Feb. 21, 1939. A. SPRENGER 2,147,997

COMPOUND FIRING FOR GAS-HEATED ZONE THRUST FURNACES

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Fig. 1

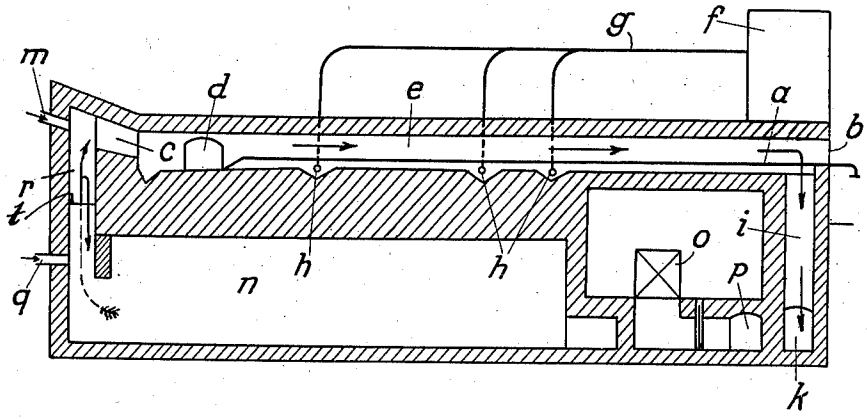
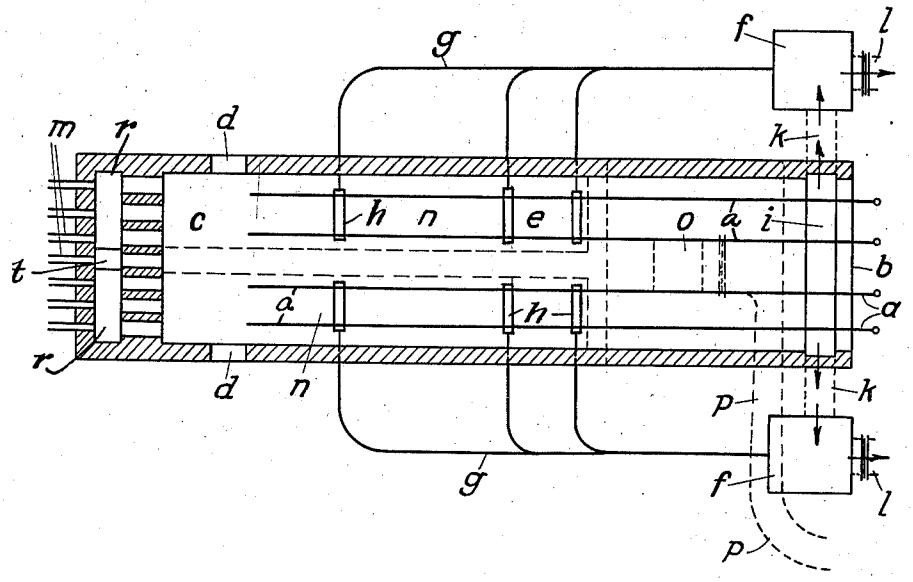


Fig. 2



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Fig. 3

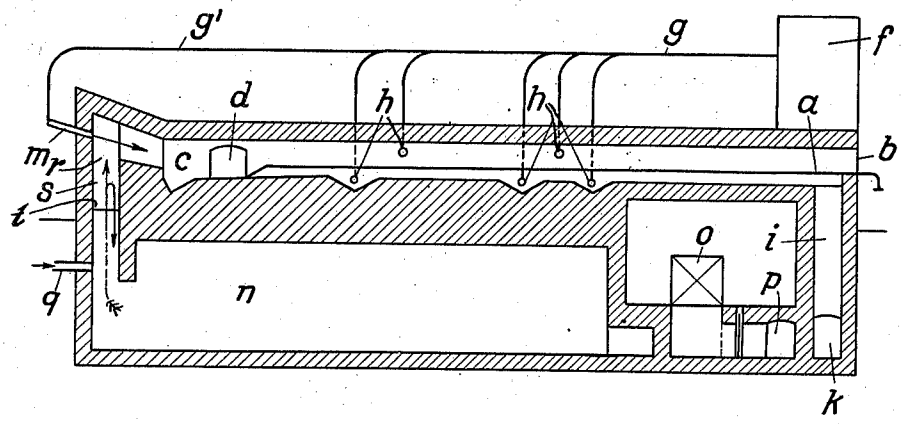
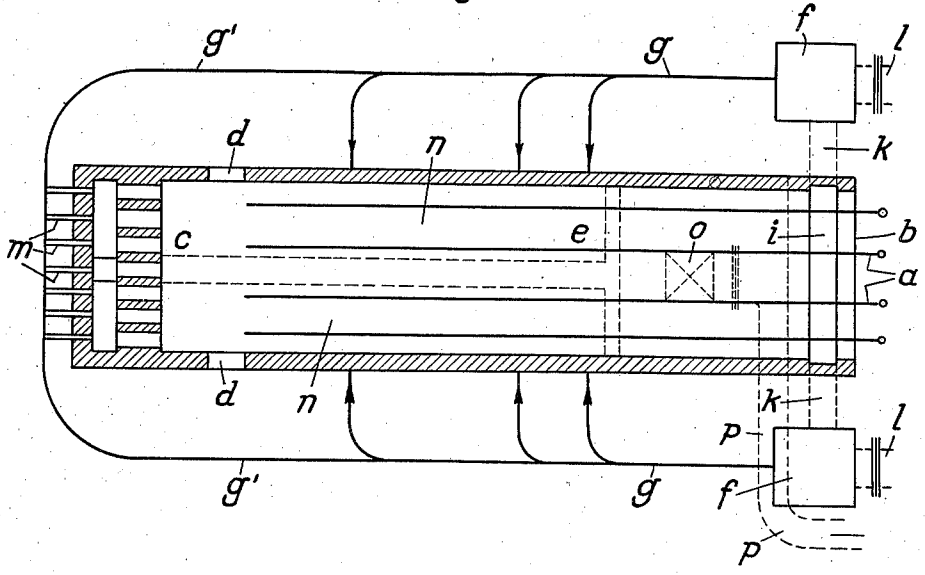


Fig. 4



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Fig. 5

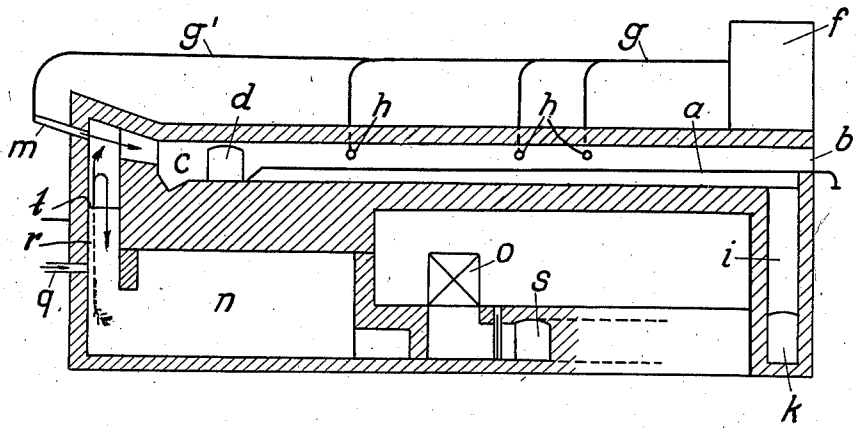
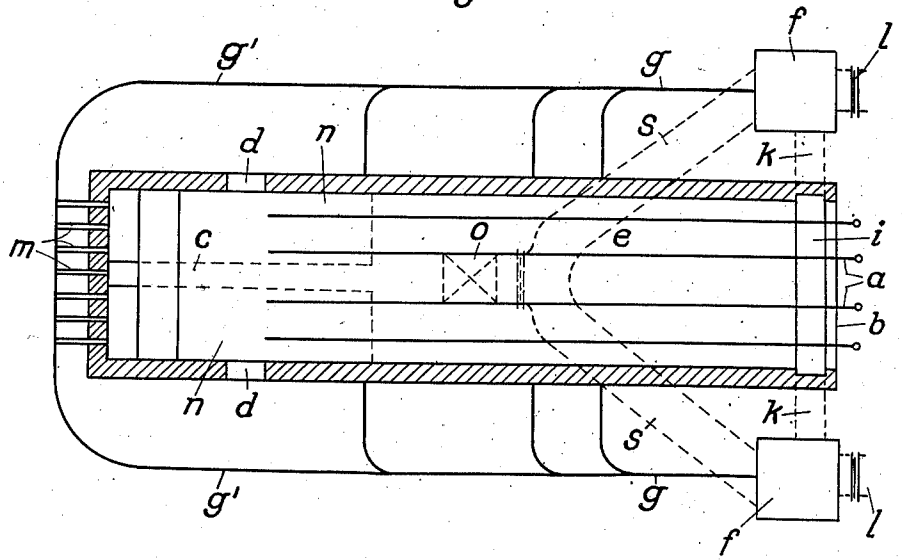


Fig. 6



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UNITED STATES PATENT OFFICE

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COMPOUND FIRING FOR GAS-HEATED ZONE THRUST FURNACES

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Application December 13, 1937, Serial No. 179,600
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5 Claims. (Cl. 263—6)

Gas-heated counter-current furnaces, and therefore in general thrust furnaces for heating ingots or billets for rolling, are frequently constructed as zone furnaces. In these zone furnaces, which have been known for a long time, the metal to be heated is pushed through in the usual manner from one end to the other, but the firing is divided into separate parts, each of which heats a definite zone in the furnace, those requirements which are peculiar to the various zones being taken into consideration. The requirements of the individual zone are different and depend upon the waste-gas temperature that is calculated to be correct, upon the temperature to which the ingots, inserted cold, can be exposed without danger to the surface, upon the coefficients of thermal transmission by heating from above or from below, and so forth.

It has already been suggested to design the zone arrangement of the heating of such an ingot-heating furnace in such a manner that the cooler portion of the furnace, the so-called thrust hearth, is operated with recuperative firing, while for the hotter portion of the furnace, which brings the ingots up to the rolling temperature, and which is known as the welding hearth or soaking hearth, regenerative firing is provided. With the type of combination of these two methods of firing hitherto known in an ingot-heating furnace the advantages arising from this combination could not be attained, because the regenerative firing of the welding hearth took up too much room, and, with its bulky valve plant, rendered operation very difficult. The alternating flame of the regenerative firing extended in the longitudinal direction of the ingot-heating furnace, to which, therefore, not only at the head end but also on both sides of the transition from the thrust hearth to the welding hearth, burners were mounted, which of course greatly hampered the access to the furnace.

This invention obviates the disadvantages of the combination hitherto known of these two forms of firing in a furnace, so that the advantages of both methods of firing are fully attained, and in addition further valuable advantages are also yielded. This success is mainly obtained according to the invention by selecting for the welding hearth a regenerative firing with a constant direction of flame, for instance by heating the regenerators of this firing directly, and passing the hot gases, highly preheated in the regenerators, into the furnace in unidirectional flow by means of a reversing valve. In this way some of the burner heads, which take up a great deal of space, are shifted into the chamber region, and therefore no longer disturb the accessibility of the welding hearth, the hottest portion of the furnace.

As is known, any correctly built regenerative firing yields an excess of heat, which does not admit of being utilized in the firing but is lost by radiation or through the chimney. In the combination of regenerative firing with unidirectional flow and recuperative firing according to the invention, this excess of heat is completely utilized, for the unidirectional flame of the regenerative firing, which enters at the furnace head, and the waste gases thereof, then flow through the entire furnace in its full length, and thus assist the action of the recuperative firing of the welding hearth of the furnace, and leave the furnace mixed with the waste gases of the recuperative firing, to be led away with the said gases through the recuperators, so that they also assist the action. The capacity of the recuperators is thereby increased, and they can deliver the preheated gas for the regenerative firing, so that the latter only needs the two regenerators for the air, these being directly heated alternately in a known manner. In this way the furnace plant as a whole is considerably simplified, the advantages of both kinds of firing being fully obtained.

The output of the recuperators may be still further increased by also passing the waste gases from the chambers of the regenerative firing wholly or partially through the recuperators, which is however already known in itself. What is not known in this connection, however, is that it is then possible to make these chambers of the regenerative firing substantially smaller than has hitherto been usual, because the waste gases of this firing, which are still hot, can be better utilized in the recuperators.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which

Figures 1 and 2 are respectively a sectional elevation and a horizontal longitudinal section of a thrust furnace according to the invention;

Figures 3 and 4 are similar views of a modification; and

Figures 5 and 6 are similar views showing a further form of construction.

The thrust furnace is of the usual elongated form. The ingots to be heated are slid upon rails *a* from the admission end *b* by an ingot-pusher, not shown, through the thrust hearth *e* into the hottest portion *c* of the furnace, the so-

called welding hearth or soaking hearth, where they are brought up to the requisite rolling temperature, and then leave the furnace through withdrawing doors *d*, and are conveyed to the rolling mill.

The heating of the first or cooler portion of the thrust furnace, the so-called thrust hearth *e*, is effected recuperatively. The recuperators are indicated at *f*, and communicate by pipes *g* with burners *h*, which in Figure 1 are indicated in the thrust hearth *e* underneath the rails *a*. Some or all of the burners may alternatively be located above the rails *a*, as illustrated in Figures 3 and 5. The waste gases of the furnace leave the latter through a shaft or flue *i* arranged near the admission end *b* of the furnace, and pass through passages *k* into the recuperators *f*, from which they are discharged through passages *l* into a chimney, not shown. In the recuperators gaseous fuel or air or both are preheated in a known manner by the waste gases. The gas and the air to be heated are supplied to the recuperators in a known manner, which is therefore not specifically illustrated.

The regenerative firing for the hottest portion of the furnace, the welding hearth *c*, is here constructed in a manner known in itself as follows: Only two chambers are provided for the preheating of the air. The heating of the cooled regenerator chamber *n* is effected by a separate flame, for the production of which gas is supplied to each chamber alternately through pipes *q*, while the air required for combustion is split off from the hot air ascending one branch of the shaft *r* from the other chamber to the hearth passes over the top of a partition *t*, and descends the other branch of the shaft *r* into the chamber *n* that is being heated, as indicated in Figure 1 by a forked arrow in full lines in the shaft *r*. Through pipes *m*, gas is introduced in a constant manner into the furnace, this gas forming, with the main portion of the hot air, the flame of constant direction in the soaking hearth *c*. The waste gases of this flame flow right through the entire furnace, and are preferably discharged, along with the waste gases of the thrust hearth *e*, into the recuperators *f*.

Here however it is assumed that for the regenerative firing a gas is available which does not need special preheating. If cold low-grade gases have to be used, the invention enables this gas to be preheated for the regenerative firing in the recuperators, and this without any difficulty, because the reversal of the gases in the burner heads is absent.

Figures 3 and 4 show this combination of the two methods of firing in a thrust furnace similar to that of Figures 1 and 2. A comparison of these two embodiments shows that according to Figures 3 and 4 the pipes *g* starting from the recuperators *f* are merely lengthened by an amount g^1, so that the recuperatively preheated gaseous medium, for instance gas, is introduced into the pipe *m* and into the furnace to form the flame of the welding hearth *c*.

For the purpose of further increasing the output of the recuperators *f* it is possible, as is indeed known in principle, to pass the waste gases from the regenerator chambers *n* into the recuperators. According to the invention, however, the regenerator chambers *n* are then substantially smaller than usual. The waste gases, which are not yet sufficiently cooled after leaving these chambers, are passed, as illustrated in Figures 5 and 6, through the recuperators of the recuperative firing, in which the cooling at low temperatures is effected more systematically than in regenerators. The thrust furnace here represented is distinguished from the one shown in Figures 3 and 4, for instance, merely by the fact that the regenerator chambers *n* are considerably diminished in size and are connected with the recuperators by passages *s* branching off beyond the change-over valve *o*, so that the waste gases of the regenerator chambers *n* are utilized in the recuperators *f*.

The combination of the two firings also involves the advantage that the furnace then remains capable of work even if the iron recuperators are burnt through. The latter are then disconnected, and the recuperative firings are then operated with cold gases, in which case the output of the furnace is indeed lower, but not the rolling temperature, for the maintenance of which the regenerative firing provides under all circumstances.

What I claim is:—

1. A gas-heated furnace in which different portions of the furnace are at different temperatures with regenerative firing for the hottest portion of the furnace combined with recuperative firing for the less hot portion, the direction of the flame of the regenerative firing being constant.

2. A gas-heated furnace in which different portions of the furnace are at different temperatures with regenerative firing for the hottest portion of the furnace combined with recuperative firing for the less hot portion, the direction of the flame of the regenerative firing being constant, and at least one of the gaseous fluids for the regenerative firing being supplied from the recuperators of the recuperative firing.

3. A gas-heated furnace in which different portions of the furnace are at different temperatures with regenerative firing for the hottest portion of the furnace combined with recuperative firing for the less hot portion, the direction of the flame of the regenerative firing being constant and at least a portion of the waste gases of the regenerative firing being passed into the recuperators of the recuperative firing.

4. A gas-heated furnace in which different portions of the furnace are at different temperatures with regenerative firing for the hottest portion of the furnace combined with recuperative firing for the less hot portion, the direction of the flame of the regenerative firing being constant, and at least one of the gaseous fluids for the regenerative firing being supplied from the recuperators of the recuperative firing, and at least a portion of the waste gases of the regenerative firing being passed into the recuperators of the recuperative firing.

5. A gas-heated furnace for heating ingots or billets for rolling, in which the temperature of the furnace zone at which the ingots or billets leave the furnace is higher than the temperature of the zone at which they enter it, with regenerative firing for the zone of higher temperature combined with recuperative firing for the zone of relatively low temperature, the direction of the flame of the regenerative firing being constant.

ARTHUR SPRENGER.