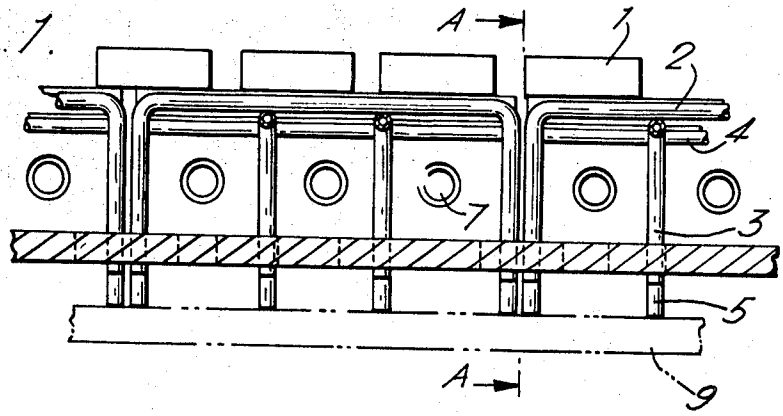
March 2, 1971 KEIJI KAKUTA ETAL 3,567,195

WALKING BEAM CONTINUOUS HEATING FURNACE

Filed April 24, 1968 4 Sheets-Sheet 1

Fig. 1.



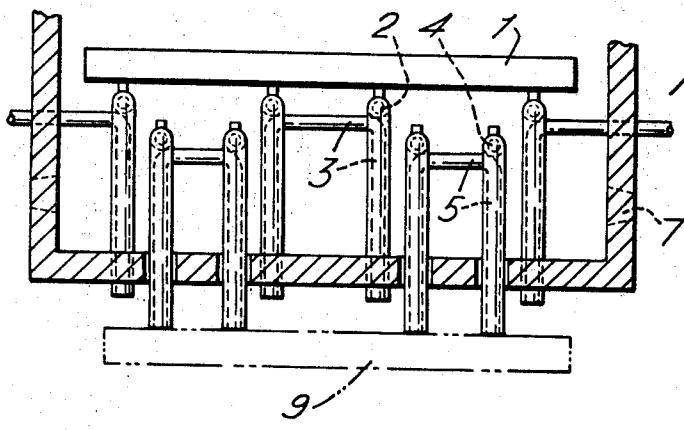
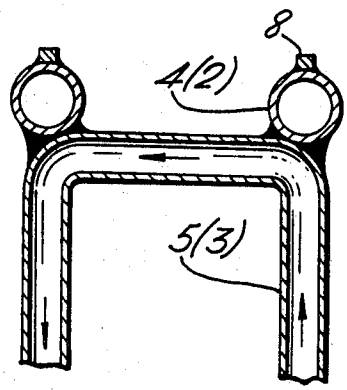


Fig. 2.

Fig. 3.



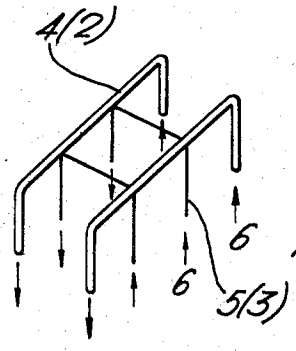


Fig. 4.

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WALKING BEAM CONTINUOUS HEATING FURNACE

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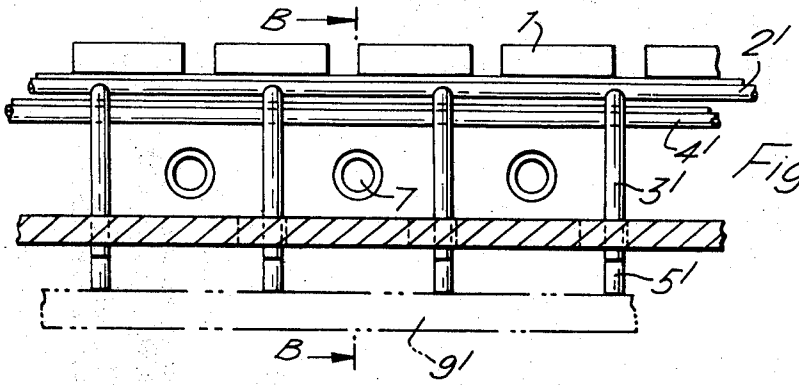
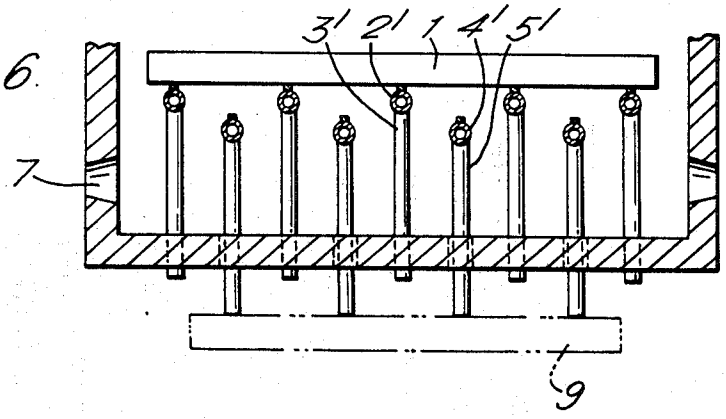


Fig. 5.

Fig. 6.



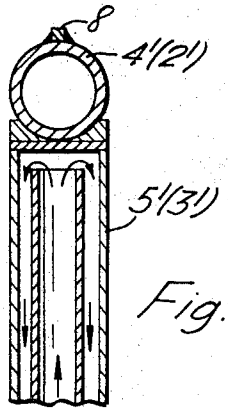


Fig. 7.

Fig. 8.

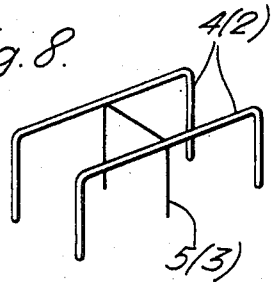
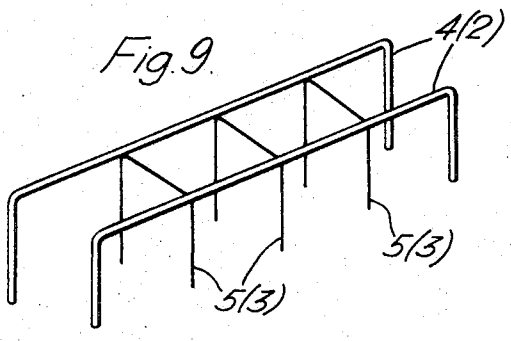


Fig. 9.



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WALKING BEAM CONTINUOUS HEATING FURNACE

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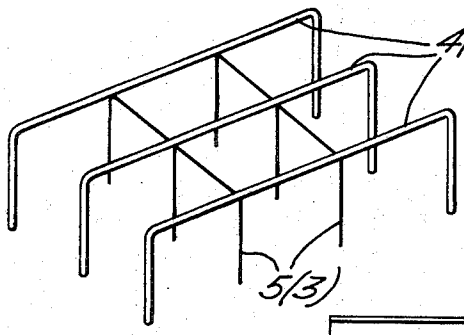
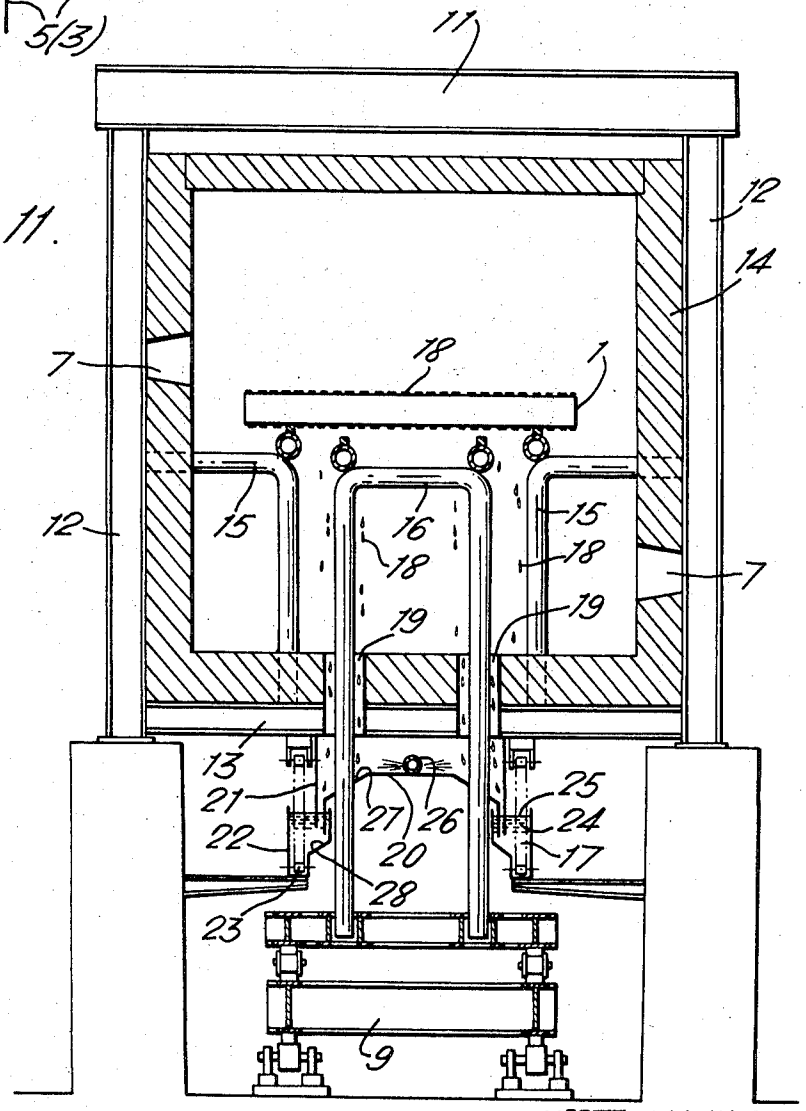


Fig. 10.

Fig. 11.



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WALKING BEAM CONTINUOUS HEATING FURNACE

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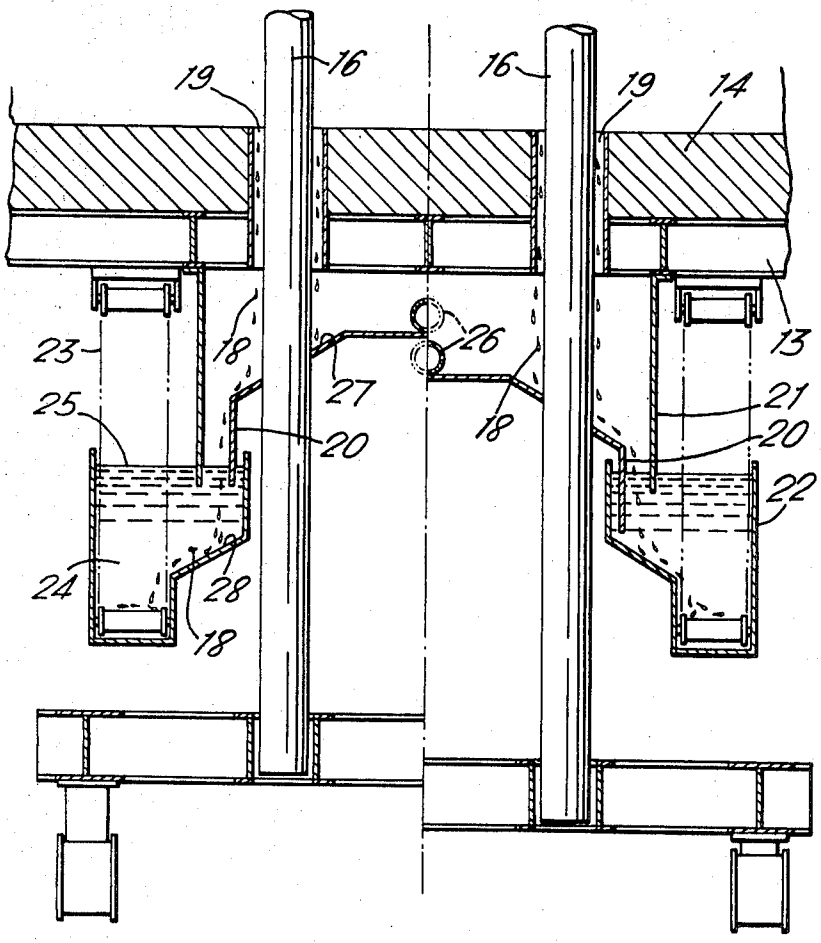
Fig. 12.



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United States Patent Office 3,567,195
Patented Mar. 2, 1971

3,567,195

WALKING BEAM CONTINUOUS HEATING FURNACE

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Filed Apr. 24, 1968, Ser. No. 723,836
Claims priority, application Japan, June 26, 1967, 42/40,549; Dec. 12, 1967, 42/104,328
Int. Cl. F27d 3/12
U.S. Cl. 263—6 4 Claims

ABSTRACT OF THE DISCLOSURE

A continuous heating furnace of walking beam type wherein a suitable number of walking beams of Rahmen structure are arranged in parallel in the direction of the movement of the object to be heated along with a suitable number of fixed beams of Rahmen structure, both of said type of beams being constructed by fixing a required number of hair-pin beams to a plurality of longitudinally placed beams and wherein cooling water in both of said types of beams is made to flow in one direction only.

DETAILED EXPLANATION OF THE INVENTION

As a continuous heating furnace to treat slabs and billets, the Pusher heating furnace has been used in most of the cases in the past. A walking beam type heating furnace has been used mainly for heat treatment and as a light duty heating furnace. Most of such heating furnaces are those in which materials are heated on their upper surface only and therefore were not fully efficient. On the other hand, few walking beam type heating furnaces in which the material can be heated on both upper and lower surfaces have so far been put in practical use and there has been little or no prior art with respect to its construction.

FIG. 1 is a longitudinal cross-sectional view of the walking beam type continuous heating furnace according to the present invention.

FIG. 2 is a cross-sectional view at A—A of the heating furnace shown in FIG. 1.

FIG. 3 is an enlarged view of the upper part of the beam shown in FIG. 2.

FIG. 4 is a diagram of the entire structure of the beams used in the heating furnace of the present invention.

FIG. 5 is a longitudinal cross-sectional view of a conventional walking beam type continuous heating furnace.

FIG. 6 is a cross-sectional view at B—B of the heating furnace shown in FIG. 5.

FIG. 7 is an enlarged view of the upper part of the beam as shown in FIG. 6.

FIGS. 8 to 10 are diagrams of the entire structures of the beams used in the heating furnace of the present invention.

FIG. 11 is a longitudinal front section of a walking beam type furnace of this invention equipped with a water-sealing system.

FIG. 12 is an enlarged view of the water sealing part of FIG. 11. (The left half shows the water sealing section with the sealing plate raised and the right half shows the section with the water sealing plate lowered.)

FIGS. 5 to 7 show supposed structures of the conventional walking beam type heating furnace in which the material is heated on both sides.

In the said system, the material to be heated **1** is introduced into the furnace at the inlet of the furnace by means of a charger, placed on the fixed beams **2'**, **3'** and

thereafter gradually moved forward inside the furnace toward the extraction end by the rectangular motion of the walking beams **4'**, **5'**, until finally it is extracted by the extractor at the discharging end. Throughout its forward movement, the material is heated on both sides by means of a burner **7**.

In the said structure, the beams **2'**, **3'** and **4'**, **5'**, as shown in FIGS. 5 to 7, consist of the longitudinal beams **2'**, **4'** in which cooling water is flowing, individually supported by the vertical beams **3'**, **5'** in which cooling water is likewise flowing, with the walking beam **4'**, **5'** provided between adjacent fixed beams **2'**, **3'** in the direction perpendicular to the movement of the material to be heated **1**. Thus the material **1** is moved toward the discharging end by the forward movement of the base **9** after the material is lifted up from the beam **2'** by the said base **9** integral with and supporting the walking beams **4'**, **5'** when the base is raised upward. Then the base is lowered and goes back to its original position, leaving the material **1** on the beams **2'**. Thus, such forward movement of the material is accomplished by the rectangular movement of the base **9**.

The beams as shown in FIGS. 5 to 7 have a disadvantage that their strength in the transverse direction is rather weak in spite of their large diameter, because their vertical supports **3'**, **5'** are only connected with each other at their lower ends and otherwise individually support the beams.

The detailed structures of the longitudinal beams **2'**, **4'** and the vertical beams **3'**, **5'** are shown in FIG. 7. As seen therein, the longitudinal beams **2'**, **4'** are a hollow pipe with cooling water running inside, to the upper side of which is welded a support **8** for the material **1** and to the lower side of which is connected the beam **3'** or **5'** at suitable intervals. The vertical beams **3'**, **5'** are a concentric double pipe in which cooling water goes up through the inner pipe, and after it is reflected at the upper and, flows down along the inner wall of the outer pipe.

As described above, this structure is too complicated and there is a danger of the cooling water being obstructed in the pipe due to a formation of fur. Furthermore, there is a possibility of deformation caused by expansion or contraction by heat because most of the structure is of continuous construction.

And, as a result of the increasing use of a walking beam type continuous heating furnace for heating slabs, billets, etc. in recent years, the temperature inside the furnace tends to become higher and produce large amounts of scales, which fall into the sealing system on the furnace floor, deposit between the movable sealing plate and the bottom of the sealing trough, and may damage the sealing system. In order to prevent such damage, a scratch plate was attached to the lower part of the movable sealing plate to remove the scales that have built up on the bottom of the sealing trough but this expedient has not proved fully satisfactory with respect to the effective prevention of damage and the ease of maintenance and inspection.

The present invention relates to a walking beam type continuous heating furnace designed to eliminate the aforementioned disadvantages and characterized in that it comprises a suitable number of fixed beams and walking beams of Rahmen structure composed of a plurality of longitudinal beams provided in the direction of movement of the material to be heated and of vertical hairpin beams fixed thereto, said fixed beams and walking beams being arranged in plurality in the direction of movement of the material and at the same time said fixed beams and walking beams being provided in suitable numbers at a right angle to the said direction, thereby forming blocks, and the means for flowing the cooling water in only one direction inside the said beams.

The walking beams type continuous heating furnace of this invention has been designed to eliminate the aforementioned disadvantages and comprises a movable sealing plate mounted on the movable support which is provided between the fixed supports in the furnace and moves upward and then forward (that is, in a rectangular path when viewed from the side) through the opening of the floor of the space, and the fixed sealing plate mounted on the floor beam of the furnace, the lower ends of both of such sealing plates being immersed in the water in the trough having on its bottom a transport means for the scale, thereby effecting sealing, and the movable sealing plate and the side walls of the sealing are provided with a slope down which scales falling through the opening of the floor of the furnace are led to the transport means.

An embodiment of this invention is described below with reference to the accompanying drawings. As shown in FIG. 3, the vertical beams **3, 5** of both the fixed beam and walking beam are so constructed as to be of a hairpin shape and a plurality of the longitudinal beams **2, 4** are fixed on to a plurality of the beams **3, 5**, thus forming blocks. A furnace of a suitable length is composed of such blocks placed side by side. The numbers shown in FIGS. 1 to 4 correspond to those shown in FIGS. 5 to 7. Because of the hairpin shape of the beams **3, 5**, unlike the corresponding beams **3', 5'** which in the conventional furnace individually support the material to be heated **1** as shown in FIGS. 5 to 7, more strength in the transverse direction is obtained and more safety is ensured against lopsided load or horizontal shake caused by an earthquake, etc. Furthermore, because of their Rahmen structure, smaller vertical beams than conventional ones can be used and therefore there is less heat loss. Such structure also enables regularly flowing cooling water in one direction and simplifies the water pipe system, minimizing trouble caused by fur, etc. On the other hand, their block structure with separated supporting means for the material to be heated ensures minimum distortion of the beams due to expansion or contraction.

Other than the one shown in FIG. 4, there may be various modifications of the block formation of the present invention, including but not limited to those shown in FIGS. 8, 9 and 10.

An embodiment of the walking beam type continuous heating furnace provided with the water sealing system of this invention is shown in FIG. 11 and 12 in the attached drawings by way of explanation of our invention.

In these figures, numerals indicate the following parts respectively: **11** the roof beam, **12** the support for the roof beam, **13** the hearth beam, **14** the furnace wall made of refractories, **15** the fixed support, **16** the movable support provided between the said fixed supports, composed of a combination of steel pipes which are water-cooled inside, **17** the sealing, **18** the scales produced when the treatment material is heated, **19** the opening of the hearth, **20** the movable sealing plate mounted on the movable support, **21** the fixed sealing plate fixed or detachably mounted on the hearth beam, **22** the sealing trough mounted on the base, into which the lower ends of the said two sealing plates are inserted, **23** the transport means for the scales mounted on the bottom of the sealing trough, e.g. a conveyer, **24** the sealing water contained in the sealing trough, **25** the surface of the sealing water, **26** the spray pipe mounted on the movable sealing plate, **27, 28** the slopes provided on the movable sealing plate of the sealing trough.

The water sealing system in the walking beam type furnace of this invention is constructed as described above and the material to be heated **1** which is supported on the two suports is heated by the burner **7** both from above and from underneath. The movable support **16** provided between the fixed supports, which is moved both vertically and horizontally, that is, in a rectangular path when viewed from the side, by the base **9**, lifts up the material **1** from the fixed beams **15**, moves it forward and places it again on the fixed supports, while lowering itself. Then the lowered support returns backward and completes one cycle of its movement. By repetition of this procedure, the material **1** continues forward movement while it is heated and produces a large amount of scales **18**, a portion of which fall into the sealing system **17** through the opening of the floor of the furnace.

As shown in FIG. 12, the lower end of the movable sealing plate **20** is always immersed to a necessary depth in the water contained in the sealing trough when it is raised or lowered and the lower end of the fixed sealing plate **21** is likewise kept in the water **24**. This prevents an outburst of the gas inside the furnace and an entry of air into the furnace. The movable sealing plate **20** is cooled and protected from possible overheat due to the radiation of heat inside the furnace by water sprayed by means of the spray pipe **26** mounted on said sealing plate.

Thus, the scales **18** produced inside the furnace fall through the opening in the furnace floor and slide down the slope **27** of the movable sealing plate **20** mounted on the movable support **16** into the water **24**, where they are led along the slope **28** of the side wall of the sealing trough **22** onto the conveyer **23** and are carried away by the conveyer regardless of their size and shape.

If a sufficient clearance is provided between this fixed sealing plate **21** and the side wall of the sealing trough **22**, it is possible to conveniently inspect from outside through water surface **25** the conditions of the lower end of the movable sealing plate in its lowered position, the falling scales and the conveyer **23**.

Furthermore, it will facilitate servicing of the conveyer if the return portion of the conveyer **23** belt is hung from the floor beam **13** of the furnace opposite the outside of the fixed sealing plate **21**. Also, the fixed sealing plate **21** can be easily detached for servicing if it is bolted to the floor beam **13** of the furnace with a packing inserted in between.

As described above, the walking beam type continuous heating furnace provided with the water sealing system of this invention has the following advantage:

(i) As slopes in the direction of the transport means are provided on the movable sealing plate under the opening of the floor of the furnace and on the sidewall of the sealing trough, the scales falling through the opening can be easily and completely carried away on the transport means regardless of their size and shape.

(ii) The lower ends of the fixed sealing plate and of the movable sealing plate always stay in the water contained in the sealing trough, thereby preventing an outburst of gas in the furnace and an infiltration of air into the furnace.

(iii) It is conveniently feasible to inspect from outside through the surface of water contained in the sealing trough the conditions of the lower end of the movable sealing plate when it is in a lowered position, the scales that have fallen into the water and the conveyer system for the scales.

What we claim is:

1. A continuous heating furnace of walking beam type comprising a suitable number of fixed beams and walking beams consisting of necessary number of vertical hairpin beams fixed to a plurality of longitudinal beams arranged in the direction of movement of the material to be heated, a plurality of said fixed beams and walking beams being arranged in the direction of movement of the material to be heated and at the same time a suitable number of such fixed beams and walking beams being provided in the direction at a right angle to the said direction of movement, thereby forming blocks, and further in that there are provided means inside said beams for permitting flow of cooling water in one direction only.

2. A walking beam type continuous heating furnace described in claim 1, provided with the water sealing system wherein the lower ends of the movable sealing plate mounted on the movable support which is provided between the fixed supports in the furnace and moves both vertically and horizontally through the opening of the floor of the furnace, and of the fixed sealing plate mounted on the floor beam of the furnace, are both inserted in the water contained in the sealing trough having a transport means for scales on its bottom, thus effecting a sealing, and wherein there is provided a sufficient clearance between the fixed sealing plate and the sidewall of the sealing trough so as to make visible through the exposed water surface all of the lower end of the movable sealing plate in its lowered position, the scales which have fallen into the sealing trough and the transport means provided in the trough.

3. A continuous heating furnace of walking beam type comprising a plurality of fixed beams and of walking beams consisting of vertical hairpin beams fixed to a plurality of longitudinal beams arranged in the direction of movement of the material to be heated, a fixed sealing plate mounted on the floor beam of the furnace, a horizontally elongated opening in the furnace floor, a beam support movable both vertically and horizontally through

said opening, a movable sealing plate mounted on said movable beam support, and a fixed sealing trough beneath said sealing plates, the lower edges of said sealing plates extending into said trough, and said trough and sealing plates being so proportioned and positioned that, when a suitable depth of water is in said trough, said lower edges extend into such water in all relative positions of said edges.

4. A furnace according to claim 3 in which at least one of said plates is disposed to direct scales falling from the furnace into said trough, and which includes a conveyor in said trough and means actuating said conveyor to transport said scales.

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U.S. Cl. X.R.

198—219; 266—6