United States Patent

Fukada

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[54] **TRANSPORTATION METHOD FOR USE IN EQUIPMENT OF MOVABLE BEAM TYPE**

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Sept. 7, 1968 Japan....................................43/64515

[52] **U.S. Cl.**..**198/219**
[51] **Int. Cl.**..**B65g 25/04**
[58] **Field of Search**..198/219

[56] **References Cited**

UNITED STATES PATENTS

1,921,956	8/1933	Vickers	263/6
3,416,646	12/1968	Boos et al.	198/218
2,888,131	5/1959	Allen	198/210

FOREIGN PATENTS OR APPLICATIONS

627,777	3/1936	Germany	198/218

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Assistant Examiner—Douglas D. Watts
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[57] **ABSTRACT**

A transportation method for use in a heating furnace of movable beam type or other equipment of such type, which transportation is carried out by the movement of the movable beams, such movement being subjected to speed reduction during the upward and the downward strokes just before the upper surface of said movable beams approaches that of the fixed beam.

6 Claims, 9 Drawing Figures

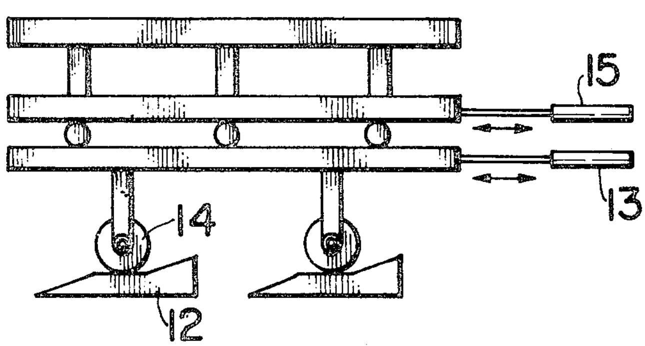

FIG. 1
PRIOR ART

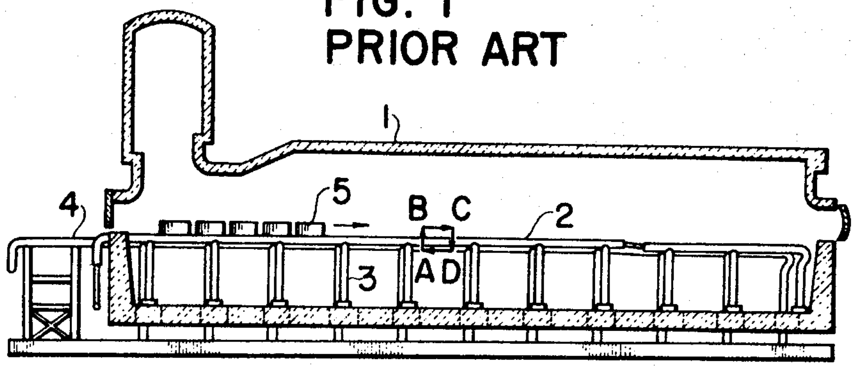

FIG. 3 PRIOR ART

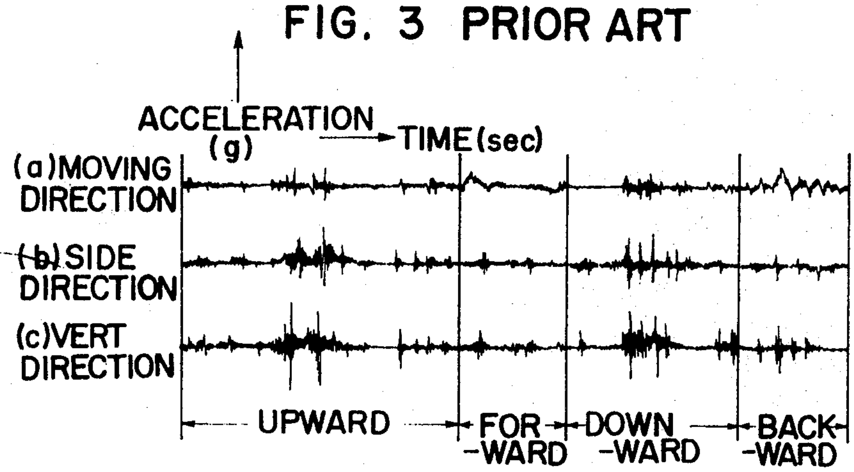

FIG. 5

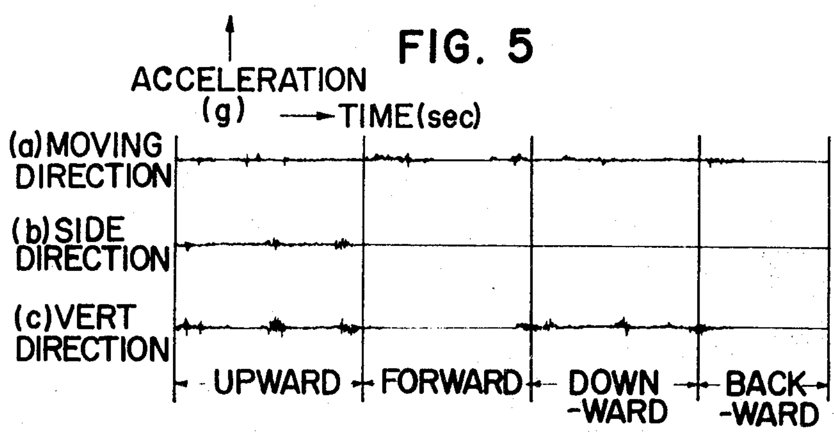

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FIG. 2
PRIOR ART

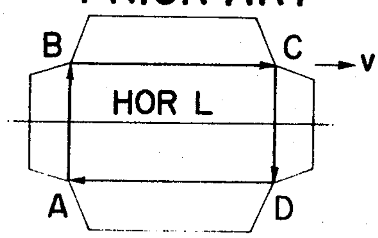
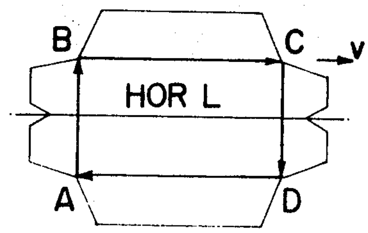


FIG. 4



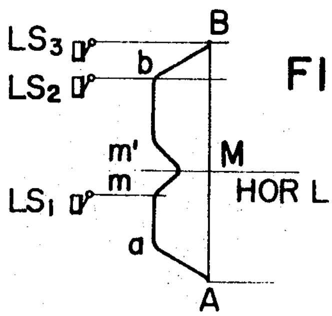


FIG. 7

FIG. 6

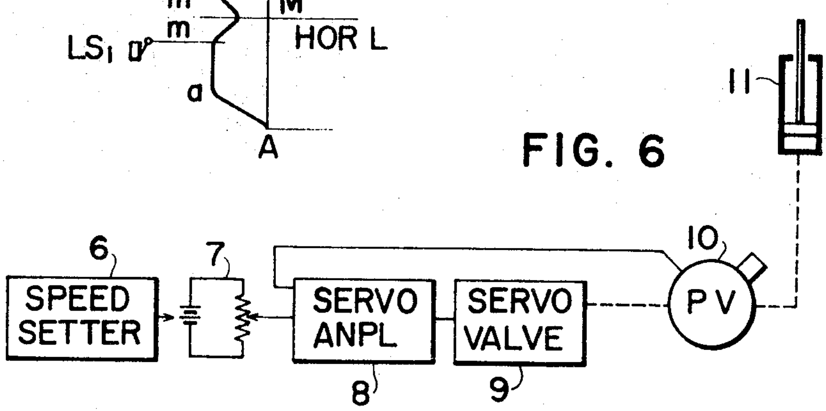


FIG. 8

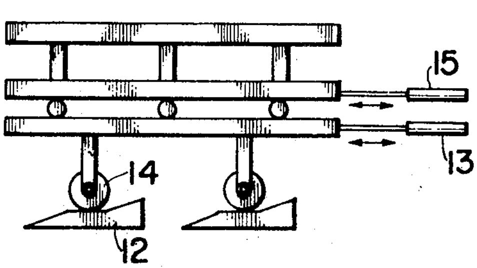
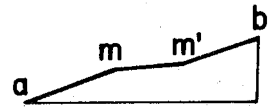


FIG. 9



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TRANSPORTATION METHOD FOR USE IN EQUIPMENT OF MOVABLE BEAM TYPE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates in general to the improvement of the transportation method in the use of equipment of the movable beam type, and more particularly a method for the driving of the movable beams in a heating furnace of the movable beam type.

2. Description of the Prior Art

In general, the transportation device of such equipment as a heating furnace of the movable beam type consists of movable beams, fixed beams and a device for driving said movable beams. The transportation of the to-be-heated materials, etc., in the heating furnace is so made that the to-be-heated material charged on the fixed beam is moved forward step by step by the periodic repititions of the parallel movement of the movable beams.

More in detail, the to-be-heated material charged on the fixed beam is transferred onto and supported by the upward stroke of the movable beam, and moved forward by the forward stroke of the movable beam; then transferred to the position corresponding to the end of said forward stroke on the fixed beam during the downward stroke of the movable beam; and then the movable beam takes the backward stroke to return to the starting position to complete a cycle of movement. By the periodic repetition of such movement of the movable beam, the to-be-heated material is moved forward step by step in the heating furnace.

However, when the to-be-heated material is transferred from the fixed beam to the movable beam during the upward stroke, and also from said movable beam to the fixed beam during the downward stroke, great shock is produced on said movable beam, causing strong side shaking thereof. Such shaking causes the to-be-heated material such as steel slabs, to move away from the correct course of transfer, thereby destroying the inside wall of the furnace or the material stopping in the furnace, with such a serious consequence that the material cannot be taken out from the furnace. Such tendency is strengthened as the length of the furnace is greater, and as the to-be-heated material is heavier.

As the capacity of rolling mill, etc., has recently become greater, the unit weight of the to-be-heated material such as steel slabs becomes greater, and also such equipment as the heating furnace is sized greater. Therefore, the abovementioned shock and the shaking caused thereby constitute serious problems with equipment of the movable beam type.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a transportation method for use in equipment of the movable beam type, particularly heating furnaces of such type, whereby the shock produced on the movable beam and shaking caused thereby when the to-be-heated material is transferred from and onto the fixed beam, are reduced to a minimum, so as to prevent the material from moving away from the correct transfer course and also to raise the transportation velocity of the material.

Another object of the present invention is to provide a method for driving the movable beams in equipment of the movable beam type, particularly heating furnace of such type, so as to avoid the shock produced on the movable beam and its shaking caused thereby when it is transporting the material, and also so as to raise the transportation velocity of the material.

In order to attain these objects, in the transportation method, according to which the to-be-transported material is moved forward step by step on the fixed beam by the periodic repetition of the parallelogrammic movement consisting of the upward, forward, downward and backward strokes, the method is characterized by subjecting the movable beam to a speed reduction just before it approaches the upper surface of the fixed beam during the upward and the downward strokes of the movable beam, thereafter the to-be-transported material being transferred from and onto the fixed beam.

Thus, even when a high moving speed is used for the upward and the downward strokes, the transferring of the to-be-transported material onto the movable beam (from the fixed beam) and onto the fixed beam (from the movable beam), is carried out very softly, thus reducing the shock produced on the walking beam and the shaking caused thereby, as said speed is slowed just before the above transferring.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the vertical sectional view of one embodiment of the conventional, generally used heating furnace of the movable beam type.

FIG. 2 shows the speed pattern graph of a movable beam.

FIG. 3 shows a graph of the shaking of the movable beam moving in accordance with the speed pattern of FIG. 2.

FIG. 4 shows the speed pattern graph of the movable beam according to the method of the present invention.

FIG. 5 shows a graph of the shaking of the movable beam moving in accordance with the speed pattern of FIG. 4.

FIG. 6 shows one embodiment of an apparatus for practising the present invention.

FIG. 7 shows the speed graph of the movable beam moving in accordance with the system of FIG. 6.

FIG. 8 shows another embodiment of an apparatus for practising the present invention.

FIG. 9 shows the speed graph of the movable beam moving in accordance with the system of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The following is an explanation of the present invention, particularly in reference to the problems of the conventional furnace of the movable beam type for heating steel slabs.

The conventional heating furnace of the movable beam type has generally its floor consisting of the fixed beam and movable beams. The structure for transporting steel slabs by the movable beam is of conventional type, as shown in FIG. 1 and FIG. 2, wherein the steel slab 5 charged in the heating furnace 1 is placed on the fixed beam 2 set on the supports 3. During the upward stroke of the movable beam 4 driven by the dribing device (not shown), starting at the point A and continuing as far as the point B, the upper surface of the walking beam 4 passes the upper surface line (H.L.) of the fixed beam 2, and the steel slab is transferred onto the movable beam 4. Then, during the downward stroke $\overline{CD}$ of the movement following the forward stroke from the point B to the point C, the upper surface of the movable beam 4 passes the upper surface line (H,.L.) of the fixed beam 2, and the steel slab 5 is transferred back to the fixed beam 2. The movement cycle of the movable beam 4 is completed with the backward stroke from the point D to the starting point A. In the course of this cyclic movement, the steel slab 5 is moved forward on the fixed beam over the distance $\overline{BC}$; thus, by the periodic repetition of the cyclic movement of the movable beam 4, the steel slab 5 is moved forward step by step at a constant velocity (V) in the furnace, as shown in FIG. 2.

However, when the steel slab 5 is transferred during the upward stroke and the downward stroke of the movable beam 4, great shock is produced on the movable beam 4, causing the support of said movable beam to severely shake sideways.

FIG. 3 shows one example of the shaking of the movable beam 4 moving in accordance with the speed pattern of FIG. 2, in degrees of the moving, direction (a) the side direction (b) and the vertical direction (c), respectively, of the upward, the forward, the downward and the backward strokes of the movable beam 4.

As mentioned above, such shaking of the movable beam 4 causes the steel slab 5, the to-be-transported material, to move away from the correct transfer course, and also other troubles.

The reason of the occurance of such shaking is that, as shown in FIG. 2, the movable beam of conventional type is moving at an unchanged speed even when the steel slab 5 is transferred during the upward and the downward strokes of its movement.

On the other hand, there is a demand for the reduction of the cycle time of the movable beam 4, that is, speeding up of its movement, in order to take out the heated steel slab 5 from the furnace as rapidly as possible, such speeding-up causing greater shock. Such shock and the increased weight of the charged material constitute important problems to be solved in designing a large-sized heating furnace.

Among the four strokes, upward, forward, downward and backward, constituting one cycle of the movement of the movable beam, only the forward stroke relates directly to the transportation of the to-be-heated material. The remaining three strokes constitute time which is considered to be a loss of operation time. Therefore, it is desirable to use the operation time efficiently by speeding up these three strokes, and also by distributing the so reduced time effectively among them. Regarding the speed of the forward stroke, however, if it is raised excessively, shock will become greater at the time of acceleration and deceleration which must be avoided as it not only produces a strain on the support of the movable beam, but also causes the steel slab to move away from the correct transfer course on the fixed beam.

Another method for reducing the time of one cycle of the movable beam is to raise the ratio of the length of the forward stroke to the upward and the downward strokes, so as to reduce the loss of time due to the latter strokes in relation to that due to the former. But the length of the forward stroke is limited technically by the structure of the movable beam.

In view of the above disadvantages of the movable beam of conventional type, the present invention reduces to a minimum the shaking of the movable beam occurring when the steel slab is transferred, by providing a speed reduction midway on the upward and the downward strokes, which, however, does not hinder raising the speed prior and subsequent to the above speed reduction and on the other strokes, thereby making it possible to make the total time for one cycle of the movement the same as or shorter than that obtained by the movable beam of conventional type.

The following explains a preferred embodiment of the present invention with particular reference to FIG. 6 and FIG. 7.

FIG. 6 shows one embodiment of an apparatus for practising the present invention by using an oil pressure unit as the driving device of the movable beam. In this system, the variable discharging volume pump is used for controlling speed. Its mechanical structure consists of the speed setter 6 memorizing speed patterns, the voltage setter 7 for transforming the so made speed pattern into voltage, the servo-amplifier 8, the servo-valve 9, the servo-pump (variable discharging volume pump) 10, and the driving cylinder 11. This apparatus is so operated that the speed setter 6 which has memorized the speed patterns for start, medium operation, speed reduction and stop, issues an appropriate pattern selected therefrom to the voltage setter 7, which sends a voltage corresponding to the pattern through the servo-amplifier 8 to the servo-pump 10, which operates the driving cylinder 11 through the servo-valve 9.

FIG. 7 illustrates only the upward stroke of the cyclic movement of the movable beam in the case of using the apparatus of FIG. 6. As shown in the figure, the movable beam moves upward on the stroke $\overline{AB}$. Its speed rises from the starting point A gradually up to the highest at the point a and then continues to the point m (which has been set appropriately) just before the upper surface of the movable beam approaches to the upper surface line (H.L.) of the fixed beam. When the upper surface line of the movable beam reaches the point m, the limit switch LS_1 set at the point m is turned on, to thus instruct the speed setter 6 to give a signal to the movable beam to reduce the velocity thereof to a prescribed value.

The limit switch LS_1 may be set on the cylinder rod or any other place on the driving cylinder 11.

At the point M where the speed is slowed down by the speed reduction for the prescribed time, the movable beam receives the steel slab from the fixed beam, and resumes its original speed at the point m' in accordance with the pattern made by the speed setter 6. Having moved upward at the original maximum speed to the point b just before the prescribed stroke end, the limit switch LS_2 works for speed reduction, and at the stroke end point B, the limit switch LS_3 works to stop the upward stroke to be followed by the next forward stroke. Such speed control can be preformed easily by the cooperation of the abovementioned limit switches LS_1, LS_2 and LS_3 with the speed setter 6. Explanation of the operation of the downward stroke is omitted, as it is the same as that of the upward stroke. FIG. 4 shows the stroke and speed pattern graph of one cycle of the movement of the movable beam.

Thus, it can be easily understood that the transferring of the steel slab between the movable beam and the fixed beam is carried out very softly, thus the shaking of the movable beam to a minimum.

FIG. 5 shows the graph of one measured case of the shaking of the operation of the movable beam according to the present invention, which illustrates that the shaking is far less than in the case of the operation of the movable beam of conventional type shown in FIG. 3, in the moving (a), the side (b) and the vertical directions (c) during all of the upward, the forward, the downward and the backward strokes.

As shown in FIG. 3, the movement of the movable beam by the conventional method takes the longest time in the upward stroke and the downward stroke (that is, it is the slowest), in order to reduce such shock as mentioned above, and it takes the shortest time in the forward stroke and the backward stroke (that is, it is the fastest), to make up for the above slow movement. This makes it sometimes necessary to provide two kinds of cylinders for the fast and the slow movements.

However, as shown in FIG. 5, according to the present invention, the movements in the upward stroke, the forward stroke, the downward stroke and the backward stroke are made nearly constant in terms of time, and so can be driven by one cylinder, thus smoothing the movement of the movable beam and making easier its upward movement.

The structure for obtaining the midway speed reduction according to the present invention is not limited to the abovementioned, but any structure such as a reciprocal movement apparatus equipped with cams stand 12 shown in FIG. 8, moving in accordance with the speed pattern shown in FIG. 9 may be used. Such cam stand 12 has the pattern of a speed predetermined at $\overline{am}$ and $\overline{m'b}$ as shown in FIG. 9; and at $\overline{mm'}$ provides the profile of a midway speed reduction pattern. The reciprocal movement apparatus 13 makes the wheel 14 move on the cam 12 making possible the midway speed reduction, as prescribed, during the upward and the downward strokes. 15 denotes the reciprocal movement apparatus for the forward and the backward strokes. Explanation of the control of each stroke of the movement of the movable beam is omitted, as it is substantially the same as explained with regard to FIG. 6 and FIG. 7.

For carrying out the midway sped reduction according to the present invention, there are available many means such as:

i. By direct control of the rotation of the motor which directly drives the movable beam.
ii. by controlling the flow in an oil pressure circuit with an alternating switch and a throttle valve in the case of using a fixed discharging volume pump.
iii. by controlling flow by altering the number of operating pumps in the case of using a plural number of such pumps as mentioned in (ii) above.

The means used for the midway speed reduction according to the present invention is not limited to the abovementioned.

Also, the practice of the present invention is specifically explained above in an embodiment using a steel slab and a heating furnace, but it is not limited to such specific environment.

The method of the present invention is applicable to any equipment of movable beam type, thus reducing to a minimum shaking and avoiding such irregular movement of the to-be-transported material such as the steel slab from the correct transfer course on the fixed beam. Therefore, the method of the present invention is greatly effective when such equipment as the heating furnace is made to have a larger size and capacity.

Moreover, in spite of the midway speed reduction, one cycle of the movement of the movable beam for moving and taking out the to-be-transported material such as steel slabs, requires the same length of time as or a shorter time than required by the conventional method of moving the movable beam, with the transferring speed of the to-be-transported material remaining the same as that of the conventional method.

What we claim is:

1. In a method for transporting objects on a transportation system including fixed beams and movable beams comprising the steps of

elevating said movable beams to a position where the upper surfaces thereof are higher than the upper surfaces of said fixed beams, whereby said movable beams raise said objects under transportation away from said fixed beams;

advancing said movable beams horizontally to effect a forward movement of said objects under transportation;

lowering said movable beams to a position where said upper surfaces thereof are lower than said upper surfaces of said fixed beams, thereby transferring said objects from said movable beams onto said fixed beams; and

reversing said movable beams horizontally to their initial position;

the improvement comprising reducing the speed of said movable beams midway in the course of each of said elevating and lowering steps just before said movable beams raise said objects under transportation from said fixed beams and place said objects onto said fixed beams, respectively.

2. In a method as claimed in claim 1, wherein each of the upward, forward, downward and backward movements of said movable beams are caused to take substantially the same length of time.

3. In a method as claimed in claim 1, wherein said midway speed reducing is carried out by operating an oil pressure unit as the driving apparatus of said movable beam, and wherein the speed of said movable beam is controlled by operating a variable discharging volume pump.

4. In a method as claimed in claim 1, wherein said midway speed reducing is carried out by operating a reciprocal movement apparatus equipped with a cam having a desired speed pattern.

5. In a method as claimed in claim 1, wherein said midway speed reducing is carried out by operating the speed control of a motor connected directly with said movable beam as the driving apparatus thereof.

6. In a method as claimed in claim 1, wherein said midway speed reducing is carried out by operating the flow control in an oil pressure circuit of an alternating valve and a throttle valve used by a fixed discharging volume pump.

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