(No Model.) 2 Sheets—Sheet 1.

O. KERN.

INCANDESCENT BURNER.

No. 574,805. Patented Jan. 5, 1897.

Fig. 1.

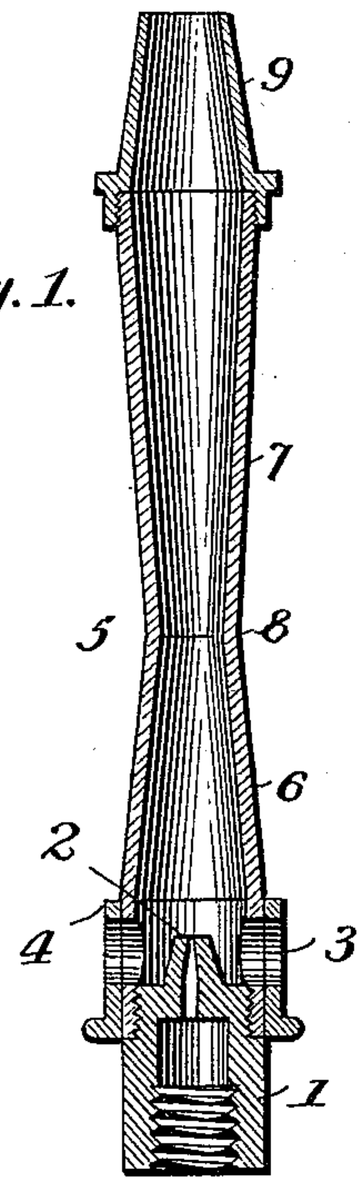


Fig. 2.

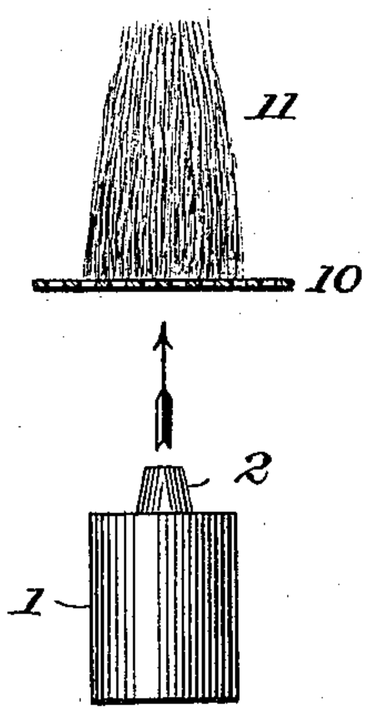


Fig. 3.

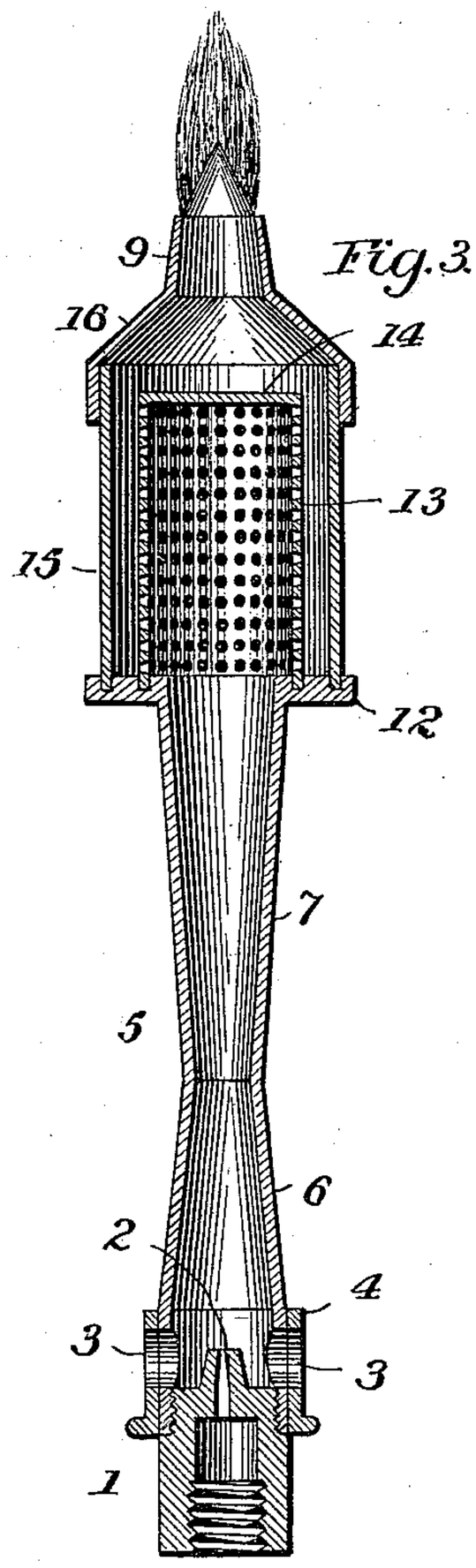


Fig. 4.

Fig. 5.

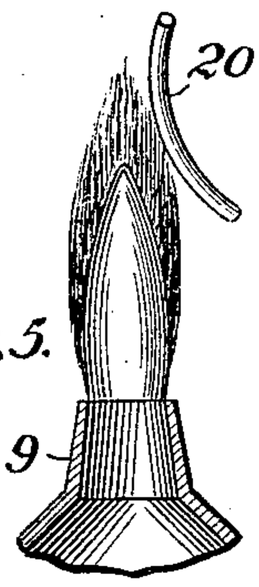


Fig. 6.

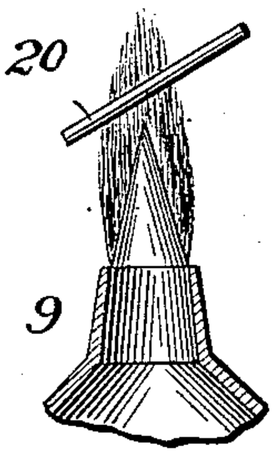


Fig. 7.

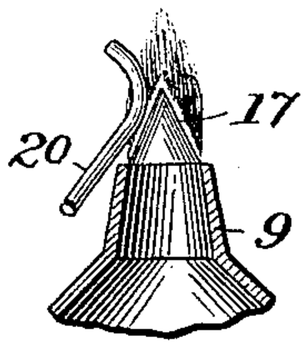
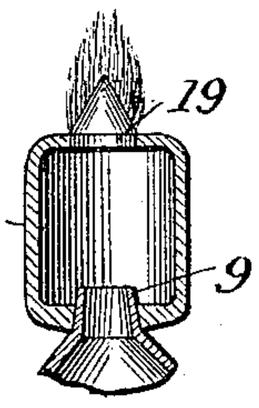


Fig. 8.



Witnesses
J. G. Hinkel
C. E. Marshall

Fig. 10.

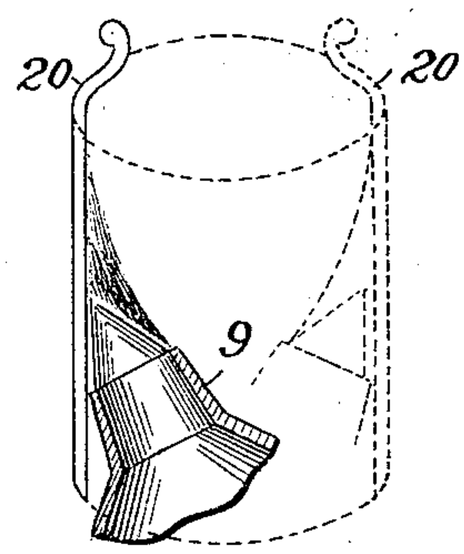
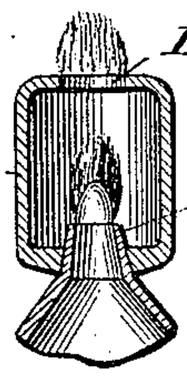


Fig. 9.



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(No Model.) 2 Sheets—Sheet 2.

O. KERN.

INCANDESCENT BURNER.

No. 574,805. Patented Jan. 5, 1897.

Fig. 11.

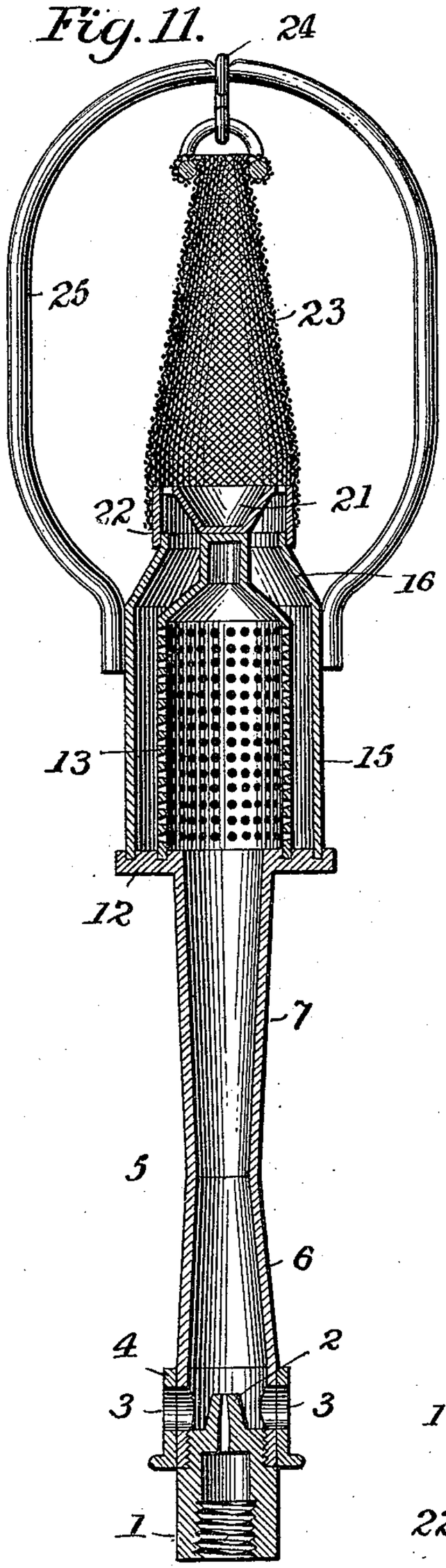
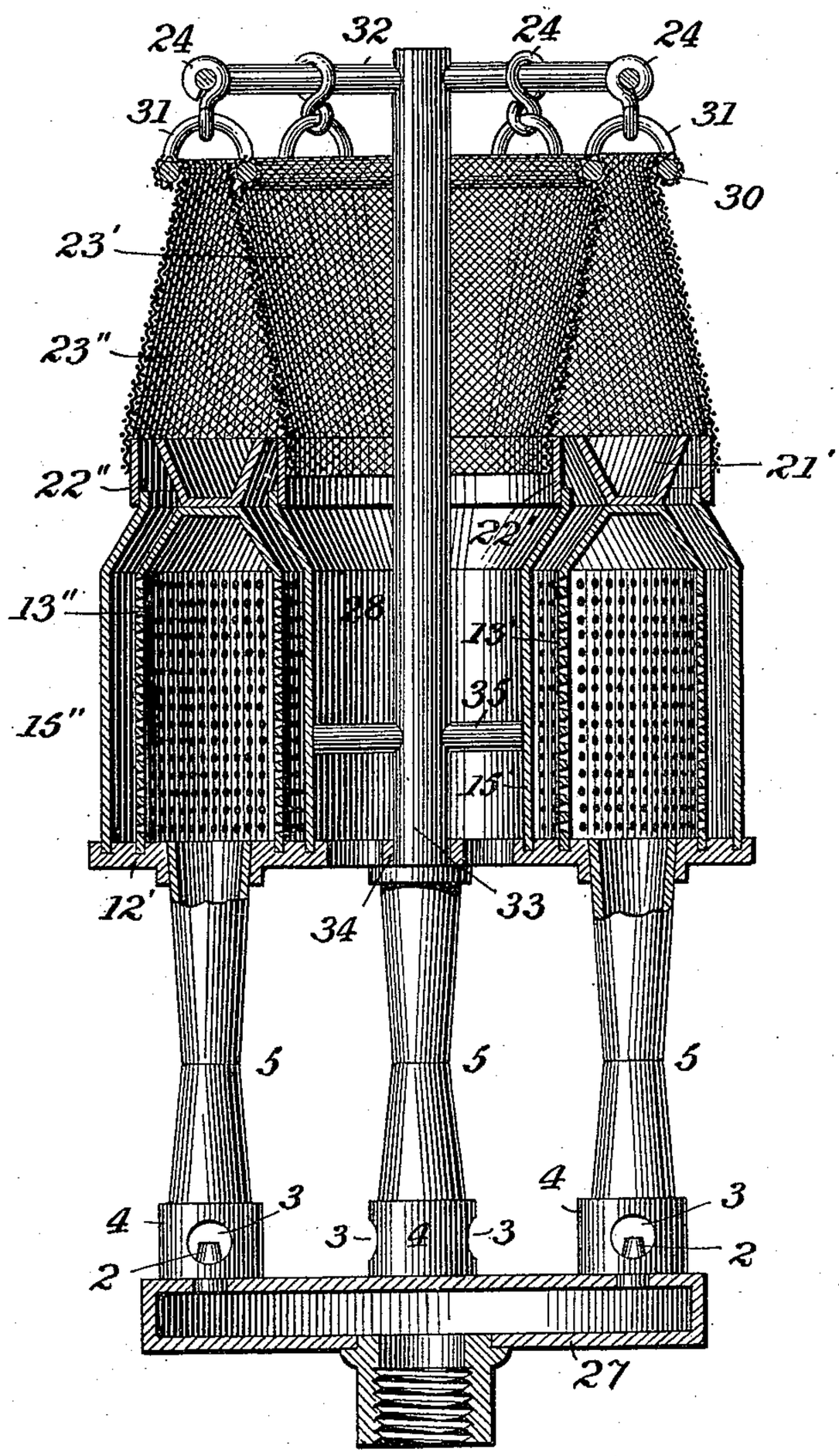


Fig. 13.



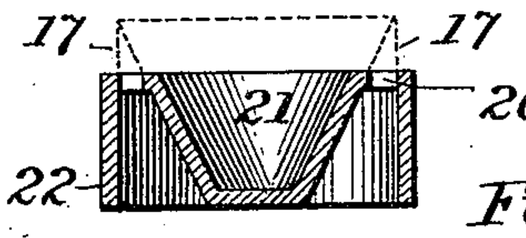
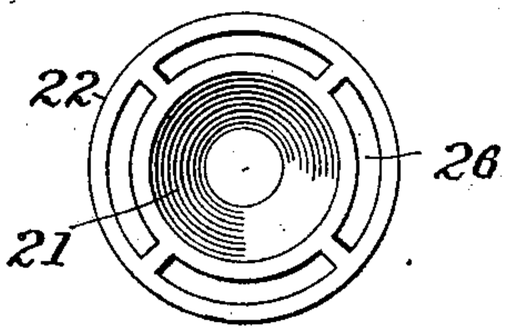


Fig. 12.



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Attorney

UNITED STATES PATENT OFFICE.

OTTMAR KERN, OF PARIS, FRANCE.

INCANDESCENT BURNER.

SPECIFICATION forming part of Letters Patent No. 574,805, dated January 5, 1897.

Application filed September 8, 1896. Serial No. 605,180. (No model.)

To all whom it may concern:

Be it known that I, OTTMAR KERN, a citizen of the United States of America, and a resident of Paris, in the Republic of France, have invented certain new and useful Improvements in Incandescent Burners, of which the following is a specification.

My invention has reference to improvements in incandescent gas-burners of the kind which originally became known as the "Clamond" incandescent gas-burners, and which latter have been variously improved by numerous inventors, and particularly by Auer von Welsbach; and the object of the invention is to produce a burner that shall raise the refractory mantle or hood to a higher degree of incandescence than has heretofore been accomplished with the same amount of illuminating-gas and at the ordinary pressures at which gas is ordinarily delivered, and this without the use of an artificial draft, such as is ordinarily produced by glass chimneys, and sometimes by mechanical blowers. This object I realize by constructing a burner in which the admission of air to the gas is so adjusted that, in the mixture obtained, the amounts of oxygen and hydrogen are practically in the proportion of the chemical equivalents of these two gases. Thereby the mixture becomes self-burning, that is to say, it will burn in a closed chamber from which the external air is excluded. This self-burning mixture is, by my improved burner, caused to issue from the burner-tip under greater pressure than that furnished by the normal pressure of the gas-distributing system and with greater speed than that with which the flame can propagate itself through the mixture, whereby the flame is prevented from burning backward and is thus steadily maintained above the exit-opening of the burner-tip. Within the flame of such self-burning mixture there is a zone of superior incandescence, which zone I call the "hyperincandescent" zone, and which is very much hotter than the rest of the flame. My burner is so arranged that the refractory filament or mantle of filaments is exceedingly close to or immersed in this hyperincandescent zone, whereby the filament or mantle of filaments also becomes hyperincandescent, and thus furnishes, with the same consumption of gas, a more intense light, or the same amount of light with a less consumption of gas. All this will more fully appear from the following detailed description, in which reference is made to the accompanying drawings, which form a part hereof, and in which—

Figure 1 is a longitudinal section of a Bunsen burner modified in accordance with my invention. Fig. 2 shows, partly in elevation and partly diagrammatically, an experimental apparatus used for determining one of the dimensions of the improved Bunsen burner. Fig. 3 is a longitudinal section of the improved Bunsen burner provided with a gas-mixing chamber; Fig. 4, a cross-section of a portion of the same. Figs. 5, 6, 7, 8, and 9 show burner-tips and the flames produced by various gas mixtures. Fig. 10 is a diagram illustrating hypothetically the utilization of the principles of my invention; Fig. 11, a longitudinal section of a complete incandescent gas-burner constructed in accordance with my invention; Fig. 12, a central section and plan view, respectively, of the burner-tip used in the construction shown in Fig. 11; and Fig. 13 is a central section of a duplex incandescent gas-burner constructed in accordance with my invention.

Like numerals of reference indicate like parts all throughout the drawings.

Referring now particularly to Fig. 1, there is shown a burner of the Bunsen type, but modified in accordance with my invention in one particular respect. There is the ordinary gas-inlet 1, with its nozzle 2 screwed into the Bunsen pipe 5, as usual. The pipe has the customary air-ports 3 and the throttle-ring 4, whereby the admission of air can be regulated at will. The distinguishing feature of this pipe 5 is that it is formed to present two cone frusta 6 7, joined at their smaller bases at 8, the lower cone frustum being shorter than the upper. A pipe or tube of this general construction, but with its parts differently proportioned, has become noted in hydraulics as "Venturi's" pipe. It is sometimes used as a nozzle through which water or other fluids are discharged, and when so used increases the amount of the discharge. I have found that when this double-cone pipe is used in a Bunsen burner it operates to increase the quantity of air forced through the pipe, produces a more thorough mixture of

the air and gas, and at the same time delivers the mixture at a much higher pressure than the ordinary Bunsen burner does. The lower cone frustum 6 I call the "mixing-cone," since within the same the air and gas are primarily mixed. The upper cone 7 I call the "suction-cone," since its function is to accelerate the issue of the mixture at a narrow section 8. I have found that the best results are obtained when the angle of divergence of the suction-cone is between five degrees and seven degrees. When the angle of divergence is increased beyond seven degrees, the suction diminishes, and almost disappears when the angle becomes greater than ten degrees.

The angle of convergence of the mixing-cone may be varied between wider limits, but I have found it best not to make this angle larger than ten degrees. The length of the mixing-cone must be such as to permit the air and gas to be well mixed before the mixture reaches the narrow section 8, and this length of the mixing-cone is determined experimentally in the following manner: Over a jet of gas issuing vertically upward from a nozzle 2 (see Fig. 2) I arrange a wire-gauze 10 horizontally and so that its distance from the nozzle-opening can be adjusted. I then light the mixture of air and gas above the gauze, and by the appearance of the flame it is noticed that the quality of the mixture varies with the distance of the gauze from the nozzle. This distance is then adjusted until the flame 11 shows the characteristic of a self-burning mixture, as hereinbefore explained, and which will be dwelt upon more in detail farther on. The proper distance thus determined is then used as the measure of the length of the mixing-cone 6.

I have found that the suction-cone, in order to obtain the best results, should be about twice as long as the mixing-cone. In practice, however, it is not necessary to make it quite so long, since it may be considerably shorter and still produce sufficient suction for the purposes of my improved burner; but while the length of the suction-cone may be varied considerably without appreciably affecting the suction effect the same thing is not true of the angle of divergence of that cone, since, as above stated, this angle should be, in order to obtain the best effect, between the limits of five degrees and seven degrees and should never exceed ten degrees.

As an illustration of the dimensions of a burner constructed upon these principles, let us assume that the burner is to consume eighty liters of gas per hour. In that case the narrow section 8 of the pipe 5 should be seven millimeters, the length of the mixing-cone three centimeters, and the length of the suction-cone six centimeters. Now the length of the suction-cone might be reduced to five centimeters and might be made even shorter and still have sufficient suction effect. The angle of divergence of the suction-pipe, however, should always be within the limits of five degrees and seven degrees, since any reduction of this angle below five degrees or any increase of the same above seven degrees reduces the suction effect very considerably. It is therefore not sufficient that the Bunsen tube be shaped so that its bore defines two truncated cones joined at their small bases, since this general construction would be altogether useless for the purposes of my invention unless the proportion of dimensions above indicated be carefully observed.

If a Bunsen tube is constructed as thus far described and without the nozzle 9, (shown in Fig. 1,) and the gas mixture issuing from the flaring opening of the suction-pipe is ignited, it will not maintain a flame at and above the opening, since the velocity of the gas under ordinary pressure is not sufficient to prevent it from burning back downwardly into the tube. In order to prevent this, the nozzle 9, by which the exit-opening is reduced, is applied, and with a burner thus constituted the flame will be maintained at and above the nozzle.

Owing to the fact that the air and gas are forced together through the narrow section 8 of the pipe 5 from the mixing-cone into the suction-cone, a tolerably intimate mixture is obtained; but in order to still more intimately mix the air and gas the construction shown in Fig. 3 is employed. In this case the upper end of the suction-cone 7 is formed with a flange 12, having two concentric grooves, as shown. Into the inner groove is fitted the lower edge of a hollow perforated cylinder 13, the upper end 14 of which is solid. The perforations of the cylinder are preferably conical, flaring inwardly, as indicated in Fig. 4, and while these perforations are very small the aggregate of their cross-sections must be large enough to offer no appreciable resistance to the passage of the gas mixture. Into the outer groove in the flange 12 is fitted a hollow cylinder 15, which, together with the perforated cylinder or diaphragm 13, constitutes a mixing-chamber. The cylinder 15 is surmounted by a cap 16, which terminates in the nozzle 9. The gas mixture issuing from the suction-cone 7 passes through the perforations of the diaphragm 13, whereby the mixture is made more perfect and then issues by the nozzle 9.

An investigation of the flame under various adjustments of the throttle-ring shows the following results: When the throttle-ring is turned so as to close the air-admission ports 3 completely, the flame produced has the shape and characteristic of the flame of an ordinary Bunsen burner when the air-ports of the same are closed; but when now the air-ports are gradually opened more and more, in three successive steps, the appearances of the flame become as indicated in Figs. 5, 6, and 7. First, with a slight admission of air the flame is long, as shown in Fig. 5, blue in color, with a central cone of a darker blue;

second, by increasing the admission of air the size of the flame is diminished, the central cone assumes a greenish hue, and is surrounded by a blue envelop; third, when the port-holes are entirely opened, the flame becomes much reduced in size, the central cone becomes quite small, loses its greenish color, and appears to be enveloped by a violently-agitated zone of a whitish hue. This is indicated in Fig. 7, where the white zone is marked by the reference-numeral 17. The peculiar properties of the flames thus produced may be investigated in a variety of ways. In Figs. 8 and 9 there is shown a chamber 18, closely fitted over the burner-tip 9, with an opening 19 for the escape of the gas mixture. If the gas mixture is such as has been discussed with reference to Figs. 5 and 6, that is to say, when only a small or a moderate quantity of air is mixed with the gas, the mixture will burn at the opening 19 of the chamber 18, as shown in Fig. 8, that is to say, it will not burn until after air from the surrounding atmosphere has been added to the mixture; but when the gas mixture is such as has been discussed with reference to Fig. 7 and when the mixture is ignited at the opening 19, the flame will immediately jump back and burn at the nozzle 9, although a small flame may still remain at the mouth of the opening 19. This proves that the mixture produced, when the ports of my improved burner are wide open or properly adjusted, is a self-burning mixture, and this is the kind of mixture of air and gas which must be produced in my improved burner in order to accomplish the results aimed at. The small flame which still remains at the opening 19 is due to a small portion of gas which is not burned at the burner-tip 9, and this indicates that the mixture is not absolutely self-burning, that is to say, that there is not yet sufficient air mixed with the gas. Now by the admixture of additional quantities of air the small flame at the opening 19 may be reduced to a minimum, thus showing that the mixture is more and more approaching that condition in which it is absolutely self-burning.

It will now be understood that for different qualities of lighting-gas and for different pressures the air-ports must be adjusted differently in order to produce a self-burning mixture, and the burner shown in Fig. 3, with the addition of the top chamber 18, is a convenient means for determining in each case the required adjustment of the throttle-ring.

The heating capacities of the different portions of the flames produced by the three different adjustments of the throttle-ring, contemplated with reference to Figs. 5, 6, and 7, can be examined by the introduction into the flames of refractory filaments, as indicated in Figs. 5, 6, and 7, where such filaments are shown at 20.

In the case of the flame indicated in Fig. 5 it is found that the filament reaches the highest degree of incandescence when it is placed within the outer part and near the outer surface of the flame, as indicated in the drawings, and not when it is immersed into the interior of the flame. This shows that the most perfect combustion occurs where the gas mixture comes in contact with the surrounding atmosphere, from which it receives additional oxygen, while the combustion within the flame is comparatively very imperfect. With such flame as is indicated in Fig. 6 it is found that the filament is raised to the same degree of incandescence in all parts of the flame, from which it must be concluded that the degree of combustion is the same all throughout. When comparing the degree of incandescence of the filament 20, which just touches the outer surface of the flame shown in Fig. 5, with the degree of incandescence of the filament immersed in the flame shown in Fig. 6, it is found that these incandescences are about the same, that is to say, the combustion in the case of Fig. 6 all throughout the flame is of the same degree as the combustion on the outer surface of the flame shown in Fig. 5. If now the flame produced by the self-burning mixture, as represented in Fig. 7, is explored with a refractory thread, it is found that it is raised to an exceedingly high degree of incandescence in the hyperincandescent zone 12, while in all other parts of the flame the incandescence of the thread is comparatively low. These observations conclusively show that the highest degree of incandescence of a refractory mantle would be obtained by exposing it to the heating effect of the hyperincandescent zone of a self-burning mixture of air and gas, and it will presently be shown how this is accomplished.

Suppose a burner, such as described, with an ignited self-burning mixture issuing from the same be inclined, as shown in Fig. 10, so as to make the side of the hyperincandescent zone along one line (the generatrix) vertical, and suppose that a refractory thread 20, also extending vertically, be adjusted either near to or actually touching or immersed in the vertical portion of the hyperincandescent zone. Then the whole flame will take the shape indicated in Fig. 10, and a considerable portion of the refractory thread will be raised to hyperincandescence. Supposing now that this whole hypothetical structure be rotated about a vertical axis, as diagrammatically indicated, it is evident that the hyperincandescent thread will trace in space the surface of a cylinder, and if rotated fast enough the eye of the observer will be impressed as by a hyperincandescent cylinder. These considerations led to the following construction of my improved incandescent gas-burner, the simplest form of which is shown in Fig. 11: In this case there is fixed upon the top of the diaphragm 13 a conically-flaring cup 21, while upon the cap 16 of the cylinder 15 is fitted a short cylindrical tube 22, and the

dimensions of these two parts are such as to form between their upper edges an annular nozzle from which the gas mixture issues in such direction that when ignited the outer surface of the hyperincandescent zone will be vertical, or nearly so, while the inner surface of that zone will be inclined outwardly. A mantle 23, of refractory threads, is fitted over the short cylinder 22 and is suspended at its upper end from a copper hook 24, fitted to a bail 25, also of copper or other good conductor of heat and which is secured to the exterior cylinder of the mixing-chamber. A burner thus constructed does not require a draft of air along the surface of the mantle of refractory threads, since the combustion of the self-burning gas mixture is perfect without resort to such artificial draft. No glass chimney therefore need be employed. The hyperincandescent zone of the flame of the self-burning gas mixture does extend upwardly, but not throughout the whole length of the mantle. A portion of the length of the mantle therefore only will be raised to hyperincandescence, while the upper portion of it will be heated less, but still to a high degree of incandescence, and the effect of the whole will be that of an extremely highly incandescent body much higher than is obtained by the ordinary incandescent gas-burners.

It is evident that the upper portion of the bail 25 will be heated considerably by the ascending jet, and, being connected with the external cylinder of the mixing-chamber, it will heat the gas within the same by conduction, which is an additional advantage.

Instead of making the burner-tip in two concentric parts 21 22 the tip may be stamped out of one sheet of metal and have the form indicated in Fig. 12, in which case, however, the flame will not be completely annular, since the gas mixture will issue only by the sectoral ring-openings 26 or by a number of holes, which may be circularly arranged. In each case, however, whatever be the shape of the burner-tip opening or openings the hyperincandescent zone or zones 17 of the flame or flames will have the shape which is indicated in Fig. 12, that is to say, one side will be vertical and the other inclined outwardly.

For a greater amount of light the duplex structure of incandescent burner shown in Fig. 13 may be employed. In this case there are a number of Bunsen pipes receiving the gas from a gas-chamber 27, upon which they are mounted. The upper ends of these Bunsen pipes are fitted into a metal ring 12′, which thus forms a common flange for the upper ends of the suction-cones of the modified Bunsen pipes. Into four cencentric grooves formed in the upper surface of the ring 12′ is fitted the annular mixing-chamber 28, composed of two concentric cylindrical perforated diaphragms 13′ 13″ and two concentric cylinders 15′ 15″, both being capped, as shown. In this case the burner-tip is composed of two concentric cylinders 22′ 22″, fitted upon the cap of the cylinders 15′ 15″, and an annular flaring trough 21′, fitted upon the cap of the diaphragm. In this manner there are in reality produced two concentric annular burner-tip openings, which would furnish two concentric annular flames, each having a hyperincandescent zone. Upon the short outside cylinder 22″ is fitted the upwardly-converging mantle 23″, and within the inner short cylinder 22″ is fitted the upwardly-diverging mantle 23′ of refractory threads. These two mantles, therefore, together inclose an annular space, and both the outer and inner walls are exposed to the heating effect of the hyperincandescent zone of the flames of the self-burning gas mixture. The mantles may be mounted upon rings 29 30, joined by bails 31, which in turn may be suspended from hooks 24, descending from arms 32, radiating from a rod 33, which rises from a cross-piece 34 of the ring 12′. A number of short radial arms 35, extending from the vertical rod 33, are connected with the inner solid wall of the mixing-chamber. All these connections are made of good conductors of heat, so that the gas in the mixing-chamber is heated preparatory to its ignition.

It will be understood that the details of construction of my improved incandescent gas-burner may be varied in a great number of ways without departing from the fundamental principles of my invention; that, therefore, I am not limited to the exact details of construction herein shown and described, and that I am in no way limited to the use of mantles of any particular refractory material or composition of such materials.

Having now fully described my invention, I claim, and desire to secure by Letters Patent—

1. The method of raising a refractory body to a high degree of incandescence, which consists in subjecting the refractory body to the heating effect of the hyperincandescent zone of the flame of a self-burning mixture of air and gas, substantially as described.

2. The method of raising a refractory body to a high degree of incandescence, which consists in maintaining such body, as nearly as practicable, in superficial contact with or within the hyperincandescent zone of the flame of a self-burning mixture of air and gas, substantially as described.

3. The method of giving high illuminating power to a mantle or hood of refractory material, which consists in maintaining the hyperincandescent zone or zones of a flame or flames of a self-burning mixture of air and gas, as nearly as practicable, in superficial contact with a part or parts of such mantle or hood, substantially as described.

4. The method of giving high illuminating power to a mantle or hood of interlaced threads of refractory earths, which consists in subjecting the lower portion of such mantle or hood to the heating effect of the hyperincandescent zone or zones of a flame or flames

of a self-burning mixture of air and gas, substantially as described.

5. The method of giving high illuminating power to an annular mantle or hood of interlaced threads of refractory earths, which consists in directing the hyperincandescent zone of an annular flame of a self-burning mixture of air and gas, as nearly as practicable, into contact with a portion of the inner surface of said mantle or hood, substantially as described.

6. An annular gas-burner tip, designed for the consumption of a self-burning mixture of air and gas, composed of an exterior cylindrical tube and a concentric interior, upwardly and outwardly widening, conical tube, whereby the outer surface of the hyperincandescent zone of the flame forms, approximately, as a vertical cylinder, substantially as described.

7. In an incandescent gas-burner, designed for the consumption of a self-burning mixture of air and gas, the combination of an annular burner-tip constructed to shape the outer surface of the hyperincandescent zone of the flame into an approximately vertical cylinder, with a mantle or hood of refractory threads, concentric with such zone and, as nearly as practicable, in superficial contact with the same, substantially as described.

8. An incandescent gas-burner, composed of two concentric mantles or hoods of threads of refractory material, and two concentric annular burner-tips, each directing an annular flame into heating proximity to one of the mantles, substantially as described.

9. An improved Bunsen burner for producing a self-burning mixture of air and gas, composed of an upwardly-converging hollow mixing-cone, into which the air and gas are admitted, and an upwardly-diverging hollow suction-cone, having an angle of divergence of not more than ten degrees, substantially as described.

10. An improved Bunsen burner for producing a self-burning mixture of air and gas, composed of a hollow, upwardly-converging truncated cone, whose apex angle is not greater than ten degrees, and into which the air and gas are admitted; and a hollow, upwardly-diverging truncated cone whose apex angle is between the limits of five degrees and seven degrees, substantially as described.

11. An improved Bunsen burner, composed of an upwardly-converging, hollow mixing-cone, of such determined length as to mix the admitted air and gas into a self-burning compound, and an upwardly-diverging truncated hollow suction-cone of suitable length, and having an apex angle preferably between five degrees and seven degrees, and not more than ten degrees; the two cones being joined at their smaller bases, substantially as described.

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

OTTMAR KERN.

Witnesses:
EDWARD P. MACLEAN,
PAUL SAUTREAU.