(No Model.) 2 Sheets—Sheet 1.

W. G. BELL.

REGENERATIVE STEEL FURNACE AND BRICK EMPLOYED THEREIN.

No. 302,974. Patented Aug. 5, 1884.

Fig 1.

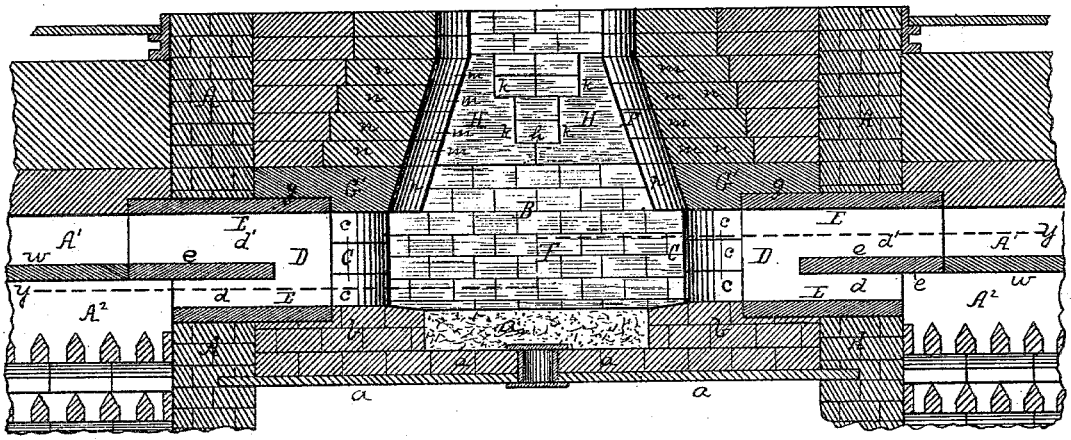


Fig 3.

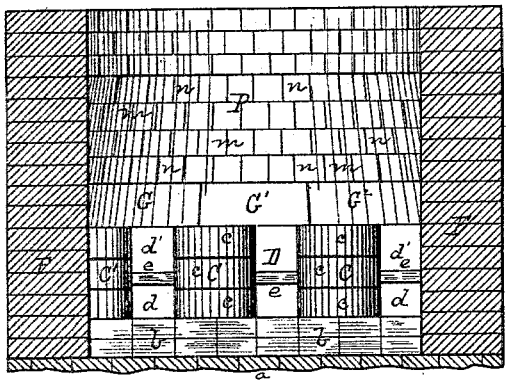
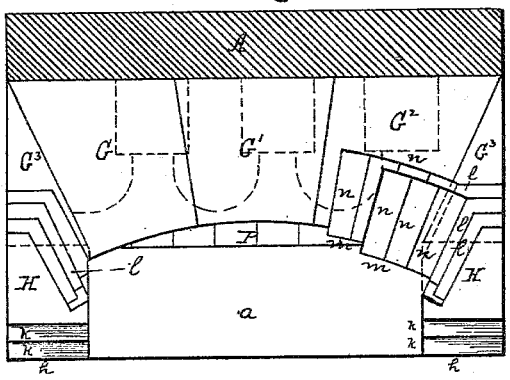


Fig 4.



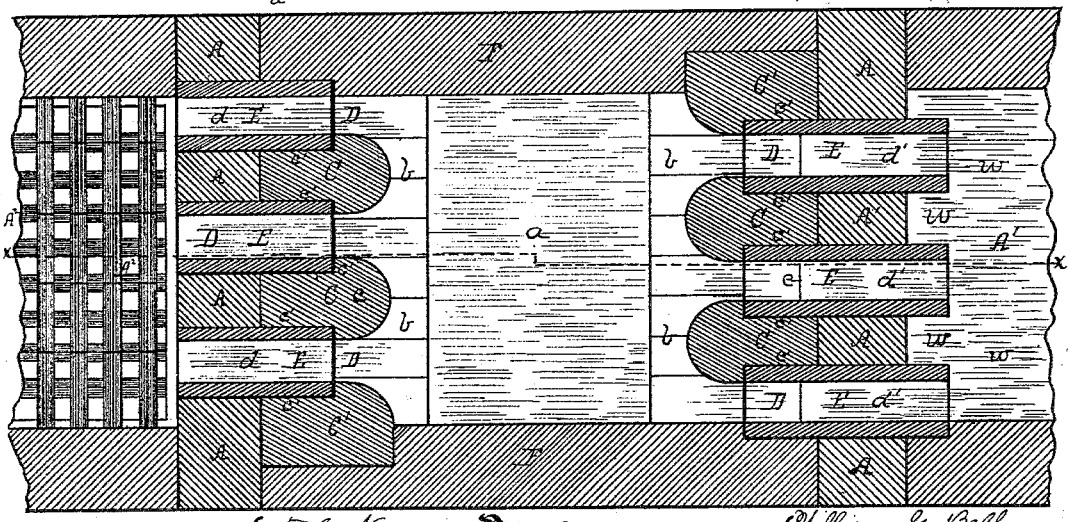


Fig 2.

Witnesses. F. G. Kay, J. N. Cooke

Inventor. William G. Bell, by James D. Kay, Attorney

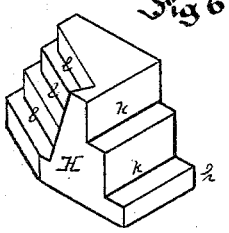
(No Model.) 2 Sheets—Sheet 2.

W. G. BELL.

REGENERATIVE STEEL FURNACE AND BRICK EMPLOYED THEREIN.

No. 302,974. Patented Aug. 5, 1884.

Fig 6



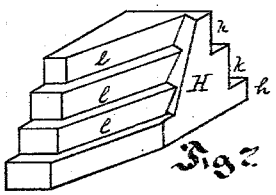


Fig 7.

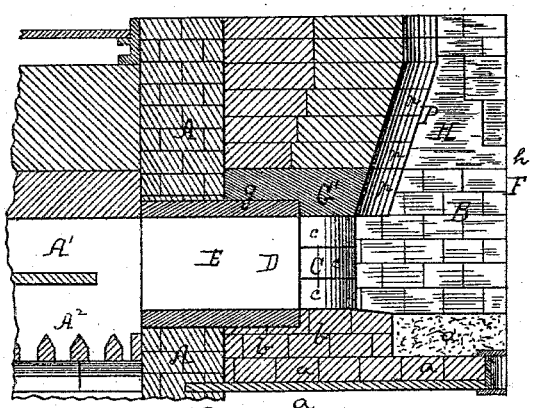


Fig 5.

Fig 13.

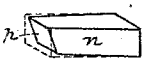


Fig 8

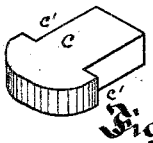


Fig 9.

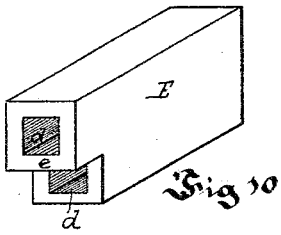


Fig 10

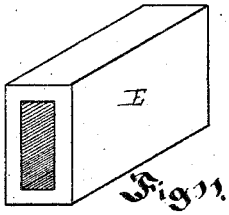


Fig 11.

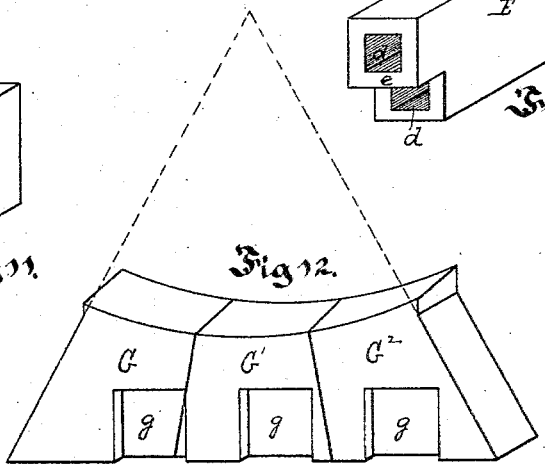


Fig 12.

Witnesses.
F. G. May
J. M. Cooke

Inventor.
William G. Bell
by James F. May
Attorney

UNITED STATES PATENT OFFICE.

WILLIAM G. BELL, OF ALLEGHENY CITY, PENNSYLVANIA.

REGENERATIVE STEEL FURNACE AND BRICK EMPLOYED THEREIN.

SPECIFICATION forming part of Letters Patent No. 302,974, dated August 5, 1884.

Application filed July 10, 1883. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM G. BELL, of Allegheny City, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Building Regenerative Steel Furnaces and the Bricks Employed therein; and I do hereby declare the following to be a full, clear, and exact description thereof.

My invention relates to the building and construction of regenerative gas-furnaces for melting steel in crucibles, and to certain improvements in the method of introducing the gas and air into the same. These furnaces are generally built to heat six crucibles, the crucibles being placed on the bed of the fire-chamber, the air and gases igniting at or about the ports, and the heat and flame passing among and over the crucibles and into the ports on the other side of the fire-chamber, through which they pass to the regenerators, and thence to the stack, and the gas and air being reversed at suitable intervals, as is usual in regenerative furnaces. The construction of these furnaces has remained the same for many years, and is as follows: The walls or piers between the gas-ports are built of flat tile or brick, the ends of which fit against the breast-wall, while the faces are rounded horizontally, forming the faces of the piers. On the top of these piers, and covering the ports, are placed blocks of peculiar shape, the upper surfaces of which form an arched base for several courses of key-shaped bricks, which, when built, form a combined arch and key, these courses forming the convergent side walls of the fire-chamber, by means of which the heat is thrown down upon the crucibles and prevented from rising through the furnace-mouth. These side walls have been thus constructed because the intense heat of the furnace has a tendency to shrink and draw the brick-work, and the keying thereof causes the courses to bind tighter, while the arching thereof gives a support to the casting-floor and prevents its sinking when the brick-work shrinks under the heat of the furnace. The space between the side wall and breast-wall is filled in with suitable brick-work or grouting. It is found that the intense heat of the furnace causes the shrinking of the brick-work, even when made from the best obtainable material, and also that the brick-work is drawn toward the fire-chamber because the part exposed to the direct heat of the chamber is raised to the highest heat, and therefore shrinks or draws the most. In the practical working of the furnaces it is found that the intense heat required therein comes most directly upon the piers and causes such shrinkage in them that they settle from under the arch, leaving an opening for the entrance of the gas and air or flame; and the heat also draws the converging side walls away from the breast-wall toward the fire-chamber, so that the gas and air can pass under and behind the arch and enter the space behind the side wall and burn, causing the rapid burning out of the side wall, as it is subjected to the heat on both sides, as well as causing a large loss of fuel. As the courses of brick-work in the converging side walls were arched as well as keyed, they could not sink down and fill up this space behind them, or between them and the piers, and thus prevent the entering of the gases and flame therein. In these furnaces the gas and air meet behind the breast-wall, and as their meeting-point is the point of combustion, the heat and flame pass through the breast-wall and ports before entering the fire-chamber, thus both burning out the breast-wall and piers and wasting the fuel before the crucibles are reached.

The object of my invention is to so construct the furnace that it will be made more compact when shrunken or drawn by the heat of the furnace, and that it will settle down so as to prevent the formation of a space for the entrance of the flame and gases behind the convergent side walls, as well as to improve the construction of the entering-ports, to prevent any escape of the gases through the side or top walls thereof, and regulate the point of combustion of the gas and air, to prevent the burning out of the breast-wall and piers and cause an increase of heat in the fire-chamber.

My invention consists, essentially, in building the courses of brick-work composing the converging side walls on a flat key toward the fire-chamber, so that in case of shrinkage of the furnace the courses, not being arched, will

settle down and prevent the formation of a space for the entrance of the flame and gases behind the wall.

It also consists in tubular port-liners adapted to extend from the regenerator-flues, and to fit within the furnace port or flue and prevent the gases from escaping through the piers or wall above the ports.

It also consists in providing this tubular port-liner with one or more partitions or division-walls extending entirely or partially through it, so as to separate the air and gas until they reach the proper point to create the greatest heat within the fire-chamber and prevent the rapid burning out of the breast-wall and piers.

It also consists in certain improvements in the construction of the tile forming the top of the flues and the brick forming the side walls.

It also consists in certain improved "step-blocks" to receive the courses of the converging side walls or other courses where the brick-work differs in thickness from the ordinary brick and accommodate it thereto.

It also consists in certain other details of construction, hereinafter specifically set forth.

To enable others skilled in the art to understand my invention, I will describe the same more fully, referring to the accompanying drawings, in which—

Figure 1 is a longitudinal vertical section of my improved furnace on the line *x x*, Fig. 2. Fig. 2 is a horizontal section on the line *y y*, Fig. 1. Fig. 3 is a cross-section of the same. Fig. 4 is a top view of one-half the furnace, showing the tile covering the piers and the step-blocks for receiving the course of the convergent side wall and part of this wall. Fig. 5 is a longitudinal section of one-half of the furnace-chamber, illustrating the employment of the port-liners without the partition. Figs. 6 and 7 are perspective views of the step-blocks. Fig. 8 is a like view of the key-bricks used in the courses forming the convergent side walls. Fig. 9 is a like view of the pier-bricks. Figs. 10 and 11 are like views of the tubular port-liners for the piers. Figs. 12 and 13 are like views of the tile above the ports on which the convergent side walls rest.

Like letters of reference indicate like parts in each.

My improved furnace is built upon the ordinary bed and plate, *a*, and between the ordinary breast-walls, A, employed in the regular regenerative crucible-furnace, and on either side of the fire-chamber B are the gas and air regenerators, a portion of the gas-regenerators A^2 being shown, as well as the flues A′, leading to the air-regenerators.

On each side of the bed *a* is the foundation *b* for the piers and converging side walls of the fire-chamber, and on this foundation are the piers C, between the ports or flues D. These piers are formed of brick, *c*, the front portion whereof is the full width between the flues, and is rounded so as to form the rounded faces of the piers. The brick fit back against the breast-wall A, and are rabbeted along each side, as at *c′*, for the reception of the tubular port-liner E, which fits into these rabbets, and also into a recess in the foundation *b*, so that the same sized opening is left for the passage of the gas and air. The liners E extend forward close to the rounded ends of the piers and back through and to the outer end of or beyond the breast-wall A, so that all gas and air must pass through these liners from the regenerators to the forward part of the piers. The ends of the port-liners fit into these rabbets, in order that they may be protected from the direct action of the incoming heated products of the combustion on their passage from the furnace-chamber to the regenerators. If desired, the piers may be made of two of these tubular liners having thick walls and placed together, so that the joint is along the center of the pier; and the mouths of the liners may be rounded to impart the rounded ends to the piers; or the liners may extend to the mouth of the piers, and brick or tile be built between them.

The liners may be provided with a partition, *e*, by means of which two different ports, *d d′*—one for gas and one for air—are formed, and the gas and air are thus separated until directed into the port D or to the mouth thereof, the partition extending entirely or only part way through the liner, as described. Combustion can thus be formed at the proper place to obtain the greatest heat within the fire-chamber, and at the same time the breast-wall and piers be protected from being burned out by the high heat generated around them where the gas and air meet before entering the furnace. When the partitions *e* are employed, the liners extend out over the gas-regenerator A^2, the partition meeting the top wall, *w*, thereof, and the top wall extends between the liners, as shown in Fig. 2, to separate the air-ports from the gas-ports. Two or more of these partitions *e* may be employed, and a more thorough commingling of the gas and air in the fire-chamber be obtained. If desired, the liners may be set at a slight angle, in order to cause the gas and air to enter in a downward direction and throw the heat and flame upon the lower part of the crucibles. The piers on one side of the furnace are arranged opposite the ports on the other side, and the end piers, C′, are built of brick, having the rabbets at one side and extending into the end walls, F, of the fire-chamber. The ports D are bridged by means of the covering-tile, G G' G^2, which rest on the piers extending across the mouths of the ports. One such tile is employed to extend over each flue, and these tile support the converging side walls and other brick-work at the side of the fire-chamber and extend from the front of the side wall to the breast-wall, so that no joints are made in the brick-work, the heat and flame naturally attacking the joints or seams. They are

divided in a line from a common center to make them key and hold as they shrink or draw toward the fire-chamber, the triangle-blocks G^3 being employed to fill up the space at the ends of the tile and support them against the end breast-walls of the furnace, or against the walls of an adjacent fire-chamber. The inner faces of the tiles G G′ G^2 are curved to the same curve as the convergent side walls, and are given the same bevel, the side walls thus sloping from the base of the tiles upward. Where the port-liners E are employed, the lower faces of the tiles are recessed to receive the liners, as at *g*, and to prevent the weight of the furnace-walls from coming thereon. The tops of these covering-tile are flat, so that regular courses of flat-keyed brick can be built thereon. The end walls, F, are built up of regular brick-work until level with the top of the tile G G′ G^2, and the step-blocks H are then built thereon, there being two of these blocks at each end, and the blocks meeting at the lower end, as at *h*, so that they form a strong brace at the base of the convergent side walls, as hereinafter described. One side of the blocks H is stepped, as at *k*, to suit it to the ordinary two and one-half inch brick which are built in between them, and the other side is stepped, as at *l*, to receive the courses of the convergent side walls, these brick being in the furnace shown about three inches in thickness. This stepped block can thus be used in different parts of the furnace where the thickness of the bricks differ, to accommodate bricks of different thickness to each other, and thus form a more solid wall, the shape and proportions of the block being altered according to the position required.

The courses *m*, forming the convergent side walls of the fire-chamber, are built on the tile covering the piers, and are built flat upon the tile, there being no arch in them whatever. They are, however, keyed toward the fire-chamber, being formed of key-brick, *n*, (shown in perspective in Fig. 8,) the outer ends of the brick being of greater width than their inner faces, thus forming the "key." The ends of the courses rest in the steps *l* of the blocks H, these steps *l* being made on a line extending to the same center as the course of key-bricks, so that the steps *l* form strong braces between the courses and the end breast-walls or the brick-work of the next fire-chamber, so that if the courses of brick shrink or draw toward the fire-chamber they will be braced by this stepped block and held more compactly. The stepped blocks H may be formed with only the steps *l* to receive the courses *m* of key-bricks, the other ends being formed so that they bear against each other for their entire height. The block thus formed is, however, difficult to bake sufficiently, and consequently liable to shrink more than when not so large. The inner faces of the key-bricks *n* are beveled on the line or angle at which it is desired that the side walls, P, shall converge, as at *p*, the slope of the side walls being obtained entirely from the sloping faces of the bricks. After laying the courses *m* of key-bricks, the side and end walls of the fire-chamber are carried up to the desired height and the space behind the courses *m* filled in by means of suitable brick-work or grouting, a slight arch to support the casting-floor being built above the furnace, if desired.

The shape given to the fire-chamber is exactly that of the ordinary steel-melting furnace, so that its operation is the same, the gas and air entering from the regenerators through the ports D, forming combustion, and passing across the fire-chamber through the ports on the opposite side and the regenerators to the stack. The heat generated in the fire-chamber shrinks or draws the convergent side walls and the end walls, and as the brick-work shrinks under the heat the walls of the furnace gradually sink together, there being no arch to support the convergent side walls, so that they sink down upon the piers, and no opening or space for the entrance of the gas and air is left behind the side walls or above the piers. If the heat within the fire-chamber draws the brick-work, the whole tendency will be to draw the furnace-walls more completely together, as the tile covering the piers are keyed toward the fire-chamber and braced against the end walls and end breast-walls or brick-work of the adjoining furnace, and the step-blocks in the end walls fit against each other and hold the flat-key courses *m* of the convergent side walls. The convergent side walls are also held more rigidly by these step-blocks, so that they cannot be drawn over, as is the case where these courses are arched as well as keyed, and fit against common brick-work in the end walls. Even if a space should be formed behind the convergent side walls, the gas and air are prevented from entering therein by the tubular port-liners and the tile covering the ports, and for this reason the side walls are only subjected to the heat on the face thereof. These tubular port-liners can, for this reason, be employed to great advantage in the furnaces having the arched and key side walls. Where the tubular port-liners have partitions, as above described, any combustion at the back of the breast-wall and piers is prevented, and the point of meeting of the gas and air and combustion thereof can be regulated so as to obtain the highest heat within the fire-chamber by the length of the partition, as would be well known to the skilled mechanic. For these reasons the furnace will last much longer than those now in use, being only subjected to the wear from the heat and working of the furnace.

Though I have described my improvements in connection with furnaces for melting steel in crucibles, it is evident they may be applied to regenerative furnaces of other construction and for other purposes.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. A steel-melting furnace having its con-

vergent side walls built of flat courses of key-bricks, substantially as and for the purposes set forth.

2. A steel-melting furnace having step-blocks at the ends thereof, and its convergent side walls built of flat courses of key-bricks braced at the ends by said step-blocks, substantially as set forth.

3. A fire-brick block for building furnaces, having steps on one side corresponding to one thickness of brick, and steps on another side corresponding to another thickness of brick, substantially as and for the purposes set forth.

4. In steel-melting furnaces, the combination, with the piers dividing the ports, of a series of tile adapted to bridge said ports and keyed horizontally toward the fire-chamber, substantially as and for the purposes set forth.

5. In steel-melting furnaces, the combination, with the piers dividing the ports, of a series of tile adapted to bridge said ports and keyed toward the fire-chamber, and triangular blocks to support said tile against the end breast-walls of the adjacent furnaces, substantially as set forth.

6. In steel-melting furnaces, the combination, with a tubular port-liner, of bricks for building piers of said furnaces, having rabbets to receive said liners, and so protect it at its end from the direct action of the heated products of combustion.

7. In steel-melting furnaces, the combination, with tubular port-liners and piers dividing the ports, of tile for bridging said ports, having recesses to receive the liners, substantially as and for the purposes set forth.

8. In regenerative furnaces, a tubular port-liner having a partition therein, in combination with a regenerator beyond the breast-wall of the furnace, having its top wall meeting said partition, substantially as and for the purposes set forth.

In testimony whereof I, the said WILLIAM G. BELL, have hereunto set my hand.

WILLIAM G. BELL.

Witnesses:
JAMES I. KAY,
J. N. COOKE.