# J. B. PEARSE.

## Cupola Furnaces.

No. 138,184. Patented April 22, 1873.

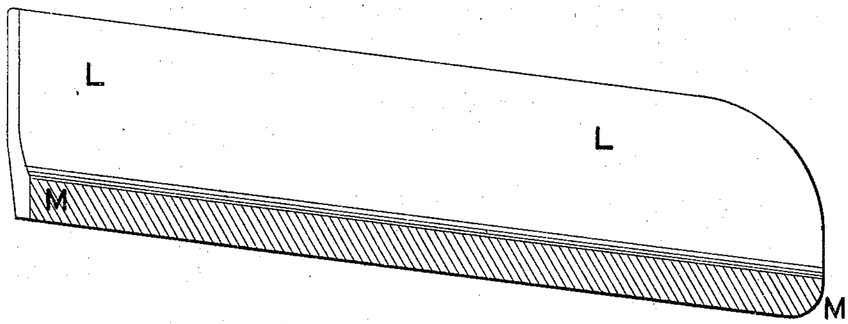


Fig. 4.

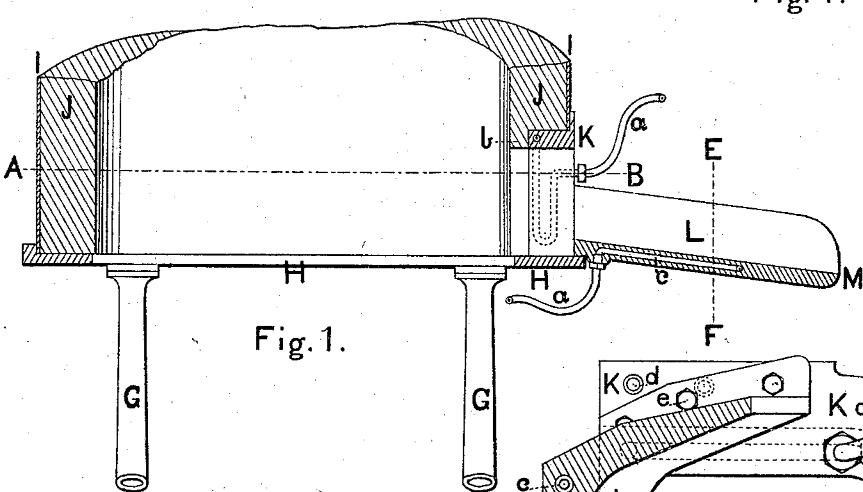


Fig. 1.

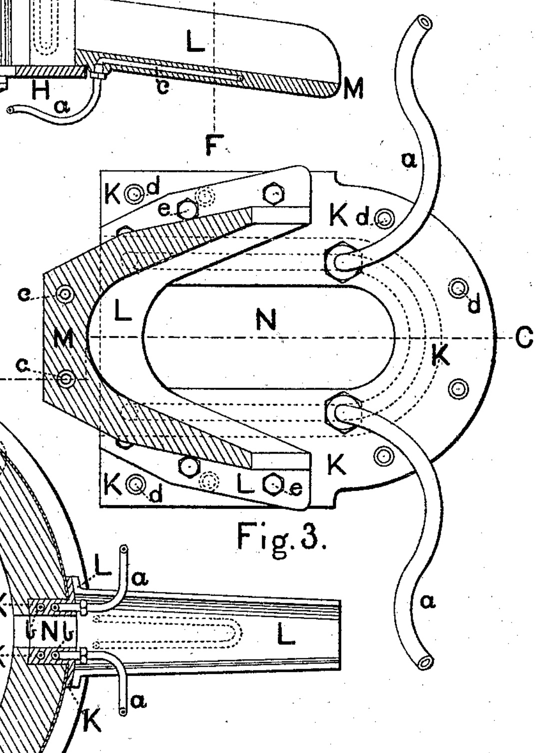


Fig. 3.

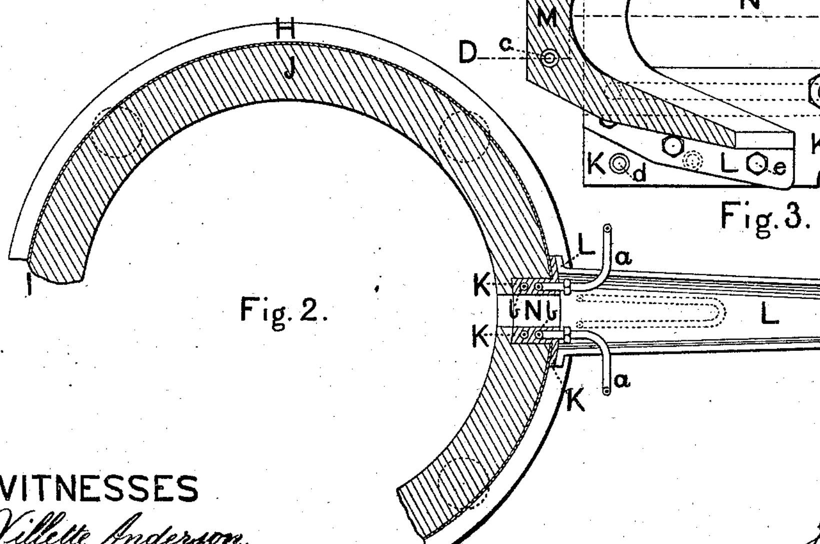


Fig. 2.

WITNESSES

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JOHN B. PEARSE, OF SWATARA TOWNSHIP, DAUPHIN COUNTY, PA.

## IMPROVEMENT IN CUPOLA-FURNACES.

Specification forming part of Letters Patent No. **138,184**, dated April 22, 1873; application filed January 18, 1873.

*To all whom it may concern:*

Be it known that I, JOHN B. PEARSE, of Swatara township, in the county of Dauphin and State of Pennsylvania, have invented a certain new and useful Improvement in Apparatus for Melting Iron and other Metals, of which the following is a specification:

This invention relates to the construction of cupolas, and to the means of conveying the molten metal away from them to the point where it is used. In this latter application it relates equally to air-furnaces. The improvement consists in an improved method of constructing the opening—or, rather, that part of the cupola in which the opening is made—from which the molten metal is tapped or let out. It also consists in an improved method of constructing the runners by means of which the molten metal is conveyed away to the point where it is used.

As cupolas have heretofore been constructed, they have consisted merely of five general parts—first, a frame, consisting of four legs and a cast-iron circular or elliptical—according to shape of the cupola—flanged plate, which is laid on the legs, and has an opening of large size in its center. To close this opening when the cupola is in use swinging doors are fitted to the flanged plate; second, a wrought-iron exterior shell, resting upon the flanged plate just described; third, a fire-brick lining, built inside of and in contact with this wrought-iron shell; fourth, a convenient number of tuyeres to convey air into the cupola when in use; fifthly, a wrought-iron runner of U-form, bolted to the wrought-iron shell, and leading away from the same. This runner is invariably lined with loam, or with a mixture of molding-sand and plastic clay of considerable thickness—often four inches thick—with the object and for the purpose of protecting the wrought-iron runner from being burned away by contact with the molten metal running through it. Just where this runner leaves the cupola there is a simple opening made by leaving a fire-brick or two out of the lining, and filling the space so made with sand, leaving a hole of convenient size for the molten metal to flow through.

When the cupola is used the swing-doors are raised so as to close the opening in the cast-iron flanged plate forming the bottom of the cupola, and the doors are then covered on the inside with sand to a depth of about six inches.

Heretofore it has been customary to make a hole of various forms in the fire-brick lining where the runner joins the cupola, and to make a corresponding hole in the wrought-iron shell. This opening is usually six to eight inches wide, by ten to twelve inches high. When the cupola is used a lump of coal is so placed behind this opening that the latter may be rammed full of refractory material, preferably molding-sand. This filling is usually as thick as the cupola-lining—say, six to nine inches—and is called the "breast" of the cupola. Through it the tapping-hole is made, out of which the molten metal is let or tapped when a sufficient quantity has been melted. This practice has certain radical defects, which prevent the cupola from being worked longer than twelve to fourteen hours. The breast of molding-sand or other material melts away so as to become dangerously thin, and allows the molten metal to break through it and escape to waste. Further, the tapping-hole gradually enlarges itself to the shape of a funnel, opening out toward the interior of the cupola. As the sand melts and is worn away the funnel becomes larger and larger, till the hole becomes too large to be conveniently closed by any usual means.

Further, the usual method of making up the runners by lining the wrought-iron trough with a refractory mixture is a very imperfect method. It is very difficult to get a good lining, as refractory material fit for the purpose shrinks strongly, causing cracks, which must be carefully filled. Again, the molten metal is always accompanied out of the cupola by more or less molten slag or scoria. This slag takes hold of the sand lining, sticking to it to such an extent that the runner, after being used five or six hours, gradually fills up. If, now, we try to remove this concretion of slag and sand it tears away with it a great part of the lining of the runner, so that the latter must be relined with care before any more molten metal can be run through it. This operation takes from one to two hours just at the time the cupola or furnace should be busiest, and, besides causing loss of time, the stoppage cools off the heat of the cupola so much that often an entire stoppage ensues till another cupola can be got ready.

All these troubles are extremely annoying and unprofitable, and are of such character as to seriously diminish the capacity of a cupola or furnace.

My improvements entirely remove all difficulties with the runner and the breast and tapping-hole, and enable a cupola to be run as long as may be convenient or be desired.

To enable others to construct and carry out my improvement, I have shown the details of it in the annexed drawing, which is made a part of this specification.

Of these, Figure 1 shows a general section of the cupola, breast-block, and a short runner. Fig. 2 shows a section of the cupola and breast-block on the line A B, Fig. 1. Fig. 3 is a front view of the breast-block with the runner bolted to it, the runner being shown in section as cut by line E F, Fig. 4. Fig. 4 is a longitudinal section of the short runner along its center.

Fig. 1 represents the general section of the bottom of a cupola, of which G G are the legs; H, the annular, circular, or elliptical flanged plate; I, the wrought-iron shell; and J, the fire-brick lining. K is the breast-block—that is, the casting—which is shaped like an inverted U, and surrounds or forms the breast-opening. The exterior side of the breast-block K has a flange, which is bolted or riveted fast to the shell of the cupola. I cool the breast-block off by means of the wrought-iron pipe *b* cast in it, with a number of folds upon itself, as shown. The pipe *b* is fed with water by the gum hose *a*, and, beginning at the outside, runs in for an inch, then down to the bottom of the breast-block, where it turns inward and upward, and running up and through the top of the block to the other side, where it runs down on the interior, and there turns up and out, and is connected at its exit from the block with a similar hose, *a*, to carry the water away. The circulation of water keeps the block cool; and as the sand-breast is made up in the opening of the block the breast is kept cool as well, and is prevented from melting away, as it otherwise would. The length of time the breast and tapping-hole in it can be used is thereby indefinitely extended.

The runner used in connection with a cupola may be of any length; but for purposes of illustration a short runner, L, is shown in Fig. 1. M represents the metal in the bottom of the runner, which I make of cast-iron; and *c* is a pipe cast in the bottom M for a short distance from the cupola.

I believe I am the original and first discoverer of the fact that a thin cast-iron runner may be cooled by the cooling action of the air alone, to such a degree that molten metal of any kind, even very hot molten cast-iron, may be run through it without attacking it in the least. I have found by trial on several cupolas that it is not necessary to use the water-pipe *c* near the cupola, provided the metal M of the runner is quite thin, preferably two to two and a half inches, according to amount of metal melted and run through the runner in a given time. If the amount of melted metal is very large, it will be advisable to use the cooling-pipe *c* to aid the action of the air.

Fig. 2 is a section of the cupola and breast-block K on the line A B, Fig. 1. H is, as before, the annular flanged plate; I, the wrought-iron shell; and J, the refractory lining. L represents a plan of the short runner, looking down upon it, while the cooling-tube *c*, Fig. 1, is shown by dotted lines. K is the breast-block, and the cooling-pipe *b b b* is shown as it appears in this section of the block. The letters *a a* represent the gum hose previously described. N is the opening left for the breast of sand, and is preferably made seven inches wide, so as to allow the water circulating through the breast-block to exercise sufficient cooling action on all parts of the breast.

Fig. 3 is a front view of the breast-block K, and of the runner bolted to it. The runner is shown partly in section on the line E F, Fig. 1. The heads of the bolts or rivets, by which the flange of the breast-block K is fastened to the iron shell of the cupola, are shown by the letters *d d*. L L designates the runner, as before, while *e e* show the heads of the bolts, by means of which the runner is fastened to the breast-block. The letters *c c* designate the cooling-tube as it appears in this section of the runner. N represents, as before, the opening (of the breast-block) in which the breast is rammed.

Fig. 4 represents a section of the runner as it appears when used without the cooling-tube. The section shown is longitudinal, and along the center. M shows the solid metal in the bottom of the runner as appearing on this section.

In order to enable others to use my invention I append a brief description of the method of putting it into practice. When a cupola is about to be used the swinging doors are closed, covered with sand, and the whole bottom part of the cupola is then filled with coal, which is set on fire. When the coal is thoroughly ignited, and the cupola well warmed up, a lump of coal is put against the inside of the breast-hole in such a position that the sand may be rammed against it. The tapping-hole is made by putting a round tube or bar (of the proper diameter) into the sand before it is rammed fast. After the breast is finished the bar is withdrawn, leaving an open hole. The blast is then put on the cupola, and the tapping-hole is kept open till the molten metal begins to run out. When this occurs the water is turned into the cooling-tube of the breast-block to keep it cool, and the tapping-hole is closed. From this time on the water circulates continually in the block in order to keep the sand-breast cool. When sufficient metal has been melted the tapping-hole is opened, and the metal is allowed to escape into the runner. The runner may either be a short one, five to eight feet long, and leading into a ladle or a receptacle of any kind prepared for the accumulation of the metal for use, or the metal may be run through a runner of any desired length to the point where it is to be used. One of my runners may be run to any distance, though two hundred feet is as far as will generally be convenient. My improvement furnishes in its cast-iron runner one that is always ready for use. The only preparation the cast-iron runner needs is that it be roughly daubed over with the so-called "clay-wash" of the foundries, a mixture of yellow clay, water, and facing, the two first ingredients being commonly sufficient. After this is done the cast-iron runner, as above described, can be used continuously for a week, if necessary. If the slag that accompanies the iron sticks to the iron at all it may be removed, and the small amount of clay-wash required to renew the film of clay may be daubed on and dried in five minutes by the heat of the runner. When, by the continuous running of large quantities of metal, the runner is heated very much, a cooling-tube, *c*, may be used to cool down the hot metal of the runner. The thinner the cast-iron of the runner is made the less need will there be to use the cooling-tube. If the quantity of metal run through the runner in an hour does not exceed ten tons a cast-iron runner of a thickness of two inches will be sufficiently cooled by the air. It is only when the quantity of metal exceeds fifteen tons per hour that the continual use of water in the cooling-tube is necessary.

It is, of course, evident that sometimes runners of extreme length may be required where cast-iron or other metal is melted for use. In such cases it often happens that it is necessary to collect the metal in a ladle or other receptacle placed near the cupola, instead of being run directly away to be used. In such cases I connect my improved cast-iron runner with the ladle as well as with the cupola or furnace. I use my improved runner to go to any distance and in any direction from the cupola or furnace, and either in one length or several. The runner may be in one continuous line or be broken by the interposition of a ladle or pool at any convenient point. In all modifications I claim its use, and find its application advantageous, because all the labor previously taken to prepare loam or sand runners for use on a single occasion is saved, and because the runners being made in short lengths bolted together may be easily taken to pieces and quickly laid in any new direction. There is a further advantage in the extremely clean state in which my improved runner delivers the metal.

My improvements as above described, may be used in a Bessemer works to very great advantage, because on the one hand the cupolas or furnaces thereof will be enabled to work continuously like a blast-furnace, and on the other hand all the labor of renewing (every twelve hours) the long runners used in connection with the cupolas and ladles is entirely done away with.

In a cupola in which copper is melted, or in a foundry or metallurgical works, my improvement is equally useful in saving labor and in increasing the capacity of the plant.

I cannot, of course, specify the exact thickness of the cast-iron runners above described. That must be determined in each instance by three elements, viz: The heat of the melted metal or alloy, the quantity melted in a given time, and the shape in which it may be necessary to have the runners made. Nor do I expect in every instance to use the cooling-tube to cool the runner, because in many instances it may not be required by the nature of the case. Whenever the cooling-tube does not seem to be required in combination with the runner, I expressly desire to omit it, because it is my object to make the runner as cheap and simple as possible. I wish, therefore, to cause it to be distinctly understood that it is, in every case, necessary to be guided by the actual requirements of the case, both in regard to the thickness of the cast-iron runner and as to the necessity of combining with it the cooling-tube, as described.

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

1. The combination, with a cupola as ordinarily constructed, of a water-cooled breast-block containing the sand-breast, substantially as and for the purpose specified.

2. The combination, with a cupola as ordinarily constructed, of a cast-iron runner, sufficiently thin to be cooled by the air, substantially as set forth.

3. The combination, with a cast-iron runner, as described, of a cooling-tube cast in the bottom of the same, substantially as and for the purpose specified.

In testimony that I claim the above I have hereunto subscribed my name in the presence of two witnesses.

JOHN B. PEARSE.

Witnesses:
JOSEPH POTTS,
H. S. NOURSE.