closed, there being further provided a fourth feed means to feed work from the carburizing chamber into the diffusing chamber through the second interconnecting door means, and a fifth feed means to feed work in the diffusing chamber towards the outlet door means.

4. A furnace according to claim 3, wherein the heating chamber and the carburizing chamber are arranged in generally parallel but transversely offset relation, and with the downstream end of the former overlapped longitudinally with the upstream end of the latter, to provide for communication between the two chambers through said interconnecting door means.

5. A furnace according to claim 4 wherein the first feeding means, second feeding means, and third feeding means each comprise a pusher device for engaging the work, or a work support, to advance same longitudinally of the heating chamber, in the case of the first feeding means, to advance same transversely of the heating chamber and the carburizing chamber through the interconnecting door means in the case of the second feeding means, and to advance same longitudinally of the carburizing chamber in the case of the third feeding means.

6. A furnace according to claim 4 wherein an access door means is provided to provide communication to the overlapping end sections of the heating and carburizing chambers.

7. A furnace according to claim 4 wherein the diffusing chamber is situated adjacent to the downstream end of the carburizing chamber, and in transversely offset relation thereto, and wherein said fourth feeding means comprises a pusher device for moving the work transversely of the carburizing chamber through said second interconnecting door means.

8. A furnace according to claim 7 wherein the fifth feeding means provided in said diffusing chamber is in the form of a rotary hearth.

9. A continuous carburizing furnace comprising heating and carburizing chambers through both of which work can be fed in a direction longitudinally of the chambers and which are arranged in generally parallel transversely offset relation to each other with the downstream end of the former adjacent to the

upstream end of the latter; inlet, interconnecting, and outlet door means controlling communication into the heating chamber, between the chambers and out of the carburizing chamber respectively; and first, second and third feeding means for continuously feeding the work through the heating chamber, therefrom to the carburizing chamber and through the carburizing chamber respectively; and a control system coordinating operation of the door means and feeding means

to maintain at least one of said door means closed at any given instant in the feeding cycle.

5 10. A furnace according to claim 9 wherein the outlet door means are situated at an outlet of a diffusing chamber communicating with the carburizing chamber, the operating means for the interconnecting door means being operable when both the inlet and the outlet door means are closed.

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