March 31, 1964 F. W. BUSCH 3,127,034

FURNACE FEED APPARATUS

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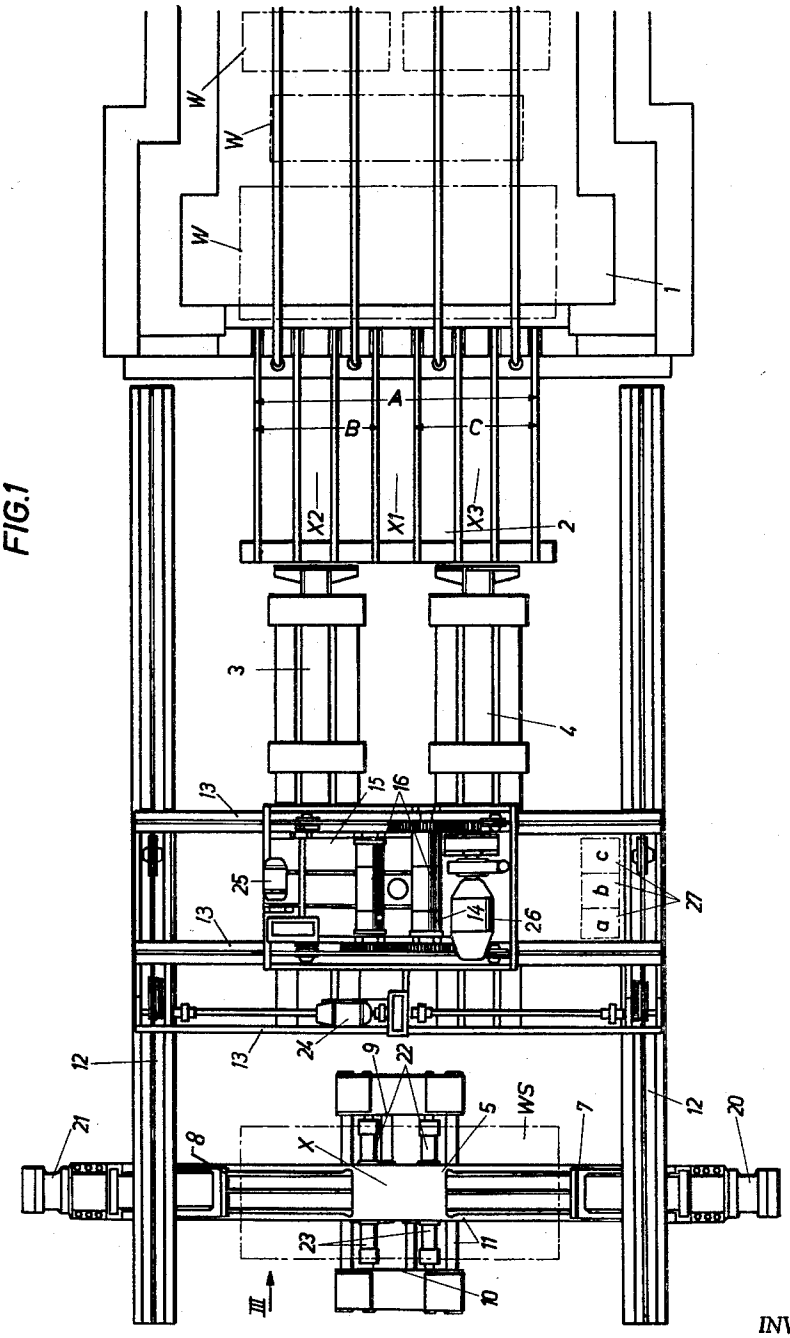
FIG.1



INVENTOR.
FRIEDRICH W. BUSCH

BY Marvin S. Blodgett
ATTORNEY

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FURNACE FEED APPARATUS

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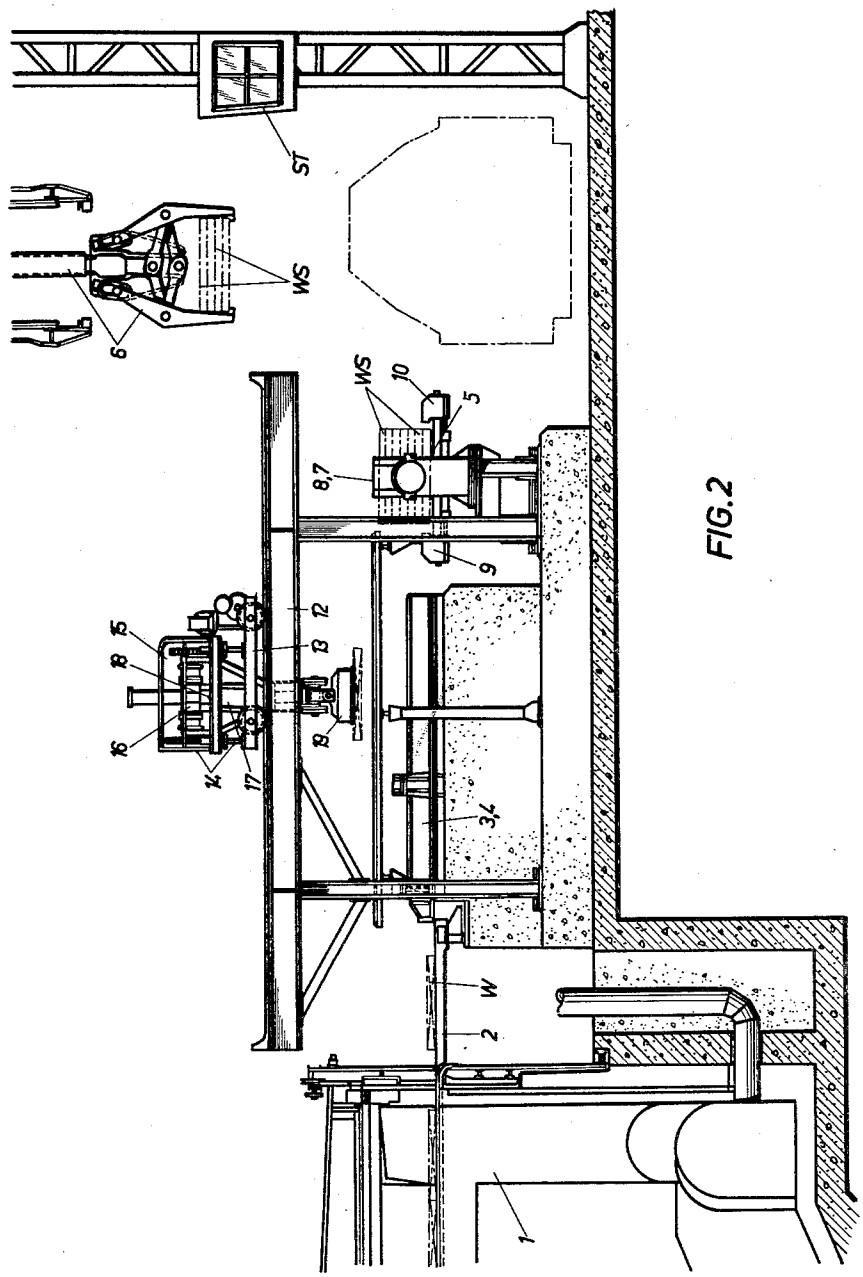

FIG. 2

INVENTOR.

FRIEDRICH W. BUSCH

BY Ulman S. Blodgett

ATTORNEY

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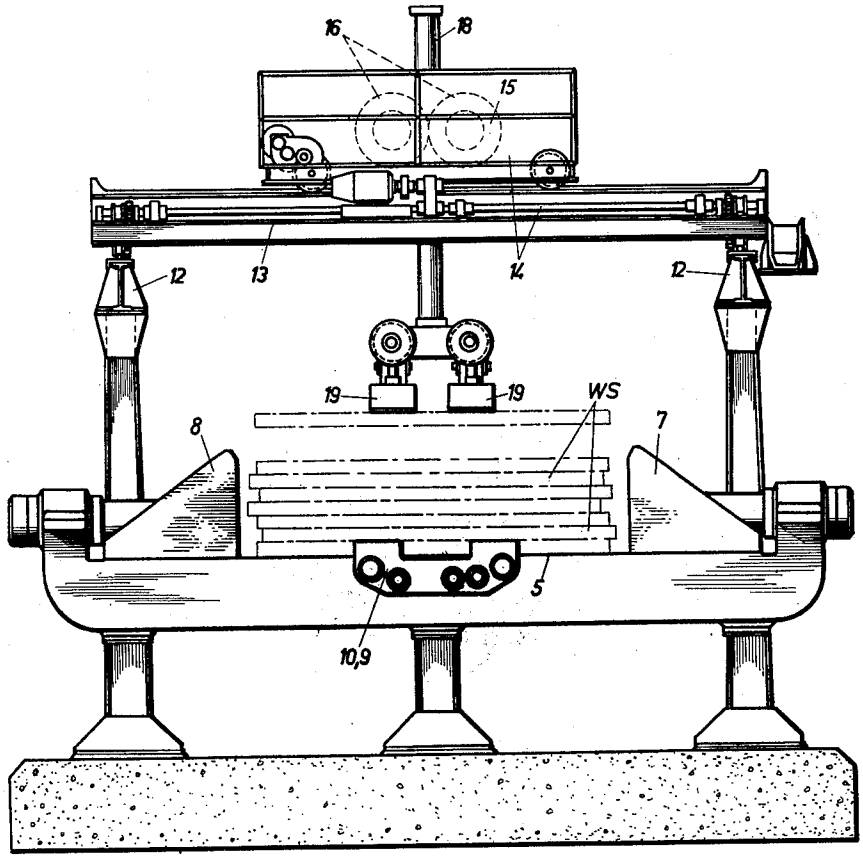
FIG.3



INVENTOR.

FRIEDRICH W. BUSCH

BY Thomas S. Blodgett

ATTORNEY

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FURNACE FEED APPARATUS

Friedrich W. Busch, Dusseldorf, Germany, assignor to Siemag Siegener Maschinenbau G.m.b.H., Dahlbruch, Westphalia, Germany, a corporation of Germany

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3 Claims. (Cl. 214—18)

This invention relates to a furnace feed apparatus and, more particularly, to means arranged to introduce slabs or the like into a reheating furnace.

In a steel mill, after the initial rough rolling operation from the ingot, the slabs or the billets are allowed to cool. Therefore, before being subjected to a further finish rolling operation, the stock must be heated in a reheating furnace. In modern rolling mills with high rolling speeds it is, of course, necessary to heat slabs or billets in a sufficient number and at a sufficient speed to keep up with the rolling mills. To meet these requirements a cross-pusher reheat furnace has been developed in which the stock is introduced at one end of the furnace, pushed through the furnace, and emerges at the other end at rolling temperature. After leaving the reheat furnace, the stock rolls along a conveyor to the rolling mill. Now, according to the well-known method of operation, the rolling stack which is to be heated is brought to the inlet end of an elongated reheat furnace along a path which is longitudinal of the stock and transverse of the long dimension of the furnace. From there it is pushed by cross-pushers through the furnace. In many of these arrangements two cross-pusher mechanisms are used in side-by-side relationship at the inlet end of the furnace. These cross-pushers are operated together when introducing long pieces of stock, but they can also be operated independently and alternately for stock which does not occupy the entire width of the furnace. A considerable disadvantage of these known arrangements appears during the alternate method of operating the rolling mill cross-pushers, particularly when the stock is moved into the furnace in the transverse direction. During the operation of the cross-pusher closest to the furnace entrance, access to the other cross-pusher will be blocked by the first one. Therefore, the rolling stock cannot be supplied to the far side of the furnace before the first cross-pusher has moved back. This situation causes uneconomical operation, particularly when the furnace must work at peak capacity and it is necessary to bring the stock to the furnaces at a rapid rate. These and other difficulties experienced with the prior art devices have been obviated in a novel manner by the present invention.

It is, therefore, an outstanding object of the invention to provide a furnace feed apparatus resulting in improved operation in the charging of a reheat furnace with slabs or billets.

Another object of this invention is the provision of a furnace feed apparatus for use with a reheat furnace having double-cross-pushers wherein stock to be heated can be introduced in front of one of the cross-pushers without interfering with the operation of the other cross-pusher.

A further object of the present invention is the provision of apparatus for introducing slabs and the like into a reheat furnace wherein each slab may be individually and accurately located relative to the cross-pusher devices.

It is another object of the instant invention to provide an apparatus for handling slabs or the like and accurately and quickly introducing them into a cross-pusher-type reheat furnace.

It is a further object of the invention to provide a stock-handling apparatus for use with a reheat furnace

which apparatus is simple and rugged in construction, relatively inexpensive to manufacture, and is capable of a long life of useful service.

A still further object of this invention is the provision of a reheat furnace of the cross-pusher type wherein elongated stock may be introduced broadside into the furnace rather than transversely in the direction of stock length.

It is a still further object of the present invention to provide a reheat furnace apparatus permitting the introduction of stock of various lengths wherein the entire width of the furnace is in substantial use at all times.

With these and other objects in view, as will be apparent to those skilled in the art, the invention resides in the combination of parts set forth in the specification and covered by the claims appended hereto.

The character of the invention, however, may be best understood by reference to one of its structural forms as illustrated by the accompanying drawings, in which:

FIG. 1 is a plan view of apparatus embodying the principles of the present invention;

FIG. 2 is a side elevational view of the apparatus; and

FIG. 3 is an end elevational view of the apparatus taken along the plane III of FIGURE 1.

Broadly speaking, the advantages of the present invention are obtained by providing a pile of rolling stock consisting of slabs or the like laying one on top of the other, which is adjusted relative to a fixed point near the heating furnace. Then, individual pieces of stock are removed from the pile in working sequence and brought to the input side of the reheat furnace. By adjusting each piece to a fixed point relative to the furnace, it is possible to use automatically-controlled apparatus for placing the slab in a pre-determined position in the furnace. According to the invention, a traveling crane is used to transport the stock; this crane can be brought into operation automatically from a zero position which lies between the feed side of the reheat furnace and the fixed point of the rolling stock pile. The crane lifts each piece of stock from the pile and transports it along a pre-determined path and sets it down on a slideway or grate, from which point the crane (after releasing the stock) returns to its zero position. The apparatus is provided with a platform which is situated a substantial distance in front of the reheat furnace, which, in turn, is equipped with a grate and conventional cross-pushers. Furthermore, the distance between the stock pile and the grate of the reheat furnace is bridged by the traveling crane, which, as has been stated, is provided with a steering arrangement which leads it automatically from its rest position over the platform to seize each stock piece and set it down in a position on the grate. The traveling crane works at a substantially higher elevation than the cross-pushers, thus permitting charging of the furnace in any selected sequence. By this arrangement, the inlet end of the furnace is not cluttered with miscellaneous feed apparatus at floor level; therefore, the space which is thus free of obstruction may be used for other auxiliary machines.

Referring to the three figures of drawings, which show both the general and specific characteristics of the invention, the reheat furnace, indicated generally by the reference numeral 1, is shown as being of the elongated rectangular type having an inlet end and an outlet end. The furnace is provided with an operating floor having slide bars along which workpieces W may be slid in consecutive relationship, the length of each piece extending transversely of the furnace. A grate 2 is mounted at the inlet end of the furnace which is provided with a transversely-elongated opening permitting the broadside introduction of the longest workpiece to be encountered. Cross-pushers 3 and 4 of a well-known type are arranged on the operating floor in side-by-side paral-

lel relationship and are selectively operative together or separately to move workpieces over the surface of the grate 2. The width of the grate 2 (indicated by the reference letter A) is substantially equal to the width of the reheat furnace 1 and is the same as the length of the longest workpiece to be encountered. An elongated workpiece W sufficient to occupy the entire width A of the grate would be moved by the simultaneous use of both cross-pushers 3 and 4. The width of the grate is divided into two halves B and C which would be used in the case of smaller workpieces introduced in side-by-side relationship into the furnace at which time the cross-pushers 3 and 4 would be operated independently. At the side of the cross-pushers 3 and 4 opposite the grate 2 is arranged a horizontal platform 5 on which a pile of slabs or other rolling mill stock (indicated by the reference letters WS) are supported. The stock is placed on the platform by means of a crane 6 (see FIG. 2) which is equipped with grippers. The platform 5 is provided with two transversely-adjustable aligning members 7 and 8. The platform is also provided with two longitudinal aligning members 9 and 10. The transverse aligning members 7 and 8 will adjust the stock transversely of the centerline of the furnace and the longitudinal aligning members 9 and 10 will adjust the stock in the direction of the furnace axis, so that each piece of stock is located in an exact position relative to a fixed point X. Extending at a right angle to the centerline of the reheat furnace 1 is a movable crane bridge 13 which is movable on wheels along spaced parallel rails 11 and 12. Mounted on the bridge for sliding movement transversely of the furnace is a carriage 15 supporting a material-handling device such as a crane 14. The carriage 15 is equipped with a well-known type of hoisting unit in which a bushing 17 supports in sliding relationship a vertical bar 18 which is adjustable for lifting and lowering and which is provided at its lower end with a material-grasping means such as an electromagnet 19. The rails 11 and 12 are of such a length that the crane bridge 13 can be moved from a position over the platform 5 to a position over the grate 2 passing over the top of the cross-pushers 3 and 4. The rails 11 and 12 are separated by a distance that is at least as great as the width of the reheat furnace 1, so that the carriage 15 can be moved transversely of the furnace and adjusted exactly over a desired position on the portions A, B, and C of the grate 2.

It is contemplated that the entire apparatus will be operated and controlled by a single person from an operator's booth, indicated by the reference letters ST in FIG. 2. For adjusting the stock on the platform 5 relative to the reference point X, the alining member 7 is movable under the action of a linear actuator such as a hydraulic cylinder 20. The transverse aligning member 8 is provided with a similar cylinder 21; the longitudinal aligning member 9 is provided with actuating cylinders 22 and the aligning member 10 is movable by means of actuating cylinders 23.

After the crane 6 has lowered a stock pile WS onto the platform 5, a switch in the control booth ST will be closed, which action will operate the cylinders 20 and 21. These cylinders will move the aligning members 7 and 8 in synchronization and the stock pile will be moved to an exact position relative to the fixed point X. When the aligning members 7 and 8 press against the sides of the stock pile WS (when it is in the exact position relative to the fixed point X), the pressure in the cylinders will rise and the cylinders 20 and 21 will be reversed by means of a well-known pressure-operated switch. At the same time, the cylinders 22 and 23 will be switched to forward operation. These cylinders press the aligning members 9 and 10 in synchronization relative to one another and this moves the stock pile, if necessary, in a longitudinal direction (relative to the centerline of the furnace) to the fixed point X. Here again, when the aligning members 9 and 10 have the pile in the proper place, pressure will build up in the cylinders 22 and 23; a pressure-operated switch will then reverse the actuating cylinders 22 and 23 and move the aligning members 9 and 10 away from the pile.

In order to move the bridge 13 along the rails 11 and 12, an electric motor 25 is provided. The hoisting unit 16 mounted on the carriage 15 is driven by an electric motor 26. Normally, the crane 14 is located in a zero reference position, as shown in the drawing; this position is located between the grate 2 of the reheat furnace 1 and the fixed point X on the platform 5. A main control 27 is provided with control units *a*, *b*, and *c*, in which the control unit *a* is operative with the electric motor 24 to move the bridge 13; the control unit *b* is operative with the electric motor 25 to move the carriage 15; and the control unit *c* is operative with the electric motor 26 to operate the hoist unit 16. Electrical contacts and other switch media will be operated by the control units *a*, *b*, and *c*, and will be released in an exact pre-determined working sequence relative to the positioning and operation of the crane by the main control 27, in the well-known manner. In order to provide one of three different working sequences, the operator in the control stand ST has only to close one of three switches arranged in a row. These three switches are marked to indicate each of the three different possible places for deposit of the rolling mill stock workpieces W on the grate 2 in front of the inlet end of the reheat furnace 1. Each working sequence of the crane 14 is started by the operator by pressing one of the three switches. Any switch, after actuation, operates to start the electric motor 24 in one direction of rotation which moves the crane bridge in the direction of the platform 5. The control unit *a* of the main control 27 receives a signal indicative of the movement of the bridge 13.

When the crane bridge 13 has reached a position in which the vertical bar 18 and the electromagnet 19 are aligned with the fixed point X on the platform 5, the control unit *a* of the main control 27 acts to stop the electric motor 24. At the same time, the electric motor 26 is started by its control unit *c* and the hoisting unit 16 operates to lower the electromagnet 19. Upon the starting of the motor 26, the control unit *c* also activates the electromagnet 19 associated with the crane. This is done, for example, by means of a cable-release switch so that, as soon as the electromagnet touches the top piece on the pile WS of rolling stock the electromagnet is energized. With the energization of the electromagnet 19 the control unit *c* again energizes the electric motor 26 for lifting and causes one of the workpieces W to be lifted from the pile, as shown in FIG. 3. In the uppermost lifting position the motor 26 will again be stopped by means of a limit switch operating the control unit *c*. All other movements of the traveling crane 14 (up to the time the workpiece is lowered onto the grate 2) are different in the three possible working sequences. For example, when the operator wishes to place a very long workpiece W along the dimension A of the grate, the operator will actuate the center switch in order to set in motion a corresponding crane working operation. After the workpiece W is lifted from the pile and the motor 26 is stopped, the motor 24 will be energized by the control unit *c* of the main control 27 into rotation in such a direction that the crane bridge 13 will move in the direction of the grate 2. As soon as the vertical bar 18 of the hoisting unit is aligned with a fixed point X1 on the grate 2, the motor 24 will be stopped by the control unit *a* of the main control 27, which is moving along with the motor 24. The motor 26 will then be switched on for the lowering operation. The workpiece W attached to the electromagnet 19 will be set down on the grate 2 in such a position so that the point

on the workpiece which corresponds to the fixed point X on the platform 5 is now aligned with the fixed point X1 on the grate 2. The cable release switch (which works with the control unit *c*) will de-energize the electromagnet 19 and will energize the electric motor 26 for lifting. At the uppermost position of the hoisting unit the motor 26 will be shut off by the control unit *c* and the motor 24 energized for producing a reversed longitudinal movement of the bridge. The control unit *a* which moves along with the motor 24 disconnects the electric motor 24 from the system automatically when the zero rest position of the crane 14 is reached.

Let us suppose, for example, that it was determined by the operator (by pressing the left hand switch) that the workpiece W should be set down on the grate 2 in the range indicated by the dimension B. Then, after lifting the workpiece W from the pile, the motor 26 is shut off by the control unit *c* and the lifting motion terminates. At the same time, the motor 24 will be energized and also the motor 25 for driving the crane carriage to one side. The control unit *a* of the main control 27 moves along with the motor 24 and the control unit *b* moves with the motor 25. The electric motor 24 will be shut off by the control unit *a* as soon as the axis of the vertical bar 18 is in the same transverse plane as the fixed point X2 on the grate 2. The motor 25 is shut off by the control unit *b* at the moment when the axis of the vertical bar 18 is aligned with the fixed point X2 on the grate. By shutting down the electric motors 24 and 25, the position of the axis of the bar 18 becomes aligned with the fixed point X2 on the grate 2. Then, the motor 26 is switched on to lower the workpiece over the fixed point X2. Because of the functioning of the control unit *a* and *b*, the point on the workpiece W that was previously aligned with the fixed point X on the platform 5 now is in alignment with the fixed point X2 on the grate 2.

When the workpiece W has been set down on the grate 2 the electromagnet 19 is released by means of the aforementioned cable-release switch which operates as a function of the control unit *c* and the electric motor 26 is reversed. In the uppermost position of the hoist unit the motor 26 is shut off by the control unit *c* and the motors 24 and 25 are energized to return the crane back to zero position where it will be stopped automatically by the control units *a* and *b*.

On the other hand, if the operator closes the right hand switch, the crane, after lifting the workpiece W from the pile, will operate as a function of the control units *a*, *b*, and *c* of the main control 27 to operate the electric motors 24, 25, and 26 so that the workpiece will be set down on the grate 2 in the range of the dimension indicated by the reference numeral C and aligned with the fixed point X3.

The cross-pushers 3 and 4 are actuated by the operator in the booth ST by using the same three switches. Pressing down on the left switch the cross-pusher 3 operates and pushes a workpiece which was set down on the portion B of the grate 2 into the reheat furnace 1. On the other hand, by operating the right hand switch, the cross-pusher 4 operates alone and pushes a workpiece along the portion C of the grate 2 into the furnace. Again, by pressing the center key the cross-pushers 3 and 4 operate simultaneously and synchronously to push a large workpiece resting across the whole portion A of the grate into the furnace. The control devices for the cross-pushers 3 and 4 are arranged so that, by advancing the pushers automatically, the operating doors associated with the inlet opening of the furnace open to permit the admission of a slab. In reverse movement of the cross-pushers, the control means automatically closes the doors. In the preferred embodiment two doors would be used, one extending across the portion B of the grate and the other across the portion C, each door operated individually with its individual cross-pusher 3 or 4 and both operative together when both cross-pushers are energized.

It will be obvious from the above description that it is possible to operate the apparatus and introduce the slabs into the furnace without blocking, because the operator can pre-determine readily the charging sequence. For instance, while the crane operates in a pre-determined working sequence, it is also possible by the simple closing of the same switch to charge the furnace in a proper manner by means of the cross-pushers. It is possible quickly to adjust with accuracy a rolling mill stock pile which is set down on the platform 5 by operating the aligning members on the platform. To secure the exact positioning of the treveling crane 13 in the lifting and lowering positions for various rolling mill workpieces, the motors would preferably be switched automatically to a lower speed operation just before the crane reaches the wanted position and, therefore, the apparatus will be operating at a correspondingly lower speed. In a similar manner, the motor 26 for lifting may be switched to a lower speed for a gentle placement of the workpiece onto the grate 2.

It is obvious that minor changes may be made in the form and construction of the invention without departing from the material spirit thereof. It is not, however, desired to confine the invention to the exact form herein shown and described, but it is desired to include all such as properly come within the scope claimed.

The invention having been thus described, what is claimed as new and desired to secure by Letters Patent is:

1. Furnace feed apparatus, comprising
   (*a*) a rectangular reheat furnace having an inlet and an outlet end, the furnace having a horizontally-elongated opening along the inlet end,
   (*b*) a horizontal grate extending from the opening,
   (*c*) a cross-pusher mounted adjacent and operative over the said grate,
   (*d*) a platform located opposite the cross-pusher from the grate,
   (*e*) a conveyor extending over the platform, cross-pusher, and grate and adapted to carry stock from the platform to the grate without interfering with the cross-pusher operation,
   (*f*) said platform being provided with power-activated aligning members operative to adjust stock transversely of the center line of the furnace for properly relating the stock to the cross-pusher, and
   (*g*) power-activated aligning members operative to adjust stock longitudinally of the centerline of the furnace.

2. Furnace feed apparatus as recited in claim 1, wherein the conveyor comprises a pair of spaced, horizontal rails extending parallel to the centerline of the furnace at a substantial elevation above the grate, a bridge movable along the rails longitudinally of the said centerline from a position over the platform to a position over the grate, and a carriage movable along the bridge transversely of the said centerline.

3. Furnace feed apparatus as recited in claim 2, wherein a hoist is mounted on the carriage for vertical movement relative thereto.

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