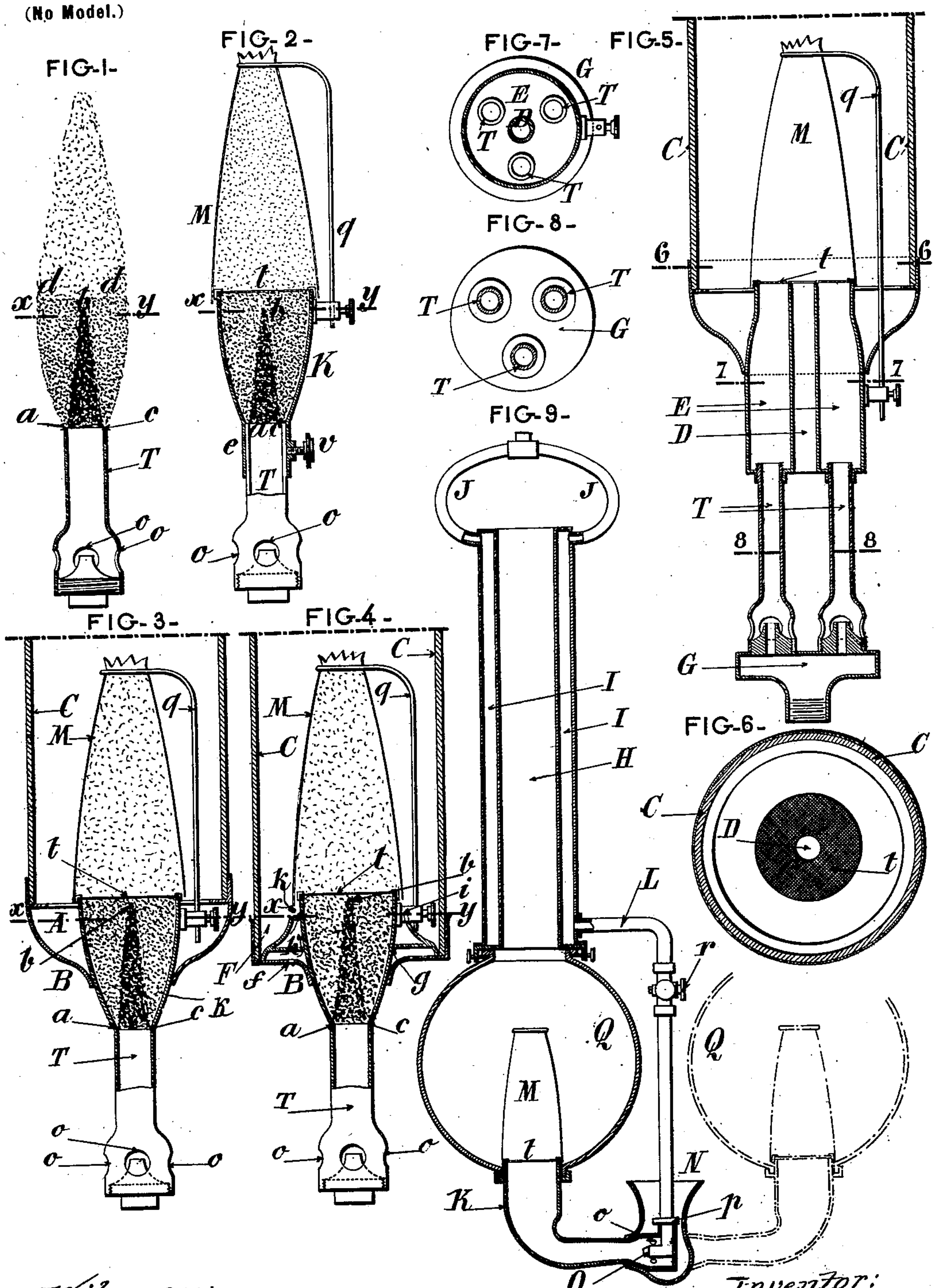
No. 673,705. Patented May 7, 1901.

L. DENAYROUZE.

BUNSEN BURNER FOR INCANDESCENT GAS LIGHTS.

(Application filed July 8, 1897.)

(No Model.)



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UNITED STATES PATENT OFFICE.

LOUIS DENAYROUZE, OF PARIS, FRANCE.

BUNSEN BURNER FOR INCANDESCENT GAS-LIGHTS.

SPECIFICATION forming part of Letters Patent No. 673,705, dated May 7, 1901.

Application filed July 8, 1897. Serial No. 643,794. (No model.)

To all whom it may concern:

Be it known that I, LOUIS DENAYROUZE, a citizen of the Republic of France, residing in Paris, France, have invented certain new and useful Improvements in Bunsen Burners for Incandescent Gas-Lights, of which the following is a specification.

This invention has been patented in France, No. 259,985, dated September 25, 1896; in Belgium, No. 123,759, dated September 28, 1896; in Austria, No. 46/4,466, dated November 4, 1896; in Italy, No. 42,772, dated October 4, 1896; in Great Britain, No. 28,491, dated December 12, 1896, and in Switzerland, No. 14,035, dated January 27, 1897.

My invention has reference to improvements in gas-burners with refractory mantles, such as the Welsbach mantles, its object being to obtain a more brilliant light with a smaller consumption of gas, and I accomplish this result by supplying to the mantle an intimate mixture of gas and air prepared by novel means.

Experience has shown that to secure a light of exceptional brilliancy from an incandescent mantle it is necessary that the gas and air shall be thoroughly mixed before ignition. In my former devices I have used an external motive power for actuating an agitator with paddles for thoroughly mixing the gas and air. By continued experiments I have demonstrated that a mechanical device is not indispensable for effecting the intimate mixture required. The essentials of complete success in incandescent gas-lighting are that there shall be an absolutely intimate mixture of the gas and air, with a proportion of one volume of gas to approximately four or five volumes of air, varying according to circumstances, that the pressure of the mixture at the burner shall be very small, and that the mixture shall have sufficient velocity when discharged from the burner. These conditions are successfully fulfilled by my present invention. Furthermore, my present invention is designed as an improvement on the type of burners in which the original pressure of the gas is used to produce by suction or driving power actuating a mixing device a more intimate mixture. Burners of this type if not supplied with gas at a sufficient excess of pressure to actuate the mixer are obviously worse than if there were no mixer, the latter acting to obstruct the flow. In my burner the infinitesimal jets of air and gas move in parallel vertical lines, which is the condition of most rapid flow for a given pressure.

The nature of my invention will be best understood when described in connection with the accompanying drawings, in which—

Figure 1 represents a vertical section of an ordinary Bunsen burner and of the flame produced by the same. Fig. 2 is a vertical section of one form of my improved burner. Fig. 3 is a vertical section of another construction thereof. Fig. 4 is a vertical section of a further development thereof. Fig. 5 is a vertical section of a multiple burner constructed according to the principle of my invention. Figs. 6, 7, and 8 are horizontal sections on the lines 6 6, 7 7, and 8 8, respectively, Fig. 5. Fig. 9 is a vertical section of a further development of my apparatus.

Before describing the mechanical construction of my improved burner in its different forms I will proceed to explain the principle underlying my invention with reference especially to Fig. 1. My invention is based upon a discovery which I have made resulting from a study of the flames of Bunsen burners. Referring to Fig. 1, which shows an ordinary Bunsen burner and the flame issuing from the tube T thereof, it is seen that this flame expands toward the middle of its height and terminates in a point at its top. In the center of the body of the flame is a relatively dark bluish-green conical core *a b c*, having for its base substantially the opening of the tube T and varying in height with the length of the tube and approximately of the same length as the tube. Around the dark core is a brighter zone *a d d c*, confined by a translucent surface of rotation of a canoid form, its length depending on the length of the blue core. The dark core *a b c* results from an incomplete mixture of the gas and the air which it draws with it, and this mixture is incomplete from the base of the flame to the level of a plane *x y* at about the top of the dark core. The mixture of gas and air becomes more and more intimate as it rises from the base of the flame to the level *x y*. I have found that if the mixture is not permitted to burn until reaching this level *x y*, where it

becomes complete, and if only the portion above this plane acts on the incandescent mantle the illuminating power of the mantle with a given consumption of gas is augmented from three to four times. To attain this remarkable result in the construction of a practical incandescent burner, I inclose the portion *a x y e* of the flame in an envelop, forming a chamber, which I will call the "mixing-chamber," which chamber has a height equal, or approximately so, to that of the dark core *a b c* and which expands from the diameter of the tip of the Bunsen tube T to a cylindrical diameter equal, approximately, to the full diameter of the flame shown in Fig. 1, and I prevent any ignition of the gases while flowing through this chamber by covering over the top thereof with a screen of gauze of sufficiently fine mesh. Thus the flame is limited to the portion above the level *x y* and has no dark or non-luminous core corresponding to that shown in Fig. 1, with the result that the heating effect of the flame thus restricted is so augmented and concentrated upon the mantle which incloses this flame that its illuminating effect is multiplied to three or four times that which is ordinarily obtained from the same amount of gas.

Fig. 2 shows one mode of applying my invention in connection with an incandescent burner, T being, as before, the induction-tube or injector of an ordinary Bunsen burner, and K being the mixing-chamber, *t* being the gauze screen closing its top, and M designating the Welsbach mantle. The mixing-chamber preferably has a contour corresponding to that of the lower part *a d d c* of the flame in Fig. 1, or of gradually-increasing area of cross-section from its bottom upward; but this is not essential, as it may be given a cylindrical form. Its cylindrical diameter at top should, however, at least equal the greatest diameter of the flame in Fig. 1. It thus has a height at least equal to or approximating that of the dark core *a b c* of such flame, as clearly indicated in Fig. 2, where by way of illustration this core is reproduced from Fig. 1, it being, however, understood that, in fact, there is no flame or ignition within the chamber K, but that the dark core shows the proper quantity and position of the unmixed gases, gradually tapering centrally as the gases rise and become more intimately mixed, attaining complete homogeneousness at the apex of the core, and that the flame is confined to the space above the gauze *t* and within or against the mantle M. The mantle may be suspended in any ordinary manner—as, for example, by a rod *q*, fastened by a set-screw to the side of the chamber K.

The tube T and chamber K may be permanently connected by soldering or by forming them in one piece; but where the burner is to be used with gas under varying pressures it is desirable that the chamber should be adjustable in height, and to this end I form it with a socket or neck *e*, fitting over the tube T and adjustably fastened thereon by a set-screw *v*, so that the entire chamber may be set higher or lower to accommodate it to different pressures. When the whole device acts with a chimney, as hereinafter stated, the admission of air and its velocity may be varied by raising or lowering the chamber K, which permits the point of the core of unmixed gas to be kept a little beneath the gauze *t* and the base of the mantle.

My burner, in which the gas and air issue in a condition of perfect mixture, will burn without a chimney. In most cases, however, I prefer to use a chimney, in which case I arrange it so that its base is closed, or substantially so, in order that the suction due to the chimney shall act mainly upon the air entering through the holes *o o* of the Bunsen burner, so as to further improve the mixture of gas and air and increase the velocity thereof beneath the mantle. Fig. 3 shows one suitable means for applying such a chimney or globe. The chimney C is placed upon a closed socket B, connected in a practically air-tight manner to the chamber K, so that little or no air can enter the chimney except through the Bunsen burner. Thus the air is drawn in forcibly through the holes *o*, and the mixture effected in the chamber K is more perfect, while the velocity of the issuing gases is increased.

The application of aspiration of air in the Bunsen apparatus by a chimney, as in Fig. 3, causes a rapid heating of the socket B by conduction, so that it may be used as a regenerator, as shown in Fig. 4. The socket is there shown provided with a regenerating-chamber F and a partition *h*. The bottom of the socket B has oblique holes *f*, which direct the external air against the chamber K. The air passes along the outer surface of the chamber, the partition *h* still following the chamber, so that the air passes out at *i* to the whole circumference of the lower end of the mantle M. This heated air completes the combustion of the particles of gas traversing the meshes of the mantle incompletely burned, and thus the incandescence of the mantle is intensified.

When the pressure of the gas is very low, neither the intimate mixture nor the velocity of the gas and air arriving at the mantle are sufficient for giving the desired incandescence. In this case the burner shown in Figs. 5 to 8 may be used to advantage. In this case the Bunsen apparatus is formed of a group of several tubes T T T, three being shown in the drawings, the upper ends of which are connected to a mixing-chamber E, of annular shape, its height being greater than that of the internal dark cores which flames from the Bunsen burners T T would give. In the center of this annular chamber is a tube D, through which air in the form of a central column is drawn in and freely admitted to the center of the mantle. This column of pure air slightly pushes the mixture of air and

gas issuing from the annular chamber E against the surface of the mantle. By this lateral action from the center toward the mantle the molecules of mixed air and gas are more thoroughly mixed and for a longer time, so that even at a low pressure and under the action of a globe concentrating the draft at the lower part of the Bunsen jet a high illuminating effect is obtained.

To afford the maximum velocity of the mixed gases with the minimum pressure of the mixture at the burner, the draft may advantageously be intensified by lengthening the chimney to form an elongated draft-tube, which from a level suitably above the mantle is so reduced in diameter as to afford a sufficiently strong suction, while below said level the chimney is enlarged to form an expansion-chamber surrounding or inclosing the mantle and relatively of larger capacity than in incandescent gas-lamps as heretofore constructed. Into the chamber thus formed the burning gases may freely expand, flowing laterally through the mantle under moderate velocity and at a low pressure, while the highly-heated products of combustion are drawn from this chamber by powerful suction in the upper part or draft-tube of the chimney. This form of my invention is shown in Fig. 9, where the mantle is inclosed within a relatively large lower chimney or globe Q, shown as having faced rims and suspended from a flange at the base of the contracted draft chimney or tube H. The latter is extended high enough to give the requisite strong suction, which acts to draw in air and gas through the Bunsen burner, whereby to cause the admixture of a large proportion of air with the gas. The bottom of the chimney or globe Q is preferably mounted in substantially air-tight manner upon the mixing-chamber in order to prevent any material direct access of air to the chamber inclosed by it, although the construction shown in Fig. 4 may be employed where it is desired to bring a minute air-supply directly to the exterior of the mantle; but in such case the air thus externally admitted is of proportionately small volume and insufficient to impair the lateral expansion of the burning gases within the mantle. The draft chimney or tube H is shown as of slightly-larger diameter than the upper end of the mixing-chamber, while the lower chimney or globe Q is of materially-larger diameter than the draft-tube, whereby the expansion-chamber formed within it is of such proportions as to avoid concentrating the draft upon the flame, so as to tend to draw it directly upward, but instead to afford room for the lateral expansion of the burning gases, whereby the most intense combustion is effected in close contact with the mantle and the latter is raised to the highest incandescence. The preferable form of mantle is that shown, the mantle being widest at its base and contracted toward its upper portion. The construction shown in Fig. 9 produces the most brilliant light with the least expenditure of gas.

One other element which I may make use of to advantage in connection with my system of automatically producing the mixture of gas and air is the heat of combustion of the mixture burned beneath the mantle. I use this heat for heating the gas and the air before arriving beneath the screen, thus increasing the brilliancy while at the same time assisting the draft without additional expense for gas. By these combined actions—perfect mixture, maximum velocity due to the draft, conservation of a high temperature around the mantle, and previous storage of the heat in the elements of the mixture by regeneration—the luminous effect is very brilliant and the consumption of gas is reduced to a few liters of gas only per carcel.

In the arrangement shown in Fig. 9 the mixture of gas and air leaving the Bunsen tip passes into a horizontal or nearly horizontal tube with gradually-increasing cross-section, where the fluid elements intermix, and thence into the mixing-chamber K, wherein the mixture becomes perfect on its arrival at the screen *t* at the base of the mantle M. The draft-tube H of the chimney is surrounded by a jacket I, to the upper end of which the gas-tubes J are joined. A tube L at the lower end leads from the jacket to the Bunsen injector O and is provided with a cock *r*. The products of combustion rising in the draft-tube or chimney H heat the gas passing down between it and the jacket I. Besides an injector-funnel N permits heating of the air at the entrance to the burner. A pivot *p* is provided on the pipe L to permit swiveling of the whole Bunsen apparatus and of the burner, as shown in dotted lines in Fig. 9, for the purpose of exchanging the mantle and for cleaning the apparatus.

It will be seen that whatever the pressure of the gas in the distributing-pipe may be it is possible to create artificial draft by the waste gases of combustion or to use the heat of combustion of the burner for heating the air which passes around the mantle or the gas and air passing to the mantle or to use both means at the same time, and thus to obtain the most favorable conditions for producing the greatest possible quantity of light at the smallest possible cost.

I claim as my invention the following-defined novel features, substantially as hereinbefore specified, namely:

1. The combination with a Bunsen burner of a mixing-chamber surmounting the tube thereof, having a height approximately equal to the height that would be assumed by the dark core of a flame issuing from said tube, and expanding to a diameter equal to the greatest diameter of such flame, and a gauze screen covering the top of said chamber, said chamber being free from any obstruction to the vertical flow of the gases, whereby the flame is confined to the space above said

gauze and the flame is solid or devoid of a dark core.

2. A Bunsen burner having a mixing-chamber surmounting the tube thereof, having a height approximately equal to the height that would be assumed by the dark core of a flame issuing from said tube, and expanding to a diameter equal to the greatest diameter of such flame, and a gauze screen covering the top of said chamber, said chamber being free from any obstruction to the vertical flow of the gases whereby the flame is confined to the space above said gauze and the flame is solid or devoid of a dark core, combined with an incandescent mantle surmounting such chamber and inclosing the flame above said gauze.

3. The combination with a Bunsen burner of a mixing-chamber surmounting the tube thereof, having a height approximately equal to the height that would be assumed by the dark core of a flame issuing from said tube, and expanding to a diameter equal to the greatest diameter of such flame, and a gauze screen covering the top of said chamber, said chamber being free from any obstruction to the vertical flow of the gases, and said chamber adjustably attached to said tube so as to be adjustable vertically thereon.

4. The combination with a Bunsen burner of a mixing-chamber surmounting the tube thereof, having a height approximately equal to the height that would be assumed by the dark core of a flame issuing from said tube, and expanding to a diameter equal to the greatest diameter of such flame, with a gauze screen covering its top, so as to confine the flame to the space above said gauze, said chamber being free from any obstruction to the vertical flow of the gases, an incandescent mantle inclosing such flame, and a chimney surrounding the mantle, and substantially closed at its base for inducing a forcible draft through the Bunsen burner.

5. The combination with a Bunsen burner of a mixing-chamber surmounting the tube thereof, having a height approximately equal to the height that would be assumed by the dark core of a flame issuing from said tube, and expanding to a diameter equal to the greatest diameter of such flame, with a gauze screen covering its top, so as to confine the flame to the space above said gauze, said chamber being free from any obstruction to the vertical flow of the gases an incandescent mantle inclosing such flame, a chimney surrounding the mantle, and substantially closed at its base for inducing a forcible draft through the Bunsen burner, and a regenerator-chamber at the base of said chimney adapted to admit a limited inflow of air against said mixing-chamber to cool the same, and shaped to direct the heated air against the base of the mantle.

6. The combination of a Bunsen burner having a mixing-chamber, a mantle, and a chimney inclosing said mantle, substantially closed at its bottom to prevent any material direct access of air and to substantially confine the entering air to that which passes through the Bunsen burner, and of relatively large diameter to form an expansion-chamber adapted to permit the burning gases to expand laterally through the mantle.

7. The combination of a Bunsen burner having a mixing-chamber, a mantle, a chimney inclosing said mantle, substantially closed at its bottom to prevent any material direct access of air and to substantially confine the entering air to that which passes through the Bunsen burner, and of relatively large diameter to form an expansion-chamber adapted to permit the burning gases to expand laterally through the mantle, and continued upward to form a draft-tube of reduced diameter adapted to cause a strong suction acting to draw the gaseous products from said expansion-chamber, and to draw a mixture of air and gas through the Bunsen burner.

8. The combination of a Bunsen burner having a mixing-chamber, a mantle, and a chimney of relatively large diameter inclosing said mantle, having an elongated draft-tube of reduced diameter forming an upward continuation of said chimney, said chimney being proportioned relatively to the mantle to afford an extended free space above the mantle and between it and the base of said draft-tube, and to form an expansion-chamber adapted to permit the burning gases to expand laterally through the mantle, and substantially closed at its bottom to prevent any material direct access of air such as to impair such lateral expansion, and to substantially confine the entering air to that which passes through the Bunsen burner.

9. The combination of a Bunsen burner having a mixing-chamber of a height approximately equal to the height that would be assumed by the dark core of a flame issuing from such burner, and expanding to a diameter approximately equal to the greatest diameter of said flame, with a gauze screen covering the top of said chamber, a mantle surmounting said chamber, and a chimney of relatively large diameter inclosing said mantle, substantially closed at its bottom to prevent any material direct access of air, and having a draft-tube of reduced diameter forming an upward continuation of said chimney adapted to cause a strong suction acting to draw in a mixture of air and gas through said Bunsen burner, and to draw the gaseous products of combustion from within said chimney.

10. The combination of a Bunsen burner having a mixing-chamber of gradually-increasing diameter, a mantle surmounting said chamber, and an enlarged chimney substantially closed at its bottom and surmounting said mantle, and having a draft-tube of reduced diameter forming an upward continuation of said chimney.

11. The combination of a Bunsen burner having a mixing-chamber, a mantle surmount-

ing said chamber, and a chimney inclosing said mantle substantially closed at its bottom, and having a draft-tube forming an upward continuation of said chimney and of a diameter exceeding that of said mixing-chamber, said chimney below said draft-tube being of materially-greater diameter than said draft-tube, whereby to form an expansion-chamber adapted to permit the burning gases to expand laterally through the mantle.

12. The combination of a Bunsen burner having a mixing-chamber, a mantle surmounting said chamber, a chimney inclosing said mantle, substantially closed at its bottom, and having a draft-tube of reduced diameter forming an upward continuation of said chimney, and a regenerating-passage in contact with said draft-tube and communicating thence with the admission to the Bunsen burner, whereby to utilize the heat of the waste products of combustion to heat the gas and air entering said Bunsen burner.

13. The combination with a gas-burner having a mixer and a mantle surmounting it, of means for producing a forced draft of air through the air-admission openings of the mixer, consisting of a draft-chimney extended above the mantle, and substantially closed at its base.

14. The combination with a gas-burner having a mixer, and a mantle surmounting it, of a chimney having an enlarged lower portion which is substantially closed at the bottom and having a draft-tube extending above said mantle for producing a forced draft of air through the air-admission openings of the mixer.

15. The combination with a gas-burner having a mixer, and a mantle surmounting it, of a chimney having a globular lower part surrounding said mantle, and having a draft-tube extending above said mantle for producing a forced draft of air through the air-admission openings of the mixer.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

LOUIS DENAYROUZE.

Witnesses:
JULES ARMENGAUD, Jeune,
EDWARD P. MACLEAN.