MODERN

STREET LIGHTING.

BY

WILLIAM T. SUGG, A.I.C.E., M.R.I.,

HONORARY MEMBER OF THE GAS INSTITUTE.

SECOND EDITION.

London:
WALTER KING, 11, BOLT COURT, FLEET STREET E.C.

1887.

[Entered at Stationers' Hall.]

Price 1s. 6d.

To this end the energies and skill of the Author in this branch of the science of Gas lighting are devoted; and, although he may not directly succeed, yet that success which is sure ultimately to be obtained is at least accelerated by the contributions he has made towards it.

Westminster, 1871.

ADVERTISEMENT TO SECOND EDITION.

Although the first edition of this work was issued sixteen years ago, the groundwork and principal requirements of the subject remain the same.

The traffic is so enormous that the main arteries have been widened to such an extent that well-lighted refuges are made at the principal crossings.

The author, in submitting this second edition, trusts, however, that it will convince those who may be wavering that gas is fully able to meet the ever-increasing demand for "More Light," and to distribute it to any extent.

Westminster, 1887.


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PREFACE.

THIS little Work is issued by the Author in order to supply a want which, he has abundant proof, has been felt by many who have had to deal with the much-vexed question of Public Lighting. The greater portion of the information contained in these pages has already been given by him in the form of letters, more or less lengthy, in reply to questions. It may be that many of those letters have either got inadvertently mislaid, or become the victims of the waste-paper basket; so that the information, given with some amount of trouble, and received perhaps not without appreciation, has accordingly been lost.

In this pamphlet the Author has endeavoured to arrange in a connected form a quantity of information, which the long study he has given to the question emboldens him to say will be found of great practical utility.

The systems indicated are possibly not everything that may be desired, but they will at least serve as starting points from which to arrive at others which shall be found still nearer perfection.

London Stereo. & Photo. Co., Ltd., Photomezzotype. *[From a Photograph by the Author.*

WILLIAM SUGG'S PATENT "GLOBE" LAMP.

HYDE PARK IMPROVEMENTS.

MODERN

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FIXING THE APPARATUS.

The best method of fixing this apparatus is that shown in the drawing on page 63.

The inlet (G) of the apparatus should be connected to the outlet-pipe of that gasholder which gives the most uniform pressure on the works. If the apparatus be not fixed on a gas-works, then it is necessary to have a gasholder (Fig. 40) on purpose. This may also be used for testing meters.

Although lamp governors are made for the purpose of maintaining by their action uniformity at the burner under varying pressures in the street mains, yet they themselves cannot be well adjusted unless there is a possibility of starting from a standard pressure which can be relied upon to remain unchanged during the whole process of adjustment.

At the same time it is necessary, in order to prove the delicacy of the governor, to have a means of increasing the pressure at its inlet by degrees till the highest pressure is reached, which being shut off, the standard pressure resumes its influence.

To maintain this standard pressure is the province of the double governor (F), fixed on the right of the meter, while that on the left (E) serves to regulate the degree of variation in the pressure which it is intended to cause at the inlet of the lamp governor under examination.

ADJUSTMENT OF THE APPARATUS.

Having arranged the apparatus in the order pointed out, see that the pointers of the pressure gauges are at zero when the gas is turned off.

NOTE.—For this purpose open the blow-off cocks (AA), shut the gas-cocks (BB).

Adjust the (F) or standard pressure governor till it gives a pressure upon the (C) pressure gauge equal to the lowest or day pressure in the mains (say 6-10ths).

NOTE.—In adjusting this governor (which is double), the inlet holder must be weighted to give about 2 or 3 10ths more than the outlet holder; thus, supposing the operator were adjusting the low pressure governor (F) to give 6-10ths pressure, he would adjust the inlet holder to 8-10ths and the outlet holder to 6-10ths. This is done to allow for any variation of pressure which may occur at the outlet of the first holder, and in order that the second may be enabled to maintain at its outlet a perfectly uniform pressure.

Weight the test or store gasholder (if it is not possible to obtain the pressure from a large gasholder, or in any other way), up to 2 inches or 2½ inches.

For all the purposes of testing, excepting for soundness, a pressure of 2 inches is amply sufficient. To increase the pressure gradually from 6-10ths to 1½ inches is a severer test for a governor than suddenly to change it from 6-10ths to 6 inches.

Adjust the high pressure governor (E) to 2 inches, or nearly the pressure of the test gasholder.

APPARATUS FOR TESTING LAMP GOVERNORS.

The requisites for this purpose are:—

An experimental meter (A) made in the simplest manner with a measuring drum holding 1-12th of a foot, and equal at the rate of one revolution per minute to the rate of 5 cubic feet per hour, into which number the dial is divided, each foot being subdivided into tenths of a foot.

A minute clock (B) striking each minute and fitted with stop action.

A King's pressure gauge (C) capable of showing 4 inches of pressure.

Another (D), capable of showing 1½ inches of pressure, with subdivisions into hundredths of an inch.

A single dry governor (E).

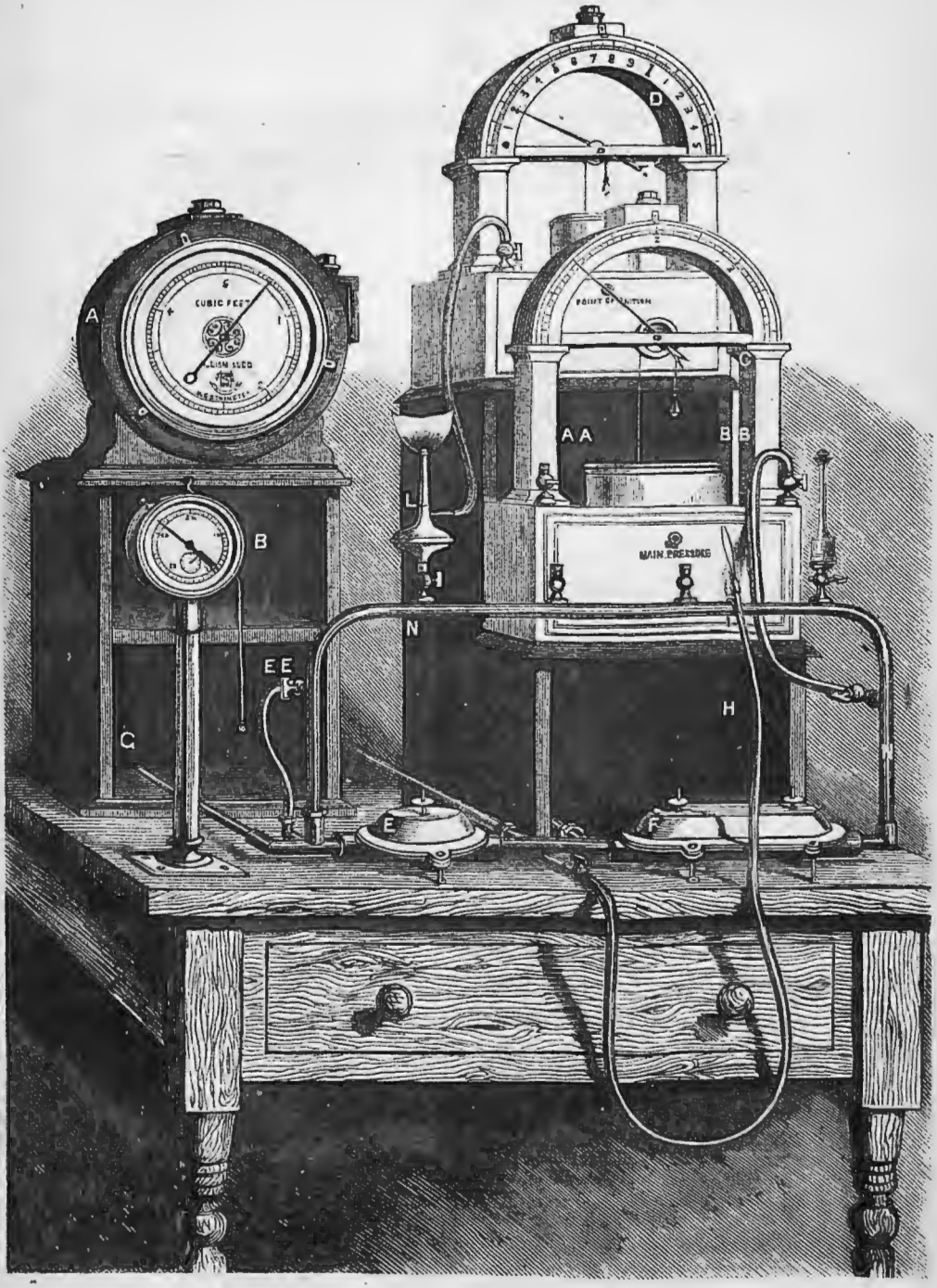
A double dry governor (F).

A float (NN) fitted with lamp cocks and stopcock (EE) for high pressure gas supply.

A brass T-piece (L) screwed ⅝ inch inside at the bottom and ⅜ outside at the top, so that it may be inserted between the cone and the case of a governor, which it is requisite to test, in the readiest manner without disturbing the joints.

This communicates by means of an india-rubber tube with the delicate King's pressure gauge (D), which indicates the pressure of the gas after passing the governor. This pressure is considered to be

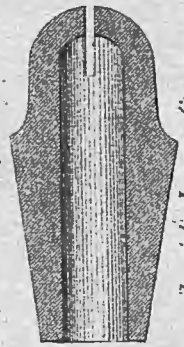
APPARATUS FOR TESTING LAMP GOVERNORS.



SUGG'S STEATITE

For 4 and 5 fr per hour

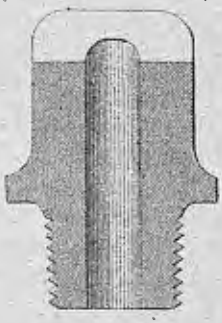
used with Lamp Governor



1858

SUGG'S STEATITE

PUBLIC LIGHTING

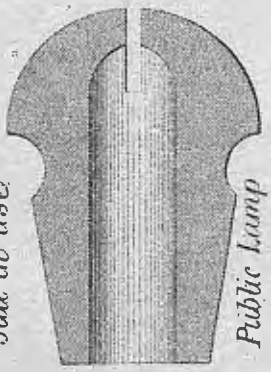


1860

SUGG'S STEATITE

MADE SPECIALLY

Still in use



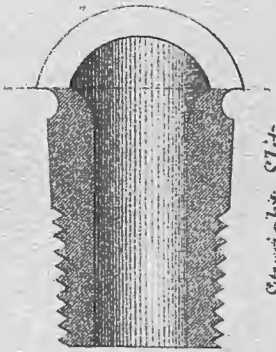
Public Lamp

FOR AMSTERDAM

1868.

SUGG'S STEATITE

HOLLOW TOP



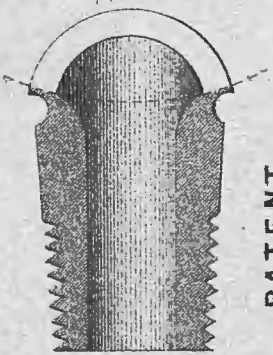
Straight Slit

1868

SUGG'S STEATITE

HOLLOW TOP

Circular Slit

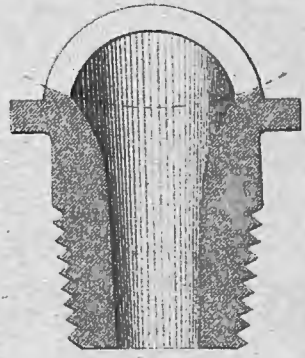


PATENT

1874

SUGG'S PATENT

TABLE TOP



Circular Slit

1880

WATERLOW BROS & LAYTON LONDON

DESCRIPTION OF LAMP GOVERNOR.

1866 MODEL.

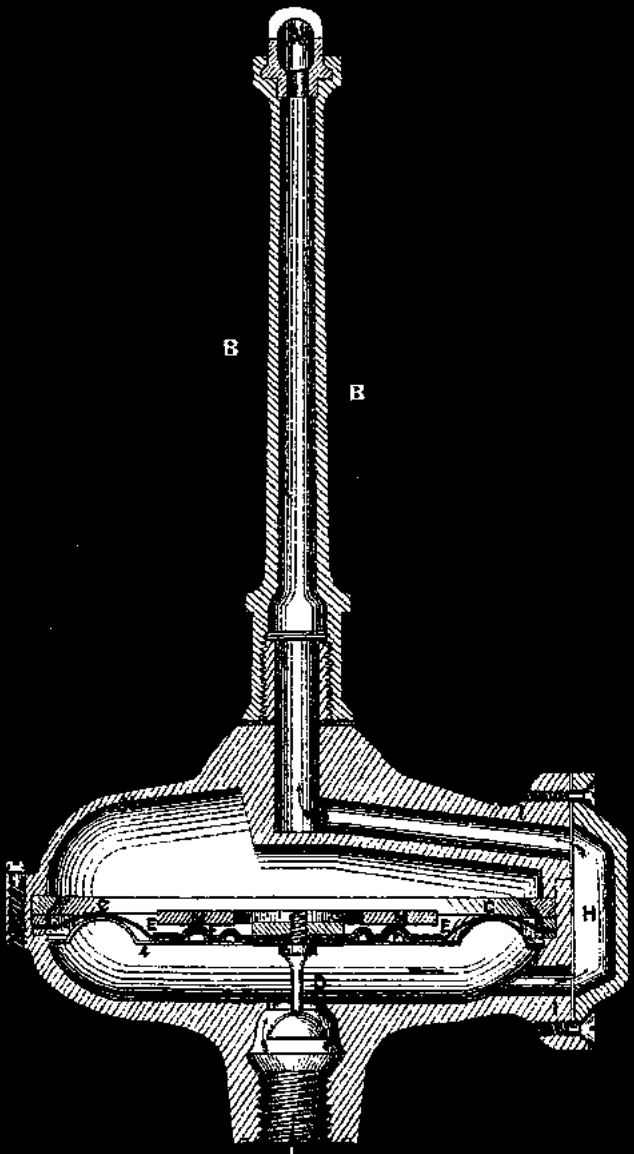
(A) is a steatite burner tip, and the diagram shows the method by which it is fastened into the cone (B), which is screwed to the governor by an ordinary $\frac{3}{8}$ gas thread. The best burner for the purpose, and the one that is now almost universally adopted is the table-top.

(C) is a metal ring which, being screwed into the body of the governor, holds the leather firmly to its seat. Between the leather and the metal ring is a turned card washer, which prevents the leather from being injured by the turning of the screw in tightening it down to its bearing.

NOTE.—Some of the old governors will be found to have a brass ring instead of a patent metal one for the same purpose. This new ring, and the method of securing the leather, form the subject of a second patent, which will be found to possess the merit of greater simplicity.

(D) is the regulating valve, fixed to the leather (E), by means of two shields (FF), which clip the leather between them, these shields being held firmly by a screwed brass nut (G) on the top of the upper shield, and a tin washer on the under side of the lower one. The leather (E) answers the same purpose in the dry as the gasholder does in a wet governor, rising and falling accordingly as the pressure is strong or weak at the inlet (L).

WILLIAM SUGG'S
PATENT
PUBLIC LAMP GOVERNORS.



Sectional Elevation of 1861 Model serving to Illustrate the essential Parts of the other Models.

CHAPTER V.

LAMP GOVERNORS AND APPARATUS, &c.

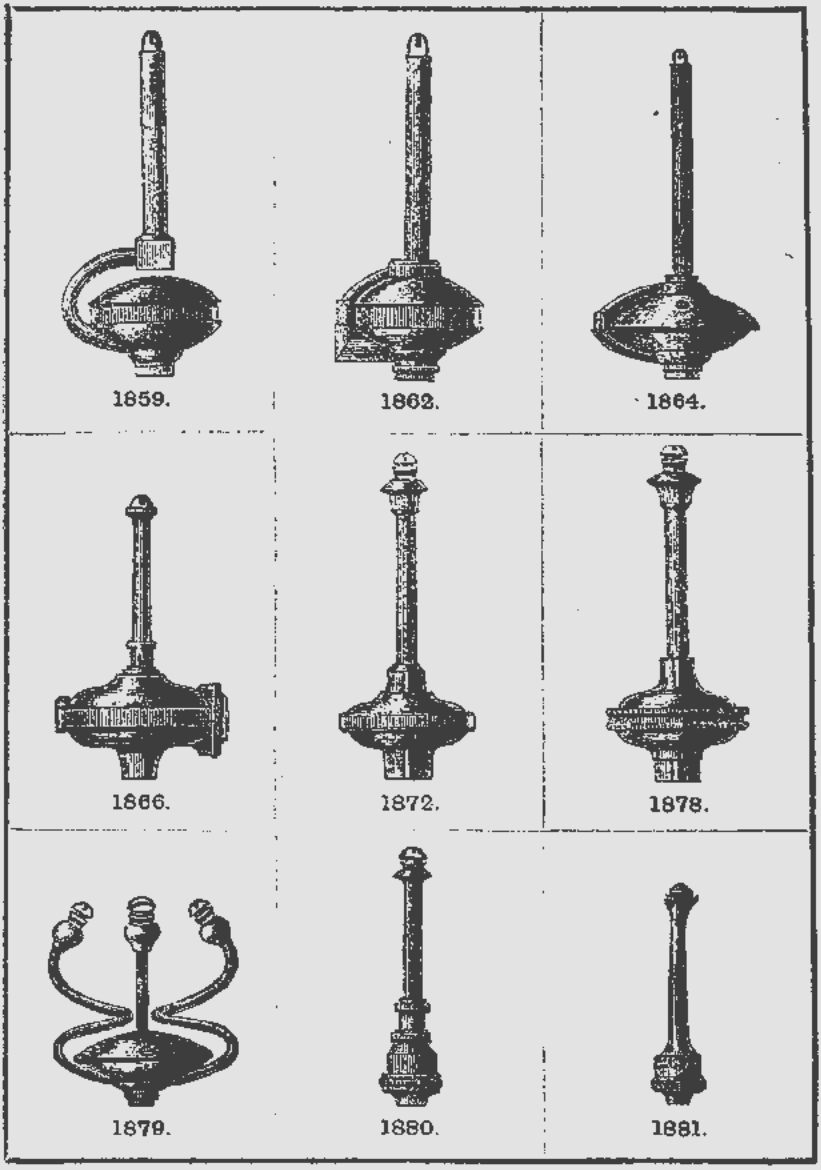
When we consider the enormous mileage of public thoroughfares, in the civilized world, which are now lighted by gas, and the fact that the burners are left lighted without supervision from sunset to sunrise, the importance of the subject of this chapter cannot be over estimated. An uncontrolled burner, when passing double its proper allowance of gas, is giving less light and only wasting the money of either the company or the vestry, as the case may be. That this subject has received much consideration and attention from gas engineers is evident from the following

Series of Lamp Governors

invented and manufactured by the author arranged chronologically, showing the progress made in these articles during the past 26 years. Many of the 1859 and later patterns are still in use, having been in constant work for over a quarter of a century. Upwards of 3 millions are in use in various parts of the globe.

LAMP GOVERNORS ARRANGED CHRONOLOGICALLY.

Drawn to Scale of One Quarter.



1859. 1862. 1864.

1866. 1872. 1878.

1879. 1880. 1881.

In order to impress more firmly the fact that, while countries north of the equator are having long days, those south of the equator are having long nights, the Table may be divided into two portions at Midsummer, see pages 52 and 53. The numbers at the bottom of the curves will then show that their relative positions are reversed.

In the arrangement on page 52 the spaces between the curves of the same title indicate the length of the day in various parts of the world as enumerated on pages 49 and 50. The reversed order, as shown on page points out to the gas engineer the number of hours of darkness under various circumstances of time and place, and enables him to construct, on an accurate basis, a Lighting Table suitable to the requirements of the locality.

Roughly speaking, the hours between sunset and sunrise amount in the course of a year to 4,300, and some Vestries make their contracts for Public Lamps on this basis. The majority, however, take advantage of the twilight and dawn, especially during May, June, and July, and by lighting later and extinguishing earlier, they reduce the number of hours to 3,940. Some reduce the number of hours of lighting to 3,836, while some even adopt the rule of lighting half-an-hour after sunset and extinguishing 1 hour before sunrise, thus bringing the total down to 3,760.

In country districts the Moon is often taken into consideration. In those parts the instructions are

that the lamps are to be lighted 1 hour before the moon sets and extinguished 1 hour after the moon rises. This rule only gives about 2,300 hours of lamplight.

The following Table gives the Monthly Totals of Lamplight for the yearly totals of 4,300, 3,940, and 3,836 hours at all places mentioned under Curve 3.

	H. M.	H. M.	H. M.
January . . .	484.2 ..	466.0 ..	457.13
February . .	397.45 ..	378.16 ..	370.16
March . . .	375.35 ..	346.59 ..	338.12
April . . .	303.54 ..	269.5 ..	260.35
May	260.28 ..	211.23 ..	202.36
June	224.31 ..	174.55 ..	166.25
July	246.18 ..	199.15 ..	190.28
August . . .	294.1 ..	254.58 ..	246.11
September . .	341.54 ..	310.53 ..	302.28
October . . .	414.41 ..	397.14 ..	388.27
November . .	454.57 ..	444.32 ..	436.20
December . .	501.59 ..	486.30 ..	477.36
	4,300.0	3,940.0	3,836.24

But the distribution of those hours over the month is a matter of considerable importance if it is desired to avoid the absolute waste of gas which must result from the use of defective Lighting Tables, not constructed on proper astronomical data.

LEVER COCKS FOR LARGE AND SMALL LAMPS,

SPECIALLY CONSTRUCTED FOR TORCH-LIGHTING.

STREET-LAMP COCK.
SUGG'S "NOTTINGHAM."

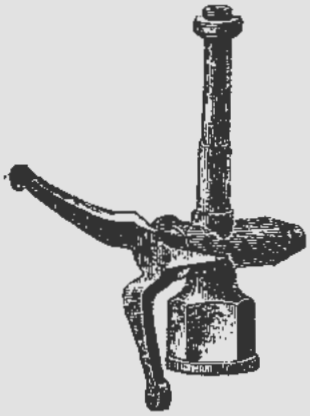


Fig. 28.

STREET-LAMP COCK
(JOHN OHREN'S PATENT.)

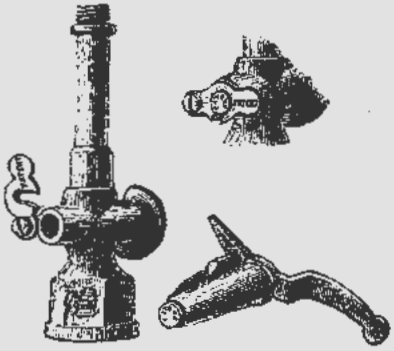


Fig. 29.

These cocks are fitted with stout knobs at the ends of the levers, and with a pointer to indicate whether the gas is off or on.

The improved lamp cock (fig. 29), which is the patent of Mr. John Ohren, Engineer of the Rio de Janeiro Gas Company, is so constructed that in the event of stoppage, the plug can be removed by the lamplighter without the aid of any tools.

TRIPLE-LEVER COCK FOR LARGE LAMPS,

Invented for the purpose of facilitating the lighting and extinguishing lamps in which it is required to reduce the consumption of gas after midnight.

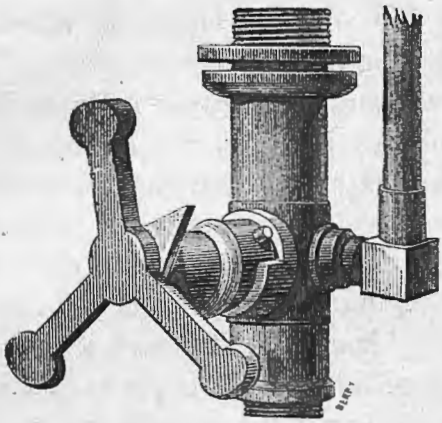


Fig. 30.

When the full-power lighting is turned on, the pointer (fig. 30) is upright.

When the midnight supply is on, the pointer is turned in the direction of the elbow carrying that supply-pipe. When the pointer is turned in the opposite direction, it indicates that the gas is entirely shut off.

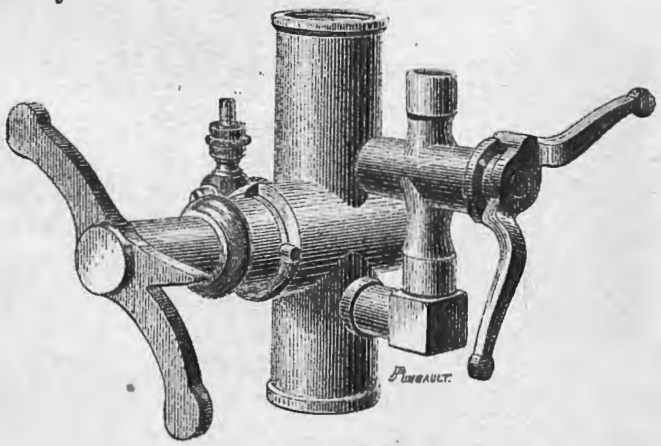


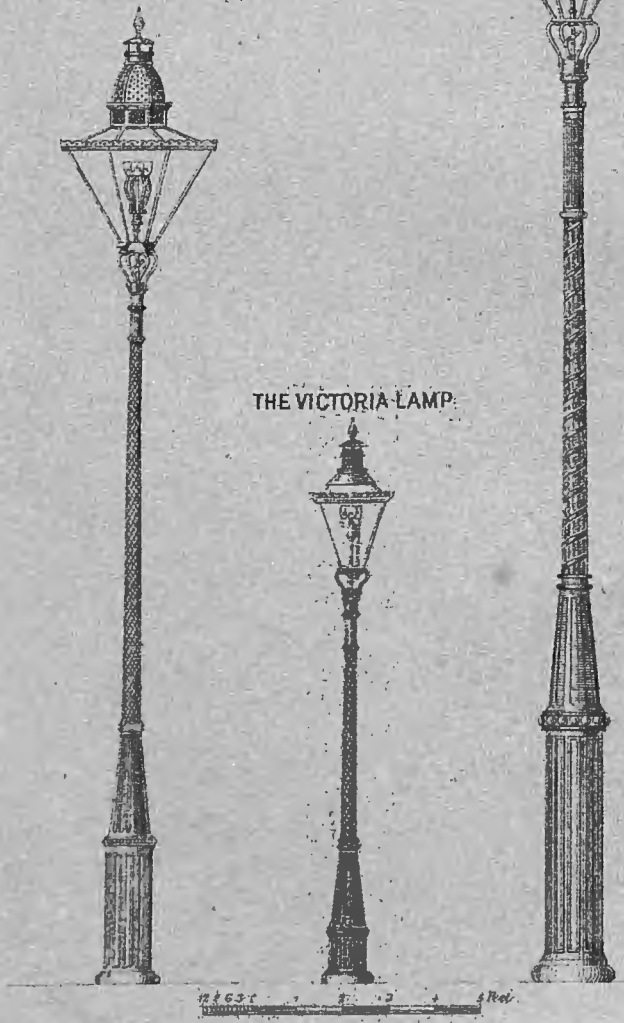
Fig. 31.

SUGG'S PATENT STREET LAMPS
ON
REGISTERED COLUMNS

THE GREENOCK LAMP

THE WESTMINSTER LAMP

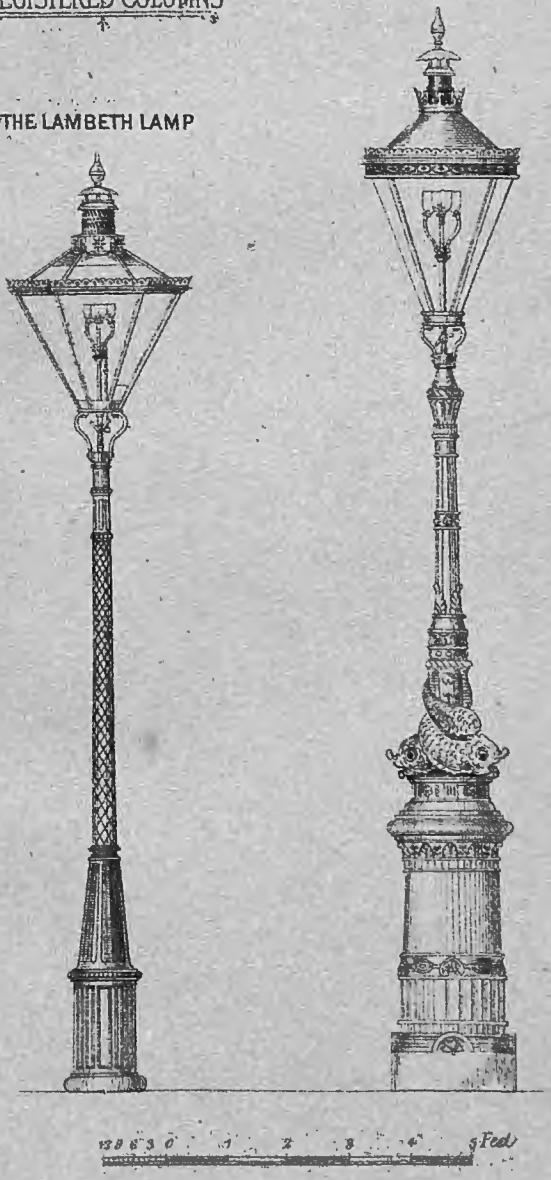
THE VICTORIA LAMP



SUGG'S PATENT STREET LAMPS
ON
REGISTERED COLUMNS

THE WHITEHALL LAMP

THE LAMBETH LAMP



WATERLOW BROS & LAYTON LONDON

London Stereo. & Photo. Co., Ltd., Photomezzotype. *From a Photograph by the Author.*

WILLIAM SUGG'S PATENT "GREENOCK" LAMP,

FOR DOCK LIGHTING.

London Stereo. & Photo. Co., Ltd., Photomezzotype. [*From a Photograph by the Author.*

WILLIAM SUGG'S PATENT "LAMBETH" LAMP,

FOR DOCK LIGHTING.

zontal movement of one-quarter or one-eighth of a circle, will be found to work well.

This latter is made of gun metal with a barrel of a hard white alloy, so as to avoid as much as possible any liability to stick fast. From the fact of the barrel working on the plug in a vertical

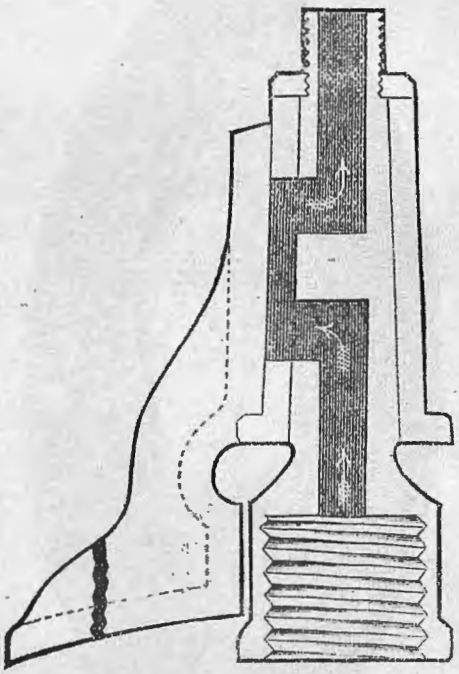


Fig. 24.

position, it will readily be seen that there is a certainty of its remaining sound for a longer time than when, as in the ordinary way, the plug itself works in a horizontal position.

The system above given entails frequently the

COMPOUND CHIMNEY.

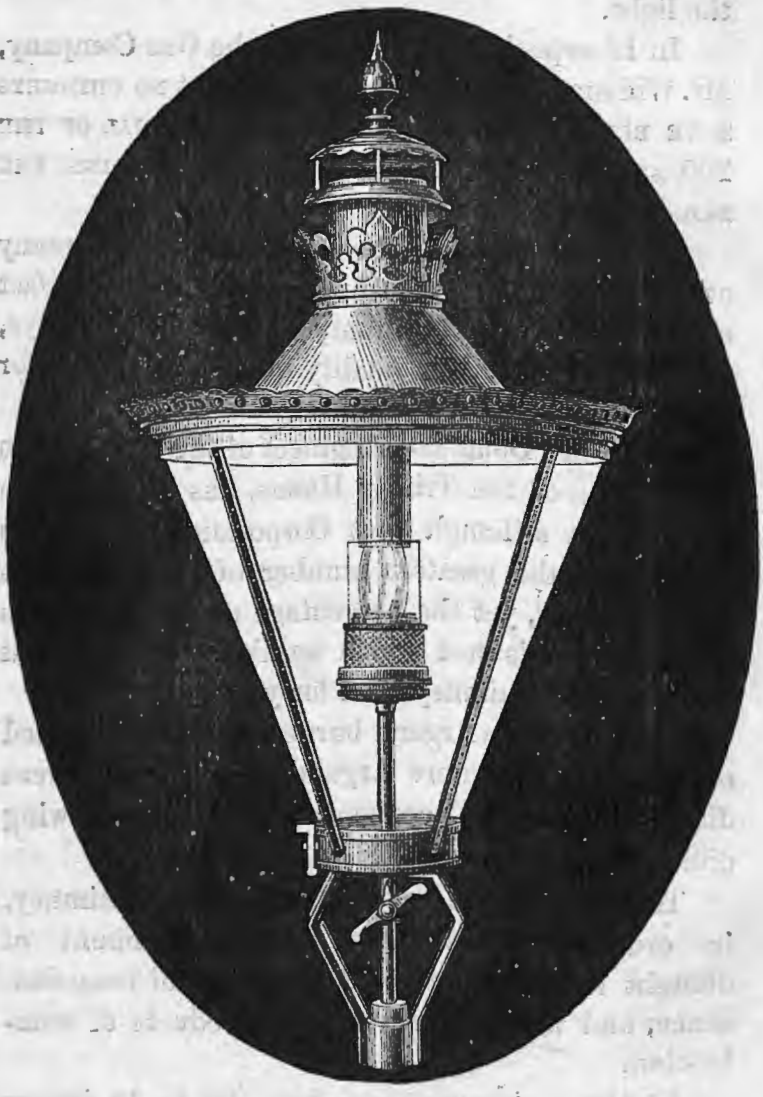


Fig. 11.

they are very unequally heated; that part in close proximity to the flame becoming much hotter than the upper part. This unequal heating renders them liable to break.

Another difficulty is that the air admitted to the burner at the base of the flame is soon exhausted, and the top of the flame does not receive its proper supply of oxygen. The result of this is smoke and a loss of illuminating power. A long chimney is, moreover, liable to render the flame unsteady by creating at times too great a rush of air.

These difficulties, are, however, overcome by the employment of the author's patent compound chimney. In this arrangement the glass chimney is just the height of the flame, and above this glass chimney a metal one of somewhat smaller diameter, and lined with a refractory substance, is suspended so that it will just enter the glass chimney. See Fig. 11, which illustrates a Whitehall lamp fitted with a 200-candle Argand burner and compound chimney.

In this manner an annular space will be formed between the edges of the two chimneys by which air can pass to the top of the flame and cause perfect combustion. This entirely prevents the elongation of the flame, the formation of smoke, and the loss of illuminating power.

the light produced is equal to 80-candles. In four instances the ancient lamp-posts have been superseded by others of modern construction, designed by Mr. Sugg, and which have several structural features below as well as above ground to recommend them. The four lamps on the refuges have the improved lanterns, and are now fitted with London burners, having three concentric columns of flame, each burner consuming 23 cubic feet of gas per hour, and affording the light of 100 candles. The two improved lanterns on the standards between the Athenæum and the United Service Clubs have the same kind of burners, but with four concentric flames, consuming 45 feet of gas per hour, and giving a light equal to 200 candles.

"The lanterns are of a similar pattern to those used in the Waterloo Road, which, with the burners, were also supplied by Mr. Sugg. In vertical section they approach the diamond shape, and are hexagonal in plan, with the exception of the two largest and the four of intermediate size, which are respectively 12-sided and octagonal. The upper portion of each lantern is glazed with a new kind of white glass, which serves to reflect as well as to transmit the light. The lower portion is of clear glass, which allows the reflected as well as the direct rays to be distributed around, and such is the arrangement of the framing that no shadows are thrown on the ground immediately under the lantern, as with the ordinary street lanterns. The ventilation of the lantern is very perfect, and is such that a high wind does not affect the steadiness of the gas-flame. The burners are so arranged that they are self-lighting upon the gas being turned on. To effect this each burner is fitted with a central jet of gas termed a flash-jet, which burns a quarter of a cubic foot per hour, and always remains alight. This little jet is maintained at a constant rate of consumption by a small governor of very ingenious construction, which Mr. Sugg has recently devised. Each of the large burners is also provided with a governor, so that variations of pressure in the street mains do not in the least affect the height of the flame. Each lamp is provided with a lever tap, so arranged that the gas can be turned on and off without the use of a ladder. When turned on, the small flash-light ignites the gas, and when turned off

the "flash" remains burning, there being thus no necessity for opening the lanterns to light the burners, notwithstanding that they are of the Argand type with chimneys.

"With regard to the cost of the gas for the improved system of illumination, it will be observed that the 36 footway lamps, at 19 cubic feet each, burn a total of 684 feet per hour; the four refuge lamps, at 23 feet each, 92 feet per hour; and the two large lamps, at 45 feet each, 90 feet per hour. This gives a total of 866 feet of gas per hour, affording an illuminating power of 3,680 candles, and costing, at 4s. 4d. per 1,000 cubic feet, 9s. 6½d. per hour. This is, of course, a marked increase upon the 105 cubic feet per hour consumed by the 42 old lamps, and costing only 5½d. per hour. But equally marked is the advance in the illumination, which is of the highest character. During the progress of the work of modification temporary burners were used. These were Sugg's London burners of a smaller size, consuming 6 feet per hour and of six-candle illuminating power. This lighting was of itself a very great improvement upon the system it superseded, but was of course inferior to that by which it had been succeeded. By it (the intermediate arrangement) an approximately efficient light could be obtained at a cost of 1s. 1¼d. per hour for gas, larger burners being used on the refuges and in the open spaces. As in the case of the Waterloo Road experiment, the new system is not intended to be applied indiscriminately (unless desired), but is an example of what might be done during certain hours of the night in our leading thoroughfares and at the intersections of roads where the traffic is heavy. It is to be observed that the cost of lighting the 600 yards of road in Waterloo Place is considerably in excess of that of the 500 yards of the Waterloo Bridge Road. But then the illumination is greatly superior in the former case, and, in fact, may be taken as the perfection of street gaslighting. A few private burners on the route which were still lit formed a negatively admirable contrast to those of the new type, while the lamps surrounding the Guards' Memorial were simply ludicrous in their feeble effect. There are three results now afforded, and these are: first, those of the Waterloo Place experiments, as exemplified by the present system of lighting, which affords a very high rate of illumination and

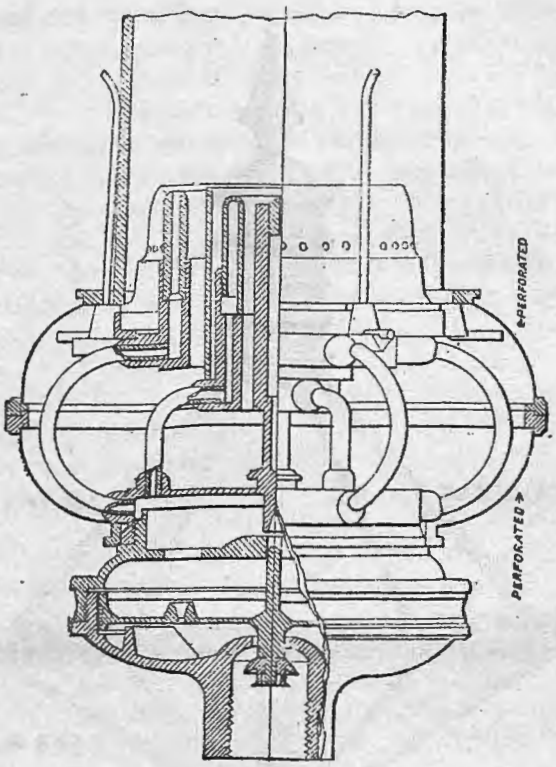


Fig. 10.

IMPROVED GAS LIGHTING.

We publish illustrations (figs. 9 and 10) of Mr. Sugg's improved gas burner and lamps, together with a plan of their installation in Waterloo Place, and we reproduce from a recent issue of the *Times* the following description of the system :—

"In a recent article on gas lighting we observed that the comparative inefficiency of street lighting in London had been brought into unpleasant prominence by the appearance of the electric light in our midst, and we pointed out that that inefficiency was due to the fact that the lamps were placed too far apart, and that the supply of gas to them was far too small, the

consumption being kept as low as possible by the vestries from motives of economy. That these shortcomings were not due, as some had begun to imagine, to the impossibility of obtaining a better light from gas except at a prohibitory cost, was shown by the particulars we then gave at the experimental lighting of a portion of the Waterloo Bridge Road with gas, on a liberal scale, by the Phœnix Gas Company. This was practically intended as an answer to the experimental lighting of the Holborn Viaduct and the Thames Embankment by electricity, and, although the cost of illumination was certainly increased under the improved system of gaslighting, it was not increased unduly or extravagantly. A similar answer has now been given by The Gaslight and Coke Company, who, having obtained the sanction of the St. James's Vestry, have now revolutionised the gaslighting of Waterloo Place and a part of Regent Street at their own expense. The Gaslight Company some little time since appointed a committee of their directors to take action in this direction, and they placed the matter in the hands of Mr. William Sugg, of Westminster, to carry into effect, and he has very successfully accomplished their wishes. The arrangements were recently completed, and the whole series of lamps are now lighted.

"The ordinary lighting of this piece of roadway, which is about 500 yards in length and of considerable width at the lower end, is effected by means of 42 lamps, burning 2½ cubic feet of gas per hour, and the light from each was equal to nine candles. Thirty-six of these lamps are on the footways, four on the street refuges, one between the Athenæum and the United Service clubhouses, and one opposite the County Fire Office. There were, therefore, 105 cubic feet of gas used per hour in these lamps, which, being cannel gas, costs 4s. 4d. per 1,000 cubic feet, and amounts to 5½d. per hour. There are also several lamps attached to the Guards' Memorial, but owing to their special construction they had to be excluded from the experiment. The thirty-six footway lamps have had the old lanterns and burners removed, and they have been replaced by new lanterns, specially designed by Mr. Sugg, and his London Argand burners (fig. 10) having two concentric columns of flame. In each of these the consumption is 19 cubic feet per hour, and

CHAPTER II.

LARGE LAMPS—ARGAND.

In every direction the demand is for more light, and as facilities of travelling and intercommunication are increased the demand will increase. As long as the thoroughfares were amply wide enough for the traffic the illumination of the streets and roads by the small lamps was sufficient.

When, however, as those who have lived in the City will remember, the *block* at the Mansion House, caused partly by the darkness and partly by the narrowness of "The Poultry," occurred *every* evening, the meagreness of the public lighting became apparent.

This state of affairs remained until, in 1878, the electric light made such rapid progress, and its illuminations (regardless of expense) caused so much excitement that holders of gas shares were becoming quite despondent. The faint-heartedness increased, and, when the Thames Embankment was lighted by electricity on the 13th of December, and

Authorities, Railway Companies, Contractors, &c., and by H.M. Government.

THE "VICTORIA."—18 *inch Square.*

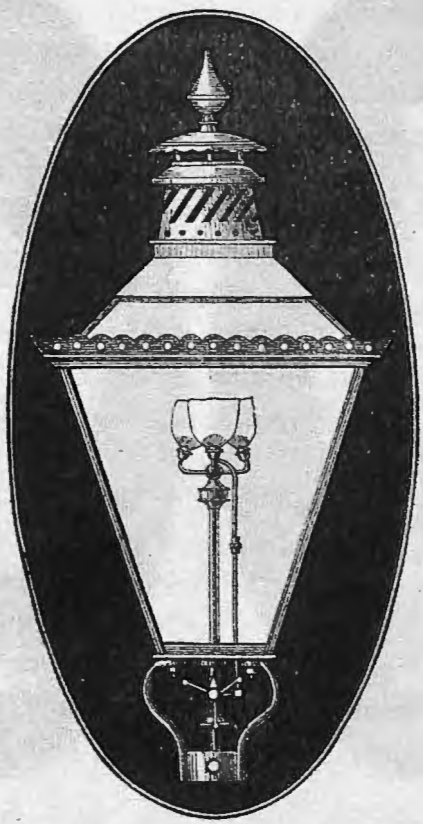


Fig. 6.

The "Metropole" (figs. 7 and 8) is a new lamp for side-walks, important thoroughfares, street corners, &c., to burn from 5 to 10 feet per hour.

which, however, it can easily be removed if necessary. The top is reflecting, and, as well as the knob, is made of porcelain.

NOTE.—These have been in use for many years on Ryde Pier, Beckton Gas-Works and Pier, and various other places.

THE "YORK."—16 *inch Square.*
ENAMELLED IRON OR PORCELAIN REFLECTING TOP.

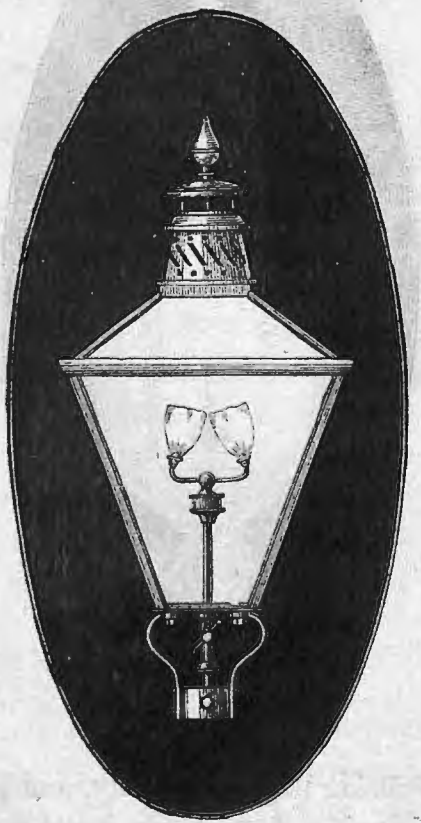


Fig. 3.

The "York" is a new lamp designed by the Author, suitable for fixing at the corners of streets in thoroughfares where a good light is required, and where it is not desirable to fix one of the powerful and more perfect lanterns.

The drawing on the opposite page (fig. 3) shows this lamp as fixed on an ordinary street lamp column. The Burner shown is Sugg's Patent "Billingsgate" (fig. 4) Flat-Flame Combination

THE "BILLINGSGATE" BURNER.

Fig. 4.

Fig. 5.

Burner, fitted with regulator adjusted to permit the burners to consume a total quantity of 15 cubic feet per hour, giving a light equal to nearly 45 candles.

The lamp can be provided with a regulating cock and a centre burner, so that the consumption can be reduced to 5 or 4 cubic feet per hour after midnight.

ing and extinguishing, so as not to leave an opening for the unrestricted rush of the wind during rough weather.

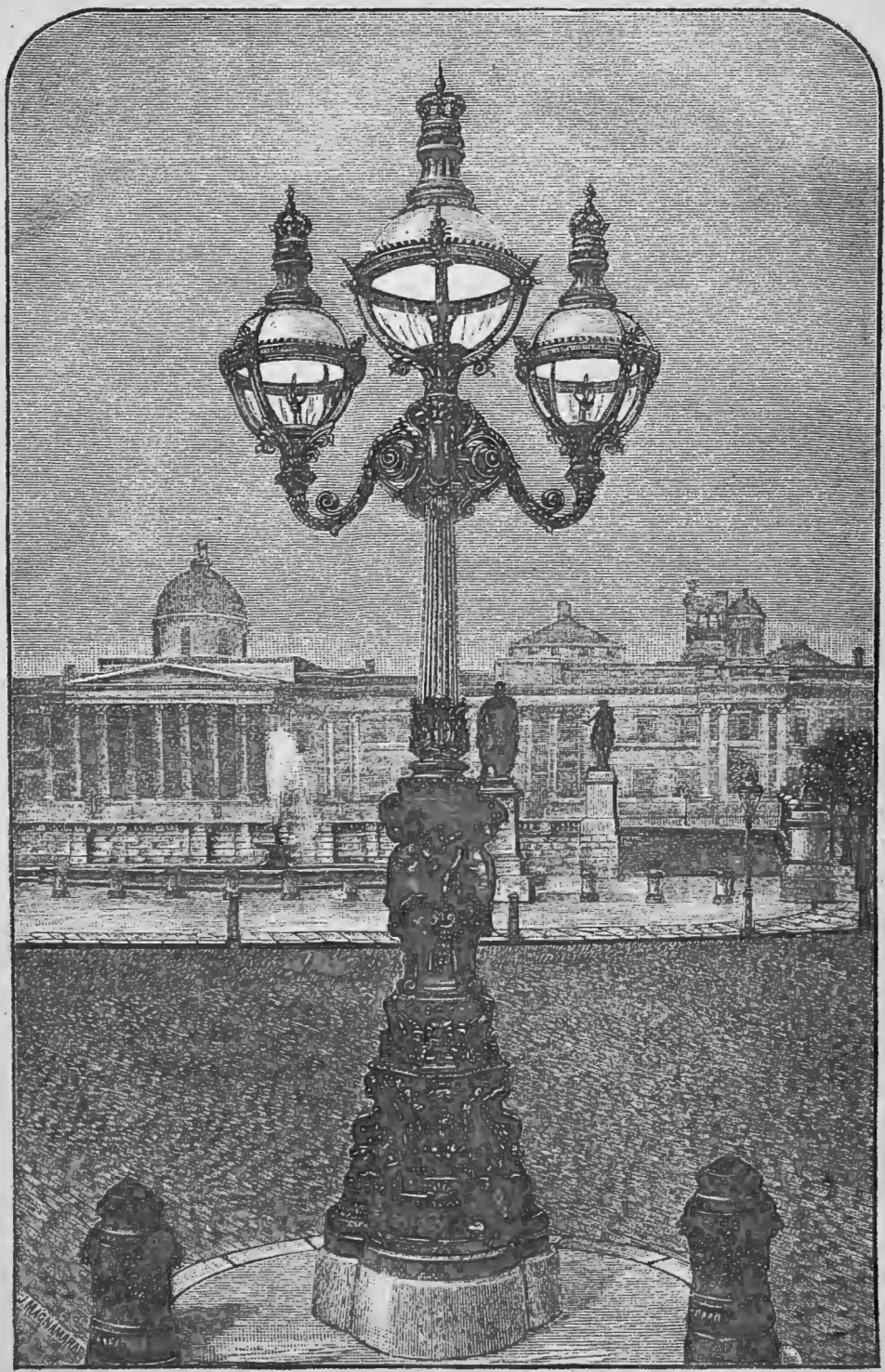
In places near the sea, or where the lamps are much exposed, the flaps for torch lighting must be specially arranged, or provided with a door hinged at the top and secured at the bottom by means of a self-acting catch, or the flaps will be blown up and the lights extinguished on stormy nights.

Above all, it is important that every part of the lantern be made to gauge, so that broken glass may be easily replaced from stock.

The application of such general principles as these must result in the production of lanterns suitable for the use to which they are to be put.

The old model street lamps are remarkable for a too abundant illumination of the sky, and the opposite effect upon the ground.

The shadows of the ribs and ironwork about them are such that, projected over the road, they are exceedingly annoying to drivers of vehicles. while to timid pedestrians they are looked upon as hiding places for thieves. Indeed, as a general rule, a lamp-post, surmounted with one of the old pattern lamps, may be said to be an excellent strategic point for thieves and roughs. The advancing pedestrian is prevented by the light from the lantern itself from seeing, till he is close to it, whether or not there is anyone standing against the lamp-post. This is especially the case in country districts, and



SUGG'S PATENT GLOBULAR LAMPS,

FIXED IN NORTHUMBERLAND AVENUE.

STANDARDS FOR STREET LAMPS.

[*From the* METROPOLITAN, *Oct. 27th*, 1883.]

THE question of the most satisfactory mode of lighting large open spaces which are also important centres of traffic is one in regard to which very considerable difference of opinion exists among public authorities. The first object, of course, should be the provision of an adequate illumination, but it has not unnaturally been also desired that the lights should be erected upon something more than the ordinary bare poles, and where the surrounding buildings have been architecturally of an imposing or conspicuous order, the provision of some special means of lighting has become a necessity. It has, however, unfortunately too frequently happened that the ornamentation has interfered materially with the lighting, and in the provinces, particularly, we could point to several instances where the primary object of street lamps has been apparently ignored altogether. The Metropolitan Board of Works have recently carried out an improvement in the matter of public lighting which is deserving of more than passing attention. There is, perhaps, no spot in London, nor possibly even in the country, in respect of which there was greater room for effective lighting, combined with handsome columns and surroundings, than was presented at the junction of Northumberland Avenue with Trafalgar Square. The opportunity was altogether exceptional in its character; but the architect to the Metropolitan Board of Works (Mr. George Vulliamy), with the assistance of that master of gas lighting, Mr. William Sugg, has provided at this great centre what may almost be said to mark quite a new departure in public lighting of the kind. Two exceedingly handsome standards, each with three branches, have been here provided, and some idea of the elegant nature of the columns is afforded by the accompanying illustration. These standards are from the designs of Mr. G. Vulliamy; the castings are from the foundry of Messrs. Young and Co., of Pimlico, and are from the models made by Messrs. Mabey and Co., of Westminster, sculptors and modellers. The lamps, of globular form, are constructed according to Mr. Sugg's latest patents, and are fitted with his patent combination flat-flame burners, each lamp having a group of four. Three of the burners burn 10 feet each, and one in the centre 5 feet per hour. The centre one is intended to be burned after midnight, and there is an arrangement by which the lamplighter may extinguish the outer three of the group, leaving only the centre one to burn till daylight. Each lamp is provided with a white glass reflecting top, first introduced, we believe, by Mr. Sugg in the experimental street lighting by gas in Waterloo Road and Waterloo Place in January, 1879. The effective illuminating power from each of the six lamps, measured by a photometer on the ground, is 175 candles, making for each candelabrum a total equal to 525 candles. This, we are told, is the highest result yet obtained by common coal gas burned in street lamps fitted with flat-flame burners.

REFERENCES

TO WHOLE-PAGE ILLUSTRATIONS.

WOOD ENGRAVINGS.

LITHOGRAPHS.

PHOTOMEZZOTINTS.

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CHAPTER VII.

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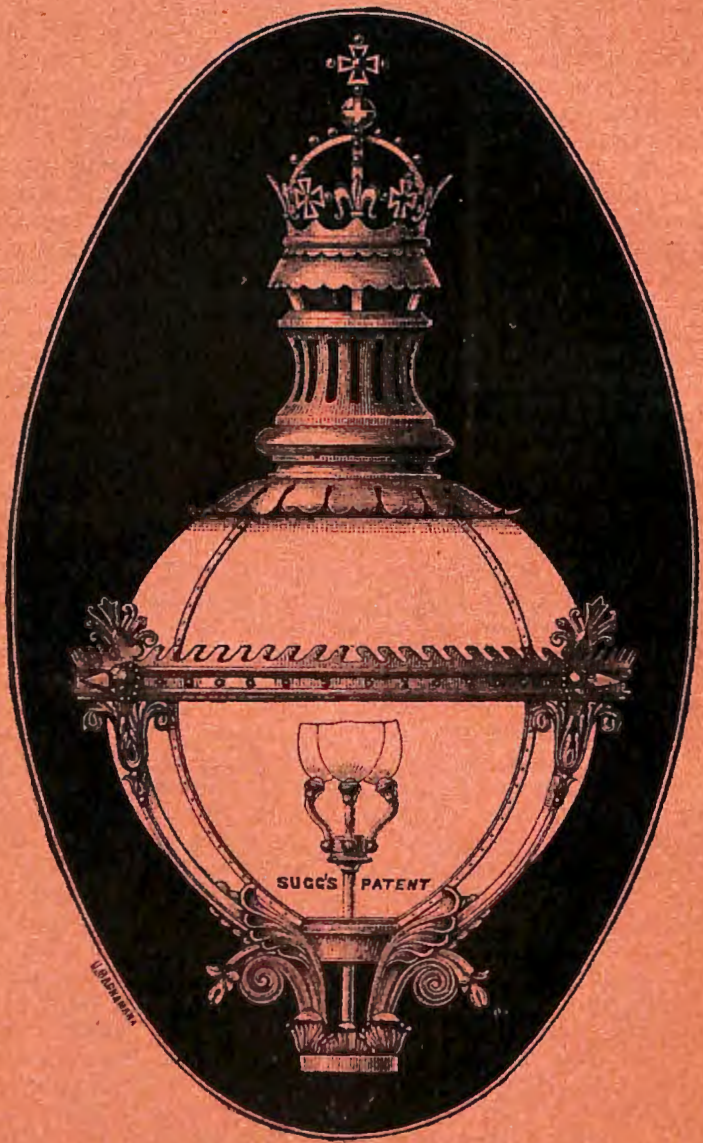
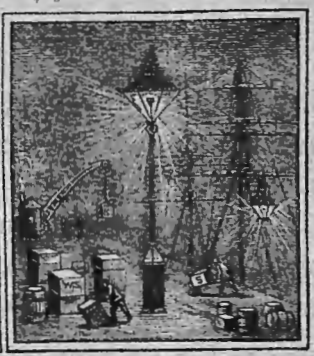


THE "NORTHUMBERLAND AVENUE" LAMP.



CHAPTER I.

STREET LAMPS AND LANTERNS.

Much thought has already been bestowed upon the subject of suitable lanterns; but, as its consideration involves so many points of taste and design, it will be best in this work simply to define the principles which admit of most easy application to differing circumstances, rather than to discuss the merits of the many kinds of lanterns designed by the author and now before the public.

The requisites for a good serviceable street lantern may be summed up as follows, viz.:—

Strength, and at the same time lightness, throughout the framework. As much glass as possible, firmly secured. Ventilation sufficient, and so arranged as to carry off the carbonic acid produced by the burning gas, and supply a sufficient quantity of fresh air to the flame. The door strongly hinged and fastened. The bottom arranged for torch light-

it is precisely in these places where the remedy can be most easily applied.

In town it is doubtless as important, for police purposes, that the fronts of houses should be lighted, at least to the height of the first floor, as it is that the pavement itself should be so.* Hence comes the argument in favour of glass tops to lanterns. But this does not apply in the case of hundreds of thousands of lanterns fixed along roads where there are no houses, or where the houses are low. A reflecting top fixed in these would utilize those rays of light, in number and intensity not inconsiderable, which are now projected up into the sky, and consequently lost. It must be borne in mind, however, that the fronts of houses are more uniformly and usefully lighted by the lamps which are on the opposite side of the road than by those which are close to them, because the shadows of the ribs of the latter are too strongly defined on the house front.

By the use of a properly-constructed lamp, it is easy to obtain all the advantages of reflecting tops without interfering with the illumination of the fronts of houses.

Figs. 1 and 2 are the designs for two lanterns suitable for street lighting, which will be found in a marked degree to fulfil the necessary requirements.

The "Nictheroy" Lantern (fig. 1), which was originally fixed in 1865, is made in three parts—viz., the knob and ventilator, the reflector top, and

* See "Domestic Uses of Coal Gas," p. 108.

the body. Although this arrangement is carried out more with a view to packing than anything else, yet it is found to offer advantages which, in the opinion of some, warrant its adoption in those cases where it is not necessary for the purposes of transport.

Fig. 1.

The Lantern (fig. 2), which is the original "Westminster," as fixed in Dean's Yard in 1868, is rather a modification of the hexagonal lantern

than altogether a new pattern. Its principal features are, that it does not require any lamp head, and is, besides, arranged to facilitate lighting and extinguishing.

It is also fitted with an improved bolt, which

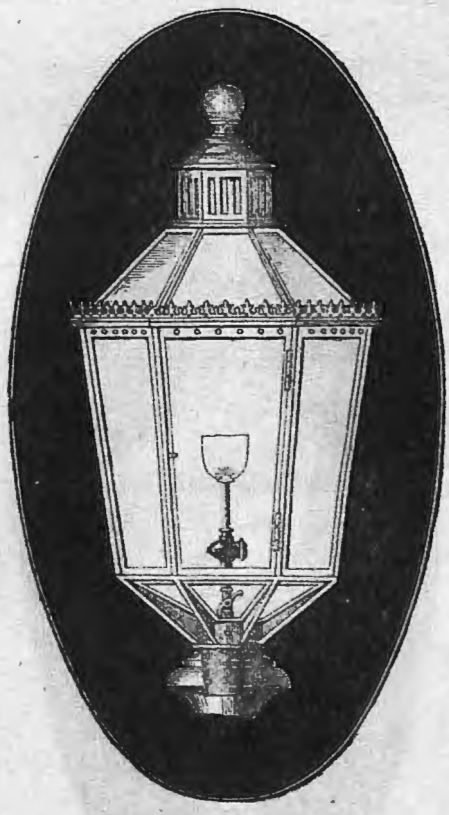


Fig. 2.

holds the lighting flap very firmly, and prevents the wind from blowing it up in any weather.

It drops firmly into the top of the column, from

There is also another size of the "Billingsgate" Pattern Burner (fig. 5), which can be adjusted to 12 feet per hour, giving a light equal to about 35 candles when burning 16-candle gas.

The lantern, 16 inches square, is very strongly made of best tinned plate, and the ventilator is made of copper. The reflecting top is made of best porcelain or enamelled iron, and is easily kept clean. It is made suitable for torch-lighting by means of a strong swing-door hinged to the top.

One great advantage which this lamp possesses over those in ordinary use is the ease with which it can be cleaned. There are only four glasses in it, while in the ordinary 14-inch street lamps there are twelve. The lamp is also very steady in windy weather.

The arrangement of the reflector renders the lamp nearly shadowless, and permits of the introduction, in the lower portion of the glasses, of the name of the street, which can appear on two sides; the distance of nearest fire-plug on the side facing the roadway; and the distance of nearest post office or pillar box on the side nearest the footway.

The "Victoria" Lamp (fig. 6) is fitted with a triple lever cock (see page 46) and central burner. This may be varied according to the amount of light required after the hours of general lighting. This lamp has been very extensively adopted in London, and throughout the United Kingdom by Lighting

It gives nearly twice the light of an ordinary lamp with the same quantity of gas.

"THE METROPOLE."—14 *inch Square.*

Fig. 7.

"THE METROPOLE."—16 *inch Square.*

Fig. 8.

LIGHTED BY LARGE LAMPS MARCH, 1879.

QUEEN VICTORIA STREET, LIGHTED BY LARGE LAMPS MARCH, 1879.

the Holborn Viaduct followed its example on the following evening, many expressed the opinion that gas *must* give way.

This the gas engineers refused to admit, and Mr. Corbet Woodall persuaded the Phœnix Gas Company to provide gas for some large lamps in Waterloo Road. At the same time The Gaslight and Coke Company appointed a committee of their directors to take action in the same direction. Both companies placed the matter in the hands of the author, who erected large lamps fitted with his multiple Argand burners.

Waterloo Road was lighted on the 11th of January, 1879; Waterloo Place on the 31st of the same month; and Queen Victoria Street early in March. These experimental illuminations proved conclusively that by its more liberal employment gas could furnish any desired degree of light, and yet be under absolute control.

The lamps (fig. 9) approach the diamond shape in vertical section, and are, in plan, hexagonal, octagonal, or 12 sided, according to their size. The top of the lamp is glazed with a new kind of opal glass which does not allow the passage of any direct rays of light, but which presents a brilliantly illuminated even white surface. The lower portion is of clear glass, which transmits the direct rays as well as those from the brilliant white roof of the lamp. The result of this is that there are no shadows, and even the lamp-post is distinctly visible.

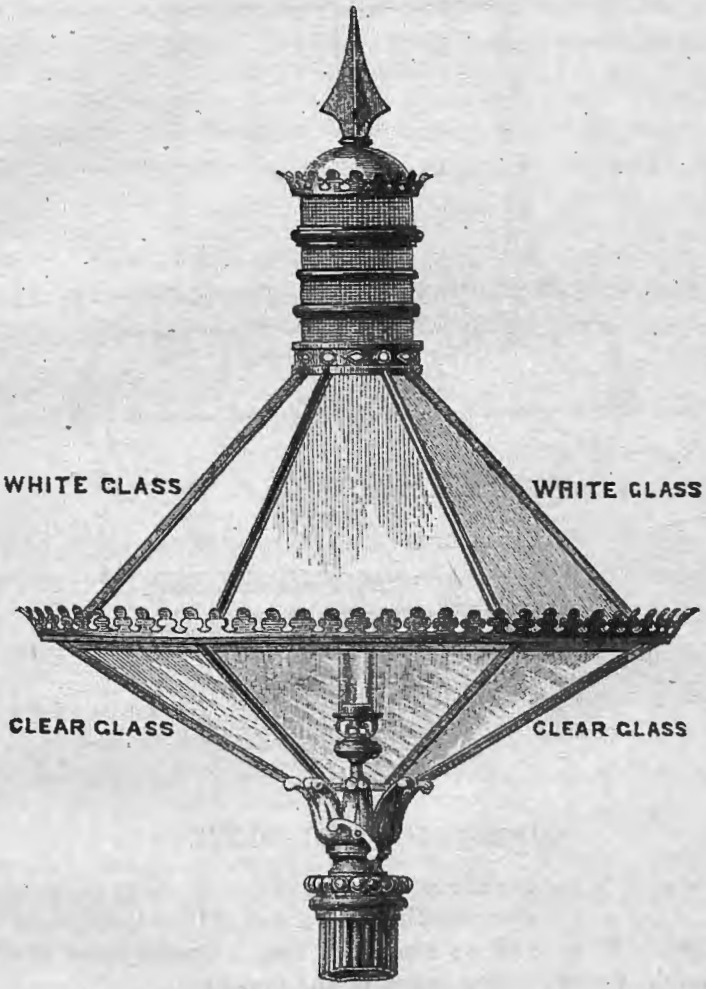


Fig. 9.

The extract, on the following pages, from *Engineering*, Feb. 14th, 1879, gives a detailed account of the cost, and compares the new system with the old.

which costs for gas 3s. 6½d. per hour; secondly, those of the Waterloo Road experiment, where the cost is 1s. 7d. per hour; and, thirdly, the intermediate system temporarily applied in Waterloo Place by Mr. Sugg during the transition period already alluded to, and in which the cost of gas was 1s. 1½d. per hour. These three degrees of excellence form examples of what can be done with gas, and they illustrate the value of these experiments, inasmuch as they point out that any desired degree of illumination can be obtained from gas, and that it is only necessary for a vestry or any other public body to say what amount of light they are prepared to pay for and they can have it."

NOTE.—The burner powers referred to in the above report are those actually given by the burners when removed from the lanterns. The higher illuminating value obtained by means of the large reflecting lanterns described in Chapter III. is due to the fact that they allow free passage to the direct horizontal and descending rays, but also utilise, to the fullest extent, the upward rays.

In some parts Argand burners have been thrown out of use, and a diminished light for the same consumption of gas has been tolerated because so many chimneys have been broken. It might be very difficult to find out how it is that in some districts the breakages have been so numerous; but it may be that care has not been taken to see that the ventilation at the bottom of the glass was quite free, and that there was no accumulation of dirt or insects. It may have been that the lamplighter, thinking them more trouble than the old lamps, has not *always* been as careful as he might have been. Anyhow, the following reports will show that with *proper* care the presence of the glass chimney is

not a sufficient reason for sacrificing a portion of the light.

In Liverpool, the Engineer of the Gas Company, Mr. William King, has informed me that NO CHIMNEYS HAVE BEEN BROKEN IN EIGHT MONTHS OF TRIAL OF THE 200 AND 100 CANDLE LAMPS, NOTWITHSTANDING THE BAD WEATHER.

This statement has been corroborated by many others who have used the Argand lamps—a fact showing that with ordinary care the chimneys, which are of the best quality of glass, will last for many months or even years.

Sir James Douglass, Engineer of the Honourable Corporation of the Trinity House, has informed the author that although that Corporation has in its lighthouses the greatest number of Argand lamps and chimneys, yet the percentage of breakage is so small that it is not worth speaking of, and that many of their chimneys last for years.

With the large Argand burners which are formed of two, three, or more Argand burners of different diameter arranged concentrically, the following difficulties occur:—

The large flame necessitates a long chimney, in order to obtain the requisite amount of draught to raise it to its highest state of incandescence, and also to carry off the products of combustion.

As these chimneys are from 12 to 18 inches in length, according to the size of the burner,

CHAPTER III.

LARGE LAMPS—FLAT-FLAME.

ALTHOUGH the Argand lamps have in every respect held their ground for steadiness, illuminating power, and durability, they have been largely replaced, as public lamps, by flat-flame burners.

It may not be out of place to mention here that marsh gas, which is present in gas in such large quantities, has no illuminating power when consumed in a flat-flame burner; but has a considerable illuminating value when an Argand burner is employed.

This surrender of light must be mainly attributed to the lamplighters. They have their allotted number of lamps to light, and are expected to have them all lighted within a certain time; they must, therefore, have lamps which can be opened readily by the torch and lighted at once. This change in the form of the burner involved the entire reconstruction of the lamp. With the Argand and its chimney, the burner provided its own draught,

and the heated products of combustion ascended in such a definite column that the chimney of the lamp-case only required a very elementary wind-guard. When, however, the lamp-case had to protect a combination of several flames, the top required to be protected from the heat, and the air had to be admitted in such a way that it did not blow the flames about.

After many experiments, and a careful consideration of all the points involved, the author has constructed a series of lamps in which each lamp is designed and made to meet its requirements.

Of these the most important are the "Lambeth" (fig. 12), "Westminster" (fig. 13), "Whitehall" (fig. 11), "Globe" (fig. 14), "Nottingham" (fig. 15), and "Strand" (fig. 16), from 60 to 150 effective candle power. They are specially designed for use in Parks, Promenades, and important thoroughfares, where a less ornate form would be out of place.

The following are the special advantages of these lamps.

1st.—The system of ventilation, which supplies air to the burners from the top of the lamp, is that invented and introduced by the author in 1879. Previous to that time public lamps were usually ventilated from the bottom, with generally gauze or other expedients to restrict the inlet of the air.

By the author's improvement the top of the lamp is kept cool by the incoming air, which, on its

THE "LAMBETH" LAMP.

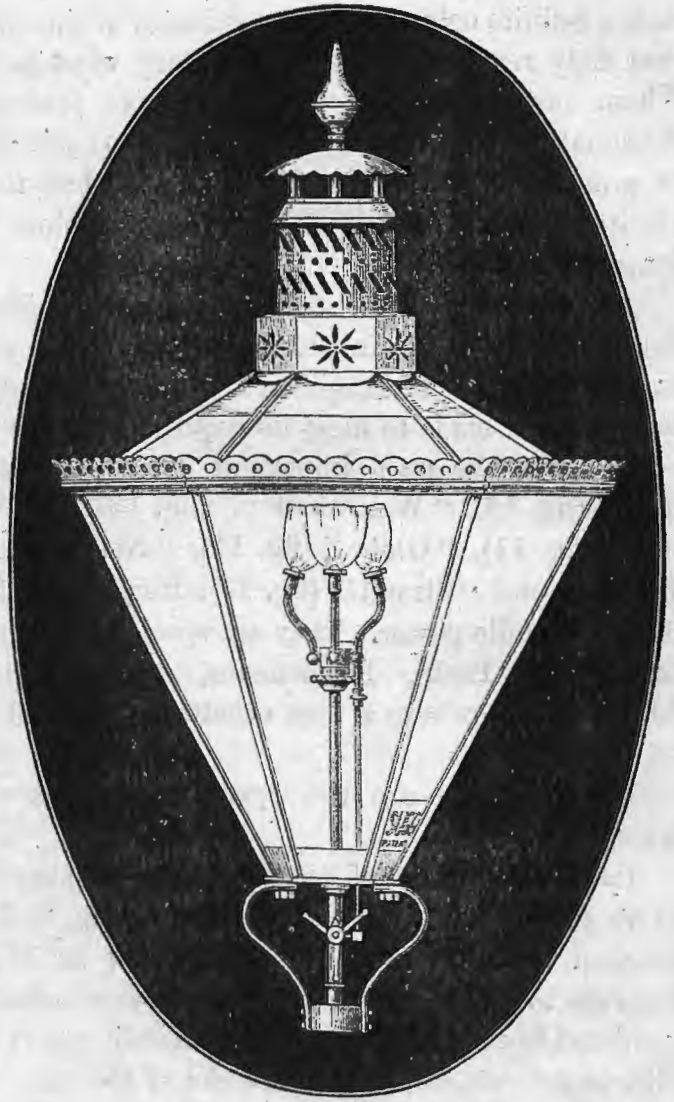


Fig. 12.

This lamp when tested *in situ* gives a light of 150 candles for 30 cubic feet of 16-candle gas consumed.

London Stereo. & Photo. Co., Ltd., Photomezzotype.] *[From a Photograph by the Author.*

WILLIAM SUGG'S PATENT "LAMBETH" REFUGE LAMP.

London Stereo. & Photo. Co., Ltd. Photomezzotype.] *[From a Photograph by the Author.*

WILLIAM SUGG'S PATENT "WESTMINSTER" LAMP,
FOR REFUGES.

Improved Street Lighting at Westminster.

[*From the* Journal of Gas Lighting, *March 29th*, 1881.]

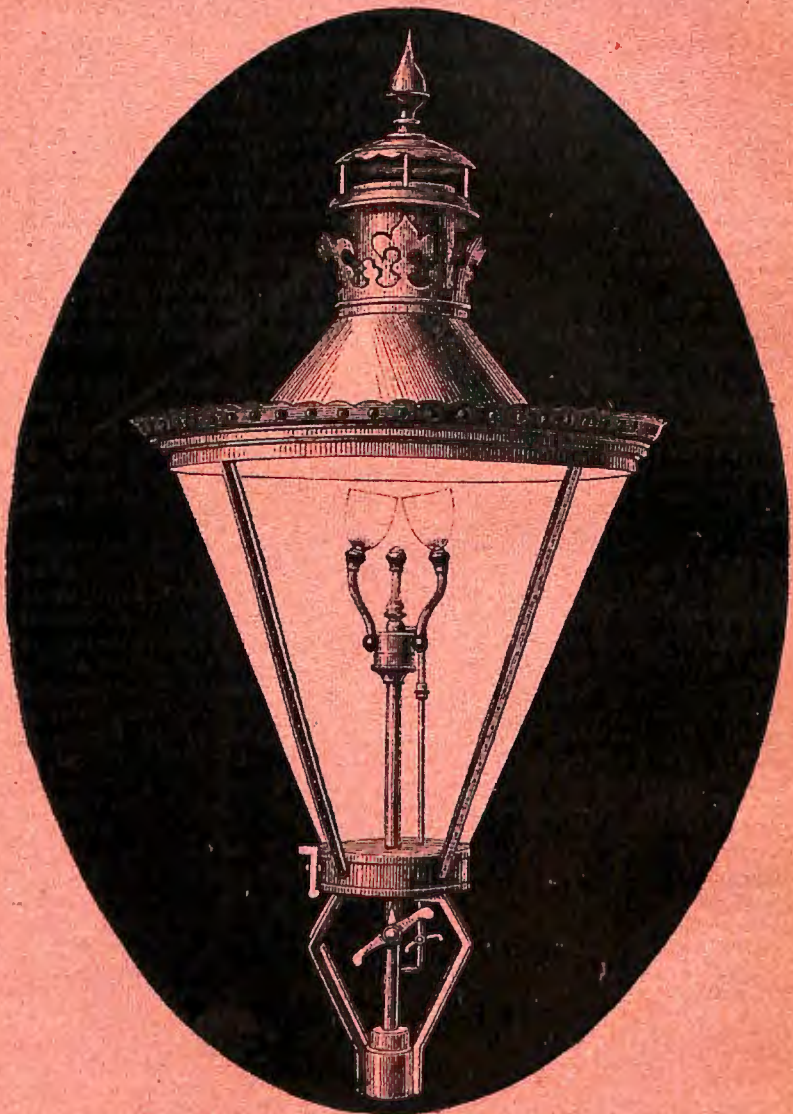
At the meeting of the Chartered Gas Company on the 11th ult., it was stated by the Governor (the Hon. R. Howe Brown) that permission had been obtained of the vestries, and other bodies concerned, to make an experiment in improved street lighting by means of gas, for the whole length of Parliament Street, Whitehall, and Charing Cross to Trafalgar Square, and that the matter would be immediately proceeded with. In accordance with this announcement, and with the least possible delay, considering the extent of the change contemplated, and the number of the persons to be consulted in reference to the matter, the Chief Inspector of the Company (Mr. T. C. Hersey) arranged with Mr. Sugg for the carrying out of the work; and after various slight modifications, the experiment was successfully put into operation last week.

As the existing lamp-posts were sufficiently near together, they were throughout utilized, and no changes were made in their positions; two additional posts only being placed on refuges almost opposite Downing Street, in order to light the wide stretch of roadway at this part. A special form of shadowless lantern—the "Whitehall"—was designed by Mr. Sugg; and the burners used therein are groups of three, four, and five flat-flame governors.

As to the position of the different sized lights, as at present arranged there are 68 lamps with 60-candle burners fixed on the posts along the edges of the roadway from the Great George Street end of Parliament Street, through Whitehall, to Charing Cross. Here round the statue of Charles I. are 4 lamps with 100-candle burners each; while to complete the display there are, at intervals, on the refuges in the centre of the carriage-way, 11 lamps with 180-candle burners in each. The estimated consumption of gas will be 20, 30, and 50 feet per hour respectively, costing for the whole illumination of 6160 candles, by the consumption of 1920 feet of gas, 6s. 8d. per hour. It is intended, however, in order to economize, that the major part of the small-size burners—55 out of the 68—shall be extinguished at midnight; leaving the lighting to be performed by the whole of the larger lights assisted by 8 only of the small ones. This, it is stated, will reduce the cost, after twelve o'clock at night, to 2s. 1d. per hour; the lighting power then being equal to 2460 candles by the use of 710 feet of gas. It may be mentioned, for the sake of comparison, that formerly the 76 lamps then in use consumed 848 feet of gas per hour, at a cost of 1s. 0·2d., and gave, it may be assumed, something like 700 candles of illuminating power. The relative annual cost will be seen from the following figures:—

	New System.				Old System.		
Before midnight	£718	6	8	...	£108	15	8
After midnight	222	19	2	...	108	15	8
Total for 4280 hours in the year	£936	5	10	...	£217	11	4

In connection with this experiment we learn that Mr. Sugg, on his own account, is proposing to light up Trafalgar Square, and the immediate neighbourhood, with similar sized lanterns and burners. It is intended to employ 40 of the 60-candle burners—9 only being retained alight after 12 o'clock each night—and 8 of the large 180-candle burners. The preliminaries only in regard to this proposal have so far been arranged, no step having been taken to carry out the work.



THE "WHITEHALL" LAMP.

THE "WESTMINSTER" LAMP.

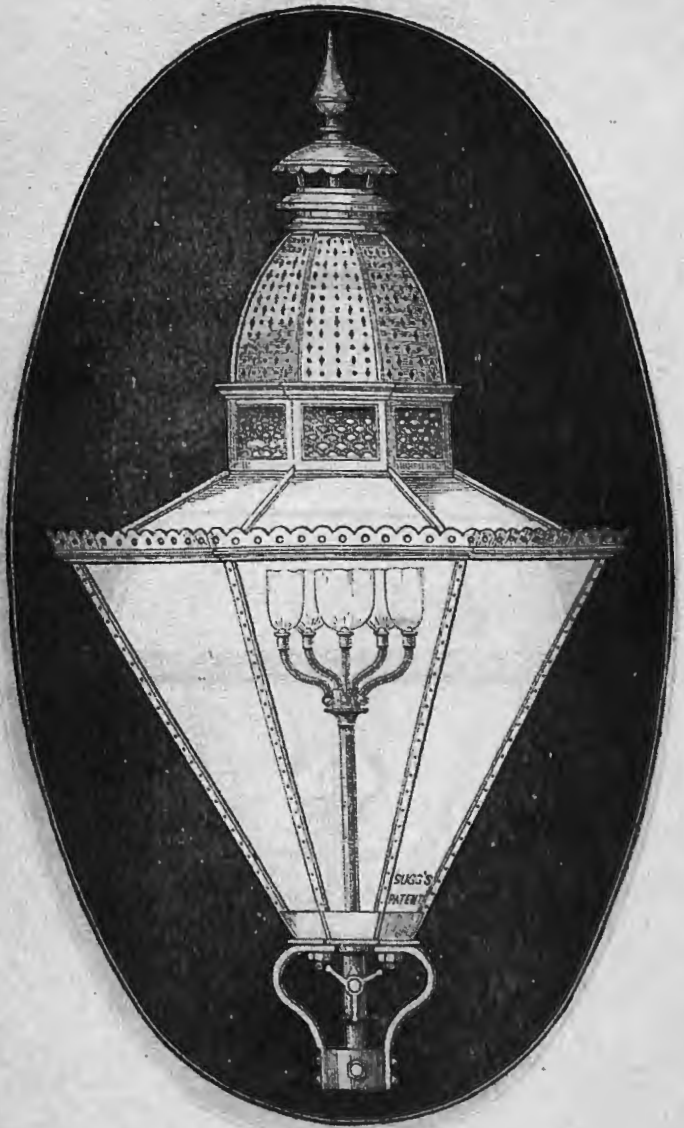


Fig. 13.

This lamp when tested *in situ* gives a light of 260 candles for 50 cubic feet of 16-candle gas consumed.

THE "GLOBE" LAMP.

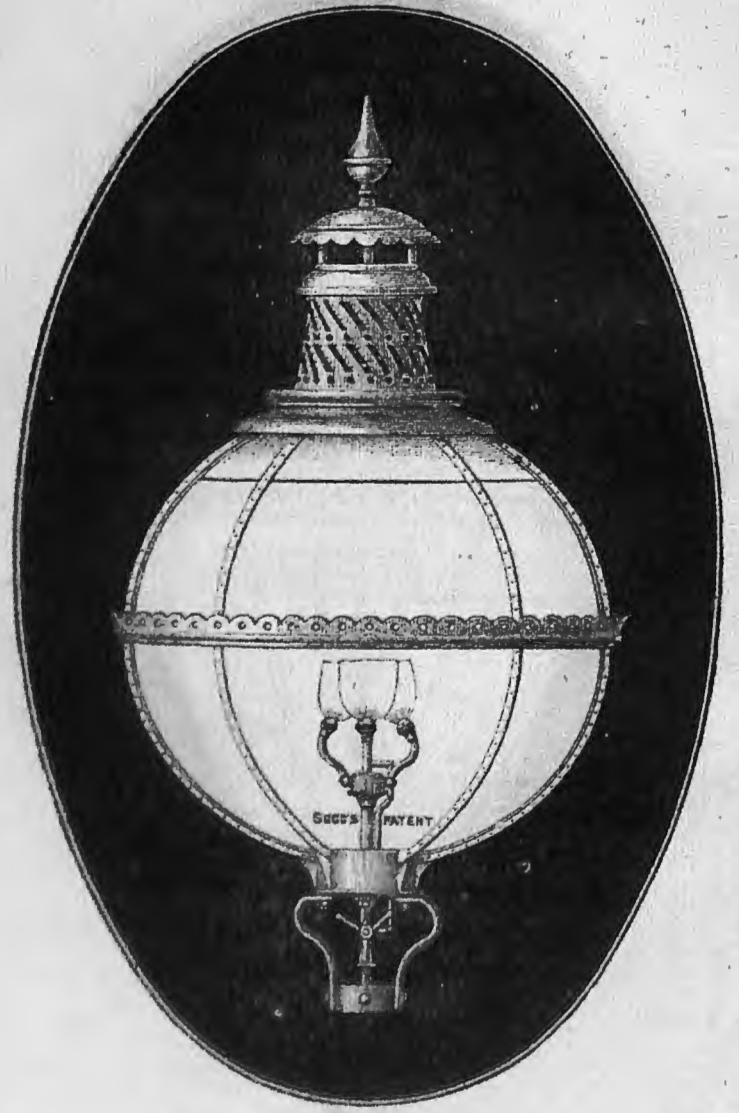


Fig. 14.

THE "NOTTINGHAM" LAMP

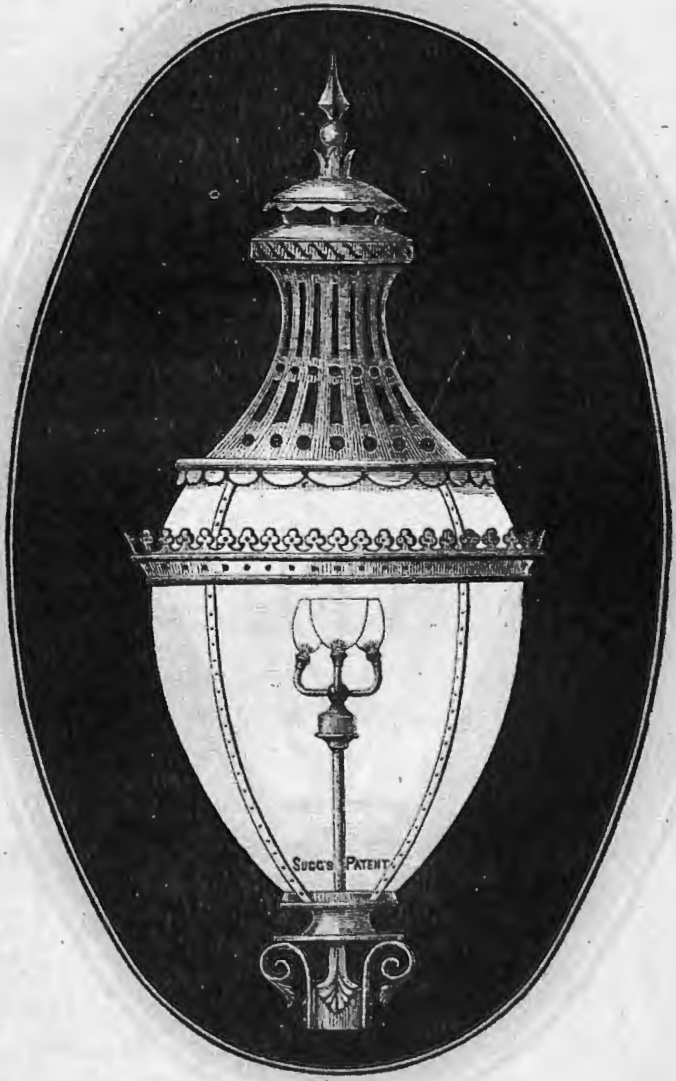


Fig. 15.

THE "STRAND" LAMP.

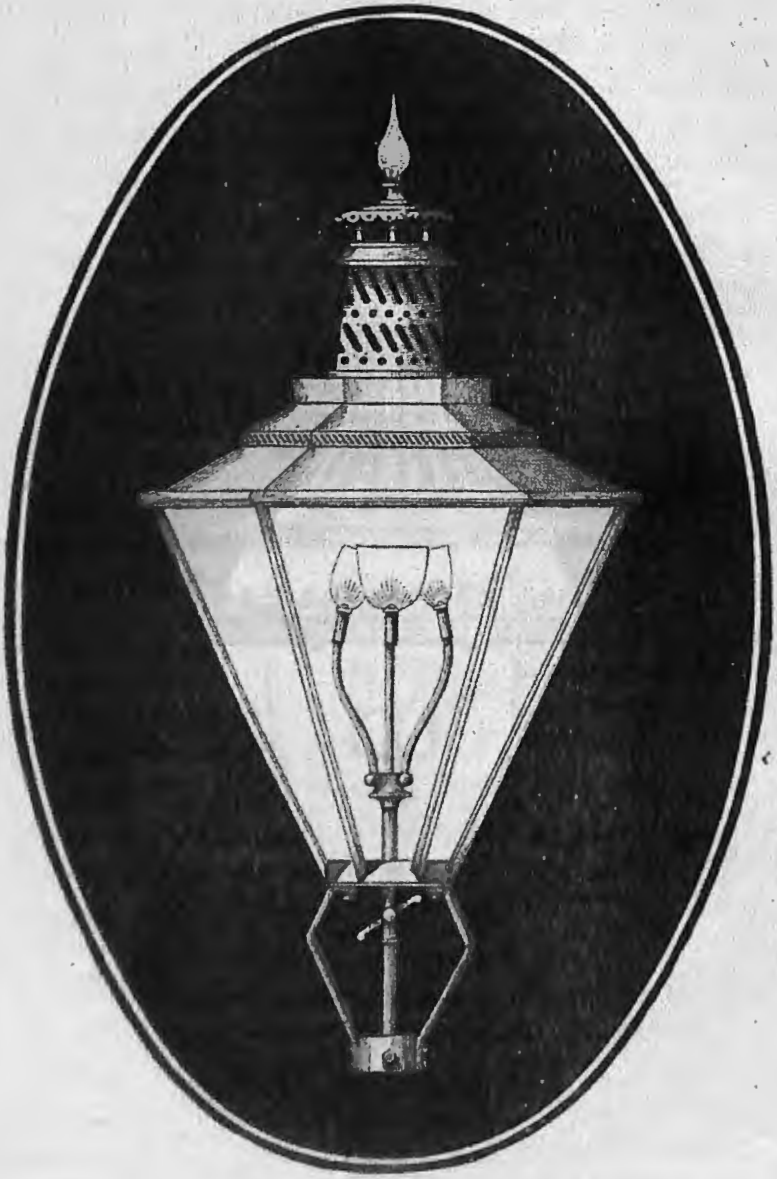


Fig. 16.

passage to the burners, absorbs the radiant heat and thus arrives at a proper temperature to feed the flames. By this system the flames are raised to a higher state of incandescence than can be achieved in any lamp in which cold air is supplied through the bottom. By this latter old-fashioned method of letting cold air into the bottom of the lantern the temperature of the flames is considerably diminished, and the illuminating power is consequently reduced; whilst at the same time the heat of the flames is driven up against the glasses at the top of the lantern, overheating them and causing them to crack.

2nd.—The "Whitehall" lamps possess the great advantage of having a combined porcelain and enamelled iron reflector and only four clear glasses. They are easy to clean and cheaply maintained.

3rd.—The opal glass used in the "Strand" and "Lambeth" models, introduced by the author, and since almost universally adopted, renders the lamp absolutely shadowless, and in conjunction with the white porcelain reflector, serves not only to brilliantly light the base of the column immediately around the lamps, but to disperse all the useful rays of light over a wide surface of roadway.

It has recently been clearly demonstrated by means of a new travelling photometer (see p. 101), expressly made for testing electric and other large lamps of every kind, that these improved shadowless lamps cover a larger area of the road with greater

COMBINATION BURNERS.

3-FLAME BURNER.

DRAWN TO SCALE OF ONE-THIRD.

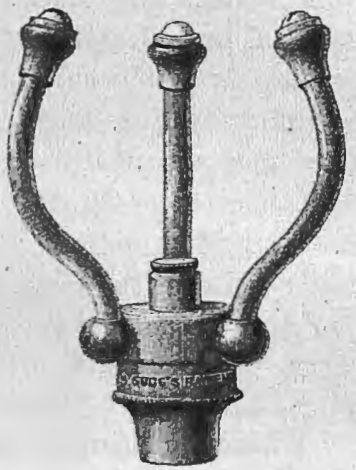


Fig. 17.

5-FLAME BURNER.

DRAWN TO SCALE OF ONE-THIRD.

Fig. 18.

illuminating power than any ordinary lamp burning a like quantity of gas, while at the same time the refuge and base of the column are brilliantly lighted, so that drivers of vehicles can readily see the persons standing there and thus avoid accidents.

4th.—The burners used are Sugg's Patent Table-Top Flat-flame Burners (figs. 19 and 20), in

UNCASED.

Fig. 19.

CASED

Fig. 20.

combinations from 50 candles upwards. (See figs. 17, 18, and 21). They are most carefully made of the very best selected steatite, a substance which is absolutely incorrodible, a non-conductor of heat, and harder than the very hardest steel, thus producing a finer and more durable burner, which maintains the heat in the flame, and therefore gives greater illuminating power than can be obtained by the use of a burner made of metal or any other material hitherto employed for the purpose. (See "Domestic Uses of Coal Gas," p. 88.)

The steadiness of these burners in any weather

is guaranteed to be superior to any other form of lamp.

The burners are fitted with the Patent Governor with Steatite Float (see p. 60), accurately adjusted to the required consumption per hour.

5th.—These lamps can be lighted by a torch (see p. 44). They can be fitted with a bye-pass arrangement, originally introduced by the author, enabling the lamplighter to reduce the consumption at midnight to 4 or 5 feet per hour.

For lighting large spaces and in prominent positions such as dock-heads and dock entrances, the most suitable lamps are the "Greenock." In pattern they resemble the "Lambeth" lamps, but are of 500 effective candle power which, by the same arrangement as before mentioned, can be reduced by a turn of the hand from their full power down to half power, one-third power, 10-candle power, or one rushlight power, with the important economic result of a proportionate reduction in the cost.

Thus, a large ship arrives at the mouth of the dock. At once, without any preparation, the captain of the dock, or the nearest labourer, turns on the entrance lamps full power, and the flash-light left burning lights them up to 500-candle power each simultaneously.

A broad flood of shadowless light is thrown all over the surroundings of the dock entrance.

Simultaneously with this a row of smaller lamps

of 150-candle power are as rapidly produced from ordinary 5 feet per hour burners, which burn only at that rate when there is no need for a greater light.

The ship is docked by this means, and with the same facility, by night as by day, at a mere nominal cost in comparison with the work performed. There

THE "GREENOCK" BURNER.
DRAWN TO SCALE OF ONE THIRD

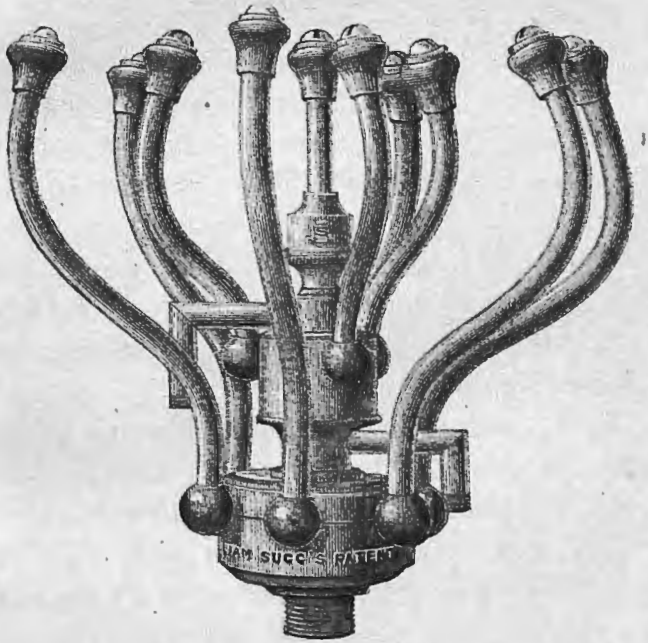


Fig. 21.

are also now means by which gas can be laid on to a ship in dock, and lamps (fig. 22) of 150-candle power constructed to throw a powerfully concentrated light down the hold as well as all around the ship. These can be hung at three or four different

points in the rigging, so as to permit of the unloading a ship during the night. This kind of work is now required by the new large fast steamers which are discharged and loaded again as soon as they arrive, without the delay of an hour.

M. Serment, in his notice of the improved public lighting in Marseilles, in which the lamps adopted were the "Lambeth," the "Whitehall," and the "Greenock," states :—

"Their distinctive character is a large reflector so arranged that the light above the flames is utilized, and the result on the roadway is more light, instead of shadows of the framework of the lantern.

"A lamp is made to light a portion of a public thoroughfare, and not to merely render itself visible from a distance; this is the duty of lighthouse lamps and signals."

"These lamps have another feature which is valuable everywhere, but especially at Marseilles—viz., that the flames are not in the least affected by the wind, even during a gale. This is effected by allowing the air to enter by a number of small holes in the ribs of the lantern, the apertures being made obliquely, so that the currents of air clash and enter quietly.

"We took special notice of this feature as it is well known that Marseilles is exposed to a north-westerly gale called the *Mistral*, formerly spoken of as one of the three plagues of Provence."

THE "SURREY" DOCK LAMP.

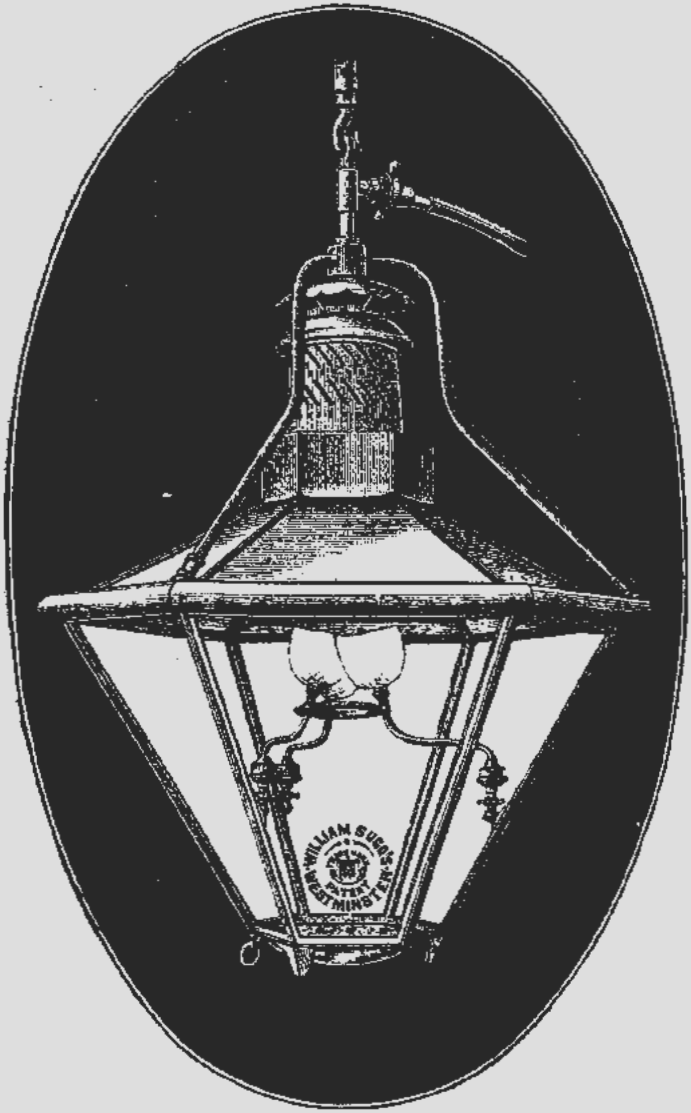


Fig. 22.

CHAPTER IV.

LIGHTING AND EXTINGUISHING.

The following, though not suitable to every locality where it may be required to fix governors to the public lamps, will, however, be found to be most advantageous in the majority of cases. It is based upon the experience gained since the introduction of governors by those who have had them in constant use in Great Britain and Ireland, and various parts of the world.

LANTERNS ON COLUMNS.

These are best fixed in the manner shown in fig. 23; the cock (fig. 24 or fig. 28) being just under the lantern. The governor being fixed in this manner, the burner will, in an ordinary 14-inch street lantern, just reach the middle of the side pane, which will be found to be the most convenient

height. For lanterns of a larger size, a longer cone must be employed.

NOTE.—The hole in the bottom of the lantern is not required to be larger than $\frac{3}{4}$ of an inch.

In cases where the space between the bottom of

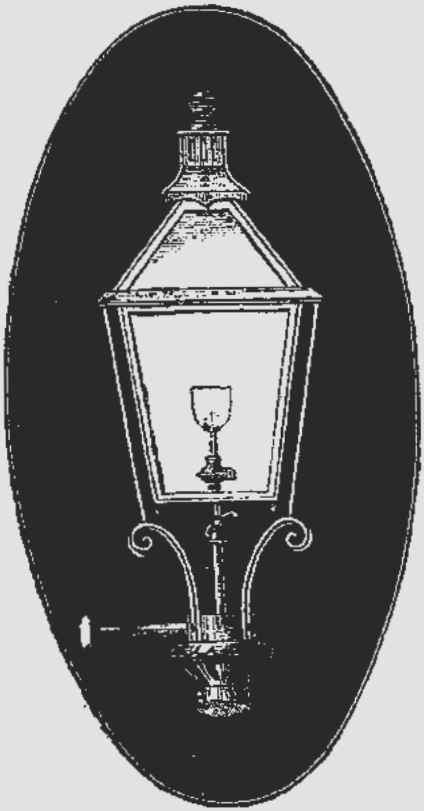


Fig. 23.

the lantern and the top of the column will not be sufficient for the lever cock (fig. 28), the improved patent (fig. 24) which turns on and off by a hori-

necessity of cutting and rescrewing the standpipes, which, however, by the aid of proper tools, can be readily done *in situ* without disturbing the ground.

Upon this point, it may be as well to mention that in all cases the standpipes ought to be wedged tightly in the top of the columns, for the continual vibration they are subject to, when not so treated, seriously interferes with the soundness of the joint at the bottom of the post. The difficulty of getting at this joint is a sufficient reason why attention should be paid to this detail.

LAMP COLUMNS.

The lamp columns illustrated in the accompanying lithographs are based on the same principles as the one designed by the author in 1878. As their object is not merely to have an ornamental appearance by daylight, but to carry a lamp, they are entirely divested of any projecting capitals, which cause strong shadows.

BRACKET LANTERNS.

In the case of bracket lanterns, it has been usual to convey the gas into the lanterns by means of copper and sometimes metal tubes or "twiggings," as they are technically termed. The inconvenience

and extravagance of this system, from the frequent derangement of the conduits and their almost constantly leaky state, have led to the substitution of iron pipe so fixed that it is not necessary to disconnect the fitting in order to remove the lantern.

The cock made use of is shown in fig. 25, and is made, the barrel of brass and the plug of gun metal, turning on and off, with a horizontal motion of the lever of one quarter of a circle. If the lamp is fixed near a wall, and is supplied from an iron T-piece or elbow, it is advisable to use the pattern

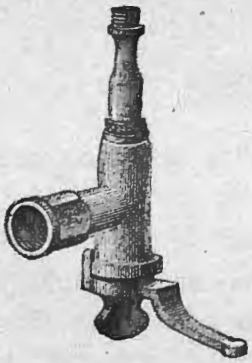


Fig. 25.

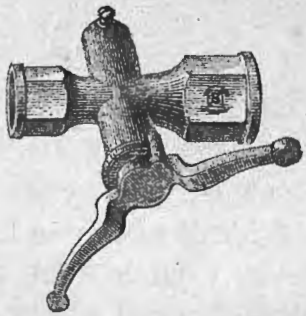


Fig. 26.

fig. 26. It can then be removed easily without interfering with the gas-pipe, as the stop-cock may be placed close to the wall.

NOTE.—In screwing on the cock, care must be taken that the thread fits tightly, or there will be a possibility of its being turned a little by the frequent stroke of the torch in lighting and extinguishing.

TORCH LIGHTING AND EXTINGUISHING.

This system which, since its introduction into England a comparatively short time since, has been constantly increasing in favour, is however no new thing, for on the Continent it has been practised for a very long time.

However it may have succeeded there, it was nevertheless clearly unsuited to the system of lighting adopted in this country, until the application of governors and steatite burners to street lamps. With these improvements it is found to work uncommonly well, because a simple movement is all that is necessary to turn on the gas, which requires no adjustment, and if the lamplighter brushes his burners when he cleans the lamps, he may confidently depend upon the shape of the flame being always good. The turning off of the gas has for many years been done almost everywhere with the aid of a stick, and to this cause may be traced the almost universal loss of one or more of the quarter bottoms which ought to be found in every street lantern.

A proper amount of ventilation is necessary, or the lanterns would soon fall to pieces from the heat generated by the combustion of what is, considering the size of the chamber in which it is consumed, a very large quantity of gas; but no one who sees the flames blowing about in the manner they do can reasonably say that the best way of insuring that

result is attained by the absence of the bottom of the lantern. It is very probable that the loss of gas and consequent loss of light caused by this strong draught would compensate in a very short time for the expense of putting in the bottoms and keeping them in proper repair. In Paris the Gas Company has become so strongly convinced of this fact that they have gone to a very considerable expense in fitting to the lanterns an arrangement of plate glass mounted upon a brass swivel fixed on the supply pipe, which is opened and closed by the lamplighter when he lights the lantern, the hole through which the supply enters the lantern being carefully stopped, if not by the arrangement just spoken of, then by putty.

Fig. 27.

The torch-lighting system requires but little explanation, and is as follows, viz.:—

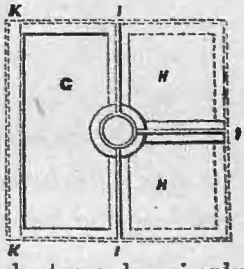
The lamplighter is provided with a torch (fig. 27), which is simply a small lamp in a brass case, the top part of which is drilled full of holes to admit air to the flame, but so guarded by an inner screen that the wind or a violent motion in carrying it about will not extinguish it, and mounted upon a light staff, varying in length, and jointed or not as may be required. With this he hits the lever of the cock (fig. 28) on one side to turn it on, and the other to

shut it off. There is a little hole at the top of the torch which projects a ray of light upon the lever sufficient to enable the lighter to find it upon a dark night.

NOTE.—On rainy nights the torch should not be carried perfectly upright, or a drop of rain falling into this small hole may extinguish the light.

Immediately the cock is turned on the torch slips off the lever, and striking the glass flap (G), which is hung on a piece of brass tube soldered along the back of the frame into which it fits, lifts it, and passing up ignites the gas immediately; the torch being withdrawn the flap falls of itself.

NOTE.—These flaps may be made of 20-oz. glass, and will last a very long time. They do not readily break even with a violent blow. They are slipped into grooves and held by a copper tack at each end. The flap bottom complete, as shown at (G, H, H), may be easily applied to existing lanterns by simply cutting out the old cross bottom and soldering the new one at three points (I, I, I) outside the bottom of the lantern; the wire for the flap hinge is put through two holes drilled one on each side of the bottom frame at (K, K).



It is obvious that, to ensure the success of the system, and prevent loss of gas, it is essential that the stops of the cocks should be sufficiently strong to withstand the continual blows of the torch.

In the case of large lamps, in which it is required to have a reduced consumption of gas after certain hours, and in addition to that a flash-light which is always burning, the arrangement represented in fig. 31 has proved the most satisfactory. This enables the lamplighter to have the main ring, or cluster of flames, alight without the centre one.

For supplying gas by means of a flexible tube to the "Surrey" lamp (fig. 22), the arrangement illustrated in figs. 32 and 33 is to be recommended. When it is not in use the gascock is out of danger, as it is below the ground, and when it has been used the coupling cannot be removed until the gas has been turned off.

Fig. 32.

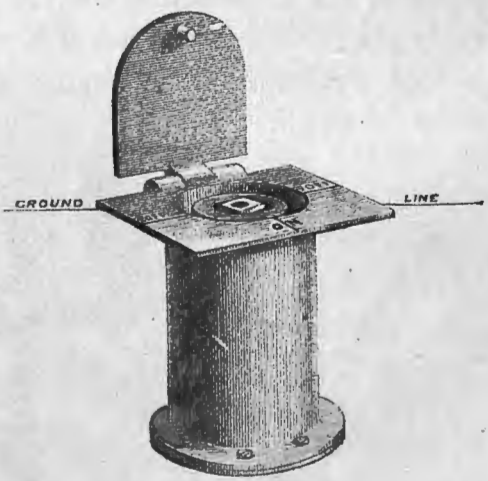


Fig. 33.

SUGG'S LIGHTING TABLE.

In order to avoid disputes, it has always been necessary that the Lamplighters should work according to a properly-constructed Lighting Table.

These Tables are now mostly made up from the data given in the Nautical Almanack. As will be seen by an inspection of the various curves given on page 51, such tables can only be accurate for certain places (see page 50).

By the use of the author's lighting table, extended and rendered applicable to all parts of the world, by Mr. Jas. T. Brown, and given in this work on pages 52 and 53, accurate tables may be constructed for any part of the globe. The curves on the accompanying diagrams have been calculated from astronomical data. The horizontal lines are at intervals of one week, and the perpendicular lines represent the hours of the day and night. The curve which crosses and re-crosses the Noon line shows the irregularity in the Sun's time.

The following are the places to which the various curves refer :—

CURVES.

No. 1. Lat. 64° North.—
Norway, N. of Christiania. Russia, N. of St. Petersburg.
Sweden, N. of Stockholm.

No. 2. Lat. 58° North.—

Scotland.	Russia, N. of Warsaw.
England, N. of York.	Denmark.
Ireland, N. of Belfast.	Norway, S. of Christiania.
Russia, S. of St. Petersburg.	Sweden, S. of Stockholm.

CURVES.

No. 3. Latitude of London.—

England, S. of York.
Ireland, S. of Belfast.
Russia, S. of Warsaw.
France, N. of Bordeaux.
Belgium.
Holland.
Switzerland.
Canada.
United States, N. of Oregon.
Austria.
Germany.
Prussia.

No. 4. Lat. 35° North.—

Spain.
France, S. of Bordeaux.
Portugal.
Italy, S. of Turin.
Turkey.
Turkey in Asia.
Persia.
Egypt.
Algeria.
United States, S. of Oregon.
Greece.
India, N. of Allahabad.
China.
Japan.

No. 5. Lat. 14° North.—

India, S. of Allahabad.
Africa { N. of Equator. / S. of Egypt.
South America N. of the Equator.
Canton.

—Equator—

No. 6. Lat. 14° South.—

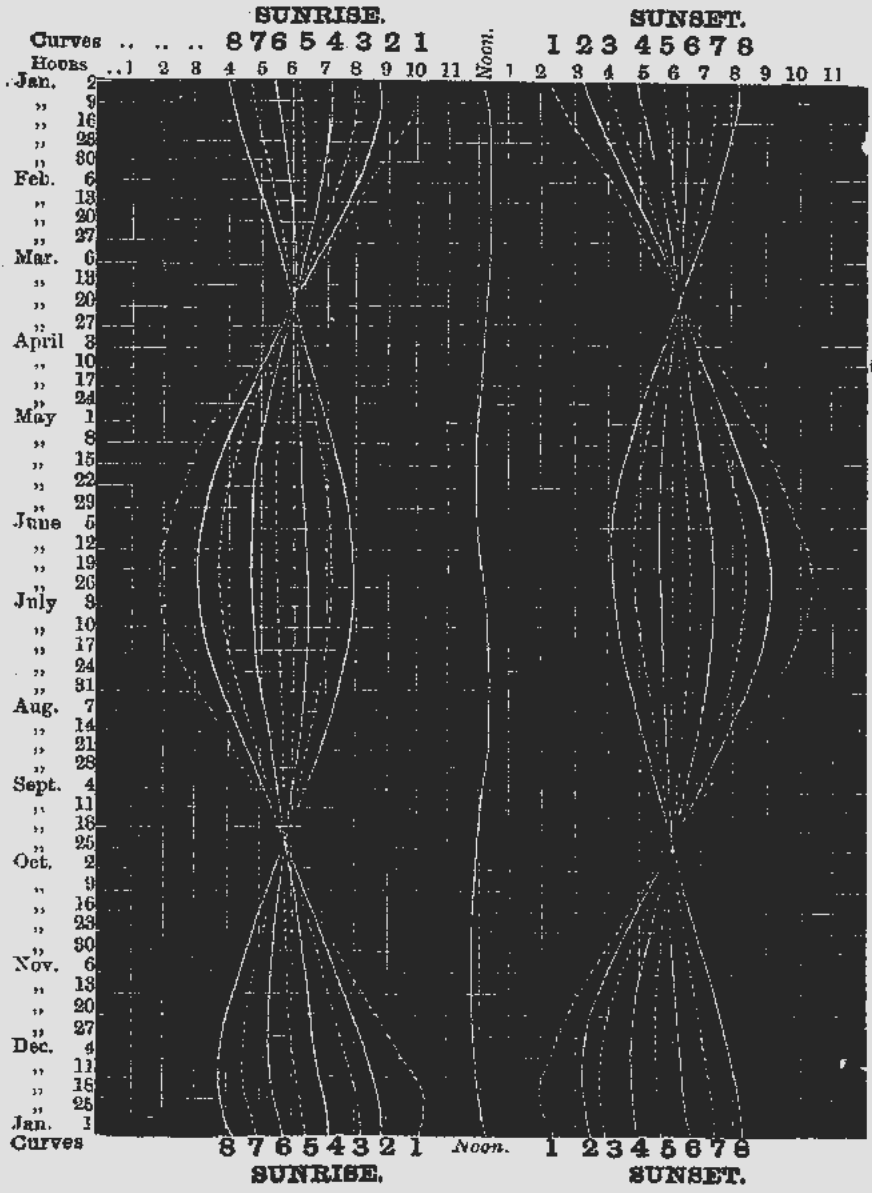
Northern Australia.
Africa { S. of the Equator. / N. of Cape Colony.
S. America { N. of Rio Janeiro. / S. of the Equator.

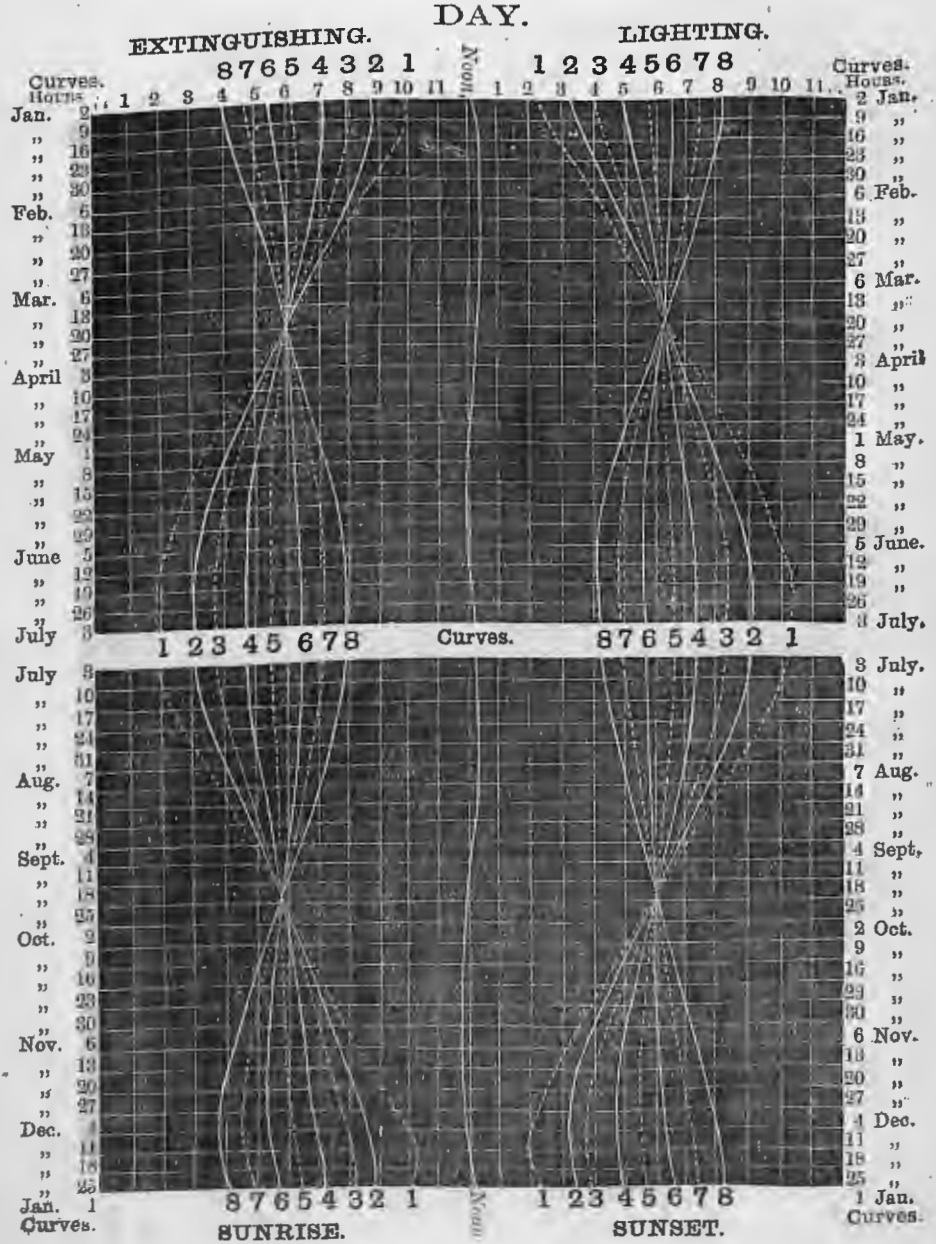
No. 7. Lat. 35° South.—

Southern Australia.
Cape Colony.
S. America { S. of Rio Janeiro. / N. of C. Corriento.

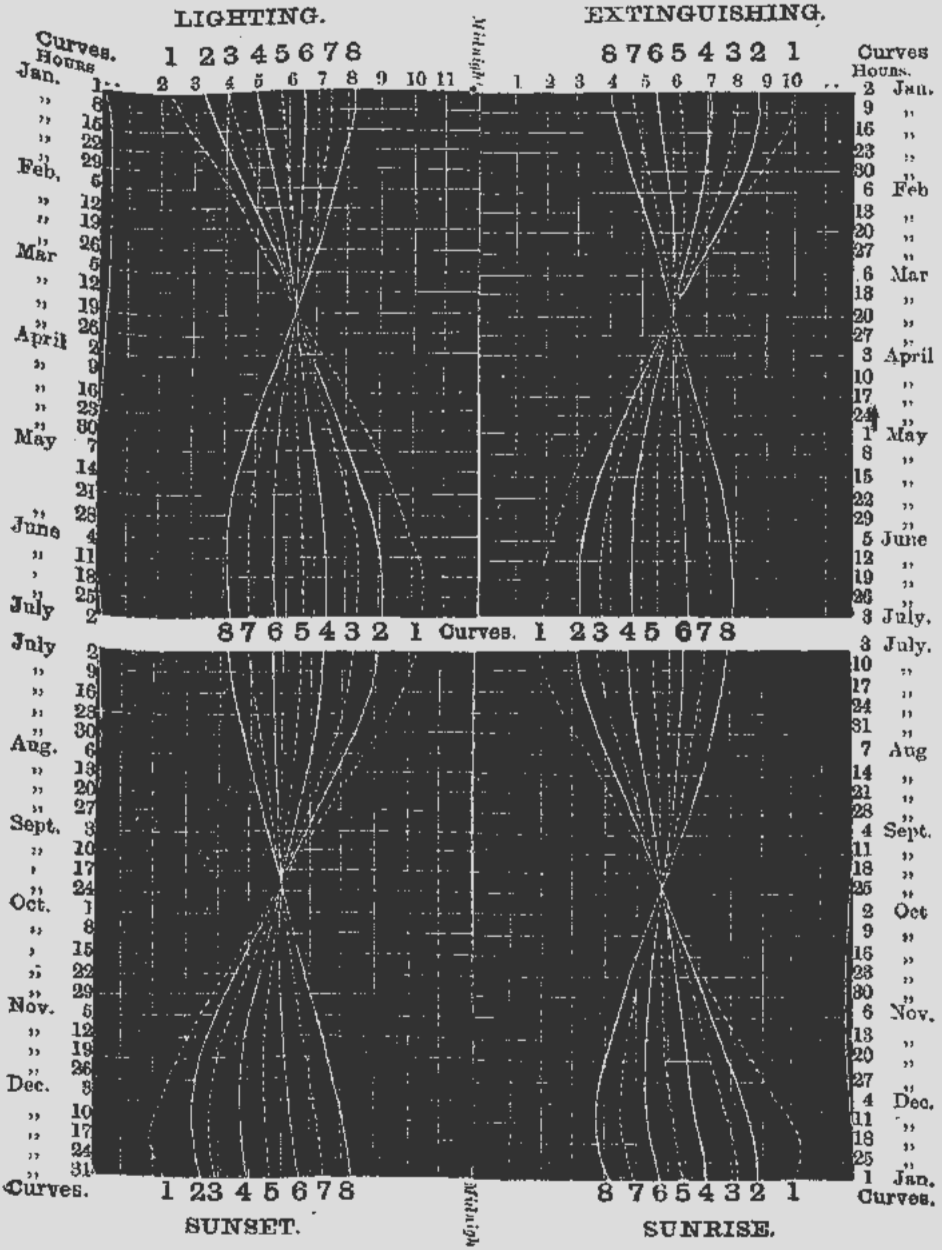
No. 8. Lat. 49° South.—

Cape Horn.
Tasmania.
New Zealand.


SUNRISE.
SUNSET.
Curves .. .. .. 8 7 6 5 4 3 2 1 Noon. 1 2 3 4 5 6 7 8
Hours .. 1 2 3 4 5 6 7 8 9 10 11 Noon. 1 2 3 4 5 6 7 8 9 10 11
Jan. 2
" 9
" 16
" 23
" 30
Feb. 6
" 13
" 20
" 27
Mar. 6
" 13
" 20
" 27
April 3
" 10
" 17
" 24
May 1
" 8
" 15
" 22
" 29
June 5
" 12
" 19
" 26
July 3
" 10
" 17
" 24
" 31
Aug. 7
" 14
" 21
" 28
Sept. 4
" 11
" 18
" 25
Oct. 2
" 9
" 16
" 23
" 30
Nov. 6
" 13
" 20
" 27
Dec. 4
" 11
" 18
" 25
Jan. 1
Curves 8 7 6 5 4 3 2 1 Noon. 1 2 3 4 5 6 7 8
SUNRISE. SUNSET.


DAY.
EXTINGUISHING.
LIGHTING.
8 7 6 5 4 3 2 1
1 2 3 4 5 6 7 8
Noon
Curves.
Hours.
1 2 3 4 5 6 7 8 9 10 11
Jan.
Feb.
Mar.
April
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
Curves.
SUNRISE.
SUNSET.

NIGHT.


LIGHTING.
EXTINGUISHING.
Curves.
Hours
1 2 3 4 5 6 7 8
8 7 6 5 4 3 2 1
Midnight.
Jan.
Feb.
Mar
April
May
June
July
Aug.
Sept.
Oct.
Nov.
Dec.
SUNSET.
SUNRISE.

(H) is the junction gasway connecting the out let of the lower part of the governor to the cover through which the gas passes up the cone (B) to the burner, in the direction shown by the arrows.

(II) are screws which hold the gasway to its seat- Between the gasway and the seat is interposed a washer made of paper, which, being painted with a little red lead and oil, secures the soundness of the joint.

(K) is a screw for holding the top securely and preventing damage to the gasway should the lamp-lighter strike the cone too hard with his torch in lighting, or catch the burner with his sleeve in cleaning the lantern.

(L) is the inlet of the governor screwed to the ordinary ¾ gas thread, and the direction of the gas is shown by arrows.

(MM) is an annular leaden weight by which the pressure to be maintained at the point of ignition is fixed. As in the ordinary wet governor a lighter weight will give less pressure, and *vice versâ*.

(N) is a hole communicating with the external air for the purpose of allowing the leather to rise and fall.

NOTE.—If this hole becomes stopped, the governor will cease to act. The leather being sound, no escape of gas can take place from here when the governor is in operation.

NOTE.—This description is given because there are still a great many of these governors in use.

THE NEW PATENT STEATITE FLOAT LAMP GOVERNOR

FULL SIZE.

INTRODUCED 1881.

Fig. 34.

has been introduced to meet the requirements of modern times, and it is capable of working under a much higher pressure than was usual at the time the first governors were invented. It comes into action at the ordinary day pressure, and makes a constant rate of consumption under pressures varying from 8-10ths to 6 inches.

The working parts being made in steatite it is not corroded by damp or heat. It works without mercury, glycerine, or other fluid, to freeze, gum, or evaporate.

It is of most simple construction, and, therefore, not liable to get out of order; wearing parts, if broken by accident, can be easily replaced.

It is practically indestructible, the material of which the governor is made being of brass, and the working parts of steatite.

The governor, it will be seen, can be adopted on high and low lying districts, with equally good results.

As it frequently happens in the case of decorated or specially-designed lamps that the governor burner just described would not be in harmony, the governors are also made of the following patterns: Figs. 35-38. By employing these the burners may be inserted in cones or elbows of any desired pattern, and the governor may be placed in any convenient position.

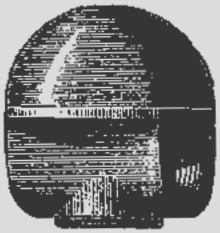


Fig. 35.

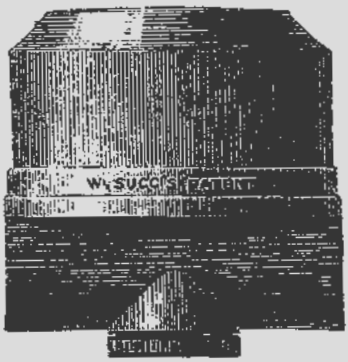


Fig. 36.

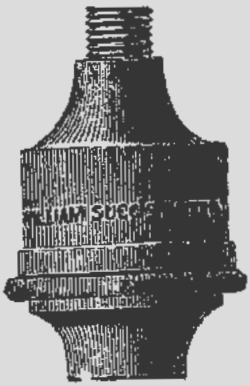


Fig. 37.

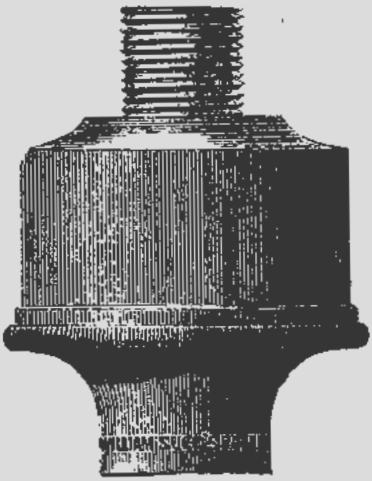


Fig. 38.

that which would be found just inside the orifice of the burner, and is spoken of as the pressure at the point of ignition.

Note.—In the case of the steatite float lamp governors (see p. 60), in which the cone is in one piece with the case of the governor, the burner must be removed and the T-piece must be screwed to the top of the cone in the manner here illustrated (Fig. 39).

Fig. 39.

A flash-light (H) for lighting the burners, and connected, by a long india-rubber tube, with the ordinary gas service, so that it is not in communication with any part of the apparatus.

ACTION OF THE APPARATUS.

The mode of action of the apparatus is the following:—The high-pressure gas enters by the supply pipe (G), passes through the governor (E) to the meter (A). Thence it returns and passes through the double governor (F) to the pipe (NN) called the float. This pipe is provided with stop-cocks, to which the governors or burners under examination can be attached, and is in communication at the one vertical portion with the gauge (C), and at the other with the high-pressure gas supply through the stopcock (EE).

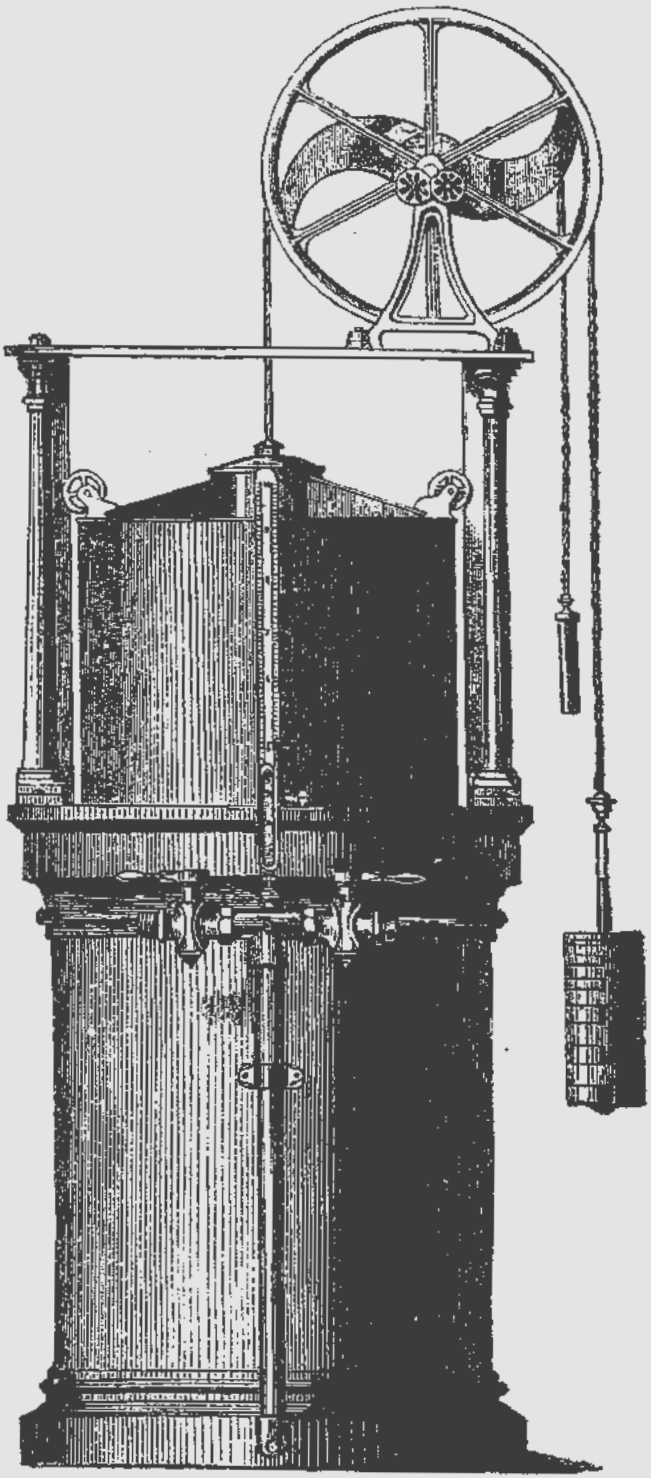


Fig. 40.

The apparatus will now be in order for testing.

Supposing it is required to test a governor taken from, or ready to be fixed in a lamp, screw it on one of the cocks as at (L), commence by turning on the high pressure cock (EE), and light the burner.

> NOTE.—This is done in the case of the old pattern governors to put the governor in action in case it may have lain by for some time, and have become stiffened by reason of the oil from the gas being viscid. If put in action for a short time, the gas will itself restore the leather to its former condition.

Turn off the high-pressure cock and let the flame burn for at least one minute, then, when the hand of the meter is at 5, start the minute clock (which should be at zero), and at the moment when the bell strikes one minute, notice the position of the hand of the meter. The distance travelled over by that hand in one minute equals the rate per hour at which the gas is consumed by the burner; thus, if the hand has made the complete circuit of the dial, the consumption of gas is 5 cubic feet per hour; if from zero to 1, 1 foot per hour, and so on.

If it be necessary to ascertain whether the governor under examination varies under different pressures, then unscrew the cone and insert the T-piece (L), connecting the outlet of the T to the point of ignition gauge (D).

Commence with the low or standard pressure, and ascertain the rate per hour, after which turn on the high-pressure cock (EE) so as to gradually

increase the pressure until the gauge shows that the highest point desired is attained.

NOTE.—The weight must be put on the outlet holder; after the first adjustment the inlet holder must not be touched, unless it is desired to increase or diminish the standard maximum pressure.

By counting the number of hundredths of an inch of variation shown by the pressure gauge, that of the governor may be accurately ascertained; and by observing how much the consumption is increased, a table of variations for that particular size of burner may be readily made.

GENERAL REMARKS.

To ensure success in lighting street lamps upon the old governor system, the burner and governor must be considered as one, and any accident which happens to either ought to be followed by the removal of both for readjustment.

No watchspring or hard substance should be made use of to clear the burners; because, as there is no corrosion to remove but simply dust, a brush or piece of paper will be sufficient for the purpose. The effect of any attempt to clean with watchspring or hard tools will probably be either damage to the burner or its total destruction. It is evident that unless the material of which the burner is compose is capable of resisting enlargement, the maintenance of the regulated consumption at the burner must soon be at an end, and the inevitable loss of gas

would in a short time be equal in value to the cost of a new governor and burner.

With careful cleansing, in the manner suggested, the burners will remain in order for many years.

It is recommended that all governors should be brought in for testing and cleaning at least once in three years.

This system has been adopted with great success by the Gaslight and Coke Company, and it has been one of the causes which have tended to the reduction of the leakage account.

CHAPTER VI.

THE SUPPLY OF PUBLIC LAMPS ON THE SYSTEM OF AVERAGE METER INDICATION.

This question has been so fully and ably treated in a paper read before the British Association of Gas Managers, at their meeting in June, 1868, by Mr. Chas. Hawksley, that to reprint it in this work will be to give the best description of the system as originated and carried out by Mr. Thos. Hawksley, the Past-President of the Association, at Nottingham. This being the only instance, up to that time, in which the average meter system has been put in operation with equal advantage to the gas company and the public authorities, the kind permission of the President and Committee has been asked and obtained for the reprinting *in extenso* of the paper.

On the Lighting of Public Lamps on the System of Average Meter Indication.

The necessity for the regulation of public lights having been already discussed in the paper submitted to the Association by Mr. Methven, the present paper will be confined principally to a

description of the method adopted in the town of Nottingham for effecting the supply of gas to the public lamps on the system of average meter indication.

Average meter indication appears to have been in use in one or two of the smaller towns in this country for a period of at least sixteen years, but was first brought prominently into public notice when applied in conjunction with the "double tap" in the town of Reading during the year 1863, under the direction of Mr. Samuel Hughes.

The attention of the Nottingham Gas Company was, in the year 1860, called to the excessive quantity of gas consumed by the public lamps, and on investigation it was found that the mean average consumption by each lamp amounted, during the six months ended September 1, 1860, to no less than 7·3 cubic feet per hour, although the contract with the town authorities provided only for 5 cubic feet per hour per lamp; and during a portion of the period referred to—viz., from the 1st to the 22nd of June—the consumption per lamp was found to have attained the enormous quantity of 9·5 cubic feet per hour. The amount of gas actually consumed (as ascertained by meters attached to several of the lamps), when divided by the number of hours during which the lamps ought to have been lighted according to the lighting table, gave the results mentioned above, showing great negligence on the part of the lamplighters, who, especially during the height of summer,

lighted the lamps earlier and extinguished them much later than the hours stated in the table.

It was to amend the then unsatisfactory state of the arrangements with the lighting authorities of the town that the Company applied to Parliament, in the session of 1864, for an Act having amongst other objects the making of better and more effectual provisions with regard to the lighting of the public lamps. The clauses relating to this subject in the Bill as introduced into Parliament were as follow:—

"16. Subject to the provisions of this Act the Company shall, at their own expense, upon the request in writing of any lighting authority, provide, lay down, fix, maintain, and keep in repair all mains and service-pipes, lamp-posts, brackets, lamps, burners, stop-cocks, regulators, and other apparatus connected therewith, necessary for the proper lighting of such of the streets within the said limits as are mentioned in such request, and provided the lamps to be supplied shall be fixed at not exceeding the average distance of *eighty* yards along the course of any main to be laid down by the Company for conveying gas to such lamps.

"17. The Company shall, at the request in writing of any such lighting authority, supply all or any of the present public lamps within the said limits, or such other public lamps to be hereafter provided and fixed as aforesaid, with so much gas, and to be delivered at and for such times and periods as the parties on whose request the supply of gas is made may from time to time desire.

"18. The price to be charged by the Company, and to be paid to them by the lighting authority, for all gas so supplied to or for any such public lamps, shall always be calculated and fixed at and according to the lowest sum per one thousand cubic feet for the time being charged by

the Company to any private consumer in the parish or place in which such public lamps shall be situated; but this shall not in any manner alter or affect any contract for the supply of gas to such public lamps entered into before the passing of this Act, and then subsisting, or the price to be charged and paid for the gas supplied or to be supplied under any such contract.

"19. The Company shall light, clean, and extinguish all public lamps to which they shall supply gas, and the sum to be paid to the Company by the lighting authority for such lighting, cleaning, and extinguishing, and for the use, maintenance, and repair of the service-pipes, lamp-posts, brackets, lamps, burners, stop-cocks, regulators, and other apparatus as aforesaid, shall be *sixteen* shillings per lamp per annum, payable quarterly.

"20. Notwithstanding anything hereinbefore contained, the quantity of the gas supplied to the public lamps under any contract hereafter made shall, at the option either of the Company or of the lighting authority, be ascertained during the period of any such contract by meter, and in such case the necessary meters shall be provided and fixed and kept in repair by the Company, at the expense of the party requiring the same.

"21. The Company shall, within *six* months after the passing of this Act, pay to the lighting authority such sum of money, by way of compensation, as may be agreed upon between them as the reasonable value of the lamp-posts, brackets, lamps, and the fittings and apparatus connected therewith, belonging to and used by such lighting authority; or in case any difference shall arise as to such value, the same shall be settled by arbitration, in manner provided by the clauses of 'The Companies Clauses Consolidation Act, 1845,' with respect to the settlement of disputes by arbitration; and at the termination of the current quarter in which the payment is made, the lamp-posts, brackets, lamps, and the fittings and

apparatus in respect of which the payment is so made shall belong to the Company; and any sum of money agreed on or awarded to be paid, together with the cost of the reference (if any) as settled by the arbitrators under the provisions of the said Act, shall be paid out of the reserved fund of the Company."

The Bill was opposed by the corporation and the lighting authorities of the town, and after a severe contest before a select committee of the House of Commons, during which certain alterations were made in the Bill affecting the regulation of the public lamps, the Act was passed with the following clauses :—

"15. Subject to the provisions of this Act the Company shall, at their own expense, upon the request in writing of any lighting authority, provide, lay down, fix, maintain, and keep in repair all mains necessary for the proper lighting of such of the streets within the said limits as are mentioned in such request, and provided the lamps to be supplied shall be fixed at not exceeding the average distance of eighty yards along the course of any main to be laid down by the Company for conveying gas to such lamps.

"16. The Company shall, from time to time, at the request in writing of any such lighting authority, supply all or any of the present public lamps within the said limits, or such other public lamps to be hereafter provided and fixed as aforesaid, with so much gas, and to be delivered at and for such times and periods as the parties on whose request the supply of gas is made may from time to time desire.

"17. The price to be charged by the Company, and to be paid to them by the lighting authority, within the extended limits by this Act authorized, for all gas so

supplied to or for any such public lamps, shall always be calculated and fixed at and according to the lowest price for the time being charged by the Company to any private consumer in the parish or place within such extended limits in which such public lamps shall be situated.

"18. The gas supplied to the public lamps within the limits of this Act and the recited Acts shall be consumed by meter, at the option from time to time of the lighting authority or the Company; and in case of its being consumed by meter, the meters shall be provided by the Company at the expense of the lighting authority, but neither party shall, except as hereinafter provided, be entitled to require that a meter be affixed to more than one in every twelve lamps then supplied with gas under this Act or the recited Acts; provided also, that the Company shall be at liberty, if they think fit, to have a meter affixed to any additional number of lamps, they providing such meters, and paying to the lighting authority the additional expense of providing and adjusting lamps, lamp-posts, and other things necessary for their reception and use; provided always, that if the gas shall, under the provisions of this Act, be supplied to the public lamps by average meter indication, the Company shall, for securing uniformity of consumption between the metered and the unmetered lamps, from time to time provide the public lamps under the control of the lighting authority with proper regulating apparatus and burners to the satisfaction of the lighting authority, or, in case of difference, as from time to time shall be settled by the Justices in Petty Sessions assembled.

"19. The average amount of the indications of all the meters attached to the public lamps under the control of any lighting authority shall be deemed to be the amount consumed by each such lamp.

"20. The gas supplied to any such public lamp shall be permitted to pass unrestricted to and from such regu-

lating apparatus for the whole of the period during which any such public lamp shall be lighted."

Subsequently, Mr. Hawksley, the engineer to the Gas Company, was instructed to take the necessary steps for the introduction into the town of Nottingham of the system of average meter indication, and with the assistance of Mr. William Sugg, he devised the modified form of meter and the burner-cock now in use, with the view to overcome some of the difficulties which had previously been encountered where that system had been tried. The lamps at Nottingham were first lighted on the system of average meter indication in the beginning of the year 1866, since which, and up to the present time, that method of lighting has been maintained in operation without interruption. The apparatus employed is as follows:

1. Every lamp throughout the town is furnished with a brass cock, above which are fixed a governor and steatite burner.
2. One lamp in twelve has, in addition to the above, a wet meter placed underground, near the foot of the lamp-column.

The meter is of the compensating class, and, in order to reduce the friction to a minimum, the drum is made of the same diameter (about 12 inches) as that of an ordinary 5-light meter, but is so diminished in width as to have the capacity of a 3-light meter only; it makes eight revolutions for each cubic foot of gas measured, and requires to work it a pressure

of only half a tenth of an inch when passing 5 cubic feet of gas per hour.

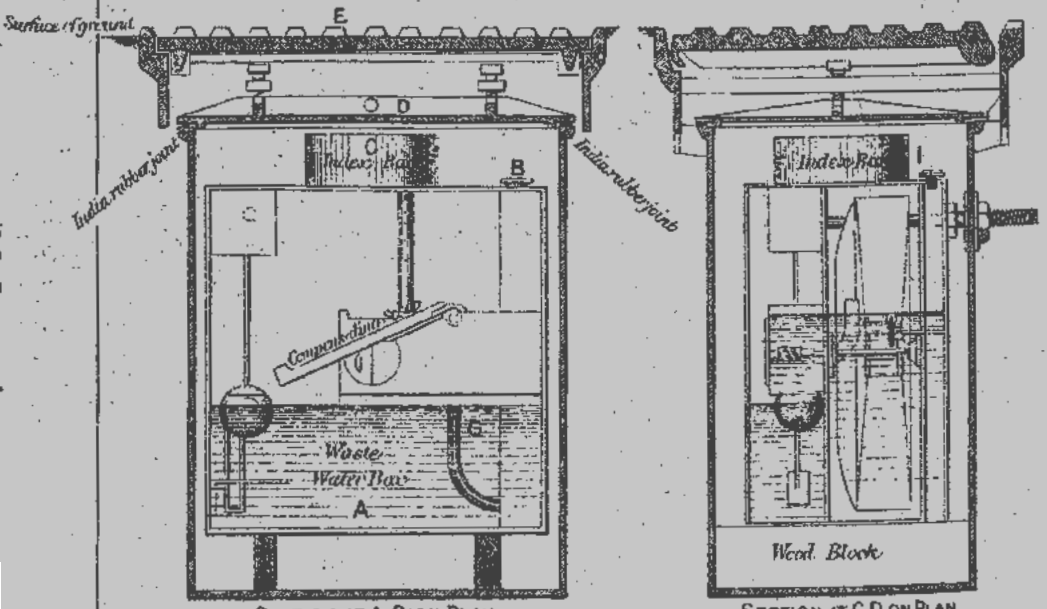
The waste-water box (A) is so arranged as to be capable of being emptied by means of an exhausting syringe introduced through a plug-hole (B) in the top of the meter-case.

The index (C) is placed horizontally on the top of the meter, so as to be visible on raising the cover (D) of the cast-iron box in which the meter is placed. The index at first employed was made of brass, and of the ordinary pattern; but great trouble being given by the meters ceasing to register, it was discovered that the condensation in the dial-box due to changes of temperature, and probably in some measure also to the evaporation from the water in the meter, corroded the wheelwork to so great an extent as to cause the breakage of the teeth of the wheels, and consequently to permit the passage of the gas without registration. It was then determined to make the indexes with strong wheelwork of gun-metal, afterwards tinned to preserve it from corrosion; and a simplified arrangement of index, suggested by Mr. Henry T. Humphreys, was used, consisting of two large wheels, each about 4¼ inches in diameter. Both wheels are worked by the same pinion fixed on a vertical shaft, which is driven in the usual way by a worm on the drum-shaft. One of the large wheels is provided with 202 teeth, and is attached to a revolving dial-plate, the circumference of which has 100 divisions, each representing

THE LIGHTING OF PUBLIC LAMPS ON THE SYSTEM OF AVERAGE METER INDICATION

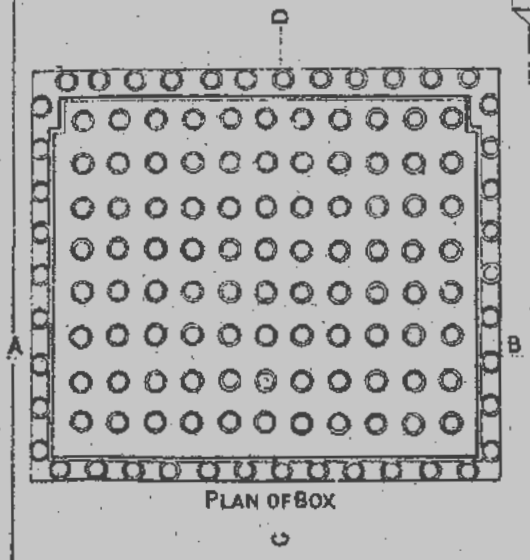
THE ORIGINAL

PUBLIC LAMP METER AND CAST IRON METER BOX

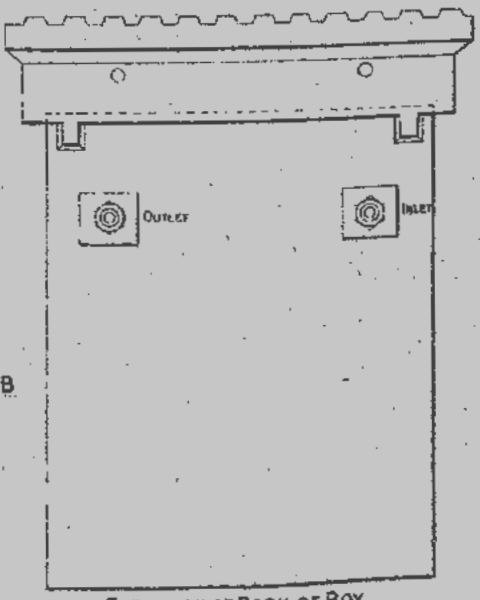


SECTION AT A.B. ON PLAN.

SECTION AT C.D. ON PLAN



PLAN OF BOX

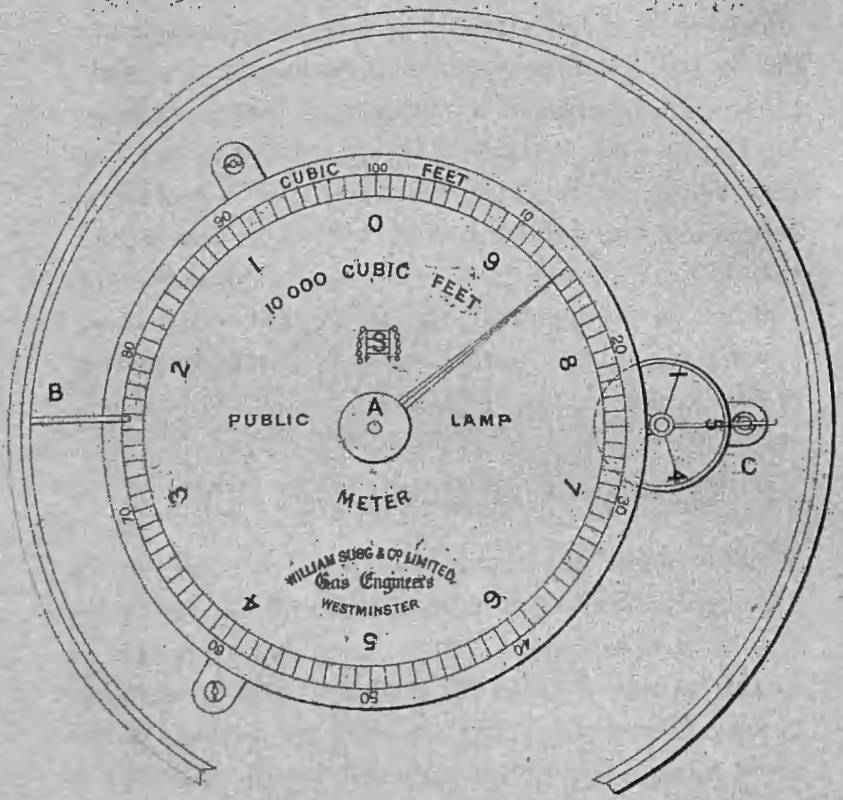


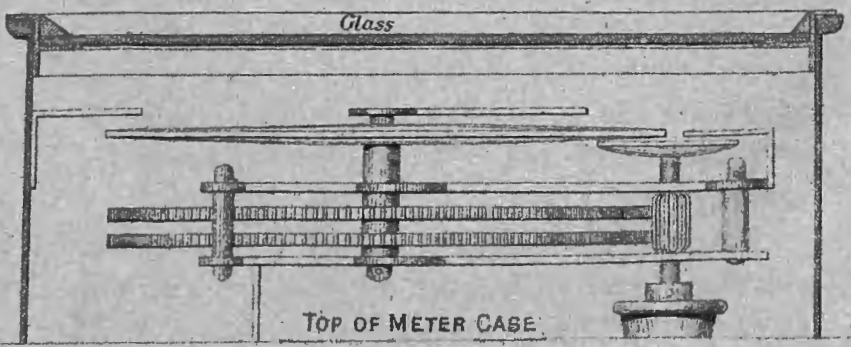
ELEVATION OF BACK OF BOX

Scale 1½ Inch = 1 Foot

THE LIGHTING OF PUBLIC LAMPS ON THE SYSTEM OF AVERAGE METER INDICATION.

INDEX FOR PUBLIC LAMP METER





Scale ¾ Full size

one cubic foot of gas, indicated by means of a fixed pointer. The other large wheel is furnished with 200 teeth, and has attached to it a hand also pointing to the before-mentioned divisions on the dial-plate, each of which now represents 100 cubic feet; but the number of teeth in this wheel being two less than those on the wheel to which the dial-plate is connected, the hand revolves 1 per cent. faster than the dial plate, and thus indicates every 100 cubic feet of gas consumed up to 10,000 cubic feet, beyond which it is unnecessary to record in meters of this class.

METHOD OF READING THE INDEX.

The index (*see* lithograph) is of the kind called differential. The index-hand and dial both revolve; but, as a consequence of the hand being fixed to a wheel having 200 teeth and the dial to another having 202 teeth, both of which are driven by the same pinion, the hand gains on the dial two teeth every complete revolution of the latter, which occurs when 100 cubic feet of gas have passed through the meter. Thus it follows that each of the smallest divisions is equal to 100 feet, by the indication of the central hand (A), and one foot by that of the fixed pointer (B).

When the former has made a complete revolution of the dial, 10,000 cubic feet of gas will have been passed through the meter.

The reading of the index shown in the diagram is 8575½ cubic feet, because the pointer stands at between 85 and 86 and between 8 and 9 thousand. The hundreds being shown by the small divisions—of which five are complete, the sixth being incomplete—are read from the pointer (B), which is at 75½ cubic feet.

It will readily be seen that this is the easiest index possible to read, because the entire quantity consumed may be read with sufficient accuracy by noting the position of the centre hand (A) only.

Care must be taken in the event of this being between two numbers that the lowest be taken as thousands.

The small dial showing 5 cubic feet per revolution is only of use to the official tester. It is fixed on the pinion and revolves with it.

As a further precaution against corrosion, the index-box is filled with refined oil to the level of the under side of the dial-plate, and with the index thus made and protected no further difficulty has been caused through the meters having ceased to register.

The freezing of the water during the winter has been effectually prevented by the introduction into each meter of a small quantity of methylated spirit. This was at first found to interfere with the proper action of the meter, and it was then discovered that the spirit as ordinarily sold is mixed by the Customs authorities with gum to prevent its use for the pur-

pose of defrauding the Excise. Unadulterated spirit was afterwards obtained, on a certificate being given to the authorities as to the use to which it was to be applied, and no further inconvenience has been experienced. Additional protection against frost is afforded by filling with felt the space between the two covers of the meter-box.

> Note.—This has not been effectual in every case, in consequence of the felt becoming wet, and serving as a conductor. It has been found that the air space between the lids is quite sufficient during ordinary frosts.

The meter is placed in a cast-iron box let into the ground near the foot of the lamp-post, so that the cast-iron lid (E), see p. 78, which is hinged, is level with and forms part of the foot pavement; beneath this lid is a false cover of iron (D) to afford additional protection to the meter, which cover may, if required, be tightly screwed down on to an india-rubber washer, thus forming a water-tight joint and keeping the interior of the box dry even when immersed in water. Apertures are left in the back of the box, as shown in section at C, D, through which to pass the inlet and outlet pipes, and these are made water-tight by means of washers and back nuts.

The author's new Patent Public Lamp Meter has many points of superiority, and is rapidly superseding that just described.

It consists of a cast-iron box, with roughed external lid, and with internal lid made tight with india-rubber, and fastened down by cotters and

screws. The internal lid is fitted with glass, to enable the inspector to read the index without removal, and improved double latch lock, made to prevent dirt from falling through the keyhole into the meter.

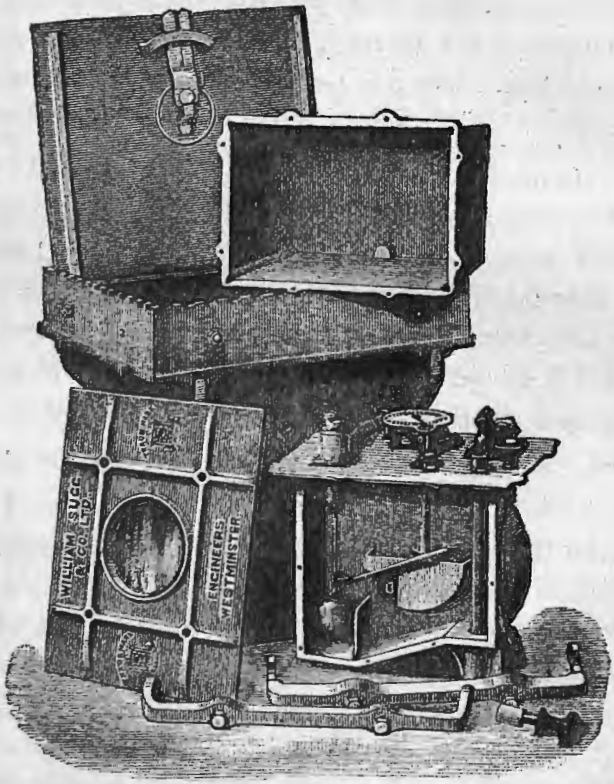


Fig. 41.

The box is also fitted with inlet and outlet unions, fixed in a water-tight manner to the box.

An incorrodible metal service inlet, with plug

for cleaning out stand-pipe. The external lid covers these arrangements so that they are at any time accessible without breaking the ground or disturbing the pavement. The external lid and frame are adjustable, by means of four screws, to the pitch of the pavement in any direction.

The meter is provided with levelling screws and flexible joint with strong gun-metal union.

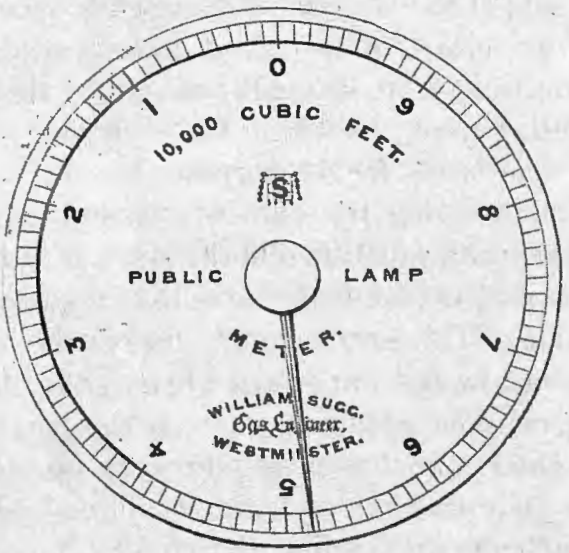


Fig. 42.

It is provided with a new form of index, which is made of bronze, has no pinions, and only one large wheel. It can be rapidly read in any direction. It is provided with a compensator and water-line regulator.

It is made with independent back and front, so that the working parts of the meter can be lifted

bodily out of the case, for the purpose of repairing, and for adjusting the bearings—which may be done by an unskilled mechanic rapidly and surely on the spot.

After having passed through the meter, the gas ascends by a pipe placed in the usual manner in the lamp-column until it reaches a brass cock (fig. 27), see p. 46, placed between the top of the post and the under side of the lantern. This cock is opened and closed by means of two short brass arms, curved downwards, so as to be readily caught by the end of the lighting torch, see Chap. IV. The plug is made longer than usual, for the purpose of securing tightness and resisting the blow of the lighting torch when used with rapidity, and the stops are so placed that the plug cannot make more than a quarter of a revolution. This arrangement ensures the opening of the cock to the full extent whenever the lamp is lighted, without requiring care on the part of the lamp-lighter, who has merely to push up the lever as far as it will travel, and who would, indeed, have some difficulty in opening the cock only partially, were he even disposed so to do.

Immediately above the cock, but inside the lantern, is placed the governor, see Chap. V., an instrument without which the system of average meter indication could never have been satisfactorily adopted. The governor in use at Nottingham is the one made by Mr. Sugg, which is so generally known that it is almost unnecessary to state that it is of the kind

called a dry governor, and consists of a leather diaphragm from which is suspended a cone which regulates the size of the aperture admitting the gas to the under side of the diaphragm, and which can by means of weights be so adjusted as to give any required pressure at the burner, the stem of which is screwed on to the top of the governor. The burner is a table-top, see Chap. V, formed of steatite, and placed at the upper end of a brass stem made of unusual length, with a view to prevent the heat of the flame injuring the leather of the governor,* to diminish to an almost imperceptible amount the shadow which would otherwise be thrown on the pavement by the governor, and to obtain a regular flow of the gas before it reaches the point of ignition—a matter of some moment where it is desired to have a steady flame.

Meters are, as has been already stated, attached in the case of Nottingham to one lamp in twelve, the lighting authorities having elected to have that proportion, although the gas company were willing to adopt one in twenty; it is, consequently, of the utmost importance that the governors and burners of any one series of twelve lamps should each be accurately adjusted to consume an equal quantity of gas, otherwise the metered lamp would cease to afford a correct indication of the consumption of

* It is found in practice that even with a very short cone the heat does not affect the leather injuriously.—W. S.

the whole of the remaining eleven lamps. The governors, with their burners attached, are therefore, in the first instance, separately adjusted to a consumption of 5 cubic feet of gas per hour; they are then placed twelve in a row, and are again tested for an hour, when, if the total consumption during that time is found to be 60 cubic feet, they are issued for fixing to the lamps, the governor and burner for the metered lamp being taken indiscriminately from the set of twelve. Care is, however, taken to keep each set distinct, and in the event of any future readjustment or repair being required to the governor or burner of any one of the set, the remaining eleven are also removed from the lamps, and the whole are again tested together before being refixed. With these precautions no difficulty is experienced in maintaining uniformity of consumption in both the metered and the unmetered lamps.

It is of the greatest importance that the meters should be regularly tested—say once in two years. By the use of a portable test meter, the inspection can be made with the meter *in situ;* but regard must be had to the temperature. Thus, in very cold weather, or when it is extremely hot, it is well to pass about 15 feet through before commencing a test.

PORTABLE STANDARD TEST METER,

As supplied to the Metropolitan Board of Works.

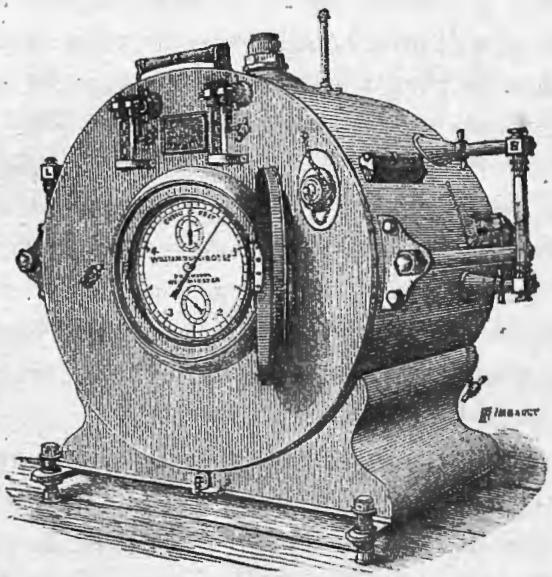


Fig. 43.

This meter, which is especially constructed for portability, is used to test meters *in situ*, and thus avoid the inconvenience and expense connected with their removal to a testing office.

It is provided with stout levelling screws, two spirit levels, two pressure gauges, two water level gauges, and a thermometer. For safety during removal the gauges and thermometer are disconnected, and the apertures are closed by caps, which

are attached to the meter by small chains. The glass in front of the dial is protected by a metal door, which can be secured by a padlock. The case is made extra strong, and is provided with two stout handles.

Having described the apparatus in use at Nottingham, it will now be shown with what results the application in that town of the system of average meter indication has been attended. The public lamps have been supplied on that system for nearly 2½ years, but as some months of that period were necessarily occupied in bringing the system into perfect operation, the results given will be confined to the eighteen months ended March 31, 1868, that being the date of the last quarterly return of the indication of the meters.

There are within the town of Nottingham about 860 lamps, to 72 of which meters are attached; this is exclusive of places without the town in which the system is in operation, and where the results are similar to those obtained within the town. The indices of the meters are recorded monthly, and returns are made both monthly and quarterly showing the situation of each metered lamp, the state of the index, the number of cubic feet of gas consumed during the period, the number of hours during which the lamp was lighted, and the consumption per hour by each lamp.

The table on the opposite page shows the results of the 18 months' working.

TABLE *showing the Results of the System of Average Meter Indication as applied to the Public Lamps within the Town of Nottingham, during the Eighteen Months ended March* 31, 1868.

Number of Metered Lamp.	Situation.	Consumption in Cubic Feet per Hour for the Quarter Year ended						Consumption in cub. ft. per Hour at each Lamp on Average of 18 Months.
		1866.	1867.				1868.	
		Dec. 31.	Mar. 30.	June 29.	Sept. 30.	Dec. 31.	Mar. 31.	
10	Newdegate Street . .	4·54	4·74	4·86	4·71	4·56	4·72	4·68
20	Park Row	4·15	4·37	4·49	4·55	4·47	5·00	4·50
30	Wilford Road . . .	4·69	5·02	5·05	5·20	4·88	4·90	4·95
40	Canal Street . . .	3·70	4·19	4·49	4·87	4·56	4·45	4·37
50	Robin Hood Street .	4·23	4·46	4·68	5·20	4·64	4·63	4·64
60	Vicarage Street . .	4·23	4·56	4·86	4·87	4·88	4·63	4·67
70	Stoney Street . . .	4·38	4·56	4·68	4·55	4·31	4·27	4·45
	Average consumption per hour of the above 7 lamps during each quarter year	4·27	4·55	4·73	4·85	4·61	4·65	4·60
	Average consumption per hour of the 72 metered lamps within the town of Nottingham during each quarter year.	4·32	4·64	4·71	4·86	4·69	4·68	4·65
	Maximum consumption per hour of any of the 72 metered lamps within the town of Nottingham during each quarter year	4·85	5·3	5·24	5·36	5·29	5·27	—
	Minimum consumption per hour of any of the 72 metered lamps within the town of Nottingham during each quarter year	3·70	4·09	4·11	4·22	4·15	4·27	—

In order to economise space the indications of seven only out of the 72 metered lamps are tabulated in detail; it should, however, be stated that the instances given have not been specially selected, but that every tenth metered lamp has been taken for illustration exactly in the order in which it happened to stand in the quarterly return of the company, as would be at once apparent by a comparison of the table with the company's printed form of returns.

It will not fail to strike the members of the association how closely the average results of the eighteen months' consumption of gas by the seven lamps given in the table in detail corresponds with the average consumption during the same period of the whole of the 72 metered lamps within the town, being in the one case 4·60 cubic feet per hour, and in the other case 4·65 cubic feet per hour, showing that almost precisely the same result would have been arrived at had the meters been applied to 1 lamp in 120 instead of to 1 in 12. Indeed, had it not been for some unusual irregularity in the burning of metered lamp No. 40 during the quarter year ended December 31, 1866, the average hourly consumption of the seven lamps would probably have been exactly equal to that of the 72 lamps. It would, however, in practice probably not be prudent to attach meters to fewer than 1 lamp in 25, in order not only to obtain security against fraud on the part

of the lamplighters, but also to give satisfaction to all parties.

Since the preceding paper was read, the system detailed therein has been in operation up to the present time, and is still so continuing. The results have been of the most satisfactory kind.

By the aid of information derived from copies of returns supplied to the Nottingham Gaslight Company, and kindly lent to the author by Messrs. T. and C. Hawksley, it has been shown with what almost clockwork regularity the system has worked since it was first put in operation.

FIXING THE PUBLIC LAMP METER.

The cast-iron box which is to contain the meter should be sunk into the ground at the foot of the column on that side facing the footway, the cover forming part and being level with it. It is roughed upon the top, so as to render it safe for passengers.

It is generally considered by those who have had much experience of this system, that the service-pipe from the main to the meter box is best made of lead, a wooden trough being laid under the tube to keep it from sinking. There is no harm done if the fall of pipe is towards the meter.

The outlet-pipe should be in lead, and the stand-pipe in iron, as usual.

The stand-pipe should be supported in such a manner that its weight is not upon the outlet of the meter. This is easily done by making the pipe

longer than usual, and allowing the end of it, which should be capped, to rest on a stone placed inside the base of the column and firmly rammed into the earth.

A T-piece inserted at the proper height receives the outlet-pipe from the meter.

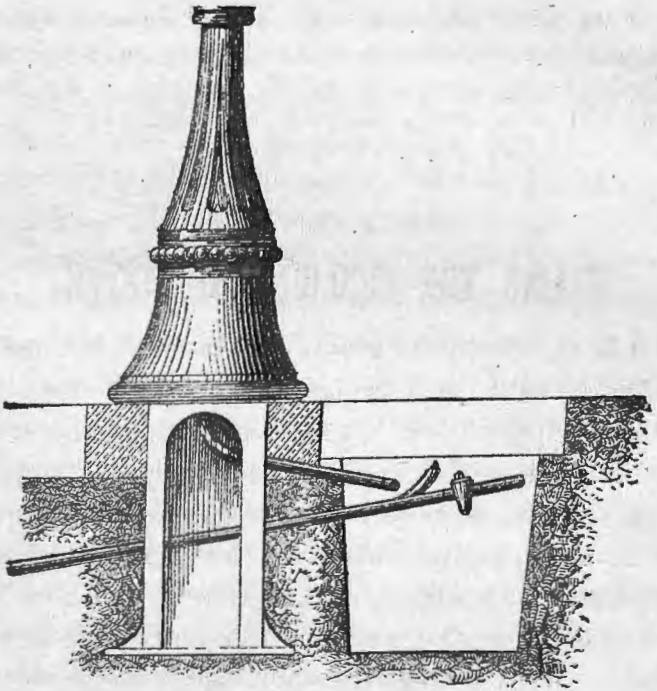


Fig. 44.

The meter, when fixed in the box, should be levelled.

The levelling points are across the meter in front, and on the right side of the index-box.

If levelled up in this manner, it will stand exactly in the position in which it was tested.

METHOD OF FILLING AND ADJUSTING THE WATER-LINE IN PUBLIC LAMP-METERS.

After removing the lid of the box, take out the plug (I). Pour in the water from here till it is presumed that the meter is quite full,—*i.e.*, the measuring-chamber filled to its proper water-line, and sufficient allowed to overflow so as properly to charge the waste-water box.

Fig. 45.

Then insert the long tube of a syringe (fig. 45), at B, and draw out as much water as possible.

It will readily be perceived that as soon as the tube (G) is unsealed, the syringe will cease to draw water, and the waste-water box will be left full.

Sufficient water to seal the tube can then be added, and the meter is then properly charged. Replace the plugs and it is ready for work.

It is not necessary to have the tube (G) in the meter at all; some have merely a hole in the bottom of the side tube, at the point where the present water-line tube (G) enters it. In this case, the long tube of the syringe

is pierced in the side, at a point corresponding with the height of the water-line when the waste-water box is full.

It is obvious that by this arrangement sufficient water must always be left when the syringe ceases to draw.

In the front of the meter will be found a plug at the full water-line of the waste-water box. This is merely for the use of the official tester, and cannot be got at when the meter is at work in the street.

The capacity of the measuring drum of these meters is 1-12th of a cubic foot per revolution.

The average friction of the meter in work, passing gas at the rate of 5 cubic feet per hour, is equal to the pressure given by a column of water half a tenth of an inch in height.

The index-box may be filled with best almond oil; doubtless any oil will do, such as paraffin or petroleum, which will not thicken, dry up, or freeze hard.

When all this is done, the top must be well screwed down to prevent water from entering.

GENERAL REMARKS.

In order to ensure the success of this system, great attention must be paid to the soundness of the pipes and connections of the metered lamps, especially that leading from the meter to the lantern. Every leak in the pipe, cock, or governor is multiplied as many times as there are lamps represented by the metered lamps, *i.e.*, if there are 12 unmetered to one metered lamp the error is multiplied by 12, and so on.

Another important point is that the lamps should be lighted and extinguished at the proper time, care being taken that the cocks are effectually opened and closed.

The arrangement of the stop affords a ready means of verifying this fact to the lamplighter.

The recommendations to be found under the head of "General Remarks," page 69, must be attended to.

Thus the much-vexed question of Public Lighting may be satisfactorily arranged and troublesome disputes avoided, at a cost considerably less than that incurred very often in one year by litigation.

In every case, the general determination of the seller of gas to act up to his contract is effectually shown, and distrust on the part of the buyer is entirely removed.

PUBLIC LIGHTING BY THE DOUBLE TAP SYSTEM.

In the Paper read by Mr. Thos. H. Methven, mention is made (page 72) of this system, the adoption of which was at one time thought by some few admirers of it to be a certain remedy against dissatisfaction either on the part of lighting authorities or Gas Companies.

Although not originally invented by the late Mr. Samuel Hughes, yet undoubtedly to him it owes that amount of popularity, not however large, which it obtained. His faith in it as a means whereby an equitable adjustment of the difficulties between the contracting parties in the matter of public lighting could be arrived at was very great, and he made several trials in various towns, without, however, obtaining any definite result in its favour. It was finally submitted to the Lighting Committee of the Corporation of Folkestone about the beginning of the year 1867, as a "proper regulating apparatus" within the meaning of that section of the Act relating to public lighting, obtained during the previous session by the local Gas Company.

The Folkestone Gas Company, advised by their Engineer, Mr. Barlow, strongly opposed the idea of Mr. Hughes, and submitted "Sugg's Self-acting Governor" as an instrument more nearly approaching to that "proper regulating apparatus" mentioned in their Act.

At a conference between the two parties, it was

resolved that Messrs. Hughes and Barlow should jointly institute certain experiments, with a view finally to determine which of the two systems proposed was the best, and extracts from the report made to the Gas Company by Mr. Barlow are here given. These are deemed sufficiently conclusive, as they entirely establish the superiority of the "Self-acting Lamp Governor" over the "Double Tap."

"And for the purpose of securing, as nearly as was possible under this system of adjustment, uniformity of consumption between the several lamps, he employed a wet experimental meter, which was fixed on trestles and carried about from lamp to lamp, till, by adjusting the gauge tap, the consumption of each lamp was stated by Mr. Hughes to be 3 ft. an hour, when it was secured by soldering it firmly in its position; and, for the sake of further security, Mr. Hughes attached a wax seal to each. A one-light dry meter was then fixed to each post, and the gas conducted to and from it by flexible tubing to the double tap, and the consumption of each lamp noted for twenty-four hours, at the expiration of which the double taps were removed and replaced by Sugg's regulators, and the consumption of each lamp again noted for another twenty-four hours, with the following results."

SERIES No. 1.

"The result shows that the Company would have supplied 26½ per cent. more gas than they would have been paid for, had they accepted double taps thus adjusted as proper regulating instruments within the meaning of the 41st section of their Act. With Sugg's regulators the loss would only have been 1 per cent."

SERIES No. 2.

"This series is even more unfavourable to the double

tap than the first series, inasmuch as it shows that the Company would have supplied 40½ per cent. more gas than they would have been paid for, had they consented to the use of such an instrument, the night pressure being uniform with the day pressures. Sugg's regulators: average excess per cent. of consumption of unmetered over metered lamp, 5·84."

SERIES No. 3.

"In this series of experiments, the approach to uniformity is nearer than in the previous ones, but still the Company would have supplied 18½ per cent. more gas than they would have been paid for, had they accepted the double taps thus regulated as a proper regulating instrument within the meaning of the Act."

The Table on page 99, which has been very carefully prepared by Mr. Medhurst, the Secretary of the Company, shows very clearly how well-founded is the opinion formed of the Lamp Governors by Mr. Barlow after his experiments, that they are such a "proper regulating apparatus" as is contemplated by the Company's Act of Parliament.

An analysis of the table shows that, on the whole, the arrangements, both as regards quantity of gas supplied and regularity in lighting and extinguishing, have been thoroughly well carried out. The grand average for the year 1868-9 was only 4 per cent. above the quantity calculated on.

The grand average for the following year is only 1 per cent. over the quantity required to be supplied.

Further comment is unnecessary. Actual prac-

tice has completely established the correctness of the assumption that it is possible, by the means pointed out in this work, to arrive at a satisfactory solution of the vexatious question, How can the public lamps be supplied with gas in a manner to satisfy all parties?

TABLE *showing the consumption of the Metered Lamps at FOLKESTONE during the Two Years ending June 30th, 1870, the whole of the Public Lamps throughout the Town being supplied with Gas under the "Average Meter System," a Meter being affixed to every twelfth Lamp, and each Lamp being furnished with a "Sugg's Regulator," adjusted to a consumption of 4 cubic feet per hour.*

Date.	Estimated No. of Lighting Hours as per Contract.	No. of C. F. per hour each Regulator is adjusted to consume	Quarter's Consumption as per Estimate.	Actual Consumption as per Meters.
1868.			c. ft.	c. ft.
Quarter ending Sept. 30th	683	4	2,732	2,983
,, ,, Dec. 31st	1229¾	,,	4,919	4,962
1869.				
Quarter ending March 31st	1129½	,,	4,518	4,571
,, ,, June 30th	604¾	,,	2,419	2,624
1869.				
Year ending June 30th .	3647	,,	14,588	15,140
1869.				
Quarter ending Sept. 30th	683		2,732	2,902
,, ,, Dec. 31st	1229¾	,,	4,919	4,846
1870.				
Quarter ending March 31st	1129½	,,	4,518	4,334
,, ,, June 30th	604¾	,,	2,419	2,661
1870.				
Year ending June 30th .	3647	..	14,588	14,743

The following table shows the results during ten years on the average meter system, and is a further proof of the advantages of this system, and of the reliability of the governors :—

Consumption of Gas per Lamp per Hour in the Parish of St. Mary Abbotts, Kensington, under the Average Meter System.

	1877	1878	1879	1880	1881	1882	1883	1884	1885	1886	1887
January . . .		4·53	4·43	4·31	4·40	4·30	4·34	4·30	4·35	4·39	4·45
February . .	4·42	4·56	4·45	4·43	4·38	4·50	4·60	4·52	4·52	4·53	4·72
March . . .	4·44	4·58	4·45	4·32	4·46	4·42	4·28	4·56	4·51	4·38	4·52
April. . . .	4·42	4·64	4·51	4·42	4·49	4·57	4·40	4·55	4·51	4·70	
May	4·64	4·52	4·40	4·40	4·49	4·57	4·34	4·43	4·58	4·54	
June	4·68	4·61	4·52	4·45	4·57	4·74	4·55	4·73	4·50	4·70	
July	4·61	4·60	4·70	4·64	4·55	4·52	4·58	4·62	4·50	4·50	
August . . .	4·64	4·70	4·58	4·50	4·44	4·59	4·50	4·50	4·59	4·48	
September . .	4·59	4·67	4·56	4·51	4·51	4·42	4·62	4·46	4·58	4·60	
October . . .	4·58	4·67	4·47	4·43	4·43	4·41	4·44	4·48	4·43	4·52	
November . .	4·53	4·64	4·49	4·36	4·52	4·54	4·51	4·35	4·45	4·45	
December . .	4·53	4·36	4·50	4·33	4·35	4·41	4·41	4·33	4·31	4·40	

(Signed) PHILIP MONSON,

Superintendent.

CHAPTER VII.

TESTING PUBLIC LAMPS.

The Evans Photometer was originally constructed to supply an instrument which could be employed to test the actual amount of light given by a public lamp, *in situ*, as compared with a standard sperm candle. This want was felt in consequence of a dispute which had arisen between the gas company and their customers, the parishes of St. Margaret and St. John, Westminster; and the first of these instruments, in the form of a long box lined with black cloth, was used to test the light given by a gas lamp burning under ordinary circumstances in the public street. Since the introduction of the electric lights, however, the importance of testing their power easily and rapidly has led to the construction of a more portable instrument, viz.:

SUGG'S TRAVELLING PHOTOMETER.

The standard of light used for comparison is a Keates's lamp, burning sperm oil, provided with a

Methven slit placed across the flame of the burner, instead of vertically as in the Methven standard of light. The slit is of such size as to allow a portion

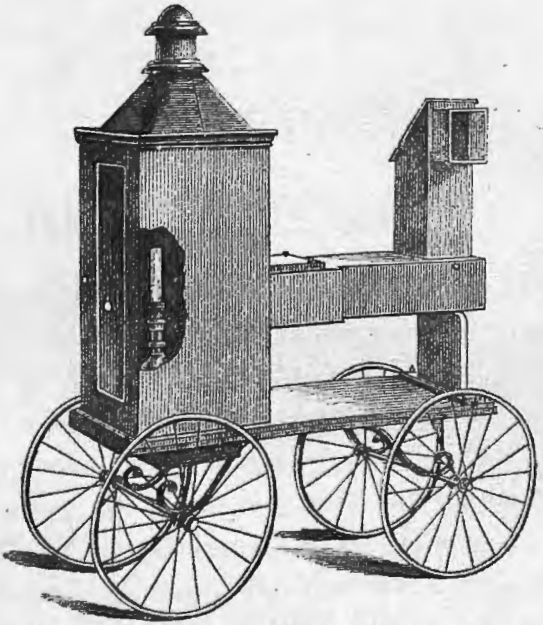


Fig. 46.

of the whole light of the lamp equal to 2 candles to pass through it. This standard light, which is constant, is enclosed in a dark chamber, properly ventilated; the front part of the chamber communicating by means of a square wooden tube with one side of the comparison disc. This disc is shaped like the letter **A**, and covered on both sides with white paper. On each side of the disc is pasted a cutting from a newspaper, one half the reading being on one side of the disc, and the other half on the other. The

two sides are separated by means of a partition, which is carried up some distance above the discs. One side—that nearest the lamp—is covered so that no other light but that of the lamp can fall upon it; the other side is left open to receive the full light from the electric or other light to be examined. A mirror properly placed enables the observer to see both sides of the disc at once, and thus to judge of the relative amount of light falling on each. The standard degree of light adopted is therefore equal to that which will fall on a white surface from the rays of 2 candles placed at a distance of 3 feet from that surface. The photometer as thus used is on the Church and Mann principle, but it may be arranged on the King principle, and thus be used to measure the amount of light falling in any part of a roadway at a distance of 3 feet from the ground.

PRESSURE GAUGES.

The Gas Referees have issued instructions that, for the purpose of testing the pressure of gas supplied to Street Lamps, such testings shall be made by unscrewing the governor and burner of one of the ordinary public lamps, in any street or part of a street which the controlling authority may from time to time appoint, and attaching in their stead a portable pressure guage.

Each testing place is provided with a gauge pre-

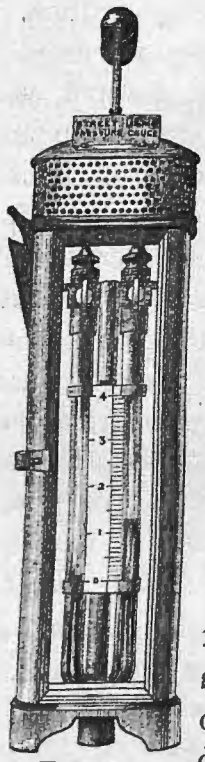


Fig. 47.

scribed for this purpose by the referees, consisting of an ordinary pressure gauge enclosed in a lantern, which also holds a candle for throwing light upon the tubes and scale. The difference of level of the water in the two limbs of the gauge is read by means of a sliding scale, the zero of which is made to coincide with the top of the lower column of liquid.

The gas examiner having fixed the gauge, gas-tight, and as nearly as possible vertical, on the pipe of the lamp, and having opened the cocks of the lamp and gauge, shall read and at once record the pressure shown. From the observed pressure one-tenth of an inch is to be deducted to correct for the difference between the pressure of gas at the top of the lamp column and that at which it is supplied to the basement of neighbouring houses.

If the pressure of the gas is tested in the daytime the portable gauges, Figs. 48-51, are the most convenient; but in the case of a contract being made with the authorities of any parish or district, it is advisable that a recording pressure gauge, Fig. 52, be connected with the supply. In this instrument the pressure is open to inspection, and a record is made of the time and extent of the variations.

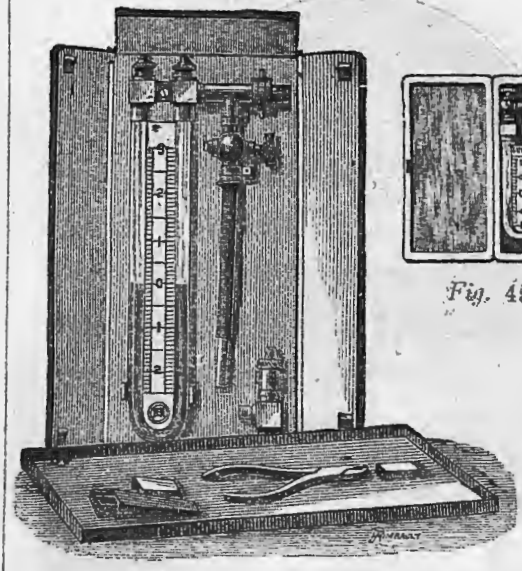


Fig. 48.

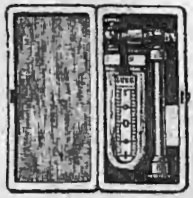


Fig. 49.

Fig. 50.

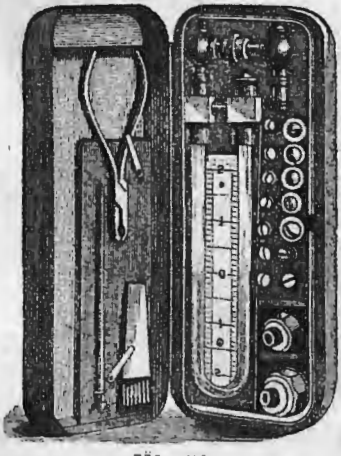


Fig. 51.

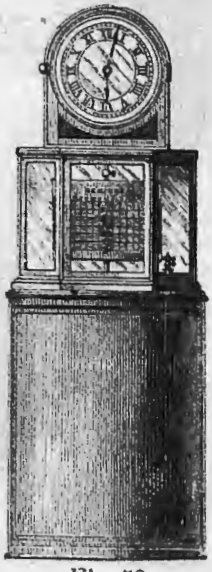


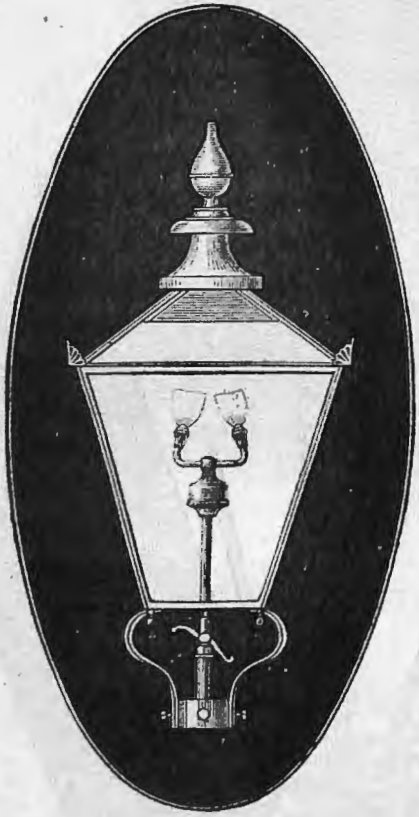
Fig. 52.

THE "NORTHUMBERLAND AVENUE" LAMP

THE "WHITEHALL" LAMP.

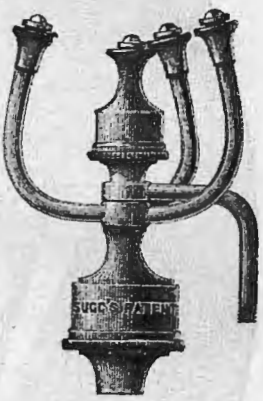
NOTE.—The Compound Chimney Argand Lamp illustrated on Page 22 was fixed to light a portion of the Gardens of the Fisheries (1883), Inventions (1885), and Colonial and Indian (1886) Exhibitions.

THE "METROPOLE" LAMP.
16 inches square.



Fitted with the Double
"Billingsgate" Burner.

TREBLE
"BILLINGSGATE"
BURNER.



Fitted with Independent
Centre Burner.

NOTE.—The references to the "Billingsgate" Burner on Page 7 are reversed, as the Double Burner (Fig. 4) has a consumption of 10 or 12 feet, and the Treble Burner (Fig. 5) has a consumption of 12 or 15 feet of gas per hour.

OPINIONS OF THE PRESS.

[*From the* DAILY NEWS, *January 13th*, 1879.]

A GAS RETORT.

AFTER a good deal of energy and ingenuity displayed in conducting the interesting controversy on the respective merits of gas and electricity, it has at length occurred to a gas company to give a practical illustration of what gas can do if it be fairly dealt with. The promoters of the electric light have recommended it to the public by the simple expedient of displaying its powers in the public thoroughfares, and for some months they have had it all their own way, mocking the puny lamplights in the Strand, on the Embankment, and on Holborn Viaduct with globes of glorious light. After a period of apparent paralysis, the gas companies are beginning to regain courage. There is no question of the superior brilliancy of the electric light as applied to street illumination. But behind looms the question of cost, and the dark shadow of the ratepayer is a deterrent influence on street illumination which the most powerful electric light yet known has not succeeded in overcoming. This is the weak point in the attack of the advocates of the new light, which the gas companies have not been slow to see, or diffident in insisting upon. The streets of London are lit in accordance with contracts entered into between the various gas companies and the vestries in whose parishes their several districts are situated. Gas is sold at so much per foot, and the vestries get just as much as they are inclined to pay for. The vestries, having the wholesome fear of the ratepayer in their eyes, are chiefly anxious to keep down the rates; the gas companies, having dividends to pay and new shares to issue, are careful not to give a foot and a quarter of gas for the price of a foot; and between the two London is very badly lighted. But it is obviously not fair to lay the blame on the ill-treated and over-economized gas. It is all a matter of cost, and if the people of London will pay for a good light they can have it through the familiar agency of the contemned lamp-post.

This is the argument of the gas engineers, and to the Phœnix Gas Company belongs the credit of submitting its soundness to the test of public experiment. By arrangement with the Lambeth Vestry a section of Waterloo Road was on Saturday

night lighted on improved principles, and the popular verdict, as far as it might be gathered from the freely expressed opinion of the crowd attracted by the unwonted illumination, was that the experiment was a success. The "improved principle" was mainly based upon the simple expedient of burning more gas in order to get a better light. But this end was furthered by all that sedulous care, high skill, and long experience could suggest. The section of road experimented upon extends from Waterloo Bridge southward to the railway station, a distance of 500 yards. Hitherto 22 gas lamps, including a feeble galaxy of six at the York Road crossing, have dimly lighted the thoroughfare. Under the direction of Mr. Woodall, the accomplished engineer of the Phœnix Gas Company, with whom the experiments originated, these lamp-posts were removed, and 48 new ones set up, of course at closer distances. The new lamp-posts differ from the old in many important particulars. In the first place they are 2 feet shorter—a hopeful recognition on the part of gas companies that it is the street pavement that wants lighting, not the first-floor rooms of the adjacent premises. The lanterns are crowned with opal glass, which reflects downward a greatly increased proportion of the light. Moreover, the iron framework in which for many generations the lantern has been set is done away with, and with it vanish the black shadows cast on the pavement which have made the space at the foot of a lamp-post the darkest in the street. Finally, the supply of gas is increased, though not materially, the new burners giving a supply of 15 candles as against 12, the former maximum. The effect of the alteration may perhaps be best conveyed by the statement of the simple fact that, standing in the middle of the road just below the bridge, where no assistance is derived from shop-lights, it was possible at seven o'clock to read a newspaper.

This illumination, brilliant as it appears by comparison with the ordinary lighting on the bridge, or in any of the streets which bisect the roads, pales before the still greater things accomplished at the York Road crossing. Here single lamps stand in the two "sanctuaries" in the middle of the road, and there are other smaller lanterns at each corner of the cross-roads. In respect of mere ornament these lanterns are most grateful to the eye, and the vision which rises up in the excited imagination of the streets of London dotted with them in place of the forbidding posts that rise out of the ground at intervals down the long unlovely street is very pleasant. The larger lanterns in the centre of the road are formed of concentric rings of steatite with air passages between, and were specially designed for the purpose by Mr. Sugg, the well-known inventor of gas-burners, whose services have been enlisted in this experiment in street

ighting. A light equal to, in one case, 200 candles, and in the other to 130, is obtained from the larger lamps, whilst the four smaller ones at the corners of the cross-roads diffuse through Argand burners a measure of light equal to 50 candles each. For all practical purposes, no greater illumination than is hereby supplied could be desired.

But, after all, the cost is the thing, and having admitted the success of the illumination let us look at the bill. Under the old arrangement of lighting the Waterloo Road (which is, perhaps, no worse or no better than an average thoroughfare), the 500 yards of road were lit by 22 gas lamps, showing a light equal to 264 candles, and the cost was £93 10s., or 5¼d. an hour. The total cost of lighting the street, after the manner shown on Saturday night, would be, including interest on first cost, £387 2s. per annum, or a cost of 22d. per hour, including maintenance and all charges. But it obviously is not necessary that so lavish a display of light should be maintained after midnight. By extinguishing half the lamps at 12 o'clock, which would still leave a better light than we now have under the most favourable circumstances, there would follow a reduction of the cost to 17d. an hour. To treble the cost of street lighting is a prospect which the boldest vestryman would shrink from, and it may be said that the mere statement of such an alternative settles the question of improved street lighting. But of course the matter actually at issue is not a comparison between two methods of lighting by gas, but between street lighting by gas and by electricity. Here again the question of cost comes in, and we have, fortunately, material at hand for instituting a comparison. The Paris municipality paid at the rate of 1s. per light per hour for the world-famed experiments which illuminated Paris during the Exhibition. The electric lights on the Embankment are separated by spaces of 50 yards. Taking this as the proper distance, it would require twenty electric lights to illuminate the section of road operated upon last Saturday. At a shilling per light per hour the cost of illuminating Waterloo Road by electric light would accordingly be £4200 per annum, as against the increased cost of £387 per annum in which a maintenance of the illuminating power exhibited on Saturday would involve the vestry. As Captain Bunsby was accustomed to remark, "the bearings of this observation lies in the application of it."

In the meantime the experiments of Saturday night have supplied an interesting and valuable contribution to a controversy in which the public take the keenest interest. What they want is good and sufficient light, furnished at a moderate cost, for houses and streets, and they will be thankful if either the

gas companies or the promoters of the electric light will supply them with it. The retort courteous of the Phœnix Gas Company to the brilliant arguments of the electric light seem to prove that the gas companies can light the streets if the public will consent to pay for the luxury.

[*From* THE TIMES, *Tuesday, April 15th*, 1879.]

GAS LIGHTING.

A THIRD example of improved gas lighting in the public thoroughfares of London is now afforded by the lighting of a portion of Queen Victoria Street with a generous supply of gas. The other two examples are those of Waterloo Road, Lambeth, and Waterloo Place, Regent Street, particulars of which have been given in *The Times*. In the present instance, as in that of Waterloo Place, the experiment has been instituted by The Gaslight and Coke Company, and the details have been carried out for them by Mr. William Sugg, of Vincent Street, Westminster. In all 35 lamp standards have been dealt with, 26 being situated along the pathways and nine on the various refuges. The old lanterns have been removed from the standards, and others of an octagonal pattern on the pathways and one refuge, and of a 12-sided pattern on the other refuges, have been fitted in their places. The tops are glazed with opalescent glass, so that the upward rays of light are intercepted and thrown down. The burners are Sugg's London Argand, and are similar in construction to those in the other two experiments. They are fitted each with a flash-jet, which lights the gas upon its being turned on, which is done by means of a lever tap and a stick, neither torch nor ladder being required. Thirty are 80-candle burners, each consuming 22 cubic feet of gas per hour, the other five being 200-candle burners, each consuming 50 cubic feet of gas per hour. The distribution of these lights is, twenty-six 80-candle burners on the pathways, four 80-candle burners on the refuge opposite Watling Street, and five 200-candle burners on the other refuges, one being opposite the Mansion House and another in front of the Mansion House Railway Station, which two points define the extent of street thus lighted. This piece of roadway was previously lighted by 26 flat-flame burners on the pathway, each consuming 5 feet of gas per hour, and 29 similar burners on the various refuges, placed in groups of five fives and one four on the standards. There were thus originally 55 burners, each consuming 5 cubic feet of gas per hour, giving a total consumption of 275 cubic

feet of gas per hour, which at 3s. 6d. per 1000 feet, gives a total cost of 11½d. per hour for the whole number of lights. Under the improved system the total consumption for the 35 lamps is 910 cubic feet of gas per hour, which at 3s. 6d. per 1000 feet, gives a total cost of 3s. 2d. per hour for the whole number of lights. The increase in the consumption of gas is, therefore, at the rate of 635 feet per hour in the new as against the old system. But, then, the 275 feet of gas burnt in the 55 ordinary flat-flame burners only yielded a light equal to 550 candles, while the 910 feet of gas consumed in the London Argand burners under the present system afford a light equal to 3400 candles. The gas consumption is, therefore, increased rather more than three-fold; but by burning the gas in an efficient manner the light is increased six-fold.

With respect to the result of this experiment as regards the improved light afforded, it is unnecessary for us to say anything. The superior illumination is patent to every one, and stands out in marked contrast with that of the adjoining thoroughfares, and especially with that of the remaining portion of Queen Victoria Street, which actually affords an example of good lighting under the ordinary system. One point, however, arises which is worthy of notice, as showing that it does not much matter whether cannel gas or ordinary gas be used so that it be properly burnt. It will be remembered that in Waterloo Place cannel gas is used, the price of which is 4s. 4d. per 1000 cubic feet. Now, taking the Queen Victoria Street lighting, we have thirty 80-candle burners, each consuming 22 feet per hour, which equals 660 feet, giving an illuminating power of 2400 candles, and five 200-candle burners, each consuming 50 feet per hour, which equals 250 feet, or 1000 candles. The totals are 910 feet of gas per hour, giving a light equal to 3400 candles. The cost of this gas for the entire length of street lighted is, at 3s. 6d. per 1000 feet, 38·22d., or a light of 88·95 candles for 1d. per hour. In Waterloo Place there are forty-three 80-candle burners, each consuming 19 feet per hour, which equals 837 feet, or 3440 candles, and two 200-candle burners, each consuming 45 feet per hour, which equals 90 feet, or 400 candles. The totals here are 927 feet of gas per hour, and a light equal to 3840 candles. The cost of the gas at 4s. 4d. per 1000 feet is 3s. 7½d. per hour for the whole number of lamps, or a light of 88·24 candles for 1d. per hour. It will thus be seen that the lighting with common gas at 3s. 6d. per 1000 feet is slightly superior to that with cannel gas at 4s. 4d. per 1000 feet. It therefore follows that if the gas be burnt properly, it is of little consequence whether cannel or common gas is used, the cost being practically the same for the same illuminating power.

[*From the* GLASGOW HERALD, *Friday, April 25th*, 1879.]

NEW SYSTEM OF STREET LIGHTING.

LAST night a new system of street lighting was inaugurated in the city with a success that exceeded the anticipations of those more immediately concerned in its introduction, and must have astonished all who witnessed its illuminating effects. The old series of dingily-lit lamps that stood at the junction of St. Vincent Place and Buchanan Street have given way to one of Sugg's patent lanterns, which diffuses a light of a brilliancy that completely pales the ordinary "rat-tails" in the lamps around. We in Glasgow have frequently had good cause for complaint on account of the indifferent manner in which the public thoroughfares are lighted, but ground for grumbling on that score will be quite removed should the new method receive that general adoption which its evident superiority to the existing system amply warrants. The vast improvement of Sugg's patent on anything we have been accustomed to can only be appreciated by observations of the results it produces, but the following outline and description will help to convey some idea of the leading characteristics of the new lantern :—

The upper portion of the lamp is composed of a new kind of white glass, and the lower part of clear glass. The flame burns in the small funnel which rises from the centre of the lower part, the consumption of gas being maintained and regulated by a nicely-contrived governor. The light exhibited last night was equal to 360 candles, more than double that given by the old lamps, while the consumption of gas was exactly the same, 40 cubic feet per hour. These facts speak so conclusively in favour of the new lantern that further comment is unnecessary. The "shadowless lantern," as Mr. Sugg styles his patent, is to be immediately fitted up in St. Enoch Square, in George Square, at Charing Cross, and at one or two other central points; and as the principle can be applied on a reduced scale to the ordinary street lamps, we may look forward hopefully to a speedy shedding of more light on our dark and dingy wynds and closes.

[*From the* BRIGHTON GUARDIAN, *Jan. 23rd*, 1884.]

THE sea front is now lighted at night by the Sugg's burners, which the Brighton and Hove Gas Company so liberally offered to place there.

The result is veritably brilliant. Whitehall seems somehow to have been transported by a magic Barnum from the London

of smoke and grim to its sister by the sea. Anyhow, the result is very much the same. The splendid broad thoroughfare which runs from Palace Yard to Trafalgar Square is, perhaps, the best lighted, and is certainly the most satisfactorily lighted in the whole City of London. With a flood of good light similar to that with which that busy street is wont to be bathed is the King's Road now illumined. Cimmerian darkness has fled before the refulgent glory of Sugg. Plenty of light is shed over the entire roadway and sidewalks, and the erstwhile gloomy front is unrecognizable under the blazing groups of burners. It is just the thing for which so many people have been clamouring since ever so long ago. It will be interesting to note the result, so far as public appreciation is concerned.

[*From the* HASTINGS NEWS, *Sept. 24th*, 1886.]

BOROUGH IMPROVEMENTS, &c.—The lamps which have been erected outside the New Town Hall with Sugg's patent burners emit quite a refulgence of light, and are in every way an ornament to the town. The broad pavements, which are quite finished, are already proving a boon to pedestrians wishing to gain Mead's Lane, or from thence to Grove Road. The interior of the edifice is being finished, and soon the new hotel de ville will be ready for occupation by our civic and judicial dignitaries. On Tuesday, for the first time since the gradual demolition of the old railway station, the new illuminated clock in the central tower was lighted. The public in this part of the town will be greatly benefited, as the hands of the clock can be seen denoting the time by persons from several streets.

[*From the* JOURNAL OF GAS LIGHTING, *Jan. 3rd*, 1882.]

ST. LOUIS, MO., *Oct. 18th*, 1881.

Eight of Sugg's 150-candle power flat-flame "Westminster" Lamps were distributed along Olive and Fourth Streets. One of Sugg's 100-candle power "Whitehall" Lamps was put at the north-east corner of Fifth and Olive Streets, which place is illuminated by the Weston Electric Company. One electric lamp hung immediately over this little Sugg, one on each side, not more than three feet from the lamp, and yet not a wink, not a shade of yellow, not the slightest effect discernible that any electric lamps were about. Now, this may sound like exaggerating; but the very next day the Jewellery Company (who showed the electric light) sent word to the Gas Company to

please remove that lamp, as it spoiled *their* light. The Gas Company, with their usual alacrity, removed the 100-candle power, and put up a 150-candle power "Westminster" Lamp in its place. The electric lamp at this place did excellently, and the two different lights showed to splendid advantage—no one, gas man or not, could say which was the better of the two, although for uniformity and steadiness of flame the gas excelled the electric lamp.

Wednesday and Friday evenings were repetitions of the gas illuminations of Tuesday night. The stores were all open for the exhibition of goods—no sales—while the streets depending upon the electric light were dark and gloomy, Fourth Street was teeming and bustling with life.

Impartially speaking, gas showed its immense advantage over electricity on these nights—its reliability whenever wanted; and Fourth Street is mentioned by all in terms of praise. I append a slip from one of our morning papers of what the merchants think of it.

Further, I will state that a movement is on foot among the merchants to make the illumination of Fourth Street a permanent one, and papers are drawn to illuminate the street on the 28rd instant, when the Convention for the Improvement of the Mississippi River meets here. The Sugg lamps fulfilled all expectations, and are continued on the principal street by the Gas Company.

The result of the trials of the two lights plainly indicates the course for Gas Companies to pursue—to give good light, plenty of it, and an exercise of liberality and brains.

The *St. Louis Globe Democrat* says:—"It is gratifying to learn that the merchants on Fourth Street are negotiating with the Gas Company with a view to the permanent illumination of Fourth Street after the manner that attracted so much attention last week. The idea is favourably regarded by the merchants, and the question may be said to turn entirely upon the point of expense. If satisfactory terms can be arranged, the pipes will at once be put up in permanent shape, and St. Louis will have the most beautiful night promenade in the world. It is not improbable that the illumination will be extended in this event beyond its present limits. Franklin Avenue would probably be the northern, Myrtle Street the southern limit, with western extensions on Franklin and Washington Avenues, and Olive and Locust Streets. For the present the project simply includes the limited section of Fourth Street now illuminated, but the extensions mentioned would follow almost as a matter of course."

[*From the* JOURNAL OF GAS LIGHTING, *March 29th*, 1881.]

IMPROVED STREET LIGHTING AT WESTMINSTER.

AT the meeting of the Chartered Gas Company on the 11th ult., it was stated by the Governor (the Hon. R. Howe Brown) that permission had been obtained of the vestries, and other bodies concerned, to make an experiment in improved street lighting by means of gas, for the whole length of Parliament Street, Whitehall, and Charing Cross to Trafalgar Square, and that the matter would be immediately proceeded with. In accordance with this announcement, and with the least possible delay, considering the extent of the change contemplated, and the number of the persons to be consulted in reference to the matter, the Chief Inspector of the Company (Mr. T. C. Hersey) arranged with Mr. Sugg for the carrying out of the work; and after various slight modifications, the experiment was successfully put into operation last week.

As the existing lamp-posts were sufficiently near together, they were throughout utilized, and no changes were made in their positions; two additional posts only being placed on refuges almost opposite Downing Street, in order to light the wide stretch of roadway at this part. A special form of shadowless lantern—the "Whitehall"—was designed by Mr. Sugg; and the burners used therein are groups of three, four, and five flat-flame governors.

As to the position of the different sized lights, as at present arranged there are 63 lamps with 60-candle burners fixed on the posts along the edges of the roadway from the Great George Street end of Parliament Street, through Whitehall, to Charing Cross. Here round the statue of Charles I. are 4 lamps with 100-candle burners each; while to complete the display there are, at intervals, on the refuges in the centre of the carriageway, 11 lamps with 180-candle burners in each. The estimated consumption of gas will be 20, 30, and 50 feet per hour respectively, costing for the whole illumination of 6160 candles, by the consumption of 1920 feet of gas, 6s. 8d. per hour. It is intended, however, in order to economize, that the major part of the small-size burners—55 out of the 63—shall be extinguished at midnight; leaving the lighting to be performed by the whole of the larger lights assisted by 8 only of the small ones. This, it is stated, will reduce the cost, after 12 o'clock at night, to 2s. 1d. per hour; the lighting power then being equal to 2460 candles by the use of 710 feet of gas. It may be mentioned, for the sake of comparison, that formerly the 76 lamps then in use consumed

348 feet of gas per hour, at a cost of 1s. 0·2d., and gave, it may be assumed, something like 700 candles of illuminating power. The relative annual cost will be seen from the following figures:—

	New System.	Old System.
Before midnight . . .	£713 6 8	£108 15 8
After midnight	222 19 2	108 15 8
Total for 4280 hours in the year	£936 5 10	£217 11 4

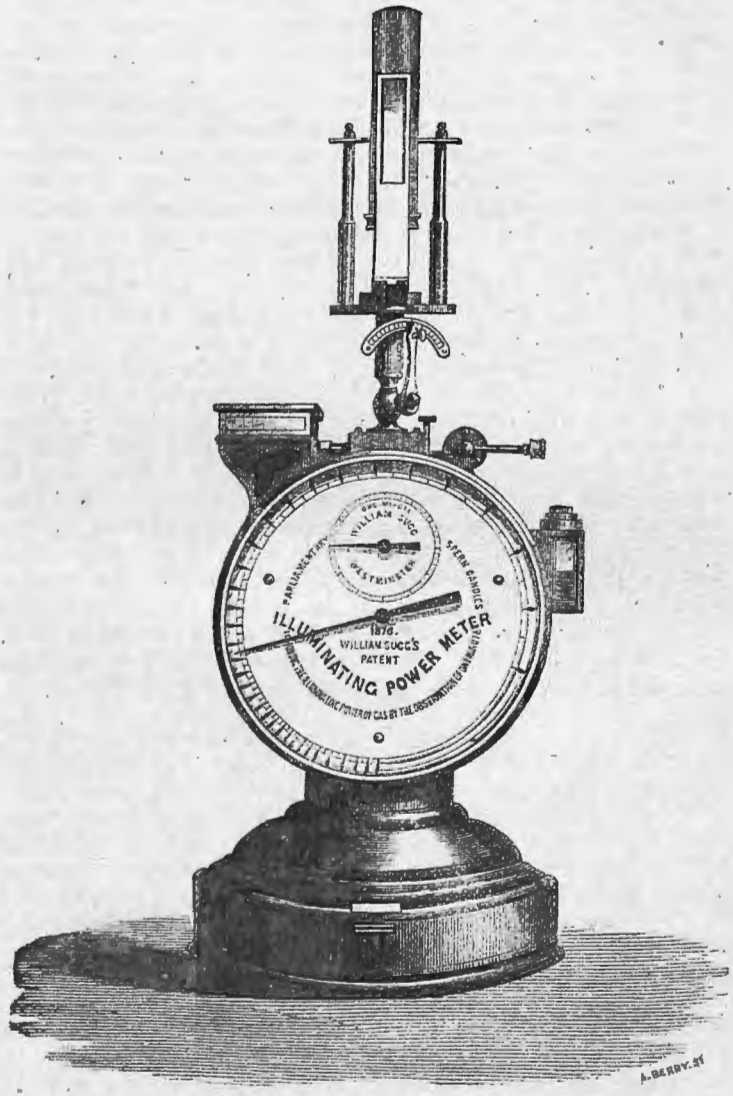
In connection with this experiment we learn that Mr. Sugg, on his own account, is proposing to light up Trafalgar Square, and the immediate neighbourhood, with similar sized lanterns and burners. It is intended to employ 40 of the 60-candle burners—9 only being retained alight after 12 o'clock each night—and 8 of the large 180-candle burners. The preliminaries only in regard to this proposal have so far been arranged, no step having been taken to carry out the work.

[*From the* METROPOLITAN, *Oct. 27th*, 1883.]

STANDARDS FOR STREET LAMPS.

THE question of the most satisfactory mode of lighting large open spaces which are also important centres of traffic is one in regard to which very considerable difference of opinion exists among public authorities. The first object, of course, should be the provision of an adequate illumination, but it has not unnaturally been also desired that the lights should be erected upon something more than the ordinary bare poles, and where the surrounding buildings have been architecturally of an imposing or conspicuous order, the provision of some special means of lighting has become a necessity. It has, however, unfortunately too frequently happened that the ornamentation has interfered materially with the lighting, and in the provinces, particularly, we could point to several instances where the primary object of street lamps has been apparently ignored altogether. The Metropolitan Board of Works have recently carried out an improvement in the matter of public lighting which is deserving of more than passing attention. There is, perhaps, no spot in London, nor possibly even in the country, in respect of which there was greater room for effective lighting, combined with handsome columns and surroundings, than was presented at the junction of Northumberland Avenue with Trafalgar Square. The opportunity was altogether exceptional in its character;

but the architect to the Metropolitan Board of Works (Mr. George Vulliamy), with the assistance of that master of gas lighting, Mr. William Sugg, has provided at this great centre what may almost be said to mark quite a new departure in public lighting of the kind. Two exceedingly handsome standards, each with three branches, have been here provided, and some idea of the elegant nature of the columns is afforded by the accompanying illustration. These standards are from the designs of Mr. G. Vulliamy; the castings are from the foundry of Messrs. Young and Co., of Pimlico, and are from the models made by Messrs. Mabey and Co., of Westminster, sculptors and modellers. The lamps, of globular form, are constructed according to Mr. Sugg's latest patents, and are fitted with his patent combination flat-flame burners, each lamp having a group of four. Three of the burners burn 10 feet each, and one in the centre 5 feet per hour. The centre one is intended to be burned after midnight, and there is an arrangement by which the lamplighter may extinguish the outer three of the group, leaving only the centre one to burn till daylight. Each lamp is provided with a white glass reflecting top, first introduced, we believe, by Mr. Sugg in the experimental street lighting by gas in Waterloo Road and Waterloo Place in January, 1879. The effective illuminating power from each of the six lamps, measured by a photometer on the ground, is 175 candles, making for each candelabrum a total equal to 525 candles. This, we are told, is the highest result yet obtained by common coal gas burned in street lamps fitted with flat-flame burners.



ILLUMINATING POWER METER.

ILLUMINATING POWER METER

(WILLIAM SUGG'S PATENT)

For showing the Illuminating Power of Gas in Parliamentary Sperm Candles, by the Observation of One Minute.

DESCRIPTION OF CONSTRUCTION AND MODE OF USING.

The annexed engraving shows the appearance of the instrument, and the following is a description of its construction, and the mode of using it:—

A "London" Argand Burner, provided with a well-made cylindrical chimney, is fixed, by means of a ground swivel joint, on the top of a pillar screwed on to a hollow rectangular base, which is firmly soldered to the outer case of an experimental meter. This base has no communication with the inside of the meter-case. That part of the pillar between the top of the base and the burner forms a cock, the gas-way of which is not drilled in the usual manner, but is slotted across the plug. The sides of this gas-way being parallel to each other, it follows that, unlike those cocks fitted with round-way plugs, the cock opens when the lever is turned by regular gradations until it is full open. A quadrant divided into 45 equal divisions, attached to the cock, enables the operator to regulate the flow of the gas to any required rate with rapidity and precision. Above the quadrant a sighting frame is fixed, having two upright pillars, crossed by a flat bar at one end, and at the opposite end a frame fitted with blue glass. A scratch is made across the glass exactly 8 inches above the solid part of the frame. The bottom of the opening, the top of the burner, and the termination of the thick part of the back columns are all on the same level. The scratch on the glass, and the bar which crosses the back pillars, are also on the same level, and parallel to the three lower points just mentioned. By these arrangements the operator is enabled to adjust the height of the flame to the level of the scratch and the back bar.

It may be observed, in passing, that if some points in the flame pass the line by about one-eighth of an inch, it will make but a very slight difference to the result. There will always be small

points which will look like flame, but which are only heated air. A few minutes' practice will suffice to enable any one, without previous knowledge of the instrument, to adjust the height of the flame.

On the left side of the hollow base on which the pillar stands is a tube which connects this base to the outlet of a double governor. The square box on the left of the meter is this governor, which serves to maintain uniformity of pressure during the time the instrument is in use. This governor is adjusted so as to give pressure enough to make the flame tail over the chimney when the regulating cock is full open.

On the right of the hollow base is fixed a two-way cock, with a lever ending in a knob fixed to its plug. The cock is quarter stopped, so that when it is turned in one direction as far as the stop it is full open, and in communication with the inside of the meter, which is full of measured gas. In this position this measured gas passes through the length of the plug of the cock, and by means of a tube fixed to the end of the cock at one end, and to the inlet of the double governor at the other, it finds its way through the governor to the hollow base, and finally to the burner. While the gas is passing to the burner by this route, the measuring-drum of the meter revolves; but if the lever of the cock is turned in the opposite direction until it meets the stop, another route is opened for the passage of the gas. Now it passes directly from the inlet to the meter without passing into the measuring-drum, through the length of the plug of the cock, and out by the same tube as before to the inlet of the governor, thence to find its way to the hollow base and the burner. In this position of the lever the measuring-drum of the meter is at rest, and the gas is unmeasured. The governor having been properly adjusted, and the meter having from 8-10ths to 1 inch of pressure at its inlet, this change in the position of the lever will not influence the height of the flame.

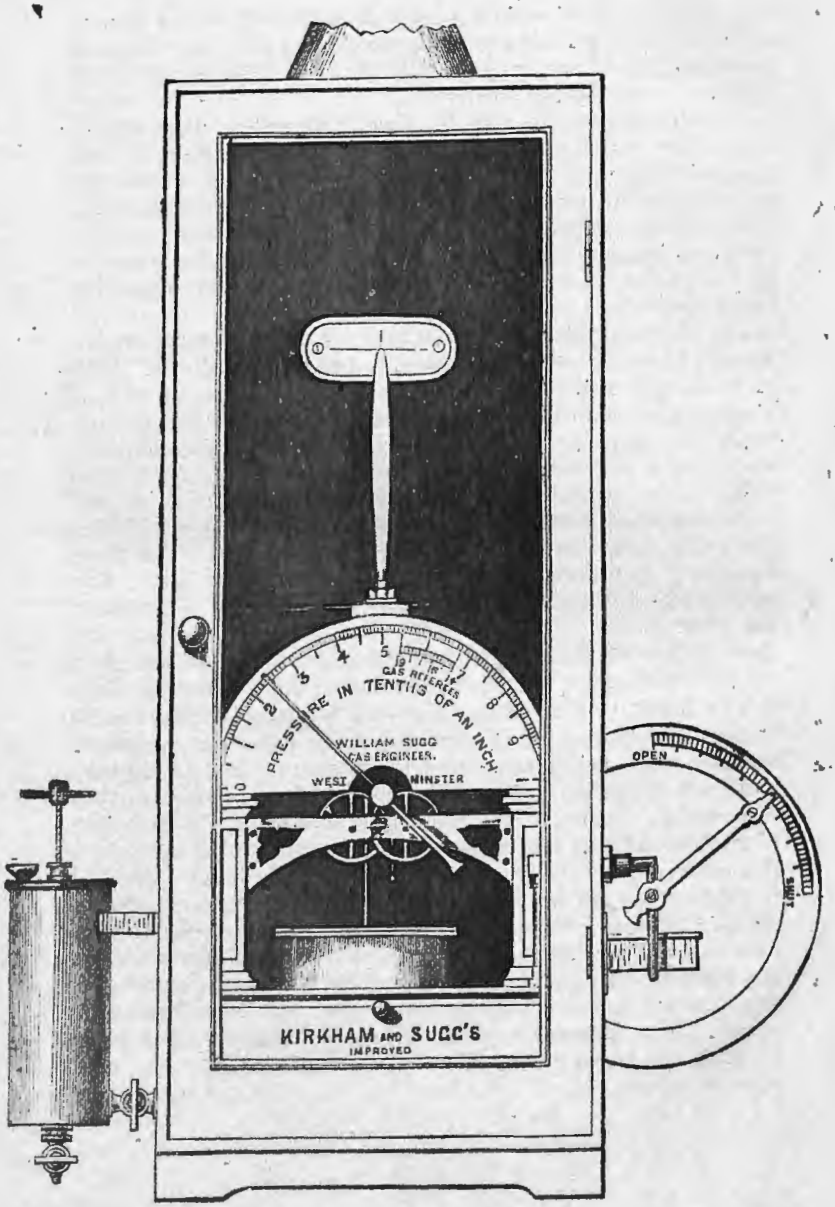
The index-hand is attached to the arbor of the measuring-drum, and therefore revolves with it, both making a revolution in the same time. The dial is divided into a number of divisions corresponding with the illuminating power in average parliamentary standard sperm candles, of the different qualities of gas which will give a flame of 3 inches in height. Thus, if the meter is supplied with 16-candle gas, and the flame is maintained at 3 inches, the index-hand will make one complete revolution in one minute. If the meter is supplied with 12-candle gas, and the flame maintained at the 3-inch line, the hand will make one revolution, and a part of another, arriving at the figure 12 in one minute. With 20-candle gas it will make less than a complete revolution in one minute, and arrive at 20. The

instrument is provided with a very accurate and strong minute clock, with one pointer hand, which makes a complete circuit of the small dial in one minute. This dial is divided into 60 equal divisions, representing seconds.

On the right of the cylinder which forms the outside case of the meter is the water-line gauge, fitted with back and front glasses. At the correct water-line these glasses are scratched across. On the top of the water-gauge is a large nut, which can be unscrewed when it is required to fill the meter or clean the gauge-glasses. The plug at the lower part of the gauge is for the purpose of running out the water if there is too much in the meter.

In the base of the meter is a cock for the purpose of emptying all the water out of it, when it is requisite to do so. This meter should never be turned upside down for the purpose of emptying, or some water will get into the governor and connections, and probably cause trouble. For the purpose of filling the meter a solution of one part of good glycerine, free from acid, in three parts of distilled water, should be used.

The mode of putting it into operation is very simple. Having filled the meter up to the water-line scratched on the glass, connect it to the gas supply with a piece of metal tube. The inlet is a ground union joint, fixed in the centre of the back of the instrument. Turn the lever so as to make the gas pass through the measuring-drum, and let it get rid of all the air or other kind of gas in it. Light the burner and adjust the flame to 3 inches in height. Then, when the large hand arrives at 16, change the position of the lever, so as to make the gas pass to the burner without going through the measuring-drum. The large hand will then stop at 16. Wind up the clock by means of the *remontoir* on the top of the meter just in rear of the dial ring. Start the clock by moving the slide which is on the left side of the meter, close to the governor. Then, when the hand of the clock is passing any one of the divisions of the minutes, change the position of the lever of the bye-pass, so as to make the gas pass through the meter. When the minute-hand has made one complete revolution, stop the meter by means of the lever, in the manner before described, and read off the illuminating power. The minute clock should not be stopped either before or after the observation, unless it is desired to put the clock entirely at rest.



LOWE'S JET PHOTOMETER.

LOWE'S JET PHOTOMETER

(SUGG'S IMPROVEMENTS).

With New External Water-Line Regulator; Improved Micrometer, with Quadrant divided into 45 degrees; Valve with pro rata opening; Improved Ventilator; Purple Glass Height of Flame Measurer; King's Gauge working on Friction Rollers, with Improved Scale showing actual Illuminating Power in Candles. In French Polished Pine Case.

DIRECTIONS.

In fixing the instrument care must be taken to have it placed perfectly level on a firm base, so as not to be affected by vibration, or other disturbing causes.

Now proceed to fill the tank with water up to the overflow line.

Hang on the float so that it falls on the left side of the wheel.

Let the balance weight cord have one turn round the wheel, and it will then hang close up to the wheel on the right side.

Hold the wheel with the thumb and finger of one hand, and shift the pointer (which is loose on the shaft) with the other, till it stands at zero, taking care that it works freely.

It is necessary once a day to turn off the inlet cock and open the vent cock in order to ascertain whether the pointer will fall to zero when the pressure is off.

If it does not do so the water-line must be readjusted as follows:

Turn on the cock between the well of the pressure gauge and the brass cylinder fixed on the left side of the instrument, which latter is the water-line regulator; when this cock is open the water in the cylinder rises to the height of that in the well. A plunger which nearly fits the cylinder is attached to the cover of the latter by means of a fine-screwed piston-rod terminating into a milled head. If it is made to descend into the water it causes a displacement equal to the bulk of that portion which is forced below the water-line, and the water displaced goes into the well of the pressure gauge, moving the pointer in the direction above zero. If, on the other hand, the plunger is raised

out of the water in the cylinder, the bulk withdrawn is immediately replaced by water from the well of the pressure gauge, and the pointer is moved in the direction below zero.

NOTE.—The alteration of the water-line is caused by evaporation, but the position of the pointer is sometimes altered by the effect of the atmosphere on the float-line.

The pointer having been properly adjusted, the communication between the well and the water-line regulator is closed and must not be reopened until it is required to make another adjustment of the pointer.

Connect the apparatus with the gas, and adjust the double governor by turning on the regulating cock, lighting the jet and weighting down the gas-holder nearest it to give 9 or 10 tenths of an inch pressure. Then regulate the flame to the 7-inch mark. The pressure required to give a 7-inch flame is an index to the illuminating power, thus, 16-candle gas will give the standard 7-inch flame at ·63 of an inch pressure at the point of ignition, as shown on the dial. 14-candle gas requires ·68 of an inch to give the standard flame.

The above instructions are for Photometers rated in accordance with the Gas Referees' Burner (Sugg's No. 1 "London" Argand).

Printed by KING, SELL, & RAILTON, 12, Gough Square, Fleet Street, London, E.C.

WORKS BY THE SAME AUTHOR.

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