(No Model.) 3 Sheets—Sheet 1.

R. WALLWORK.

REGENERATIVE BURNER.

No. 407,750. Patented July 23, 1889.

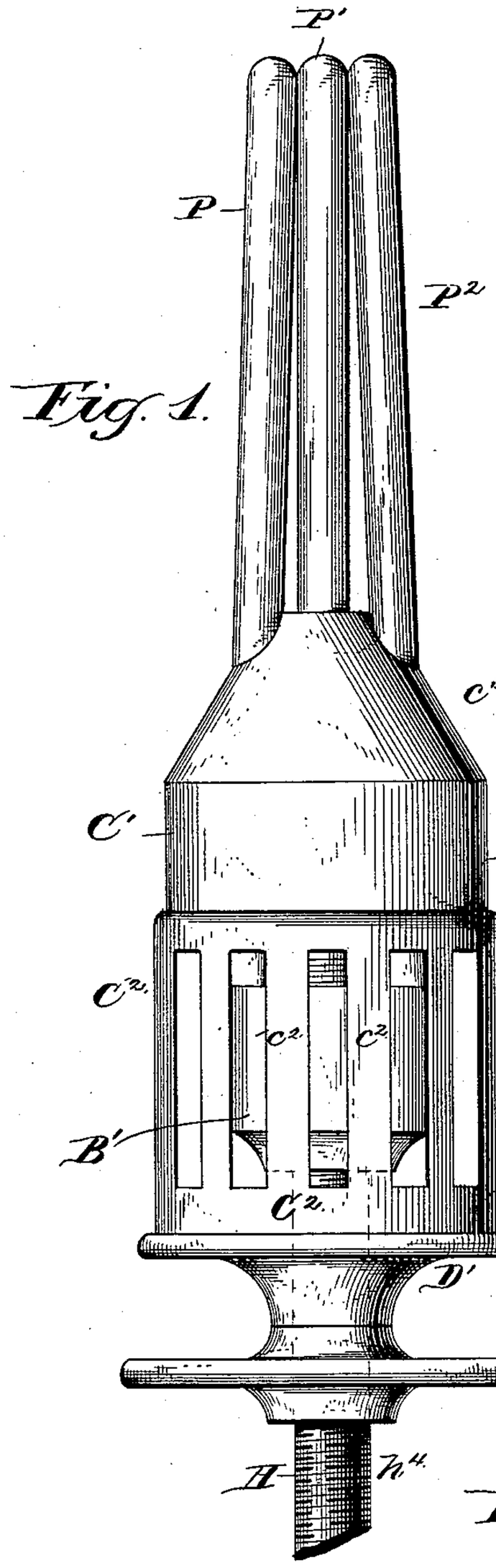


Fig. 1.

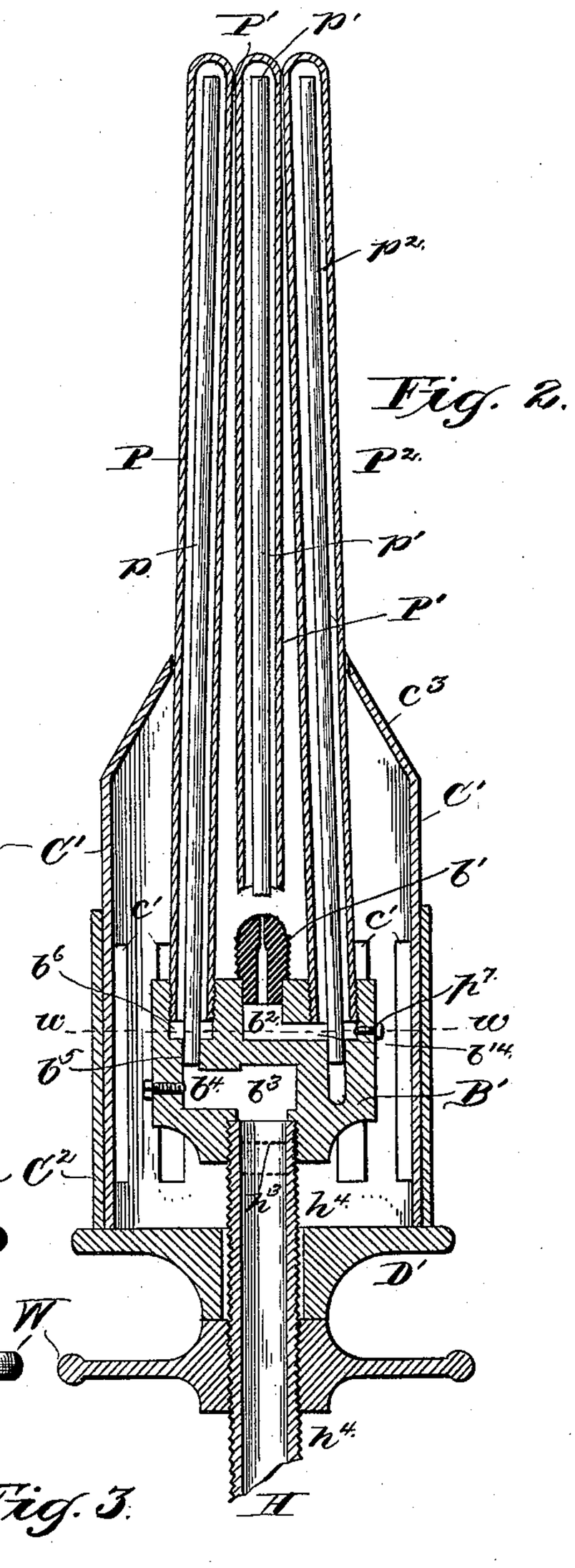
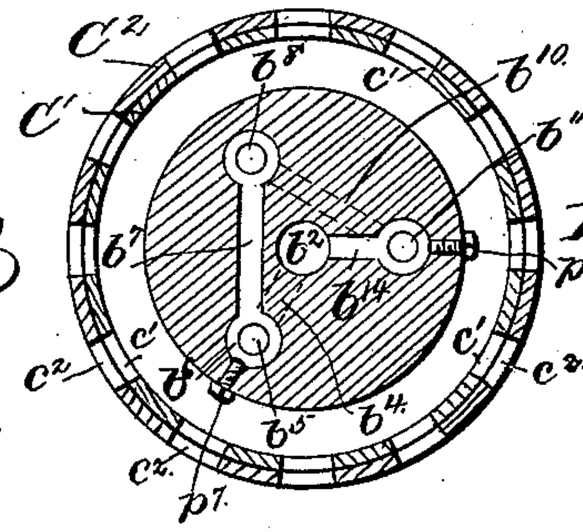


Fig. 2.

Fig. 3.



Witnesses:

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Phill. E. Rouzee.

Inventor:

Roughsedge Wallwork.

per Henry Orth

Atty.

(No Model.) 3 Sheets—Sheet 2.

R. WALLWORK.

REGENERATIVE BURNER.

No. 407,750. Patented July 23, 1889.

Fig. 2a

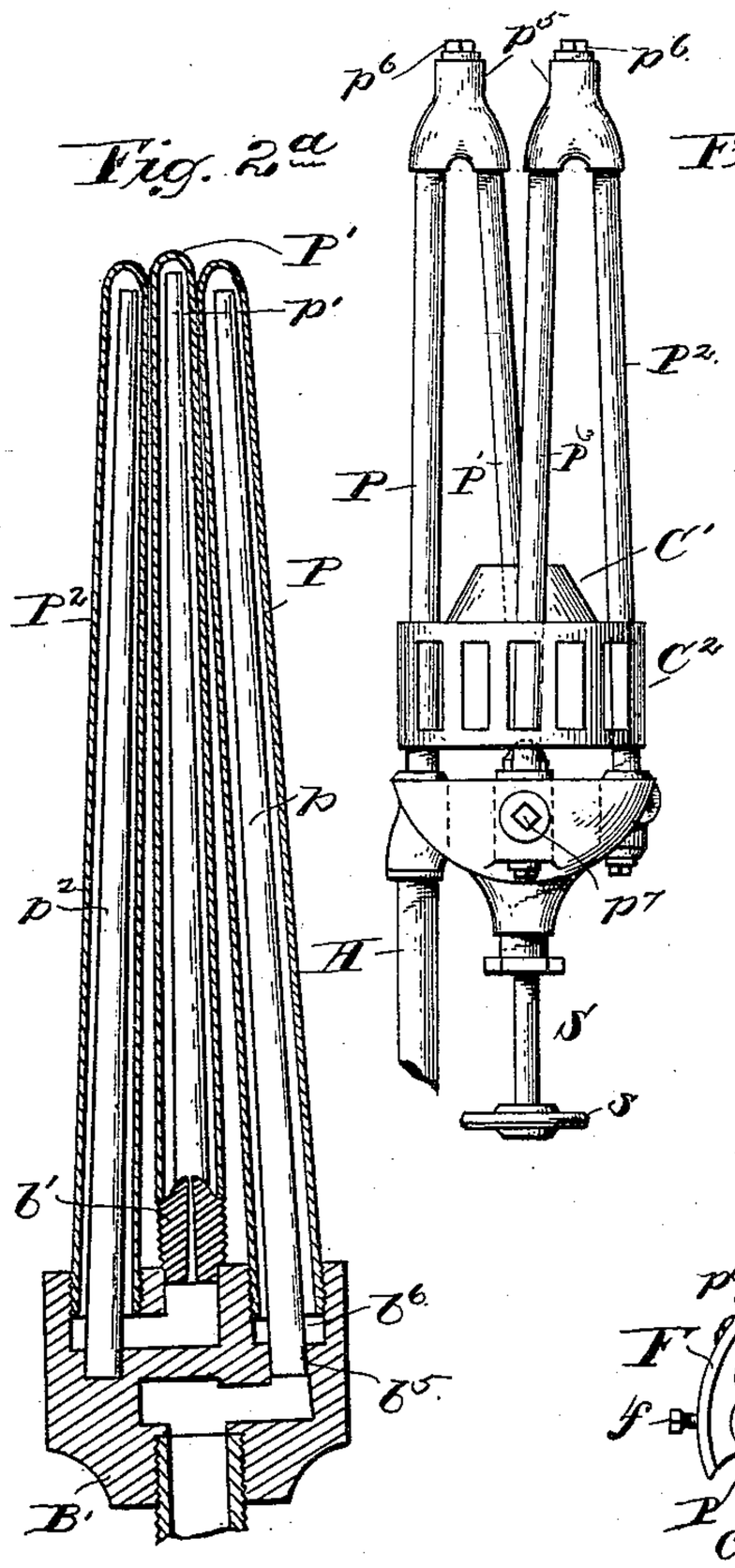


Fig. 4.

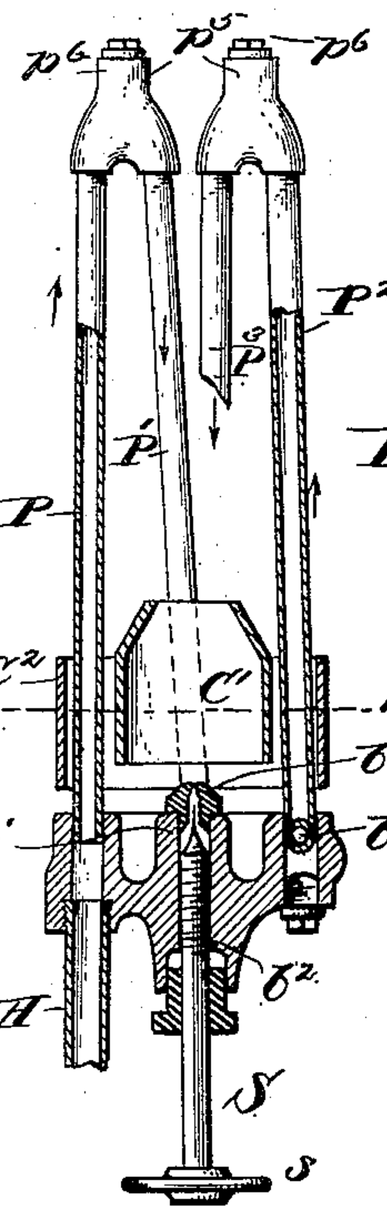


Fig. 6.

Fig. 5.

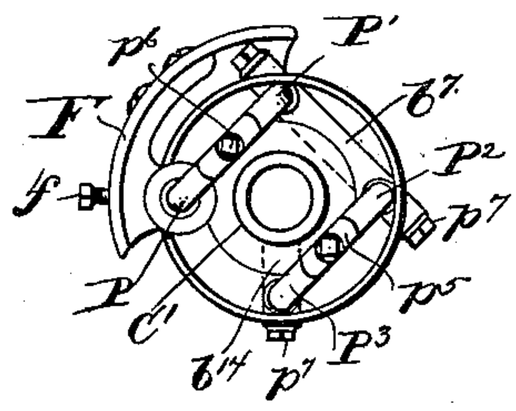


Fig. 6a

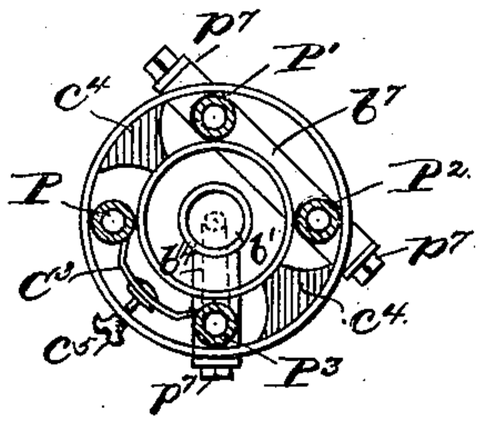


Fig. 10.

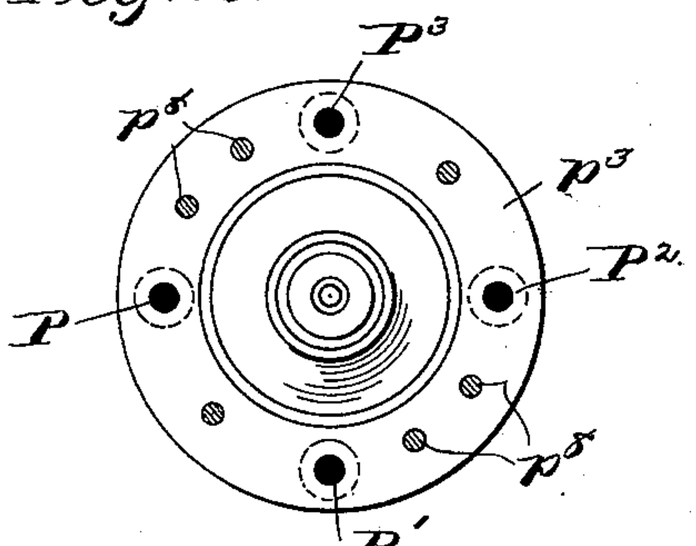
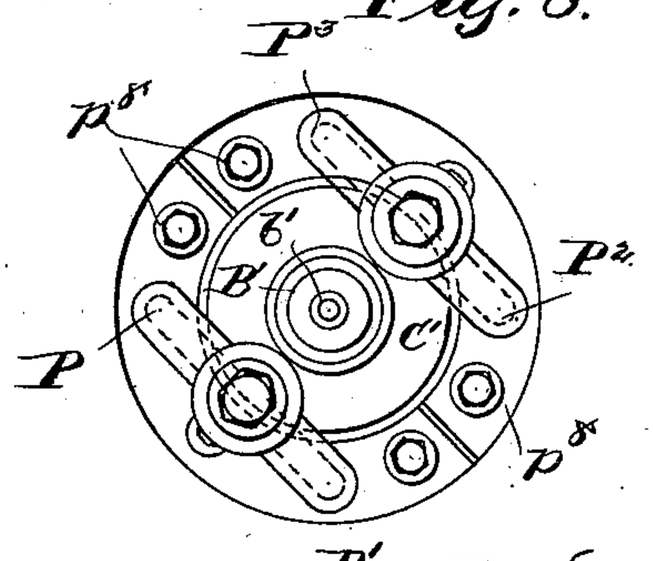


Fig. 8.



Witnesses:

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Attorney.

(No Model.) 3 Sheets—Sheet 3.

R. WALLWORK.

REGENERATIVE BURNER.

No. 407,750. Patented July 23, 1889.

Fig. 9.

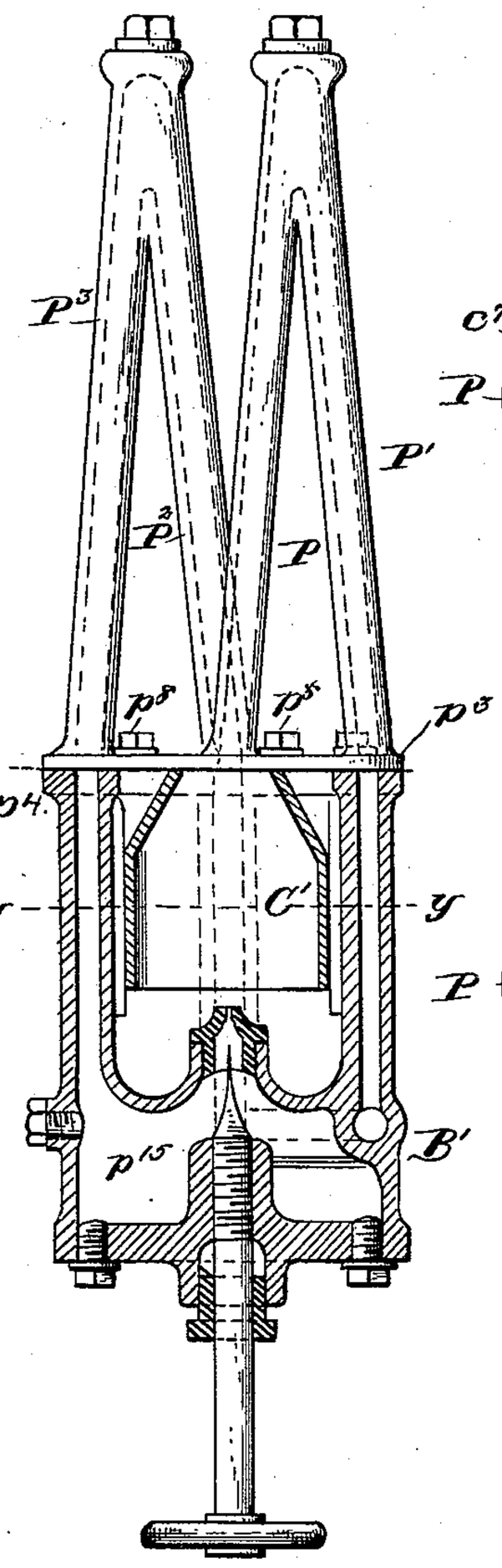

Fig. 11

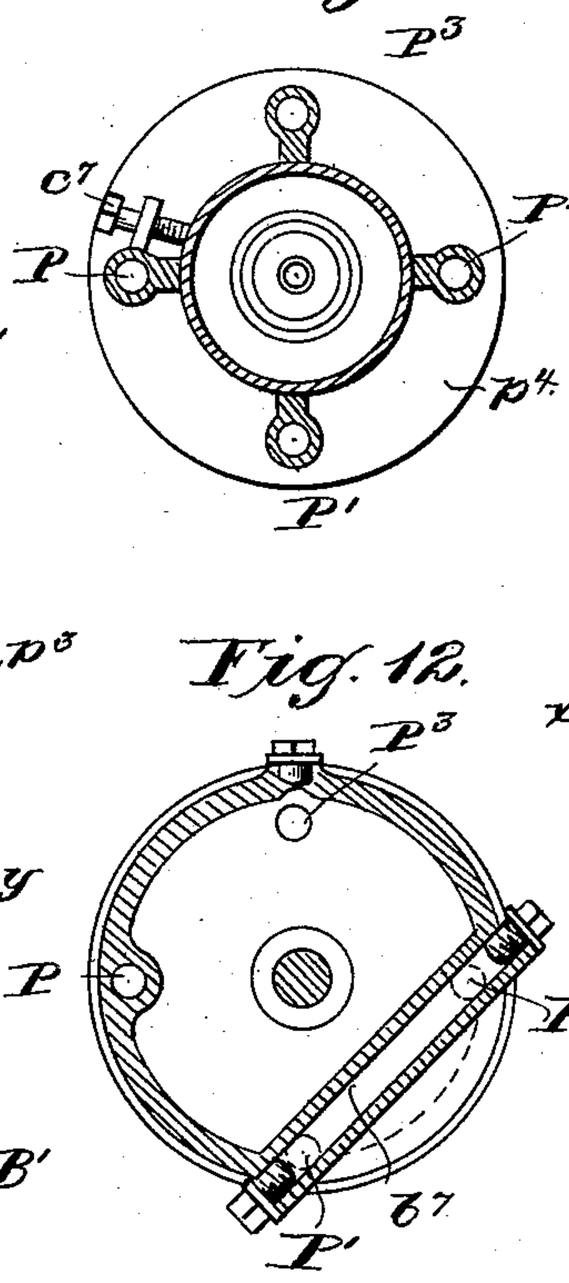

Fig. 7.

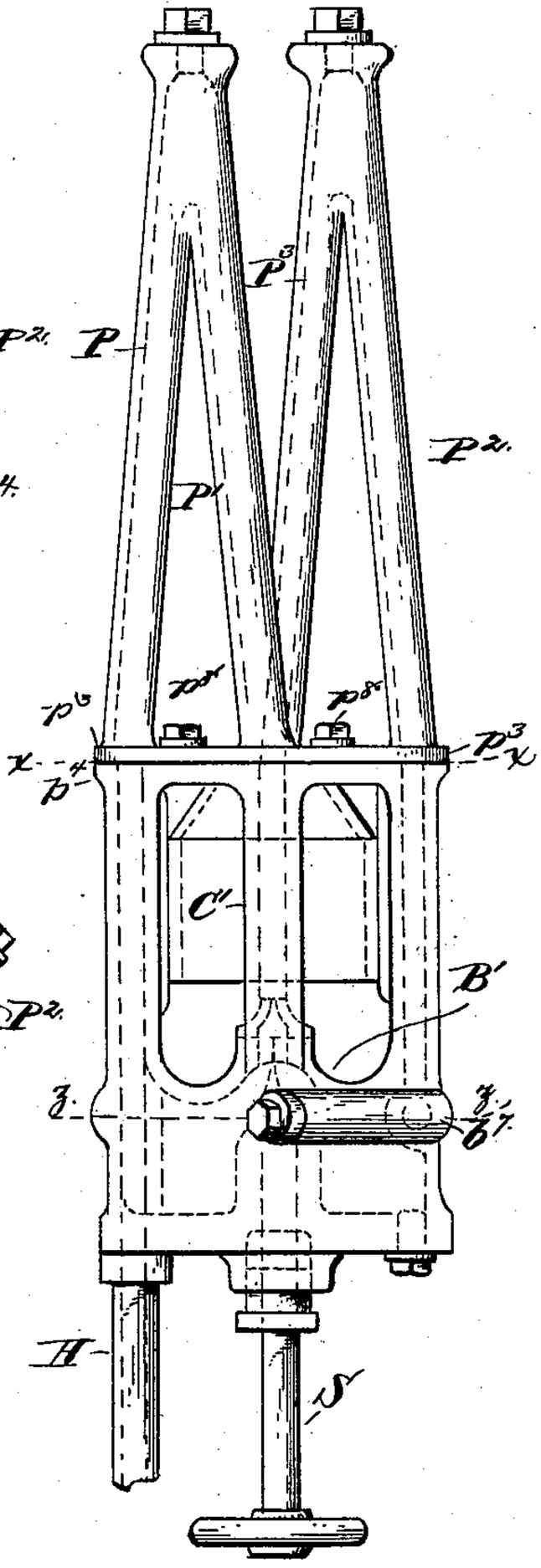

Fig. 12.

Witnesses
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Milk. E. Rouzee

Inventor.
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per Henry Orth
Attorney.

UNITED STATES PATENT OFFICE.

ROUGHSEDGE WALLWORK, OF MANCHESTER, COUNTY OF LANCASTER, ENGLAND.

REGENERATIVE BURNER.

SPECIFICATION forming part of Letters Patent No. 407,750, dated July 23, 1889.

Application filed October 24, 1888. Serial No. 289,045. (No model.) Patented in England November 24, 1886, No. 15,328; in France December 20, 1886, No. 180,379; in Belgium December 22, 1886, No. 75,679; in Germany December 22, 1886, No. 42,190; in Victoria February 1, 1887, No. 4,912, and in New South Wales March 28, 1887, No. 2,039.

To all whom it may concern:

Be it known that I, ROUGHSEDGE WALLWORK, a subject of the Queen of Great Britain, residing at Manchester, in the county of Lancaster, England, have invented certain new and useful Improvements in Regenerative Burners, (for which I have obtained Letters Patent in England, dated November 24, 1886, No. 15,328, and in part in the following countries: France, dated December 20, 1886, No. 180,379; Belgium, dated December 22, 1886, No. 75,679; Germany, dated December 22, 1886, No. 42,190; Victoria, (Australia,) dated February 1, 1887, No. 4,912, and New South Wales, (Australia,) dated March 28, 1887, No. 2,039, Book 2;) and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to letters or figures of reference marked thereon, which form a part of this specification.

In the drawings, Figure 1 is an elevation, and Fig. 2 a vertical transverse section, of a regenerative burner embodying my invention. Fig. 2ª is a sectional detail view of the burner shown in Figs. 1 and 2, illustrating a slight modification in the construction of the regenerative pipes. Fig. 3 is a section on line *w w* of Fig. 2. Fig. 4 is an elevation; Fig. 5, a top plan view thereof; Fig. 6, a sectional elevation, and Fig. 6ª a section on line 1 1 of Fig. 6, of a modified construction of burner. Fig. 7 is an elevation, Fig. 8 a top plan view, and Fig. 9 a vertical section, of a further modification of the burner. Figs. 10 and 11 are sections taken on lines *x x* and *y y*, respectively, of Figs. 7 and 9, respectively. Fig. 12 is a section taken on line *z z* of Fig. 7.

The invention relates to the art of illumination or heating, or both, and especially to that branch of the art wherein liquid and volatile illuminants—such as naphtha—or other hydrocarbons or products of the hydrocarbons are employed as the illuminating or heating agent.

The object of my invention is to provide simple means for converting the illuminant into a gas and supplying the same with the necessary amount of oxygen for combustion.

The further object of my invention is to provide means whereby the illuminating agent is converted into a gas and supplied with the proper amount of oxygen for combustion at the point of combustion itself, and also to provide means whereby the gas is superheated prior to its reaching the point of combustion, and whereby the air supplied to promote combustion is also heated prior to its admixture with the gas.

The invention consists in a regenerative burner in which the supply-pipe is divided into a plurality of branches arranged concentrically to or around the burner-orifice and projecting beyond the same, whereby said tubes are continuously enveloped by the flame and the gas generated from the illuminant is superheated, substantially as hereinafter described and claimed.

The invention further consists in the combination, with the regenerative burner, of means for preheating the air previous to its admixture with the gas and in other structural features and combinations of parts, substantially as hereinafter described and claimed.

Referring to Figs. 1 to 3, inclusive, H indicates the service-main or a branch thereof, according as one or more burners are employed, in which may be placed wire-gauze or one or more gauze diaphragms or other foraminous material, as indicated at h^3, acting as a filter to prevent solid substances from reaching the burner, and said filtering material may be placed within the pipe at any point between its connection with the reservoir and the burner or burner branches. The pipe H at the burner end is screw-threaded for a portion of the length, as shown at h^4, to receive the burner, and for other purposes presently to be explained.

The burner B′ is preferably cylindrical in form, and has an axial bore extending from opposite ends nearly to the longitudinal cen-

ter, thus forming two axial passages b^2 b^3, both screw-threaded interiorly. In the upper or outer axial passage b^2 is screwed the burner-tip b', and the lower or inner axial passage b^3 serves to connect the burner with the supply-pipe H. The passage or chamber b^3 communicates with a radial or lateral passage b^4, and the latter terminates in a vertical passage b^5, whose upper end is enlarged, as shown at b^6. In the narrow bore of the passage b^5 is screwed or otherwise secured a small pipe p, open at both ends, that extends into a large pipe P, closed at its outer end and screwed or otherwise secured in the upper or outer enlarged portion b^6 of the vertical passage b^5, a slight distance above the bottom of the passage b^6. The smaller pipe p does not extend quite to the outer end of the larger pipe P, so that the illuminant fed to the burner from pipe H will flow to b^3 b^4 b^5, into pipe p, and back through pipe P to b^6. This enlarged portion b^6 of the passage b^5 b^6 communicates by a passage or channel b^7 with a vertical passage b^8, the lower end of which is contracted or of less diameter than the upper end, a pipe p' being secured in the narrower bore of the passage b^8. A larger pipe, P', into which the smaller pipe extends, is secured in passage b^8, so that the illuminant or gas coming from channel b^7 will flow into the larger pipe P' and back through the smaller return-pipe p'.

The contracted portion of passage b^8 communicates, by a horizontal channel or passage b^{10}, with the narrower portion b^{11} of a vertical passage or channel, in which latter is secured the larger pipe P^2, containing the smaller pipe p^2, secured in the narrower portion b^{11} of said passage.

The gas coming from pipe p' will flow into the small pipe p^2 and return through the larger pipe P^2 to a horizontal channel b^{14}, which is in communication with the burner-tip passage b^2. The horizontal passages b^4, b^7, and b^{10} are drilled into the burner and their outer ends closed by screw-plugs p^7, so that ready access may be had to these passages or channels for the purpose of cleaning them when required.

In the drawings I have shown three heating or regenerating tubes or pipes P P' P^2, arranged around the burner-tip b' and preferably in such a manner as to converge toward each other at their outer ends, at which point the said pipes are in contact with one another, or nearly so. A greater number of such pipes may, however, be employed. These pipes may be of uniform interior and exterior diameter, or the diameter of the bore of the pipes may be made to gradually decrease from the point of their connection with the burner to their outer ends, or both the interior and exterior diameter of the pipes may gradually decrease from the point of their connection with the burner to their outer ends, as shown in Fig. 2^a. This construction I prefer, for the reason that better results are obtained thereby, in that the liquid illuminant supplied to the burner under pressure flows with a gradually-increasing velocity and in a correspondingly-diminished volume toward the outer end of the initial pipe, while the gas generated also circulates more rapidly therein, and as it flows from the outer end of one pipe to the inner end thereof expands and is more uniformly heated or superheated and reaches the burner in the very best condition for combustion. By means of this construction and arrangement of the regenerative pipes the maximum illuminating or heating power is obtained from the illuminant used, while the combustion is as nearly perfect as it can be. The regenerative pipes being completely enveloped by the flame nearly their full length, no liquid illuminant can possibly reach the burner if fed thereto under a proper pressure. The smaller pipes p p' p^2, arranged in the larger pipes, may also be of a uniform diameter, or they may be made tapering, like the larger pipes, as shown in Fig. 2^a; but I prefer, however, to use interior pipes of a uniform diameter.

The burner is inclosed in a cylindrical casing or housing C', the upper portion c^3 of which is conical or tapering, and said casing C' is provided with longitudinal slots or air-ports c'. This cylinder is stationary and rests upon a disk D', that is loosely mounted on the supply-pipe H and to which is rigidly connected a short cylinder C^2, that is also provided with slots c^2, adapted to register with the slots c' in cylinder C', so that on revolving the disk D', thereby revolving the inner cylinder C^2, the volume of air admitted to the burner may be regulated. It will be observed that the burner-tip b' performs here the function of an ejector-nozzle and the cone-cylinder that of a combining-cone, so that the vapor ejected under pressure from said tip into the combining-cone produces therein a partial vacuum, entraining the ambient air into the cone-cylinder, wherein it is combined with the vapors issuing from the tip or nozzle b' and producing a flame of great brilliancy and heating-power.

The disk D' is loosely seated upon an adjusting-wheel W, the hub of which is screw-threaded interiorly and screws upon the threaded end of the supply-pipe H. This wheel serves to adjust the burner-casing relatively to the burner-tip to draw, direct, and supply the air to said burner-tip to produce the most perfect combustion of the gases and give the best light or produce the greatest amount of heat.

Referring to Figs. 4, 5, and 6, the burner B' is cast with its passage in one piece. H is the supply-pipe connected with the burner at a point eccentric to the axis thereof, the axial passage b^2 extending clear through the burner, in the outer end of which passage is seated the burner-tip b', a regulating-screw S being fitted in said passage for purposes well understood, a suitable stuffing-box and gland

being provided for said screw, which carries a hand-wheel *s* for manipulation. The combustible liquid in this construction passes from supply-pipe H directly into initial heater-pipe P, thence back through pipe P′ into a horizontal passage b^7, and thence into pipe b^2. From the latter pipe the volatilized illuminant flows through pipe P^3, and thence through passage or channel b^{14}, Fig. 5, to the burner-tip b'. The upper ends of the regenerative pipes, of which I have shown four in this construction, are connected by couplings p^5, open at their outer ends, which openings are closed by screw-plugs p^6, so that access may be had to the pipes for cleaning the same, similar screw-plugs p^7 being provided for the passages b^7 and b^{14}.

C′ is the inner cone-cylinder, which in this construction is not slotted, and C^2 is the slotted outer cylinder that projects slightly below the lower edge of said inner cone-cylinder, between which cylinder the pipes P P′ P^2 P^3 pass, as more plainly shown in Fig. 6. In this construction the concentric cylinders C′ and C^2 are formed integral and connected by parts c^4, as shown in Fig. 6^a. The volume of air admitted to the burner is here regulated by a clamp C^3, Fig. 6^a, whose ends bear against two adjacent pipes P and P^3, said clamp being provided with a screw c^5, extending through the outer cylinder, the screw carrying a winged nut.

By means of the described arrangement the cylinders C′ C^2 can be adjusted vertically along the regenerative pipes relatively to the burner-tip and when adjusted secured in position to regulate the volume of air drawn in by the action of the escaping jet of gas through the space between the lower edge of the outer cylinder C^2 and the burner casing or shell, the cone acting in this case in combination with the burner the same as the exhaust-steam jet acts with the chimney in a steam-engine; hence the cylinders C′ C^2 are adjusted to produce the best results, and when so adjusted are fixed in position by means of the clamp and screw.

In some cases a shield F of thin metal may be secured by a screw *f* to the supply-pipe H, or to one of the regenerative pipes, as shown in Fig. 5, to protect the flame against strong currents of air that would tend to divert said flame from the regenerative pipes, and this shield may be applied to the construction of burner shown in Figs. 1 and 2. When necessary or desired, the regenerative tubes may be inclosed in glass-sided frames to shield the flame from currents of air.

Referring to Figs. 7 to 12, inclusive, the burner therein shown is in its essential features similar to that just described, and shown in Figs. 4, 5, 6, and 6^a, except that the upper ends of the regenerative pipes are each in one piece instead of coupled together, and are connected by means of a ring or flanges p^3 to a corresponding ring or flanges formed at the outer ends of branches which are cast integral with the burner B′. As shown, the lower ends of the pipes P P′ P^2 P^3 are secured to a ring p^4 by bolts p^8, spaces being left between the branches of the burner to which said pipes are connected for the passage of the air. The supply-pipe H is connected with the burner and, through a passage or branch formed therein or thereon, with the pipe P, Figs. 7 and 8, the combustible liquid flowing along said pipe and down pipe P′ back to the burner, and through a horizontal passage b^7 formed in the latter to a vertical branch and the pipe P^2, and through pipe P^3 to a chamber b^{15}, Fig. 10, and to the burner-tip b'. The chamber b^{15} and the horizontal passage b^7 are here also provided with cleansing-apertures, closed by screw-plugs. In this construction the cone-cylinder C′ is also arranged to slide vertically and is secured in position by means of a set-screw c^7, that screws into a projection formed on the branch with which the regenerative tube P is connected, (see Fig. 11,) for the purpose of adjusting the cone relatively to the burner-tip and regulate the volume of air drawn to the burner. The regenerative pipes are here also provided with screw-plugs, to be removed only for the purpose of cleaning the pipes.

As stated above, the number and dimension of the regenerative pipes and burners may be increased according to the amount of light the burner is to furnish, and they depend, also, in a measure upon the character or nature of the illuminant employed.

Of course it is well understood that a light hydrocarbon will require less heat to convert it into a gas and less power to force it to the burner than other heavier hydrocarbons or other volatile combustible illuminants.

When the lighter hydrocarbons are employed as an illuminating agent, the interior pipes *p* *p′* p^2 (shown in Fig. 2) may be dispensed with, as the distance traveled by the illuminant from the supply-pipe to the burner-tip or flame-orifice through the pipes P P′ P^2 is sufficiently great to insure its being volatilized and the gases superheated.

Having now described my invention, what I claim is—

1. In a regenerative burner, the combination of a supply-pipe, a group of rectilinear regenerative pipes, and a burner-tip arranged axially within the group at the base thereof and in such proximity thereto as to bring them within reach of the flame, said pipes being connected in series the initial whereof is in communication with the supply-pipe and the terminal with the burner-tip, substantially as and for the purposes specified.

2. In a regenerative burner, the combination of a supply-pipe, a group of rectilinear regenerative pipes, each composed of two concentric pipes, and a burner-tip arranged axially within the group at the base thereof and in such proximity thereto as to bring them within reach of the flame, said pipes being so connected as to form a continuous circuit the

initial whereof is in communication with the supply-pipe and the terminal with the burner-tip, substantially as and for the purposes specified.

3. In a regenerative burner, the combination of a supply-pipe, a group of rectilinear and converging regenerative pipes, and a burner-tip arranged axially within the group at the base thereof and in such proximity thereto as to bring them within reach of the flame, said pipes being connected in series the initial whereof is in communication with the supply-pipe and the terminal with the burner-tip, substantially as and for the purposes specified.

4. In a regenerative burner, the combination, with the supply-pipe and the burner tip or orifice, of a plurality of regenerative pipes, the diameter whereof gradually decreases outwardly, grouped around the burner-orifice and in such proximity thereto to bring them in contact with the flame, said pipes being connected in series, the initial thereof communicating with the supply-pipe and the terminal with the burner-orifice, substantially as and for the purposes specified.

5. In a regenerative burner, the combination, with the burner tip or orifice and the supply-pipe, of a plurality of regenerative pipes, each comprising concentrically-arranged pipes connected in a continuous series, the initial communicating with the supply-pipe and the terminal with the burner-orifice, the diameter of the outer pipes gradually decreasing outwardly, said pipes being grouped around the burner-orifice to bring them in contact with the flame, substantially as and for the purposes specified.

6. In a regenerative burner, the combination, with the burner tip or orifice, and the supply-pipe, of a plurality of regenerative pipes grouped around the burner-orifice and converging toward the axial plane thereof, each pipe comprising concentrically-arranged pipes connected in continuous series, the initial communicating with the supply-pipe and the terminal with the burner-orifice, the diameter of the outer pipes gradually decreasing outwardly, substantially as and for the purposes specified.

7. In a regenerative burner, the combination, with the burner provided with an axial gas-passage leading to the burner tip or orifice, the supply-pipe, a plurality of regenerative pipes, open-ended passages or channels formed in said burner, and apertured connections between the outer ends of the pipes to connect them in series, the initial communicating with the supply-pipe and the terminal with the passage leading to the burner-orifice, of screw-plugs for the open ends of the channels and the apertures in the pipe-connections, substantially as and for the purposes specified.

8. In a regenerative burner, the combination, with the burner tip or orifice, the supply-pipe, and a plurality of regenerative pipes grouped around the burner-orifice in such proximity as to bring them in contact with the flame, said pipes being connected in series, the initial communicating with the supply-pipe and the terminal with the burner-orifice, of an air cylinder or chamber encompassing the burner and regulating devices for regulating the volume of air admitted to the burner, substantially as and for the purposes specified.

9. The herein-described regenerative burner, comprising an injector and a multitubular regenerator, having its tubes connected in series and arranged in a projection of the plane of and in proximity to the injector-nozzle, said injector being connected with the terminal of the multitubular regenerator, substantially as and for the purposes specified.

10. The herein-described regenerative burner, comprising an injector, a combining-cone arranged in front of the injector, and a multitubular regenerator having its tubes connected in series and arranged in a projection of the plane of and in proximity to the injector-nozzle and combining-cone, said injector being connected with the terminal of the multitubular regenerator, substantially as and for the purposes specified.

11. In a regenerative burner for volatile combustible liquids, the combination of the cone-cylinder C′ with regenerative pipes arranged in proximity to the flame for converting the liquid into vapor or gas, and the ejector-tip b', connected with the regenerative pipes and arranged in the axial plane of the cone, for injecting the gas or vapor generated into said cone to produce a partial vacuum and forcibly entrain the air necessary to combustion into the cone, substantially as and for the purposes specified.

In testimony whereof I affix my signature in presence of two witnesses.

ROUGHSEDGE WALLWORK.

Witnesses:
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WILLIAM FAULKNER.