(No Model.) 3 Sheets—Sheet 1.

R. B. AVERY & R. F. SMITH.

HYDROCARBON BURNER.

No. 428,587. Patented May 27, 1890.

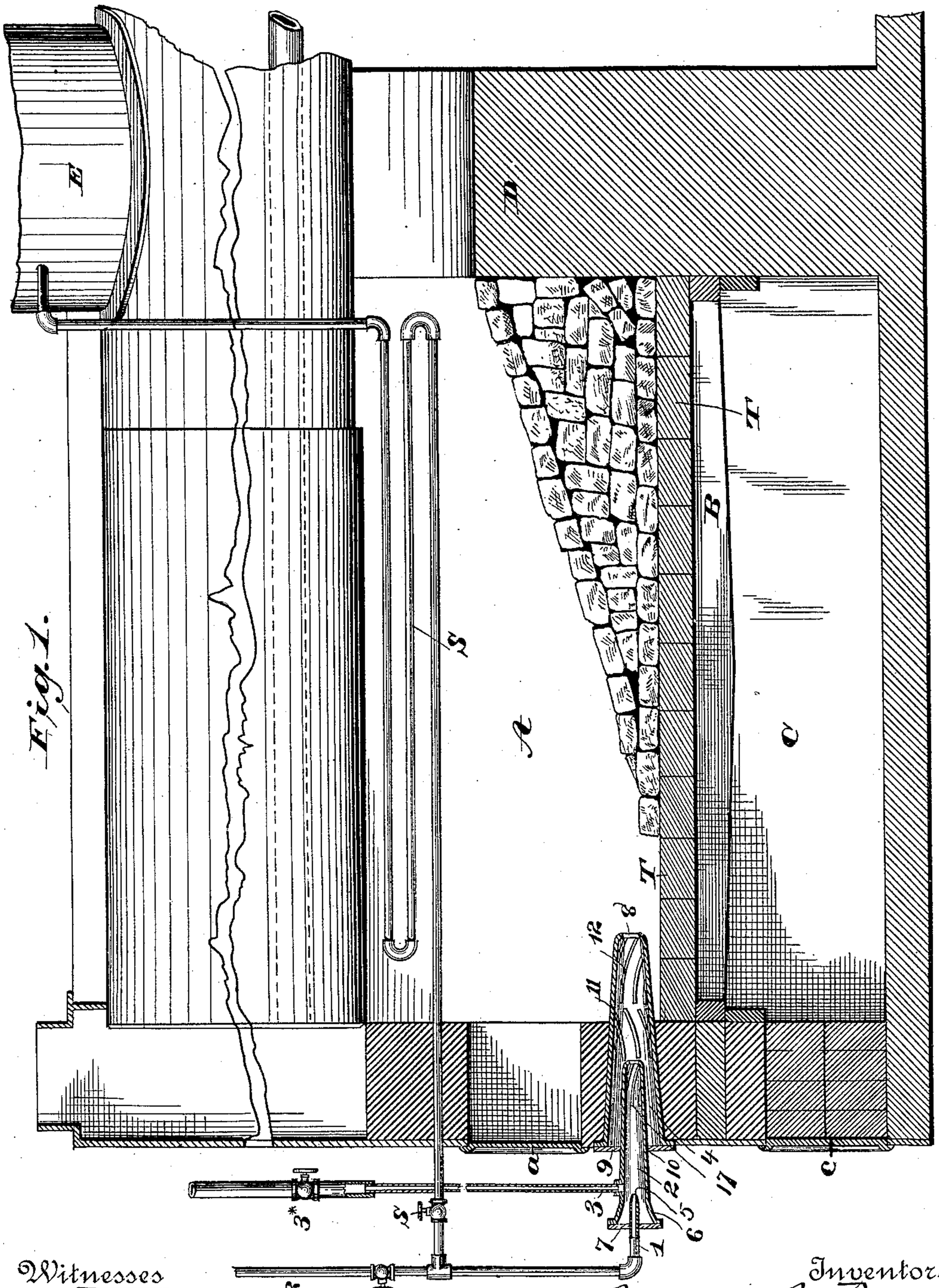

Fig. 1.

Witnesses
E. L. Wakeley
Fred. P. Cornwall

Inventors
Richard B. Avery
Richard F. Smith
By their Attorney
F. P. Cutter

(No Model.) 3 Sheets—Sheet 2.

R. B. AVERY & R. F. SMITH.

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No. 428,587. Patented May 27, 1890.

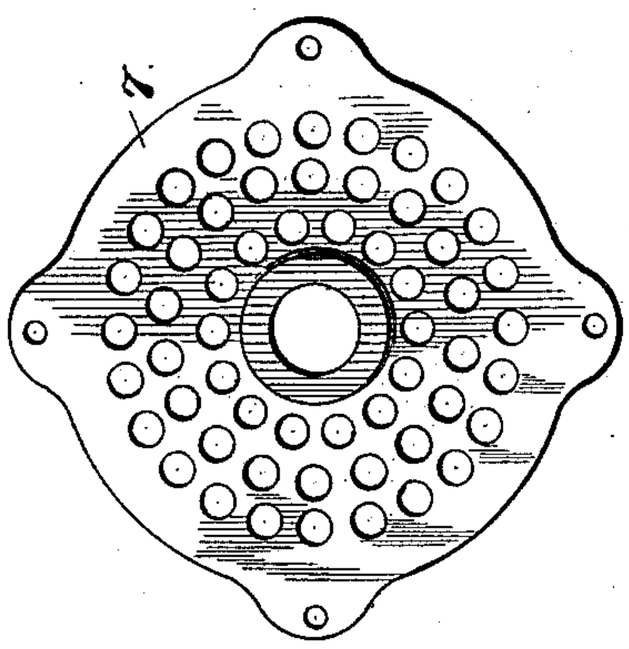


Fig. 3.

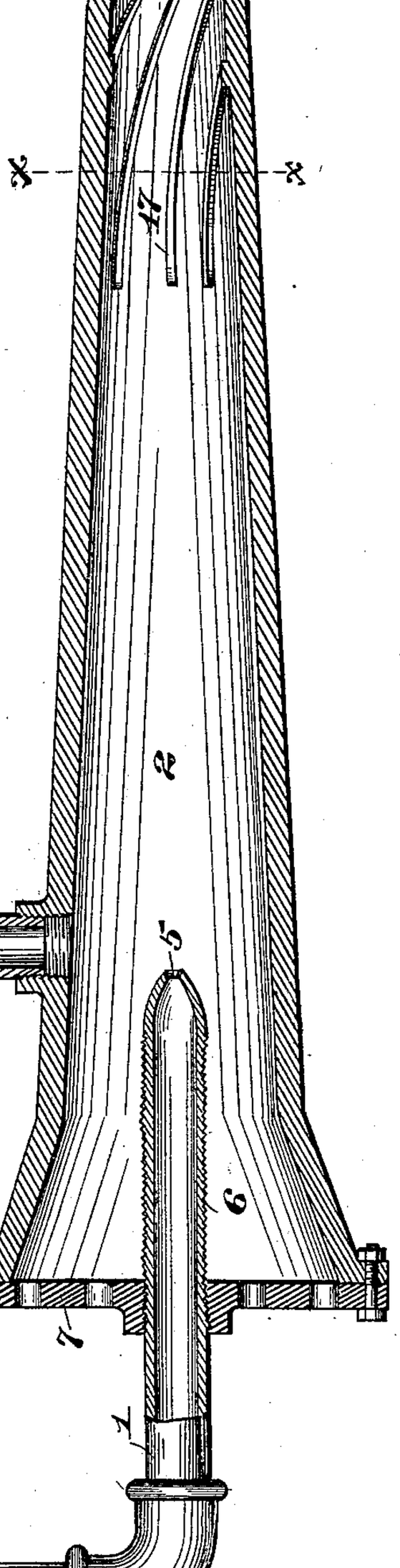
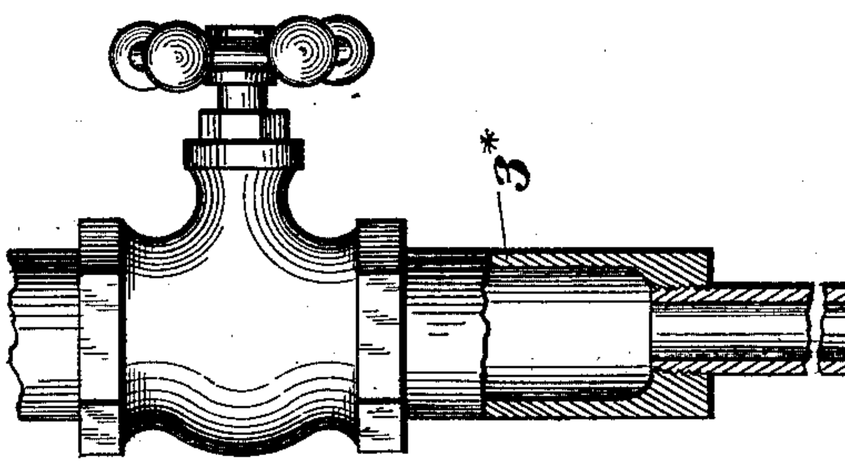


Fig. 2.



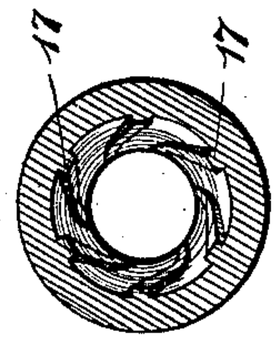


Fig. 4.

Witnesses
E. T. Walker
Fred. P. Cornwall.

Inventors
Richard B. Avery
Richard F. Smith
By Their Attorney
F. W. Ritter & Co.

(No Model.) 3 Sheets—Sheet 3.

R. B. AVERY & R. F. SMITH.

HYDROCARBON BURNER.

No. 428,587. Patented May 27, 1890.

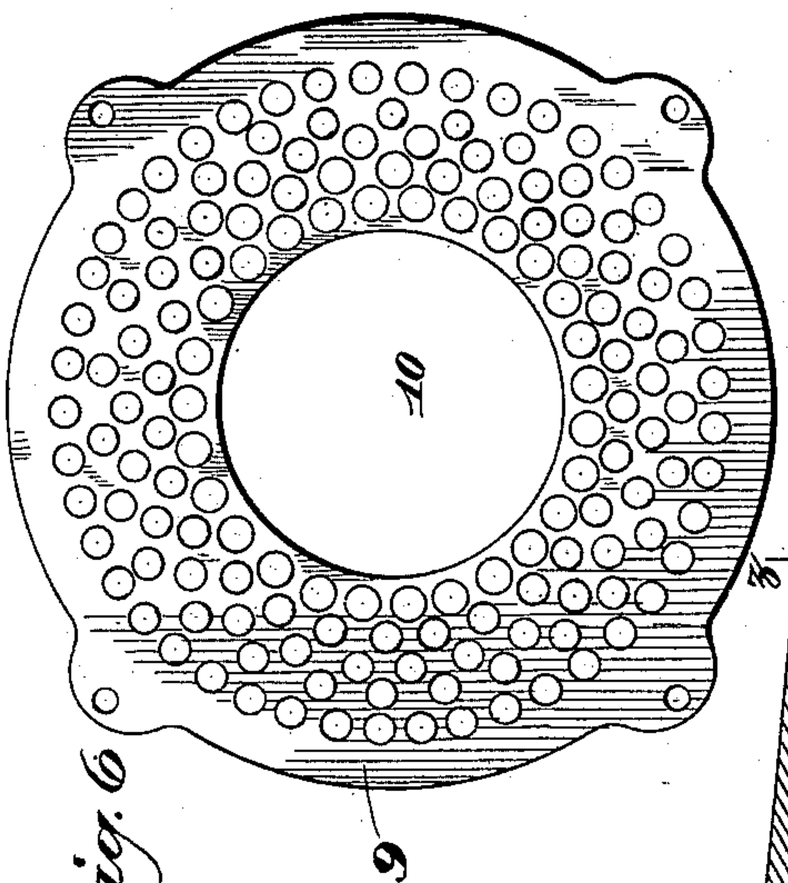


Fig. 6

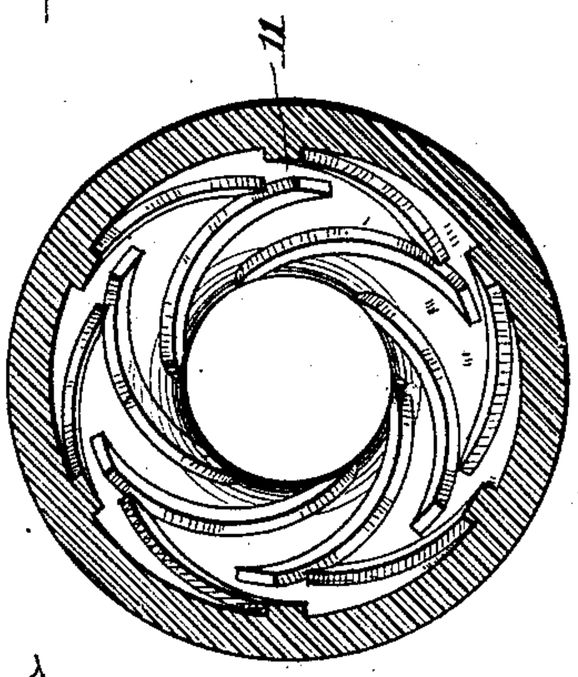


Fig. 7

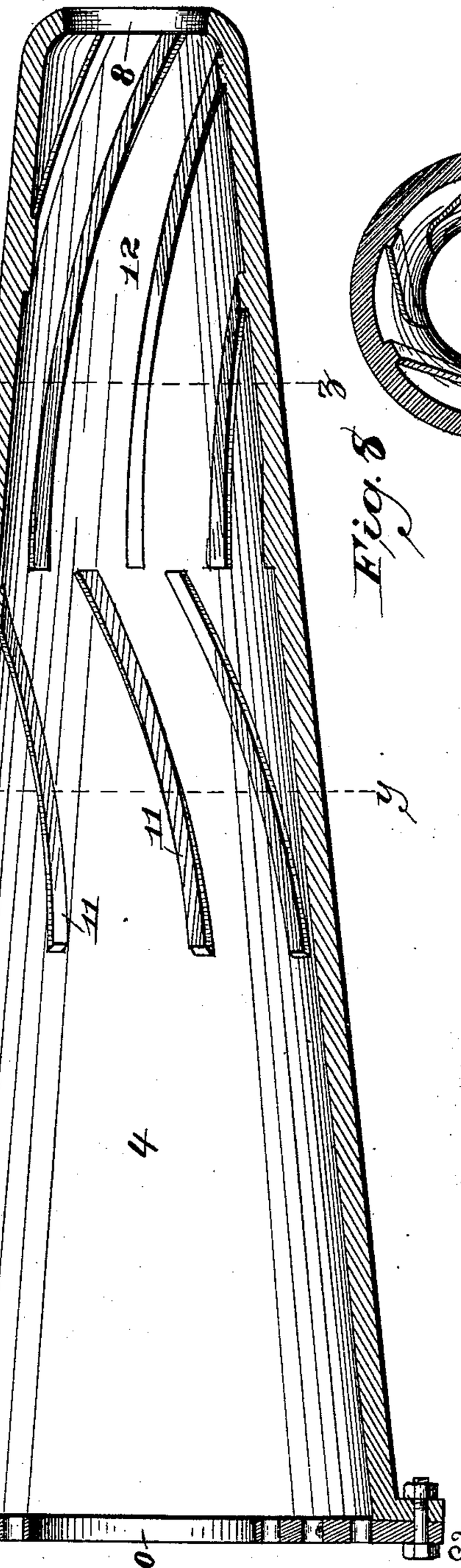


Fig. 5.

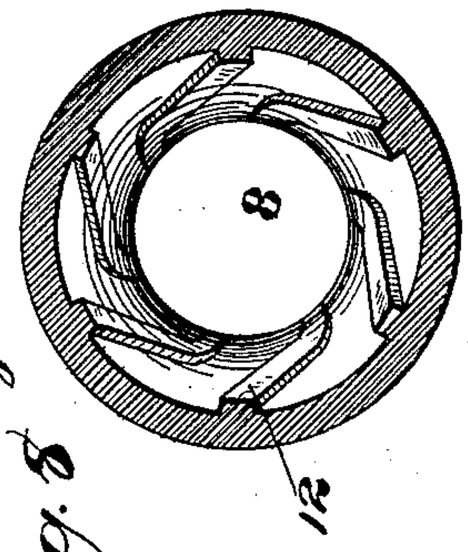


Fig. 8

Witnesses

E. L. Walker

Fred. P. Cornwall.

Inventors

Richard B. Avery

Richard F. Smith

By Their Attorney

F. W. Ritter & Co

UNITED STATES PATENT OFFICE.

RICHARD B. AVERY AND RICHARD F. SMITH, OF SAN DIEGO, CALIFORNIA.

HYDROCARBON-BURNER.

SPECIFICATION forming part of Letters Patent No. 428,587, dated May 27, 1890.

Application filed March 6, 1889. Serial No. 302,103. (No model.)

To all whom it may concern:

Be it known that we, RICHARD B. AVERY and RICHARD F. SMITH, both citizens of the United States, residing at San Diego, in the county of San Diego and State of California, have invented certain new and useful Improvements in Hydrocarbon-Burners; and we hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, wherein—

Figure 1 is a vertical longitudinal section of devices embodying our invention, and of a portion of a boiler-furnace, showing the preferred manner of setting and using the devices. Fig. 2 is a detached longitudinal sectional view of the primary section or main portion of the burner. Fig. 3 is a rear end view of the same, showing the perforated cap or cover of the air-chamber. Fig. 4 is a transverse section on the line *x x*, Fig. 2, showing the spiral ribs or deflectors on the interior of the primary section. Fig. 5 is a detached longitudinal section of the auxiliary or supplemental air and mixing chamber. Fig. 6 is a rear or end view of the same, showing the perforated cap or cover of the auxiliary air and mixing chamber. Figs. 7 and 8 are transverse sections on the lines *y y* and *z z*, Fig. 5, showing the reversely-arranged spiral ribs or deflectors on the interior of the auxiliary air and mixing chambers.

Like symbols refer to like parts wherever they occur.

Our invention relates to that class of burners for burning hydrocarbon oils, &c., usually termed "injector-burners," wherein a steam-jet is employed to vaporize the oil and introduce the air to support combustion, as well as to thoroughly and intimately mingle the whole to form a combustible gaseous mass previous to ignition.

Our invention embraces an auxiliary air and mixing chamber, which may form a permanent part of the burner, if desired, but is preferably detachable, so as to be used at will, whereby an additional quantity of air is partially heated and at the point or place of its union with the primary volume of combustible gaseous matter is given a rotary motion, which facilitates the intermingling of the auxiliary or secondary body of air with the gaseous mass; and to this end we employ a second air and mixing chamber, which incloses the end of the first or primary chamber and is provided with two independent and reversely-arranged sets of internally-projecting spirally-arranged ribs or deflectors, all as will hereinafter more fully appear.

We will now proceed to describe our invention more specifically, so that others skilled in the art to which it appertains may apply the same.

Our improved burner may be used for firing stationary, locomotive, and other boilers, for metallurgic furnaces—such as blast, cupola, reverberatory, and heating furnaces generally—for brick and other kilns, and in all places where a gaseous fuel is desired or is now employed.

For purposes of illustration we have chosen to show it as applied to the fire-chamber of an ordinary stationary boiler having the common fire-chamber A, grate B, ash-pit C, and doors *a c* for closing the ash-pit and fire-chamber.

As the air to support combustion is to be introduced through the mixing-chamber of the burner, it is desirable that the fire-chamber should be closed against other draft. We therefore close the doors *c* of the ash-pit and cover the grate-bars B with fire-brick tile T, to convert the space A above the grate into a closed chamber. We also prefer to interpose between the burner and bridge-wall D a pile of broken fire-brick or equivalent material, which will store up and retain heat and serve as an object upon which the flame from the burner will impinge. Our improved devices or burner will then be preferably inserted through the front wall of the fire-chamber A, some two or three inches above the floor of said chamber, below the usual feed-doors *a*, and will project into the fire-chamber from six to ten inches, more or less.

As steam will be required to operate the burner—preferably superheated steam—we usually tap the steam-dome E and lead a pipe therefrom through the fire-chamber, thus forming a superheater S, providing said pipe with a valve *s*, exterior to the fire-chamber, so that the coil S shall always remain full of steam.

A branch R is also connected with some other source of steam, in order to obtain a supply for starting the fire.

Any substitutes for the foregoing devices may be used, as they form no part of our present invention, except in so far as some steam-supply and some form of closed fire-chamber are necessarily used.

Our devices as a whole or in their preferred form embrace a steam-jet 1, which projects centrally or axially into a mixing-chamber 2, into which chamber 2 an oil-pipe 3 delivers the oil, the proportions and general arrangements of the elements being such as to partake of the nature of an injector for the introduction of the air and an atomizer for the incoming oil, to which is added at will an auxiliary air and mixing chamber 4, according to the size of the furnace or the intensity of the heat required.

The preferred proportions are as follows, though we do not intend or propose to be limited thereby, as other proportions will produce good results, provided the general arrangement and construction are preserved:

The jet-pipe 1 may be three-eighths ($\frac{3}{8}$) of an inch (more or less) in diameter, but its jet-orifice 5 should not exceed one-quarter ($\frac{1}{4}$) of an inch, and for ordinary uses one-eighth ($\frac{1}{8}$) of an inch jet-orifice will be found sufficient. This jet-pipe may project about two and a half ($2\frac{1}{2}$) inches into the atomizing and mixing chamber 2. The atomizing and mixing chamber 2 is preferably of general cylindrical form of about one (1) foot in length, with a funnel or bell form at the rear, as at 6, and closed by a finely-perforated plate or cap 7, through the center of which the jet-pipe 1 passes. The mixing-chamber beyond the bell or flare 6 may be about two and a half ($2\frac{1}{2}$) inches in diameter and taper gradually down to one and one-half ($1\frac{1}{2}$) inch at its delivery end, the delivery-orifice being preferably further reduced to about three-fourths ($\frac{3}{4}$) of an inch. Just within the delivery end of the atomizing and mixing chamber 2 and extending back three (3) inches (more or less) are a series of spirally-arranged ribs or deflectors 17, which should be about one-quarter ($\frac{1}{4}$) of an inch in height, and may have about one-quarter ($\frac{1}{4}$) turn, so as to give a swirling motion to the gaseous mixture before it leaves the chamber 2. Into this mixing-chamber 2 there delivers an oil-pipe 3, which may be about three-eighths ($\frac{3}{8}$) of an inch in diameter where it joins the chamber 2 and for a short distance therefrom, but may be much larger—say an inch or more—as shown at 3*, the balance of the way back to the oil-reservoir. This will be found advantageous in burning some heavy oils which have nearly the consistency of tar, for which class of oils our burner is particularly adapted.

The devices thus far described are sufficient for moderate-sized fire-chambers; but for very large fire-chambers a larger burner or a number of small burners of the class specified would be required, because, though the quantity of steam and oil delivered to the burner might be increased by raising the pressure of steam delivered by jet-pipe 1, yet the volume of air drawn in and the effectual vaporization of the oil and its thorough admixture with the air could not be effected in the limited space of the burner and in the limited time it was retained therein. Consequently such an increase of steam and oil would only result in a smoky flame and loss of fuel. To meet these emergencies, we have devised an auxiliary or supplemental air and mixing chamber 4 to be used with and as a part of chamber 2, when required.

The auxiliary air and mixing chamber 4 consists of a tapering chamber of general cylindrical form of about fifteen (15) or sixteen (16) inches in length, (more or less,) about four and a half ($4\frac{1}{2}$) or five (5) inches in diameter at the rear end, tapering gradually to about two (2) inches at its front or delivery end, and contracted so that its delivery-orifice 8 is about one and a half ($1\frac{1}{2}$) inch in diameter. The rear of the auxiliary and mixing chamber 4 is covered by a finely-perforated cap 9, having an axial opening 10, of sufficient size to receive the end of the primary air and mixing chamber 2, say about two and one-fourth ($2\frac{1}{4}$) inches in diameter. The primary air and mixing chamber 2 should project about six (6) inches into the auxiliary air and mixing chamber 4. On the interior surface of the auxiliary air and mixing chamber 4 are two or more series 11 and 12 of spirally-arranged projecting ribs or deflectors, which may be about one-fourth ($\frac{1}{4}$) of an inch in height, though they may be made to project more, if desired, said ribs having preferably about one-fourth turn, and the ribs of the two series being reverse spirals, as thereby a more thorough breaking up and intermingling of the air and combustible vapors and gases will be effected.

The devices being of substantially the character and construction and combined, as hereinbefore specified, will operate as follows: Steam at any obtainable pressure, even as low as five pounds, and saturated, may be used to start the burner, though superheated steam at a high temperature is preferred for maintaining its operation. The steam from jet-pipe 1 will induce a flow of air through the perforated cap 7 into the rear end of bell 6 of the mixing-chamber 2, which air will be slightly warmed by its contact with jet-pipe 10. At the end of jet-pipe 1, where the air meets the live steam, it will also meet the current of oil which enters through oil-pipe 3, and the combined air and steam jets or currents will spray or atomize the oil, as well as vaporize it. The air, steam, and vaporized oil will be intermingled or mixed in their passage through the next six or eight inches of the first air and mixing chamber 2, and will then be given a swirling motion by the deflectors 17, which will still further mix them, as well as project them from the said cham-

ber 2 with a rotary motion, which will facilitate their diffusion. If desired, the single air and mixing chamber 2 can be used alone and deliver directly into the fire-chamber; but we prefer to use the auxiliary air and mixing chamber 4 or second section of the devices, especially for locomotives and large fire-chambers, and in that case the jet of mixed combustible vapors and air issuing from orifice or delivery end of chamber 2 will induce an inflow or additional supply of air through perforated cap 9 of auxiliary air and mixing chamber 4, which air will be somewhat warmed by contact with the walls of chamber 2, as well as from the fire-chamber, and at its place of union with the combustible vapors, &c., it will be given a swirling motion by the spiral deflectors 11, which will project the air into and mingle it with the said vapors, and the entire mass will then be given a reverse swirl by the deflectors 12 and finally discharged into the fire-chamber A with a rotary motion, which will tend to diffuse the vapors or gaseous matters and induce rapid and complete combustion. The pressure of steam used may range from five to one hundred and fifty pounds, according to the amount of heat required. The higher the pressure the more air will be forced in with the oil and steam vapor and the more perfect the combustion, so that by a careful and judicious regulation of the steam and oil a practically flameless heat of great intensity can be obtained. We especially insist on introducing the air necessary for combustion and thoroughly intermingling it with the oil and steam vapors before ignition. It is of the first importance that the air be injected back of the union of steam and oil in fine streams, and the smaller the better, as this adapts the air to more speedy assimilation with the oil and steam vapors, permits the increase of temperature in the homogeneous vapors, and results in very marked economy. For convenience and economy of construction we have shown the perforated cap; but small holes may be drilled in the rear end of the burner, or the end may be cast open and covered with wire-cloth of small mesh. The means of dividing into fine streams the air supplied is not material, so that the division of the air into streams is complete and the jets or streams in sufficient number to supply the necessary quantity.

Having thus described the nature and operation of our invention, what we claim, and desire to secure by Letters Patent, is—

1. The combination, with a primary mixing-chamber having spirally-arranged deflectors at its delivery end, a steam-jet, and an oil-supply, of an auxiliary mixing-chamber having a series of spirally-arranged deflectors on its interior and a finely-perforated closure at its rear end, said auxiliary mixing-chamber arranged to inclose the delivery end of the primary mixing-chamber, substantially as and for the purposes specified.

2. The combination, with a primary mixing-chamber having a finely-perforated closure at its rear end and provided with spirally-arranged deflectors on its interior at or near its delivery end, of a jet-pipe arranged to project axially within the said chamber, an oil-supply which delivers into said chamber at or near the delivery end of the jet-pipe, and an auxiliary mixing-chamber having a finely-perforated closure at its rear and provided with a series of spirally-arranged deflectors on its interior, said auxiliary mixing-chamber arranged to inclose the delivery end of the primary mixing-chamber, substantially as and for the purposes specified.

3. An air and mixing chamber having a finely-perforated closure at its rear and provided on its interior with two independent or separate sets of reversely-arranged spiral projecting ribs or deflectors, substantially as and for the purposes specified.

In testimony whereof we affix our signatures, in presence of two witnesses, this 26th day of February, 1889.

RICHARD B. AVERY.
RICHARD F. SMITH.

Witnesses:
R. L. WRIGHT,
WM. B. JESSUP.