3 Sheets--Sheet 1.

F. H. LLOYD.

Tuyeres.

No. 166,617. Patented Aug. 10, 1875.

FIG I

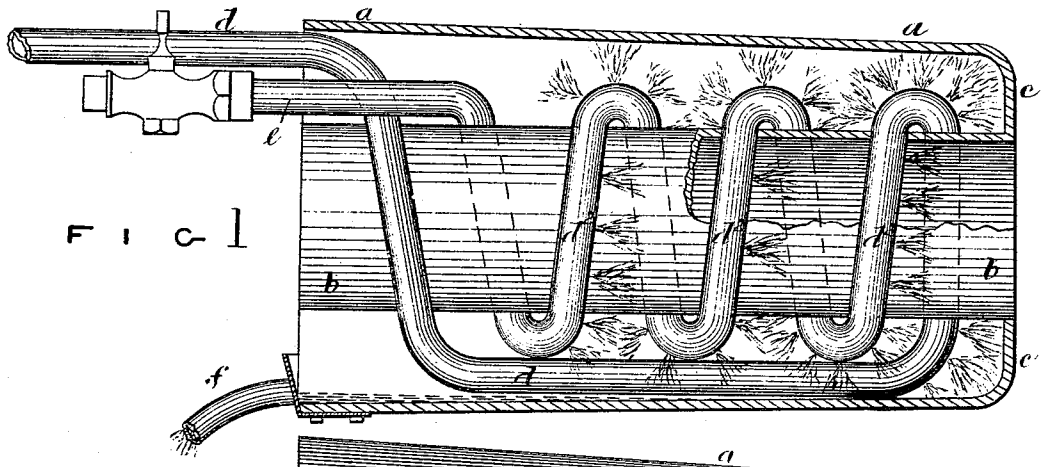


FIG II

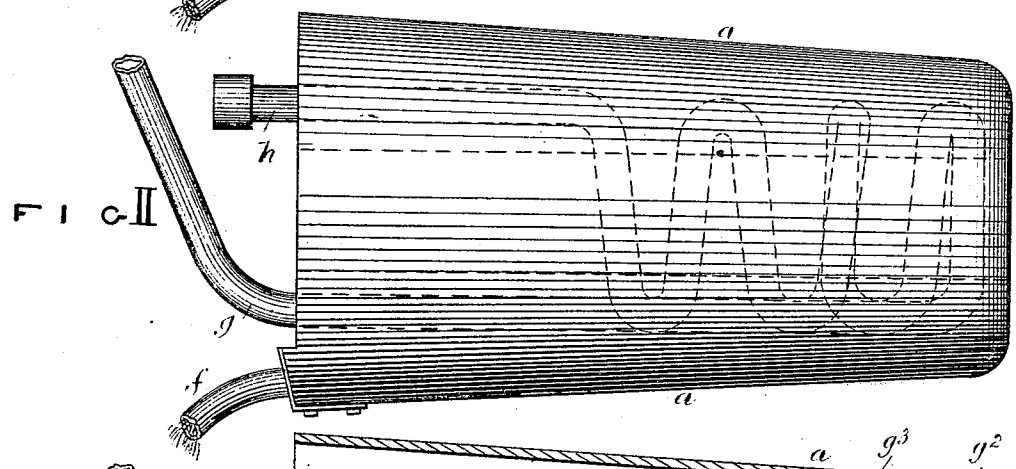
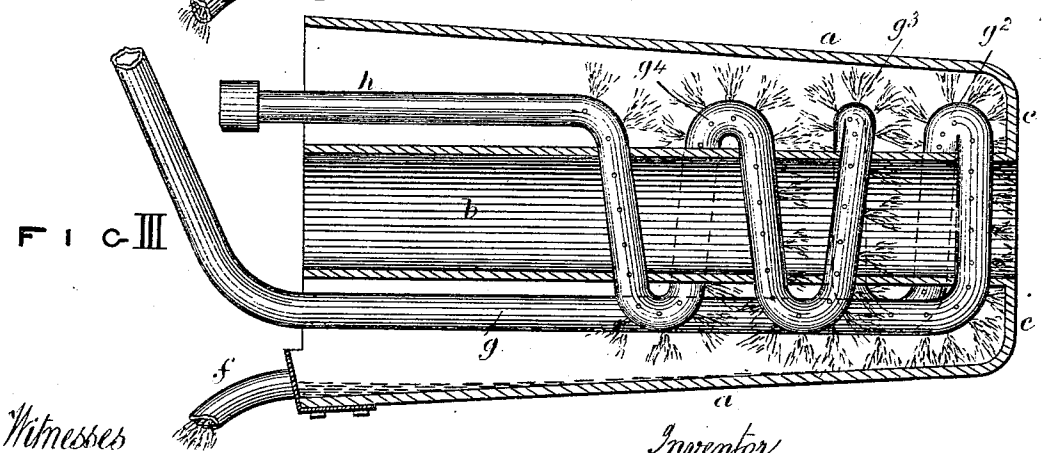


FIG III



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3 Sheets--Sheet 2.

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FIG-IV

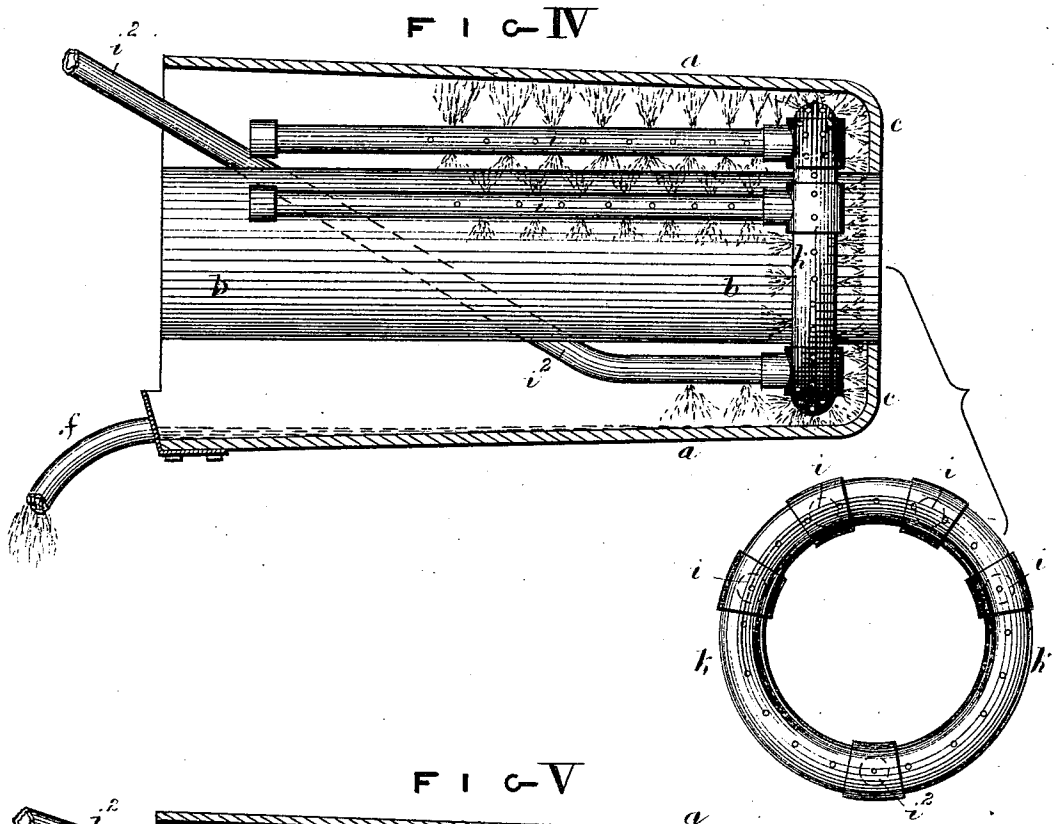
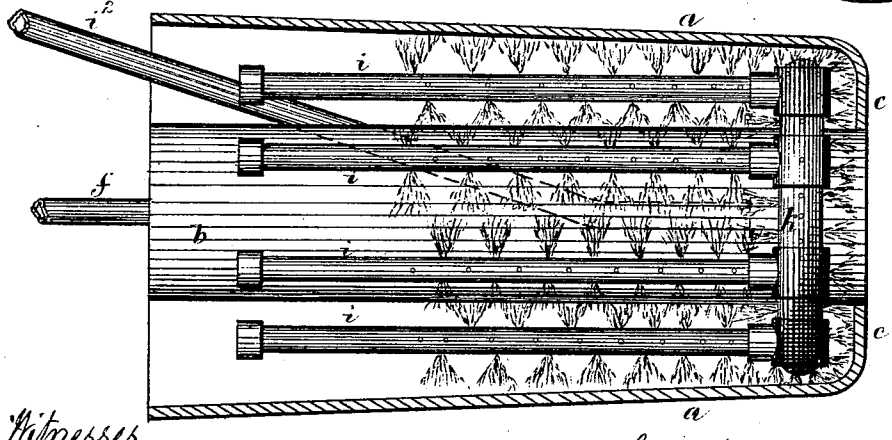


FIG-V



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3 Sheets--Sheet 3.

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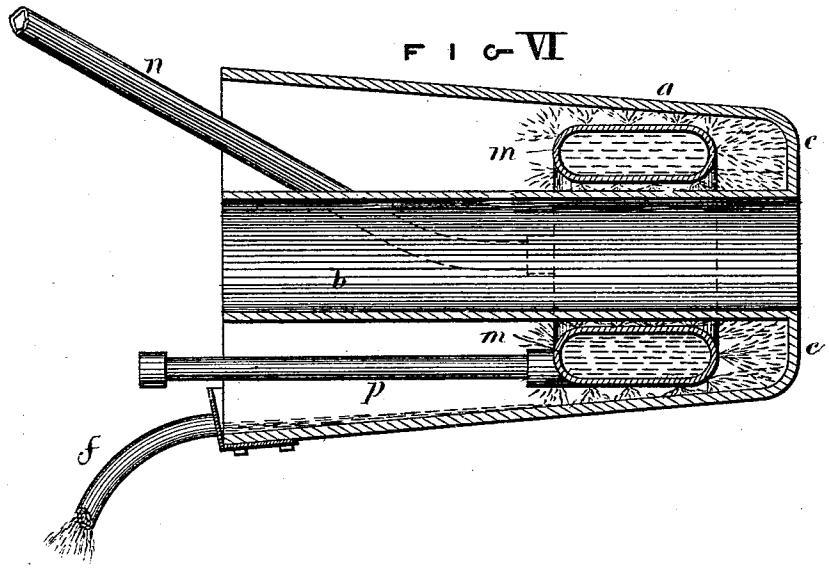
FIG. VI.



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UNITED STATES PATENT OFFICE.

FRANCIS HENRY LLOYD, OF WEDNESBURY, ENGLAND.

IMPROVEMENT IN TUYERES.

Specification forming part of Letters Patent No. **166,617**, dated August 10, 1875; application filed July 27, 1875.

To all whom it may concern:

Be it known that I, FRANCIS HENRY LLOYD, of Wednesbury, in the county of Stafford, England, manufacturer, have invented Improvements in Tuyeres for Blast-Furnaces and other Furnaces and Forges, of which the following is a specification:

My invention consists of the improvements hereinafter described in tuyeres for blast and other furnaces and forges, by which improvements the liability to explosion, which is the cause of frequent accidents in tuyeres of the ordinary kind is entirely obviated, and an efficient, economical, and safe tuyere produced.

In constructing a tuyere according to my invention I construct a conical tube of iron, the said tube having hollow walls, as in tuyeres of the ordinary construction. I dispense, however, with the closing-ring at the outer end or base of the tuyere, but retain the closing-ring at the front or nose end of the tuyere. I also dispense with the tube by which, in the ordinary tuyere, water is introduced into and conducted from the tuyere. Into the hollow or annular space inclosed between the walls of the tuyere I introduce and fix a spiral tube, the figure of the said spiral tube being such that its convolutions, when the said spiral is fixed in its placed, are situated midway between the concentric walls of the tuyere. This spiral is furnished with a series of small holes or perforations, both on the inner and outer sides of the convolutions, and the end convolution has also perforations in its end face. A stream of water, under pressure, being sent through the coil, a great number of small jets, or a spray of water, is projected on every part of the inside of the tuyere, and its overheating effectually prevented.

Instead of a spiral tube a frame or system of tubes, of a figure proper to fit the interior of the tuyere, may be employed; and instead of the small holes or perforations described a series of slits may be employed. To prevent inconvenience, should the coil or frame of tubes become choked, the said coil or frame may be made in duplicate, the convolutions or tubes of one coil or frame alternating with those of the other. There being thus two independent supplies of water, the choking of one coil or frame of tubes will be unattended by inconvenience. As the base of the tuyere is open the nose or fore end can always be inspected, and its condition ascertained.

Having explained the nature of my invention, I will proceed to describe, with reference to the accompanying drawings, the manner in which the same is to be performed.

Figure 1 represents in longitudinal section a blast-furnace tuyere constructed according to my invention. The said tuyere consists of two concentric conical tubes, *a b*, the inner tube *b* conveying the blast. The tubes *a b* are connected together at the fore end or nose by a closing-ring, *c*, which may be either made of the same piece of metal as the outer tube *a*, and welded to the end of the inner tube *b*, or the closing-ring may be made of a separate piece of metal, and connected to the tubes *a* and *b*, respectively, by riveting or otherwise. The tubes *a b* are open at their base or outer end, as represented. The pipe *d*, by which the water under pressure is supplied for keeping the tuyere cool, occupies the annular space between the tubes *a* and *b*, that portion of the pipe *d* which is within the tuyere being bent into the figure of a coil or helix, as represented, the said coil or helix surrounding the inner or blast pipe *b*. The several convolutions of the helical pipe are marked d^2, and the helix or coil terminates in the pipe *e*, which is closed by a stop-cock or screw-cap. By opening the stop-cock or removing the screw-cap any sediment in the coil may be blown out. The several convolutions of the water-pipe are provided on their outer and inner sides with a series of small holes or jets. The end convolution—that is, the one nearest the closing-ring *c*—is perforated with a large number of the said small holes or jets on its front end or face, but has also holes or jets in its outer and inner sides. From the holes described small jets or streams or a spray of water are or is thrown on the tube *a* and on the tube *b*, and on the closing-ring *c*. From the greater number, and the arrangement of the holes or jets in the end convolution, the said end convolution delivers more water than either of the others, and directs it principally on the closing-ring *c*.

I prefer to make more jets on the upper or outer sides of the top portions of the coils than

on the inner or under sides of the said top portions of the coils; and I prefer to make more jets on the upper sides of the lower portions of the coils than on the under sides of the said lower portions of the coils. By this arrangement water is thrown upward upon those parts of the tuyere which the water can only reach by being projected thereon while the surfaces on which the water is received, when it falls from the surfaces on which it has been projected, receive less water direct from the coils. In this way every part of the tuyere is kept cool, and the heated waste-water escapes by the pipe *f*. The steam produced escapes at the open back of the tuyere.

Instead of circular holes the convolutions d^2 of the water-pipe may be provided with slits at intervals for supplying the water to the interior of the tuyere.

From an examination of Fig. 1 it will be seen that the coil or system of pipes *d* d^2 *e* may be readily withdrawn from and introduced into the tuyere. It will be further seen that the interior of the tuyere can at all times be readily examined from the open end or base of the tuyere. Instead of making the water-pipe of the figure of a continuous coil or helix, it may be bent into a zigzag figure, as illustrated in Figs. 2 and 3, Fig. 2 representing the tuyere in elevation, and Fig. 3 representing the same in longitudinal section.

By an examination of Fig. 3 it will be seen that in this modification the water-pipe *g*, passing along the lower part of the tuyere, ascends on one side the inner tube *b*, and passing over it at g^2 descends on the other side of the said tube *b*. Rising on the same side of the tube *b*, it crosses the said tube *b* at g^3, and again descends, but is bent so as to ascend on the same side of the tube. Crossing the top of the tube *b* at g^4 it descends, and passing under the tube *b* again ascends and terminates in the return-pipe *h*, which is closed by a screw-cap or stop-cock. The water-pipe, bent as described, is provided with holes or slits, as described with reference to the tuyere, Fig. 1.

Although I have represented the forms of coil or bent water-tube which I prefer, I do not limit myself to these particular figures, as the said water-tube may be bent into other figures more or less resembling a coil or the zigzag arrangement, Figs. 2 and 3, with like effect. The convolutions or bendings may also be varied in number and distance apart. Instead of a coil or the zigzag arrangement of the water-tube, Figs. 2 and 3, a system of pipes of the kind illustrated in Figs. 4 and 5 may be employed, Fig. 4 being a side elevation partly in section, and an end elevation of of a tuyere having the said system of pipes, and Fig. 5 a horizontal section of the same.

In this modification of my invention a series of straight perforated pipes, *i*, is arranged, in the manner represented in the annular space between the outer and inner tubes *a b*. These pipes *i* are connected together at the nose end of the tuyere by a hollow ring, *k*, their rear ends being closed. The ring *k* and pipes *i* are supplied with water by the pipe i^2. The said pipes are provided with small holes or slits on their outer and inner sides, so as to deliver jets or sprays of water in the direction of radiuses on the outer and inner tubes *a b* of the tuyere, and the hollow ring *k* is provided on its face with holes or slits, so as to deliver jets or sprays of water on the closing-ring *c* of the tuyere. The principal supply of water or spray is from the holes or slits in the ring *k*. The last described modification may be varied in the manner illustrated in Fig. 6, which represents in longitudinal section a tuyere constructed according to this modification. Instead of the system of separate pipes *i i* and ring *k*, Figs. 4 and 5, a hollow flattened ring, *m*, may be used, the said hollow flattened ring *m* being provided on its upper and lower surfaces, and on its front face or end, with small holes or slits, which throw water both on the outer and inner tubes *a b*, and upon the closing-ring at the nose of the tuyere. Water is supplied to the ring *m* by the pipe *n*. Any sediment may be blown out at the pipe *p*. The ring *k*, Figs. 4 and 5, may be dispensed with, and water under pressure supplied to the open-ended tuyere by one or a series of straight perforated pipes.

In every form of my invention the water from the jets collects on the bottom of the outer pipe of the tuyere and passes away at the open rear end of the tuyere. The whole of the tuyeres constructed according to my invention may be made of wrought-iron, copper, brass, or gun metal; or the said tubes may be made principally of wrought-iron, and provided with a nose-piece of copper or gun metal; or, when the tuyere is made of iron, the nose end may be coated or covered with a coating or covering of copper or gun metal; or a coating of copper or other metal may be applied to the tuyere or its nose end by the process of electro-deposition. The object of the said copper or gun metal in each case is to prevent the attachment of scoria to the tuyere.

In order to prevent the choking of the water-pipes or the holes or slits therein by sediment or impurity in the water, I prefer to insert at any convenient place in the supply-pipe a filter or strainer by which solid particles may be arrested. The filter or strainer consists of a chamber in the course of the supply-pipe containing sponge or other filtering material, and does not interfere with the pressure at which the water is delivered.

An alarm may be connected with the tuyere for indicating when the tuyere becomes overheated by any deficiency in the water supply.

Tuyeres constructed according to my invention are not attended in case of accident with danger of explosion, or with the inconveniences arising from leakage of water into the furnace.

My invention is specially applicable to the tuyeres of furnaces used in smelting iron, and commonly called blast-furnaces; but it is also

applicable to the tuyeres of other furnaces where a blast is used—such, for example, as the tuyeres used in a refinery, as well as to smiths' forges or fires.

Having now described the nature of my invention and the manner in which the same is to be performed, I wish it to be understood that I do not limit myself to the precise details herein described and illustrated, as the same may be varied without departing from the nature of my invention; but

I claim as my invention of improvements in tuyeres for blast-furnaces and other furnaces and forges—

The combination, with a tuyere open at its base or rear end, as described, of a water-delivery pipe or system of pipes placed between the inner and outer tubes of the said open tuyere, and perforated for the passage of water under pressure in the form of small jets or spray, substantially as and for the purpose set forth.

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