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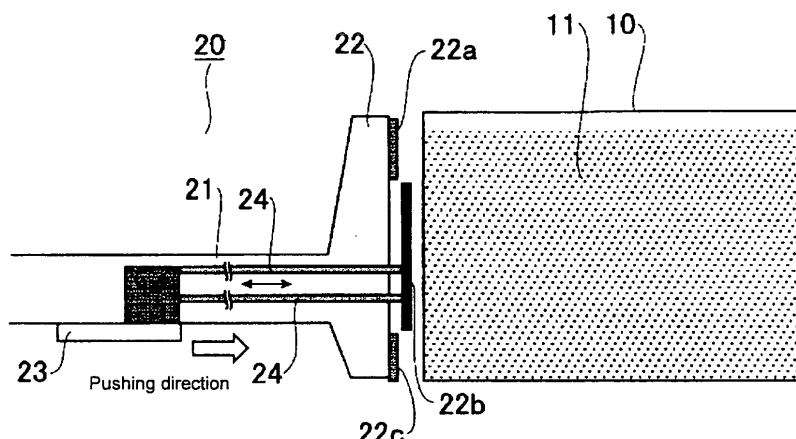
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(54) **COKE PUSHING METHOD AND COKE PUSHER MACHINE**

(57) Provided is a coke pushing method and a coke pusher machine, which surely decrease the pushing load to decrease the damages of coke oven walls on pushing out the lump coke from the carbonization chamber of

coke oven. Specifically, the pushing face 22b of the ram head 22 against the lump coke 11 is vibrated by the vibrator 23 in the pushing direction, thereby conducting the pushing operation while applying vibration to the lump coke 11

Fig. 1



Description

TECHNICAL FIELD

[0001] The present invention relates to a coke pushing method and a coke pusher machine, which push out coke generated in a coke oven from a carbonization chamber therein, and specifically relates to a coke pushing method and a coke pusher machine, which decrease the coke pushing load and decrease the damages of coke oven walls, thereby attaining life-prolongation of the coke oven walls. Unless otherwise noted, the term "coke oven" referred to in the present invention signifies the "chamber oven type coke oven". The chamber oven type coke oven has a row of regenerators at lower section thereof, and has combustion chambers and coke oven chambers above the regenerators with an alternate arrangement thereof.

BACKGROUND ART

[0002] On pushing out the coke (lump coke), generated in the carbonization chamber of coke oven through the dry distillation of coal, from the carbonization chamber using a coke pusher machine, there may occur sticking of coke in the carbonization chamber, which increases the pushing load to apply strong force against the oven walls of the carbonization chamber, resulting in damages of oven walls. If the sticking is serious, the oven walls may be broken or the pusher machine may fail to push out the coke. In these cases, the stuck coke has to be raked out from the chamber by hands after cooling the oven. Accordingly, the coke oven has problems of increase in the repairing work cost of oven walls and decrease in the amount of production caused by the stop of oven operation.

[0003] To those problems, there are proposed several technologies of decreasing the pushing load and of preventing the damages of oven walls. Examples of those technologies are given below.

[0004] A proposed technology is that, on repairing the oven floor bricks in the carbonization chamber of coke oven, dried coke powder is charged into the carbonization chamber so as to fill the concavities on the surface of the oven floor bricks to flatten the surface thereof, thus decreasing the friction between the lump coke and the oven floor during pushing out the coke, (refer to, for example, JP-A-59-187082, (the term "JP-A" referred to herein signifies "Unexamined Japanese Patent Publication)).

[0005] According to another proposed technology, a granular (5 mm or smaller size) fire-proof material (such as graphite and Si_3N_4) is spread all over a tilted oven floor in the carbonization chamber before charging the raw material coal in order to decrease the friction between the lump coke and the oven floor during pushing out the coke, thereby preventing the damages of the oven walls, (refer to, for example, JP-A-8-120278).

[0006] According to a further proposed technology described in Soviet Patent No. 981340, there is disclosed an apparatus to take out coke by a vertically vibrating horizontal shovel to break down the coke in the carbonization chamber into a bucket.

[0007] The technologies disclosed in above JP-A-59-187082 and JP-A-8-120278, however, can not attain sufficient reduction in the pushing load.

[0008] That is, both the technologies disclosed in JP-A-59-187082 and JP-A-8-120278 intend to decrease the friction force between the lump coke and the oven floor in the carbonization chamber. However, the main cause of the generation of sticking of coke and of the increase in pushing load is not the friction force between the lump coke and the oven floor in the carbonization chamber but the phenomenon in which the lump coke being pushed by a ram head of the pusher machine is deformed and broken down during the operation of the pusher machine to push out the lump coke, thus the pushed lump coke spreads in horizontal directions lateral to the pushing direction, which results in the increase of friction force between the lump coke and the side-walls of the carbonization chamber.

[0009] The Soviet Patent No. 981340 does not use the pusher machine which is adopted by the present invention but applies a vertically-vibrating horizontal shovel attached to a bucket, thus breaking down the coke in the carbonization chamber into the bucket, and then repeatedly scooping out the coke from the oven using the bucket. Compared with the coke oven which adopts the pusher machine, the method of vibrating shovel takes a long time to take out the coke.

[0010] The present invention was derived to cope with the above-described circumstances, and an object of the present invention is to provide a coke pushing method and a coke pusher machine, which push out lump coke from the carbonization chamber of coke oven while surely decreasing the pushing load and decreasing the damages of coke oven walls.

DISCLOSURE OF THE INVENTION

[0011] To solve the above problems, the present invention provides the followings.

1. A coke pushing method having the step of pushing out a lump coke from a carbonization chamber of a coke oven by pressing a ram head of a pusher machine against the lump coke in the carbonization chamber while applying vibration to the lump coke.
2. The coke pushing method of above 1, wherein the vibration is applied to the lump coke when the pushing load against the lump coke becomes at or higher than a specified value.
3. The coke pushing method of above 1, wherein the vibration is applied to the lump coke when the moving distance of the ram head from the position of beginning the pushing is within a specified range.

4. The coke pushing method of any of above 1 to 3, wherein the vibration is applied by vibrating the ram head.

5. The coke pushing method of above 4, wherein the ram head is divided into pluralities of sections in the height direction, and vibration is applied to at least one of these divided sections.

6. The coke pushing method of any of above 1 to 5, wherein the direction of vibration of the ram head is a direction of vibration including at least a pushing direction component.

7. The coke pushing method of any of above 1 to 6, wherein the vibration of the ram head is a vibration including one or more of frequency components ranging from 2 to 100 Hz.

8. The coke pushing method of any of above 1 to 7, wherein the vibration of the ram head is a vibration having a wave form including one or more kinds of sine wave.

9. The coke pushing method of any of above 1 to 8, wherein the vibration of the ram head is at an acceleration level at least in a range from 0.5 to 10 G.

10. A method for manufacturing coke has the steps of charging a coal blend into a coke oven to generate coke, and pushing out a lump coke from a carbonization chamber by pressing a ram head of a pusher machine against the lump coke in the carbonization chamber of the coke oven while applying vibration to the lump coke.

11. The method for manufacturing coke of above 10, wherein the lotwise weighted mean content of volatile matter in the coal blend is 29% by mass or more, or 25% by mass or less.

12. The method for manufacturing coke of above 10 or 11, wherein the lotwise weighted mean expansion pressure of the coal blend is 6 kPa or more.

13. The method for manufacturing coke of any of above 10 to 12, wherein the blending rate of a coal having 20 kPa or more of the expansion pressure is 20% by mass or more in the coal blend.

14. A coke pusher machine which pushes out a lump coke from a carbonization chamber of a coke oven by pressing a ram head against the lump coke in the carbonization chamber, having a means to vibrate the ram head.

15. The coke pusher machine of above 14, wherein the ram head is divided into pluralities of sections in the vertical direction, and the means to vibrate the ram head vibrates at least one of these divided sections.

16. The coke pusher machine of above 14 or 15, wherein the direction of vibration of the ram head is a direction of vibration including at least a pushing direction component.

17. The coke pusher machine of any of above 14 to 16, wherein the vibration of the ram head is a vibration including one or more of frequency components ranging from 2 to 100 Hz.

18. The coke pusher machine of any of above 14 to 17, wherein the vibration of the ram head is a vibration having a wave form including one or more kinds of sine wave.

19. The coke pusher machine of any of above 14 to 18,

wherein the vibration of the ram head is at an acceleration level at least in a range from 0.5 to 10 G.

[0012] According to the present invention, since the lump coke is pushed out from the carbonization chamber while being applied with vibration thereon, the friction between the lump coke and the oven walls of the carbonization chamber changes from static friction to kinetic friction owing to the vibration, which change decreases the coefficient of friction, thereby decreasing the pushing load. As a result, there are attained the prevention of the damages of oven walls and the avoidance of delayed operation caused by sticking, thus increasing the productivity.

[0013] In addition, since the maximum pushing load current does not exceed a control level independent of the volatile matter content in coal blend, of the expansion pressure of coal blend, and of the blending rate of high expansion pressure coal, the control of coal blend becomes very easy. Furthermore, since there are applicable inexpensive coals containing large amount of volatile matter, containing small amount of volatile matter, or giving high expansion pressure, the cost merit becomes high.

[0014] The term "lump coke" referred to herein signifies the total coke within the carbonization chamber, and not limiting to a lump of coke in a block shape formed by adhering individual coke particles. Although coke cracks during the cooling step, individual coke particles closely contact with each other during the pushing step to allow transferring the vibration over the entire coke particles, thus there is no need to form a coke block by adhering individual coke particles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Figure 1 shows a side view of the coke pusher machine for illustrating an embodiment of the present invention.

Figure 2 shows a perspective view of the coke pusher machine in an embodiment of the present invention. Figure 3 is a graph showing the effect of the present invention.

Figure 4 shows a vibration experimental apparatus using a small coke oven (1 m x 0.8 m x 0.4 m).

Figure 5 shows the variations of pushing force at 40 Hz of vibration frequency and about 1 G of vibration level.

Figure 6 shows the variations of pushing force at 50 Hz of vibration frequency and about 1 G of vibration

level.

Figure 7 shows the variations of pushing force at 60 Hz of vibration frequency and about 1.5 G of vibration level.

Figure 8 shows the variations of pushing force at 30 Hz of vibration frequency and about 0.2 G of vibration level.

Figure 9 shows the relation between the volatile matter (VM) content in coal blend and the maximum pushing load current ratio.

Figure 10 shows the relation between the expansion pressure (kPa) in coal blend and the maximum pushing load current ratio.

Figure 11 shows the relation between the blending rate of high expansion pressure coal in coal blend and the maximum pushing load current ratio.

(Description of the Reference Symbols)

[0016]

10	carbonization chamber
20	coke pusher machine
21	pushing ram
22, 32	ram head
22a, 32a	upper pushing face
22b, 32b	middle pushing face
22c, 32c	lower pushing face
23, 33	vibrator
24	vibration rod
30	simulated coke oven
31	wall
34	load cell
35	hydraulic cylinder
36	converter
37	measurement equipment, personal computer (PC)
38	acceleration pickup (B&K 4383)
39	charge amplifier (B&K 2635)

BEST MODE FOR CARRYING OUT THE INVENTION

[0017] An embodiment of the present invention is described below referring to the drawings.

[0018] Figure 1 shows a side view of the coke pusher machine for illustrating an embodiment of the present invention, and Fig. 2 shows a perspective view of the coke pusher machine in an embodiment of the present invention.

[0019] Referring to Fig. 1, a lump coke 11 is generated in a carbonization chamber 10 in the coke oven.

[0020] Figure 1 and Fig. 2 show a coke pusher machine 20 in an embodiment of the present invention. The coke pusher machine 20 is provided with a pushing ram 21, a drive unit (not shown) for the pushing ram 21, and a ram head 22 located at front end of the pushing ram 21. The pushing face of the ram head 22 pressing against the lump coke 11 is divided into three sections in vertical

direction of the ram head 22: an upper pushing face 22a, a middle pushing face 22b, and a lower pushing face 22c. A vibrator 23 is attached to the pushing ram 21 to vibrate the middle pushing face 22b, which has the largest pushing area among the three pushing faces, in the pushing direction via a vibration rod 24.

[0021] With thus structured coke pusher machine 20, the lump coke 11 is pushed out from the carbonization chamber 10 following the procedure described below.

(1) Starting from the state that the pusher machine 20 is at a position in readiness outside the carbonization chamber 10, as shown in Fig. 1, the pushing ram 21 is actuated to press the individual pushing faces 22a, 22b, and 22c of the ram head 22 against the lump coke 11 in the carbonization chamber 10, thus bringing the ram head 22 to move forward.

(2) When the pushing load becomes a specified value or above, (in concrete terms, for example, when the load current of the pushing ram drive unit exceeds a specified value), the vibrator 23 brings the middle pushing face 22b to vibrate in the pushing direction. Then the ram head 22 is driven forward while the middle pushing face 22b applies vibration to the lump coke 11. The detection of the pushing load is calculated by, for example, the load current of the pushing ram drive unit.

(3) When the pushing load becomes smaller than a specified value, the vibration of the middle pushing face 22b is stopped. Under the condition, the pushing ram 21 is continuously driven forward.

(4) Finally, when all the lump coke 11 is pushed out from the carbonization chamber 10, the pushing ram 21 is retracted to the original position in readiness.

By the above-described procedure of pushing out the lump coke 11, the vibration applied to the lump coke 11 changes the friction between the lump coke 11 and the oven walls of the carbonization chamber 10 from static friction to kinetic friction, thus decreasing the coefficient of friction, which then decreases the pushing load. As a result, the damages of the oven walls are prevented, and the operational delay caused by sticking is avoided, thereby increasing the productivity.

According to above description, when the pushing load reaches or exceeds a specified value, vibration is applied to the lump coke 11, and when the pushing load becomes at or smaller than the specified load, the vibration is stopped. Since, however, the maximum pushing load generally appears at forward moving distances of the ram head 22 in a range from 1 m to 1.5 m from the point of beginning the pushing, when the forward moving distance of the ram head 22 exceeds 1.5 m, the application of vibration to the lump coke 11 may be stopped. Alternatively, the vibration may be always applied from the point of beginning the pushing to the point of end of the pushing.

(5) Vibration mode of the ram head according to the

present invention

The direction of vibration of the ram head according to the present invention may be any of the vertical direction of the oven or the pushing direction if only the entire lump coke is vibrated. The vibration mainly in the vertical direction of the oven, however, is difficult to surely transfer the vibration from the ram head to the entire lump coke, and, for example, it is necessary to provide pluralities of projections on the ram head to pierce the lump coke. In this case, however, the vibration is effective only in the vicinity of a portion of lump coke which was pierced by the projections of the ram head, and is difficult to be transmitted to entire lump coke, thus only the pierced portion of lump coke likely breaks down. Furthermore, the vibration mainly in the vertical direction includes the direction of lifting the lump coke, which increases the load to the vibrator. Therefore, the driving capacity of the vibrator has to be increased.

Consequently, the direction of vibration of the ram head according to the present invention is preferably the direction including the vibration component in the pushing direction because the structure of the ram head of the present invention becomes simple and because the driving capacity of the vibrator becomes small. More preferably, the vibration is mainly in the direction of vibration component in the pushing direction. Further specifically, the vibration of the present invention is preferably in parallel to the pushing direction. However, the vibration may be in an obliquely upward direction or an obliquely downward direction.

The above description connects the vibrator 23 only to the middle pushing face 22b. It is, however, applicable that the vibrator is connected also to each of the upper pushing face 22a and the lower pushing face 22c, and that the vibration is given to an arbitrary one or more of selected pushing face.

According to the embodiment, the pushing face of the ram head 22 is divided into three sections, and the pushing area of the middle pushing face 22b is the largest among the three pushing faces. The number of divisions and the pushing area ratio among the divided sections may be, however, adequately determined depending on the need. The pushing face of the ram head 22 may not be divided. The frequency band of the vibration is preferably a single frequency between 2 to 100 Hz in view of controllability. Inclusion of two or more frequency components in the band range may be applicable. Regular vibration or irregular vibration may be applicable. If the frequency band of the vibration exceeds 100 Hz, the amplitude of the vibration becomes small so that the effect of the vibration on the lump coke becomes small. A more preferable frequency band of vibration is 60 Hz or less. If the frequency band of vibration becomes smaller than 2 Hz, the energy input to the vibrator to attain sufficient acceleration has

to be increased, and the effect of vibration to the lump coke likely becomes insufficient. In particular, the frequency band ranging from 30 to 60 Hz is preferred.

Regarding the vibration waveform, a machine which vibrates the ram head with waveforms containing one or more of sine wave is preferred. The waveform is not necessarily sine wave, and may be the one containing triangle wave, rectangular wave, successive impulse waves, or a wave mixing of them.

The acceleration level of the vibration is requested only at 0.5 G or more to apply effective vibration to the lump coke, and 1 G or more is preferable. From the point of mechanical strength of the pusher machine, the acceleration level of the vibration is further preferably 10 G or less. The term "G" in the acceleration level is the gravitational acceleration, ($1\text{ G} = 9.8\text{ m/s}^2$). The determination method of the acceleration level is not specifically limited. For example, the acceleration level can be determined by converting the signal, which is generated from an acceleration pickup (Piezoelectric Charge Accelerometer, Type 4383, manufactured by B&K) attached to the vibrating section of the test ram, by a charge amplifier (Charge Amplifier Type 2635, manufactured by B&K), then by storing the converted signal in a personal computer to process therein.

The vibrator according to the present invention is preferably the one which arbitrarily adjusts frequency and acceleration level. The driving of the vibrator may be done by motor, hydraulic pressure, water pressure, and the like. As a vibration mechanism for high temperature load and for narrow space, a vibro-hammer, an air-hammer, and the like are applicable. (6) Volatile matter (hereinafter referred to simply as "VM") content in coal blend applicable to the present invention

The coal blend applicable to the present invention includes the one containing VM of 29% by mass or more or 25% by mass or less as the weighted mean for every lot of the coal blend, which VM content ranges were not applicable in the related art. The VM content in coal blend grade is determined and controlled by sampling of coal at every lot of coal mine, ship, and the like. Depending on the lotwise VM content before charging the coke oven, the lotwise charge amount of coal is blended. The weighted mean VM content is determined by the multiplication of the charge amount of coal and the VM content in each lot, which is then divided by the total charge amount of coal. The analysis of lotwise VM content is given in accordance with JIS M8812. That is, a sample is put in a crucible with a lid. The sample is heated to 900 °C for 7 minutes while avoiding exposure to air. The mass percentage of heating loss to the sample is determined, and then the water content determined at the same time is subtracted from thus obtained mass percentage to derive the VM content.

Generally, when VM content in a coal blend becomes 29% by mass or more, the deposition of carbon increases, and the carbon adhered to the oven walls grows. During the pushing operation, the coke cake and the carbon adhered to the oven walls contact with each other to fail in conducting smooth pushing operation. To this point, with the use of the vibration pusher machine of the present invention, however, pushing operation is established without retaining cake even under the contact of carbon with coke cake. The maximum value of lotwise weighted mean VM content in coal blend applicable to the present invention is 40% by mass because generally the maximum VM content in raw material coal grade is 40% by mass. In general, if the VM content in coal blend becomes 25% by mass or less, the gap between the oven wall and the coke cake becomes small. Accordingly, if the oven wall have convex portions, the convex portion of the surface contacts with the coke cake, which fails in conducting smooth pushing operation. In this regard, use of the vibration pusher machine of the present invention, however, the friction between the convex portion and the coke cake becomes small, which allows pushing operation without retaining cake. Since generally the minimum VM content in the raw material coal grade is 15% by mass, the minimum value of lotwise weighted mean VM content in coal blend applicable to the present invention is 15% by mass.

(7) Expansion pressure of coal blend applicable to the present invention

The coal blend applicable to the present invention includes the one having 6 kPa or higher expansion pressure in weighted mean for every lot of coal blend, which level of expansion pressures is not applicable in related art. The expansion pressure for each lot of coal blend is determined and controlled by sampling of coal at every lot of coal mine, ship, and the like. Depending on the expansion pressure of every lot before charging the coke oven, the charge amount of coal for every lot is blended. The expansion pressure in weighted mean is determined by the multiplication of the charge amount of coal and the expansion pressure in each lot, which is then divided by the total charge amount of coal. To determine the expansion pressure, a coal grade is regulated in sizes from 1 to 3 mm, which is then put into a crucible (50 mm in diameter and 70 mm in height) to 775 kg/m³ of bulk density. A lid is applied to the crucible, and a differential pressure gauge is inserted into the coal. The crucible is heated to 1000°C at a speed of 4°C/min. The maximum pressure difference during the heating process is read.

Generally higher expansion pressure of coal blend decreases more the shrinkage of the coal blend during the dry distillation, and the gap between the oven wall and the coke cake becomes small. Consequently, if a convex portion exists on the oven wall, the

convex portion and the coke cake contact with each other to fail in attaining smooth pushing operation. However, use of the vibration pusher machine of the present invention decreases the friction between the convex portion and the coke cake, thus allowing pushing operation without retaining cake. Since generally the maximum expansion pressure of raw material coal grade is generally 9 kPa, the weighted mean maximum value of the expansion pressure of the coal blend grade applicable to the present invention is 9 kPa.

(8) Blending rate of high expansion pressure coal in coal blend applicable to the present invention

The coal blend applicable to the present invention includes the one having 20% by mass or higher blending rate of high expansion pressure coal, which level of blending rate was not applicable in related art.

Generally, if a coal blend contains 20% by mass or more of high expansion pressure coal (more than 2,000 mmH₂O, more than 20 kPa), the shrinkage of coal during dry distillation becomes small and the gap between the oven wall and the coke cake becomes small. Consequently, if a convex portion exists on the oven wall, the convex portion and the coke cake contact with each other to fail in attaining smooth pushing operation. However, use of the vibration pusher machine of the present invention decreases the friction between the convex portion and the coke cake, thus allowing pushing operation without retaining cake. As of the coal blends applicable to the present invention, the maximum value of the blending rate of high expansion pressure coal is 100% by mass. Examples of high expansion coal grade are: Blue Creek (U.S.), 68 kPa (6,940 mmH₂O); South Yakut (Russia), 34 kPa (3,453 mmH₂O); Norwich (Australia), 73 kPa (7,450 mmH₂O); and German Creek (Australia), 43 kPa (4,420 mmH₂O).

EXAMPLE 1

[0022] A vibration experiment was conducted to confirm the effect of vibration. To a small simulated coke oven 30 having a size of 1 m x 0.8 m x 0.4 m, shown in Fig. 4, the lump coke 11 which was generated by dry distillation in a small coke oven having the same size to that of the simulated coke oven 30, in advance, was charged. The charged lump coke 11 was pressed by a force applied to side walls 31 of the coke oven 30, and was pushed out at a constant rate under vibration (1 to 110 HZ of frequency, 0.3 to 12 G of acceleration level, sine wave) of a test ram from an end of the lump coke 11. The necessary force for pushing was determined. A half portion of the test ram 32 was able to be vibrated, which portion was vibrated by a vibrator 33 from rear face thereof. Figures 5 to 8 show examples of the variations of pushing force. The horizontal axis is the time (giving

the position because the pushing speed is constant), and the vertical axis is the pushing force of the test ram. The acceleration level was determined by converting the signal, which is generated from an acceleration pickup 38 (Piezoelectric Charge Accelerometer, Type 4383, manufactured by B&K) attached to the vibrating section of the test ram, by a charge amplifier 39 (Charge Amplifier Type 2635, manufactured by B&K), and then by storing the converted signal in a personal computer to process therein. The pushing force was determined by a load cell 34. The vibrator 33 used a vibration motor (an off-center weight was rotated at high speed).

[0023] After a specified time had passed since the start of pushing, the vibration began, and ultimately stopped, and then the pushing was stopped. As seen in Fig. 5, the force reached almost stable level after beginning the pushing, and, on starting the vibration, the pushing force decreased to about half. When the vibration was stopped, the pushing force returned to the level of beginning the pushing. The trend shows that the vibration decreases the pushing force to about half. The vibration frequency was 40 Hz, and the vibration level was about 1 G.

[0024] Figure 6 shows the trend at 50 Hz of vibration frequency and about 1 G of acceleration level, and Fig. 7 shows the trend at 60 Hz of vibration frequency and about 1.5 G of acceleration level. Both Fig. 6 and Fig. 7 decreased the pushing force to about half owing to the vibration. For the case that the vibration frequency was in a range from 2 to 100 Hz and that the acceleration level was in a range from 0.5 to 10 G, which are the range of the present invention, though not shown in these figures, the pushing force could be decreased. In particular, the pushing force significantly decreased when the vibration frequency was in a range from 30 to 60 Hz.

[0025] Figure 8 shows the trend at 30 Hz of vibration frequency and about 0.2 G of acceleration level. Since the acceleration level was small, outside the range of the present invention, the pushing force could not be decreased. For the case that the vibration frequency was 1 Hz and the acceleration level was about 1 G, outside the range of the present invention, the pushing force did not significantly decrease during the pushing operation. As a comparative example, an experiment without applying vibration was conducted, and no significant decrease in the pushing force was attained.

EXAMPLE 2

[0026] As an example of the present invention, pushing of lump coke was conducted in a commercial chamber oven type coke oven using the coke pusher machine 20 shown in Figs. 1 and 2 following the above procedure while applying vibration to the lump coke. The determination of acceleration level was done similar to Example 1.

[0027] The vibration frequency was 40 Hz and the acceleration level was 1 G. The coal blend used in Example 2 gave 27.2% of the lotwise weighted mean VM content,

4.3 kPa of the lotwise weighted mean expansion pressure, and 17% of the blending rate of high expansion pressure coal. As a comparative example, pushing was done without applying vibration to the lump coke, as in the related art.

[0028] Figure 3 shows the pushing load ratio (relative ratio) between an example of the present invention and a comparative example. According to the example of the present invention, the maximum pushing load ratio showed a significant decrease compared with that of the comparative example. The pushing load ratio is expressed by a relative ratio based on the peak value (1.0) of the pushing load in the comparative example.

[0029] The above experiments confirmed the effect of the present invention.

EXAMPLE 3

[0030] As an example of the present invention, pushing of lump coke was conducted in a commercial coke oven using the coke pusher machine 20 shown in Figs. 1 and 2 following the above procedure while applying vibration to the lump coke. The determination of acceleration level was done similar to Example 1.

[0031] The vibration frequency was 50 Hz and the acceleration level was 2 G. The coal blend used in Example 3 varied the lotwise weighted mean VM content from 24 to 31%, the lotwise weighted mean expansion pressure from 4.1 to 7.2 kPa, and the blending rate of high expansion pressure coal from 11 to 26%. Thus the effect of the present invention was investigated. The temperature of the bottom of combustion chamber of the coke oven was 1,240°C, and the total carbonization time was in a range from 18 to 19 hours.

[0032] Figure 9 shows the relation between the VM content and the maximum pushing load current ratio (relative ratio) for a coal blend giving 4.5 kPa of the lotwise weighted mean expansion pressure, and 15% of the blending rate of high expansion pressure coal. Figure 10 shows the relation between the expansion pressure (kPa) and the maximum pushing load current ratio (relative ratio) for a coal blend giving 27.3% of the lotwise weighted mean VM content, and 15% of the blending rate of high expansion pressure coal. Figure 11 shows the relation between the blending rate of high expansion pressure coal and the maximum pushing load current ratio (relative ratio) for a coal blend giving 27.3% of the lotwise weighted mean VM content, and 5.1 kPa of the lotwise weighted mean expansion pressure. The maximum pushing load current ratio is expressed by a relative ratio based on the control value (control level) (1.00).

[0033] As shown in Figs. 9 to 11, the present invention allows very easy control of coal blend because the maximum pushing load current does not exceed the control level independent of the VM content in coal blend, the expansion pressure of coal blend, and the blending rate of high pressure expansion coal. In addition, the cost merit is high because inexpensive coal can be used, such

as a coal containing large amount of VM or small amount of VM, or a coal giving high expansion pressure.

[0034] To the contrary, for the cases without using the pushing method according to the present invention, the maximum pushing load current ratio (relative ratio) was overridden unless establishing adequate VM content range in coal blend, adequate expansion pressure coal blend, and adequate blending rate of high expansion pressure coal. Therefore, a strict control is required for the VM content and expansion pressure of applied coal blend, and further for the blending rate of high expansion pressure coal, which increases the production cost.

INDUSTRIAL APPLICABILITY

[0035] Since the present invention pushes out the lump coke from the carbonization chamber while applying vibration to the lump coke, the vibration changes the friction between the lump coke and the oven walls of carbonization chamber from static friction to kinetic friction, which decreases the coefficient of friction, thereby decreasing the pushing load. As a result, the damages of oven walls are prevented, and the operation delay caused by sticking is avoided, thus increasing the productivity.

[0036] Furthermore, since the maximum pushing load current does not exceed the control level independent of the VM content in the coal blend, the expansion pressure of the coal blend, and the blending rate of high expansion pressure coal, the control of coal blend becomes very easy. In addition, since there are applicable inexpensive coals containing large amount of VM, containing small amount of VM, or giving high expansion pressure, the cost merit becomes high.

Claims

1. A coke pushing method having the step of pushing out a lump coke from a carbonization chamber of a coke oven by pressing a ram head of a pusher machine against the lump coke in the carbonization chamber while applying vibration to the lump coke.
2. The coke pushing method according to claim 1, wherein the vibration is applied to the lump coke when the pushing load against the lump coke becomes at or higher than a specified value.
3. The coke pushing method according to claim 1, wherein the vibration is applied to the lump coke when the moving distance of the ram head from the position of beginning the pushing is within a specified range.
4. The coke pushing method according to any of claims 1 to 3, wherein the vibration is applied by vibrating the ram head.

5. The coke pushing method according to claim 4, wherein the ram head is divided into pluralities of sections in the vertical direction, and vibration is applied to at least one of these divided sections.
6. The coke pushing method according to any of claims 1 to 5, wherein the direction of vibration of the ram head is a direction of vibration including at least a pushing direction component.
7. The coke pushing method according to any of claims 1 to 6, wherein the vibration of the ram head is a vibration including one or more of frequency components ranging from 2 to 100 Hz.
8. The coke pushing method according to any of claims 1 to 7, wherein the vibration of the ram head is a vibration having a wave form including one or more kinds of sine wave.
9. The coke pushing method according to any of claims 1 to 8, wherein the vibration of the ram head is at an acceleration level at least in a range from 0.5 to 10 G.
10. A method for manufacturing coke comprising the steps of charging a coal blend into a coke oven to generate coke, and pushing out a lump coke from a carbonization chamber by pressing a ram head of a pusher machine against the lump coke in the carbonization chamber of the coke oven while applying vibration to the lump coke.
11. The method for manufacturing coke according to claim 10, wherein the lotwise weighted mean content of volatile matter in the coal blend is 29% by mass or more, or 25% by mass or less.
12. The method for manufacturing coke according to claim 10 or claim 11, wherein the lotwise weighted mean expansion pressure of the coal blend is 6 kPa or more.
13. The method for manufacturing coke according to any of claims 10 to 12, wherein the blending rate of a coal having 20 kPa or more of the expansion pressure is 20% by mass or more in the coal blend.
14. A coke pusher machine, which pushes out a lump coke from a carbonization chamber of a coke oven by pressing a ram head against the lump coke in the carbonization chamber, having a means to vibrate the ram head.
15. The coke pusher machine according to claim 14, wherein the ram head is divided into pluralities of sections in the vertical direction, and the means to vibrate the ram head vibrates at least one of these divided sections.

- 16.** The coke pusher machine according to claim 14 or claim 15, wherein the direction of vibration of the ram head is a direction of vibration including at least a pushing direction component.

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- 17.** The coke pusher machine according to any of claims 14 to 16, wherein the vibration of the ram head includes one or more of frequency components ranging from 2 to 100 Hz.

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- 18.** The coke pusher machine according to any of claims 14 to 17, wherein the vibration of the ram head is a vibration having a wave form including one or more kinds of sine wave.

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- 19.** The coke pusher machine according to any of claims 14 to 18, wherein the vibration of the ram head is at an acceleration level at least in a range from 0.5 to 10 G.

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Fig. 1

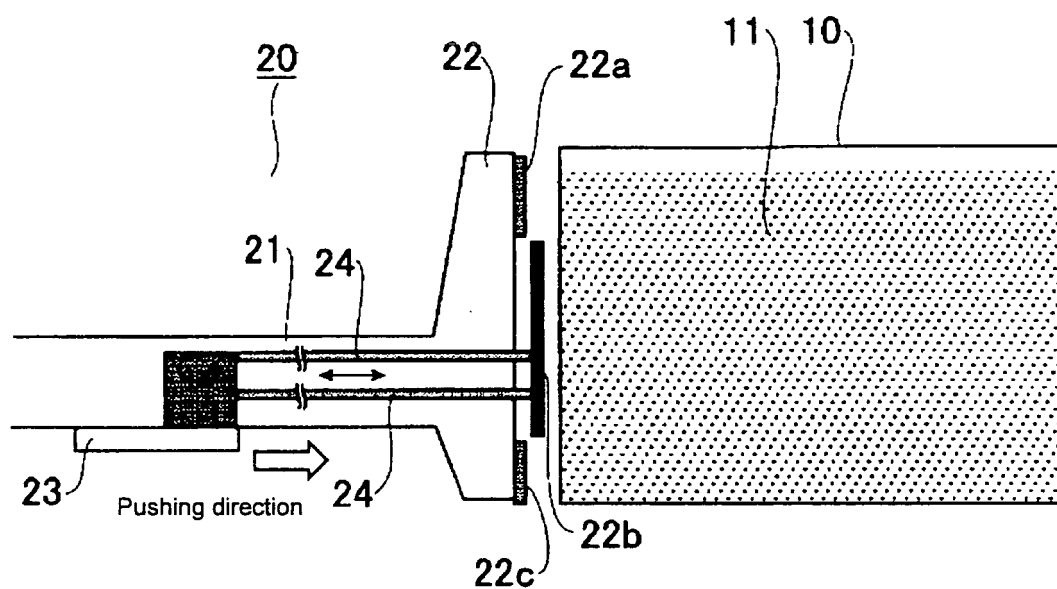


Fig. 2

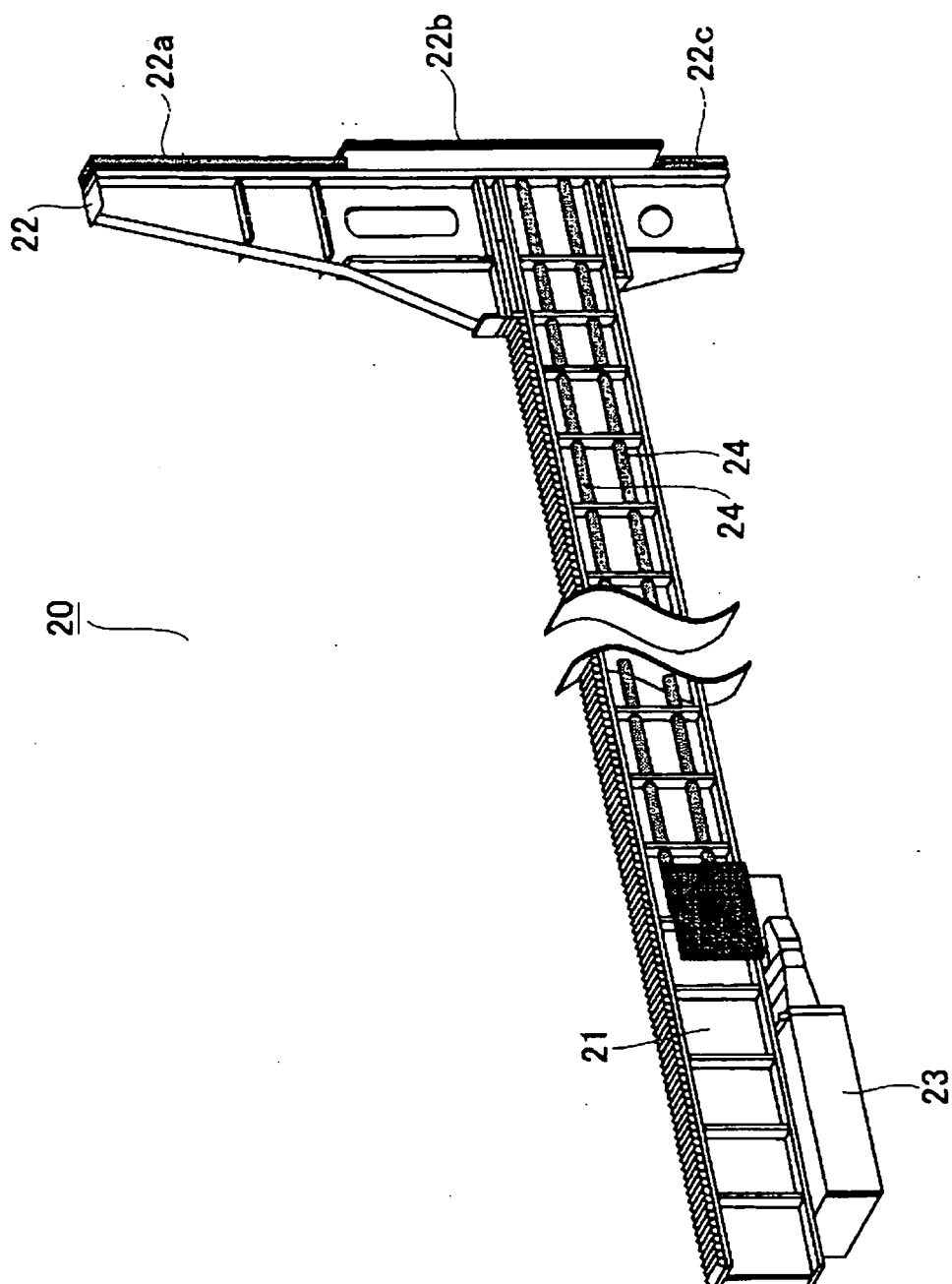


Fig. 3

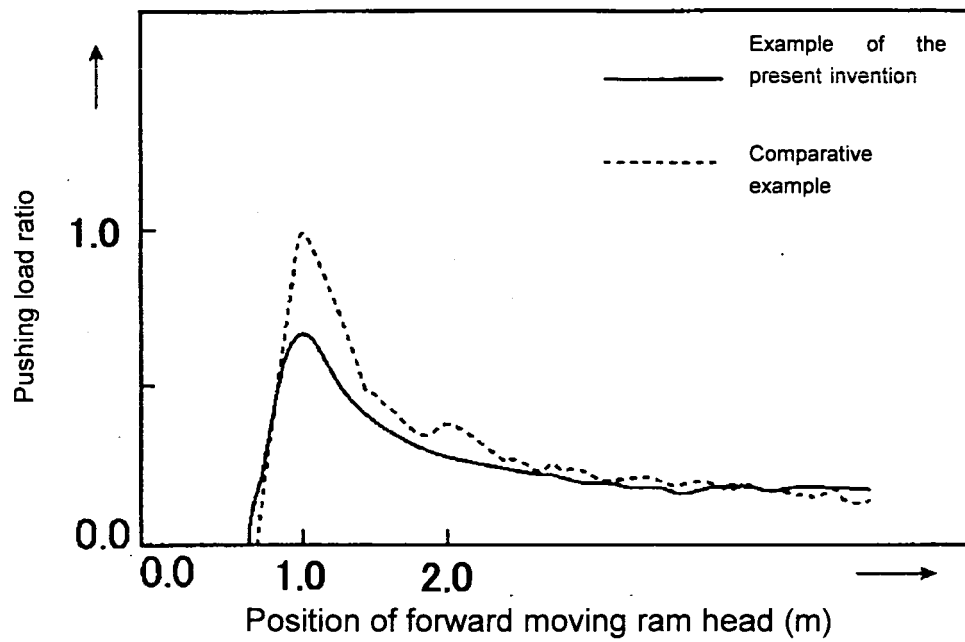


Fig. 4

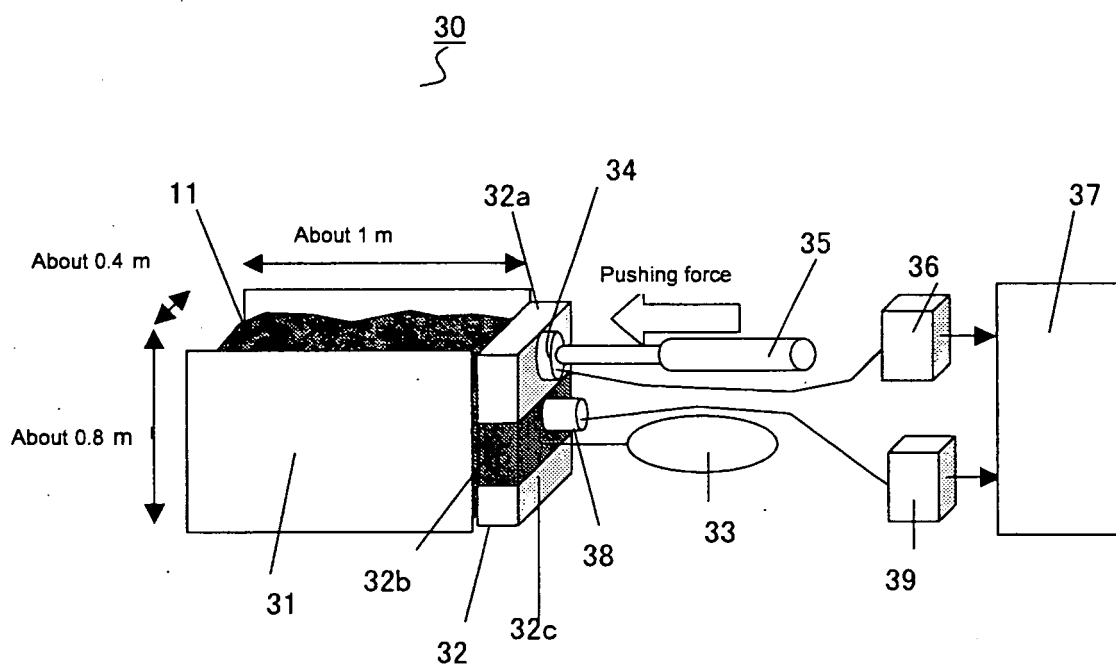


Fig. 5

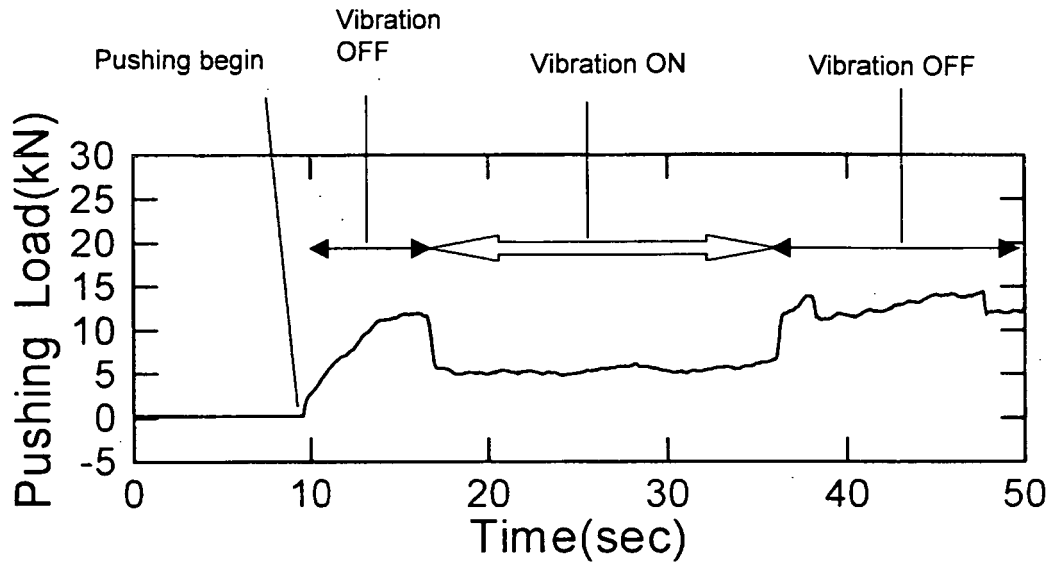


Fig. 6

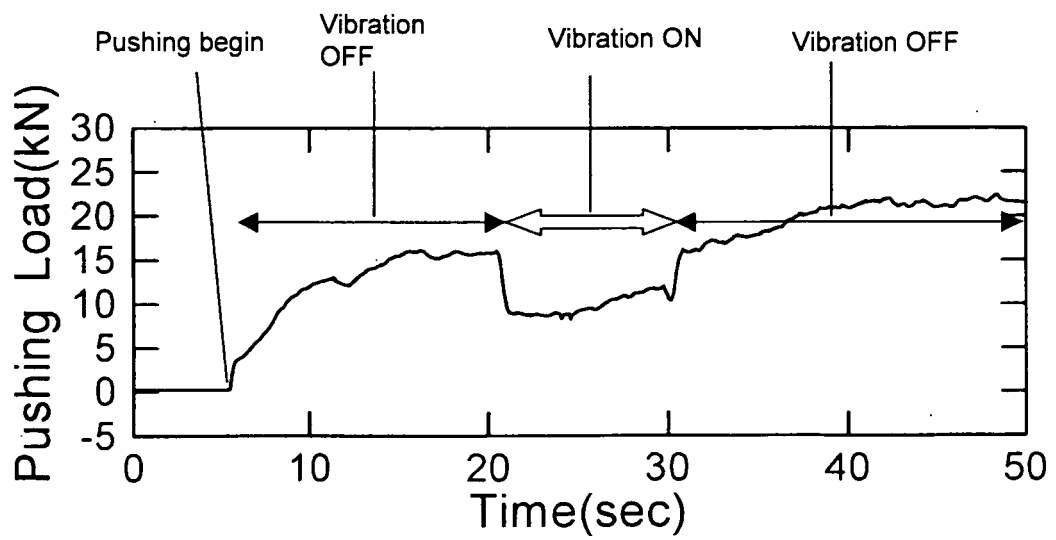


Fig. 7

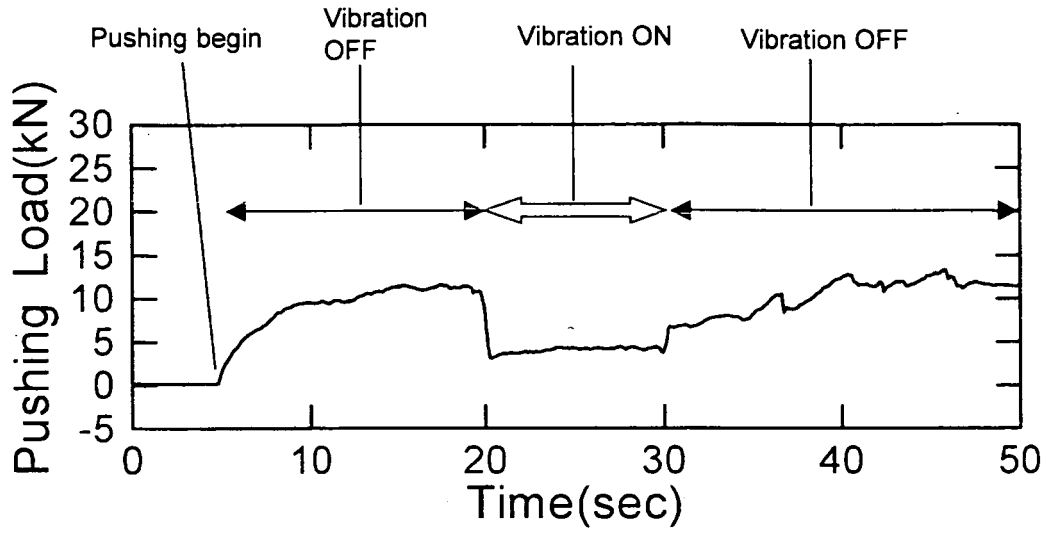


Fig. 8

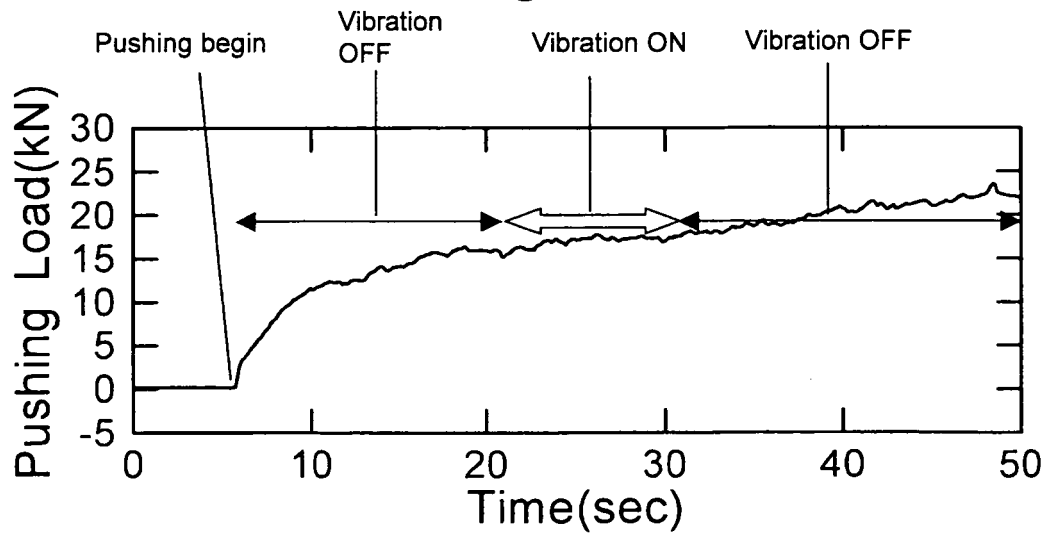


Fig. 9

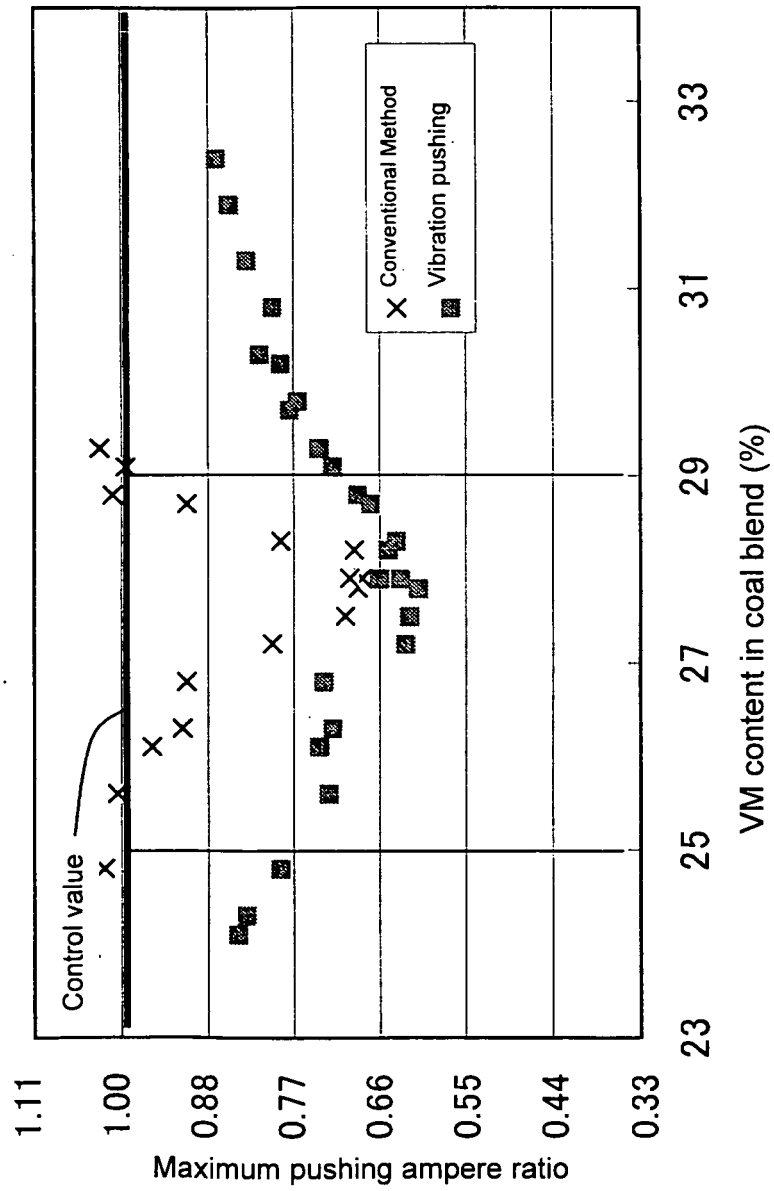


Fig. 10

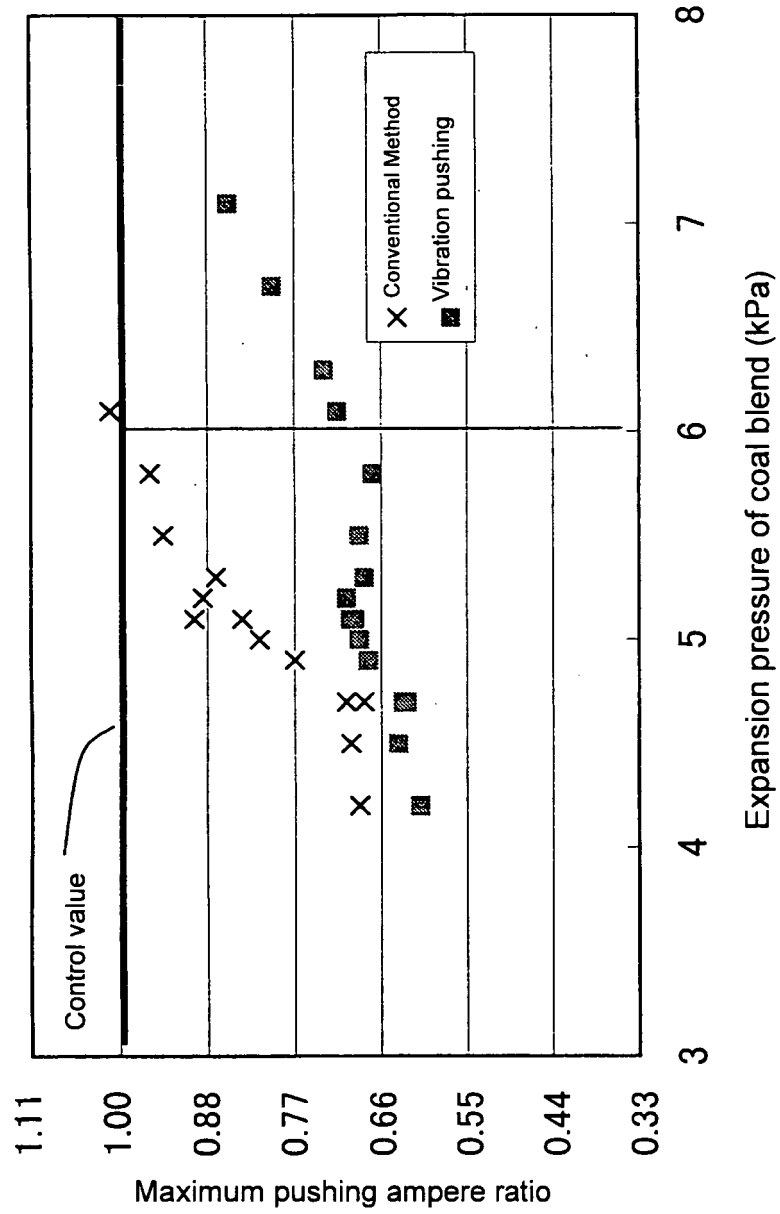
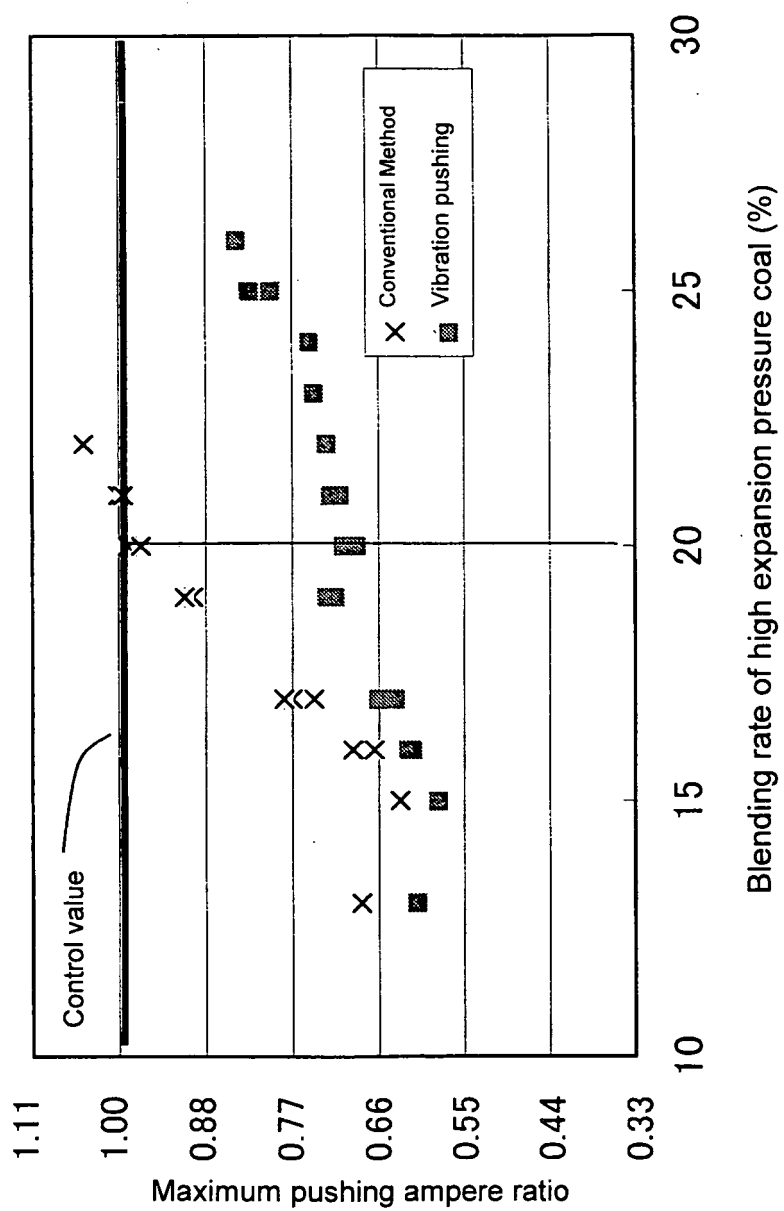


Fig. 11



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2005/024240

A. CLASSIFICATION OF SUBJECT MATTER

C10B33/10(2006.01), **C10B41/02**(2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C10B33/10, C10B41/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2006
Kokai Jitsuyo Shinan Koho	1971-2006	Toroku Jitsuyo Shinan Koho	1994-2006

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2003-172606 A (NKK Corp.), 20 June, 2003 (20.06.03), (Family: none)	1-19
A	JP 7-26266 A (Kawasaki Steel Corp., Koritsu Enjiniaringu Kabushiki Kaisha), 27 January, 1995 (27.01.95), (Family: none)	1-19

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search
27 March, 2006 (27.03.06)Date of mailing of the international search report
04 April, 2006 (04.04.06)Name and mailing address of the ISA/
Japanese Patent Office

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 59187082 A [0004] [0007] [0008]
- JP 8120278 A [0005] [0007] [0008]
- SU 981340 [0006] [0009]