No. 807,245. PATENTED DEC. 12, 1905.

C. CLAMOND.

METHOD OF BURNING GAS TO DEVELOP RADIANT HEAT.

APPLICATION FILED JUNE 19, 1901.

3 SHEETS—SHEET 1.

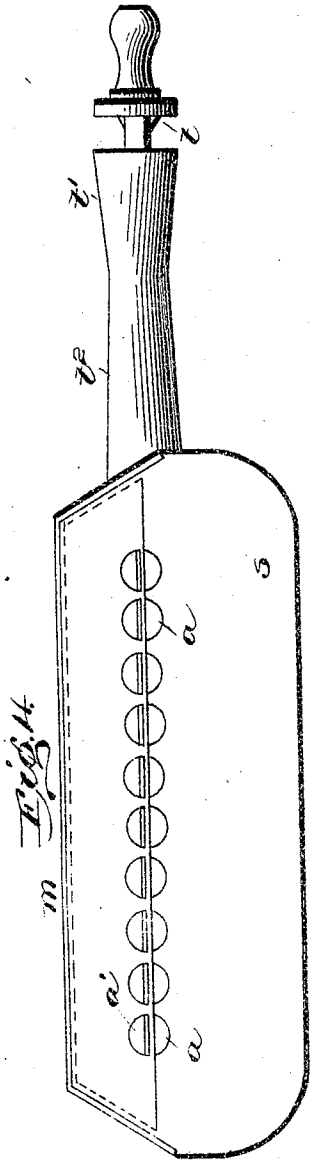


Fig. 4.

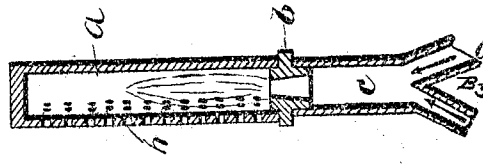


Fig. 1.

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3 SHEETS—SHEET 2.

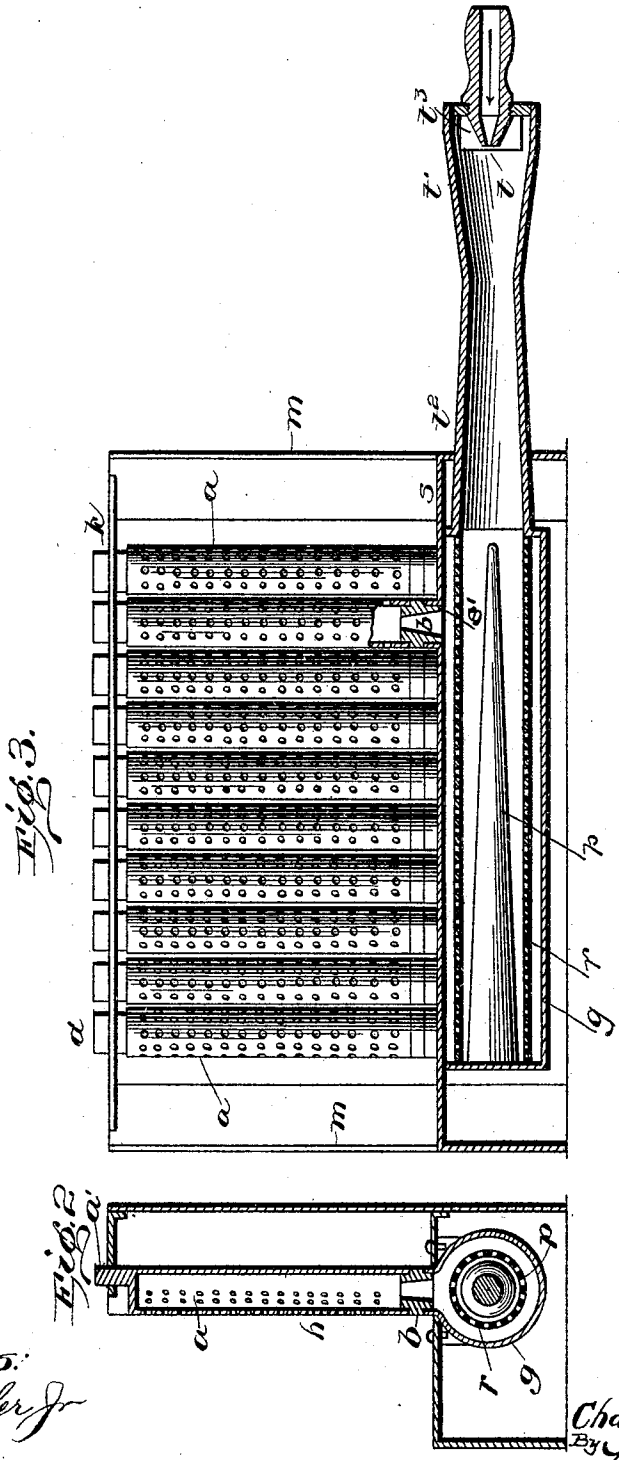


Fig. 3.

Fig. 2.

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3 SHEETS—SHEET 3.

Fig. 5.

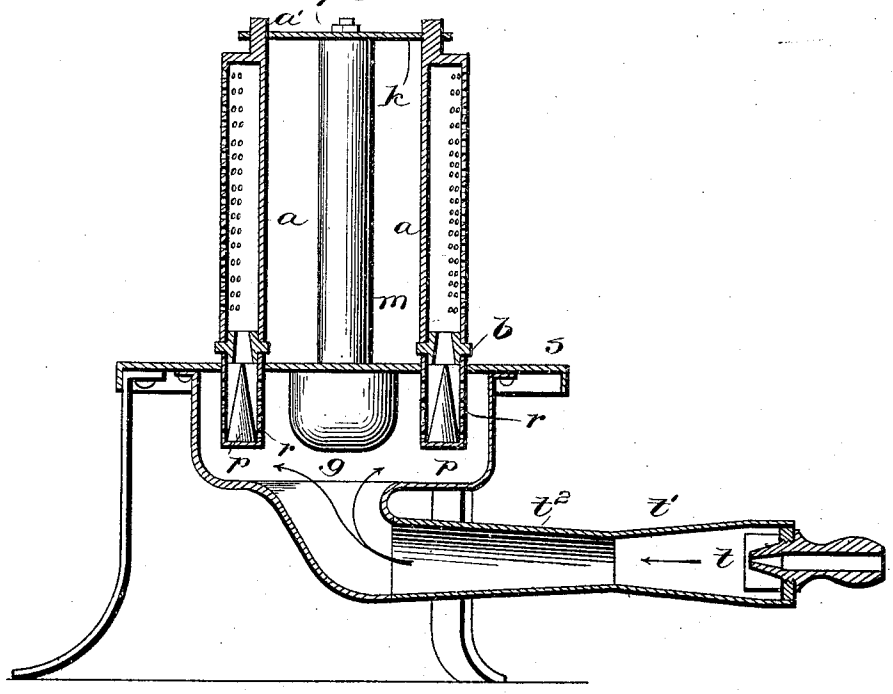
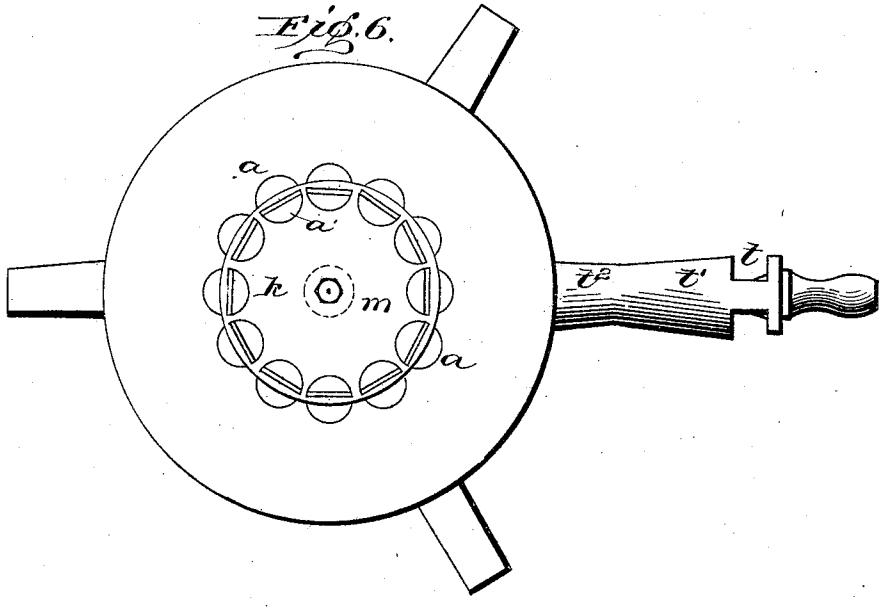


Fig. 6.



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METHOD OF BURNING GAS TO DEVELOP RADIANT HEAT.

No. 807,245. Specification of Letters Patent. Patented Dec. 12, 1905.

Application filed June 19, 1901. Serial No. 65,182.

To all whom it may concern:

Be it known that I, CHARLES CLAMOND, a citizen of the Republic of France, and a resident of Paris, in the Republic of France, have invented certain new and useful Improvements in the Method of Burning Gas to Develop Radiant Heat, of which the following is a specification.

The object of my invention is to operate a gas-stove in such a manner as to obtain the largest possible amount of localized radiant heat from the combustion of the gas.

It is well known that for heating rooms the heat produced by radiation is most healthy. When solid fuel, such as coal or coke, is burned in an open grate or stove, it becomes incandescent, and a large portion of the heat produced by the combustion of the fuel enters the room by radiation from the solid, incandescing, combustible material; but the problem of obtaining a large amount of radiant heat from the combustion of gas is more difficult of solution, and though gas-heating stoves have been largely used the heat radiated by them in proportion to the gas consumed has in the past been small and the system has not given satisfactory results.

In accordance with my invention I adopt the plan of using the combustion of the gas to heat a fire-resisting and heat-radiating body, the radiation from which imparts heat to the locality desired; but whereas in the past it has been the general practice to heat such fire-resisting bodies by a flame made by the combustion of the gas the flame has usually been applied to the outside of the fire-resisting body, which means that much of the heat of the flame has not acted to heat the fire-resisting body, and so far as the purpose of the stove is concerned, of which the fire-resisting body forms a part, such portion of the heat has practically been wasted. Thus, for instance, it has been a common practice to use tubes of fire-resisting material having perforations therein and to have the combustible gas pass through the interior of this tube and issue from the perforations to the exterior of the tube, where having been lighted it burned with a flame. This flame, be it understood, was on the exterior of the tube. Now while it is true that such flame burning on the exterior of a refractory tube imparts a certain amount of heat thereto, it is at once plain that the proportion of heat thus imparted to the tube by the flame is a small portion of the total heat of the flame and that any gas-stove constructed on such principle is correspondingly inefficient.

In my invention I take a tube of refractory material capable of becoming heated and emitting its heat by radiation when thus heated, which class of materials I call for convenience "refractory radiating" materials, and I provide this tube with a series of small apertures or perforations. Instead, however, of having the flame on the exterior of the tube I use a flame on the interior of the tube, and I obtain this result by feeding a self-burning mixture of gas and air to the interior of the tube, so that the flame may burn on the interior of the tube without any further addition of air to the mixture from the exterior of the tube. It becomes apparent at once that by this arrangement substantially a large part of the heat units in the flame are imparted to the tube of radiating refractory material. This is in sharp contrast to the older arrangement, in which the flame, being on the outside of the tube, imparted but a small fraction of its total heat units to the tube. It is also seen that the perforations in the tube fulfil a radically different function from those of the prior art. They do not act as passages for a gas which is to be ignited on the outside. Neither do they act as supply-apertures to admit air into the interior of the tube from the exterior. On the contrary, their primary purpose is to permit the escape to the exterior of the tube of the products of the combustion which is going on in the interior of the tube.

I may add, at this point, that it is possible to have the flame on the inside of the tube so large and under such pressure that this flame itself passes in jets through the apertures in the tube, which jets are visible on the exterior of the tube. In this case, however, it is to be remarked that the flame itself not only appears on the outside of the aperture, as in prior constructions, but is also located in each aperture itself, which was not the case in the prior construction. Since now by having a large number of apertures the surface of the walls of these apertures can be made very great, even greater than the outside surface of the tube, it follows that the flame on the inside of the tube not only heats the tube by its action against the inside surface of the tube, but also by its action upon the walls of these apertures, which are in the very body of the tube. It thus happens that the portion of the tube which is supplied with these apertures becomes more incandescent than the

rest of the tube, because the total wall surface of the apertures in the tube offers a very large field for action of the flame, and in this way a maximum amount of heat of combustion is absorbed by the refractory body; but even if the flame on the inside of the tube is not of sufficient size or burning under sufficient pressure to project as a flame through the apertures of the tube these apertures still serve an important function, in addition to that before referred to, of permitting the escape of the products of combustion from the flame which is burning on the inside of the tube. The walls of these apertures in such case serve to abstract much of the heat from the products of combustion escaping therethrough. It results that the products of combustion leave the tube at a temperature not much higher than the temperature of the tube itself, so that a large part of the heat of combustion of the flame in the inside of the tube is conveyed to the tube, which is the very object which my invention seeks to attain.

In a perforated tube of the character necessary for my invention the perforations are too small to permit of the admission of the proper amount of air to the inside of the tube to create a perfect combustion, the purpose of said apertures being, on the other hand, to permit of the escape of the products of combustion going on in the inside of the tube.

The arrangement of parts is such that the products of combustion of the flame on the inside of the tube are allowed to escape through the perforations in the tube, whereas no air on the outside of the tube is allowed in operation to pass to the inside of the tube through these perforations. The tubes constitute, in fact, substantially closed chambers. The perforations therein are so small as not to interfere with the substantially closed character of the chamber. In fact, the size of these perforations necessarily bears a relation to the pressure and volume under which the self-burning mixture of air and gas to be hereinafter described is supplied to the interior of the tube, the perforations never being large enough for a given condition of supply to permit any other operation than that stated. In order that a flame may burn on the inside of such a tube, it is necessary that a self-burning mixture be employed—that is to say, a mixture of air and gas which burns freely in a closed chamber where there is no admission of outside air. In order to obtain such a self-burning mixture, I may employ any of the known devices for this purpose. I prefer, however, to use a Bunsen-burner type, now commonly called a "Kern" tube, after the name of its inventor, which tube is fully described in Letters Patent of the United States, No. 574,805, dated January 5, 1897, and No. 611,914, dated October 4, 1898. Broadly speaking, such a Kern tube consists of an inlet of gas at one end of the tube and an inlet for the air at the same end of the tube, just as in any other Bunsen burner. The lowest end of the tube, however, is flared inwardly to constitute a mixing-chamber, and the upper end of the tube is flared outwardly, at an angle varying within very narrow limits, to constitute a suction-chamber. This suction-chamber leads to the common supply for a series of perforated tubes of refractory material which constitutes my gas-stove. Now in order that the volume of gas passing to each one of the separated perforated tubes of refractory material, which are at different distances from the end of the suction-chamber of the Kern tube, may be the same, I employ in connection with the Kern or other supply tube for the self-burning mixture the combination of a cone and a perforated cylinder surrounding the same, the apex of the cone being directed toward the supply-tube. The perforations in the cylinder are connected with the refractory tubes constituting the stove. In this manner the annular passage between the cone and the perforated cylinder surrounding it is continually decreasing in section, so that the lost pressure of the air and gas mixture at the end of the cylinder farthest removed from the supply-tube is made up by the diminished section of the space between the cylinder and the outside of the cone at this point. It follows that air escapes from the perforations in the cylindrical body surrounding the cone in uniform volume at all points of the cylinder.

I have before referred to the fact, which practical experience shows is a usual fact, that there is always a slight excess of flame which passes in jets through the upper holes of the perforated tubes of refractory radiating material. It is also likely to happen that such portion of the flame is not the result of an absolutely perfect combustion, although the combustion is very nearly perfect. Since in the practical application of my invention I use a number of these perforated refractory tubes side by side with a narrow space between, it happens that the outside air which circulates between the tubes comes in contact with these jets of flame issuing from the perforations of the tube and effects a complete combustion. This addition of air I have found to effect a complete combustion, which reduces the smell often observed in gas-stoves when combustion is incomplete.

In the drawings, Figure 1 is a cross-section of a tube, showing the principle of the invention. Fig. 2 is a lateral cross-section of a gas-stove embodying my invention. Fig. 3 is a side elevation, with parts in longitudinal section, of the same. Fig. 4 is a top plan view of the same. Fig. 5 is a vertical cross-section of a circular form of stove embodying my invention, and Fig. 6 is a top plan view of the same.

In Fig. 1 of the accompanying drawings I

illustrate the principle upon which my invention is based. There is there shown a cylindrical tube *a*, of refractory radiating material, such as fire-clay, closed at the top. The side of the tube is supplied with small perforations *h*. This tube or cylinder is placed on a nozzle or burner-tip *b*, which is the outlet of the self-burning mixture of air and gas. The self-burning mixture is introduced by the pipe *c*. If the self-burning mixture at the top of the nozzle *b* is lighted, it burns on the inside of the tube *a*, as contradistinguished from the outside of the tube. Thus the products of combustion escape through the perforations *h* in contradistinction to having the unburned gas pass through these perforations to become ignited on the outside of the tube. To obtain the best effects, the inside diameter of the tube should not be larger than the diameter of the flame.

As has been above explained, the heat evolved can only be absorbed by the walls of the refractory tube, except that part which escapes with the products of combustion through the perforations *h*, which are arranged on one side only of the refractory tube. Since, however, the walls of these apertures *h* offer a very large surface to the flame, the part of the tube in which these apertures are found becomes more incandescent than the rest of the tube. In this way a maximum amount of the heat of combustion is absorbed by the refractory body. As it is usually desirable to throw the heat in a particular direction, I place the perforated side of the tube in the direction in which it is desired to throw the heat.

Coming now to a description of the actual stove shown in Figs. 2, 3, and 4, I may say that this stove, as illustrated in these figures, shows a series of tubes arranged in a straight line. Such a stove would be desirable for use in a hearth or an open fireplace. There is a base-plate *s*, supplied with thimbles *s'*, upon which are fixed the nozzles or burner-tips *b*, which are also made of refractory material. The tubes *a*, of refractory radiating material, have their lower ends placed upon the upper ends of the nozzle *b* and have projections *a'* of segmental or other proper shape projecting from and preferably in one piece with their upper ends, which projections pass through apertures of similar shape, but of somewhat larger size, in a top plate *k*. These tubes *a* are placed side by side, but without touching, leaving a narrow space between each pair. The top and bottom plates *s k* are connected by a reflector *m*, which is made of polished or enameled metal and is placed behind the tubes *a*. The reflector *m* manifestly has the effect of throwing back upon the tubes *a* the heat radiated on the side directed to the reflector, so that it is utilized. Below the base-plate *s* there is a Kern tube comprising a gas-inlet *t*, an air-inlet t^3, a contracted mixing-chamber *t'*, and an expanded suction-chamber t^2. As has been fully explained in the patents mentioned in a prior portion of this specification, this Kern tube serves to supply a perfect mixture for burning purposes of air and gas; but I may say once for all at this point that although I prefer a Kern tube I regard any other means of feeding a self-burning mixture of air and gas as within the present invention. The discharge end of the Kern tube is connected with a perforated cylindrical diaphragm *r*, of perforated metal or wire-gauze, through the perforations in which the gas supplied by the Kern tube pass into a cylinder *g*, surrounding the perforated diaphragm. This cylinder *g* has apertures connecting with the nozzles *b*.

To effect a uniform distribution of the air and gas mixture to the several nozzles *b*, I place inside the perforated cylindrical diaphragm *r* a cone *p*, the point of which is turned toward the Kern tube. This cone diminishes the section of the annular passage for the air and gas as you get away from the discharge end of the Kern tube; but as you get away from the discharge end of the Kern tube it is readily apparent that gas having escaped from these apertures in the perforated diaphragm *r* nearer the Kern tube there is a tendency for a reduction in pressure of the gas within the cylindrical diaphragm at points away from the Kern tube. Since, however, the effective cross-section of this cylindrical diaphragm has been reduced at the points thus removed, it follows that the pressure of the gas within the cylindrical diaphragm remains constant at all points and that the self-burning mixture of air and gas escapes in the same proportion through the various apertures of the perforated diaphragm *r*, no matter what may be the distance of those apertures from the Kern tube.

In the gas-stove shown in Figs. 5 and 6 the tubes *a* are arranged in a circle. They rest upon a circular row of nozzles *b* and are kept vertical by the top plate *k*, which has holes of the same shape as the projections *a'* on the tops of the tubes *a*. At the center of the circle I place a circular reflector *m*. It will be seen at once that except for the difference in shape this gas-stove, as thus far described, does not differ from the gas-stove of Figs. 2, 3, and 4; but there is a difference in the manner in which the self-burning mixture of air and gas is distributed. Instead of having a common perforated cylindrical diaphragm *r* for all of the tubes, as shown in Fig. 3, I employ a separate cylindrical perforated diaphragm *r* for each tube *a*. Into these cylindrical perforated diaphragms *r* I introduce cones *b*, with their points directed to the top. The cylinders *r* are all contained in a common chamber *g*, which is supplied with the self-burning mixture of air and gas through the Kern or other Bunsen tube t^2 *t'* *t*.

It will be seen that the cone *p* serves to keep

up a uniform supply of the air and gas mixture to each cylindrical diaphragm, since it increases the section of the diaphragm in the same measure as the quantity of gas and air mixture at the point of the diaphragm referred to increases. Thus at the top of the cylindrical perforated diaphragm *r* in Fig. 5 you must provide a space not only for the self-burning mixture passing into the cylindrical diaphragm *r* through the perforations of that diaphragm at the top, but you must also supply a space in the cylinder for such of the self-burning mixture as has already passed into the cylinder from apertures in the bottom and having passed up the cylinder is now reaching the top. This space is given and in the proper proportion by the decreasing section of the cone *p*.

The radiating-stoves, as described above, may also be arranged in such a way as to superheat the air in rooms. They may also be connected with flues to take off the products of combustion into a chimney. In connection with the latter I employ a well-known arrangement which consists in allowing the products of combustion to pass through various flues round which the air of the room passes and is heated and after being heated finds an outlet through various holes into the room again. These heating apparatus may also be used for cooking purposes, and they are especially serviceable for grilling and roasting.

In the term "gas" I naturally include vapors of volatile liquids, such as alcohol, naphtha, and the like. My system applies equally well to them.

The nozzle *b*, it will be observed, acts as burner-tips for supporting the flames of the self-burning mixture within the tube.

What I claim is--

1. The method of obtaining in the form of radiant heat a large number of heat units developed by the combustion of gas, which consists in burning a self-burning mixture of the gas and air on the inside of a substantially closed chamber of refractory radiating material provided with small perforations, and of causing the products of combustion to escape through the perforations, whereby the walls of the chamber are heated both by the direct contact of the flame with the inside of the chamber and by the contact of the products of combustion with the walls of the perforations, substantially as described.

2. The method of obtaining, in the form of radiant heat, a large number of heat units developed by the combustion of gas, which consists in burning a self-burning mixture of gas and air on the inside of a substantially closed chamber of refractory radiating material provided with small perforations, and of causing the products of combustion to escape through and a portion of the flame to pass through the perforations, whereby the walls of the chamber are heated both by the direct contact of the flame with the inside of the chamber and by the contacts of the products of combustion and of the flame with the walls of the perforations, substantially as described.

3. The method of burning a self-burning mixture of gas and air on the inside of a substantially closed chamber of refractory, radiating material, provided with small perforations, under such pressure as will prevent the entrance of air through the perforations to the interior of the tube, whereby there is developed a relatively large number of heat units in the form of radiant heat, substantially as described.

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

CHARLES CLAMOND.

Witnesses:

WILLIAM MOORE ROBINSON,

EDWARD P. MACLEAN.