(No Model.) 2 Sheets—Sheet 1.

P. J. SCHLICHT.

ART OF AND APPARATUS FOR PRODUCING COMBUSTION.

No. 556,280. Patented Mar. 10, 1896.

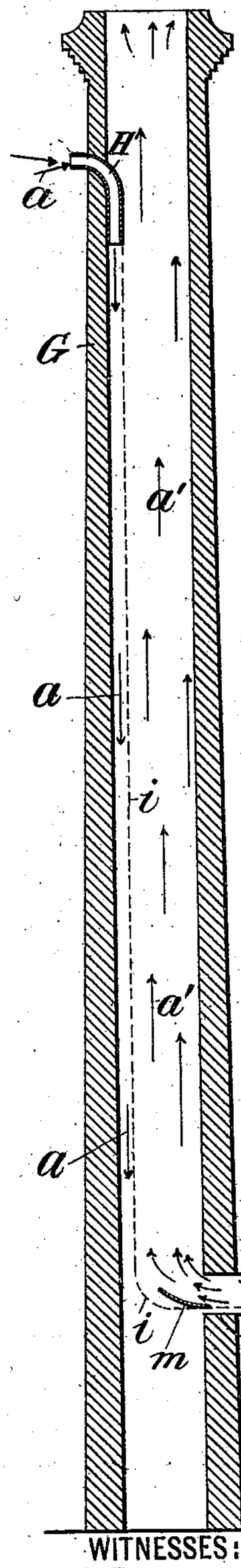


Fig. 2.

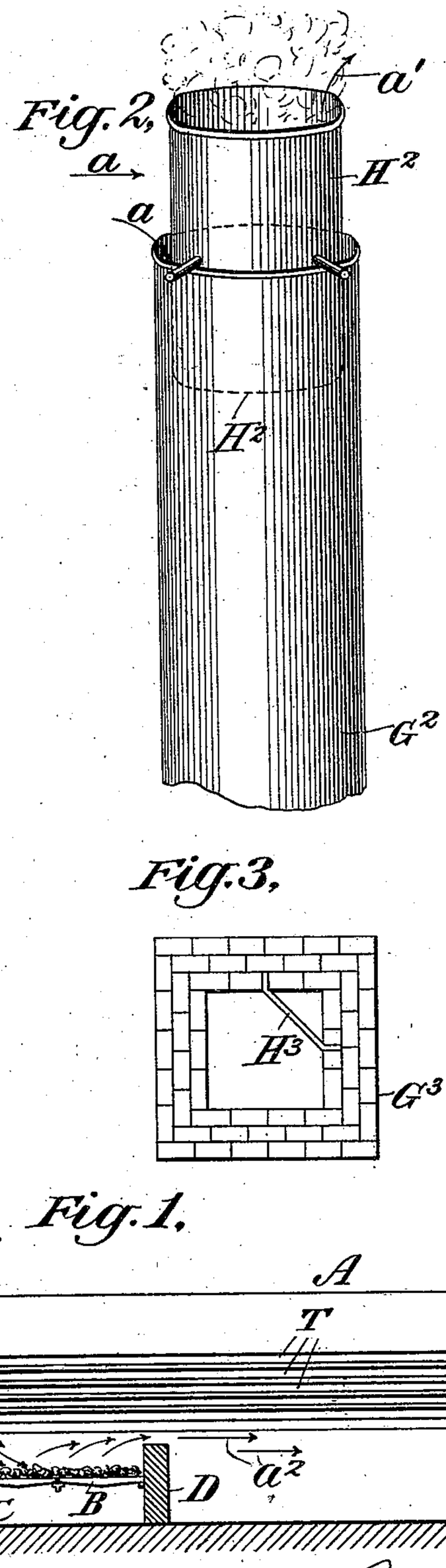
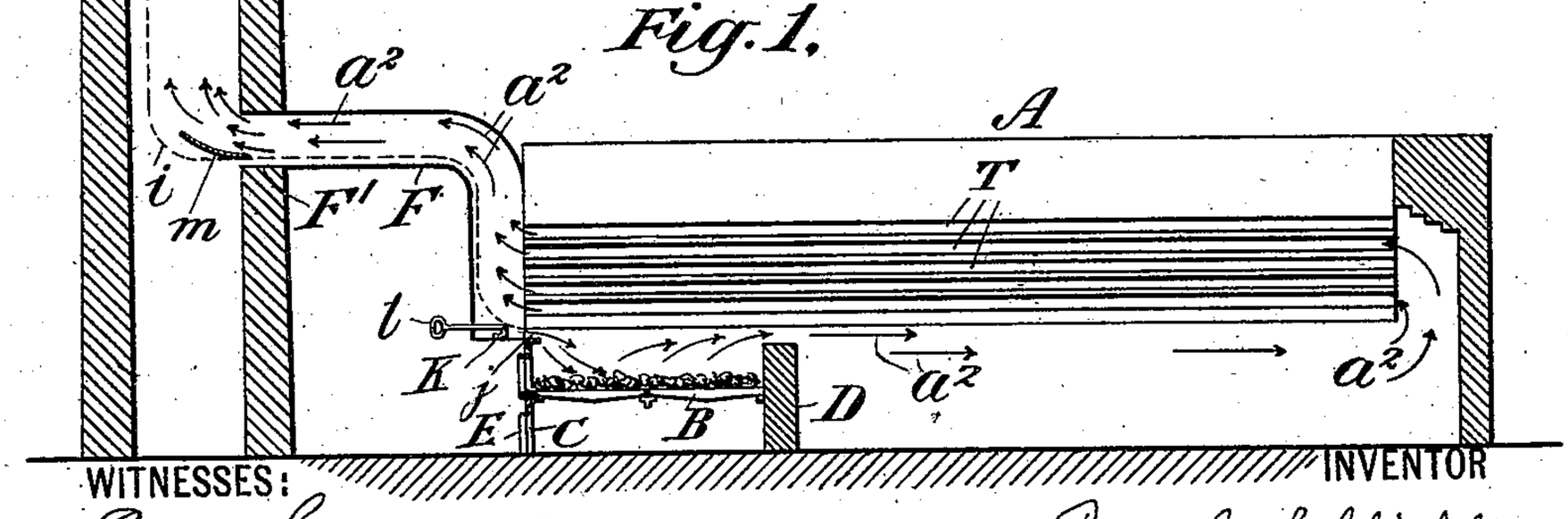


Fig. 3.

Fig. 1.



WITNESSES:

Edwin Seger.

Timothy C. Raftery.

Paul J. Schlicht.

BY

Witter Kenyon,

ATTORNEYS

(No Model.) 2 Sheets—Sheet 2.

P. J. SCHLICHT.

ART OF AND APPARATUS FOR PRODUCING COMBUSTION.

No. 556,280. Patented Mar. 10, 1896.

Fig. 5.

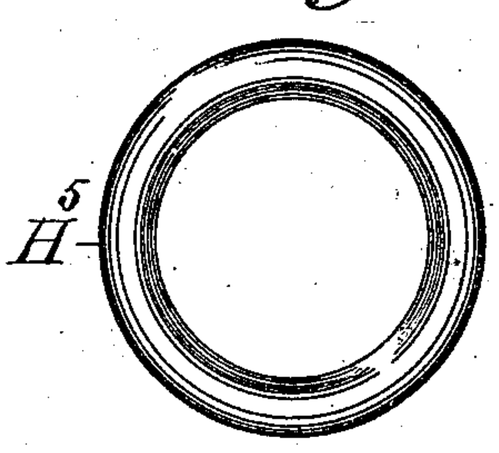


Fig. 7.

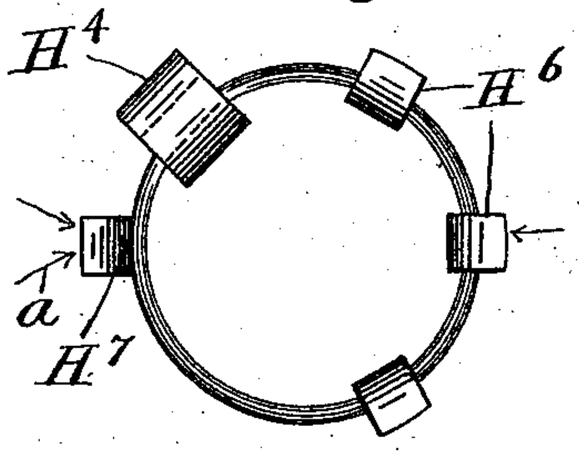


Fig. 9.

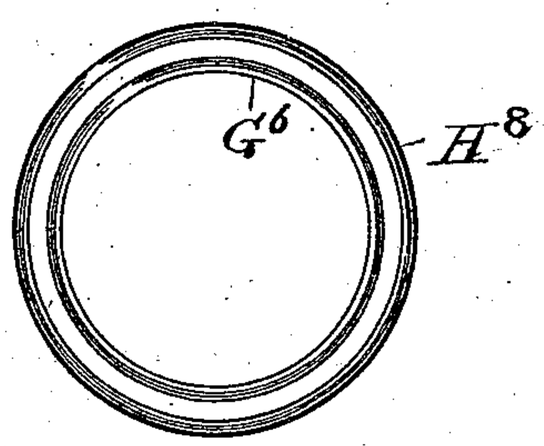


Fig. 6.

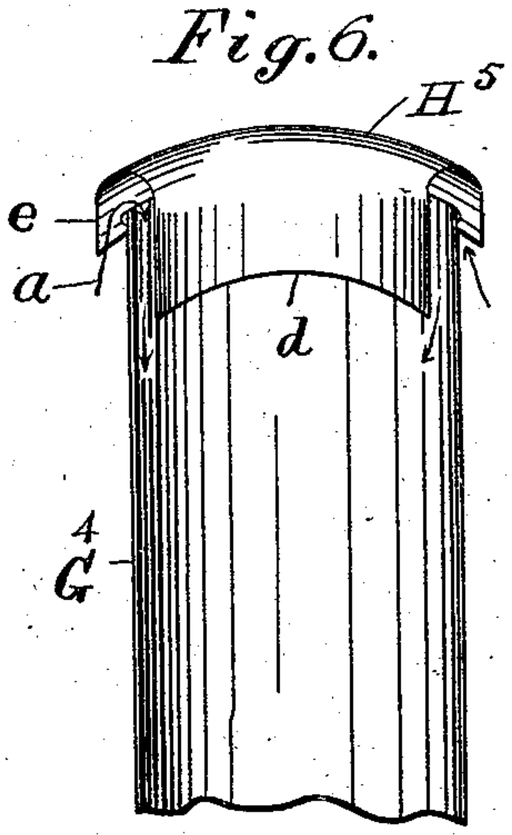
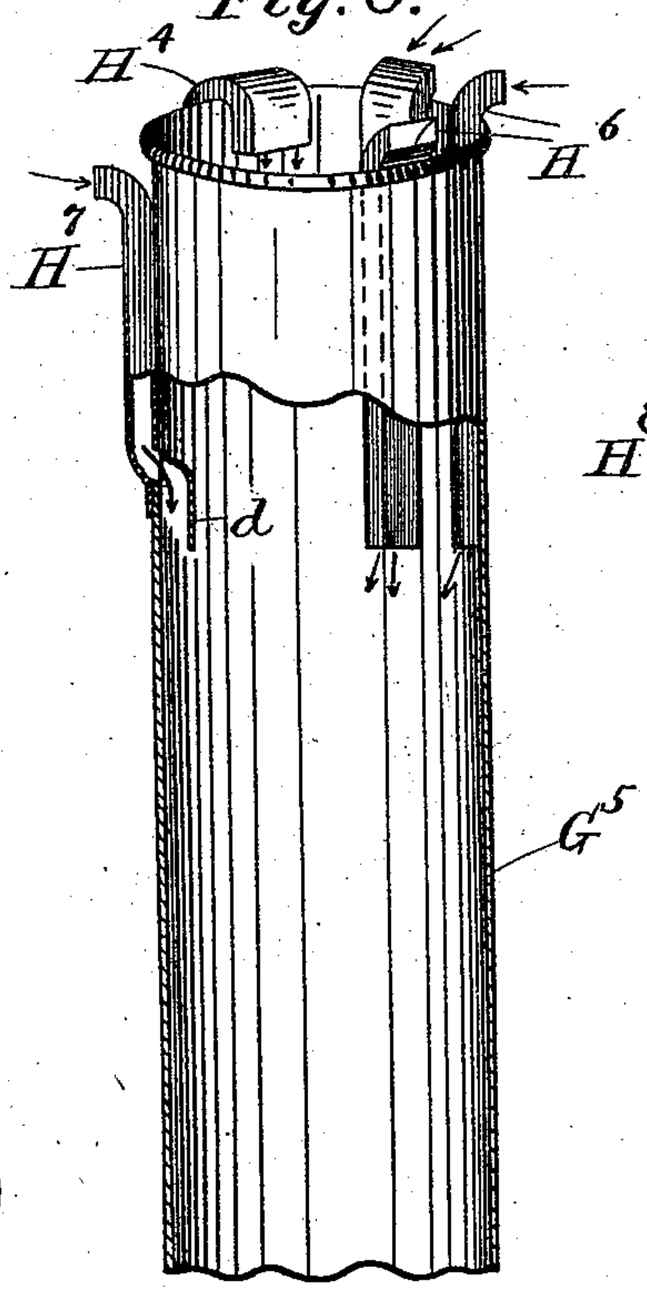


Fig. 8.



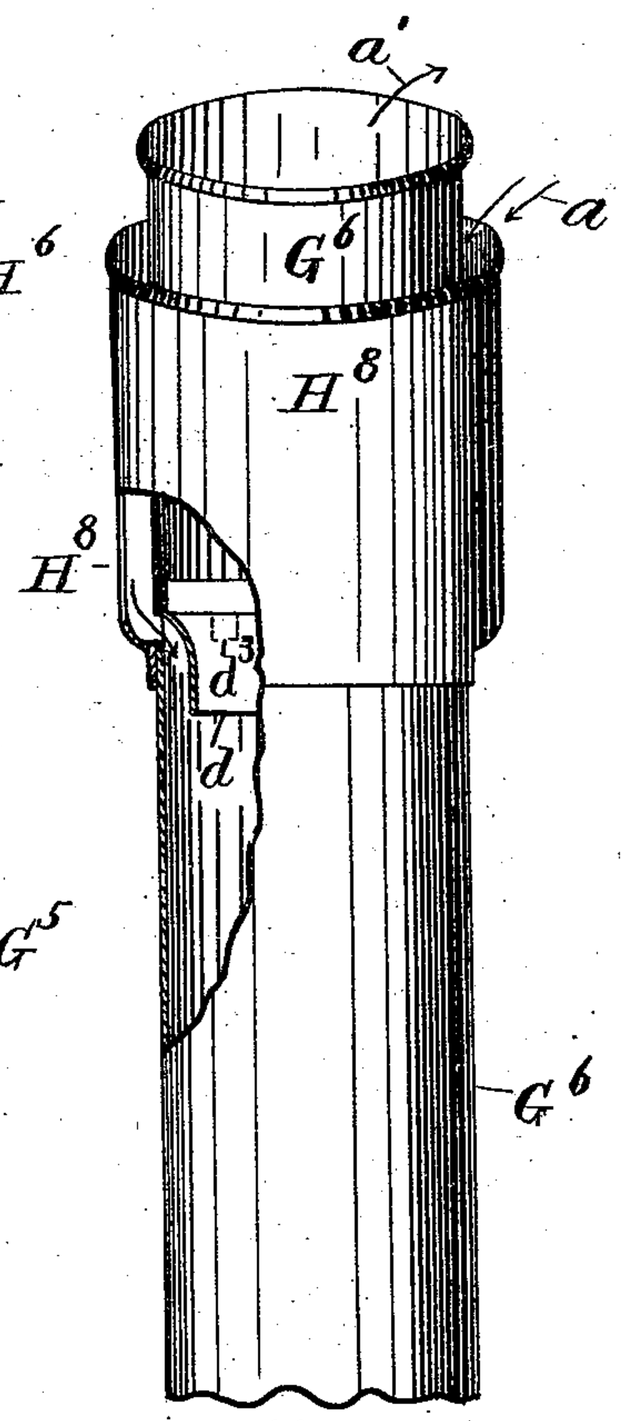
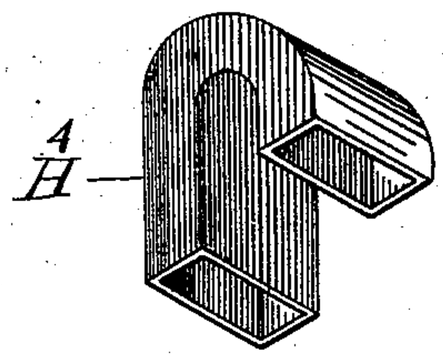


Fig. 10.

Fig. 4.



Attest:
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Edw. F. Kinsey.

Inventor
Paul J. Schlicht, per
Thomas S. Crane, Atty.

UNITED STATES PATENT OFFICE.

PAUL J. SCHLICHT, OF SUMMIT, NEW JERSEY, ASSIGNOR TO EDMUND FRANCIS ELDREDGE, OF NEW YORK, N. Y.

ART OF AND APPARATUS FOR PRODUCING COMBUSTION.

SPECIFICATION forming part of Letters Patent No. 556,280, dated March 10, 1896.

Application filed September 22, 1894. Serial No. 523,782. (No model.)

To all whom it may concern:

Be it known that I, PAUL J. SCHLICHT, a citizen of the United States, residing at Summit, in the county of Union and State of New Jersey, have invented a new and useful Improvement in the Art of and Apparatus for Producing Combustion, of which the following is a full, clear, and exact specification, reference being had to the accompanying drawings, which form a part hereof.

My improved art or method has reference to the combustion of fuel for the production of heat or light, and its object is to economically produce the greatest amount of heat available for useful work or the greatest amount of light from a given quantity of fuel.

My improved apparatus relates to means for carrying out my improved method in the most effective manner, and its object is to provide a simple means for this purpose which may be applied to or embodied in existing combustion apparatus without material alteration of their structures, and which when applied thereto or embodied therein will adapt the said apparatus to be operated in accordance with my improved method.

The new art or method consists in causing a supporter of combustion (usually air) to flow to a place of combustion in contact with a current of hot products of combustion, whereby the supporter of combustion is heated before it reaches the place of combustion.

It also consists in causing a supporter of combustion (usually air) to flow to a place of combustion in contact with a current of combustion products flowing in a direction opposite to that in which the supporter of combustion is moving, whereby the supporter of combustion is heated before it reaches the place of combustion and its rate of flow is retarded.

It also consists in causing a supporter of combustion (usually air) to flow to the place of combustion in contact with the products of combustion escaping therefrom, whereby the supporter of combustion is heated and the quantity fed to the combustion-chamber is regulated according to its needs.

It also consists in causing a supporter of combustion (usually air) to flow by gravity to the place of combustion in contact with the hot products of combustion escaping therefrom.

It also consists in causing a supporter of combustion (usually air) to flow to the place of combustion around and in contact with the hot products of combustion escaping therefrom, whereby the combustion products are encircled by the supporter of combustion and an extended contact between the two is secured.

It also consists in other steps and features hereinafter described and claimed.

The new apparatus consists of means for causing a supporter of combustion to flow to a furnace or place of combustion so as to come in contact with and be heated by products of combustion.

It also consists of means for causing a supporter of combustion to enter a chimney or flue and flow to the place of combustion in contact with the hot combustion products escaping therefrom, the said means being in some instances simply a deflector for initiating and introducing and directing the current of the supporter of combustion.

It also consists in various other devices and combinations hereinafter described and claimed.

The invention is based upon the fact which I have discovered, that a current of air and a current of combustion products will flow in contact without any substantial intermingling, and that if a current of air is properly introduced into a chimney or flue through which hot products of combustion are escaping the current of air will flow to the place of combustion in a direction opposite to that of the current of products. The current of air will, however, gradually become hotter, while that of the hot products of combustion will gradually become colder. In other words, I have discovered that substantially distinct as well as oppositely-moving currents can be maintained in a comparatively confined space—such as a furnace-flue, stack, or lamp-chimney—if the currents are once properly introduced or started, and use is made of this fact and discovery in my invention for the purpose of heating the air which is to support combustion, and for other advantageous purposes.

In carrying out my improved method in the best way known to me a current of air is introduced into the channel through which the hot products of combustion are escaping and properly directed through such channel toward the place of combustion so as to come in contact in said channel with the products of combustion which are flowing in an outward direction from the place of combustion. Under these conditions the air-current when once established will maintain itself, and during its passage will absorb heat from the escaping products of combustion and reach the place of combustion in a heated state. A difference of temperature will exist between the escaping products of combustion and the incoming air throughout the whole length of their currents, for although the temperature of the air gradually rises as it proceeds still it continually comes in contact with hotter products of combustion, since the temperature of the products of combustion is higher as the place of combustion is approached. Thus the transfer of heat from the escaping products of combustion to the incoming air will be maintained throughout the whole period of their contact. The current of air being colder than the current of combustion products will continue to flow to the place of combustion, while the current of combustion products will continue to flow in the opposite direction.

Products of combustion ordinarily escape from furnaces in a very hot state, and if their heat or a portion thereof is used to heat the feed-air a direct saving will be effected. In its broadest sense the idea of heating feed-air by utilizing some of the waste heat of the escaping products of combustion is old—that is, it is old to admit the air through a separate duct, around which or in contact with the walls of which the hot products of combustion are passing. In such a structure, however, it is found to be impracticable to raise the air to the desired temperature, because the flow of air is too rapid and because the current does not come in contact with the escaping gases; and, furthermore, the supply of air to the combustion-chamber is not regulated as it is in my method. Moreover, such a structure is complicated and expensive.

It is well known that furnaces fed with hot air are more effective than those fed with cold air, and that they are also more economical in the use of fuel. The use of hot air is more economical than that of cold air, even if the said hot air has not obtained its heat from a source of heat that would otherwise be wasted. If it is then of advantage to feed hot air to a place of combustion when the heat is not taken from a source of waste heat, it is evident that the process of combustion must be much more economical if the heat which is imparted to the air is taken from the waste products of combustion, as it is in my method, and taken, not through the walls of a separate duct, but directly from the products of combustion themselves. When the air flows through the stack to the place of combustion under the influence of gravity, as it does in the best form of my invention, and not under the pressure of a forced or even a natural draft that sweeps combustible elements from the furnace into regions of low temperature before they can be consumed and that carries away units of heat that would otherwise be available for useful work, the economy must be still greater.

There is a further advantage secured by my improved method as a result of supplying hot air to the place of combustion in regulated quantities from above the fire. It is that diffusion of gases is aided and combustion regulated and improved. The more intimately the molecules of the combustible gases are intermingled with those of oxygen the greater will be the number of atoms that unite in chemical union. A thorough diffusion of the gases and the air and a regulated supply of air to the gases are secured by my invention.

In the best form of my invention the supply of air to the place of combustion is automatically regulated. This automatic regulation is the result of the interdependence of the actions of the chemical operations within the place of combustion and of the inflowing air and outflowing products of combustion. The intensity of combustion and the volume, temperature, density, and general conditions of the current of products of combustion are affected and governed by the volume, temperature, density, and general conditions of the air-current, and the volume, temperature, density, and general conditions of the air-current are themselves directly affected and governed by the intensity of combustion and the volume, temperature, density, and general conditions of the current of combustion products. The propulsive force is the pressure of the atmosphere, and since this pressure is practically constant the flow of air to the place of combustion will be in all particulars uniform unless there are variations in the volume, temperature, density, or general conditions of the column of escaping products of combustion within the stack or duct.

My invention, as will appear from what has already been stated, differs from the prior art, in that by its operation the supporter of combustion is fed through the duct which conveys the products of combustion instead of through a separate duct which is heated by the products of combustion. In this manner the supporter of combustion comes in direct contact with the hot products of combustion which have escaped from the place of combustion and are flowing to the point of discharge and is given an abundant opportunity to absorb heat therefrom.

The feeding of air through the stack in contact with the products of combustion is automatic, and since the supply therefrom is proportioned to the needs of combustion in the furnace no more air will be admitted than is

required for the oxidation of the combustible elements. The quantity or volume of oxygen and nitrogen which must be heated is therefore reduced to the minimum, as is also the volume of nitrogen flowing from the furnace and carrying away units of heat.

In the operation of ordinary furnaces all the air which supports combustion enters the combustion-chamber through the grate and between the pieces of solid fuel resting thereon. This feeding of air is disadvantageous because the well-known formation and breaking up of carbon dioxide and the formation of carbon monoxide result in the admission to the combustion-chamber above the fuel of a body of commingled gases and air, which body is not wholly a supporter of combustion. There is a great advantage therefore in supplying an independent volume of pure or substantially pure air to the combustion-chamber above the grate, so that the combustible gases and other fuel may obtain oxygen that has not been materially diluted with non-combustible gases.

It is well known that in ordinary methods of combustion particles of carbon are liberated and carbon monoxide and other combustible gases are evolved, which, because of an inadequate supply of oxygen, escape up the stack, or, if sufficient oxygen is present to consume them, their temperatures are reduced below the point of ignition before the oxygen is thoroughly diffused through the furnace, in which case both the uncombined oxygen and the combustible elements escape. By supplying a portion of the air above the fire-bed, as described, I avoid this loss of gaseous fuel, and, furthermore, establish such conditions as will cause the oxygen to enter into direct combination with the carbon and form carbon dioxide, which is the final product of combustion, thus preventing a retardation of the process of combustion. This assertion is borne out by the fact that the appearance of the fire in a furnace fed with air in the manner described is different from that in a furnace fed with air in the usual manner.

The term "furnace" is used herein in the generic sense, and is meant to include not only furnaces that burn solid, liquid and gaseous fuel, but also lamps and gas-burners for illuminating purposes where chimneys are used in connection with these means for illumination, for I have discovered that by the proper application of my invention to an illuminating apparatus the efficiency and economy thereof can be greatly increased.

In practice the air will usually be admitted at or near the top of the flue; but its admission is not necessarily limited to this position. The advantage of introducing the air at the top of the flue is that the current of air is subjected to the action of hot gases throughout its entire length, and thus its temperature is raised much higher than would be possible if it were introduced at a lower point.

In the preferred practice of my improved method the fire is first started in the combustion-chamber, the draft-doors being left open for this purpose. After the fire is well started the draft-doors are entirely or very nearly closed, so as to cut off or very much reduce the supply of air beneath the grate. As soon as this is done the velocity of the escaping products of combustion is reduced, the air enters the stack or chimney, and, by means of the deflector, is given an initial direction down the stack and flows toward the fire-chamber in contact with the escaping products of combustion, which are passing in the opposite direction, and flows into the fire-chamber, where it immediately unites with the fuel. The effect of closing or partially closing the ash-pit doors is to cause the atmospheric pressure to be exerted wholly through the stack or to preponderate therein to such an extent that the effect of the ordinary atmospheric pressure at the initial part of the air-current will not be neutralized by the atmospheric pressure exerted from below. Sometimes the best results are obtained, however, by regulating the inflow of air at the ash-pit doors in accordance with the needs of the solid combustible elements which remain after destructive distillation of the fuel has occurred. While the supply of air through the ash-pit doors is thus arbitrarily proportioned to the needs of the solid fuel, the supply of air to the combustible gases within the combustion-chamber will be automatically regulated, as before stated. It may not ordinarily be necessary to admit air through the ash-pit doors when fresh fuel is added to the fire, although if the quantity of added fuel be large the attendant may find it advantageous with some fuels to admit a portion of the air in this manner. The best results are obtained by adding only very thin layers of fresh fuel and by leaving the ash-pit doors closed or nearly closed.

Another great advantage which is secured by my invention is the abatement of the smoke nuisance, for by feeding air to the fuel in the manner described the free carbon which usually escapes and is deposited in the form of soot is entirely or substantially consumed, and the products of combustion escaping from the stack are either perfectly clear or but slightly colored by non-combustible substances which are found in some fuels to a greater or less extent.

Having thus fully described my improved method, I shall now describe my improved means for carrying the same into effect.

Referring to the drawings, Figure 1 is a sectional view of an ordinary boiler furnace and stack, the stack being provided with one form of deflector for initiating an air-current. Fig. 2 is a perspective view of a portion of a stack with another form of deflector in position. Fig. 3 is a plan view of a square stack provided with a deflecting-plate in one corner. Fig. 4 is a perspective view of another form of air supplying and deflecting device. Figs. 5, 7, and 9 are plans; Fig. 6, a sectional

view, and Figs. 8 and 10 perspective views of still other forms.

In Fig. 1, A designates a horizontal tubular boiler of the ordinary form; B, a grate for supporting fuel to heat the same; C, the ash-pit beneath the grate, and D the bridge-wall at the back of the fire-chamber, the ash-pit being provided with the usual doors E. G designates a stack of any convenient form which has communication with the fire-chamber through the breeching and flue F, which flue enters an opening F′ in the side of the stack. An air supplying and directing device H is placed in the stack near its top for introducing a current of air and directing the same down the stack. An additional deflector *m* may be placed at the point where the breeching communicates with the chimney to direct the descending current through an opening *j*, controlled by a damper K operated by a rod *l*, but this additional deflector is not essential. A dotted line *i* is drawn within the chimney and breeching to indicate graphically the path described by the descending current of air, the direction being further indicated by the arrows *a*. The path described by the products of combustion is indicated by the arrows a^2 *a*′.

In Fig. 2, G^2 designates the top of a stack, and H^2 the means for admitting and directing the current of air. This deflector conforms to the shape of the stack and is of such a size as to enter the top of the same and leave a space between it and the stack, and it is adapted to extend both above and below the top of the stack. It here consists of a tube somewhat smaller than the stack, one end of which extends a short distance down the stack and the other a short distance above its top, and is supported in any convenient manner. By this means an annular channel is formed between the stack and tube H^2, through which the cold air is introduced, and by which it is given direction. In this form of apparatus the air-current will entirely surround the gaseous current, and thus much more effectively absorb the heat of said gaseous current than will an air-current of any other form.

In Fig. 3 G^3 indicates a brick chimney, across one corner of which a plate H^3 is fastened. This plate is arranged to extend a short distance above and a short distance below the top of the stack, so as to introduce and direct the current in the same manner as the devices above described.

Fig. 4 illustrates another form of air supplying and deflecting device H^4. It comprises a tube bent upon itself so that the two limbs are substantially parallel. In applying it to the stack it is simply hung over the edge, and may, therefore, be applied to any existing stack without making changes therein. The air enters the outer limb of this device, rises therein, and descends through the other or inner limb into the stack, and when once thus given direction continues to descend in the same manner as from the devices previously described.

In Fig. 6, of which Fig. 5 is a plan view, is shown the upper part of the stack G^4, to which is applied the attachment here designated by H^5. In this instance the attachment comprises a tube *d*, extending down within the top of the stack, the upper extremity being bent over to form a flange *e*, so that the air enters in the direction shown by the arrow *a* and is deflected and directed as with the devices before described.

Fig. 7 is a plan, and Fig. 8 a perspective, view of a stack G^5, having three deflector-tubes H^6 fitted within the same upon the right-hand side and a similar tube H^7 fitted to the outer wall at the left-hand side, and having, in addition, a bent tube H^4 applied thereto, which is simply hung upon the top of the stack and, if necessary, fastened in that position. Here the tubes H^6 and H^7 are formed with horizontally-disposed ends. The tubes H^6 are shown extending a suitable distance within the stack, the air before escaping therefrom being heated to a greater or less extent indirectly by the rising products of combustion and after passing from the tube being still further heated by coming into direct contact with the products of combustion. The tube H^7 is upon the outside of the stack, the intention being to have it enter the same at any desired point. In this position the tube is heated by conduction from the stack and in turn heats the air which passes through it. When the tube enters the stack, a deflector *d* is used to give direction to the entering current of air.

Fig. 9 shows a plan, and Fig. 10 a perspective, view of a portion of a stack G^6, provided with an annular jacket H^8, which terminates below the top of the stack. The stack itself deflects the air downward within the jacket, as indicated by the arrows *a*, whence it enters the stack and is directed to the furnace as desired. The air in descending the jacket will obviously be raised in temperature by coming in contact with the heated wall of the stack. From the jacket the air is conducted into the stack in any desired manner—as, for example, through the holes in the stack, as shown in Fig. 10 at d^3—and is then given proper direction by the deflector *d*.

The operation is as follows: The fire is started in the usual manner, with all the valves and doors which control the draft open, so that the fuel may receive a full supply of oxygen beneath the grate. When the fuel is thoroughly ignited and the fire is well under way, the ash-pit doors are nearly or entirely closed so as to greatly restrict or entirely shut off the supply of air beneath the grate. As soon as the doors are thus manipulated the velocity of the current of gases escaping through the stack is greatly reduced. Air enters and descends the stack in distinct currents in immediate contact with the hot products of combustion, thus reaching the

combustion-chamber in a heated condition. The air may flow from the stack to the combustion-chamber through any suitable channel—as, for instance, through an opening arranged between the combustion-chamber and the breeching, as in Fig. 1 of the drawings, or if such an opening is not provided it may flow through the lower part of the passage or flue connecting the stack and the combustion-chamber. In general the air-current will always establish itself in that part of the flue where it meets with the least resistance from the escaping gases. In vertical flues, such as ordinary stacks, the path of least resistance will be at the sides, while in passages which are inclined or horizontal it will be in the lower part. Hence when a construction such as that shown in Fig. 1 is used the air-current will probably follow the course indicated by the arrows *a*—that is, it will enter the stack through the tube H, descend along the wall, as indicated graphically by the line *i*, fill the lower part of the stack, flow through the lower part of the breeching, and reach the fire-chamber through the opening *j*.

When in the claims I use the term "deflector" I refer to any means whereby an independent current of air may be initiated within a stack or chimney containing a current of products of combustion in a direction opposite to that of the products of combustion.

In placing or arranging the deflectors the smoke-passage should not be too greatly restricted, for if it is too small the smoke will be forced to escape through the air-passage, as well as through that intended for the smoke. Generally it will not do to reduce the smoke-passage to less than half its normal size. The best results are generally secured by making the smoke-passage considerably larger in area than the passage for the air. It is better that the flue for carrying off the smoke shall extend above that for introducing the air.

As under the rules of practice I cannot in this application present specific claims for each of the various forms or embodiments of my invention, I have claimed the several forms shown in my applications, Serial Nos. 575,485, 575,486, 575,487, and 575,489.

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

1. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow to a place of combustion in contact with a current of products of combustion, substantially as set forth.

2. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow to a place of combustion in contact with a current of products of combustion, said contact continuing throughout a substantial part of the length of said current of combustion products, substantially as set forth.

3. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow to a place of combustion in contact with a current of products of combustion flowing in a direction opposite to that in which the supporter of combustion is moving, said contact continuing throughout a substantial part of the length of said current of products of combustion, substantially as set forth.

4. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow to the place of combustion in contact with a current of the products of combustion flowing from said place of combustion throughout a substantial part of the length of said current, substantially as set forth.

5. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow to igneous fuel in contact with products of combustion flowing from said igneous fuel, substantially as set forth.

6. The improvement in the art of producing combustion which consists in feeding air to igneous fuel in contact with the products of combustion flowing from said igneous fuel, substantially as set forth.

7. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow by gravity to igneous fuel in contact with products of combustion, substantially as set forth.

8. The improvement in the art of producing combustion, which consists in causing air to flow by gravity to the place of combustion, in contact with the hot products of combustion flowing from said place of combustion, substantially as set forth.

9. The improvement in the art of producing combustion which consists in causing a supporter of combustion to flow to a place of combustion around and in contact with the hot products of combustion escaping therefrom, substantially as set forth.

10. The improvement in the art of producing combustion which consists in feeding to the place of combustion below the top of the fuel a portion only of the air required for combustion, and in causing the remainder of the air required for combustion to flow to the place of combustion in contact with a current of the products of combustion flowing therefrom throughout a substantial part of the length of said current, substantially as set forth.

11. The combination with a furnace or place of combustion, of means for feeding a supporter of combustion to the furnace or place of combustion so as to come in contact with and be heated by products of combustion, substantially as set forth.

12. The combination with a furnace or combustion-chamber, of a chimney and means for causing a supporter of combustion to enter the chimney and flow to said furnace or com-

bustion-chamber so as to come in contact in said chimney with the hot products of combustion flowing from the furnace or combustion-chamber, substantially as set forth.

13. The combination with a combustion apparatus of means for feeding air by gravity to the said apparatus through the stack, flue or chimney thereof, so as to cause the air to come in contact in said stack, flue or chimney with the hot products of combustion escaping from the combustion-chamber, substantially as set forth.

14. The combination with a furnace or combustion-chamber, of a chimney having an air-inlet and means for deflecting and conducting air for a part only of the distance from said inlet toward the place of combustion, substantially as set forth.

15. The combination with a furnace and stack, of a deflector situated in or upon the stack, and adapted to produce an air-current in the stack in a direction opposite to the direction of motion of the products of combustion, and to separate the initial portion of such air-current from the products of combustion, substantially as set forth.

16. The combination with a chimney or stack, of an air-deflector conforming to the shape of the same and of such a size as to enter the top of the chimney or stack and leave a space between it and the chimney or stack, and supported so as to extend above the chimney or stack, substantially as set forth.

17. The combination with a chimney or stack, of an air-deflector conforming to the shape of the same, and of such a size as to enter the top of the chimney or stack and leave a space between it and the chimney or stack and means for so supporting the deflector that it will extend above the top of the chimney or stack, and also below the top thereof, substantially as set forth.

18. The combination with a furnace and stack, of a deflector conforming to the shape of the stack situated in or upon the stack, supported centrally with respect thereto, and adapted to produce an air-current in the stack in a direction opposite to the direction of motion of the products of combustion, and to separate the initial portion of such air-current from the products of combustion, substantially as set forth.

19. The combination with a chimney, of a deflector consisting of a tube extended a part of the way down within the top of the same to direct an entering current of air downward therein, substantially as set forth.

20. The combination with a chimney-top, of a tube supported centrally in the middle of the top and extending part way down within the same, and also some distance above the top, substantially as set forth.

21. The combination with a combustion-chamber, of means for admitting below the top of the fuel in said chamber a portion only of the air required for combustion, and a chimney or flue connected with the combustion-chamber, and provided with means for causing the remainder of the air required for combustion to enter the chimney or flue and flow through the same to the combustion-chamber in contact with the escaping products of combustion, substantially as set forth.

22. The combination, with a furnace having a grate and combustion-chamber above the same, of means for admitting below the grate a portion only of the air required for combustion, and a chimney or flue connected with the combustion-chamber, and provided with means for directing the remainder of the air required for combustion down the chimney to the combustion-chamber in contact with the escaping products of combustion, substantially as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

PAUL J. SCHLICHT.

Witnesses:
E. FRANCIS ELDREDGE,
THOMAS S. CRANE.