I. M. SULLIVAN.

SMOKE PREVENTIVE APPARATUS.

APPLICATION FILED MAY 22, 1908.

941,547. Patented Nov. 30, 1909.

3 SHEETS—SHEET 1.

Fig. 1.

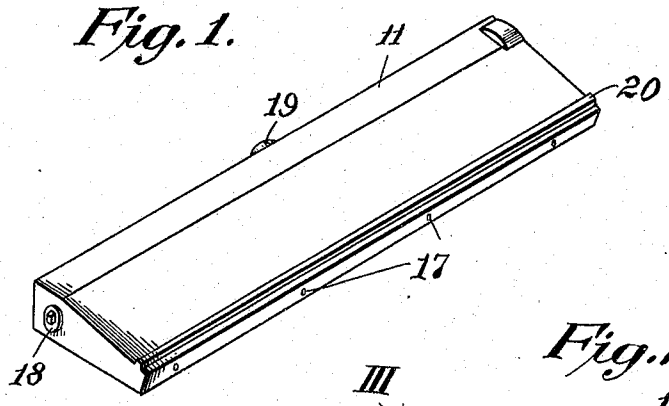


Fig. 2.

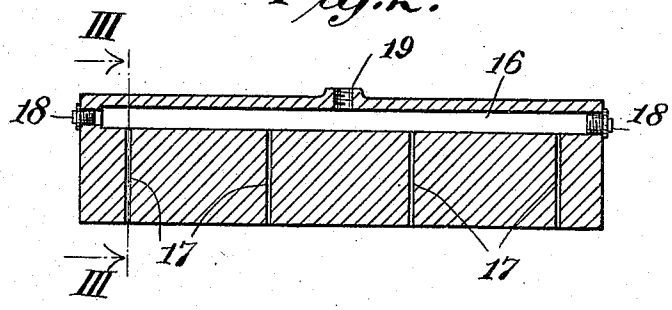
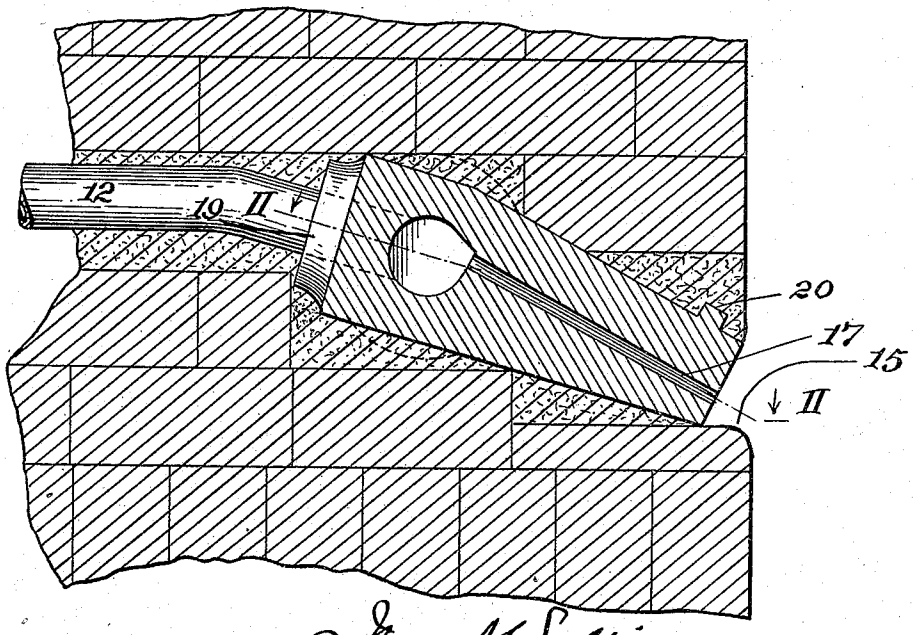


Fig. 3.



Attest:

E. Ashworth Greene

G. A. Taylor

Isaac M. Sullivan Inventor:

by H. G. Underwood Atty.

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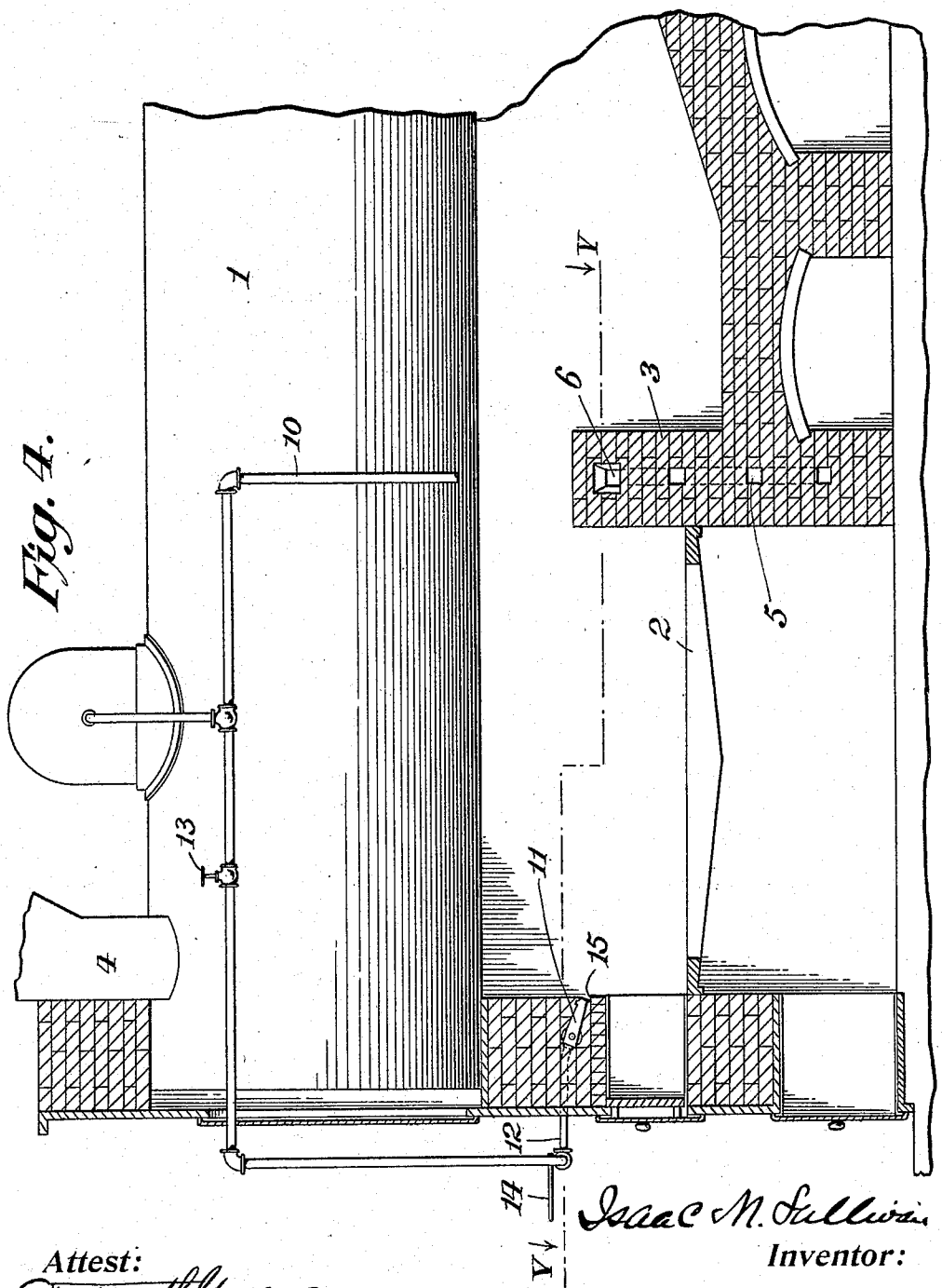
3 SHEETS—SHEET 2.

Fig. 4.



Attest:

Edgeworth Greene

G. A. Taylor

Isaac M. Sullivan

Inventor:

by H. S. Kinnear Atty.

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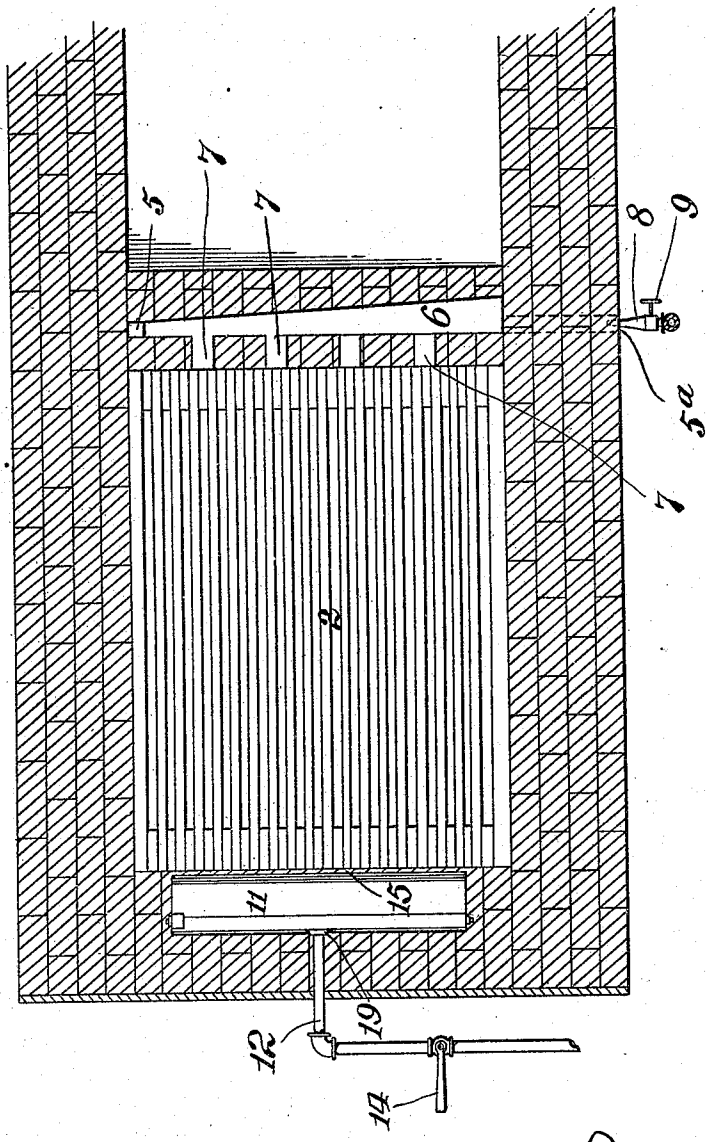
3 SHEETS—SHEET 3.

Fig. 5.



Isaac M. Sullivan

Inventor:

Attest:

Edgworth Greene

G. A. Taylor

by H. G. Underwood

Atty.

UNITED STATES PATENT OFFICE.

ISAAC M. SULLIVAN, OF SPRINGFIELD, OHIO.

SMOKE-PREVENTIVE APPARATUS.

941,547. Specification of Letters Patent. **Patented Nov. 30, 1909.**

Application filed May 22, 1908. Serial No. 434,237.

To all whom it may concern:

Be it known that I, ISAAC M. SULLIVAN, a citizen of the United States, residing at Springfield, in the State of Ohio, have invented certain new and useful Improvements in Smoke-Preventive Apparatus, of which the following, taken in conjunction with the drawings, is a full, true, and concise specification.

The invention relates to smoke preventive apparatus for furnace boilers and the like, and has particular reference to an improved construction of apparatus for injecting steam or equivalent gas into the fire chambers thereof, as will be fully described below and more particularly pointed out in the appended claims.

In the drawings forming a part hereof, Figure 1 represents an injector-head embodying my invention; Fig. 2 is a horizontal section thereof on line II—II of Fig. 3; Fig. 3 is an enlarged section of Fig. 2 on line III—III; Fig. 4 is a vertical longitudinal section of an ordinary form of return-flue boiler equipped with my invention; and Fig. 5 is a horizontal section thereof on line V—V of Fig. 4.

The prevention of smoke according to this invention involves an appropriately regulated and constant supply of heated air admitted from the fire bridge wall forwardly toward or over the burning coals, combined with an intermittent injection of steam or equivalent heated gas entering from a point above the fuel-door and directed rearwardly and downwardly over the coals at such times as the operator replenishes the fire.

In the furnace illustrated in Figs. 4 and 5, the boiler has its shell 1 supported directly over the grate 2 and the fire-bridge wall 3, as usual. The gases of combustion pass rearwardly over the fire-bridge through the usual combustion and mixing chamber in the rear thereof, and thence forwardly through the shell and out of the stack, indicated at 4. The constant supply of heated air above referred to is provided by a tortuous duct or passage 5 leading from an air-inlet opening 5^a in the side wall of the furnace (Fig. 5) to a divergently tapered and horizontal distributing chamber 6, which communicates with the fire chamber by means of a series of outlet apertures 7 of equal size and spaced at uniform distances apart, the said outlets being located at about ten or twelve inches above the grate-bars so as to be well above the level of the coals thereon. The natural draft of the furnace draws air from the outside of the furnace through the chamber 6 and the outlets 7 into the fire chamber, and by reason of the divergence or flare of the chamber 6, a substantially equal volume of air is thus drawn through each of the several outlets, notwithstanding their successively greater distance from the air-intake. The rate at which the air is introduced into the fire chamber requires to be carefully regulated and adjusted, according to existing conditions, when the apparatus is installed, and I have discovered that the most efficient rate may be readily ascertained by adjusting the capacity of the air-duct 5 until the flame in the fire chamber appears to be brightest and hottest but without producing an appreciable forward deflection of said flames toward the feed-door. In cases where the natural draft is not sufficient for this purpose, I employ a very fine needle jet of steam directed into the air intake opening 5^a to act as an aspirator for increasing the rate of air supply in an obvious manner. In Fig. 5 the needle jet nozzle is shown at 8, and is supplied with a regulating valve 9. The nozzle receives steam from the steam-dome through the pipe 10.

The means for injecting steam into the fire-box comprises an injector-head 11, which is embedded in the furnace wall above the feed-door and connected by a pipe 12 to the steam-dome. The pipe is supplied with a check-valve 13 and with a hand-valve 14, or it may be supplied with any suitable automatic arrangement, such as are now well known to the art, whereby steam may be admitted to the injector-head during and for a few moments following the times of firing. The chief objection and difficulty in prior systems of smoke-prevention employing the principle of steam injection, has been the rapid deterioration of the injector apparatus and the consequent loss of time, as well as the cost, in making repairs or replacements. Being used only at intervals and exposed in the meantime to the hottest region of the fire chamber, injecting apparatus of this kind is exceptionally liable to destruction and the injector-heads and steam nozzles as heretofore employed have not, so far as I am aware, been capable of withstanding such

severe conditions, and I have ascertained further that the artificial cooling of such apparatus, as by the employment of a current of air around it or its separation by an air space from contact with the furnace wall, is apt to impair the usefulness and economy of the apparatus, which is most effective when the injected steam is most highly superheated. After a period of experimentation extending over a number of years, I have discovered and produced an injector-head that in practice proves to have the requisite properties of withstanding the destructive action of the high temperature and which at the same time successfully maintains in itself a sufficient temperature to give the steam a high and desirable degree of superheat. A further objection to previous systems of the present type has been the inordinate consumption of steam required, but with the present apparatus, and due, as I believe, to the high temperature at which the injector-head can be safely maintained, the jet apertures may be, and preferably are, of comparatively slender diameter, with correspondingly small capacity of steam discharge.

As shown in larger scale in Fig. 3, the injector-head is embedded in the front furnace wall with three of its sides in direct contact with the masonry thereof and its free or exposed face is disposed somewhat back of the interior face of said furnace wall, as shown, so as to provide a protecting ledge or shelf 15 intended to prevent direct contact of the flame with the injector-head, and I find that in this location corrosion of the exposed surface of the injector-head by the gases of combustion is reduced to a minimum. The exposed face of the injector-head, moreover, is preferably slanted somewhat inwardly at its top, as indicated. In form, the injector-head is a one-piece slab-form block of cast iron of from two to four feet in length and about six inches in width, and consists of a thickened edge or body portion containing a longitudinal distributing channel 16 and a massive lip portion containing a number of fine transverse jet passages 17 bored through it in the direction of its width and constituting outlets from the said distributing channel. The channel is preferably and conveniently cast in the slab-form block and permanent plugs, such as shown at 18, close the ends thereof, while an interiorly threaded boss 19 at about the center of the body portion affords entrance for the steam, being connected with the pipe 12, above referred to. The injector-head is made of so-called "silver-gray" casting, well known to foundrymen, and this material I regard as a feature of my invention, inasmuch as it is particularly adapted for the conditions to which the injector-head is subjected and possesses the appropriate qualities of retaining and distributing the heat. It will be observed that the casting is of massive proportions with respect to the channels and passages within it; also that the thickness of the metal constituting the wall of the distributing chamber is substantially equal to the diameter of said channel, while the lip, though somewhat tapered toward its exposed edge, is approximately the same thickness as the body portion, thereby providing a thickness of metal surrounding the several jet passages which is at least twice the thickness of the passages themselves. For the greater part of the length of said passages, the thickness of the metal is several times as great as the diameter of said passages, and said passages are long and narrow, being desirably not greater than one-fourth of an inch, and preferably one sixteenth to three-sixteenths of an inch, in diameter, and extend from the distributing channel on one side of the central longitudinal axis of the head across the same to the opposite exposed face of the lip, thus being considerably longer than the diameter of the distributing channel and occupying the greater part of the device.

The relative proportions and arrangement of the channel and passages as described above and the thickness of the walls thereof are important features of my invention, and while I am not able to explain the reason for their satisfactory and efficient operation, my experiments lead me to believe that the massiveness of the construction, and perhaps also its direct contact with the masonry walls, give to the injector-head its faculty of retaining a certain critical temperature therein which, as stated, is sufficiently high for properly superheating the steam passing through it, without impairing the metal. The fine jet passages of the lip are bored at a great distance apart, as compared with previous injector-heads, being preferably separated by intervals of about six inches, and disposed along the lip in substantially the same plane so as to discharge the steam in fine spreading jets, covering the bed of coals. Between the jet passages, the lip is solid and continuous, and the large mass of metal between passages serves to communicate heat uniformly and equally to all parts of the head, thereby insuring equal and simultaneous contraction and expansion. In cross-section, the head tapers toward the free end of the lip, which maintains it securely against dislodgment and provides an increasing amount of metal through which the heat striking the exposed face may pass to be subsequently dissipated in the masonry. I prefer to cast a longitudinal rib 20 along the top surface of the lip portion near its exposed edge to serve as an anchorage in the masonry and this likewise serves as a convenient support for the

straight-edge which is used in adjusting the inclination of the jet passages with respect to the grate and the current of heated air.

Having described my invention, what I claim and desire to secure by United States Letters Patent, is:—

1. In smoke preventive apparatus for furnaces, the combination with the furnace wall, of an injector head embedded in the masonry thereof with but one of its sides or faces exposed to the combustion chamber and formed of coextensive body and lip portions having the same thickness, said body portion containing a longitudinal bore forming a distributing channel and said lip portion containing a series of jet passages in communication with said channel and each of greater length than the diameter of said channel.

2. In smoke preventive apparatus for furnaces, the combination with the furnace wall, of a cast-iron injector head embedded in the masonry thereof with but one of its sides or faces exposed to the combustion chamber and formed of coextensive body and lip portions, said body portion containing a longitudinal distributing channel and said lip portion being bored with a series of jet-passages extending from said exposed face to said channel, the dimensions of the said lip portion being sufficient to provide walls to said jet-passages of greater thickness than the diameters of said passages.

3. In smoke preventive apparatus for furnaces, the combination with the furnace wall, of an injector head embedded in the masonry thereof with one of its faces exposed to the fire-box and set back of the inner surface of the wall thereof, said head comprising a body portion containing a longitudinal distributing channel and an integral lip portion containing jet passages extending from said channel to the said exposed face, the dimensions of said lip portion providing walls to said jet passages of greater thickness from end to end than the diameter thereof.

In testimony whereof, I have signed my name to the specification in the presence of two subscribing witnesses.

ISAAC M. SULLIVAN.

Witnesses.

W. P. Bowen,

Edna K. Elsheimer.