THE DOMESTIC USES OF COAL GAS,

AS APPLIED TO

LIGHTING,

COOKING AND HEATING,

VENTILATION:

WITH SUGGESTIONS TO CONSUMERS OF GAS AS TO THE BEST MODE OF FITTING UP HOUSES AND USING GAS TO THE BEST ADVANTAGE.

BY

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London:

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

1884.

LONDON:
W. KING & SELL, PRINTERS,
12, GOUGH SQUARE, FLEET STREET, E.C.

To The Parkes Museum
with the authors compliments

PREFACE.

In undertaking to write a work upon the "Domestic Uses of Coal Gas"—a subject to which I have devoted upwards of twenty-six years of earnest work—I was conscious that I must of necessity have a distinct bias in favour of apparatus which I had myself tried and found practicable, over other variations or modifications of apparatus for like purposes.

The modifications of the various appliances connected with Illumination, Heating, Cooking and Ventilation by the aid of Gas are so numerous, and many of them are so nearly alike, that to describe them all would be a thankless task for the author and wearisome to the reader. I have therefore endeavoured so to describe and explain the appliances mentioned in this work, that the reader may be enabled to form a fair, independent judgment in respect of other apparatus, not described, which may at any time be presented to his notice.

In all those appliances of my own invention, which may commend themselves to my reader as being essentially practical, I desire to acknowledge the kindly aid and counsel I have received from a large circle of friends, both English and foreign, who are engaged in the manufacture and distribution of gas in all parts of the world.

When one can fully grasp the idea of what ceaseless toil and anxiety is involved in ensuring the purity and unfailing supply, in enormous quantities, of a necessary of such varied utility as gas, and also make oneself acquainted with the regulations under which that supply is carried on, one will be able to realize what a wonderful industry is gas manufacture, and how little its chief product merits such erroneous epithets as "noxious compound," and the like, which have been so freely bestowed upon it by scientific men and others whose information concerning it is not sufficient to dispose them to express themselves in more favourable terms.

If the perusal of this work serves to increase the public knowledge on the subject of Gas and its Domestic Uses, it will lead people to understand the great services which it has rendered in the past, and the still greater services it will be called upon to render in the future, in promoting the health and comfort of the human family.

Besides the primary services of the production of light, and the facile preparation of healthful food for all classes of society, gas will be required to take no inconsiderable share in the warming and ventilation of dwellings, workshops, offices, and warehouses, in such a way as to help forward the realization of that dream of the sanitarian, "smokeless cities." The products of the combustion of coal gas (mentioned in the last pages of this work), being mostly pure steam, will present a remarkable contrast to those crude products from coal fires which literally scatter valuable property to the four winds of heaven in the most extravagant and wasteful manner.

Already it has been shown, at the recent International Health Exhibition, what vast improvements can be effected by the use of gas in the baking of bread, and what a boon it will confer on the public and the working baker. The application of gas to this purpose will enable the baker to abandon altogether his underground, and consequently more or less dirty bakery, and establish himself in a well-lighted, clean bread factory, fitted with improved ovens, heated by gas, always ready, clean, and certain. The novel system of Messrs. Gilson and Booer, which is exceedingly simple, is to the larger commercial bakery what the "Vienna" oven described in this work is to the private family coal oven. The only difference is that, in the brick ovens, gas mixed with air is supplied inside the oven to heat the brickwork, instead of around the outside of the oven as in the apparatus described.

In conclusion, I trust that, in writing this book, I may have done something to help forward the great and useful work I have just alluded to; and I beg to commend myself to the kind indulgence of the reader, and to subscribe myself,

His most obedient servant,

WILLIAM SUGG.

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THE DOMESTIC USES OF COAL GAS.

CHAPTER I.

MANUFACTURE OF GAS.

COAL GAS, as supplied to the general public, is produced by the destructive distillation of coal in clay or iron retorts heated to a temperature of from 1800° to 2000° Fahr.

The coal is thrown into the retort, and the lid is closed and fastened by a kind of bolt, which thus seals the mouth of the retort.

Carbonization.

As soon as the heat begins to break up the coal, the gas is given off, at first very much mixed with steam, but afterwards becoming purer and richer in carbonaceous matter. This continues for a time, till, towards the end of the charge, when all the illuminating gases have been liberated, there remains only what is called marsh gas; and when this has been given off the residue is *Coke*.

Coke.

The gas as it leaves the retort is highly charged with the vapours of tar and ammonia, and has the appearance of smoke.

From the retort the gas passes up the ascension-pipe, the outlet end of which dips into a large horizontal pipe, called the *Hydraulic Main*, because it is partly filled with water. This serves as a seal to keep the gas which has passed into the hydraulic main from returning back into the retort when the lid is opened to withdraw the coke and put in a fresh charge.

Hydraulic main.

From the hydraulic main the gas is conveyed to the *Condenser*. This appliance consists generally of a set of upright pipes, which serve to cool the gas, and cause it to deposit the tarry and aqueous vapours, After leaving the condenser, at the temperature of the atmosphere, the gas is invisible.

Condenser.

At this point of the process the gas is composed of about 80 per cent. of hydrogen and marsh gas, which are non-illuminants, but are very useful in heating up the remaining carbon when the gas is used for illuminating purposes, and preparing it to be raised to a state of brilliant incandescence by the assistance of the oxygen of the atmosphere.

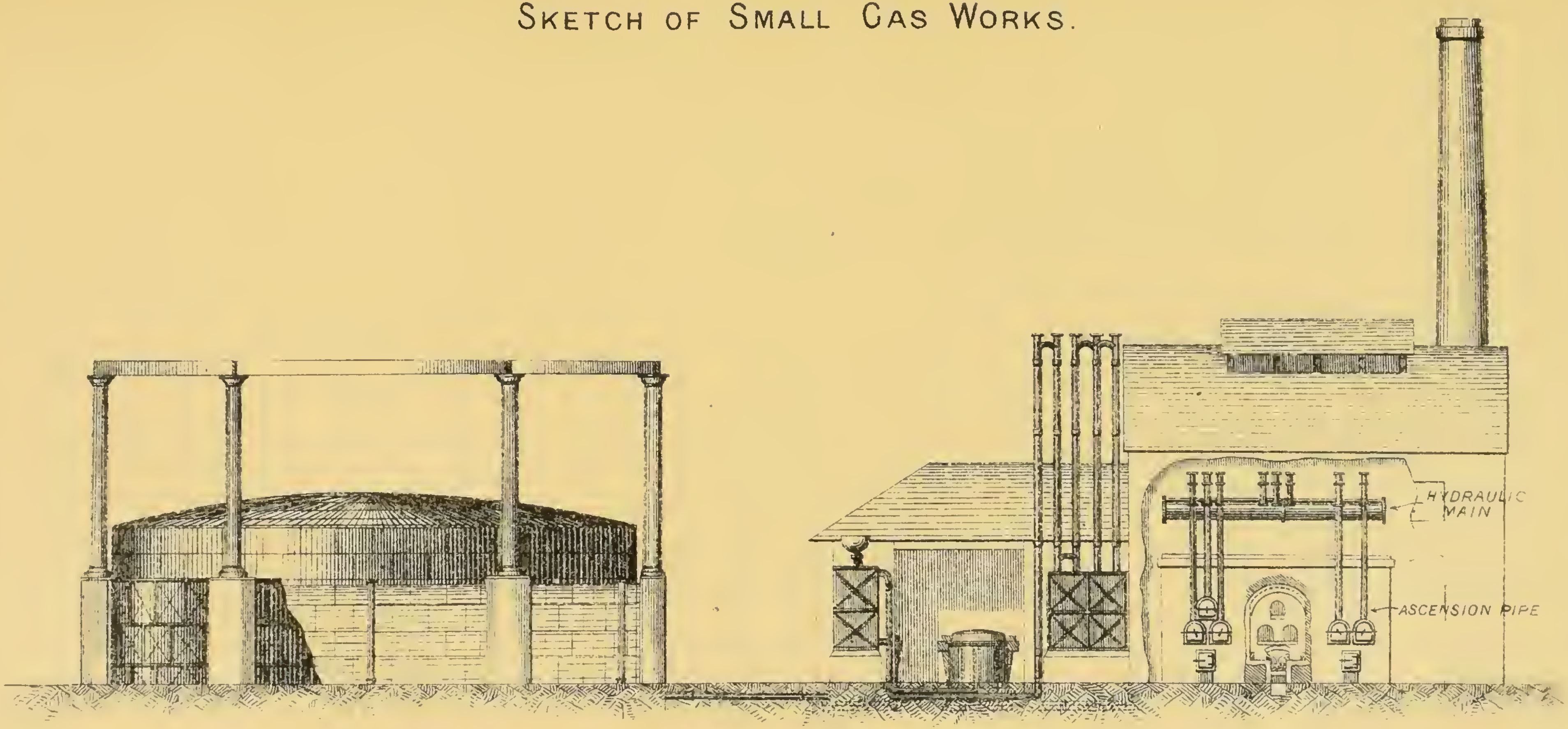
Composition of foul gas.

In this stage the gas is what is technically called *foul* gas, because it is mixed up with such impurities as *Ammonia*, *Sulphuretted Hydrogen*, and *Carbonic Acid*, none of which are useful, either for lighting or for heating, but, on the contrary, are injurious.

Impurities in gas.

Ammonia corrodes the brass fittings; sulphuretted hydrogen is evil-smelling, and destructive of furniture and decorations; and carbonic acid, by its

Sketch of Small Gas Works.



Scale, 18 Feet to 1 Inch

Plate 2.

presence, prevents the gas from giving its full illuminating power. About 2 per cent. in volume is the quantity of carbonic acid present in foul gas; while of sulphuretted hydrogen only about 1¼ per cent. is present.

There is, besides, a very small quantity of sulphur, in the form of bisulphide of carbon, or some other compound of sulphur and carbon, also found in the foul gas. In order to remove this, or, as it is technically termed, "purify the gas," it is conducted from the condensers to the *Scrubbers*. These are vessels filled with coke, wetted with water, through which the gas forces its way; leaving behind it any tarry matter that may have passed the condensers, and all the ammonia, which is readily absorbed by the water as it trickles through the interstices of the coke. Water is capable of absorbing from 700 to 1000 times its volume of ammoniacal gas. The liquor which flows from the scrubbers is called "ammoniacal liquor." It is sold to chemists, who purify it, and treat it in various ways; producing therefrom sulphate of ammonia, carbonate of ammonia, sal-ammoniac, and liquid ammonia. Smelling-salts are also produced from the ammoniacal liquor of gas-works.

Scrubbers

The removal of the sulphuretted hydrogen and carbonic acid is effected by causing the gas to pass through the *Purifiers*. These are air-tight vessels fitted with sieves, upon which are placed layers of oxide of iron, to absorb the sulphuretted hydrogen, and also layers of slaked lime, which has the

Purifiers.

property of absorbing the carbonic acid and the other sulphur impurities; so that when the gas leaves the last purifier it is an invisible fluid, containing no deleterious compounds. In fact, it is probable that it is the purest of all artificial illuminants.

Gasholders. The gas is then stored in vessels called *Gasholders*. These are simply inverted cylindrical receivers (open at the bottom, but entirely closed at the top), which are constructed so as to rise with the pressure of the gas till they are full, being sealed by the water in the tank in which they are placed.

The inlet and outlet pipes pass under the water in the manner shown in the diagram, the open ends being above the level of the water, and delivering the gas under the bell of the holder. The weight of the bell, which is supported by the gas within it, gives the pressure necessary to drive the gas through the street mains, whence it passes into the consumers' meters through pipes called *Services*. Services.

On the opposite page is a bird's-eye view of the largest gas-works in the world. They are capable of making 30 million cubic feet of gas per day. The total quantity of gas used in London in the year 1882 was about 25,000 million cubic feet, and all over England it was 72,583 million cubic feet. Paris consumes, per annum, about half the quantity of gas used in London.

BECKTON.

THE LARGEST GAS WORKS IN THE WORLD.

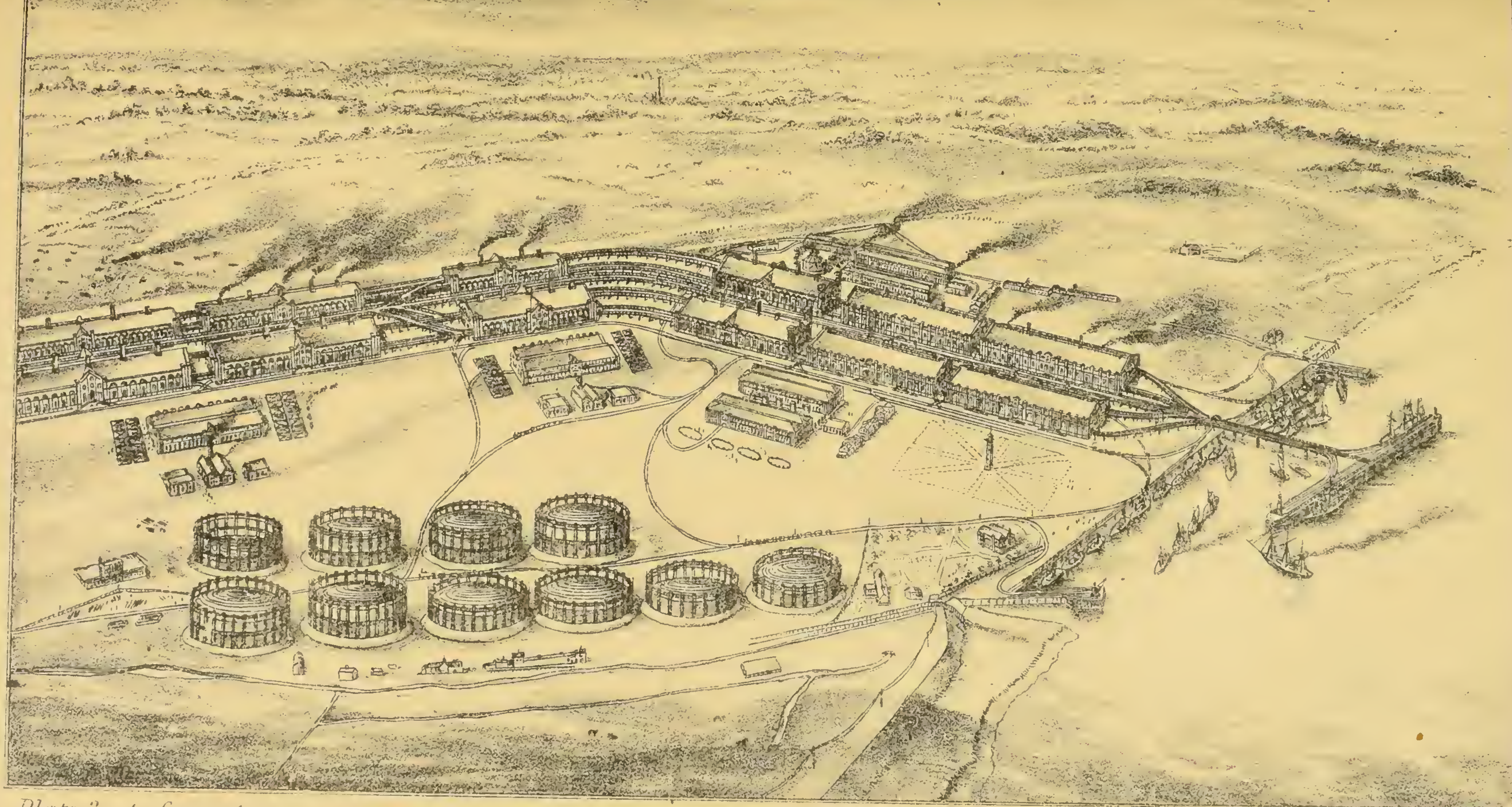


Plate 3. to face p 4.

Commenced 1869.

Erected by F. J. EVANS.

ENGINEER IN CHIEF

TO THE GAS LIGHT & COKE

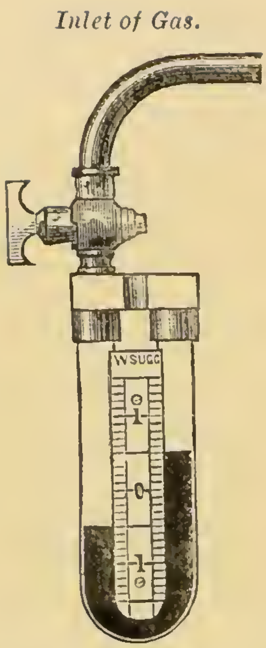
CHAPTER II.

PRESSURE AND QUALITY OF GAS.

THE pressure of gas is always calculated in linear inches, subdivided into tenths. Pressure of gas.

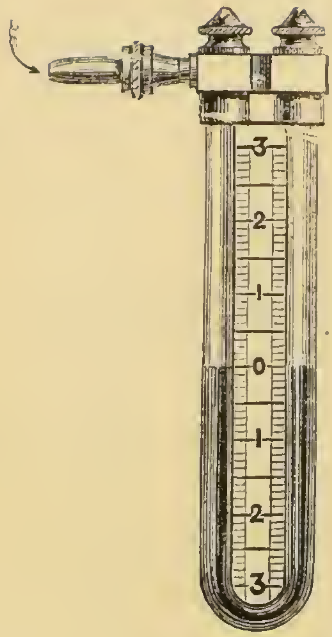
Thus, for example, when we speak of a pressure of 1 inch, it means that if the gas-pipe is put into communication with one leg of a U-tube half filled with water, as in fig. 1 on the next page, the gas will press up the water in the other leg, which is open to the atmospheric pressure, until the level of the top of the column is an inch above the level of the liquid in the closed leg. When we speak of 15/10ths or 20/10ths pressure, we mean that the differences of level between the columns of water in the legs of the U tube are $1\frac{1}{2}$ and 2 inches respectively.

The pressure in the street mains is an important question, and is the subject of special parliamentary enactment. For example: The London Gas Companies, and most provincial ones, are bound to maintain in all their street mains a pressure between sunset and midnight equal to a column of water 1 inch in height, and between midnight Pressure in street mains.



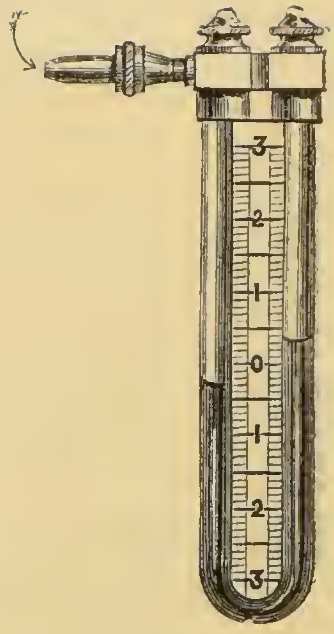
ONE INCH.

Fig. 1.



AT ZERO.

Fig. 2.



UNDER 8/10THS PRESSURE.

Fig. 3.

PRESSURE-GAUGES.

and sunset equal to a column of 6/10ths of an inch of water.*

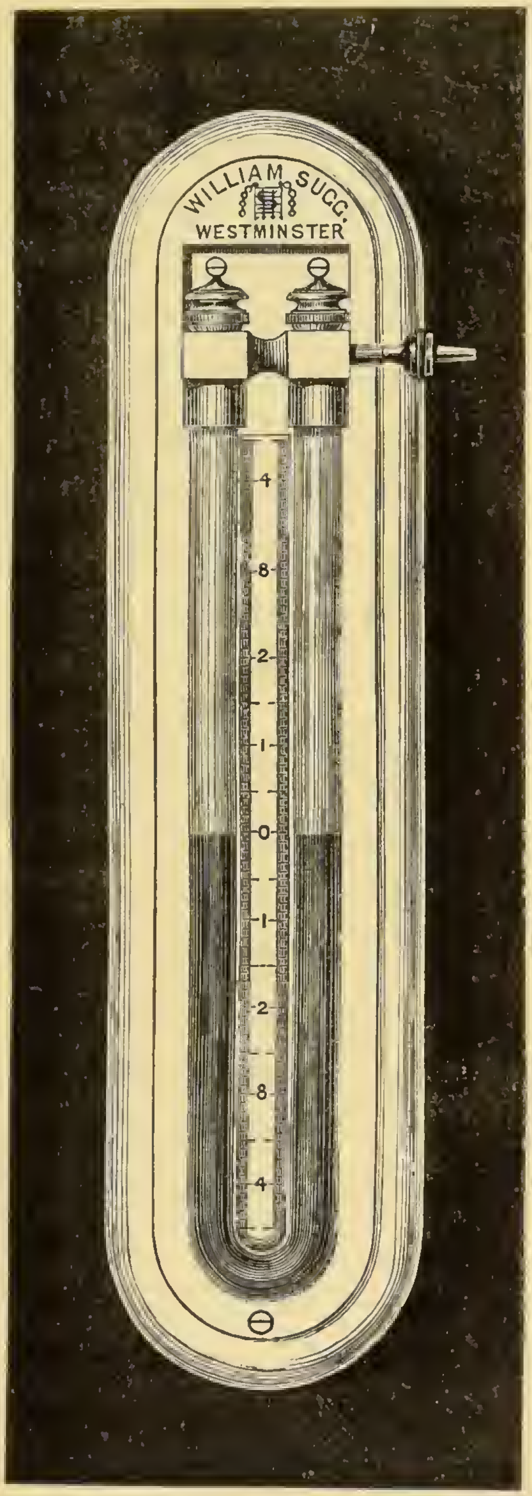
Pressure affected by height.

If the level of the streets were nearly the same, and the pipes in each house supplied with gas were of sufficient size, 8/10ths pressure would be ample for all purposes, and even 5/10ths would be sufficient in most cases. But the difference in the elevation of streets is very great, and gas is of

* The supply of gas is controlled in London by three officers of the Board of Trade, called Gas Referees. They are Dr. Tyndall, F.R.S., Mr. A. Vernon Harcourt, F.R.S., and Dr. Pole, F.R.S.

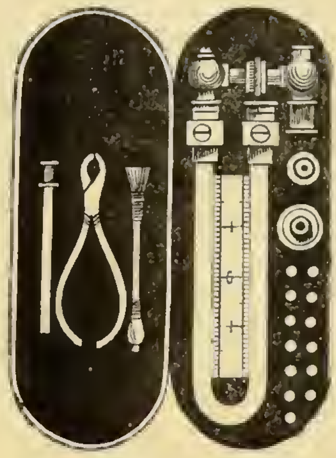
The Chief Gas Examiner for the Metropolis is Professor Williamson, F.R.S.; the Chief Gas Examiner for the City of London is Mr. C. Heisch, F.C.S.; and the Chief Gas Examiner for the Metropolitan Board of Works is Mr. W. J. Dibdin, F.C.S..

PRESSURE-GAUGES.



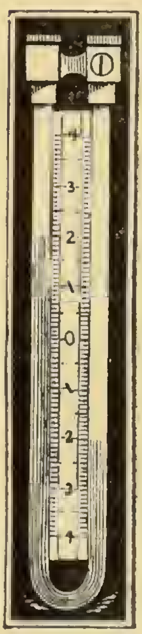
FIXED GAUGE WITH PORCELAIN BACK.

Fig. 4.



PORTABLE GAUGE,
IN CASE.

Fig. 5.



FIXED GAUGE, WITH
BOXWOOD RULE, SHOWING
4 INCHES PRESSURE.

Fig. 6.

a much lighter specific gravity than atmospheric air; therefore it follows that for every 10 feet of elevation the gas gains in pressure to the extent of 1/10th of an inch. Thus, supposing the pressure of the gas in a main situated at the foot of a hill 100 feet high to be 1 inch, the pressure at the top of the hill would be found to be 2 inches, and so on.

Another disturbing element in the pressure question is the variety in the sizes of the pipes which serve to convey the gas to the different points of supply in houses, factories, &c. Some are sufficiently large for the purpose; but many, on the other hand, are so small that a very high pressure must be given in the street mains to ensure a proper supply. Therefore, in arranging the pressure, the fact has to be taken into consideration that a number of consumers have their houses fitted with pipes which are too small for the work. It is these small pipes that almost invariably cause the popular mind to confound the question of pressure with illuminating power. The public generally suppose that if they have a good pressure of gas there will be a good illuminating power; and they complain of want of pressure whenever they do not, from any cause, obtain enough light.

Pressure checked by small pipes.

But the two things, pressure and illuminating power, are quite dissimilar. To explain: The gas supplied all over London averages more than 16 candles; and the larger gas companies are compelled, by the terms of the Acts of Parliament, to supply, at all hours of the day and night, gas of such a quality that, when burned through the adopted Government Standard Argand burner at the rate of 5 cubic feet per hour, it shall be capable of giving a light equal to that of 16 spermaceti candles of six to the pound, when each candle is burning at the rate of 120 grains of material per hour. This gas is called common gas.

Quality of common gas.

Parliamentary candle.

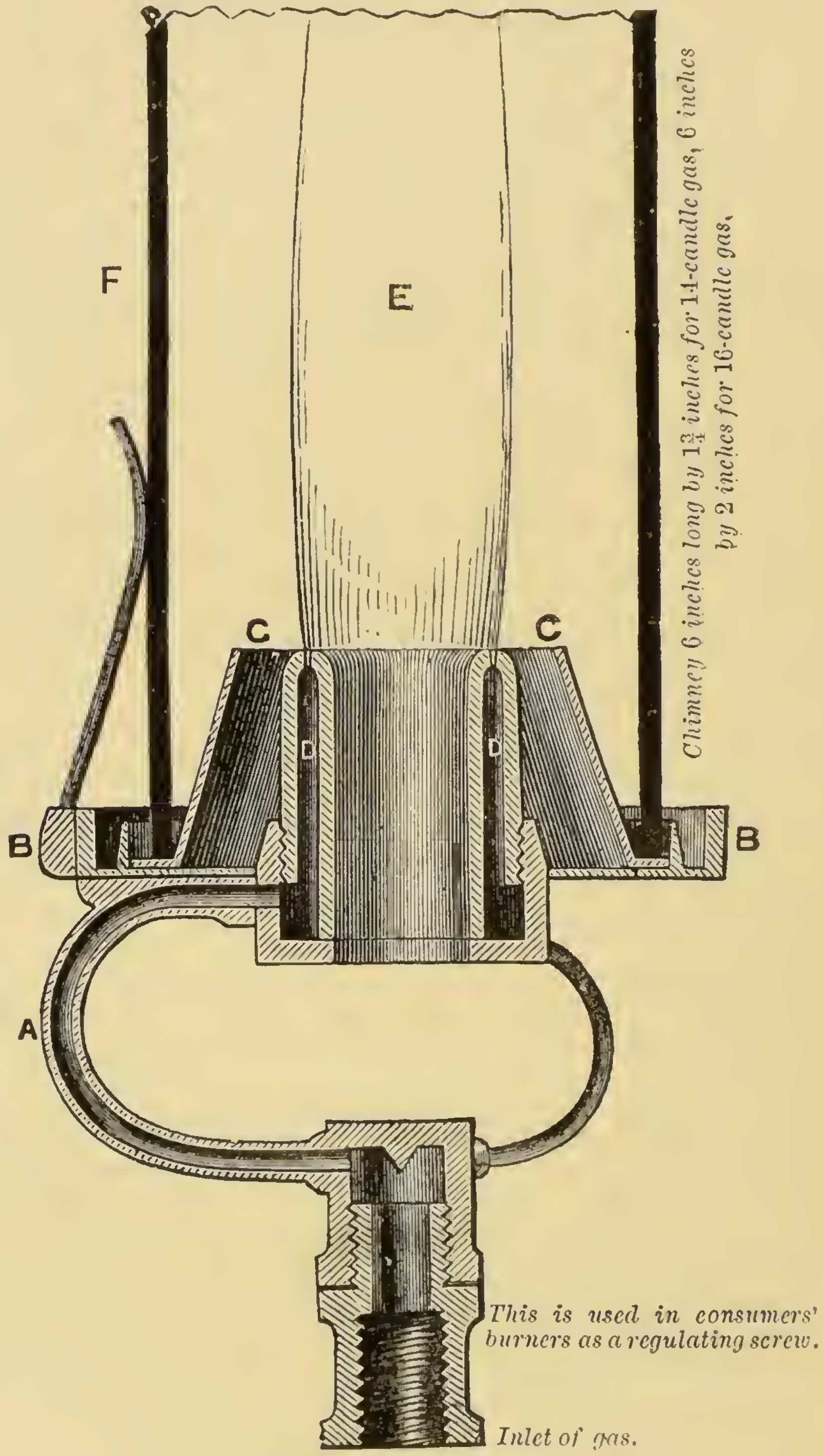
The burner which has been adopted as the standard burner for the testing of common gas was designed by the writer, and was called by him "Sugg's London Argand, No. 1."

Standard for common gas.

A full-sized section of this burner is shown on the next page; and the following are its principal dimensions:—

		Inch.
Diameter of supply-pipes		0·08
External diameter of annular steatite chamber		0·84
Internal diameter of do.		0·48
Number of holes	24	
Diameter of each hole		0·045
Internal diameter of cone—		
At the bottom		1·50
At the top		1·08
Height of upper surface of cone and of steatite chamber above floor of gallery		0·75
Height of glass chimney		6·00
Internal diameter of chimney . .		$1\frac{7}{8}$

ARGAND BURNER,
ADOPTED AS THE GOVERNMENT STANDARD BURNER IN 1869.



SECTIONAL ELEVATION.

Fig. 7.

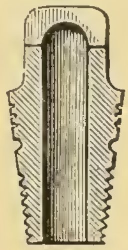
A—Supply-tube to chamber of combustion.
B—Support for chimney.
C—Cone, outer air supply.
D—Steatite chamber of combustion.
E—Flame.
F—Chimney.

Cannel gas.

There is another kind of gas, called "cannel gas," which is supplied in London to the Houses of Parliament and to several localities in Westminster. The quality of this gas is fixed by Act of Parliament at 20 candles per 5 cubic feet of gas consumed in a standard flat-flame burner called "Sugg's Steatite Burner." This burner is shown

Standard for 20-candle cannel gas.

VIEW.



SECTION.

by the above figures, and its dimensions are as follows:—

	Inch.
External diameter of top of stem . . .	0·31
Internal diameter of stem	0·17
Width of slit	0·02
Depth of slit	0·15

The gas supplied to Liverpool and Glasgow is cannel gas of this quality, and is tested precisely in the same way, and with the same standard burner.

Quality of Scotch cannel gas.

The gas supplied to Edinburgh and many of the principal towns in Scotland is cannel gas, and is called 25 or 30 candle gas. There is no recognized Government standard burner for this quality of gas, and therefore it is impossible to say in exact figures what is its *legal* illuminating power; but it may be said to average 25 candles at least, supposing it to be tested in the way in which the gas is tested in London, and with a suitable testing burner.

Gas periodically tested.

The reports of Professor Williamson (the Chief Gas Examiner), as well as those of the Chief Gas Examiners to the Corporation of the City of London and the Metropolitan Board of Works, which are given in the public journals, demonstrate that the conditions of gas supply are amply fulfilled in the Metropolis.

Instructions of Gas Referees.

Standard burner to be suitable for consumer also.

Now, a pressure of 5/10ths of an inch will be more than sufficient to enable the official standard burner to consume 5 cubic feet per hour, and to give the required amount of light. And here it may be as well to mention that the clause in the Act of 1868 (the "City of London Gas Act"), which gave power to the Gas Referees to make choice of a standard burner, specified that the burner so chosen for use in testing the gas should be such a one as was the best burner for the consumer also.

These directions of Parliament were carried out by the Gas Referees in 1869;* and at the present date the London Argand burner then adopted is still the *official* test-burner used throughout the Kingdom of Great Britain, the United States of America, Canada, and the Colonies. No alteration of any kind has been made in it, and it can always be compared with a model deposited with the Warden

* The Gas Referees of 1869 were Messrs. R. H. Patterson, J. S. Peirce, and F. J. Evans.

of the Standards at the Standards Department, Abingdon Street, Westminster.

But, although no alteration has been made in the standard burner, it is as well to state, in passing, that the *Consumer's* Argand has been so much improved that it now gives, for a consumption of 5 cubic feet of gas per hour, a great deal more light than that given by the official standard burner when consuming a like quantity.

Consumer's Argand.

It is clear from this that an increase of pressure beyond 5/10ths cannot improve the illuminating power of gas; but, on the contrary, as will be plainly shown, an increased pressure, beyond what is required by the burner, tends to reduce illuminating power. Therefore, what we need pressure for is only to force gas through the mains and service-pipes to such a degree that every consumer shall have a sufficient supply of gas for his use.

Increase of pressure does not always increase illuminating power.

Now, in any of the places mentioned, the generality of consumers are well aware, by the evidence of their own eyes, that they do not get nearly the amount of light from their gas which could be obtained from 16, 20, or 25 spermaceti candles respectively, if they were all lighted at once in the same room, and this whether the burners consume 5 cubic feet or even more per hour. In fact, it is often the case that, with three ordinary gas-burners all alight in the room at the same time, one cannot see to read at the table; and the consumer feels convinced that if, for example, 16 candles were lighted up, instead

Apparent illuminating power of gas as compared with candles.

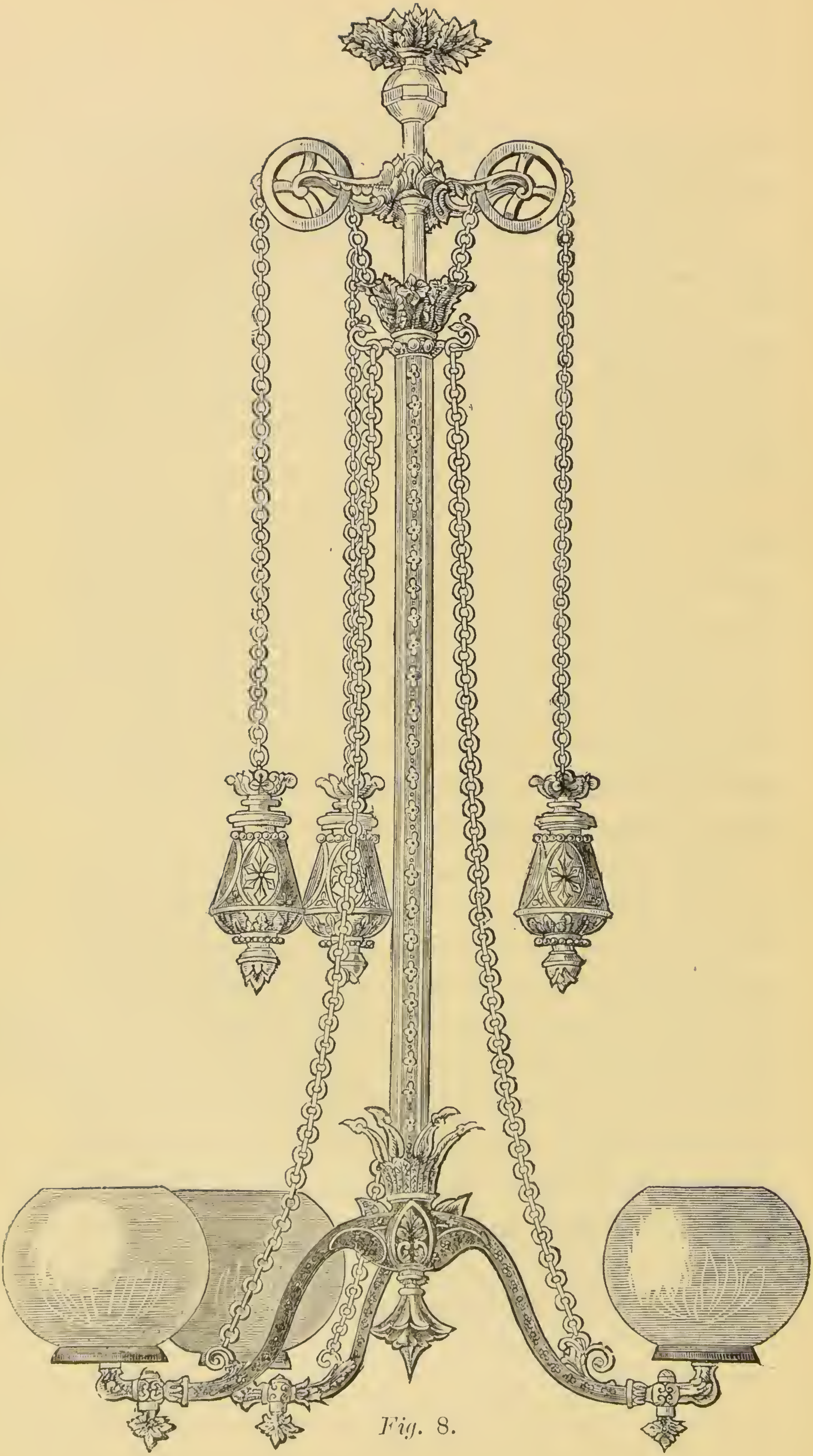


Fig. 8.

of the three gas-burners, a better light would be obtained. There is but little doubt that, in most cases, he is right; but he erroneously ascribes this want of light to the lack of pressure, and thinks that if he could only have enough pressure he would have a good light. The following experiments will demonstrate that he is entirely mistaken in the cause of the failure, and that the fault is not in the pressure of the gas, but in the burners, and in the defective arrangements of their accessories.

Experimental proof that excess of pressure does not improve illuminating power.

Fig. 8 is a chandelier of ordinary type, which was fixed in a room in London, and fitted with three fishtail burners (fig. 9), of the usual size and quality,

VIEW. SECTION.

Fig. 9.

supplied by gas-fitters to consumers throughout those towns in England and Ireland supplied with what is called common gas of 16 to 17 candle power.

Illuminating power of gas obtained by the generality of consumers from the gas burned in ordinary gas-fittings.

In the early part of a winter's evening the gas was lighted in the room, and the meter showed that the burners were consuming an aggregate quantity of gas amounting to $16\frac{1}{2}$ cubic feet. Now, the light which could be evolved from this quantity of gas, supposing that three Government standard burners had been used instead of the fishtail burners mentioned, would have been rather over three parliamentary candles per cubic foot of gas consumed. The actual value would have been 3·2 candles. Thus 3·2 candles multiplied by $16\frac{1}{2}$ (cubic feet), give 52·8—or, in round numbers, 53—candles as the amount of light which three standard Argand burners would have given for such a consumption of gas.

Fishtails only gave 19 candles.

The three fishtail burners, tested by the photometer, showed that they only gave 19 candles for a consumption of $16\frac{1}{2}$ cubic feet of gas; and it was found that 19 spermaceti candles fixed round the chandelier produced certainly a better illumination in the room, with less shadow on the table, than could be obtained with the aid of these gas-burners.

Candles gave more effective light.

Later on in the evening, as the pressure increased, the aggregate consumption of these three burners increased to nearly 30 cubic feet of gas per hour without roaring. But, although the consumption had increased to almost double the amount of gas, the light had not sensibly improved. It was still impossible to read with comfort at the table placed under the chandelier; but, on relighting the 19 spermaceti candles and extinguishing the gas, it was found that, although the general light of the gas was slightly better, so far as the ceiling was

Increased pressure no advantage.

Candles still better.

concerned, yet the candles still gave considerably the best result on the table. The photometer showed the burners to be giving then an aggregate light of 24 candles.

Slightly increased light for wasteful consumption.

These results can be compared in two ways: Either the consumption of 30 feet of gas ought to have given the light of $30 \times 3{\cdot}2 = 96$ candles; or the light actually obtained—viz., that of 24 candles—ought to have been the result of a consumption of $24 \div 3{\cdot}2 = 7\frac{1}{2}$ cubic feet of gas per hour.

Light as tested by photometer compared in two ways.

The pressure of the gas at the burners on the evening in question, was one inch at 4 o'clock, when they were lighted, and were consuming $16\frac{1}{2}$ feet per hour; and at 6.30, when they were consuming nearly 30 feet per hour, it was 22/10ths. Later on, when the pressure had increased to 34/10ths, they consumed much more than 30 feet an hour, and roared; but the amount of light given was less, although the consumption of gas had so considerably increased.

Pressure at burners when first lighted.

Greater waste under heavier pressure.

Now, it must be abundantly clear from this experiment (which any consumer can easily verify for himself) that no increase of pressure could have done anything to improve the illuminating power given by these burners, and that therefore the fault was really with the *burners*, and *not* with the pressure of gas.

True cause of defective light.

The same thing, in a slightly different degree, can be demonstrated by a trial of such ordinary burners as are used with cannel gas.

Any one who goes to Scotland must be quite unaware, from the evidence of his sight, that there is any higher quality of gas there than in London.

Cannel gas improperly burned not so effective as common gas with proper burners.

The President of either the North British or the West of Scotland Gas Association said, in his address a few years ago, that in his opinion the southern towns obtained a better result out of their 16-candle gas than the Scottish towns did out of their 25 and 30 candle gas.*

London gas, with burners in general use, gives only half the light it should.

The London Gas Referees reported to Parliament in 1870 that an examination of the burners used in many large warehouses, printing establishments, and private houses, revealed the fact that the public were only getting about half, and in some cases not more than a third of the amount of light which was capable of being evolved from the gas consumed.

Waste of gas and vitiation of air.

All this demonstrates a great waste of gas; and, more than that, a much greater vitiation of the air of rooms than ought to take place if they were properly lighted with good burners.

Registering pressure gauge.

In order to show what pressure is in practice actually required, in such a place as the Strand, so as to ensure a good supply of gas to every one, a copy of the paper taken off the self-registering pressure

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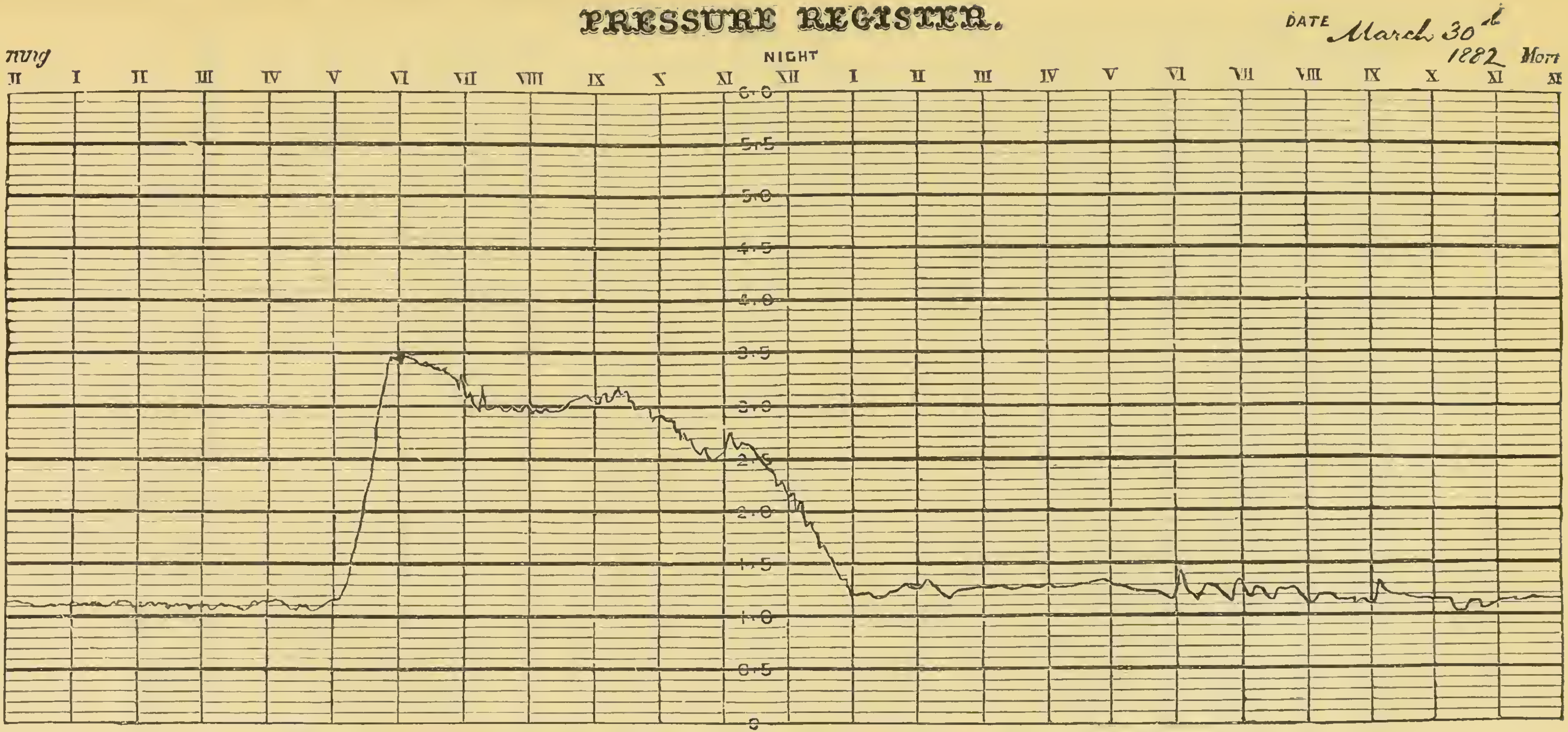
* The Liverpool gas, for example, which is only 21 to 22 candles, certainly looks better to the eye than Scotch gas usually does, although, in reality, the latter is much better, and would give, if properly used, the same amount of light with a less consumption than the former.

PRESSURE REGISTER.



When setting the time, turn the drum in the direction shown by the arrows gauge fixed in a room in No. 1, Strand, is shown in the diagram on the preceding page. It will be seen that at noon the pressure was 11/10ths, and remained, with slight fluctuations, the same till five o'clock. At that time an increased pressure was beginning to be put on, and by six o'clock it had risen to 35/10ths, or 3½ inches of water. Then it fell slowly until, at a quarter past seven, it was 30/10ths; thus it remained till 10 p.m.* From that time to 1 a.m. the pressure was gradually reduced to 14/10ths, and thence to 11/10ths, its ordinary day pressure.

Before passing from this part of the subject, it will be as well to state that in many private houses the fittings are so small, that unless there is a strong pressure the burners (which are also generally bad) do not let sufficient gas pass to permit of a light being obtained. This is doubtless the reason why the public confuse the terms "illuminating power" and "pressure."

To the public the gas is bad if it does not yield them sufficient light. The various causes which combine to destroy the illuminating power of the gas, such as small fittings, bad burners, &c., they are not aware of. The author trusts that the experiment described in the preceding pages will

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* This pressure has much increased since this paragraph was written, and it now reaches 40/10ths pressure at the maximum point.

be sufficient to indicate one of the most important causes of waste and discomfort.

The general pressure in the street mains must be so regulated as to give every consumer an ample supply, sufficient for all the purposes he requires, whether for lighting, heating, cooking, or motive power. No consumer need use more gas for any purpose than is required, and certainly no one need waste it.

CHAPTER III.

MEASUREMENT OF GAS.

When it has been decided to adopt gas lighting, the first thing to be done is to give notice to the Gas Company that it is proposed to use gas, and request that a service be laid on. In most cases this is done within three days. The better way, however, is to instruct some respectable gasfitter to make the necessary application, and have the service laid on.

Gas service.

Contract to take the gas required by Gas Company.

The Gas Company generally require the signature of a contract to take the gas, and a deposit of half the probable rental for the first quarter.

The Company lay from the main, to just inside the premises, a service-pipe of such a size as to be amply sufficient for the number of lights, gas-stoves, &c., which it is calculated will be required. They also supply a meter at a certain rental per quarter. The rentals of meters in London are as follows :—

Gas Company lay services and supply meter at rental

Meter-rents.

						s.	d.
3	lights	....	per quarter		....	0	9
5	,,	....	,,	,,	....	1	0
10	,,	....	,,	,,	....	2	0

				s.	d.
20 lights	....	per quarter	....	3	0
30 ,,	....	,, ,,	....	4	0
50 ,,	....	,, ,,	....	6	0
100 ,,	....	,, ,,	....	12	6

The gas service up to the *Inlet* of the meter belongs to the Gas Company; and it is illegal to disconnect the inlet of the meter, or to tap any pipe into it, because the gas taken from that point is not registered by the meter. Service to inlet of meter belongs to Gas Company.

After the *Outlet* the pipes are usually the property of the consumer, and any branches or attachments can be made; the gas being, as it leaves the outlet, registered on the dial of the meter. After outlet, consumer's property.

Gas Meters are of two kinds, technically termed "wet" and "dry" meters. The former are called "wet" from the fact that the measuring compartments are sealed by water, and will not pass gas until they are filled up to a certain point. The latter are called "dry" because they do not require any water to be put into them. On the contrary, if water is poured into them they will be put out of order, and no gas will flow through. Meters are of two kinds—wet and dry.

When the wet meter is short of water, through evaporation or leakage, the meter ceases to work, and no gas can go through it until it is filled up to the proper level.

The dry meters do not require this attention, therefore they are so much more in favour with the public than wet meters. Fig. 10 is a drawing

SUGG'S COMPENSATING METER.*

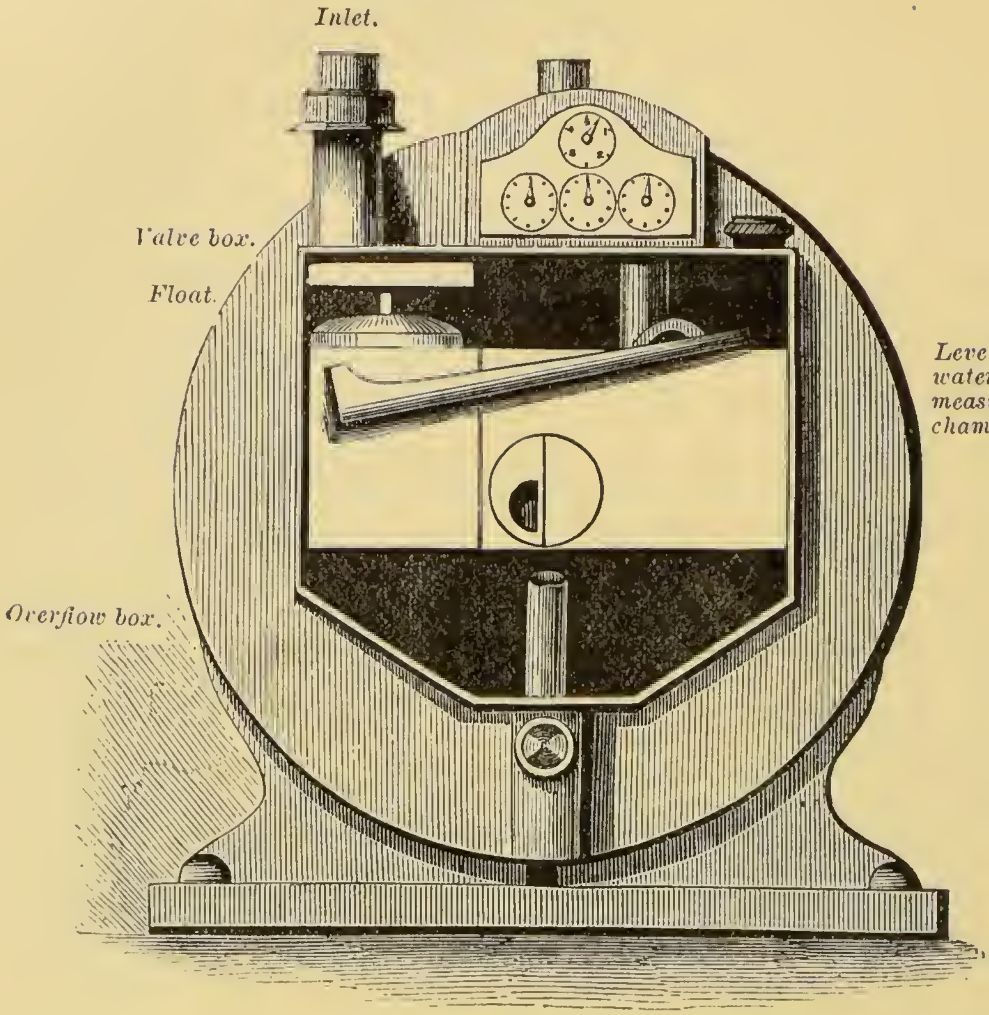


Fig. 10.

of a wet meter, which may thus be briefly described :—

Valve box and valve.

The gas enters into the meter at the inlet; from this it passes into the valve-box, in which there is a ground valve, supported on a float resting on the surface of the water, which seals the measuring apparatus. So long as the water is at its proper level the gas can pass into the meter, but

* The meter shown above is provided with a spoon, seen at nearly the top of its stroke, which lifts water from the overflow box, and puts it into the measuring chamber.

if the water has sunk so low as to unseal the measuring chambers, or make the meter register 3 per cent. less than the volume of gas passed through it, then the float following the water shuts

THE "RELIANCE" WET METER.*

WITH FRONT REMOVED, SO AS TO SHOW THE FOUR MEASURING CHAMBERS OF THE REVOLVING DRUM.

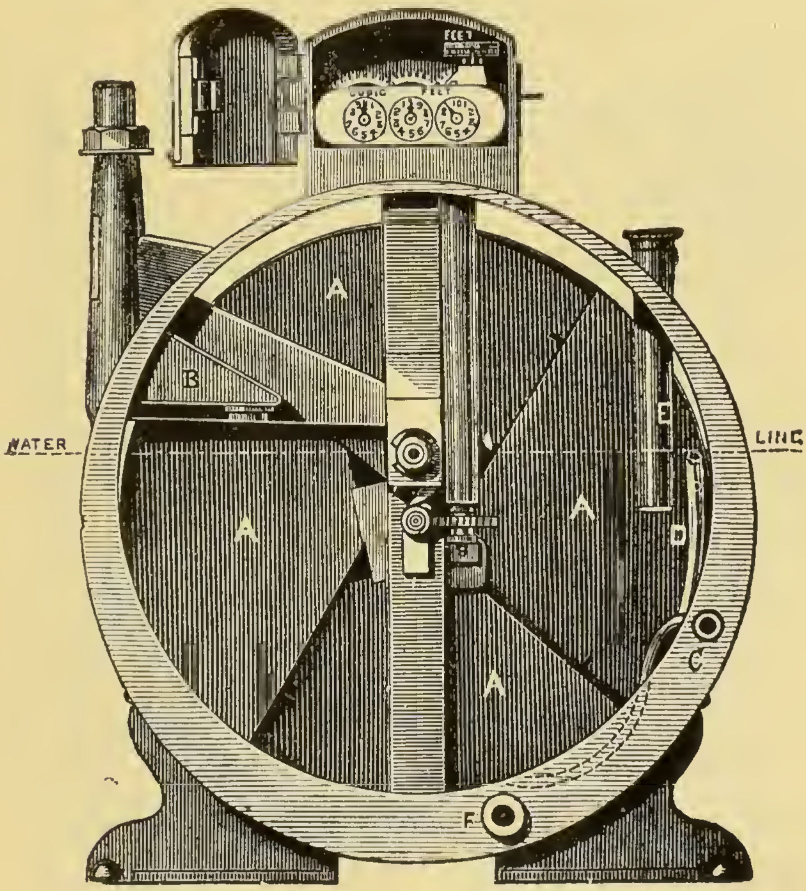


Fig. 11.

* The Reliance Meter above shown is intended to obviate the disadvantage of the ordinary float.

There is another kind of meter, called Warner and Cowan's Patent, which is so constructed that the measuring drum is not affected in its capacity by a considerable alteration of the water-line.

up the valve, and the supply of gas is stopped till more water is put in.

It may be said, in passing, that this is the most barbarously contrived arrangement which is to be found in the whole range of gas inventions. It is most unsatisfactory in its results, both as regards the consumer and the Gas Company. The former it annoys, and subjects to grave inconvenience, and even danger; the latter it does not protect, because it generally sticks up instead of following the water-line, and only tumbles into its place after it has been stuck up, perhaps for months, upon being rudely shaken by some means or other—perhaps a passing heavy waggon. Its abolition would be a great boon to consumers and a benefit to gas companies.

Objections to ordinary float.

Having entered the meter, the gas flows through the bent pipe, called the "spout." This is so made as to pass from above the surface of the water, in the front of the meter, into the measuring drum, through an opening sealed by water, which separates the inlet, or unregistered gas, from the measured gas, outside the measuring drum.

The principle and construction of the spout (*r*) are very clearly shown in the accompanying illustration (fig. 12), which is a section of a large meter, such as is used in gas-works. These meters are technically called *Station* meters, because the works at which a company manufacture their gas are called stations.

Station meter.

The measuring drum is simply a cylinder divided into four separate longitudinal compartments, arranged in the form of four blades of an Archimedean screw. The drum is fixed on a central shaft, with a bearing at each end, so as to permit of its being very easily turned by the action of the gas itself as it enters through the spout, and passes Measuring drum.

SECTION OF A STATION WET METER.

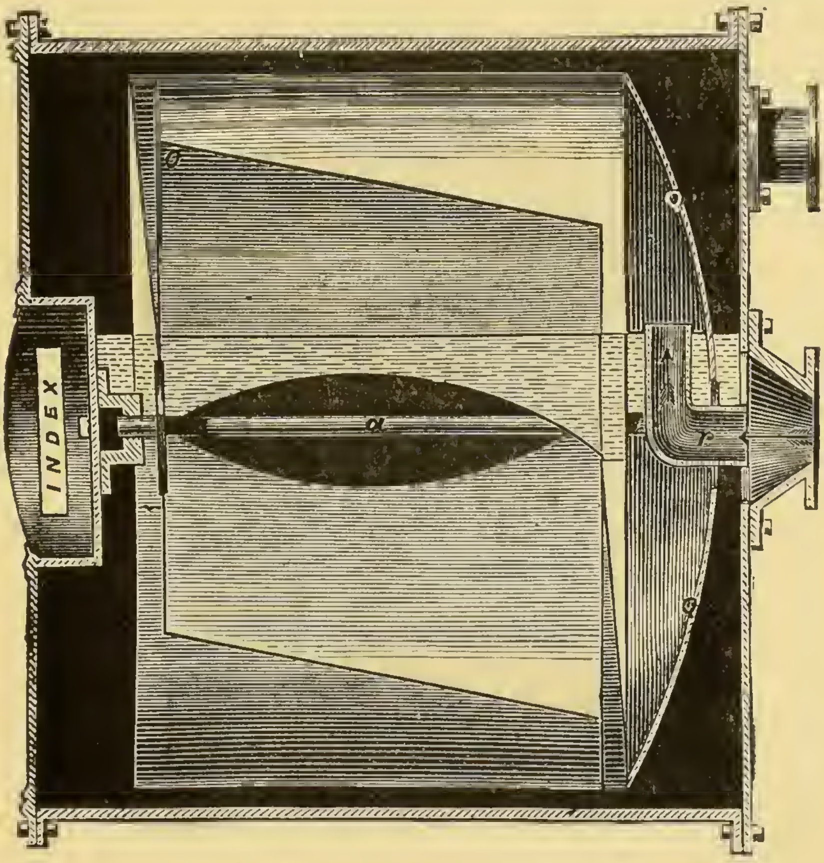


Fig. 12.

into those compartments which happen to be above the water-line. There are always two compartments above the water at the same time—one filling and the other discharging.

The gas entering the measuring drum presses against the underside of the longitudinal division, and turns the drum round for a quarter of a revolution, expelling in the process the gas contained in that chamber which has immediately preceded it, and so on. Each chamber in rotation, as it fills with gas, turns the drum round a quarter of a revolution, and expels the gas from the chamber which precedes it.

DRY METER.

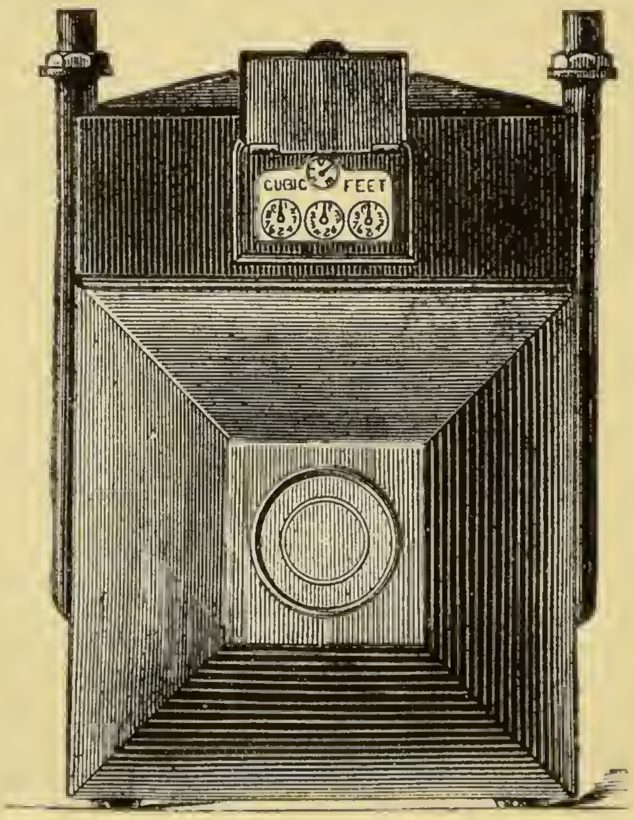


Fig. 13.

The meter works very easily, and only absorbs at the utmost 2/10ths of an inch of pressure. Thus, if the pressure of the gas at the inlet of a meter is 1 inch, at the outlet it will only be 8/10ths of an inch.

Whether a meter be of the "wet" or "dry" class, it must always take some force to move the machinery inside it, and as this work has to be done by the gas, the force required is gas pressure lost.

The *Dry Meter* (fig. 13) resembles in its action a double-cylinder steam-engine. The gas enters at the *inlet* and passes down into the valve chamber.

In this chamber are two slide-valves, each of which rests upon a smooth-surfaced "grating" (fig. 14) provided with three apertures, one in communication with the front, and the other with the back of the same piston. Both of these are

GRATING OF DRY METER.

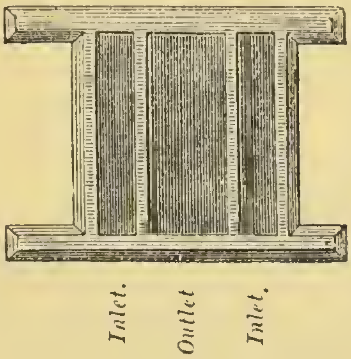


Fig. 14.

inlets for the gas when they are open to the valve chamber. Between these two openings, or "*ports*," as they are technically called, there is another port much wider than the other two; this is called the outlet or *exhaust* port, and it is common to both of the others in turn. The outlet port is never in communication with the inlet chamber, because it is covered by the slide-valve. The underside of the slide-valve is hollowed out so as to be able just to cover most of the

Ports.

exhaust port and one of the inlet ports. Thus, as it slides backwards and forwards on the face of the "*grating*" (fig. 15), it allows the gas contained in

Grating.

SLIDE-VALVE AND GRATING OF DRY METER.

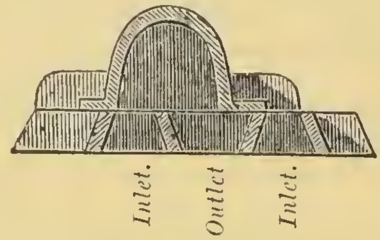


Fig. 15.

VIEW OF DRY METER, WITH OUTER CASING REMOVED.

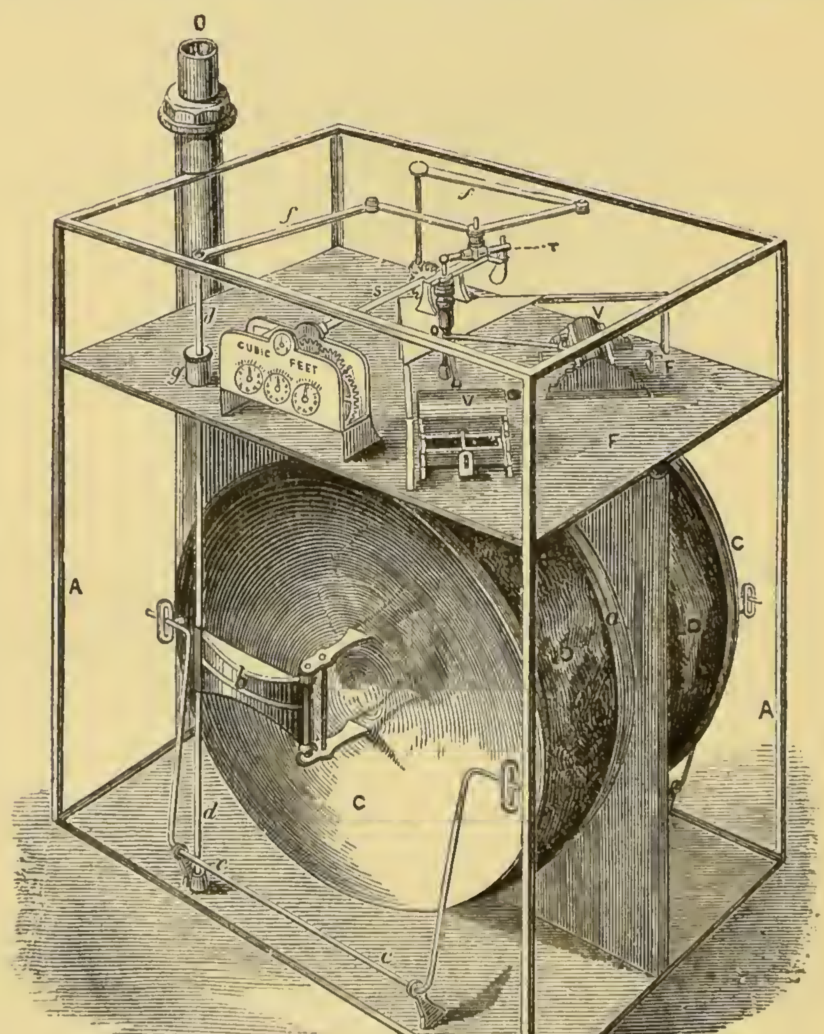


Fig. 16.

the piston chamber to flow out alternately under the valve through the exhaust port to the outlet of the meter.

Now, looking at fig. 16, it will be readily seen that the *inlet* gas passing down through one of the ports in the valve (V) behind the piston (C), pushes it forward and fills the chamber. Then, the slide-valve being shifted so as to cover this port and expose the other port, the inlet gas passes down into the front piston chamber, pushing back the piston, and expelling the gas contained in the other side through the exhaust port. Valves and Pistons.

In order to prevent any communication between the front and back piston chambers, a flexible leather joint is securely fixed, one edge to the rim of the piston and the other to the rim of the piston chamber. By this means the piston can move freely backwards and forwards, while the two chambers are kept separate and distinct. Piston chamber.

The slide-valves (V) are actuated by a crank (O), placed at the apex of a right-angled triangle, the two sides of which cut the centre of the valves, as shown in fig. 16.

The valves receive motion from the pistons through the arms in communication with them, marked *f*, *f*, called the "tangent arms," which are attached to another arm (T) fixed to the crank, and called the "tangent." Tangent arms.

The position in which the valves are placed towards each other causes them to follow the movements of the piston in such a way, that as each piston gets to the end of its stroke, the valve shuts off the inlet to the chamber which is full, and admits the gas to other chambers which have just been emptied, the previously contained gas having been expelled through the centre port, which is always in direct communication with the outlet of the meter.

A *worm* attached to the shaft of the crank communicates the motion of the meter, by means of a *spur-wheel*, to the *Index*, or counter.

Thus the same kind of apparatus in both wet and dry meters counts the number of complete revolutions of the meter, and consequently the number of measures of gas which have passed through it.

Initial measure of a meter.

The *Initial* measure of gas is the capacity of one quarter of the measuring drum in wet meters and of one piston chamber in dry meters. Thus, in wet meters, four measures or quarters constitute a complete revolution; and in dry meters, usually, four motions of the piston—two forwards and two backwards—constitute also a revolution.

It is essential that these *measures* should not be altered in their capacity, or a false indication of absolute measure will be the result.

Low water-line causes meter to lose.

Thus, if the true water-line of the wet meter is lowered, the result will be to increase the size of each chamber, and so cause the meter to pass from 101 to 103 cubic feet of gas for every 100 feet indicated on the counter. The Gas Company are, therefore, liable to lose 3 per cent. of gas from this cause.

By the provisions of an Act of Parliament—the Sale of Gas Act, 1859 (22 & 23 Vict., cap. 66)—a wet meter cannot be made to measure *fast* (or against the consumer), by the addition of too much water, to a greater extent than 2 per cent.; so that, in the case of wet meters, the Gas Company can, under any such circumstances as have been mentioned, only be losers to the extent of 3 per cent., and the consumer only to the extent of 2 per cent. of the gas registered by the meter.

Wet meter cannot be made to measure fast.

Limits of error fixed by Act.

The dry meters, depending for accuracy of measurement on a flexible material and surfaced slide-valve, may be interfered with in their working by such accidents as the contraction of the circular leather hinge, or an accumulation of dust or dirt on the surface of the slide-valve. Thus the indications of the index may be false to a much greater extent than 2 or 3 per cent. either way; but, as a matter of fact, the careful supervision of the Gas Companies over these meters, and the periodical examination of every meter after three years' wear, have practically minimized to such an extent the chances of error, that it may be estimated that the average error throughout the year over an entire district does not exceed 1 per cent.

Causes of error in dry meters.

Periodical examination of dry meters by Gas Companies.

Parliament has, however, in the Sale of Gas Act, so carefully protected the interests of the consumer that he may at any time have his meter tested,

Compensation for incorrect registration.

D

at a very small expense indeed, by a Government official, whose certificate is binding on both the Gas Company and the consumer; so that if the meter is found to register *fast*, or against the consumer, the Gas Company are obliged to deduct the percentage of error from the current quarter.

Stamping places for gas meters

There are several *stamping* places in London, and others in almost every large town. The fees for testing and stamping meters, according to the Sale of Gas Act (sec. 19), are as follows:—

Clause of Act of Parliament relating to fees.

"The fees for examination, comparison, and testing, with or without stamping, meters, shall be sixpence for each meter delivering a cubic foot of gas in four or more revolutions or complete repetitions of the action of the meter, and one shilling for each meter delivering a cubic foot of gas by any less number of revolutions or complete actions, or one revolution or complete action; and for each meter delivering more than one cubic foot of gas by one revolution or complete action, the further sum of one shilling for every cubic foot of gas delivered at one revolution or complete action beyond the first cubic foot."

The stamping offices in London are: Metropolitan Board of Works Office, St. Ann's Street, Westminster, S.W.; Metropolitan Board of Works Office, Southwark; Corporation of the City of London Testing Station, Winchester Street, City. The stamping fees are as follows:—

Stamping fees.

Dry Meters.	*s.*	*d.*
1 light	0	6
10 lights	1	0
80 ,, ...	2	0
150 ,, ...	4	0
200 ,, ...	5	0

It is an important fact, not so well known as it should be by the general public, that meters only register on the index when gas is being used in some way or other, and that when all is turned off, either at the *lights* or at the *main cock* on the inlet, the meter ought to stop. If it does not do so, then there is, somewhere in the fittings, a leak which should at once be discovered and remedied. Leaks detected by meter.

The method of finding leaks, and the effect of leaks on gas bills are treated of on pages 51 to 53 of this work.

The reading of the index is generally supposed to be a very mysterious operation, but in reality it is the simplest thing possible, and the consumption of gas at any time may be found by anyone with great ease. Fig. 17 is a diagram of the dial of a gas-meter. Reading of the index of meters.

Meter dial.

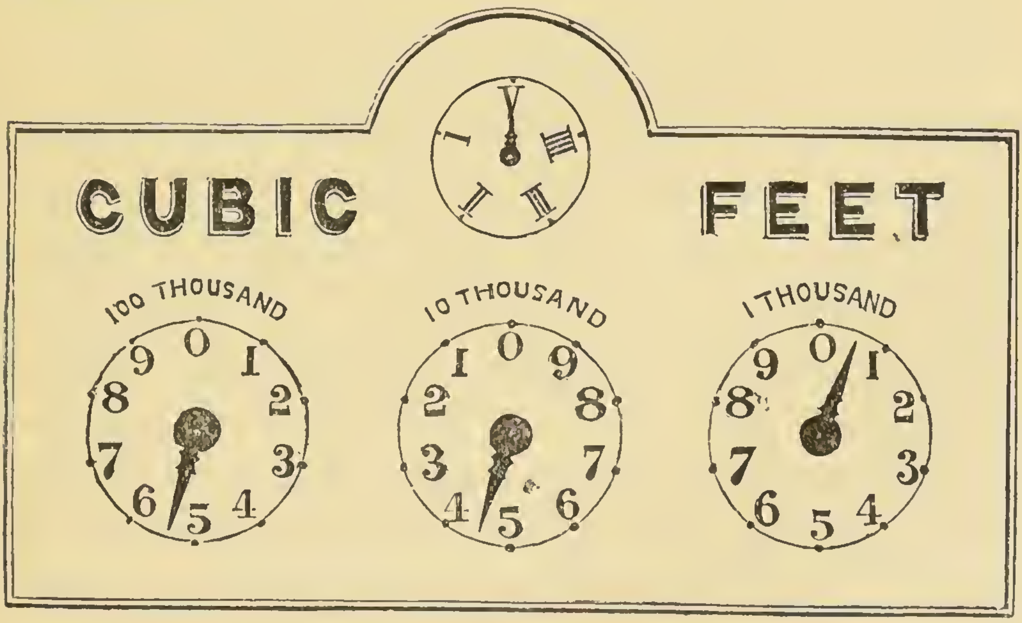


Fig. 17.

There are usually three circles on small meters up to 10-light, and four circles or more on meters beyond that size. In addition to this there is usually a small circle divided into single feet, as shown in the diagram. This latter is used only for the purpose of ascertaining the measuring capacity of the meter at the testing office, but it is very useful to the consumer, because it enables him at any time to find the hourly rate of consumption of all or any part of his burners or household fittings. But the Gas Company, in making out their bill for gas consumed, take no notice of this circle. Their servants only deal with the circles that are divided into ten, and numbered from 1 to 10.

Single feet circle.

It is an important point to notice here, that these circles do not all read in the same direction; thus, the first circle at the right hand of the dial is the lowest denomination, and represents 1 thousand cubic feet per complete revolution of the hand—the subdivisions being hundreds of feet. The figure 1 is on the right hand, and the pointer travels in the direction from left to right. The second circle from the right represents 10 thousand feet per complete revolution of the pointer, and the figure 1 is on the left hand; the pointer, therefore, travels in the opposite direction—viz., from right to left. The third circle represents 100 thousand cubic feet per complete revolution, and the figure 1 is on the right of the circle; the pointer, therefore, travels from left to right again, and so on. Each pointer in succession travels in the reverse direction to its neighbour.

Explanation of dial.

Circles do not read in same direction.

Therefore, in reading off the indications as shown on the dial, this fact must be borne in mind. No figure must be recorded on the register unless the pointer has passed it.

Method of reading the index.

Thus, taking for example the dial shown in fig. 17, and reading off the position of the pointers from right to left, the first figure will be 0, because the pointer is between 0 and 1; the second figure (to be placed to the left of the first) is 4, because the pointer has not arrived at the 5; the next figure is 5, the pointer being found between 5 and 6.

The reading is therefore

540.

The first figure on the right hand represents the lowest denomination, which is hundreds of feet; so, if two zeros are added at the right, the total number of feet of gas registered on the index will be arrived at, thus:

54,000 cubic feet.

Supposing, for example, that the meter had been fixed at the beginning of the quarter, and that all the hands had been at zero when it was fixed, the total consumption of gas for the quarter must have been fifty-four thousand cubic feet. This, at say 3s. per thousand cubic feet, would be £8 2s. 0d., or a winter quarter's consumption for a fair-sized dwelling-house where gas is being used in all the rooms, and the cooking is done by gas.

At the next quarter, which may, for example, be a summer quarter, the reading of the index is found to be

744.

Add the two zeros, making 74,400. Now place under this the reading of the last quarter, taken from the card which is always left by the Gas Company at the consumer's house, thus:

Present quarter's entry . .	74,400
Last quarter's entry . . .	54,000
Cubic feet of gas consumed in present quarter . .	20,400

costing, at 3s., £3 1s. 2d.

Examination of meter cards.

Every one should examine and compare the reading of the meter with the card left by the Gas Company's officer. This being done, there can be no possibility of a mistake, and the consumer can satisfy himself that he has received value for his money.

It will thus be seen that the interests of the gas consumer are thoroughly watched and protected throughout the kingdom—

Parliamentary regulations for the control of the supply of gas in general.

(1) By the regulations laid down in the various *Acts of Parliament*, all Gas Companies have either their own Special Act, incorporating the usual clauses as to the illuminating power of the gas, and the mode in which it is to be officially verified, or they work under the *Gas-Works Clauses Act* of 1871, which specifies the illuminating power of the gas, as well as the mode of verification of illuminating power and purity to be adopted by the Gas Examiner.

When the details of these different tests are not specified in this Act, the rules and regulations laid down by the Gas Referees of London, who are officers of the Board of Trade, are always accepted as the only legal definition of each test.

(2) The *Sale of Gas Act* of 1859 ensures the correctness of the necessary apparatus.

If, therefore, any waste of gas or inordinate consumption takes place, the fault must be looked for either in defective fittings or in faulty burners, or perhaps in both.

CHAPTER IV.

GAS-PIPES AND FITTINGS.

Buildings are not usually constructed for the proper use of gas.

Having pointed out the preliminaries required to obtain a supply of gas, the next duty of this work is to indicate to the consumer how to derive the greatest possible advantage from its use. Nothing would be easier than this if it were a case of *tabula rasa*, and all dwelling-houses and factories could be properly built with a view to the employment of gas. But taking into consideration the fact that few buildings have ever been constructed in such a scientific manner as to admit of the use of gas in the best way now known, it is necessary to show how this may be done, having regard to the defects in the existing arrangements.

There is also another important consideration, of which account must be taken in this work—viz., that many consumers of gas have to provide the necessary fittings at their own expense, and that the greater part of them must be left behind, to become the property of the owner of the house without payment. Of course, modern houses are now for the most part said to be fitted with the necessary gas-pipes, and it is supposed that the tenant only has to provide himself with the chandeliers, pendants, brackets, burners, and stoves. But the canalization is mostly very badly done by builders and plumbers, who know nothing whatever of the business of gas-fitting, and the incoming tenant finds that he has to refit the house entirely, if he desires to avoid loss of gas by leaks, escape danger from explosion, and get enough light.

Defective fittings in new houses.

The experience of the writer of this work upon this point has been that he has refitted two houses with gas—one an old house, and the other a new modern house, in which gas and water were *said* to be laid on. Both were laid on with a greater regard to cheapness than efficiency, and the result was that although the water, by dint of high pressure, could force its way through the pipes (sometimes through the joints), the gas *could not* do so in any sufficient quantity to be useful. The pipes were of the smallest bore, were most inferior in quality, and badly laid and jointed. And yet the employment of proper pipes of sufficient size, and a good mechanic, would not have cost, in the first instance, a tithe of what it cost the tenant to refit the house. It is much to be regretted that the Gas Companies have not the power, in the interests of the public generally, of examining the gas-pipes, and refusing to permit the making of any communication with their mains till the fittings are sound and in proper order.

Insufficient size and bad quality of pipes in many houses fitted with gas by builders, &c.

In France, the examination of the gas-pipes is

Official examination of gas-pipes in France.

in the power of the police authorities, and no consumer is allowed to use gas until a certificate is given that the pipes by which it is conveyed are sound. But as this is not the case here, the consumer must protect himself in the best way he can; at the same time he can always ask the opinion of the Gas Company on the state of his pipes, or employ a properly qualified gasfitter to prove his gas-pipes before he signs the lease.

Different kinds of gas-pipes.

Gas-pipes are of several kinds—viz., iron, tin, composition, and lead. Iron tubes are made of wrought iron, and screwed together in lengths, with specially made branches, bends, elbows, and other fittings (all in wrought iron) suitable to the situations in which they are to be laid. The screwed joints, previously to being put together, are smeared with red or white lead mixed with oil, to render them gas-tight. For large works, iron piping is the only kind which can be employed, because of its strength and resistance.

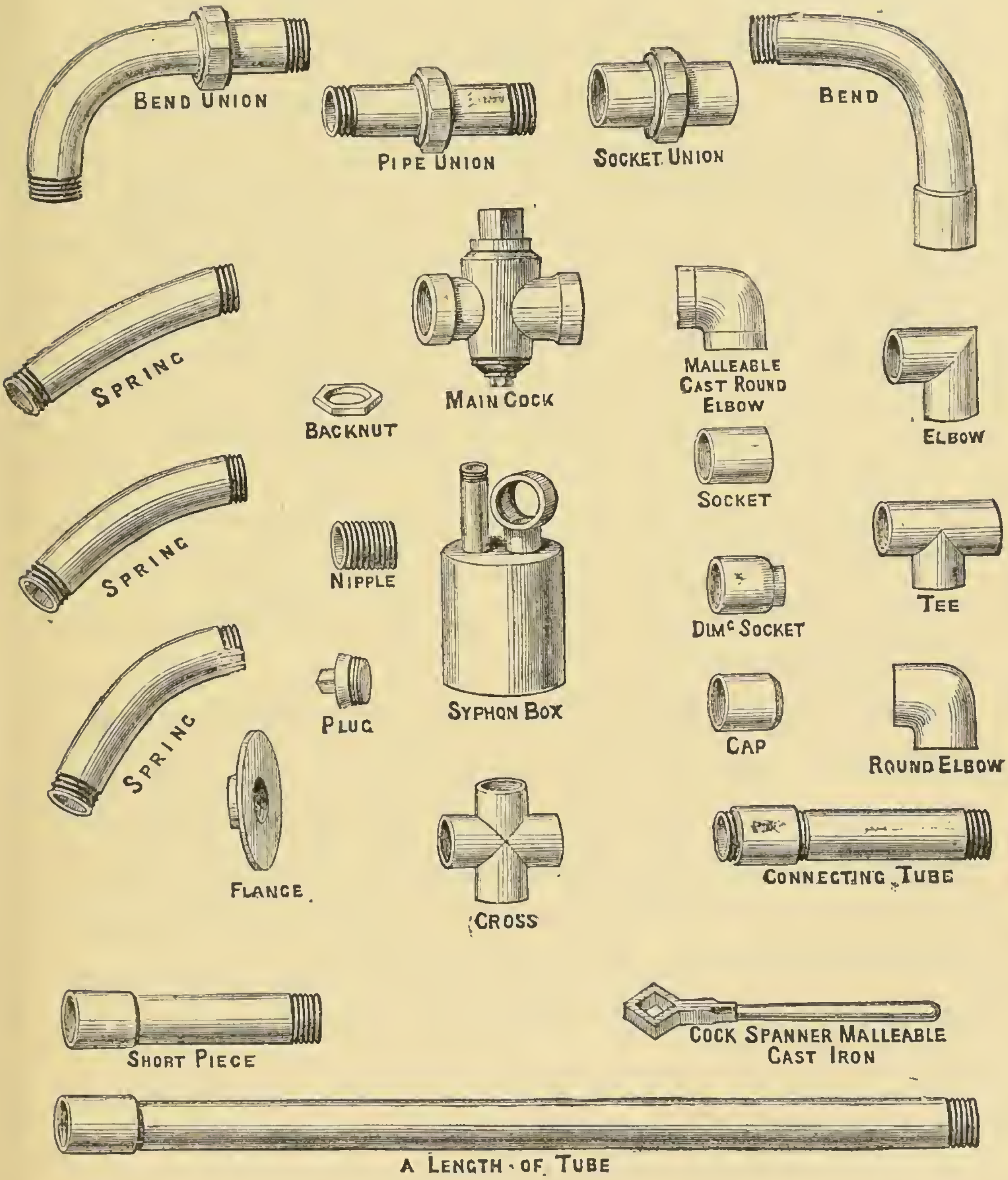
Painting pipes.

The pipes and all the joints should also be painted with two coats of oil colour, with a small quantity of varnish in it to make it set hard.

On the next page are shown the different bends and connexions, with their technical names.

WROUGHT-IRON GAS TUBES AND FITTINGS,

WITH THEIR TECHNICAL NAMES.



Flow of gas through pipes.

The following table shows the number of cubic feet of gas which a 30-feet length of the different sized pipes will pass per hour under various pressures :—

	½-inch.	¾-inch.	1-inch.
Two-tenths pressure .	53	147	302
Four ,, ,, .	75	207	426
Six ,, ,, .	92	254	522
Eight ,, ,, .	106	293	603
One-inch ,, .	119	328	675

Measurement of gas-pipes.

The diameter of iron pipe is measured across the inside of the bore; thus, 1-inch barrel, as iron pipe is technically called, measures 1 inch across the inside, and so on.

Tin pipe, and how it is made.

Tin pipe is composed of pure tin, and is made in lengths of from 60 feet in the larger sizes to nearly 300 feet in the smaller sizes, by means of special machinery, which pumps out the hot metal through a polished steel tube mandril having a polished steel core fixed in the centre of it. The metal cools down as it is pushed away from the root of the mandril and core, until at a certain distance it is sufficiently cool and hard to be coiled up.

Pure tin pipe possesses advantages which render it more suitable than iron barrel for the conveyance of gas in a house. The bore of tin pipe, being quite polished inside, offers less resistance to the passage of the gas, and a smaller tin pipe will consequently do the work of a larger iron one. As tin pipe is made in long lengths, a piece can be laid from the bottom to the top of a house in a very short time after the holes are cut; whereas the cutting and fitting of a piece of iron pipe of the same length would take at least six or seven times as long, besides being much heavier. Again, the inside of iron pipe rusts; the tin will not. Easy to lay.

But perhaps the greatest advantage in the use of tin pipe is the fact that after many years of service it is still a valuable article, whilst iron pipe is not. Thus, if a tenant lays on the gas to a house, and puts in iron pipes, the landlord reaps the benefit, without giving compensation, because it would cost too much to remove them when the tenant leaves; but if tin pipe is laid, the tenant can easily take it away with him, to be used again in his new house. Tin pipe retains its value. Facility of removal.

There is, however, one source of danger which must be carefully guarded against when tin pipe is used; that is the danger of having a nail driven through it. Sometimes, when it is laid in the walls of rooms and plastered over, a nail driven through the wall may inadvertently penetrate the pipe. This causes a most troublesome leak, because it does not *always* leak, but only when the change of temperature causes either a contraction in the nail or an expansion in the pipe. Therefore, the line of the Care required in laying pipes in walls and under floors.

pipe, when under the floor or behind plastering, must be carefully remembered when nails are being driven in. However, this is not a difficult matter to overcome; and it does not militate against the employment of tin pipe.

Compo pipe.

It will be as well to mention here that there is also a composition pipe known in the trade as "tripe," or *compo*, which is made in the same way as tin pipe, but is a mixture of lead and antimony. This is much cheaper than tin, but is not nearly so good. The compo is much too soft, and is liable to drop considerably if not well supported. Besides, the rats are rather fond of gnawing it, and it offers no resistance to their teeth. But when it is a question of cheapness, it can be used successfully by nailing a piece of wood under it all along when it runs in a horizontal position, so as to keep it straight.

Different kinds of pipes used.

The same connections and fittings are used with tin as with compo pipe, and are illustrated in the adjoining diagram. It may here be stated, to show the different appreciation of the value of the several kinds of pipes in different places, that while in London and the large towns in England it is considered best to use *iron* pipe, in Scotland and many of the provincial towns *tin* pipe is the rule; whereas in France it is mostly *lead* pipe that is used, and scarcely any iron pipe.

The only difficulty in using tin or lead pipes is the making of the solder joints. This is usually

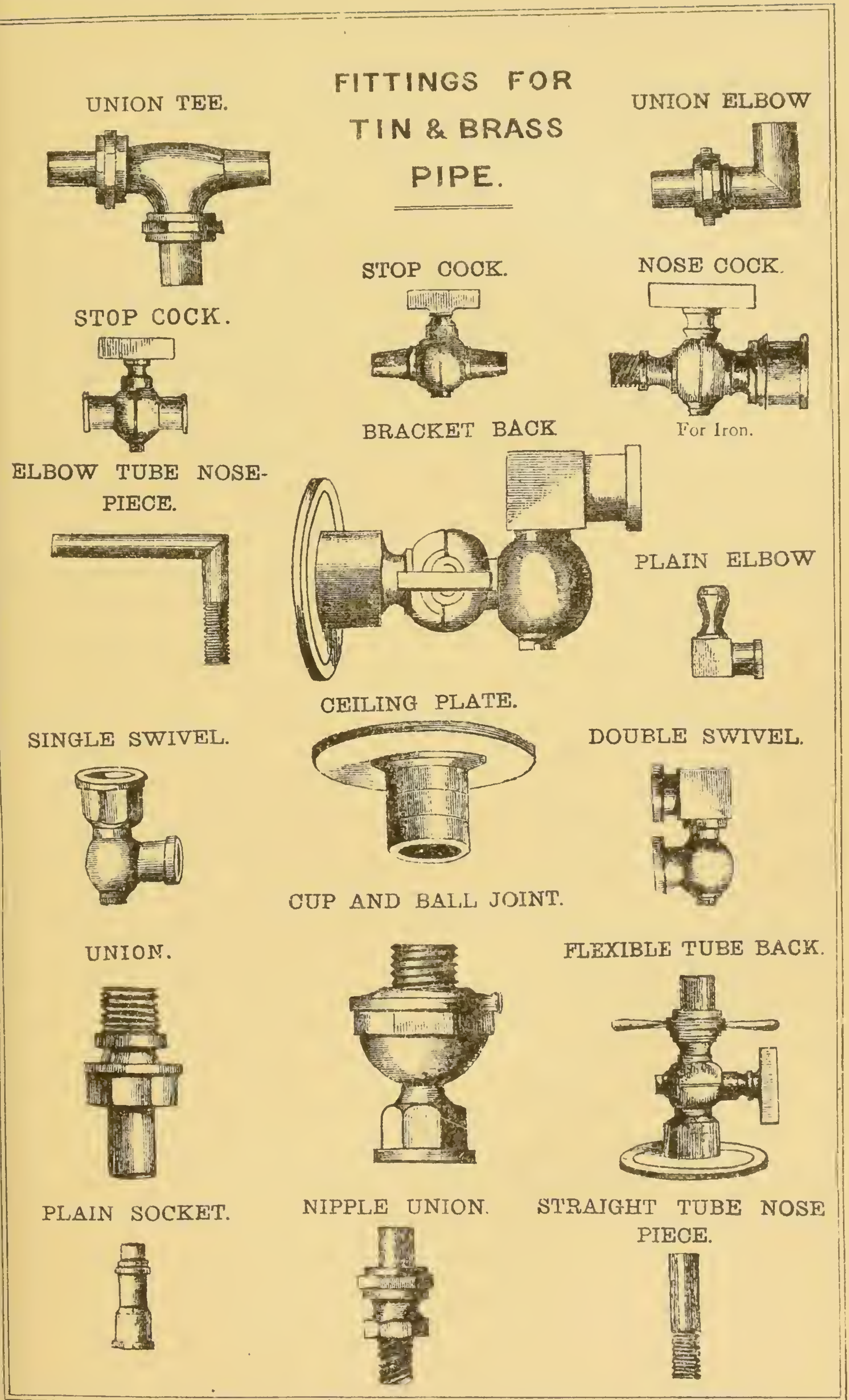


Plate 8.

To face p 46.

SPIRIT TORCH.

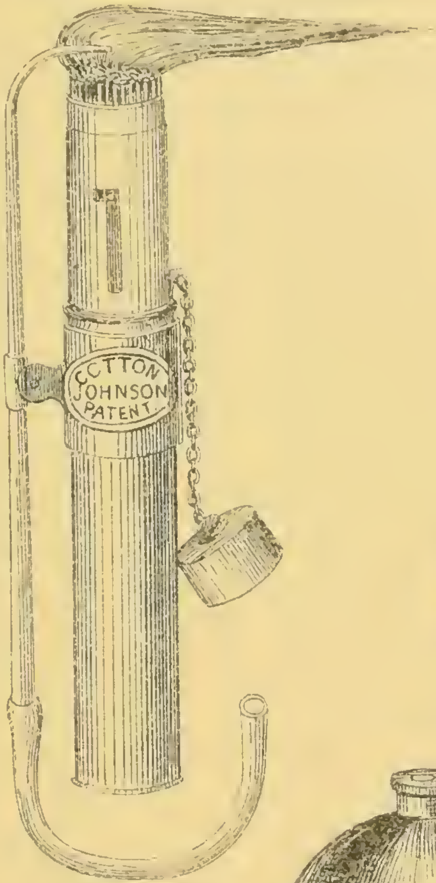


FIG 20.

TANPIN.

FIG 18.

SCRAPER.

FIG 19.

SPIRIT BLAST LAMP.

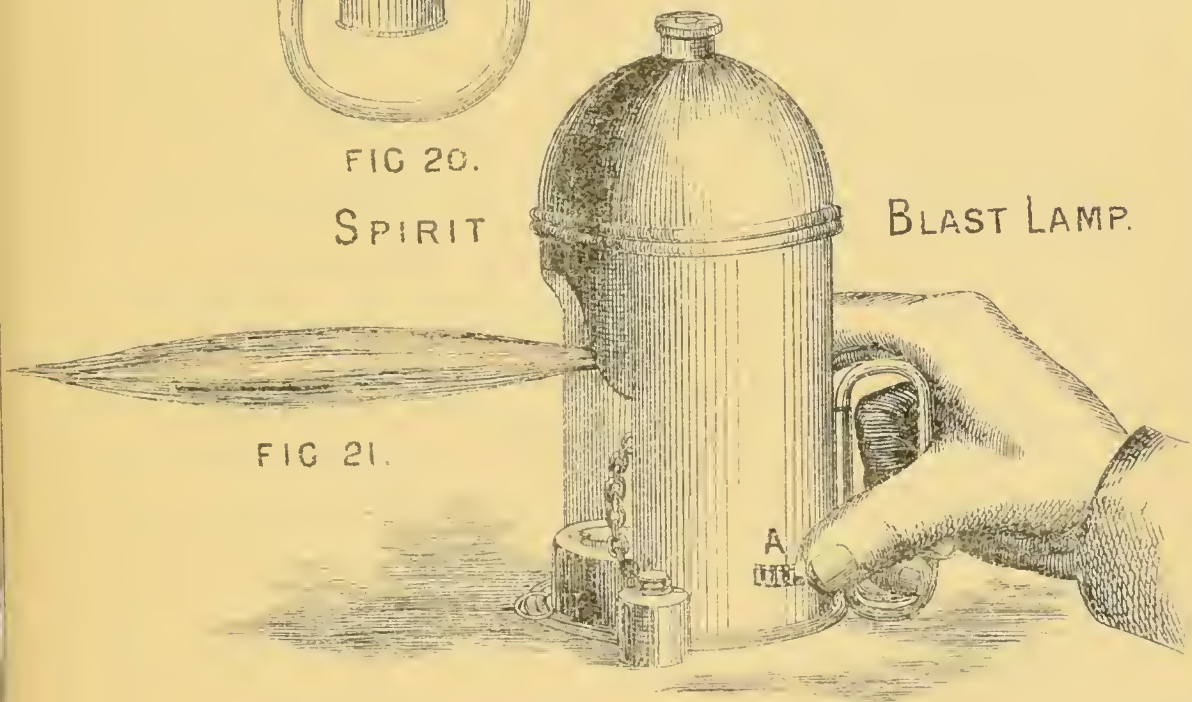


FIG 21.

JOINT FOR TIN OR LEAD PIPE.

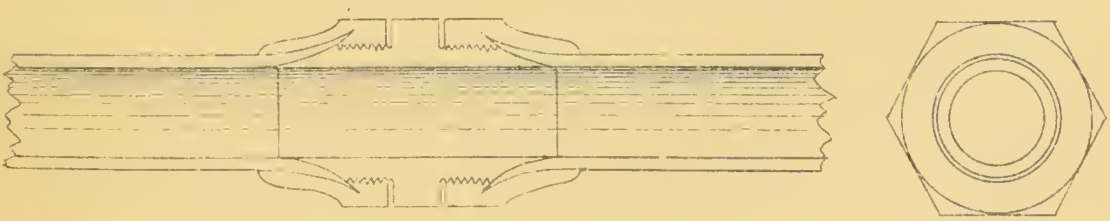


FIG 22.

done in this country by means of a blowpipe and rushes, thus:

The joint is prepared by scraping it with a scraper (fig. 19) or knife, then one end of the pipe to be soldered is funnelled out slightly by means of a conical piece of wood, technically called a "tanpin" or "tampin" (fig. 18), evidently a corruption from the French *tampon*, a plug.

Method of making soldered joints.

The end of the pipe to be joined to it is slightly tapered by means of a rasp or file, or a suitable kind of file called a "float." The two ends are then placed one in the other, upright, and a little powdered rosin or tallow is put into the joint. The flame of a blowpipe is then directed against the tube, and the solder is held against the joint. The melting point of the solder being below that of the tin tube, it runs sooner, and fills up the annular cavity round the joint, and thus fastens the two tubes together.

The rushes soaked in tallow are so objectionable and dirty to work with, that they have been to a great extent superseded by the spirit torch (fig. 20). A much neater appliance, however, is the spirit blast lamp, which renders blowing unnecessary, as the vapour from the spirit contained in a small boiler escapes from a jet, and blows through the flame of the lamp. The latest improvement in this description of lamp is shown in fig. 21. In this the wick of the lamp can be adjusted by the thumb, so that the size of the jet of flame can be varied at pleasure without any difficulty.

Directing spirit blowpipe.

Making joints by unskilled persons.

An unskilled person can rarely make a good joint, but he will probably succeed if he paints the pipe, just above and below the joint, with a mixture of size and whiting, with very little size, so as to keep the heat off the pipe except just at the joint.

Joints without solder.

In cases where it is required to make a joint in tin or lead pipe without solder, it can be done by the means here shown (fig. 22). This joint consists of a brass thimble and two sleeves. The sleeves and thimble are slightly coned, the former on the inside and the latter on the outside. The thimble is screwed at each end on the outside, one thread being right handed and the other left. It necessarily follows, therefore, that when the sleeves are fitted on to the ends of the pipe to be joined, and the thimble is screwed up, a tight joint will be made, as shown in the figure.

The author some time ago laid a considerable length of pipe for the supply of gas at the high pressure of 80 lbs. to the inch, using joints such as these, and they have never given any trouble. Every joint was sound from the first, although they were laid by men who could not make a solder joint.

These joints are equally good for water or gas. In every case, however, whether the pipes are made of iron, tin, or lead, they should be thoroughly proved before being used. It is without doubt frequently the case (much more so than people imagine) that the gas bill is very materially increased, from the fact of there being many small leaks in the pipes.

The number of houses in London in which the gas-fittings would pass a very simple test for soundness is surprisingly small. In fact, it has become an almost fixed opinion with the public generally, that it is not possible to get gas-pipes perfectly sound; and some have an idea that the penetrating power of gas is so great that it is impossible to carry it through pipes without some leakage.

Soundness of pipes.

Erroneous opinion on soundness of pipes.

This is a popular error. Gas-pipes properly laid and painted (if of iron) with a mixture of oil colour and a little varnish should be perfectly sound. Tin pipe does not require to be painted except perhaps at the joints.

In France, as before stated, no connection with the Gas Company's service-pipe is permitted until the police authorities have tested the soundness of the pipes and fittings. In this country there is no control of any kind over the internal fittings of a house. The consumer can, however, easily ascertain the soundness of the gas-pipes himself. The simplest way is by fixing on a pressure-gauge to any of the lights in a house. For this purpose a very primitive apparatus is sufficient. Take a glass U tube, open at both ends, with the legs about 3 inches long, and attach to one leg the end of an india-rubber tube; then half fill the U tube with water. The other end of the india-rubber tube should be slipped over the nozzle of a bracket or pendant, so as to be gas-tight.

Method of finding whether pipes are sound.

Now turn on the cock of the fitting, so as to allow the pressure of the gas to exert itself on the water in the U tube. The difference of the level in the tubes will, as before explained, indicate the degree of pressure in the pipes. Take care to turn off all the other fittings, and to see that the ends of the pipes where there are no fittings attached are perfectly closed.

After measuring the distance between the levels of the two columns of water, turn off the *main cock* at the inlet of the meter. If all the fittings are sound, the level of the water in the pressure-gauge will remain as before. If, on the contrary, there is the slightest leak, the water will gradually sink until it is at the same level in both limbs of the U tube. It may, however, happen that there is a small leak in the pipes on a floor above that on which the pressure-gauge is fixed. In this case the escape of the gas (which is much lighter than air) will be faster than the air can get into the pipes to replace the gas, and so a partial vacuum will be created in that leg of the siphon which is attached to the india-rubber tube. This will be maintained till almost all the gas has escaped out of the pipes, and air has taken its place.

It may be observed here that in most cases it will be best to attach the pressure-gauge near the meter, because if it is necessary to go far to turn off the main cock, there will be time for the liquid in the gauge to fall to zero before the return of the operator.

Another important point which should be determined before trying this experiment is to ascertain whether the main cock itself leaks; because, if so, a sufficient quantity of gas may be passing round the plug to keep the pipes charged and supply the leak. This may be best done in the following manner:—Shut off the main cock; take a piece of india-rubber tube of just sufficient size to allow it to be sprung on to the end of the main cock, so as to clip it quite tightly; next insert into the other end of the pipe a cone reducer, to enable a sound joint to be made, by means of another small piece of rubber pipe, with one leg of a pressure-gauge; then observe the respective heights of the columns of water. If they alter their positions, it will be owing to an escape of gas past the main cock. A very small leak indeed can thus be detected. India-rubber pipe may generally be trusted to make a sound joint, if clipped on properly, and tied round with string.

Testing the main-cock for soundness.

Another way of finding a leak, but of a more tedious nature, is to shut off all the lights, &c., and then to watch the small hand of the meter for about half an hour. If the leak is less than a foot per hour, the meter must be watched for an hour at least.

Soundness of fittings tested by meter.

The most fruitful sources of leaks are—first, the joints of brackets and pendants, and the cocks for shutting off the gas; next, the joints of the pipes; and, lastly, the seams of the pipes.

Sources of leakage.

If the leak cannot be detected by the smell, it must not be sought for with a light; because even

Danger of using a light in the event of a leak.

a small defect which has been allowing the escape of gas for some time, in any part that is closed in—such as under floor-boards, in cupboards, behind the backs of partitions, &c.—will almost invariably have produced an explosive mixture of air and gas, and a great deal of damage may be caused by incautiously seeking for an escape with a light. The discovery of a leak under these circumstances does not usually reward the ingenuity of the seeker in a way he would desire.

Risk of explosion.

The smallest leak can be detected either by the smell or by the sight. To find a leak by the sight, it is necessary to use a mixture of soap and water, such as is usually employed in those experiments in aëronautics so commonly in vogue amongst school-boys. This mixture, freshly made, is applied to the suspected parts by means of a stout camel-hair pencil. If there is the slightest escape of gas, it will blow a bubble, and the spot will be indicated. It is safest, however, if it is suspected that there is a longitudinal crack in a pipe, or a very slight leak in a joint, to paint the pipe, watching for any bubbles which may be blown by a large leak, and stopping them with a thicker coat of paint. Generally speaking, paint will not stop a leak under ordinary gas pressure unless there is a great deal of varnish and red lead with it. If the leaks are in the joints of the brackets, they must be temporarily stopped with a mixture of grease and beeswax, by taking out the plug and smearing it with the composition before replacing it.

Finding leaks by soap and water.

Small leaks can be stopped by paint.

Leaks in plugs and joints of brackets, &c.

The renewal of the plugs of brackets is too difficult for an amateur; therefore, in all cases, if a brass-finisher can be found, it is best to entrust the work to him. Grinding in with sand or emery, unless done by an experienced hand, is sure to result in making the leak worse.

The foregoing remarks relating to leaks apply, as will be readily seen, to houses in which gas has already been in use.

Soundness of pipes and fittings ascertained before floor-boards are laid down.

To be on the safe side, all pipes should be tested for soundness as soon as they are laid, and before the floor-boards are finally screwed down. All boards under which gas-pipes are laid should be screwed down over the places where it may be necessary to occasionally examine them. If this testing is not done, a great expense may be incurred, especially in those cases where expensive flooring or tesselated pavement is put down. Examination of gas-pipes ought to be made before the signature of a lease.

Accumulation of water in pipes.

If it can possibly be avoided, *no* gas-pipe should be laid behind plaster, unless it can be ensured that every joint is tight, and that the pipes are sufficiently large to allow the gas to pass readily through them, even although a little corrosion or dirt should accumulate in them. The greatest care must be taken to ensure the laying of the pipes in such a way that no water can be locked in at a low place or a "sag" in the pipe, or it will be difficult to prevent a constantly recurring annoyance from the jumping of the lights. The writer has known instances where the supply of gas in rooms has been quite discontinued, from the impossibility of clearing the pipes without breaking the plaster. There are, to his knowledge, showily-built houses in which the pipes (of very small size) are buried in the plastering of richly-decorated rooms. These pipes must, in the nature of things, very soon become rusted up and useless.

Tin pipe best for laying in walls.

But if it is absolutely necessary to lay pipe which will be buried in walls, it is better to use tin pipe, which is incorrodible and smooth on the inside, and to protect it from nails by placing over it a half-round piece of tinned iron plate.

Copper tube will not do, unless solid drawn.

Copper tube may be used if it is solid drawn, but if it is seamed tube it will not do, because the solder in the seam, which is a mixture of zinc and brass, will sooner or later perish by galvanic action, and cause a leak. In the writer's own experience a piece of brass pipe, which had been in use for some few years, became so rotten at the seam as to render a considerable length leaky, and an accident was only prevented by the fortunate discovery of the leak.

As an improvement on the elementary pressure-gauge mentioned on page 5, a properly mounted pressure-gauge (fig. 23), connected with the gas-pipe of the house, in any easily accessible place, would be found very useful. It should be fitted with a T-piece, provided with a stopcock and a short length of brass tube. An india-rubber syringe, such as is

Leak detector.

used with scent-diffusers, could be attached to this tube; then if the burners are shut off, and the stopcock

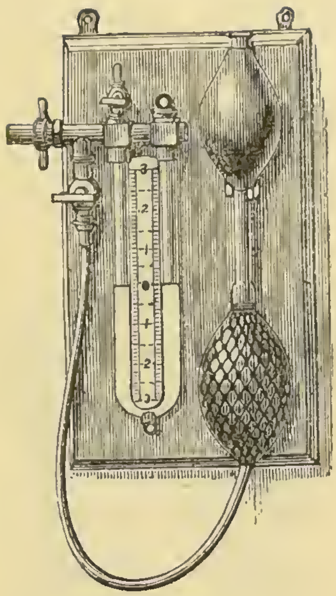


Fig. 23.

at the meter is turned off, air can be blown into the pipes, and at a pressure of 4 or 5 inches leaks will more readily exert their influence on the water-level in the gauge.

It is very annoying to find, when a heavy gas bill comes in, that you have innocently been wasting the gas at a terrible rate. If people would only take the trouble to look at their meters occasionally, they would not be taken by surprise in this manner. But, although the index of the meter would show them that their daily consumption of gas was large, it would not in the least help them to find out which burners were to blame. This is the duty of a little apparatus called a *Consumption Indicator*, an exact size representation of which is given on the next page (fig. 24).

Occasional inspection of meter index by the consumer.

Joslin's consumption indicator.

In order to test the consumption of any burner,

JOSLIN'S INDICATOR,
VERTICAL ARRANGEMENT.

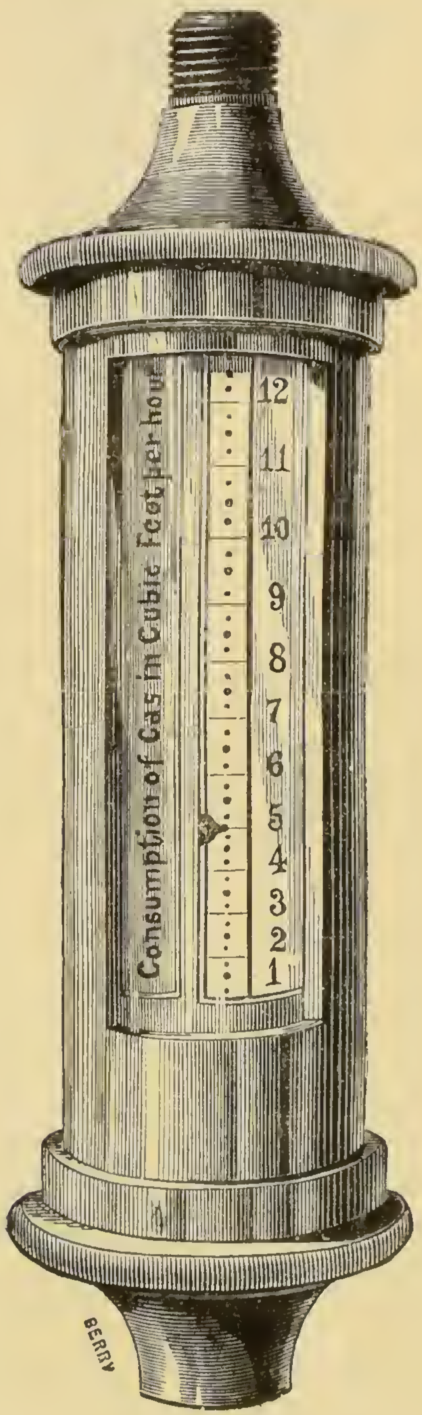


Fig. 24.

The little pointer is seen opposite the figure 5; the photograph of the Indicator having been taken when it was passing 5 cubic feet of gas per hour.

JOSLIN'S INDICATOR,

HORIZONTAL ARRANGEMENT.

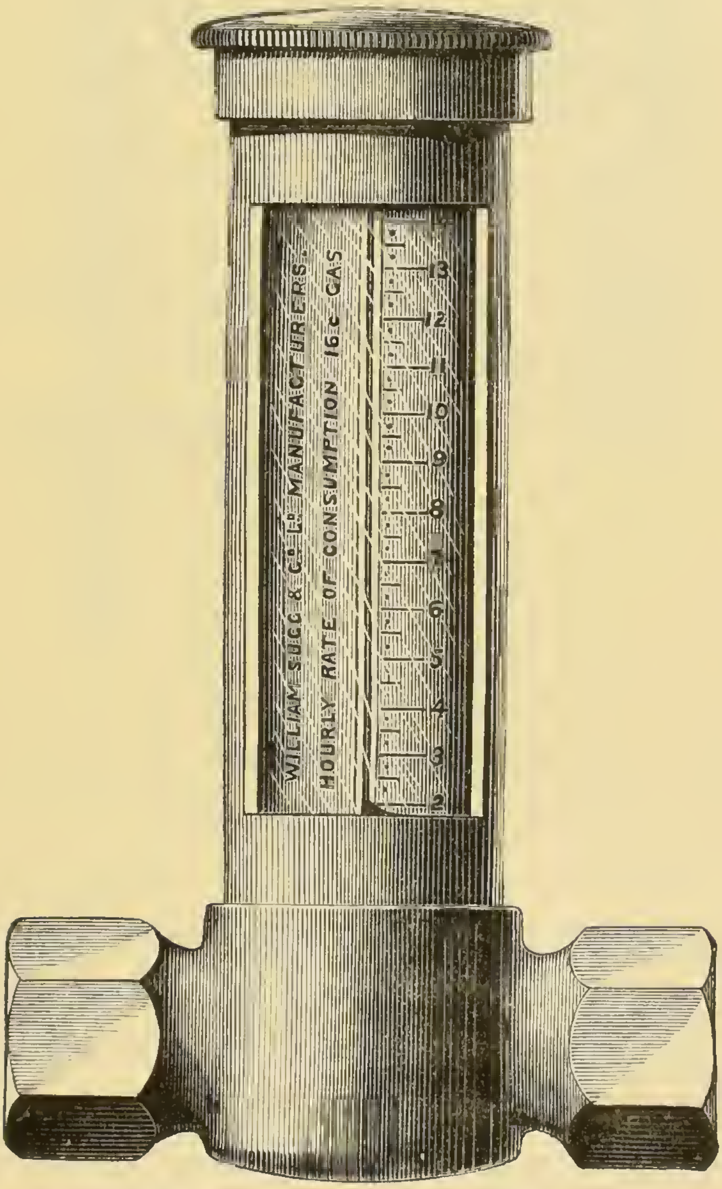


Fig. 25.

the burner is unscrewed from the fitting, the indicator is screwed on in place of the burner, and the latter is attached to the screw at the top of the indicator. Then, if the gas be turned on, the position of a little pointer in the interior of the instrument will at once show at what rate per hour the gas is passing through the indicator, and therefore through the burner. In this way, by testing the rate of consumption of the various burners, a wasteful burner will be at once detected, and the cost per hour of lighting any portion of a building may be readily calculated.

Wasteful burners detected.

Horizontal arrangement of Joslin's indicator.

The advantages of the horizontal arrangement (fig. 25) may not at first sight be so apparent, but it will be readily seen that an indicator of this pattern may be fixed at the side of a small stove or heater. It may also be made with a foot, and fitted with side tubes for india-rubber connections, so that in laboratories, where experiments are being made, the gas required for each experiment may be at once known.

Tell-tale or leak detector.

In addition to its employment as an indicator of the amount of gas consumed by a burner, the "Joslin" indicator may be used with great advantage as a constant tell-tale, or leak detector. For this purpose it is necessary to carry a small tin pipe leading from the outlet of the meter to the inlet of the indicator, and return from its outlet another small pipe to the outlet of the meter, as shown in fig. 26. Between the points at which these pipes join the

JOSLIN'S INDICATOR ARRANGED AS A TELL-TALE

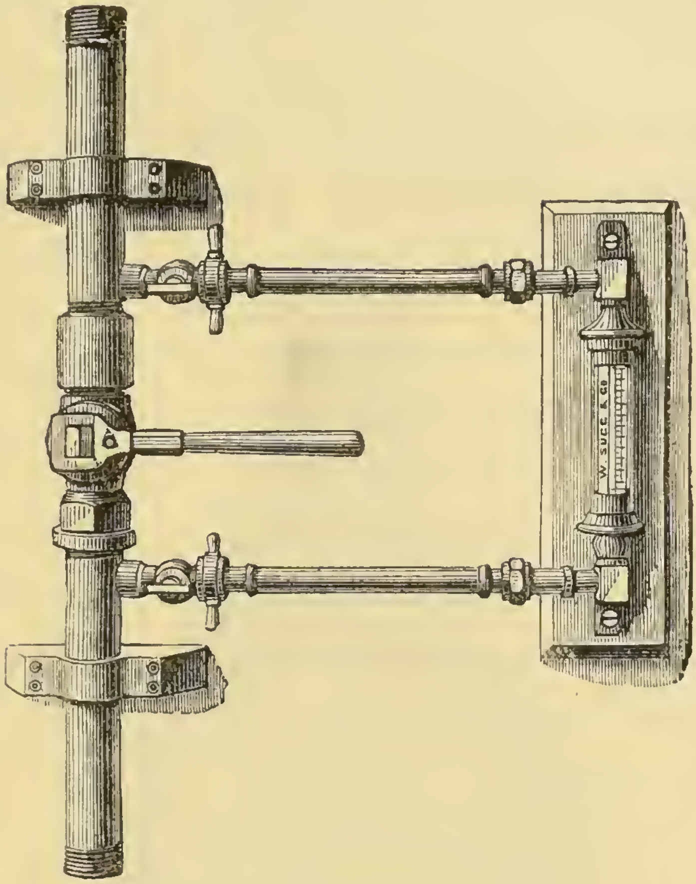


Fig. 26.

outlet a stopcock is fixed. Thus, when this main stopcock is closed, the pipes in the house are kept supplied with gas through the bye-pass, and consequently all the gas consumed must be shown on the indicator.

For example, supposing two small lights are left burning after the stopcock is shut off, the quantity of gas used by them is indicated on the "Joslin" indicator in feet per hour. Now, if all the gas lights in the house are shut off at the burners, then it necessarily follows that the gas passing through the indicator must be escaping from one or more leaks.

Gas consumed at night by watch lights.

Leaks detected.

Control of leakage in private houses.

The apparatus (fig. 27) may be fixed in any convenient spot—say the hall of a house—and the stopcock of the meter may be turned off from the hall, so that before retiring for the night it may be ascertained with certainty how many gas lights are left

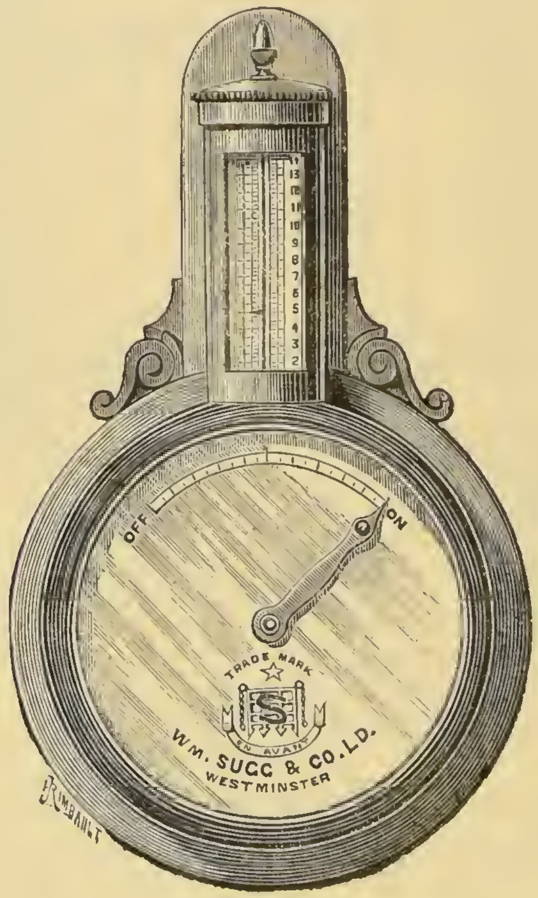


Fig. 27.

still burning, or whether the pipes are sound, or to what extent there is a waste by leakage, supposing the contrary is the case.*

* It is neither a good nor a safe plan to turn off the main cock every night, unless there is a bye-pass arrangement, such as that described, which will keep the pipes "alive," otherwise lights may be turned out, and the cocks left open, and thereby a great escape of gas may occur when the main cock is again turned on.

Modifications of this useful little apparatus can be made in a variety of ways.

Cost of leakage.

It may be stated that the escape of one cubic foot of gas per hour would cost about £1 7s. a year for gas utterly wasted; and with two or three almost imperceptible leaks the above-stated quantity of gas would be easily wasted.

Periodical examinations of pipes for soundness

In large factories and places where gas is very extensively used, a periodical examination of the soundness of the pipes can readily be made on Saturdays, or on days when the gas can be entirely turned off for a short time. The apparatus for this purpose is very simple, and should be permanently fixed alongside the meter. It is illustrated in

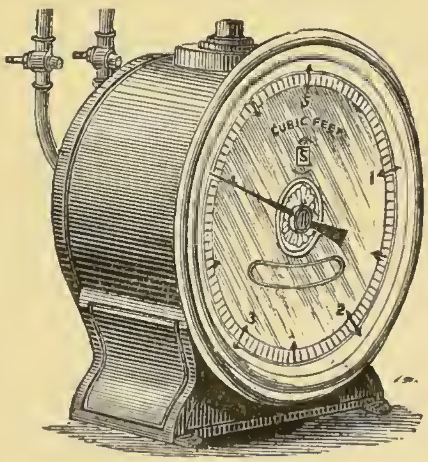


Fig. 28.

Tell-tale apparatus for large establishments.

fig. 28, and consists of a small wet meter of the most simple construction, being merely a measuring drum enclosed in a case, the centre shaft of the drum projecting through a stuffing-box in the front of the case, as shown. On this shaft a pointer is fixed, and a dial is painted on the front of the case, marked with 50 divisions, every ten divisions representing one cubic foot of gas. The capacity of the measuring drum is one-twelfth of a cubic foot, so that it would have to revolve 60 times to pass 5 cubic feet of gas through it. The dial being divided into 5 cubic feet, the actual quantity of gas passed through the meter is multiplied 60 times; and, as a consequence, the pointer will show by one minute's observation the actual quantity which would be passed through the meter in one hour at the same rate.

Method of fixing tell-tale apparatus.

The inlet of this tell-tale meter should be connected to the outlet-pipe of the meter, and a cock should be fixed on the main which supplies the premises, at a point immediately after this junction. Another junction must now be made with the outlet of the tell-tale on the other side of the cock. Thus, when the large cock, just mentioned, in the supply-pipe is turned off, a sufficient supply to the fittings to keep the pipes alive, and enough for the supply of two or three watch-lights, is kept up through the small bye-pass. These lights should be regulated by means of fixed governors, so that the quantity used by them per hour may be definite and known. Any more than this must therefore be leakage, either from cocks left turned on or from gas escaping. Thus, if there are three watch-lights burning, regulated to consume 4 feet each light, and the tell-tale meter shows that gas is passing through it at the rate of 20 feet per hour, then it is clear that 8 feet per

Regulated watch-lights.

hour is leakage; so that the leakage, if any, may be detected and its amount determined any night when the gas is turned off from the main supply, and left to the tell-tale supply.

No large establishment ought to be without a tell-tale meter. Its cost would be saved over and over again in a year, and its frequent use would add very materially to the safety of the premises.

Same apparatus can be used for testing stoves, &c.

The same apparatus may be used also to test the soundness of the pipes in the first instance, or to determine the hourly consumption of any burners or gas-stoves.

As this is a wet meter, no amount of gas, however small, can possibly pass without moving the index. It will therefore indicate, even in cases where there is no discoverable leak, but where the gas is only diffusing (or, to use the popular expression, *working*) through defective or porous places in pipes, joints, or fittings.

Smallest possible leakage detected by this apparatus

That this occurs in almost every house is well known; otherwise it would not be necessary to wait till the air is out of the pipes, before the gas can be lighted in those houses where it is shut off at the meter every night. (See page 60, in reference to shutting off gas.) If there is no leakage, the pipes and fittings which are at night fully charged with pure gas ought to remain so.

Duplicate meters for churches, chapels, theatres, &c.

In all places where the consumption of gas is large, such as factories (especially those in which there is machinery in motion), churches, chapels, concert-halls, and theatres, special arrangements should be made to prevent the possibility of sudden extinction of the gas from any cause whatever. In the first place, the meters should be in duplicate, either one being capable of supplying the entire establishment, but both connected with the supply-main, and both going at one time. It will most likely happen that one of the meters will generally do more work than the other; but no attempt must be made to check either of them for the purpose of equalizing the registers of the meters.

No harm whatever can happen if one supplies more than the other, but if any attempt is made to check one of them it may happen, in case of the breakdown of the other, that the supply may be deficient; whereas, if left alone, the sudden stoppage of one would in nowise affect the lighting, and no harm could result, because each meter is capable of doing the whole work.

Meters of larger capacity than required do not register more gas than is used.

It is a popular error to suppose that a meter larger than is required leads to a larger consumption of gas. Meters of whatever size, if they have passed the Government test, will only register the quantity of gas passed through them; but a large meter does the work more easily and steadily than a small one, in exactly the same way that a 10-horse power (nominal) steam-engine will do 10-horse power work better and much more steadily than a 5-horse power engine will do it by increased pressure of steam and accelerated velocity of the piston.

Fig. 29 is a plan of connections for a railway station, which will be found very convenient. In all large places, such as railway stations, warehouses, or works, the supplies to the different platforms or parts of the building should all be taken from the same point (as far as possible),

Connections for large establishments for controlling gas from one point.

CONTROL-VALVES FOR RAILWAY STATIONS.

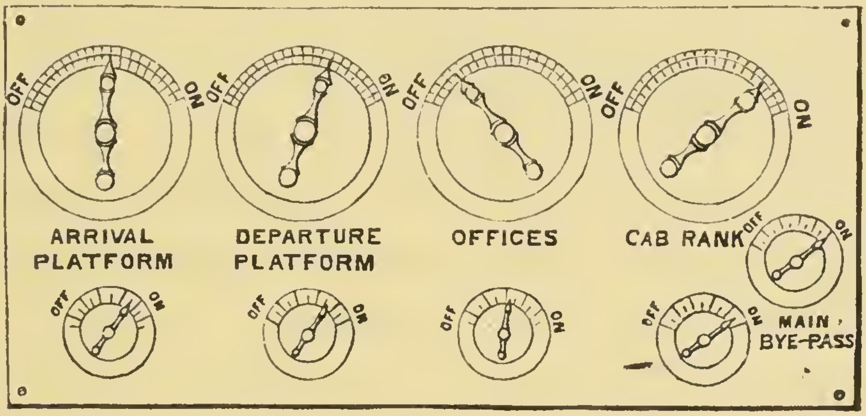


Fig. 29.

and each controlling cock or valve worked from a plate marked distinctly, so that at any time even a strange gasman may readily see how to control or turn off the gas.

For railway platforms special arrangements are required to facilitate the alteration of the power of the light when the trains are in, and when there is no work going on. These supplies, which serve to keep just a sufficient amount of light during the time when no work is going on, are called *flash-light* or *bye-pass* services.

Flash-light or bye-pass services.

The bye-pass service is a small pipe laid alongside a larger one, and at each light it is connected with a centre burner, or a jet, which consumes only a small quantity of gas, called in England a *flash-light*, and in France a *veilleuse*.

The lighting arrangements of churches, chapels, and concert-halls are all more economically managed if they are furnished with a separate flash-light service, so that while the main service may, as in the case of railway stations, be turned off at any moment, the flash-light will always be ready for lighting up instantaneously.

Separation of control of gas in auditorium from stage, and precautions to be taken to avoid accidents in case of panic or fire.

In theatres the gas on the stage should be separated from that in the auditorium, and so arranged that the latter cannot be turned out except from the front of the building. The same rule applies to churches and public halls. The turning off the gas ought to be so arranged that it cannot by any means be done in a hurry by one who, seized with a panic in case of fire, imagines he is doing a good thing in extinguishing the gas. So far from this, as Captain Shaw has recommended, "In case of fire or panic, light up everything you can."

In all these cases, whether in theatres or public halls, the gas will make no difference to the fire; or if it does, it will not cause so much mischief as its sudden extinction would entail.

Good light required at the outbreak of a fire.

Light is the first thing required even in fire; or, to put it in stronger terms, more so in a fire, because there is not always a blaze sufficient to light the firemen at their work at the commencement, which is generally the most critical time. When the fire has obtained the mastery will be time enough to shut off the gas.

Another important detail in large establishments is to put the gasman in uniform, with the name of his office in plain letters on the collar of his coat and his cap, so that at any time there can be no mistake as to who is really in charge of the lighting arrangements. In a case of emergency there is generally no time to examine credentials; and it has frequently happened that the gasman in charge is pushed aside by municipal authorities, because he is not recognized.

Gasman in uniform.

CHAPTER V.

THE GOVERNOR, OR REGULATOR OF PRESSURE.

The regulation of pressure so as to maintain uniformity of pressure and consumption at all hours.

It has been shown at page 20 that the pressure in the street mains varies very much during the hours of the day and night; and in all large towns this is the case. In hilly places the variations are very much greater. Therefore, when governor burners are not exclusively used, it is necessary to ensure the proper use of the gas and avoid waste and discomfort, that a general governor should be fixed at the meter outlet, so as to maintain a nearly constant pressure at this point.

Action of the governor.

The action of the governor is as follows (see fig. 30). The gas enters at the inlet, and, following the course indicated by the arrows, passes through the regulating plate of the governor into the gasholder; it then goes out by the opening through which a dark arrow is seen descending into the channel leading to the outlet.

It will be seen that the gasholder has, suspended from a disc in the crown, a half-ball valve, which closes or opens the orifice in the regulating plate as the gasholder rises or falls. A weight placed on the top of the holder fixes the pressure at which the gas is intended to leave the outlet of the governor. If the pressure of the gas on the inlet is greater than that required to lift the holder and weight, then the latter rises, carrying the half-ball valve with it, till such time as the annular opening left between the sides of the valve and the regulating plate is sufficient to allow of the passage of the necessary quantity of gas to supply the number of burners alight. On the other hand, if the pressure at the inlet falls below that required to supply the demand, the holder sinks, and the full opening of the regulating plate allows all the gas to flow through the governor to the burners.

Adjustment of the governor.

Thus, for example, supposing it is required to adjust the governor to maintain at its outlet a constant pressure of 6/10ths of an inch, a weight is put on the top of the gasholder, which will be sufficient to compress the gas it contains till it is equal in density to gas under this pressure; or the screw of the spring must be turned so as to compress the spring, and thus put pressure on the gas within the holder, which is the same thing. Then, supposing one light is turned on, the gasholder falls until it has opened the half-ball valve sufficiently to allow the passage of the requisite quantity of gas for this light, and so on with any further number till the limit of the capacity of the pipe on which the governor is fixed is reached. But, generally speaking, at the same time as the demand for gas at

SECTION OF A SUGG'S DRY SINGLE GOVERNOR.

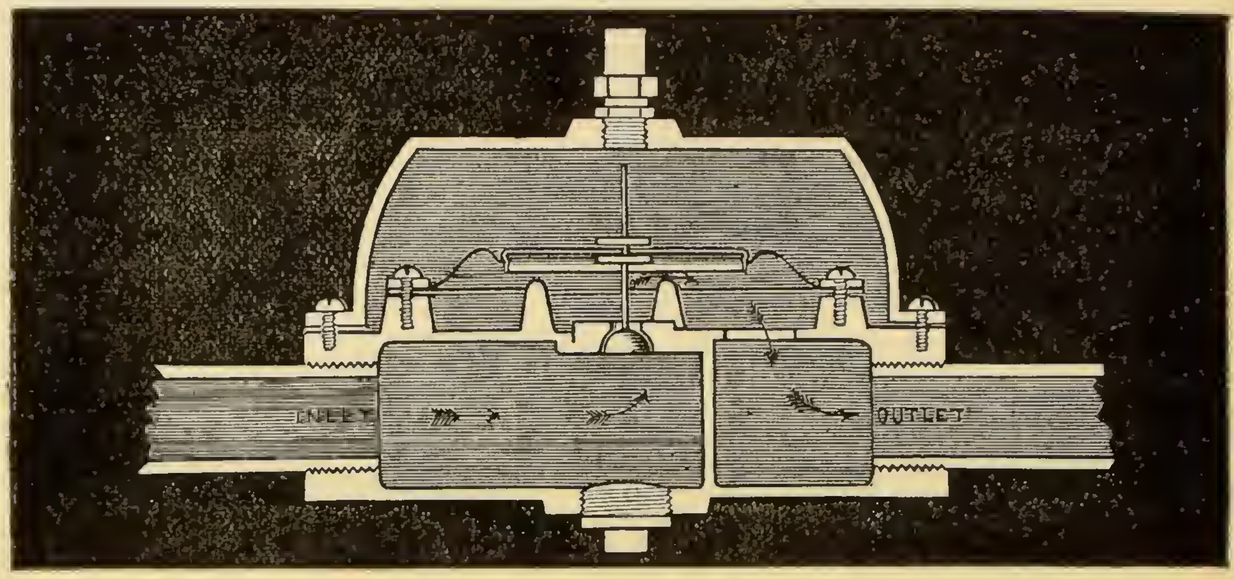


Fig. 30.

the outlet of the governor is variable, so is the pressure upon the street mains, and therefore that at its inlet. The effect of these variations is to render the action of any single governor (see fig. 30) slightly uncertain; and though this is only to the extent of perhaps half a tenth of an inch, yet it has an injurious effect upon the uniformity of the flame of good burners.

Double governor.

The employment of a double governor (fig. 31) entirely obviates this inconvenience, and all irregularities at the outlet of the first governor are entirely neutralized by the second. To the small union on the top of the governor should be attached a pipe, communicating with the air outside the house, or in any place the most convenient.*

* *All* governors which are used to maintain a constant pressure at the outlet of meters from which the supply is variable in quantity from time to time, *must* have the chamber above the diaphragm or bell in communication with the atmosphere.

SECTION OF A SUGG'S DRY DOUBLE GOVERNOR:

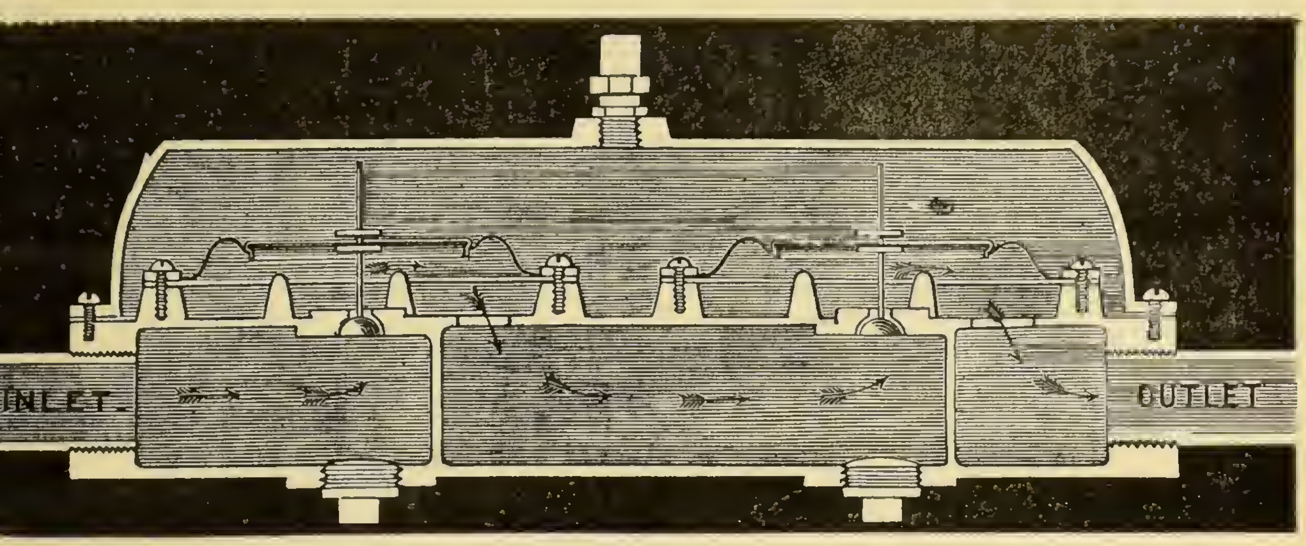


Fig. 31.

This method of adjustment by weights is not the most convenient. The use of a spring regulated by a screw is better and more suitable to situations where there is a high pressure of gas in the street mains. The following instructions will enable the consumer to re-adjust the governor himself whenever it is requisite to do so.

DIRECTIONS FOR FIXING DOUBLE GOVERNOR.

The governor should have the same size screw at its inlet as the main to which it is to be attached, thus: If the main is 1 inch, the governor must be screwed for 1 inch; and so on for all the other sizes of pipes. This is irrespective of the number of lights it is proposed to govern, which, however, should not exceed the number marked on the governor.

Governor requires same size screw at its inlet as the main-pipe to which it is attached.

Be careful to fix the inlet of the governor to the pipe leading from the outlet of the meter. The inlet of the governor can readily be distinguished from the outlet by making an examination of the apparatus. From the *inlet* the regulating valve can be readily seen, whilst from the *outlet* it cannot.

Governor wrongly connected up will not work.

If, by mistake, a governor is fixed with its *outlet* to the pipe leading *from the meter*, it will not work, because whenever there is sufficient pressure to raise the holders which carry the regulating valves they will immediately shut up and extinguish the lights. On the contrary, when the governor is properly fixed, no pressure will shut the valves whilst there is a light on the main supplied through the governor.

DIRECTIONS FOR ADJUSTING DOUBLE GOVERNOR.

These governors are usually sent out adjusted so as to give 8/10ths of an inch of pressure at the outlet of the governor. But if a greater pressure be required, proceed as follows :—Turn on the gas, put the outlet governor out of action by means of a sufficiently heavy weight, or by screwing down the spring. Then screw down the spring on the inlet governor sufficiently to raise the pressure 1/10th *beyond* what is required at the outlet of the governor. Release the outlet governor, and the pressure will fall to 8/10ths. Screw down the spring of this governor till the desired pressure is attained. In all cases the inlet governor must be weighted more heavily than the other, or the outlet governor will not come into action.

The governor is in action when the gasholder begins to lift.*

The pressure of gas is increased by screwing the thumb-screw, which is above the spring, downwards ; the reverse action will lower the pressure.

Governors for use under floors, &c., where vent-pipe cannot be carried into external air.

Figs. 32 and 33 are drawings of Sugg's Patent Glycerine or Mercurial Governors, and are intended for use with gas-stoves, or for places where it is not convenient to carry a pipe from the governor into

* A pressure-gauge must be put after the outlet of the governor before commencing the adjustment ; and there must be sufficient pressure on the inlet to raise both holders, or more than 8/10ths.

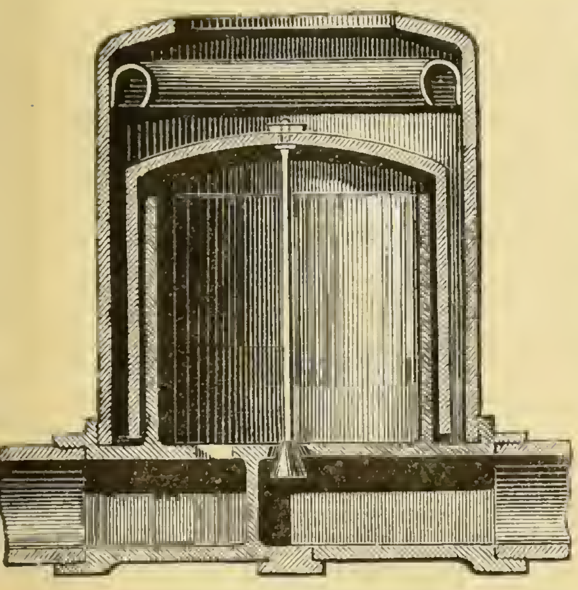


Fig. 32.

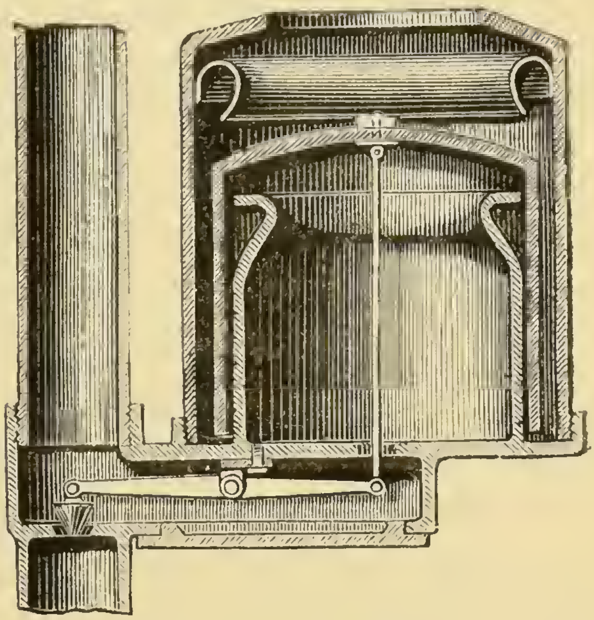


Fig. 33.

the open air to ventilate the chamber above the bell.* The bells of this kind of governor work in mercury or glycerine, and the method of adjustments is similar to that already described. Fig. 32 is suitable for a horizontal main, and fig. 33 for a rising main.

If a governor is employed at the main only, for the purpose of ensuring a constant pressure after the outlet of the meter, it must be borne in mind that the pipes all over the premises should be of full

* All governors, the bells of which work in water, as well as those on the dry system, with leathern gasholders, must be ventilated into the open air. The odour of gas impregnates the leather or the water, and the air displaced from the chamber above the bell, by the action of the governor, is therefore slightly

size to supply all the lights easily at a low pressure —not more than 5/10ths to 8/10ths of an inch.

Each burner should be provided with an adjustable screw check, similar to that shown in the "Winsor" burner, so that its consumption may be regulated when all the lights are in use.

There should be also, in large buildings, a separate governor for each floor, because, as explained at page 8, the pressure of gas increases at every 10 feet above the supply-pipe 1/10th of an inch. Thus, in a house with four floors above the basement, the pressure will vary as follows:—

Pressures on various floors.

Pressure in basement after leaving the governor	8/10ths
At pendant in kitchen, on a level with governor	8/10ths
At gaselier on dining-room floor, 10 feet above governor	9/10ths
At brackets on drawing-room floor, 25 feet above governor	10½/10ths
At brackets on bedrooms, second floor, 33 feet above governor	11¼/10ths
At brackets on nursery floor and in servants' bedrooms, 49 feet above governor	13/10ths

---

charged with it, although no leak takes place, either through the bell in the one, or the leather diaphragm in the other. These governors, however, possess the advantage (when fitted with a pipe as described) of avoiding the possibility, from any cause, of the escape of gas into the house. Any escape must blow off into the open air.

Thus, instead of only the initial pressure of 8/10ths, to which the governor is regulated, there will be 13/10ths pressure on the burners in the nursery and servants' bedrooms. Therefore, if the lights are turned out in the basement or dining-room floors, the gas thus dispensed with rises by reason of its lightness to the upper floors, increases the pressure there, and thus gets consumed at the burners instead of being saved. In fact, although the governor at the meter may be in perfect action, the reduction of ten or a dozen lights in the basement of a large house may have little or no effect on the total quantity of gas consumed from the causes just mentioned.

Governor for each separate burner and gas-stove is best.

Although in hilly places governors are necessary to control the excessive pressure, they may be dispensed with in most cases if every burner and gas-stove is provided (as it should be) with a separate governor of its own.

CHAPTER VI.

GAS-BURNERS.

There are three kinds of gas-burners now in use—

1. Those in which the supply of atmospheric air to produce combustion is aspirated by the action of the heat of a flame in a glass or talc chimney, the pressure of gas at the point of ignition of the burner being, with the best burners, practically *nil*.
2. Those which obtain the supply of air both by the use of a chimney and by means of a certain pressure at the point of ignition.
3. Those which find the supply of air being forced out against it by the agency of a certain pressure of gas at the point of ignition.

Argand burners.

The first kind are mostly known by the name of "Argand," so called after Argand, the inventor of the means of producing a hollow cylindrical flame. The invention dates nearly a hundred years back, and was first applied to oil-lamps. The first Argand gas-burners were simply slight modifications of

Argand's oil-lamps. They were fitted with a perforated top in the place before occupied by the cotton wick, and gas instead of oil was supplied to them down the oil pipe. During his apprenticeship, the author of this work altered many oil-lamps to gas in this manner.

Argand may, therefore, be said to be the inventor of the Argand gas-burner, although he did not apply gas to it. The idea of this important application is supposed to have originated with Clegg, one of the pioneers of gas lighting.

The hollow cylindrical flame burner is best illustrated on page 10, which is almost the latest development of the Argand system.

Government standard Argand burner; the principle on which depends the high result obtained from it.

The Government standard burner depends for the high duty obtained from it upon the discovery made by the author of this work in 1868, viz.:—"That the highest illuminating power per cubic foot of gas consumed is coincident with a very low rate of velocity of the issuing gas from a non-conducting steatite* gas chamber (D, in drawing, fig. 7, page 10).

* Steatite is a natural stone found in various parts of the globe, being a kind of soapstone, called in German, "Speckstein." It is of a very fine grain, and, in its natural state, is softer than ivory. It admits of being worked to a very fine polish; but after it has been burned in a kiln it becomes harder than the hardest steel, and will resist a very high temperature (2000° of heat will not alter it); it is also unaffected by the action of damp, being perfectly incorrodible. Gas-burners made of this material

Rate of velocity of issuing gas per hour in Gas Referees' Argand.

The rate of velocity of the issuing gas from this burner is probably not greater than $1\frac{1}{2}$ miles per hour. It will easily be seen, by reference to the drawing, that under these circumstances the carbon in the gas has time to combine with the oxygen of the atmospheric air which is passing up through the centre opening of the burner, and also through the annular space between the steatite chamber D and the edge of the cone C.

Rate of velocity from old form of burners.

In the old form of Argand burners the pressure at the point of ignition is high, and the speed of the issuing gas is from 50 to 90 miles per hour—sometimes even more than that. This absolutely prevents perfect combustion; and, as a consequence, the gas escapes, incompletely consumed, into the apartment, without developing its full effect in light. In fact, the gas is really being to a great extent wasted.

The Gas Referees on the waste of gas in London—first report.

On this point the Gas Referees for London, in their report to the Board of Trade, dated May 3, 1869, which was presented to both Houses of Parliament, by command of Her Majesty, in June, 1869, say: "On testing, by the photometer, the large number of burners collected, we found that the diversity as to illuminating power was surprisingly great, and such as will appear incredible to

will remain in constant use for more than twenty years without deterioration. There are several imitations of this stone, but none of them are at all comparable with the natural stone in point of fineness of grain or durability.

any one who has not ascertained the facts by careful experiments. We also found that the kinds of burners in common use are extremely defective, thereby entailing upon the public a heavy pecuniary loss, as well as other disadvantages." In a later report to the Board of Trade, dated June 22, 1871, they say: "The Referees, in the course of their investigations relative to the choice of a standard burner, made and tested a large collection of burners of all kinds, obtained from the leading gas-fitting establishments and other quarters; and, in consequence of the great numerical preponderance of bad burners in the collection, they were led to inspect the gas-lighting arrangements in several large establishments in the City—especially those in which, owing to the prevalence of night-work, an unusually large quantity of gas is consumed . . . . It was found that the burners chiefly in use were so defective that they gave out only one-half of the illuminating power of the gas actually consumed. And several of the burners tested by the Referees gave only one-fourth of the proper light of the gas!" The burners to which these remarks refer are for the most part Argands of the old type, although the Referees say, further on in their report, that three "fishtail burners, purchased at random, were found to give respectively only 27, 24, and 23 per cent. of light compared with the standard burner." They estimated that in London alone a sum of £500,000 might be saved by the use of good burners instead

The Gas Referees' second report.

Great preponderance of bad burners over good ones.

Burners chiefly in use only gave half, and some only one-fourth of the latent amount of light in gas.

Fishtail burners.

Saving by use of good burners.

of bad ones. At that time the consumption of gas was less than half what it is at present.

Fishtail burners mostly in use in Great Britain.

The burners now in use are largely of the fishtail kind. In fact, it has been authoritatively stated that throughout this kingdom three-fourths of those at present in use are of this type. Be this as it may, it is an incontestable fact that an immense number of fishtail burners are employed by the public, and that most of the old Argand type of burner have given place to them.

Importance of a good burner to the consumer.

Following up the observations of the Gas Referees of 1871, and bearing in mind the present consumption of gas in London, it appears that the cost of a gas-burner is a subject of great importance to the consumer, because it is not represented only by the sum for which he has purchased it, but by the cost of gas to obtain a desirable result from it. If the first purchase-cost is the only amount which figures in the account for lighting, it is easy to ascertain what that is. For the best and most expensive burners it can only be a comparatively small sum; but if waste and inefficiency are going to figure up in the gas bill every quarter, it is more difficult to ascertain how much its cost will really amount to, as, for example—reverting to page 15—the first cost of the three burners experimented with was one shilling. The light they produced for a consumption of 30 cubic feet of gas per hour could have been easily obtained by a consumption of $7\frac{1}{2}$ cubic feet of gas per hour, if this quantity had

Great cost of supposed cheap burners taken in conjunction with the waste of gas caused by their use.

been used in a "London" Argand fitted to a suspension, as shown in figs. 34 and 35, on Plate 18, and a beautiful soft white light would have been shed down on the table under it. There was, therefore, a waste of 22½ cubic feet of gas per hour. This quantity multiplied by 2000, or the average number of hours in a year gas is burnt in private houses, gives 45,000 cubic feet as the actual *waste* of gas by these three burners per year! The cost, at (say) 3s. per 1000 cubic feet, amounts to the large sum of £6 15s. Now, supposing the burners to last three years, they will have cost the consumer in that time £20 6s., inclusive of the shilling paid for them in the first instance, or £6 15s. 4d. for each burner. Any one will admit that for this amount per burner a most excellent and highly-finished article of the same size and construction ought to be supplied in *pure gold, set with precious stones.**

Illustration of waste of gas by bad burners.

Real cost of a bad burner.

The consumers' burner is made in a slightly different manner to the standard Argand. The total air-way is much larger in area, and a longer chimney is used—7 inches instead of 6 inches. Figs. 36, 37, and 38 are engravings of the improved standard burner, combined with a self-acting governor, the larger kinds being also provided with a central jet, which improves the flame.

"London" Argand burners for consumers, an improvement on the Gas Referees' standard burner.

Before the introduction of the governor, the Argand required a great amount of attention when

* The saving mentioned by the Gas Referees (p. 79, last line but one) is *per annum*.

"London" Argand burner in section.

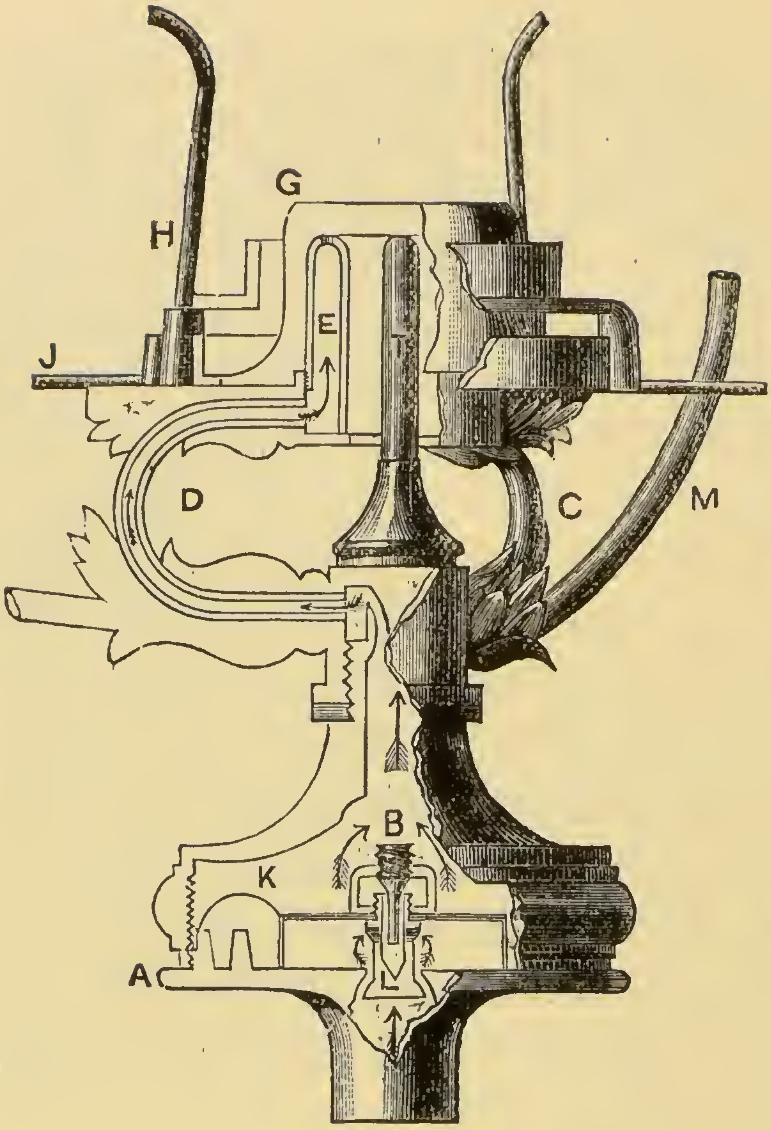


Fig. 36.

"LONDON" ARGAND BURNER

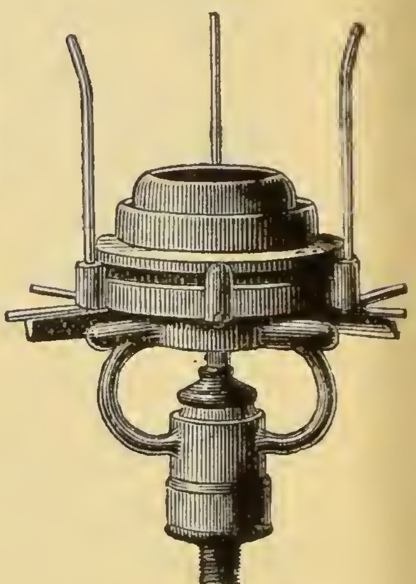


Fig. 37.

WITH STEATITE FLOAT GOVERNOR.

The gas enters through the inlet of the governor A (in the direction shown by the arrows), passes through the screw regulator B, which increases or diminishes the quantity to be consumed per hour by being screwed up or down (at the time the adjustment is made).

C is one of the tubes through which the gas is led from the governor to the combustion chamber.

D is one of these tubes in section.

E is the combustion chamber, of steatite—a non-conductor of heat.

F is the centre peg which steadies the air current to centre of flame.

G is the air cone which regulates the delivery of air to outside of flame.

H is one of the wires which hold the chimney.

I is the ring which carries the chimney, and regulates the third current of air which serves to keep the chimney cool and clean.

J is one of the wires which support the saucer.

K is the leathern gasholder carrying the valve L, and rising and falling with the increase or decrease of pressure; thus closing or enlarging the aperture for the admission of gas.

This improved burner was patented in 1874.

"LONDON" ARGAND BURNER AND SUPPORT FOR SHADE.

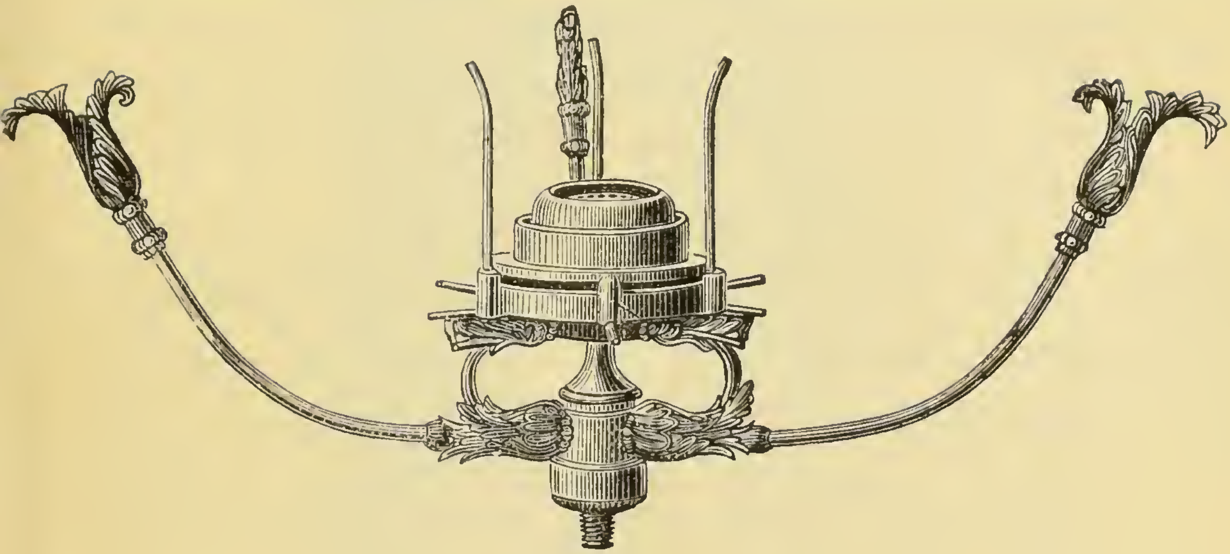


Fig. 38.

the pressures changed. Consequently, it fell considerably into disfavour, and has been in many instances replaced by fishtails. These, although they waste more gas under varying pressure, do not show it.

Arganas without governors replaced by fishtails, because former smoked under changing pressures.

The governors used with Argand burners are similar in their action to those described in Chapter V., with this exception—viz., that as they are regulated to consume a fixed quantity of gas under varying pressures, the communication with the atmosphere can be, and is, made through the burner itself. The pressure at the point of ignition is so slight that it is practically a free way between the top of the gasholder and the atmosphere.

Governors for Argand burners.

It should be said in fairness that the parties interested in the supply of the so-called cheap burners did their utmost to disparage the Argands. Alarmed, doubtless, at the high results achieved by

Opposition to the use of Argands by parties interested in the manufacture of fishtails.

a scientifically-made burner, which did not require renewal, and would be (accidents excepted) as good and as efficient at the end of twenty years of wear as it was when first new, they fancied they saw their occupation gone.

Introduction of governor Argand enables this form of burner to be used to great advantage.

But the introduction of this self-acting governor, which maintains a constant rate of consumption, entirely sweeps away the whole of the specious arguments used against the employment of the Argand burner; and, for reading, writing, drawing, painting, &c., it is at this day the most perfectly steady light in the market at the disposal of the gas consumer. The lighting power of these burners varies from 7 up to 600, or even 1200 candles. These last powerful burners are suitable for art schools, harbours, and lighthouses. They are, from 100 candles upwards, all ventilating lights.

Argands to replace oil burners in moderator lamps.

Fig. 39 (see next page), which is a burner made specially for France, so as to give the flame of the moderator lamp, and work with the same chimney, does not offer any point of great interest to the ordinary gas consumer; excepting that in places where moderator lamps are used on the mantelpiece of a room, gas may be substituted for oil with great advantage without changing the character of the lamp.

Ungoverned Argands are used largely with straight chimneys for the float lights of theatres, &c.

In closing these remarks on Argands, it may be as well to state that, by this system of burner, the

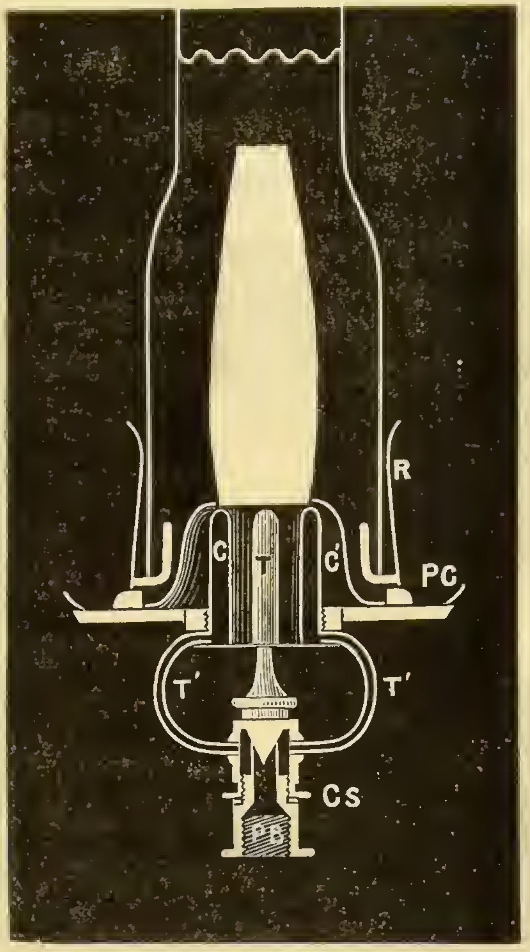


Fig. 39.

highest results in illuminating power per cubic foot of gas consumed are obtained.

Highest results per cubic foot of gas consumed obtained by Argands.

The smaller sizes realize, with 16-candle gas, from 3·3 to 3·5 candles per cubic foot of gas consumed, without reflectors; giving an equal all-round light in a direction horizontal to the flame, whilst in a vertical direction lighting a complete circle, with the exception of about one-quarter immediately underneath the burner. With reflectors they give light directly under the burner, and realize from 4 to 5 candles per foot; the largest sizes realizing 7 candles per foot.

Argands for cannel gas equally good.

A correspondingly high duty can be obtained from them with cannel gas, a less consumption per hour being required to give the same amount of light, according to the richness of the gas. No

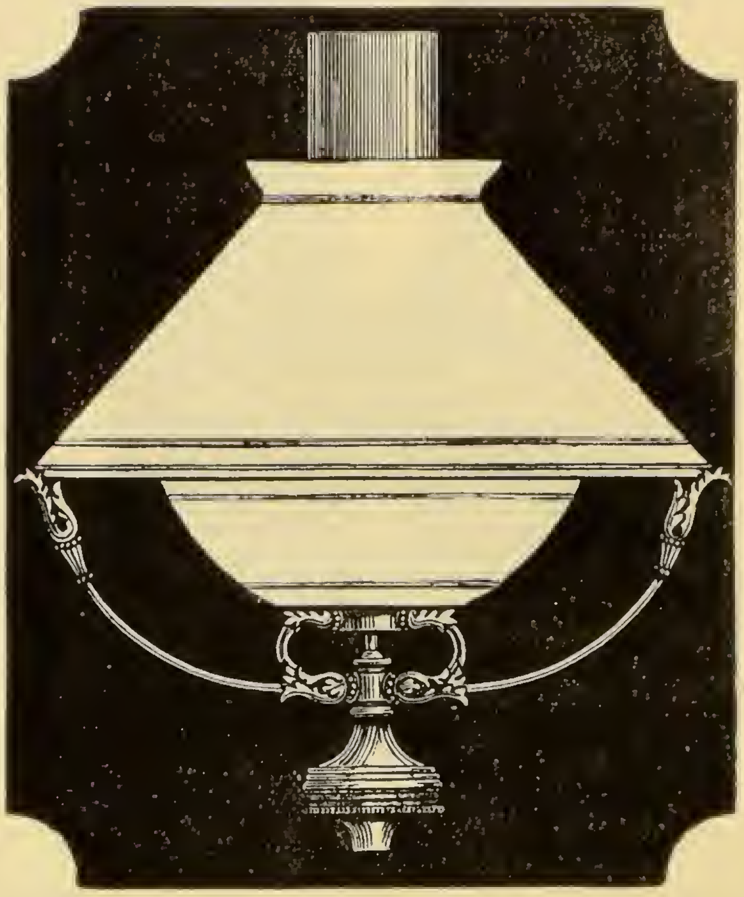


Fig. 40.

higher practical result has ever been achieved by domestic burners up to the present time.

Fig. 40 is an engraving of one of the most extensively-used patterns of the "London" Argand burner, with its shade, screen, chimney and supports, and governor complete. All the glasses are made to gauge, and each pattern is distinguished by a name. This is called the "Frankfort."

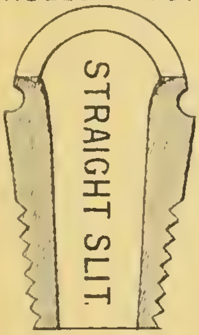
Sugg's patent "Christiania" flat-flame self-regulating burner.

The "Christiania" burner (shown in figs. 41 and 42), invented by the author, comes under the second

THE "CHRISTIANIA" BURNER AND GLOBE.

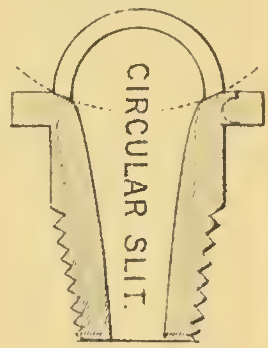
The shape of the Globe is so arranged, that it not only serves as a Reflector, but also answers the purpose of a chimney, inducing a straight, upward, gentle current of air, which makes the flame burn steadily.

HOLLOW TOP.

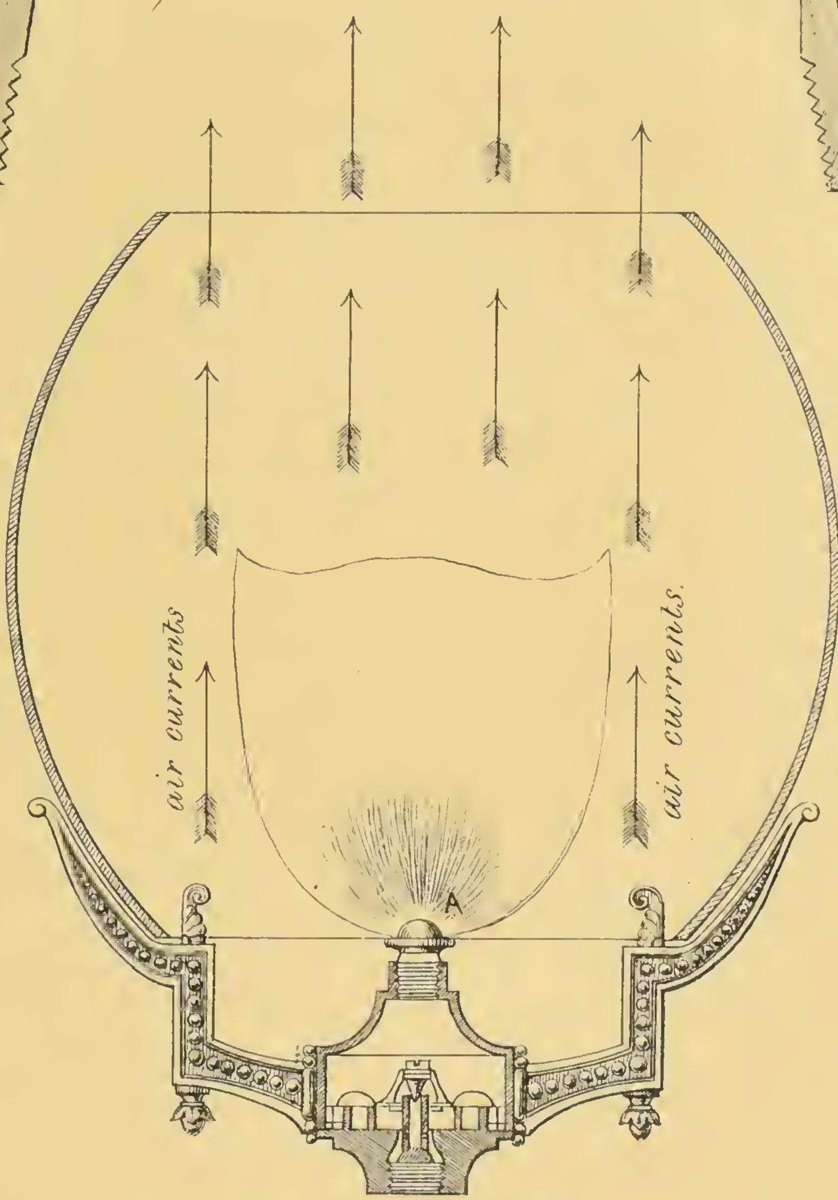


1868.

TABLE TOP.



1880.



SECTION

Showing Governor &c.

Fig 41.

The Burner at A is Sugg's Patent Table Top Circular-slit Burner as described on page 88.

The "Christiania" Burner is made in a variety of designs The one illustrated above is called

The Beaded Pattern.

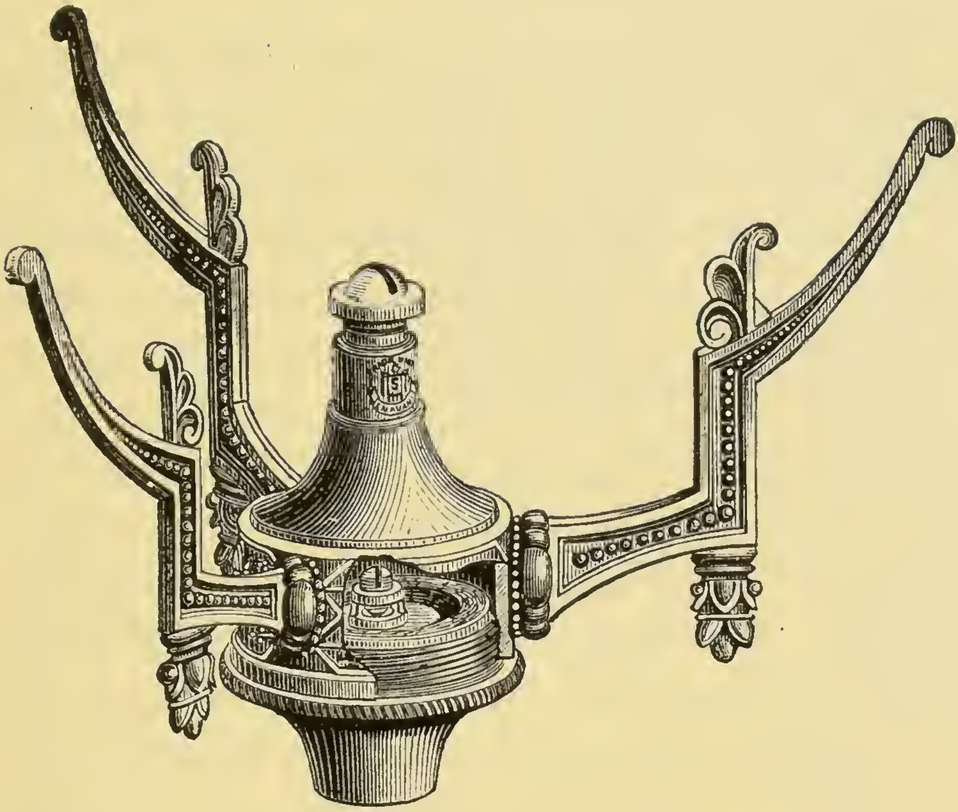


Fig. 42.

category of burners, and it is next to the Argand in order of duty per cubic foot of gas consumed. It consists of a self-acting governor similar to that used in the Argand burner just described (fig. 36), with a screw on the top of the gasholder, by which to regulate the rate of the consumption of the burner at pleasure. The support for the globe forms part of the top of the governor. The burner is made with great care, in steatite, and is called the "table-top," to distinguish it from the "hollow-top," now so well known.* The "table-top" is the latest and best development of the flat-flame burner.

See figs. 42 and 49.

* It may be said, in passing, that the hollow-top steatite burner has been adopted in every part of the globe, and it is probable that no other burner has ever obtained so great a success. Every burner maker has copied it; and it is, therefore, fair to conclude that they all consider it the best model they can follow.

The successive developments of Sugg's flat-flame burners during 22 years.

Street-lamp batswings.

"Amsterdam."

Patent circular-slit hollow-top steatite.

Patent table-top steatite.

The successive developments of the flat-flame burner by the author are shown in the following series of figures, viz.:—Figs. 44 and 45 represent the original improved steatite street-lamp batswings, made in 1858 and 1860; figs. 46 and 47 show the Amsterdam and hollow-top steatite burners, invented in 1866 and 1868; fig. 48 is the improvement on it, patented in 1874, by giving to the bottom of the slit a circular form, suitable to the shape of the flame; and fig. 49 is the latest improvement in 1880, being the "table-top" steatite burner in which the previous improvements are all combined, and still further improved upon by the addition of the table placed at a suitable distance under the flame, so as to give it the best possible shape and effect in illuminating power. The pressure at the point of ignition of this burner is higher than that of the Argand.

TRIPLE-FLAME "CHRISTIANIA" GOVERNOR BURNER.

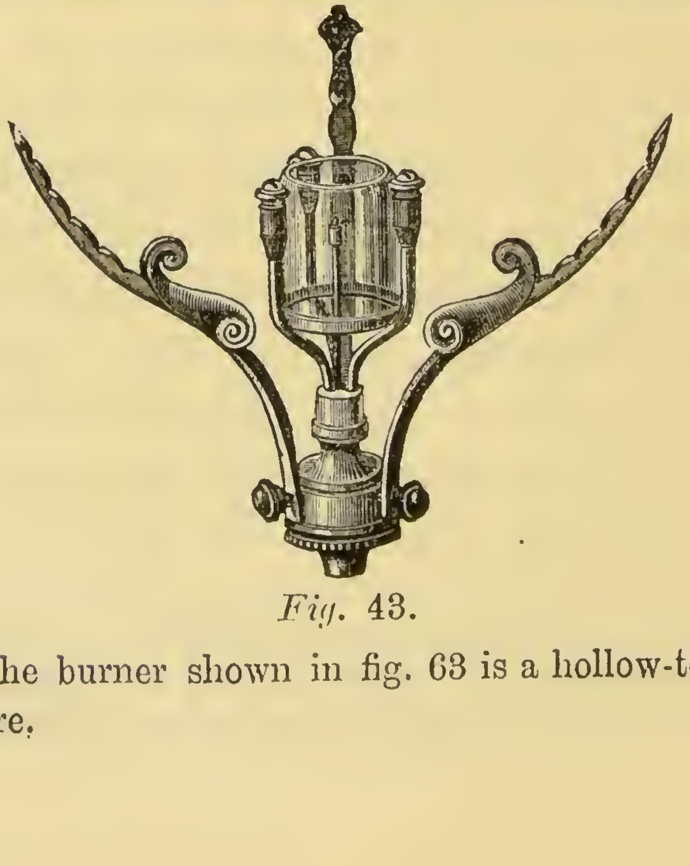
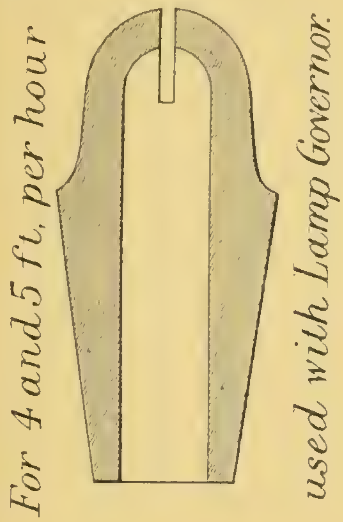


Fig. 43.

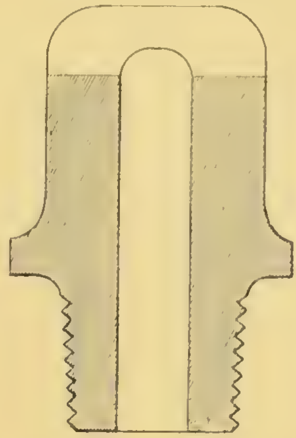
Note.—The burner shown in fig. 63 is a hollow-top, made in potters' ware.

FIG. 44.
SUGG'S. STEATITE.



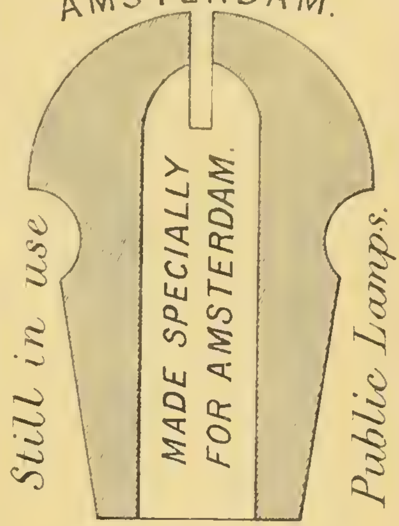
1858.

FIG. 45.
SUGG'S. STEATITE.
PUBLIC LIGHTING.



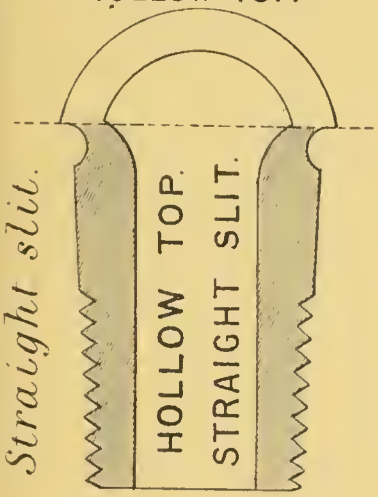
1860.

FIG. 46.
SUGG'S. STEATITE.
AMSTERDAM.



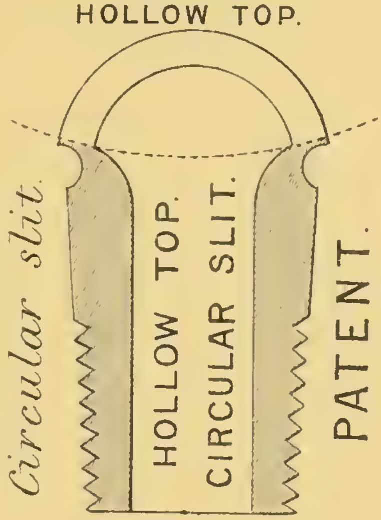
1866.

FIG. 47.
SUGG'S. STEATITE
HOLLOW TOP.



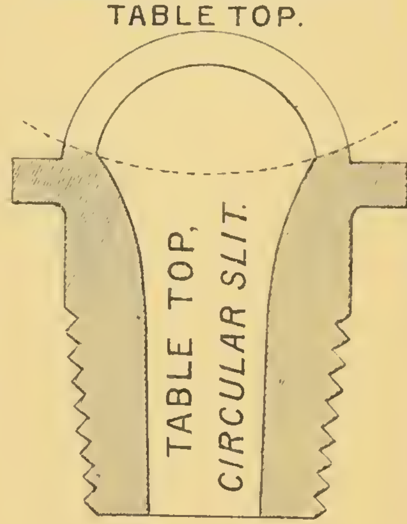
1868.

FIG. 48.
SUGG'S. STEATITE.
HOLLOW TOP.



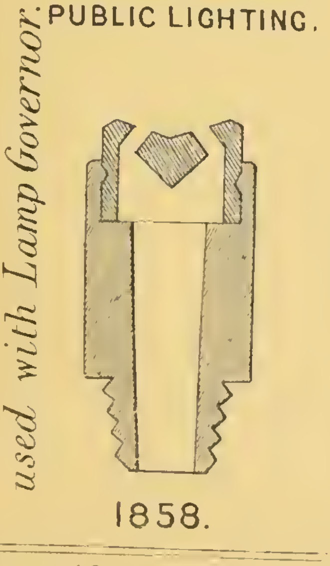
1874.

FIG. 49.
SUGG'S. PATENT
TABLE TOP.



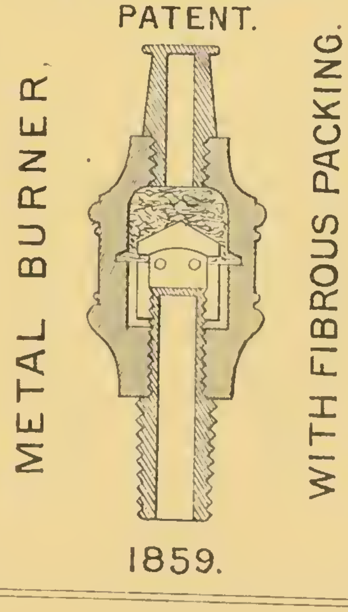
1880.

FIG. 56.
SUGG'S STEATITE.
FISH TAIL,
PUBLIC LIGHTING.



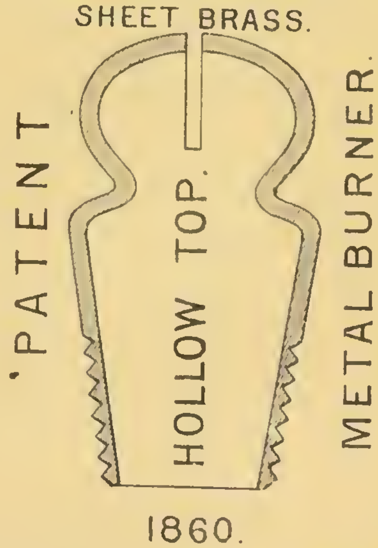
1858.

FIG. 57.
WILLIAMSONS'
PATENT.



1859.

FIG. 58.
WADSWORTH'S,
CONTRACTED NECK
SHEET BRASS.



1860.

To face p. 88.

The triple-flame "Christiania" governor burner, shown in fig. 43, gives a fine brilliant light, and is large enough for a 12-inch globe. It is a combination of three table-top burners with a small centre jet, and the light and steadiness are much increased by the employment of a short chimney below the burners.

The globe or chimney of the Christiania burner of albatrine or white glass steadies flame and reflects and diffuses light.

The globe of the "Christiania" burner, which is made of white glass of a very fine quality, and double-annealed, serves the purpose of a chimney to the burner, and by regulating the velocity and direction, and giving a gentle upward flow to the air, keeps the flame steady, and enables it to develop its best illuminating power. It also assists by reflecting the light downwards and diffusing it all around, so as to make it agreeable and soft to the eye, and yet powerful near its work. The "Christiania" is well suited for domestic requirements, and needs little attention. The light is constant and steady, notwithstanding the change of pressures in the street, or extinction of lights in any part of the house; there is therefore no waste. The first cost of a complete burner and globe does not exceed a few shillings, and its durability is practically unlimited.

First cost low—duration many years.

Cost of good burners insignificant in comparison with real cost of bad ones.

When compared, in point of cost, with such burners as those spoken of in page 15 and the first part of this chapter, it is clear that the whole cost of the "Christiania" burner and globe, amounting to a few shillings, sinks into utter insignificance by the side of that of the supposed cheap burners.

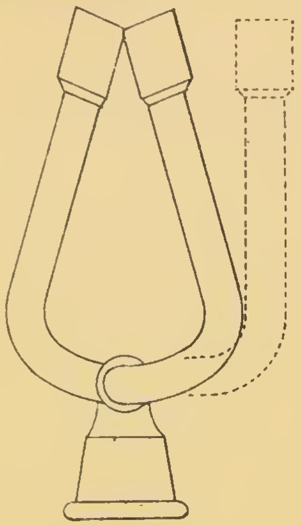
Fig. 42A.

Small steatite float governor for kitchens, passages, stables, &c.

Fig. 42A is a self-acting governor burner. It is a modification of the "Christiania," and is meant for use in kitchens, passages, sculleries, warehouses, and other places where glasses are not usually required. The burner is the steatite table-top already described. The float or gasholder is also the regulating valve, and it is made of steatite instead of leather, being simply a steatite piston, fitting and working inside a polished cylinder. It automatically opens or closes the aperture for the supply of gas to the flame, exactly as one may open and close the tap of a burner as the pressure on the supply-pipes increases or diminishes from any cause, so as to maintain a fixed rate of consumption. This rate is adjusted at the time the governor burner is made, and cannot afterwards be altered by the consumer or his servants. Being strongly made in brass, it is not liable to damage, and will work in any climate.

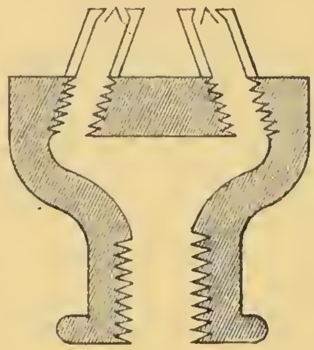
Automatic action of governor.

FIG. 52.
BILLOWS PATENT.



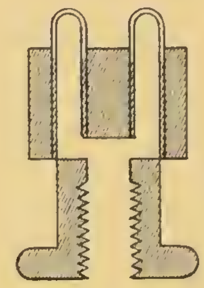
1852.

FIG, 53.
BILLOWS,
PATENT
DOUBLE FLAME.



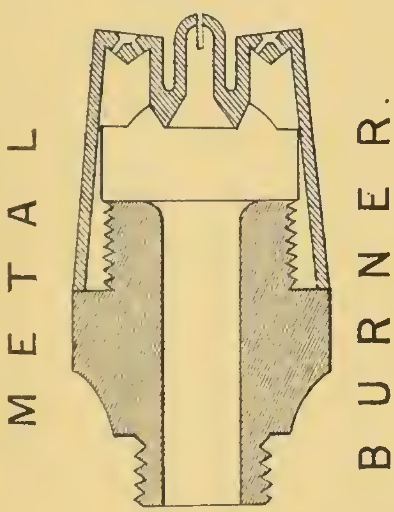
1852.

FIG, 54.
BILLOWS,
PATENT
DOUBLE FLAME.



1852.

FIG. 55.
JOHNSON'S, PATENT
TRIPLE.



1853.

FIG. 59.
LEONI'S,
PATENT
ADAMAS.

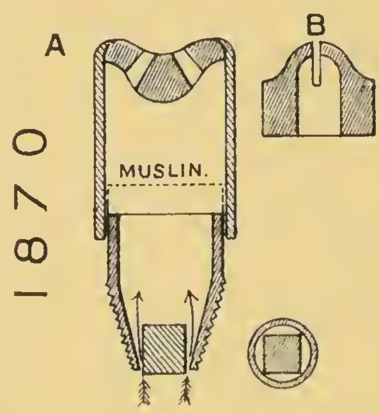
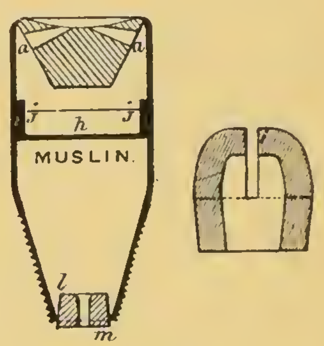
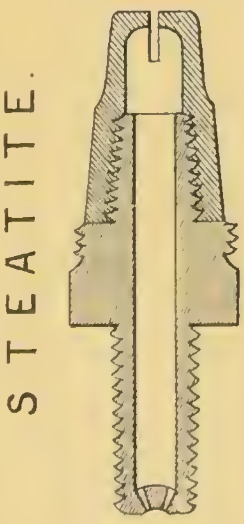


FIG. 61.
BRAY'S, PATENT
EARTHENWARE
OR METAL.



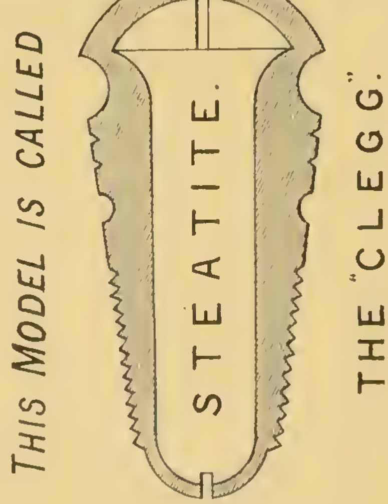
1876.

FIG. 50.
BRONNER'S
PATENT.



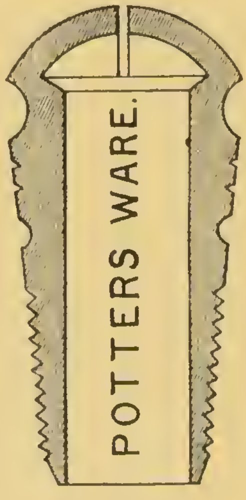
1867.

FIG. 60.
SUGG'S PATENT
CIRCULAR SLIT.
HOLLOW TOP.



1874.

FIG. 63.
BRAY'S
PATENT.



1877.

Plate 14. *To face p. 91.*

The importance of this little governor to the consumer, whose interest it protects, is manifest, and need not further be expatiated upon.

Imitations of "Christiania" burners and globes.

There are many imitations of the "Christiania" burner and globe, and they can be obtained at almost any price. The governor, however, is usually absent, and, therefore, they are not economical, although many of them surpass, in illuminating power, the ordinary type of burners commonly made use of by the public.

This latter remark applies also to the only other original kind of burner, also made of steatite, in which a good result is obtained from the gas used, and which also belongs to the second category. This burner is shown in fig. 50, and is known as the Brönner burner, invented in 1867 by Julius Brönner, of Frankfort-on-the-Maine.* The burner top is of the same form as fig. 45.

The Brönner flat-flame burners adjusted by fixed opening; consumption varying as the pressure increases or diminishes.

The regulation of the gas is effected by a carefully-adjusted opening in the base of the burner case, so that increase of pressure shall not so much affect it as it would if left open. The endeavour in this burner is to obtain an average kind of light, and the number of size of the burner must be carefully selected according to the variation of pressure in the district in which it is to be used. When properly selected, it burns with rather a small light in the beginning of the evening, increasing as the

* The sole proprietors of this burner are Messrs. Henry Greene and Son, Cannon Street, London.

pressure increases, till at the maximum of pressure it gives a full light, falling off again as the pressure decreases towards midnight.

There are numberless imitations of the Brönner burner and globes in the market, made both in steatite and in imitation steatite; but it may be generally relied upon that there is no exactitude whatever in the arrangements of such imitations, and without this exactitude the whole system of Brönner fails.

Sugg's Winsor flat-flame burners with adjustable regulators.

Sugg's "Winsor" (fig. 51) is another of this kind of burner, with a table-top burner fitted to it. It has a screw regulator at the bottom of the burner chamber, so that the consumption of *any* burner can be suited to *any* elevation or pressure. These burners are intended to be used with a

Fig. 51.

SILBER'S BATSWING GAS-BURNER.

Fig. 62.

governor at the outlet of meter, the exact regulation of the quantity consumed by each burner in its place being effected by the screw.

Both the foregoing burners are mostly used with globes, or moons made of white glass, having a wide opening at the bottom; but they can be used as naked flames.

Burners which find the supply of air by being forced out against it by comparatively high pressure at the point of ignition.

Of the last category of burners there are so many different kinds made in iron, brass, steatite, and imitation steatite, that to describe each of them with anything like sufficient detail, to enable the unscientific reader to understand their precise construction, would be a task much too extensive for this work. The general principles are all contained in the examples, figs. 52, 55, 56, 57, 58, 59, and 60.

Fig. 56 is a section of a fishtail burner, so called because the flame produced by two jets of gas flowing, under a pressure of from 8/10ths to an inch, out from the diagonally-drilled holes at the top of the burner, was supposed to somewhat resemble a fish's tail. It was originally invented by James Milne, of Edinburgh, many years ago; and it is still made and sold very largely by the firm of James Milne and Son, of that city. They were first made, very soon after the commencement of gas lighting, in metal, iron, brass, and gun metal; but it was found that they got out of order very rapidly through heat and damp.

A great improvement effected in this class of burner was the manufacture of it in steatite, about 1856, by several German manufacturers. In consequence, however, of its inherent defects (the principal one being that it required too much pressure at the point of ignition), it never produced any better result per cubic foot of gas consumed than the old metal burners, and it was never claimed for it that it did. On the contrary, its results were generally inferior to the metal burner, because, although it did produce a well-shaped flame, and did not corrode, it could not be cleaned out with a hard steel brooch without breakage. The metal burners, after they had been in use for some time, and had been well brooched out, must, from the enlargement of the holes and the consequent decrease of the pressure at the point of ignition, have produced results as, good as and often better than the steatite burners, although the flames were irregular. Be this as it may, it was not certainly known up to 1858 that there was any difference in the light obtained from any burner consuming like quantities of gas.

Old metal burners, when nearly worn out, often gave better results than new steatite fishtails.

Not known up to 1858 that there was any difference in illuminating power.

It was generally supposed that 5 cubic feet of gas, for example, gave just as good a light in one burner as in another. In fact, six of the Argand burners used for testing the gas made at the principal gas-works in London at that time varied in light power more than 40 per cent. from each other.

Expedients adopted to prevent squeaking and roaring of fishtails.

To overcome the squeaking and roaring which these fishtail burners were in the habit of producing whenever the pressure varied a little over that which was suitable to them, a great variety of expedients were adopted, most of which are still in existence under other names. Williamson's patent of 1859 (fig. 57), covers many of the expedients which are adopted at the present day. He reduced to a considerable degree the pressure at the point of ignition, by admitting the gas through small holes at the inlet of the burner,* suffering it to expand in a chamber immediately above this constricted aperture, and allowing it to issue out of the top burner, which had larger holes than the inlet burner. Sometimes he used fibrous material, but does not claim it, except when the inlet of the burner is smaller in sectional area than the outlet. It had been customary to put cotton wool or horsehair, &c., in the base of the burner, to break up the stream of the gas, and prevent that agitation at the point of ignition which particularly affected fishtail burners.

Silber's batswing burner, shown in fig. 62 (p. 92), is an arrangement similar to those of Williamson and Durrich—viz., with a smaller burner at the inlet for the gas, and a larger one at the point of ignition.

Leoni's "adamas" burners.

Leoni's "adamas" burners, invented in 1870, are made of a mixture of earthy materials. It is generally believed to be silicate of magnesia, or steatite powder mixed together with silicate of potash. This was the first imitation of steatite, and the burners being pressed into dies, could be made

* From which he says "an economy results." This arrangement is pointed out in Durrich's patent of 1856 for "regulating and economizing the consumption of gas."

nearly always alike. The top part of the burner only —at A, B—was of this material; the lower part, which formed the case, was in metal, and in this was a small "adamas" square plug fitting into the circular orifice for the admission of the gas. The top burner was larger in its orifices than those of the inlet orifices left by the sides of the square plug. Leoni also used muslin or other fibrous material to break up the stream of gas, in combination with the "adamas" orifices at the base of the burner (see fig. 59), which is one of his methods.

Method of breaking up stream of gas

Bray's fishtail burner (fig. 61) is, in most respects, similar to those of Williamson and Leoni.

Another kind of burner modified in form in several different ways is Billows' patent double-flame burner (see figs. 52, 53, and 54), in which two small batswings, placed at an angle towards each other, are made to combine their flames together. This patent dates back to 1852.

Johnson's patent (1853) is for a double fishtail burner, placed at an angle like those of Billows; and one for a combined batswing and double fishtail burner, producing a triple flame (fig. 55).

Probably in the whole range of inventions in gas-burners there has been nothing which has so much deceived inventors and the public as this arrangement. During more than thirty years it has been reinvented time after time, and has died out; still the same self-deception goes on to the present day.

To understand how it always appeared to give such excellent results, it must be borne in mind that if a burner requires a high pressure at the point of ignition to force the gas through it, the illuminating power of the flame decreases in proportion as the pressure increases at the point of ignition, from the over supply of air and the consequent absorption of the heat of the flame.

Now, if two burners consuming (say) 2½ cubic feet of 16-candle gas, both under high pressure, say 8/10ths at the point of ignition, be tested in the photometer, they will be found to give a total light of less than one-half of that which could be produced from a properly made flat-flame burner consuming 5 cubic feet of gas. But if the two flames are placed at such an angle one towards the other that they combine together to form one flame, that flame will be thickened, and the supply of air diminished, because it only flows against one side of each flame ; and it will be found that it will give, under some circumstances, the same amount of light as that yielded by a flame produced by the consumption of 5 cubic feet in a good flat-flame burner.

CHAPTER VII.

ARRANGEMENTS FOR LIGHTING.

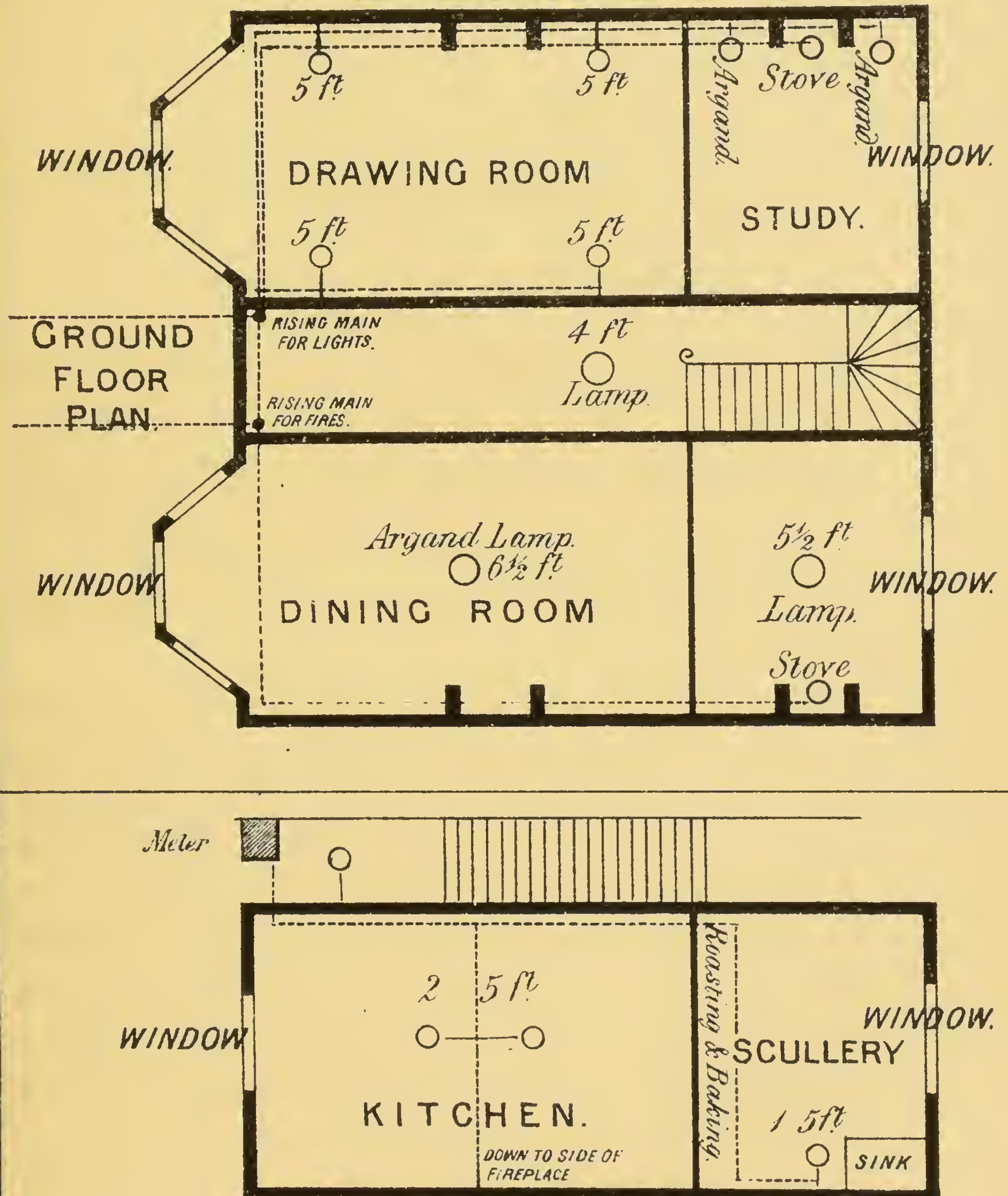
The apparatus for lighting, heating, cooking, and ventilating by gas are so numerous and so various, that, to describe them in a practical manner, it will be best to take them in the order in which they are to be found in an ordinary dwelling-house.

The most approved arrangements for light are as follows :—

Kitchen lighting.

For the kitchens: In the front kitchen, a 1-light pendant, as shown in fig. 64, with a swivel joint, so that it can be hung up to the ceiling when not required. If fixed over the table, it need not be attached with a swivel, but may be sliding, as shown in fig. 65, which has an arrangement fitted with cork, thus enabling the light to be lowered and brought near the table when required.* There are also pendants made (as fig. 66) in which the slide is sealed by water. For kitchen use they are extremely unsafe, because the ceilings are generally

* A good strong light is always required over the kitchen table, to enable the cook properly to carry out the culinary arrangements of a family.



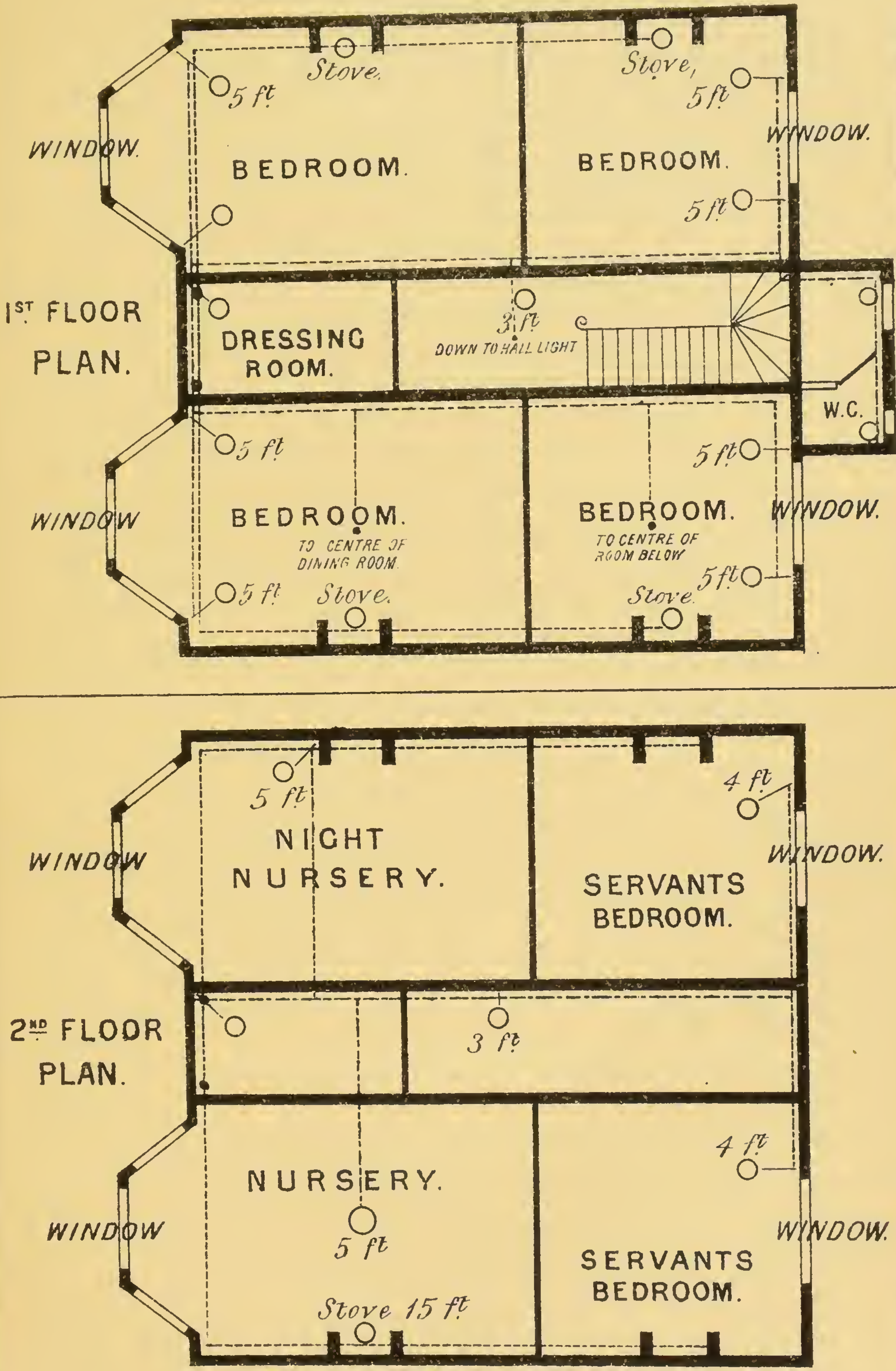
BASEMENT PLAN.

Plan of Dwelling House,

Shewing arrangements for the supply of Gas with separate service for Gas Fires.

Plate 15.

To face p 98.



PLAN OF DWELLING HOUSE.

Shewing arrangements for the supply of Gas.

Plate 16.

To face p 98.

KITCHEN LIGHTS, &C.

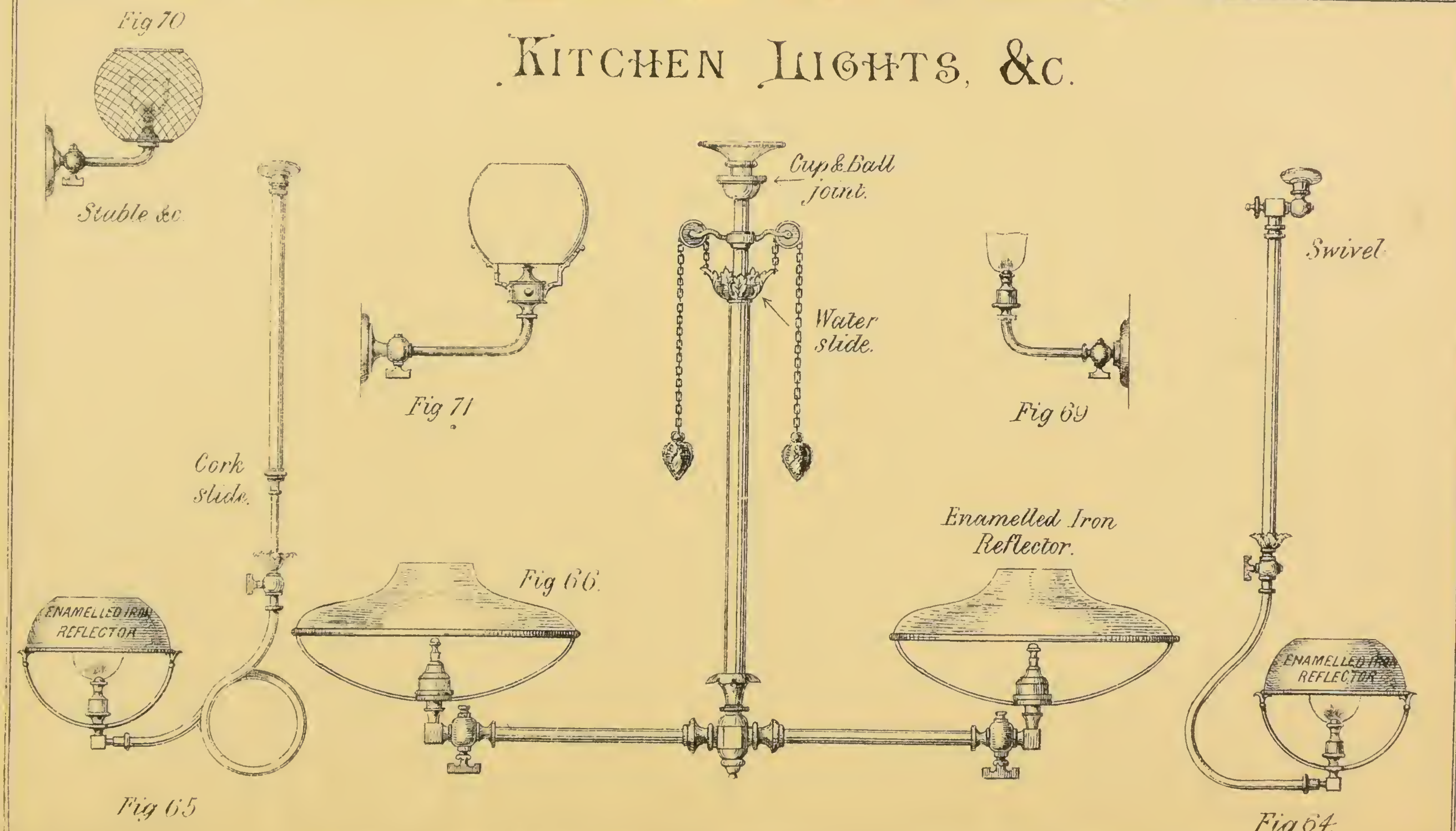


Plate 17.

To face p. 99

low and the slide is short. A little evaporation of water from the seal will allow the gas to escape when the slide is pulled down, and an accident *may* result. In any case the gas, if it escapes, is likely to find its way all over the house. These pendants should not be used.

Water-slide pendants unsafe.

A very much better plan than drawing down the lights is to fit on to the pendants burners with enamelled iron reflectors, as shown in figs. 64 and 66, which will wear for years, and always give a good light, so as to enable the servants to do their work. Very few kitchen pendants fitted with the ordinary burners and glass moons, or with naked burners, will throw a good light on to the table; and thus the servants are compelled to burn more gas than is required, and even to use candles as well, if they try to do needlework.

Enamelled iron reflectors better than sliding lights.

The same may be said of the scullery. A good, but not an extravagant light is required, generally over the sink. And here, again, a burner with an enamelled reflector is most useful and economical.

Lighting of the scullery.

Gas, in a house, is wasted mostly in the kitchen, upper rooms, passages, and stables, from the fact that with any quantity of gas the common burners usually put into such places do *not* give a light good enough to work by. As an example, a burner taken from a kitchen was found to be consuming 10 cubic feet per hour under the usual evening pressure, and only gave for that quantity of gas a light equal

Waste of gas through using bad burners in kitchens and offices.

Wasteful consumption with bad light.

to 9 candles. A good burner with the same consumption of gas will produce a light of over 30 candles.

Figs. 67 and 67A are copies of photographs (exact size) of the flames from the two kinds of burners, to illustrate the wastefulness of such as are generally used in kitchens and servants' offices.

Proper consumption with good light.

The proper consumption of gas for a good kitchen light when there is a ⊥ pendant is 5 feet for each burner, and from this they ought each to produce a light of 15 candles (see fig. 68). If the room is not a large one, it may be done with from 5 to 6 feet in one burner only.*

Passages, cellars.

For the passages, cellars, &c., plain brackets of the simplest description (as fig. 69) may be used, furnished with a governor burner to consume 3 feet of gas per hour, and without glasses of any kind.

Store-rooms.

In all places such as store-rooms, stables, &c., where there may be danger, from straw or any other inflammable substance coming in contact with the flame, wire guards (fig. 70) round the burner will be found useful.

Upper passages.

For the upper passages, plain brackets (similar in pattern to fig. 71), fitted with "Christiania" burners to consume 4 feet of gas per hour, and plain white or Venetian glass globes, will be both useful and sufficiently ornamental.

---

* It is most important, to avoid waste of gas, that every gas-bracket in the kitchen, scullery, passages, and stables should be provided with a governor burner, such as is shown in fig. 42A, on p. 90. (See chapter on "Burners.")

COPY OF PHOTOGRAPH OF THE FLAME. 1

Natural Size of Flame.

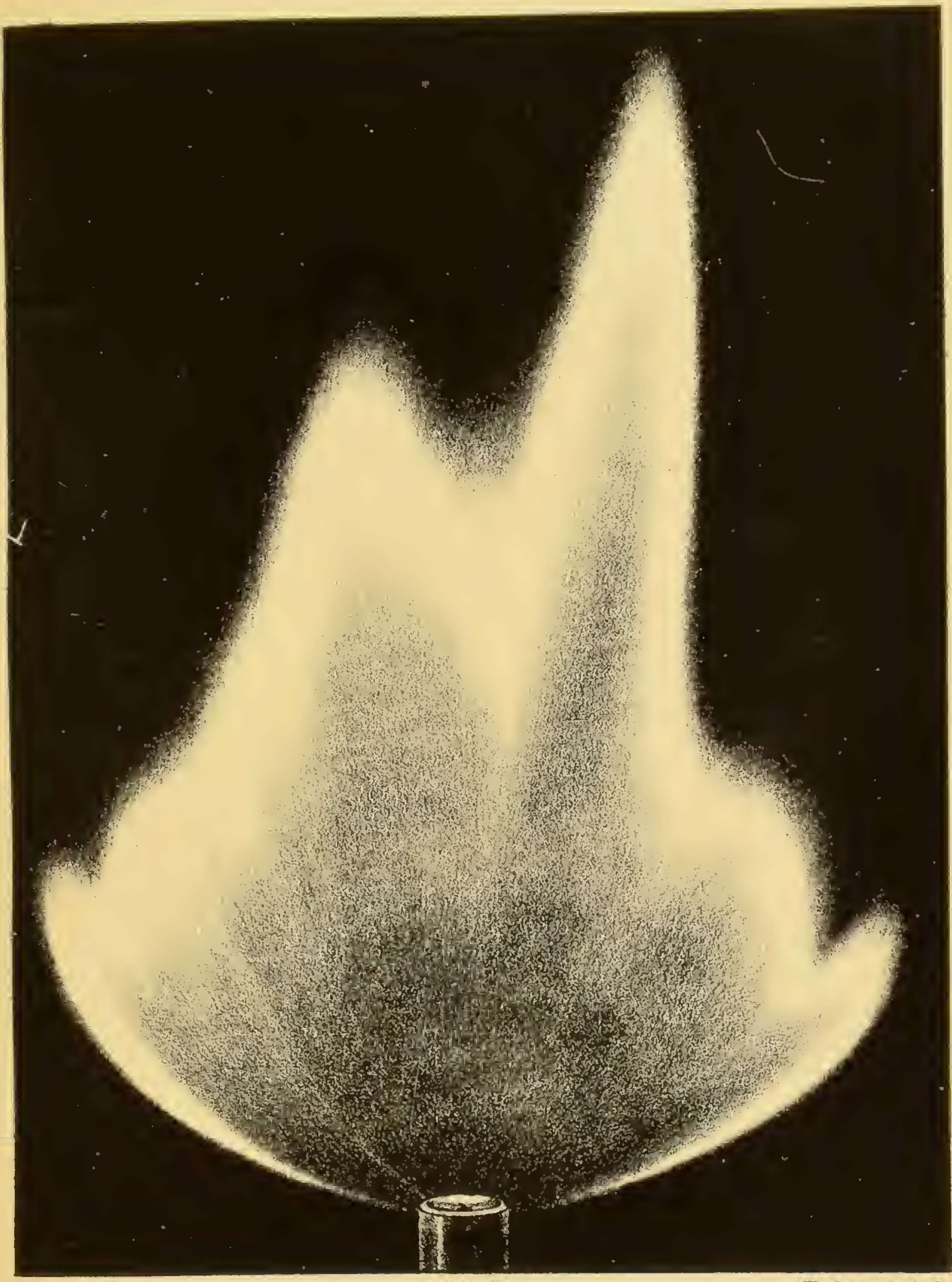


Plate 18 Fig. 67 *To face p 100*

BAD FLAME.

Burning 10 feet per hour; (evening pressure)

GIVING A LIGHT OF ONLY 9 CANDLES.

COPY OF PHOTOGRAPH OF THE FLAME.

Natural Size of Flame.

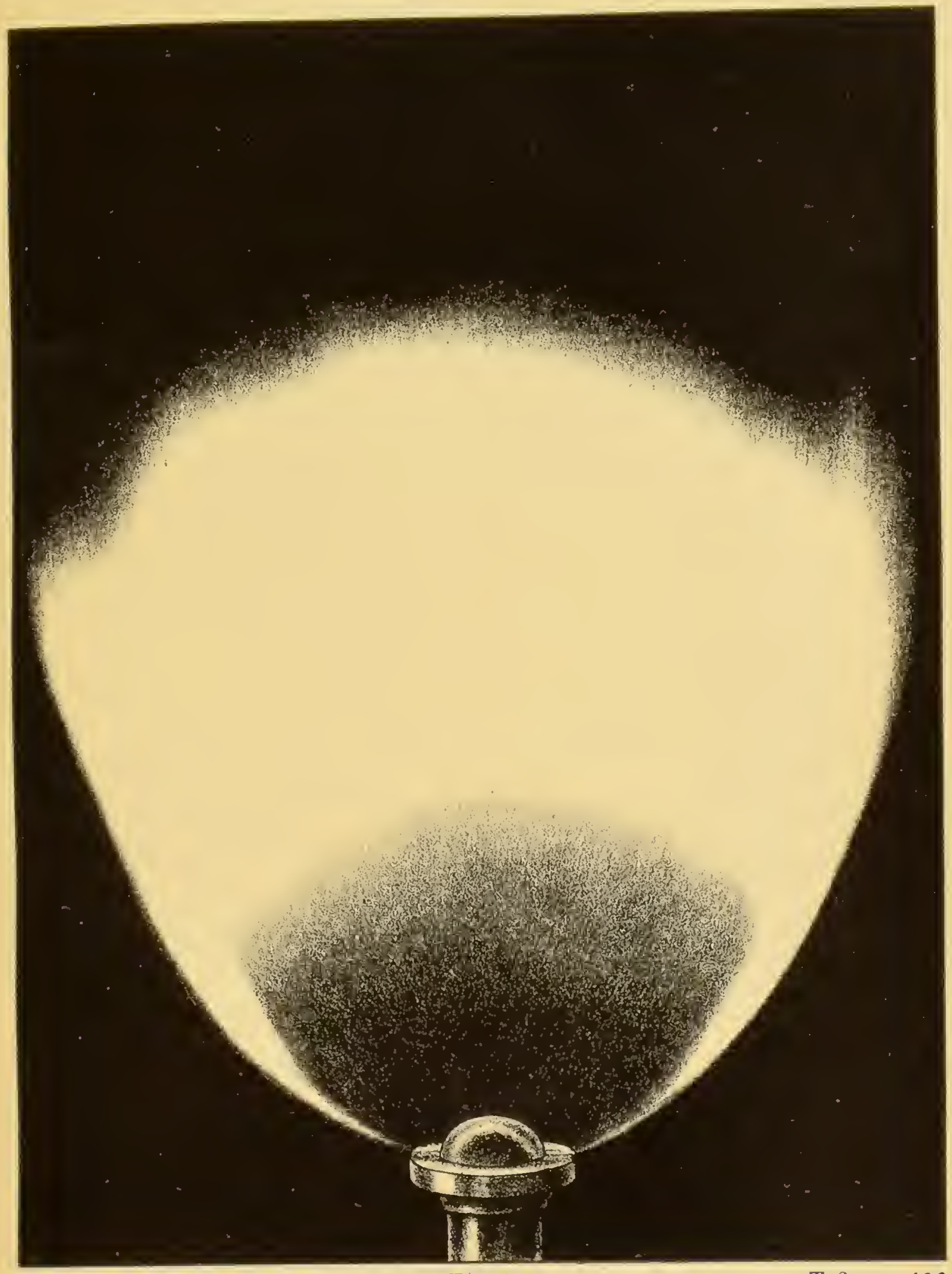


Plate 19 Fig 67ª *To face p. 100*

GOOD FLAME,

Consuming 10 feet per hour, (evening pressure.)

GIVING A LIGHT OF 30 CANDLES.

This kind of burner is used in the large public refuge lamps in Whitehall &c.

NATURAL SIZE OF THE FLAME OF A GOOD BURNER,
CONSUMING 5 CUBIC FEET OF GAS PER HOUR,

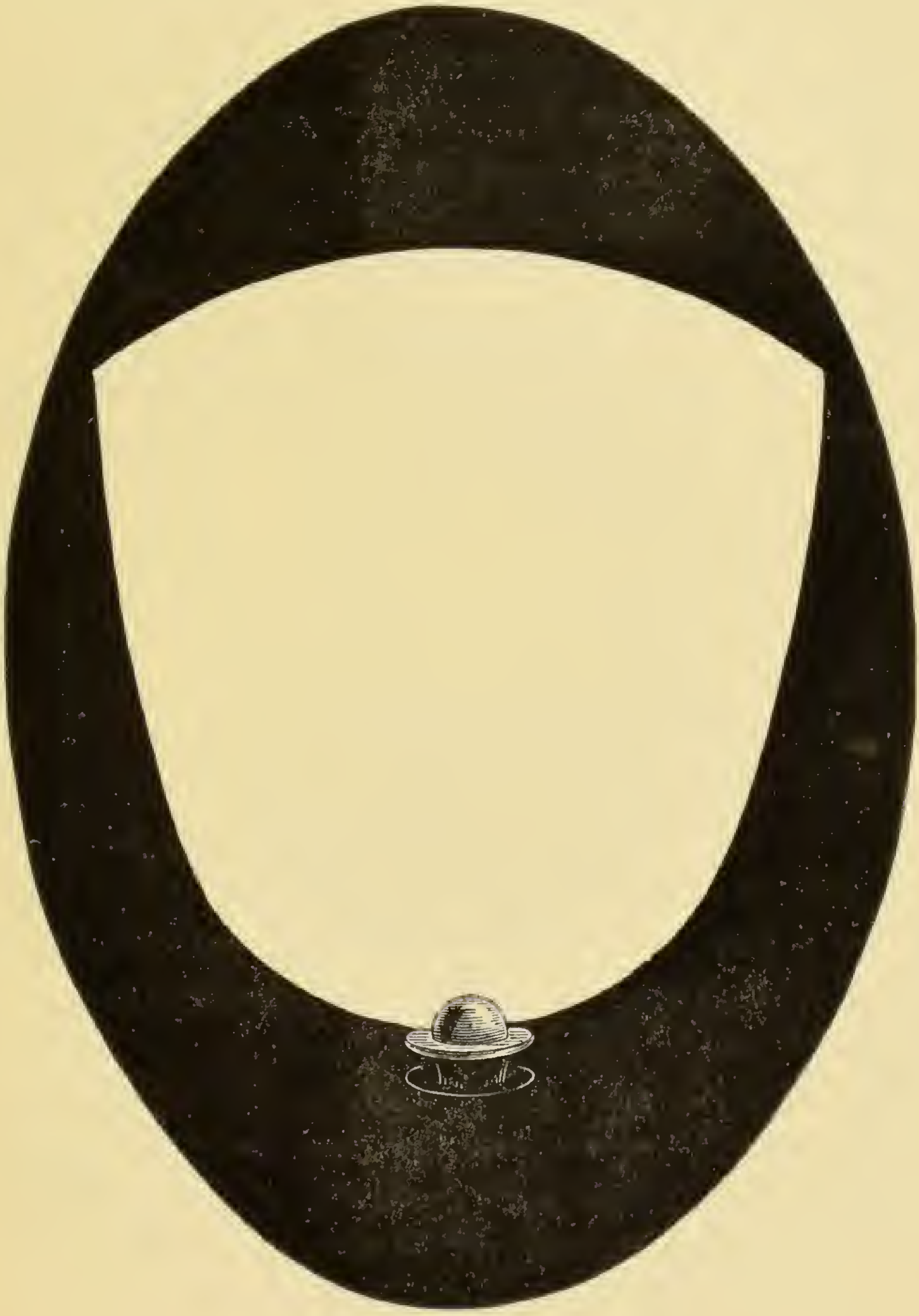


Fig. 68.

AND GIVING A LIGHT EQUAL TO 15 CANDLES.

(*Copied from a Photograph of the Flame.*)

Upper passages and hall.

In the hall, a lamp or bracket, more or less ornamental, according to the taste of the consumer, provided with a 4 or 5 feet burner, will give enough light. There is great variety in the patterns of hall lamps, but many of them cause the flame of the gas to flicker, are difficult to light, and become very dirty. The best forms are those quite open at the top and bottom, as in figs. 72 and 73; as they are steady, easily cleaned, and readily lighted.

The small square lamps, like fig. 74, are very effective, and can be fitted with cathedral glass, made in a great variety of patterns.

Fanlights not generally satisfactory.

Many houses are provided with a fanlight. This is generally a rather unsatisfactory arrangement, as it does not sufficiently light the hall inside, or the steps or front outside. A much better plan is to have a small lamp suspended over the door or under the portico. It may be of the simplest description (as shown in figs. 75 and 76), square or circular in form, and glazed in at the top with white glass or (if for a portico) with enamelled iron. It is fitted with a governor burner to consume 4 cubic feet of gas per hour, and has a lever arrangement so that the servants can easily light and extinguish it. But an arrangement can be made with the lamplighter of the district, who will undertake to light, clean, and extinguish it for a very small sum per annum. The saving of gas effected by having the gas turned off at sunrise will generally pay the lamplighter's fees, and leave a small surplus.

Outside suspension lamp better.

Arrangements made with lamplighter for lighting, cleaning, and extinguishing.

HALL AND PORTICO LAMPS.

fitted with plain or Cathedral Glass.

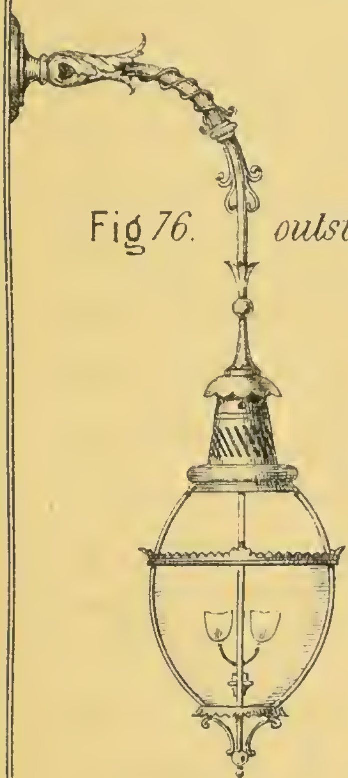
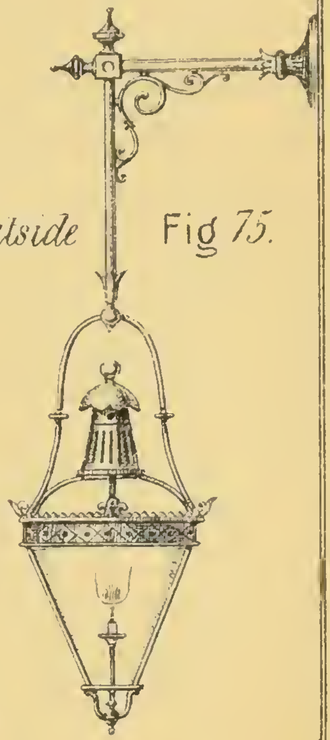


Fig 76. *outside*



outside Fig 75.

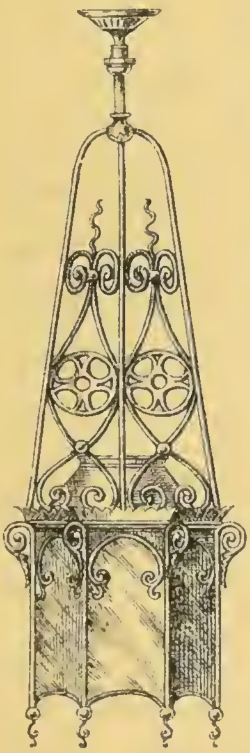


Fig 72. *inside.*

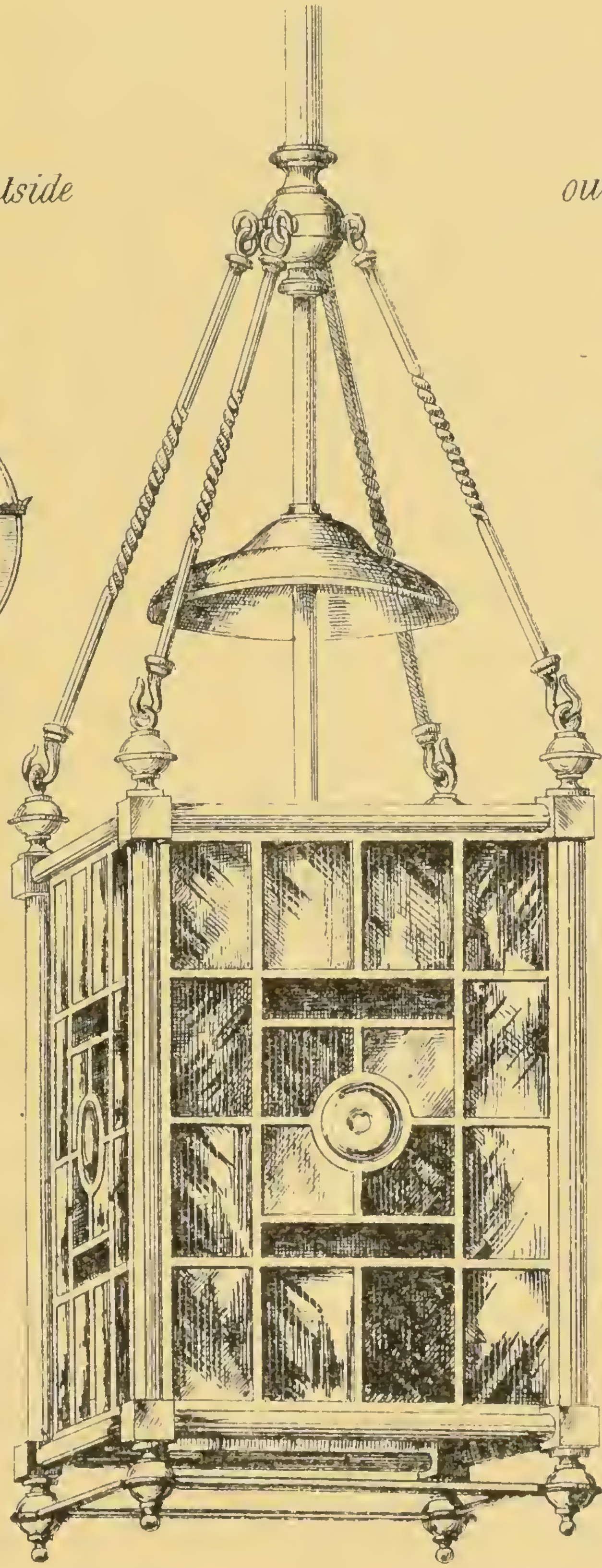


FIG. 74.

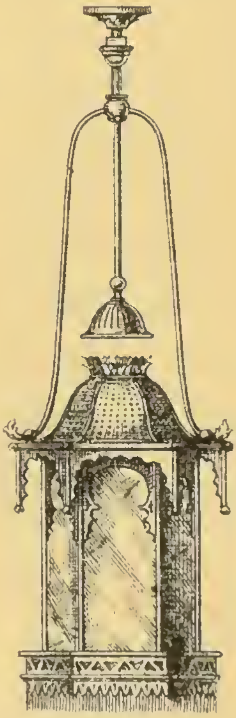


Fig 73 *inside.*

Plate. 22.

To face p 103.

A lamp burning before a house throughout the night constitutes the best safeguard against burglary. The *front* of the house is safe. Burglars, as a rule, do not like the *assistance* afforded by a gas-light. Neither do they like to turn it out, because its absence will probably attract the attention of the police. The cost of a lamp burning 4 feet of gas per hour from sunset to sunrise is, including cleaning, lighting, and extinguishing, about £3 10s. per annum. If it is preferred, the Gas Company will (by agreement) undertake the supply of gas, as well as the cleaning, &c. The charge in such case is from £4 a year, according to the size of the burner. The number of hours from sunset to sunrise is about 4300 in the year.

Cost of outside lamps lighted by the lamp-lighter.

Gas Company will light, clean, and extinguish by agreement.

When it is not thought desirable to incur the expense of a lamp outside, then the best way to use the fanlight is to put a governor burner and a globe in it. The shut-off cock should be at the side of the door at hand height, and the door of the fanlight (if arranged to light from the inside) should be provided with a spring-catch, so that it can be opened and shut by means of a lighting-torch.

The reception rooms of a house may be lighted in the following manner:—

Lighting of the drawing-room.

The drawing-room, by means of brackets, such as those shown in figs. 77 to 81, fixed round the walls, as per plan; by lamps on the mantelpiece, some patterns of which are given in figs. 82 to 84; or by brackets at the sides of the fireplace, For figures, see chapter on Burners—Argand and Christiania.

fitted with Argand (as shown in fig. 92) or "Christiania" burners (see fig. 41, in chapter on "Burners"), with paper shades or ornamental globes.*

Parallel brackets for reading.

Great comfort and convenience, for reading or working, will be found in the use of a bracket constructed as fig. 85 or 95 (which can be folded back, raised, or lowered with the greatest ease), carrying a very small Argand burner, fitted with a silvered shade, and screened by means of a rim of cathedral orange or ruby glass, according to the taste of the reader. (See plate of Reading Lights.) A pillar arranged as fig. 86 will also answer the same purpose.

Strong light on the book enables the reader often to dispense with spectacles.

The object of this moveable burner is to concentrate a strong light on the book or newspaper; thus avoiding the necessity of employing so large a burner as would otherwise be required to produce on the page the same amount of light from a greater height. The author of this work has found, by a number of experiments with different kinds of lamps, that a powerful light thrown on a book or paper enables the reader frequently to dispense with spectacles. Many persons are unable to read at night without glasses, although they can easily read small print by day. The reason can only be this—that the strength of the light afforded by

* A "Christiania" burner fixed on a long bracket (fig. 87) would be very useful for lighting the piano, and obviate the inconvenience of candles.

Reading Lights.

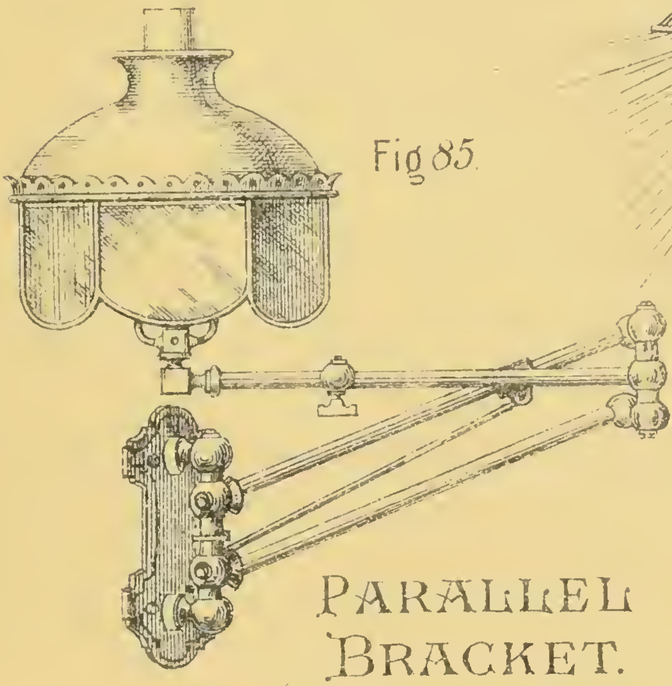


Fig 85.

PARALLEL BRACKET.
(For Drawing Room)
With Argand Burner and Silvered Shade, for Concentrating Light.

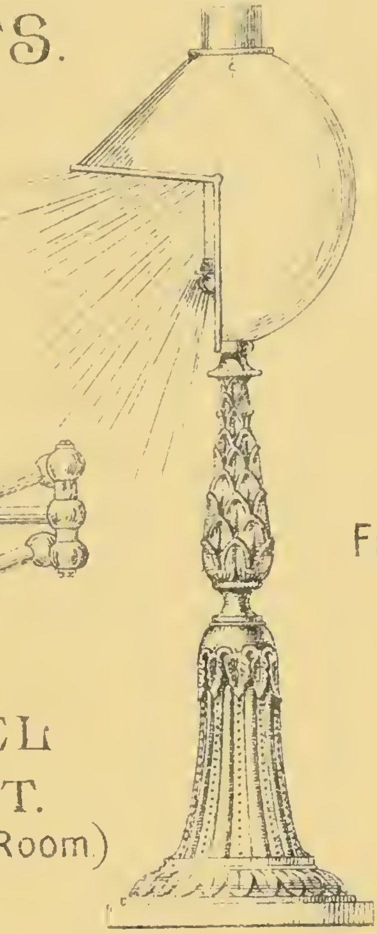


Fig 86.

ARGAND BURNER ON PILLAR
(with Silvered Reflector to concentrate Light.)

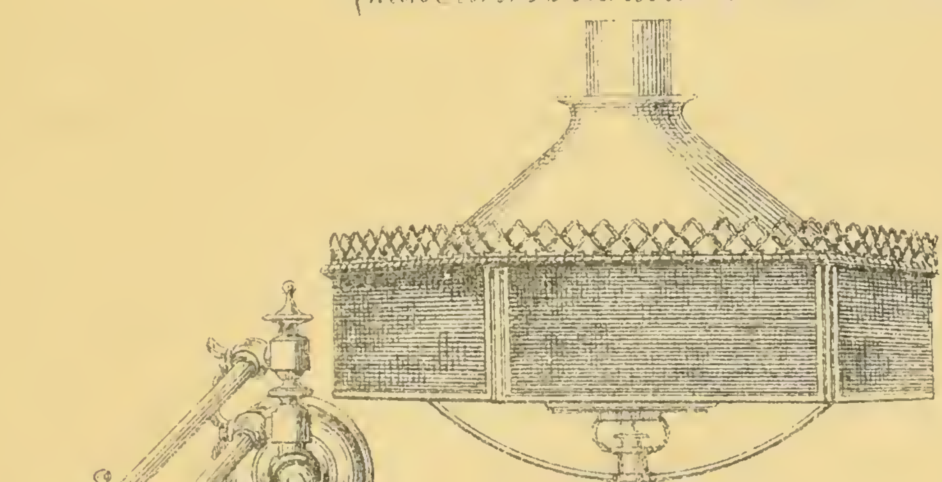


Fig 95

PARALLEL BRACKET FOR STUDY.

With larger Argand Burner and Albatrine Shade for giving a more diffused Light.

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SUSPENSION LIGHTS
SUITABLE FOR
SMALL DINING ROOMS, STUDIES, &c.

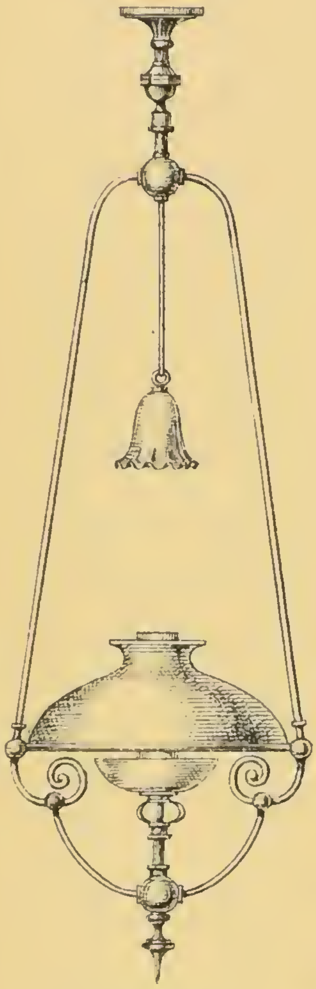


Fig 34.

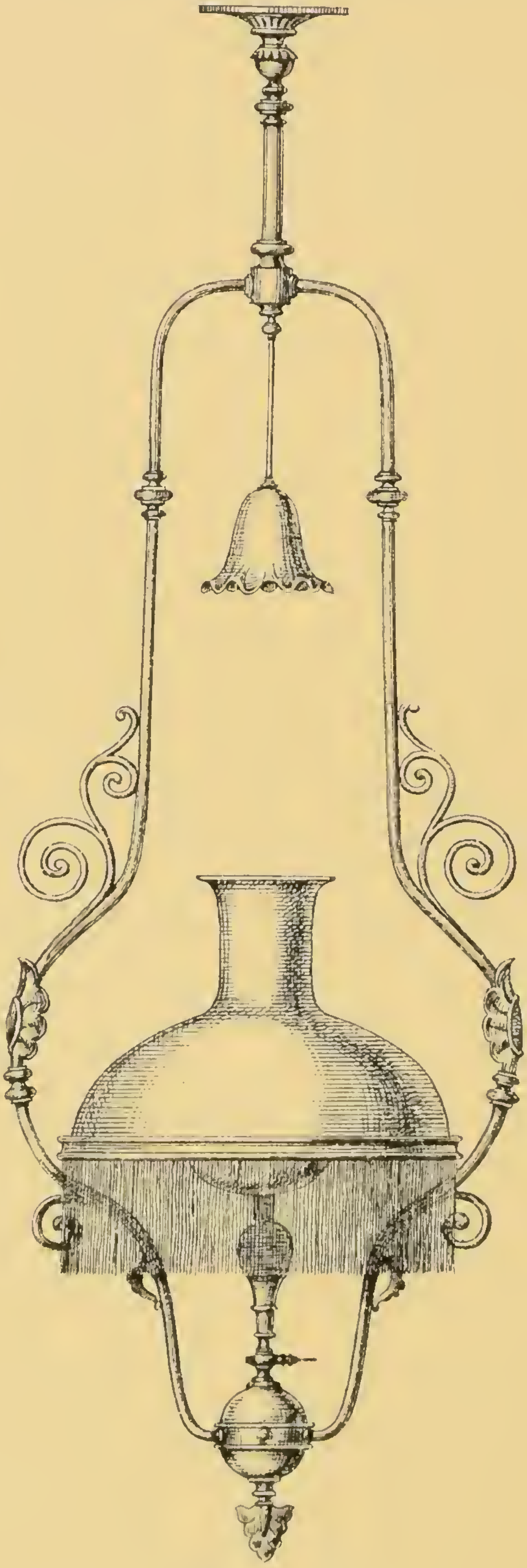


Fig 88.

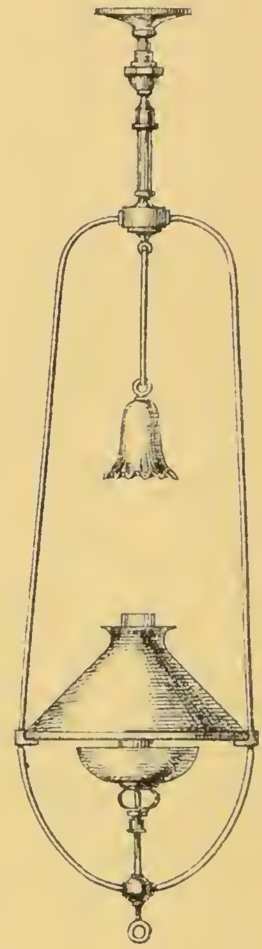


Fig 35.

A consumption of 6 cubic feet of Gas per hour will give a light of 22 candles.
" " $7\frac{1}{2}$ " " " " " 26 "
" " 8 " " " " " 30 "

Plate. 24. To face p 105.

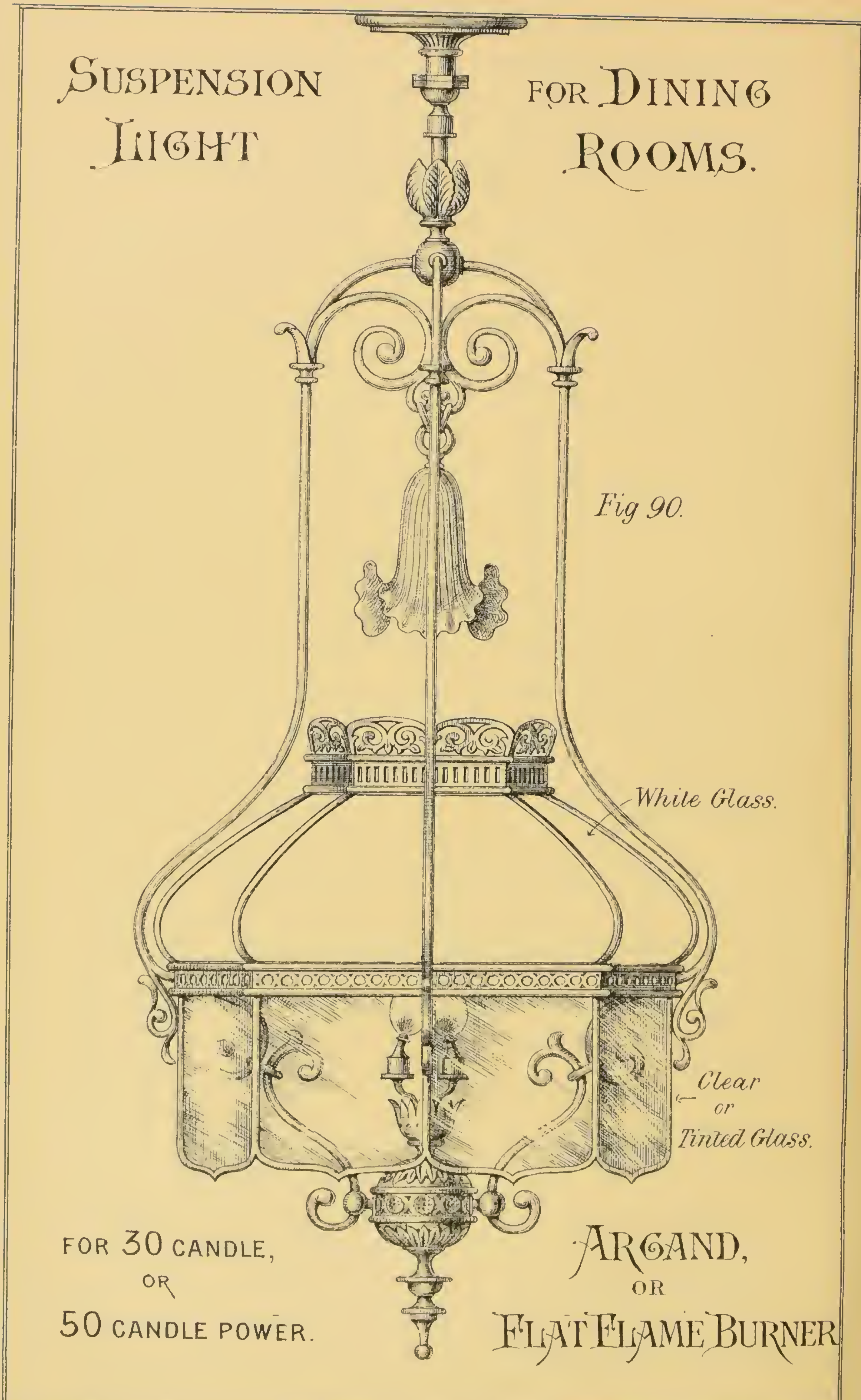


Plate. 25.

To face p. 105.


THE "SUTHERLAND"
VENTILATING LIGHT.
Ceiling line.
Perforated Basket
for ventilating top of Room.
DINING ROOM
LIGHT.
Fig 89.
Hot air from Room
carried off here.
White Glass.
Hot air from Room
carried off here.
Consumption of
Gas 16 to 30 cubic feet
per hour.
A BRILLIANT WHITE LIGHT.

 To face p. 105.

candles or ordinary gas-burners is insufficient. At the same time, if the strength of the light is increased and brought nearer the eyes, some kind of protection must be provided so as to shield the forehead from the heat, and the eyes from the brightness of the light. This can be easily done by means of the appliances just described.

Protection to the forehead and eyes from the brightness of the light important.

The lighting of a dining-room is always best done from the centre; but it is also convenient to have a light on either side of the fireplace, so that it may be used, if desired, for reading in winter time. Fig. 88 is a sketch of a suspension light, suitable for a room 16 ft. by 18 ft.; and figs. 89 and 90 are sketches of those suitable for larger rooms.

Dining-room best lighted from centre of room.

The mantelshelf and sideboard may be fitted for gas in the manner shown in figs. 82, 83, and 84, which represent vases fitted for gas, and provided with "Christiania" or Argand burners and globes suitable for taking a silk screen and fringe of a rose or other tint, to harmonize with the decoration of the room; or the old moderator or petroleum lamp formerly used may be altered to enable it to consume gas.

The morning-room or boudoir may also be lighted from the centre by a smaller light (figs. 34, 35, and 93, of about 16 or 18 candle power, with the addition of a bracket (figs. 92 or 93) at the side of the fireplace, fitted with a "Christiania" or an Argand burner, and with a paper or silk shade for reading or writing.

Lighting of morning-room or boudoir.

The centre light may be varied in style according to the decoration of the room; such, for example, as fig. 94, which is a Persian pattern lamp, which gives a white light down, but a coloured soft light around the room and on the ceiling.

Library or study.

The library or study is also best lighted from the centre, with the addition, on the *comfortable* side of the fireplace, of what is called a "parallel bracket" (fig. 95, p. 104).

Bed-rooms.

The toilet-table.

The lighting of bed-rooms is usually effected by means of two brackets placed one on either side of the window. This is done because the toilet-table is generally placed there. The object of the two lights is to enable ladies, when dressing, to see both sides of the head. But, as a rule, this kind of lighting does not give them a true idea of their appearance in the dining or drawing room, or at public assemblies. The effect of light coming from above the head is necessary to enable a lady to form an idea as to how she will appear in a ball or dining room lighted in this manner.

Arrangements to change position of lights, so as to give a true idea of appearance.

At the same time, it is necessary to be able to change the position of the light, so as to represent the effect produced by candles or lamps on the table. The best way to do this is to place a bracket similar to that shown in fig. 85 (having either an Argand or a "Christiania" burner), which can be adjusted to different heights, on either side of the dressing-table, and a suspended light (fig. 91) of about 16-candle power, above the head—say 6 ft. from

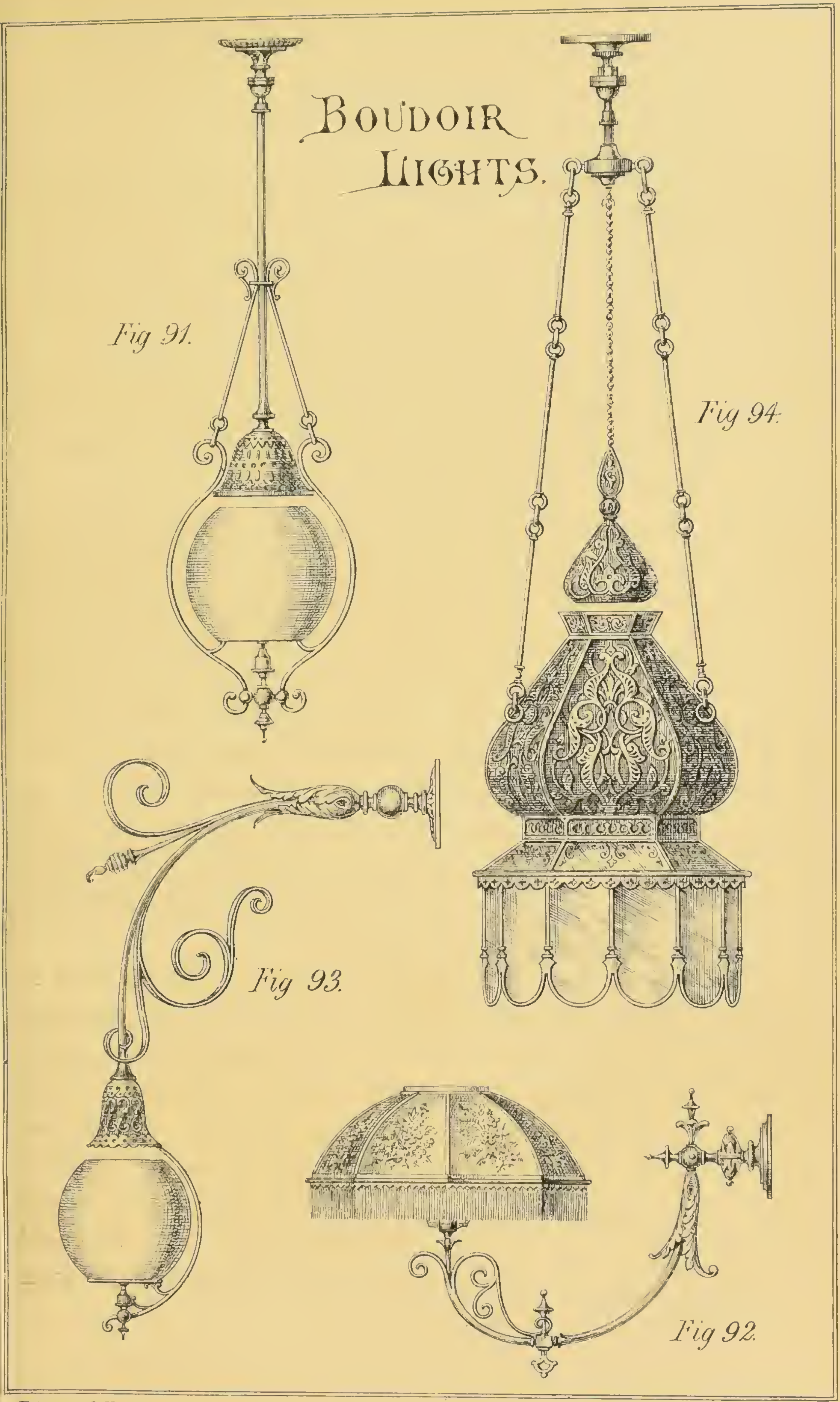


Plate 27.

To face p. 106.

THE "HOUSE OF COMMONS" SELF-VENTILATING BRACKET.

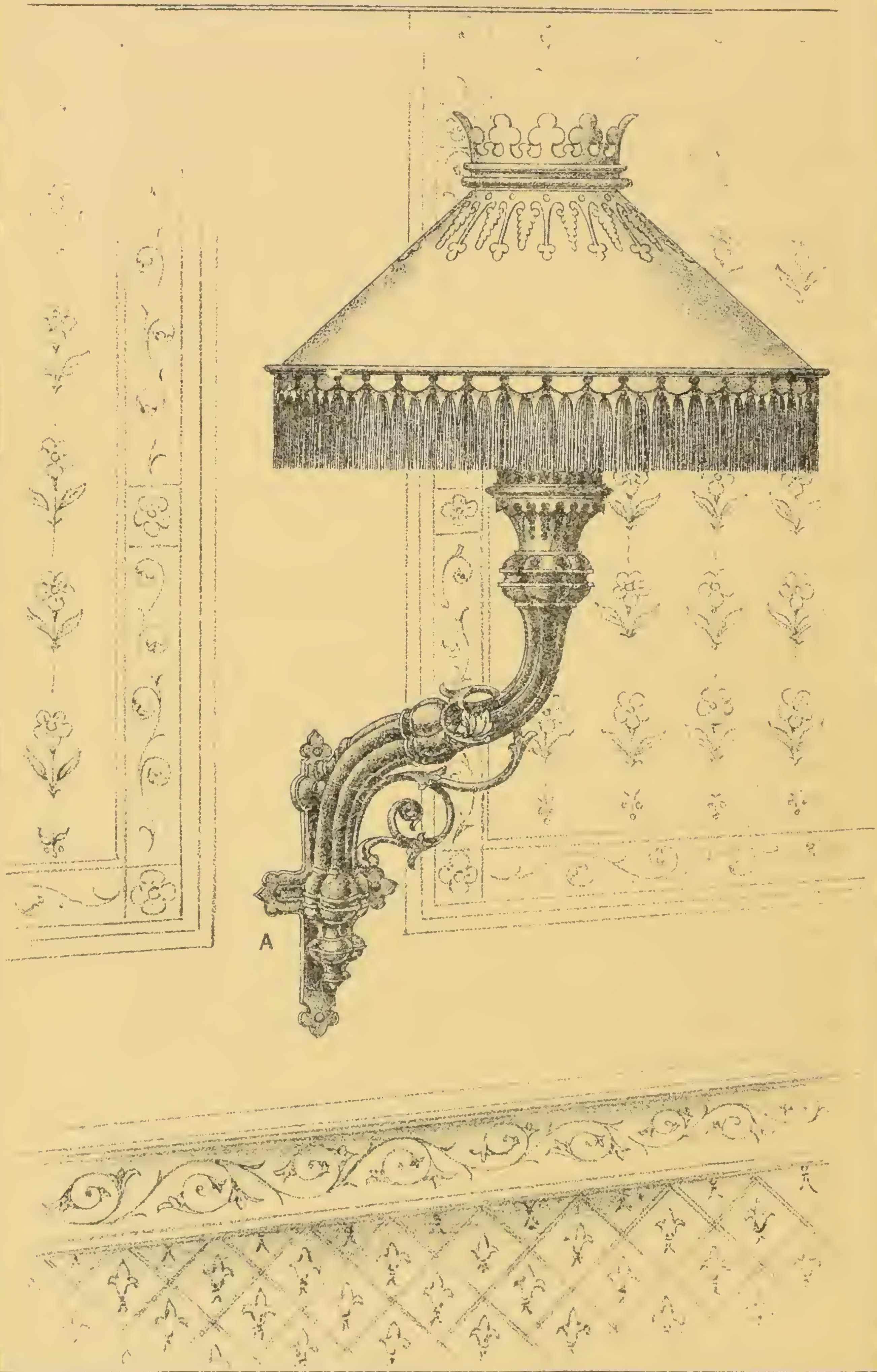


Plate 28.

Fig 96

To Face p 107.

the floor. Generally speaking, it will be found that the suspended light hanging immediately over the chair will give the best result.

Sometimes it may be required to put up a gas-bracket as fig. 85 (p. 104), on one side of the fireplace, for reading at night. In some instances a swing bracket of the same kind at the side of the bed is found very useful, with an arrangement for turning off while in bed.

Servants' bed-rooms.

The servants' bed-rooms may be lighted with governor burners on stiff brackets, as fig. 71, fixed in the most convenient position, with or without globes, as may be desirable.

Nursery.

The nursery is best lighted by means of a centre suspension light, as fig. 35.

Ventilating lights.

There are also a number of ventilating gas-lights of various kinds, by which the products of combustion and the vitiated air of the room are carried off; but the system is too extensive to be properly described in this work.

More than 30 years ago ventilating gas-lights were invented by Mr. J. O. N. Rutter, of the Black Rock Gas-Works, Brighton, who brought them to a great degree of perfection; but they have not yet made so much progress in all that time as they probably will in the next two or three years.

Fig. 96 shows the ventilating bracket used in the House of Commons lobbies. It is in connection with a long ventilating shaft in the wall at A. The products of combustion, largely mixed with cold air, pass down the bracket towards A into the shaft.

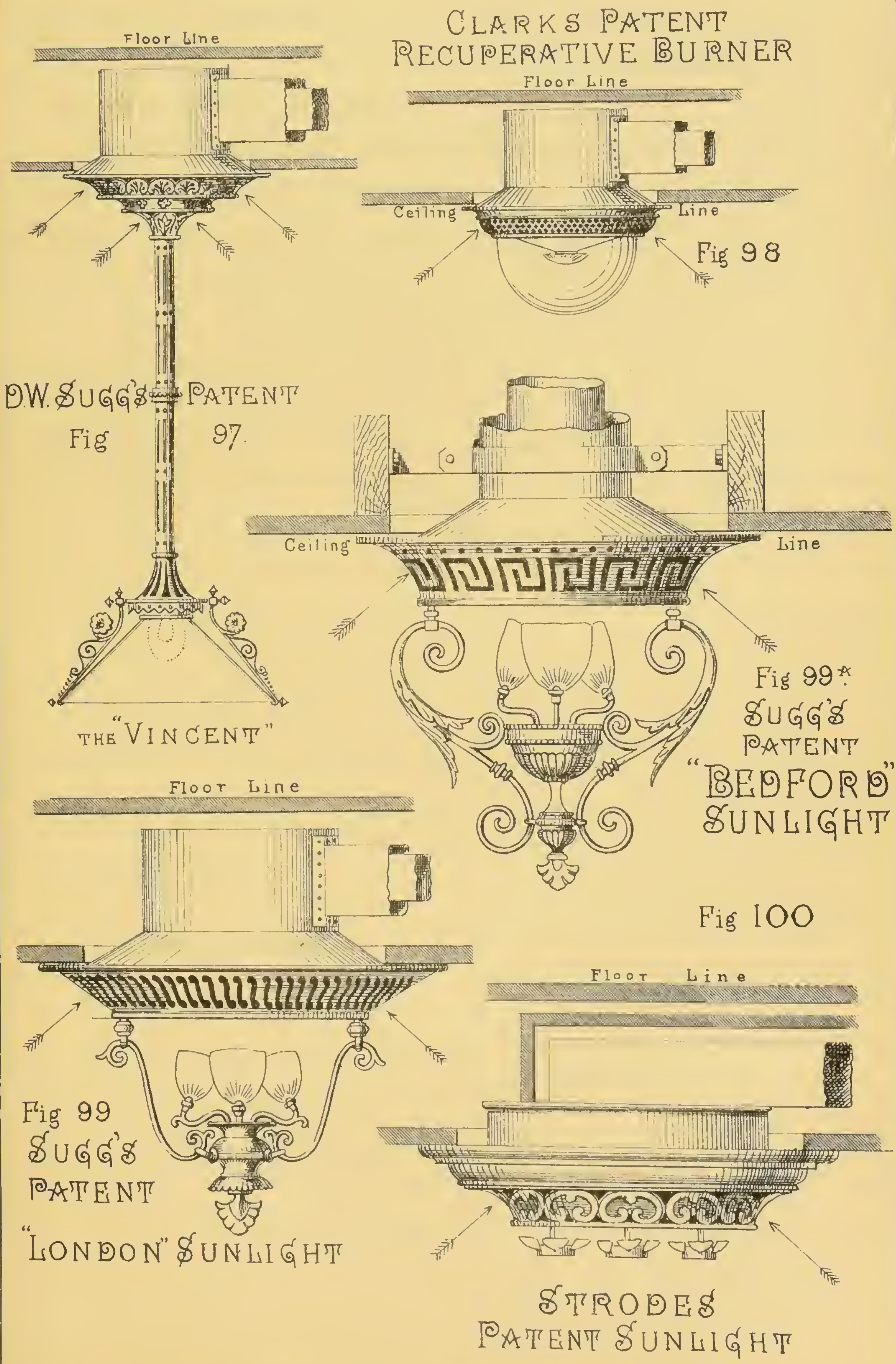
Fig. 97 is Mr. D. W. Sugg's patent "Vincent" ventilating lamp with an inverted Argand burner.

Fig. 98 is Clark's patent recuperative burner. The air supplied to both of these lamps is heated by means of the products of combustion, and the resulting light is very brilliant and effective.

Fig. 99 is one of Sugg's patent sun-lights, in which the gas is supplied in a cool state to the burner, and thereby it is prevented from choking up, and a much better illuminating power is obtained.

Fig. 100 is one of Strode's sun-burners.

VENTILATING LIGHTS



CHAPTER VIII.

COOKING BY GAS.

Of the uses to which gas can be put in promoting domestic comfort, one of the most interesting to housekeepers is undoubtedly that in connection with the preparation of food. In these operations rich and poor alike will find its aid invaluable in point of economy as well as in readiness and certainty.

Gas cooking invaluable to rich and poor.

To those who, like the author of this work, have been for many years accustomed to eat food cooked entirely by gas, it is a matter of surprise that it has not been much more extensively adopted by the general public. For roasting it is unrivalled; and where joints cooked to perfection by gas are compared, on the points of flavour, juiciness, appearance, and weight, with those roasted, under the superintendence of a professional cook, before a coal fire, it will be found that the gas-cooked meat will suffer nothing by the comparison. Roasting is considered by *gourmets* to be an operation so difficult to perform successfully, that the French proverb

For roasting gas is unrivalled.

says, "*On devient cuisinier, mais on naît rôtisseur*" —One becomes a cook, but one is born a roaster.

Plain cooks can roast with the aid of gas more easily, and with less waste than with coal fires.

With the aid of gas an ordinary plain cook can roast a joint of meat or piece of game to a turn, without as much loss of weight as would result from cooking it before a fire; and this with no more trouble than that involved in lighting up the gas in the Roaster, regulating the heat once or twice, so as to finish the operation exactly at the time required, and serving it up straight from the Roaster to the table. This has been done with great regularity in the author's kitchen for more than twenty years, and during that period not a single joint or piece of poultry has been a failure, although from time to time servants new to this mode of cooking have taken the matter in hand.

The Smoke Abatement Committee of 1882, in their examination of a variety of gas kitcheners and cooking-stoves, classified them in the following order:—

Classification of stoves by Smoke Abatement Committee.

Type 1.—"Having jets of luminous gas placed inside at the bottom."

Type 2.—"Luminous jets inside at the top, from which the heat was communicated by radiation and by reflection."

Type 3.—"Either luminous or atmospheric jets outside the oven."

Type 4.—"Atmospheric jets inside at the bottom."

Taken in this order, the only one of its kind with luminous flames only was Sugg's "Parisian"

Roaster, made in copper. In figs. 101 and 102 respectively the apparatus is shown open and closed. Sugg's "Parisian" roaster.

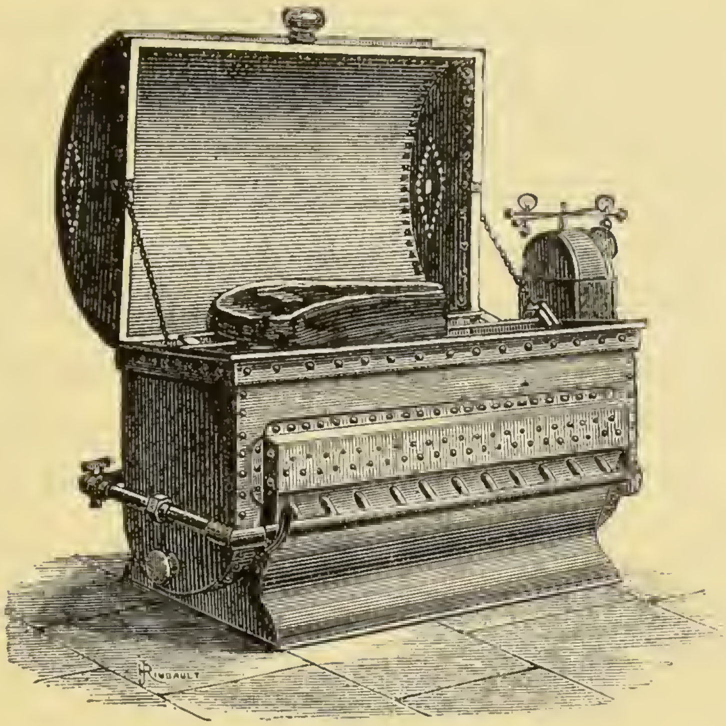


Fig. 101.

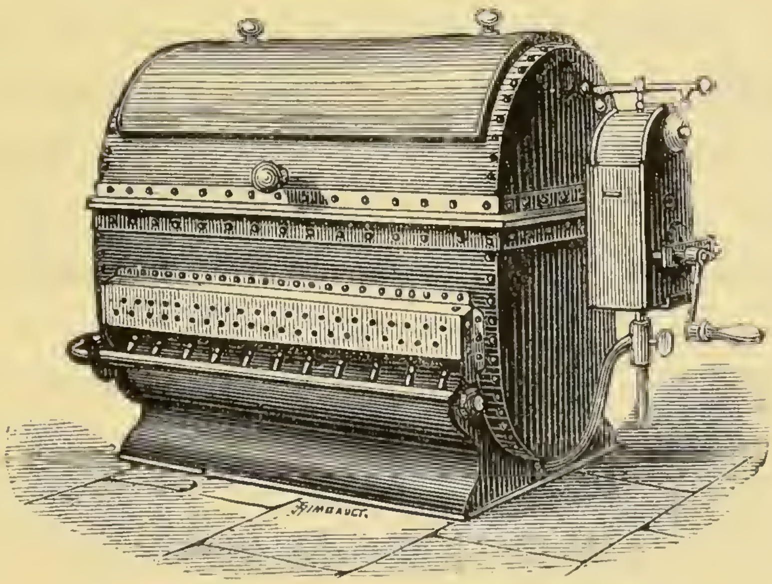


Fig. 102.

This Roaster is an improved model of one which has been in daily use by the author during the period already mentioned. In the operation of roasting it has always been placed on the kitchen table, without any flue or communication with the chimney. No smell is produced by this simple method, except the agreeable odour of roast meat when nearly done. No ill effects of any kind whatever have ever resulted from the products of combustion (carbonic acid largely diluted with atmospheric air), the quantity of which is about the same as that produced by the use of three of the ordinary fishtail burners, such as are employed in kitcheners. The reason for the absence of disagreeable smell is that the heat used for cooking is afforded by two rows of small fishtails burning with luminous flames, one row on each side of the Roaster.* There is very marked difference between the action of a roaster made of copper and one made of iron. The former maintains the heat in the interior of the Roaster with a smaller quantity of gas, giving off much less heat from the outside. At the same time the durability of copper is immensely beyond that of iron. The author has

Products of combustion not hurtful.

Durability of copper.

* The pioneers of cooking by gas—James Sharp, of Southampton, William King, of Liverpool, and Ebenezer Goddard, of Ipswich—always used luminous jets of gas. The celebrated *chef*, Alexis Soyer, roasted a bullock whole, at South Kensington, by gas, with an apparatus very similar to the roaster described. *À propos* of roasting bullocks, the records of St. Margaret's Church, Westminster, tell us that Anthony Sugg (an ancestor of the author) roasted a bullock whole on the Thames, during the great frost. It does not, however, say that he did this with the aid of gas. His present descendant would certainly use it.

found that steel is much better than iron for lining kitcheners, but is not nearly so good as copper.

The engravings show one row of burners; the other being in a precisely similar position at the back of the apparatus. All the burners are governed by a specially-made governor, which forms part of the Roaster, and thus the consumption of gas is automatically maintained at any desired point during the operation, notwithstanding that the street pressures may change or other jets be lighted up or put out in the building. To render this regulation still more a matter of certainty, the Roaster can be provided with a Joslin indicator (as shown on page 57), fitted with a table of degrees of temperature, so that at a glance it will show the rate of consumption of the gas, and approximately the temperature produced by that consumption.

All the burners are governed.

Joslin's indicator made to show approximate temperature.

The meat to be roasted is spitted on a thin steel spit, made to carry from small joints up to 50 lbs. of meat, according to the size of the Roaster. This is turned by a clockwork running train jack, commonly known in France as a *tournebroche*. The roasting chamber opens in two halves, as seen in the engravings, the bearings of the spit being in the lower half. The dripping-pan is so placed below the burners that the fat or gravy does not burn, but is always clear and good. The value of this arrangement will be at once apparent to all housekeepers.

Turnspit arrangement.

Fat does not burn.

An examination of the Roaster will demonstrate that the meat is cooked by radiated heat in a current

Meat is cooked by radiated heat.

of fresh air, as it would be before a properly made-up fire. A rapid circulation is induced by means of the two rows of burners, the flames from which play into the longitudinal openings on each side of the chamber. The large perforated openings at the top, at each end of the chamber, are the ventilators. The products of combustion from these luminous flames—simply carbonic acid largely diluted with fresh air—can in no wise prejudicially affect the meat; in fact, it may fairly be said that by no other means is it possible to roast so well, so certainly, and with so little waste.

Economy.

On the score of economy, it will be at once acknowledged, after trial, that although the cost of gas might be considerably more than it is, and much above (which it is not) the cost for coals for a fire doing the same amount of work, yet the certainty of the result, and the absence of loss from spoiled joints, or a too abundant production of dripping, would even then leave a tangible balance in favour of roasting on this system.*

Let any one compare the joints which are baked in modern coal kitcheners, or in improperly ventilated gas ovens,† with the fresh, well-cooked, nicely

* Calculating from the average of nineteen coal-burning kitcheners, tried by the Smoke Abatement Committee in 1882, it appears that they burn from 18 to 20 lbs. of coal, costing about 2d., to do the work done by this Gas Roaster.

† Above all, those cooked in some of the large ovens now used in hotels and restaurants, in which beef, mutton, pork, tart, pies, and fowls are all baked together into one average flavour.

browned joint or poultry roasted in such an apparatus as this just described, and it will be seen that, in the matter of roasted meat alone, gas properly used will prove a great boon to the general public.

As a sample of the daily practical working of this Roaster in a family, under the care of a plain cook, the average results of roasting eighty 10 to 12 lb. joints of beef and mutton show that, at the rate of $6\frac{1}{2}$ lbs. per hour, the meat is thoroughly done and browned, with an expenditure of from five farthings to a little more than three halfpence for gas. Result and cost of cooking by this apparatus.

The average difference in weight between the raw and cooked meat does not exceed 11 per cent.; and this might be reduced to 10 per cent. if those joints which had unavoidably to remain in the Roaster about half an hour after they were done, before being served up, were eliminated from the calculation.

It is here necessary to observe that there will be no difficulty in demonstrating that the same amount of work can be done with a saving of from one farthing to nearly a halfpenny in the gas used, according to the amount of fresh air passed through the apparatus during the process of cooking. Question as to quantity of gas used. But the opinion of the author, confirmed by many hundreds of trials, is that no saving in gas, to the utmost extent possible in these operations, produced by restricting the ventilation of the Roaster, will be found to compensate No real saving with less gas used if weight or flavour of meat suffers.

for the loss in weight, after cooking, and deterioration in the flavour of the meat. Meat so cooked is not roasted, but baked.

Illustration of waste.

As an illustration on the point of waste, a 12 lb. joint, or 192 oz. of prime meat, at present prices cost ¾d. per ounce, and the gas to roast it properly in the Roaster described, with thorough ventilation, costs, at the outside (including heating up ready for work), 1¾d.—say 2d. If the operation is (as it can be) done with a difference in weight between the raw and the cooked meat of only 19½ oz., or 10 per cent. = 1s. 2d., with a consumption of gas costing 2d., the housekeeper will have paid 1s. 4d. to prepare 172½ oz. of meat for the table; the total cost of the cooked meat being 0·84d. per ounce.

But if the loss in weight with a coal kitchener or improperly constructed gas-stove is 20 per cent., or 39 oz., = 2s. 5¼d. *plus* (say) only 1d. for gas or coal, then the housekeeper has paid 2s. 6¼d. to prepare only 153 oz. of meat ready for table; the total cost of the cooked meat being 0·95d. per ounce, or 13¼ per cent. more than it cost in the former case, notwithstanding the saving of 1d. in the fuel account.* In fact, a loss of only 1 oz. in the weight, or about half per cent. differ-

* In the trials of coal kitcheners, conducted by the Smoke Abatement Committee in 1882, a number of them averaged a loss of weight, between raw and cooked meat, of more than 25 per cent.

ence between the raw and cooked meat, caused by fuel unscientifically used, will entirely dispose of any possible apparent economy effected in either gas or coal.

The element of dripping has not been considered in these calculations, because, firstly, the object in view is not to produce dripping. At its best, dripping is not more than half the value of the meat; and even this estimate depends on the state in which it comes out of the operation. The object to be kept in view in roasting meat is the retention in it of as much of its juice as possible, and this is best effected—as our ancestors discovered ages ago—by rotating it at a certain rate before the source of heat. Thus the fat and delicate juices brought out by the heat do not drop off at once, but are carried round with the meat, "basting" it, as it is called—keeping it from drying up—and further sealing up the nutritious juices which will otherwise to a considerable extent be lost.

Object of roasting meat.

The constructors of some of the modern cooking apparatus appear to have been inspired not by the learned cooks of ancient times, but rather by those cooks of whom the old proverb says their antecedents are sulphurous. It is therefore time that the more scientific aid of gas should be brought into requisition, so as to prevent really wholesome, nourishing roast meat from disappearing altogether from the *menu*.

But notwithstanding all that has been said relative to the advantages of roasting by gas in such an apparatus as that described, there will be many connoisseurs of roast meat who will not be convinced that anything can equal roasting before an open red fire, with a screen at the back of the meat to keep off cold draughts of air. To these the author recommends a gas roasting-fire, made similarly to that shown in fig. 102A, on Plate 30, but with a large deep grill.

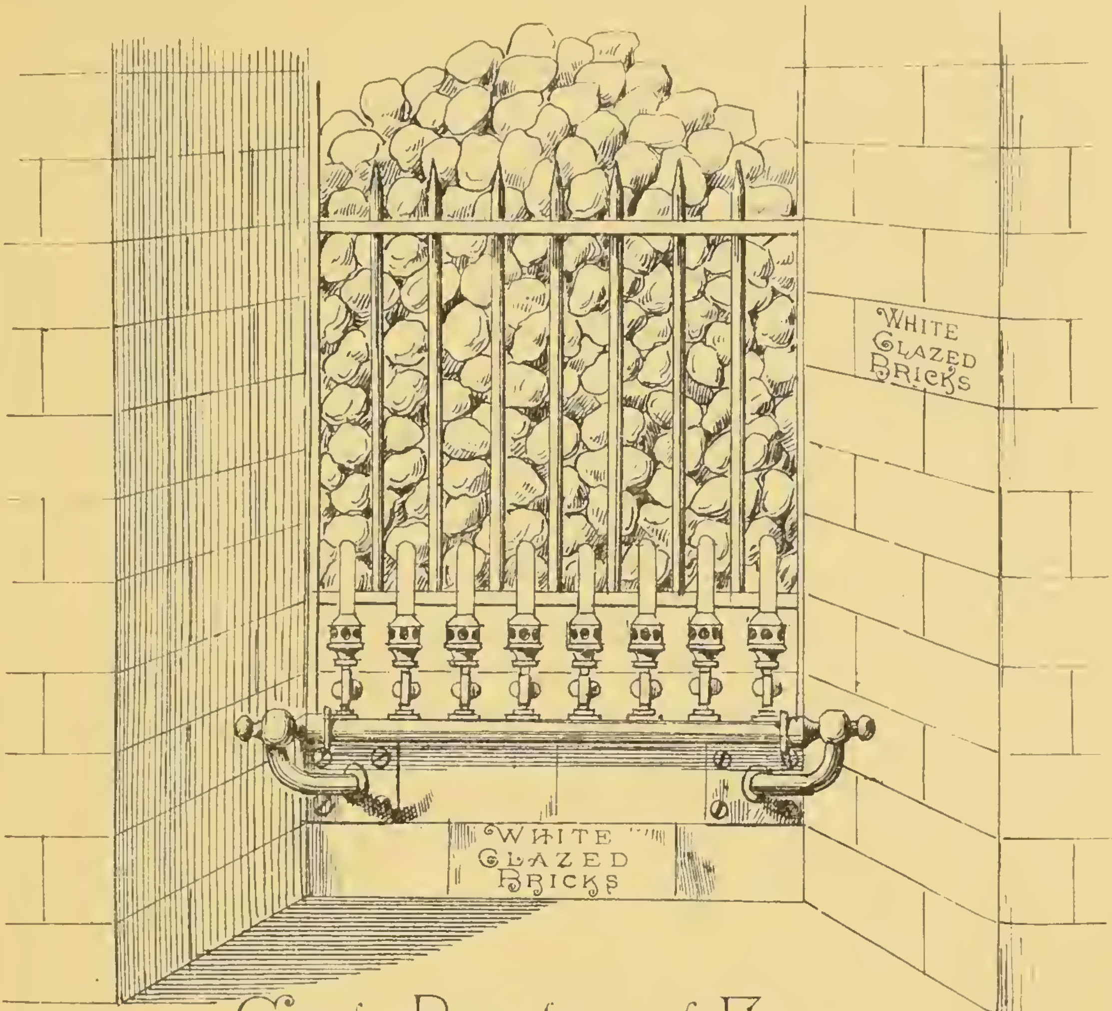
Gas roasting-fire.

Here is a constant radiant fire, never requiring to be made up, always at a suitable temperature, and capable of being made narrow or wide by turning on more or less burners as required. Such a fire must fulfil all the requirements of a professional roaster, and will be found frequently less expensive than the coal fires now used. The meat is placed before it on a *tournebroche* spit, and a screen put at the back of it, as usual with a coal fire for roasting. The absence of dirt, soot, and falling cinders, together with the perfect regularity of the heat from it, without any attention, will alone be sufficient to render its adoption in the place of coal fires a mere matter of time.

BAKING AND PATISSERIE.

Four portatif heated by gas.

For these purposes the old French cookery-books recommend the "*Four portatif*" as being the best for private families. This portable oven was heated



GAS ROASTING FIRE.
WITH INDESTRUCTIBLE FUEL
Fig. 102a

TOWEL HEATER.

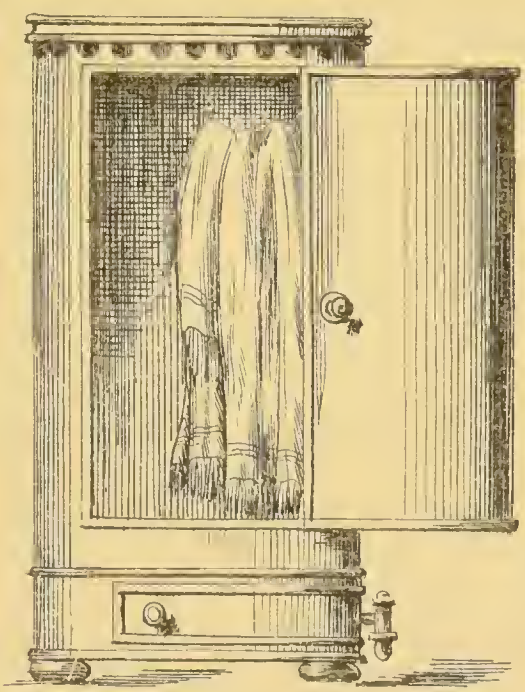


Fig. 116

[7357]

with wood or charcoal; but the author has modified it, and converted it into an oven heated by the luminous flames of a number of jets of pure gas instead of wood or charcoal, and thus made it one of the

SUGG'S "VIENNA" BREAD OR PASTRY OVEN.

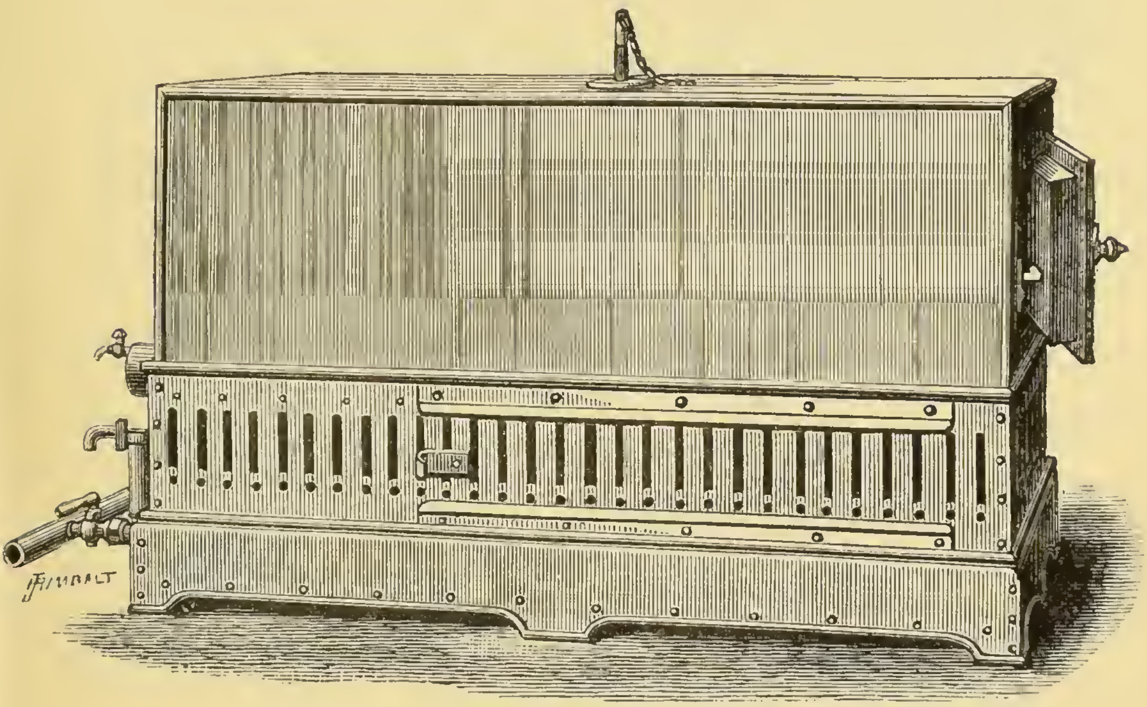


Fig. 103.

most useful appliances for the kitchen. This, therefore, also belongs to Type 1. Like the Roaster, it may be used on the table or dresser, if required; there being no disagreeable smell or hurtful products from it.

Fig. 103 is an engraving of Sugg's "Vienna" Bread or Pastry Oven. The heat from the burners (which are placed in the chamber forming the lower

Sugg's Vienna Oven.

portion of the apparatus, and supplied with air through the openings shown in the engraving) circulates under the bottom, round the sides, and over the top of the oven. This is a close chamber placed within the outer case, with quite sufficient space all round between it and the outer casing to permit of this circulation. The exit for the products of combustion from the burners, as well as the spent air, is by the top of the oven, through an opening round about the small tube shown in the engraving. This small tube communicates directly with the interior of the oven, and is used when necessary to let out the steam.

A small copper boiler, forming part of the apparatus, is placed outside the chamber, conveniently for use. This boiler serves to generate a small quantity of steam, used for a short time only in baking Vienna bread and some sorts of pastry, for the purpose of glazing it. A very simple arrangement serves at the same time as a funnel for filling the boiler, and as a safety-valve to prevent any undue accumulation of steam, if the cook forgets to shut off the gas when the boiler is no longer in use.

The temperature of the oven at the top, maintained at a constant rate as long as required, can be raised as high as 700° Fahr., or lowered to any degree, by simply turning on or off the tap of the gas supply. The lower part is tiled, so that almost all the heating is done from the top and sides.

The supply of gas to the luminous jets constituting the source of heat is regulated by an automatic governor, as described in the chapter on Governors, and is also fitted with a Joslin indicator of consumption and temperature. Thus the heat is at all times perfectly under control; and the cook has only to study her pastry, &c., without any anxiety whatever as to the cooking of it. With the aid of gas thus arranged the latter is merely a mechanical operation.

Regulated supply of gas.

The interior of the oven is 26 in. long, 11 in. wide, and 6 in. to 8 in. high, or very nearly the dimensions recommended by the French cookery-books as being the best for domestic use. The finest Vienna bread and the most delicate pastry can be successfully produced by the aid of this improved gas oven, as well as it ever could have been done by the "*Four portatif*" under the supervision of an experienced *chef*. To the *chef de cuisine* this little oven will be found invaluable.

Dimensions of oven.

This oven, like the Roaster, gives the best results when made in copper.

Sugg's Patent "Charing Cross" Kitchener, fig. 104, belonging also to Type 1, has been designed by the author to meet the requirements of families who have not room enough for the separate parts of a cooking apparatus, such as described in the preceding pages, sufficient to do all the roasting, baking, and boiling for any number of persons from six to twenty. It is also intended to meet the

Sugg's Charing Cross kitchener.

requirements of gas companies who let out gas kitcheners on hire for a very small sum per quarter, and who desire as much as possible to have but one piece of apparatus to deal with.

Principles on which it is constructed.

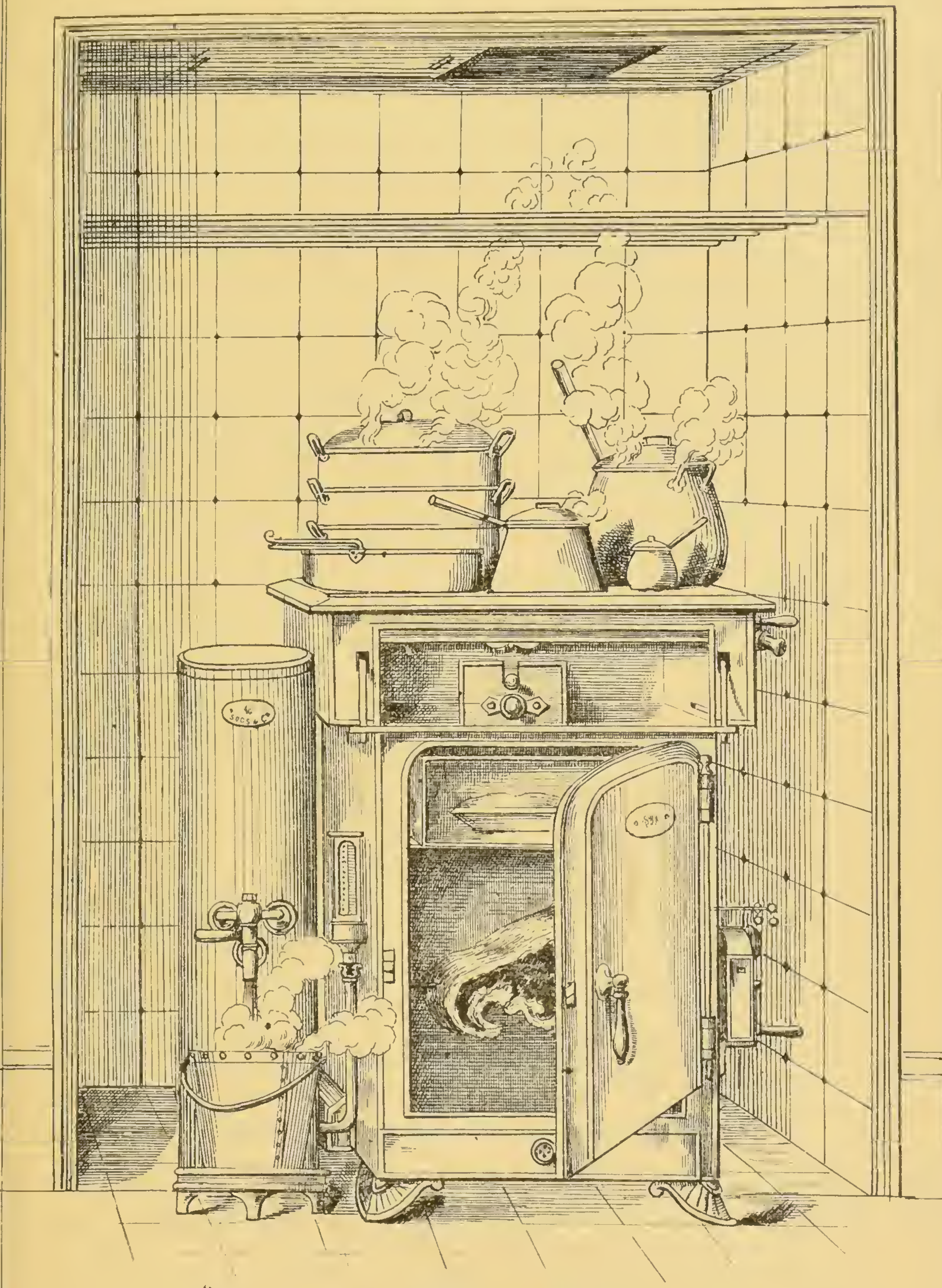
The principles upon which it is constructed are in accordance with those already spoken of in the preceding pages, viz.:—

1st.—All the heat required for both boiling and roasting is produced from the combustion of pure gas in luminous flames of either the fishtail or jet type. No mixture of air and gas is used.

2nd.—The roasting chamber is thoroughly ventilated, and the work is done by means of a current of heated air always circulating through it, and which cannot be closed either by accident or design.

3rd.—The quantity of gas used in roasting is regulated by an automatic governor provided with an indicator of consumption and temperature.

4th.—The fine pastry baking is done in a close oven which fits into the roaster. The heat passes round this as in the Vienna oven. At the same time, when the kitchener is used only for baking, this close oven may be taken out, and the shelves used as shown in the engraving.



THE "CHARING CROSS" KITCHENER.

Fig: 104.

5th.—The meat can be suspended, laid on the grid, or revolved by the *tournebroche*, as may be desired.

The dripping-pan is made of either brass* or enamelled iron.

The top of the kitchener is provided with four ring burners, each regulated by a separate tap, and, after adjustment, maintained at any degree, from a blue light to full on, as may be required, by the automatic governor before spoken of. One of the rings is especially arranged for frying whitebait or other fish in oil or any other suitable *friture*, and a special cast-iron kettle and proper cover are provided for the purpose. Thus arranged, this excellent system of cooking fish, so impracticable upon an ordinary coal fire or kitchener, is perfectly easy and certain. The temperature of the oil cannot go beyond 500°, and it may be kept at 400° or 450° to a certainty, because the quantity of gas fixed by the cook will not be affected by variations of pressure. The three other burners are smaller, with similar arrangements for regulating the consumption of gas.

There is also a separate griller, in the burner box above the roasting chamber, for cooking a chop

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* Brass or copper is much cleaner and better than iron for this purpose. There is no danger at all in the use of it. It will not corrode if wiped out, while warm, with a greasy cloth.

or steak at a moment's notice. It is provided with an enamelled grid and dripping pan.

Flash-lights.

Each of the four burners, the griller, and the roaster are provided with separate flash-lights, one to each; and these are all lighted ready for use at any time when the kitchener may be required. The consumption of these lights does not exceed $1\frac{1}{4}$ cubic feet of gas per hour, and if kept alight all day will consume only 30 cubic feet, costing 0·9d. —say, 1d.—per day. The object of this arrangement is twofold. First, every burner in the kitchener is ready for use at once, without having to seek for matches for lighting, and it lights up immediately the gas is turned on; therefore there is no necessity to turn down the burners or leave them full on, as is frequently done, *because they are going to be used again in a short time*, but the moment they are done with, if only for a few minutes, they can be turned out.

Great saving is effected by the use of flash-lights.

Cooks will soon acquire the habit of turning out the burners altogether, instead of turning them down, when they know they can always have them lighted up again without trouble by merely turning on the gas. Further than this, *au moment du coup de feu*, when the dinner is being got ready to be served up, there is often no time to seek for matches or paper to light a burner, when it is suddenly wanted for a few minutes. Secondly, if a burner is turned on by accident during the hurry, it simply lights up, and is immediately discovered.

The outside of the kitchener can, if desired, be enamelled grey or black, in order to avoid the use of blacklead or oil for cleaning it up. It will always look clean and tidy if just wiped inside and out with a cloth, while it is warm, after being used. The lining of this kitchener is made, by preference, of copper or enamelled iron.

Cleanliness of kitchener.

The average of a number of days' cooking, by a plain cook, with this kitchener, for a clerks' dining club of from 20 to 23 persons, shows that the loss in weight between raw and cooked meat does not exceed from 10 to 11 per cent., and the rate of cooking is $6\frac{1}{2}$ lbs. per hour. The heating up of the roaster takes about 8 minutes, but it is always kept warm by the flash-jets.

Slight loss in weight of meat by its use.

The cost of gas for cooking the entire dinner, consisting of 10 to 12 lbs. of roast meat, 10 to 12 lbs. of boiled potatoes, large pies or puddings, and a corresponding amount of other vegetables, averages from 2d. to $2\frac{1}{4}$d., including heating up. The meat is required to be thoroughly cooked to the bone, because the whole is carved up.

Cost of cooking.

When the gas kitchener is fixed in the manner shown on Plate 31, with tiled hearth, it forms a most useful, clean, and ornamental-looking apparatus, and effectually banishes those pests of the kitchen—blackbeetles, soot, cinders, and dust.

In order to avoid the occasional failures from want of pressure of gas which sometimes occur on Sundays, holidays, and very foggy weather, the

Work at lowest pressure given by gas company.

Roaster, "Vienna" Oven, and "Charing Cross" Kitchener, are all made to do their full work with a pressure not greater than 8/10ths of an inch.

Gas kitchener, which can be used to warm the kitchen as well as for cooking purposes.

In many houses, the gas kitchener (or cooker, as it is sometimes called), is placed in a back kitchen, and used mostly in summer. In winter it is not so much employed, because it will not warm the kitchen, excepting at the time when it is used for cooking; and even then—every care having been taken in its construction, to prevent the radiation of heat—it is not very effective. To meet the case in which the gas kitchener is required to replace the coal kitchener, and thus keep the kitchen as clean and neat in the winter as in summer, the author has devised that shown in fig. 105, Plate 32, which is suitable for a family or a hotel.

Sugg's combined kitchener, heated entirely with gas, to replace coal kitchener.

At the left is a gas-fire on the principle of that described on page 118 provided with 6 burners, each burner regulated by an automatic governor to consume 6 feet of gas per hour; so that any one, or a number, can be turned off without in any way affecting those which are left burning. A screen which fits against the front of the grate, fitted with a clockwork *tournebroche*, enables it to be used for roasting as before an open fire—considered by some the best and only successful means of roasting. The other side is a "Charing Cross Kitchener" as described on page 121. In the centre is the boiler, heated by luminous flames, which is so arranged that the act of turning on the tap to draw off hot water (which

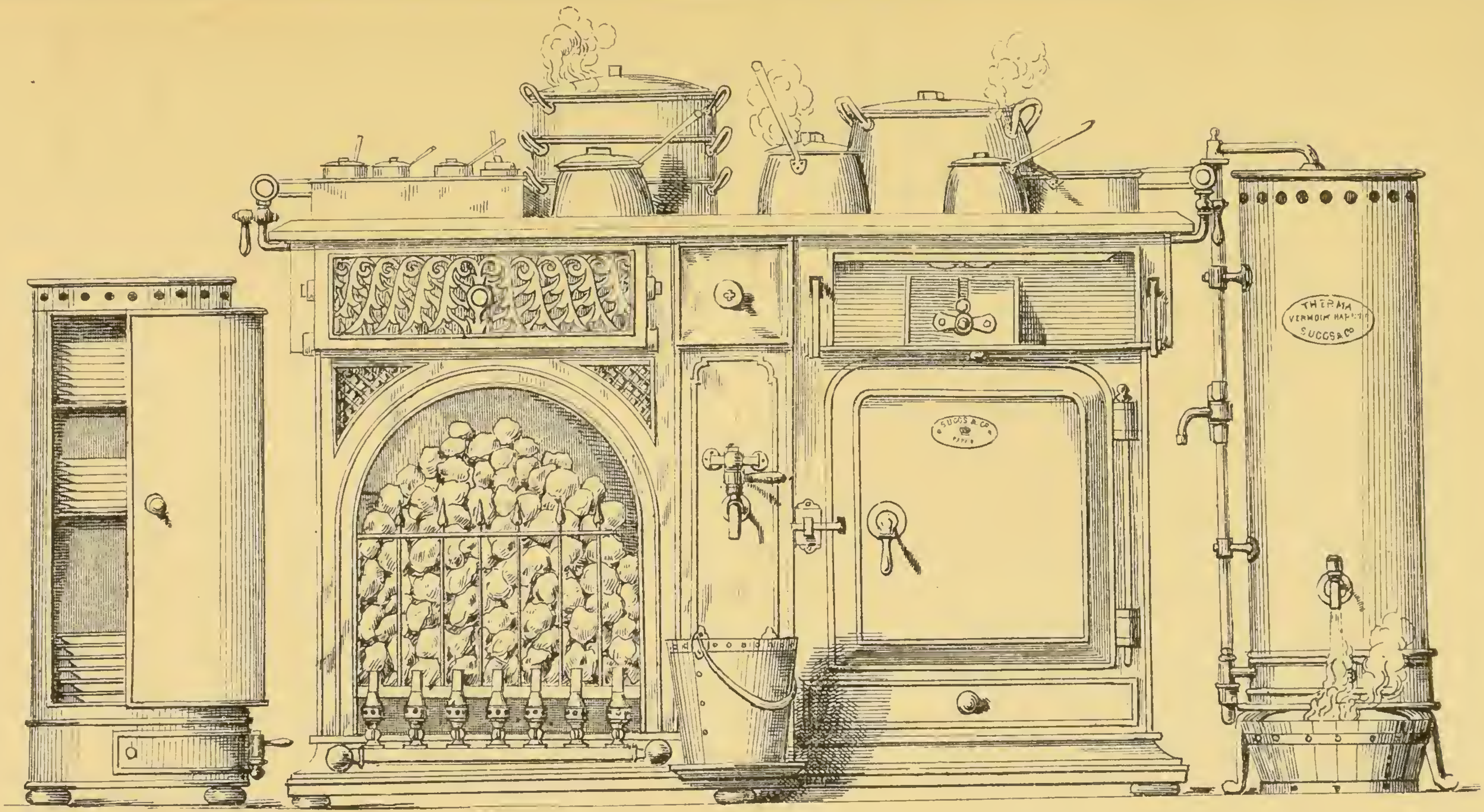


PLATE WARMER. Fig: 106

SUGG'S GAS KITCHENER. Fig: 105.

NOTE. The Roasting Screen is omitted so that the construction of the Fire can be seen.

THERMA. Fig: 115.

To face p 126

flows direct from the top of the boiler) lets in the cold water at the bottom. The former being the lighter, rises as the cold flows in, and may be completely drawn out from the boiler without the incoming cold water mixing up with it.

Boiler arrangements in combined kitchen.

When it is fixed so that it projects into the room, as shown, it is further provided with another boiler, fixed at the back of the kitchener, heated by luminous jets of gas. This takes the place of the hot-water supply apparatus to the baths and lavatories which is often fitted to coal kitcheners. This arrangement added, everything that has been before done by the coal kitchener can now be performed by the gas kitchener which replaces it.

Cost of gas.

The cost of gas for such an apparatus, to do the cooking for a large family, and preparing an elaborate *menu*—consisting of soup, fish, two or three *entrées*, roasts, game, and pastry—will certainly not be so much as that of most of the coal ranged made to do an equal amount of work. The very great amount of labour, in keeping up the fire and cleaning up, involved in the use of coal fires, will largely affect the question of comparative cost between coal and gas in the favour of the latter.

Gas plate-warmer.

That very important element of success in good dinners—hot plates—is easily and inexpensively provided by a simple gas plate-warmer, fig. 106. In this the temperature, properly regulated by an automatic governor, prevents the cracking and starring of valuable dinner services by the irregular heat of ovens, and always ensures an equal heat all over the plate.

Type 1, Waddell and Main's.

* The only other example of Type 1 tried by the Committee is Waddell and Main's, fig. 107 ("Universal Domestic"), four rows of jets, one at each side, and front and at back, lined with fire tile.

Type 2, Billing and Co.

Type 2.—Billing and Co., fig. 108. Reflector stove, having luminous jets at the top, for which a row of holes is made in a pipe. Half of the jets can be lit at a time. Atmospheric gas is used for boiling, &c. No extra casing.

Type 3, Stark and Co.

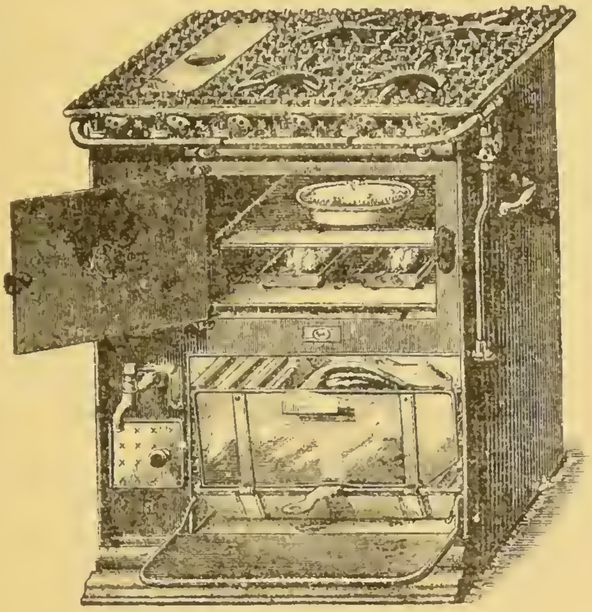
Type 3.—Stark and Co., fig. 109. Two rows of luminous fishtail jets, framed to swing outwards or under the oven as required. Atmospheric gas is used for boiling purposes. The stove is encased with slag-wool, 2 inches in thickness.

Type 3, Dean and Son.

Dean and Son, fig. 110. This is heated by two atmospheric burners, one to the right at the bottom, and one to the left at the top, so that the temperatures at the top and the bottom can be regulated independently. The flame of the lower burner circulates through a flue covering the bottom of the oven, the left-hand side, and part of the back. The flame of the upper burner circulates between the top of the oven and a hot-plate, from end to end, to and fro. The gas and air for combustion are mixed

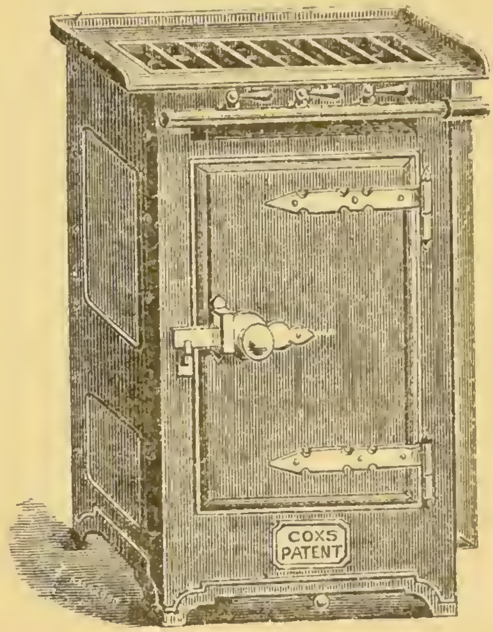
* The description of the stoves, as well as the engravings (with the one exception of fig. 108—Billing's) are taken from the Report of the Smoke Abatement Committee (edition of 1882), p. 109, and plates 45 to 48.

GAS COOKING STOVES.



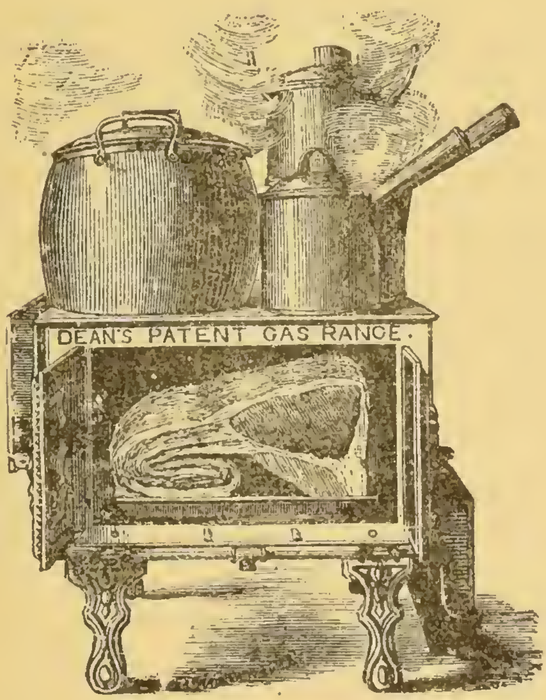
BILLING & Co.'s

Fig.108



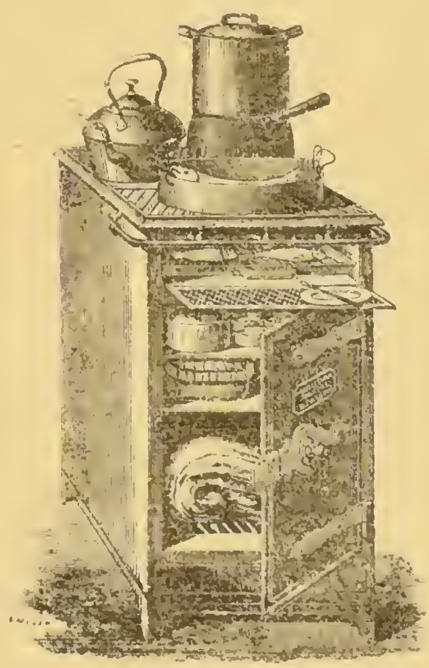
J. C. STARR & Co.

Fig.109



J. DEAN & SON'S

Fig.110

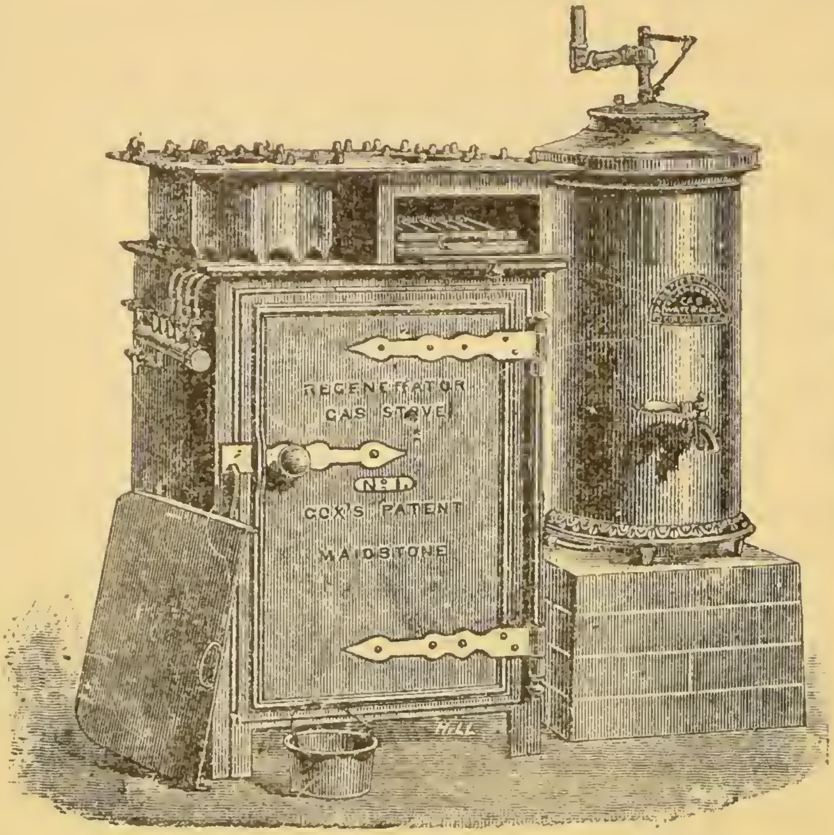


WADDELL & MAIN'S

Fig.107

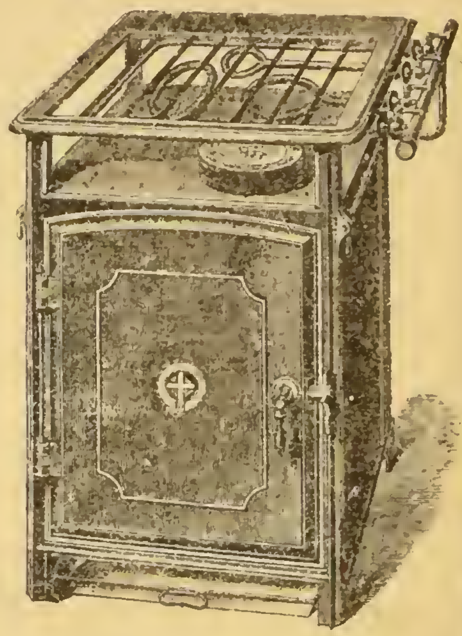
The above Drawings (with the exception of Fig. 108) are reduced copies of plates published in the Official Report of the Smoke Abatement Committee, 1882.

GAS COOKING STOVES



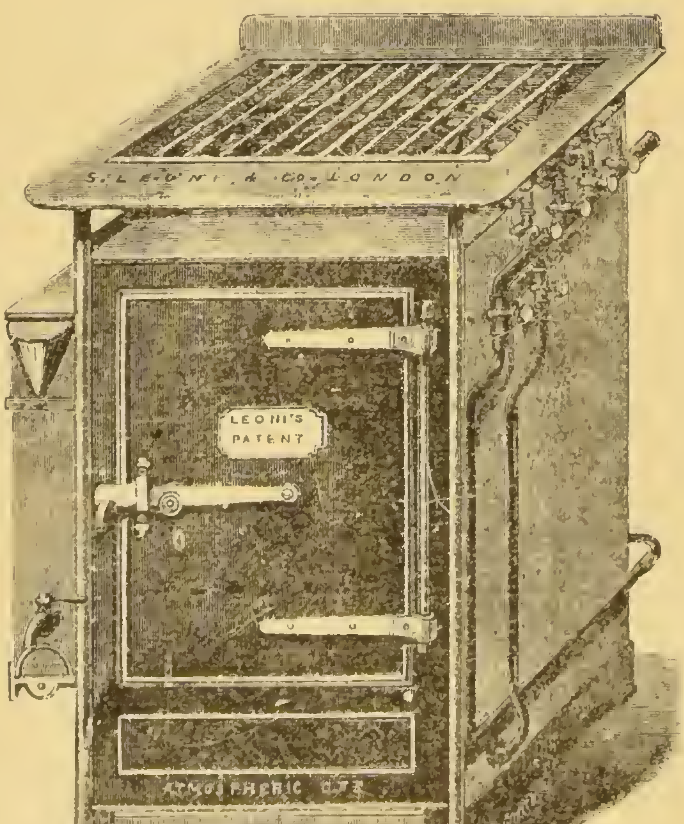
C. J. COX'S

Fig. 111



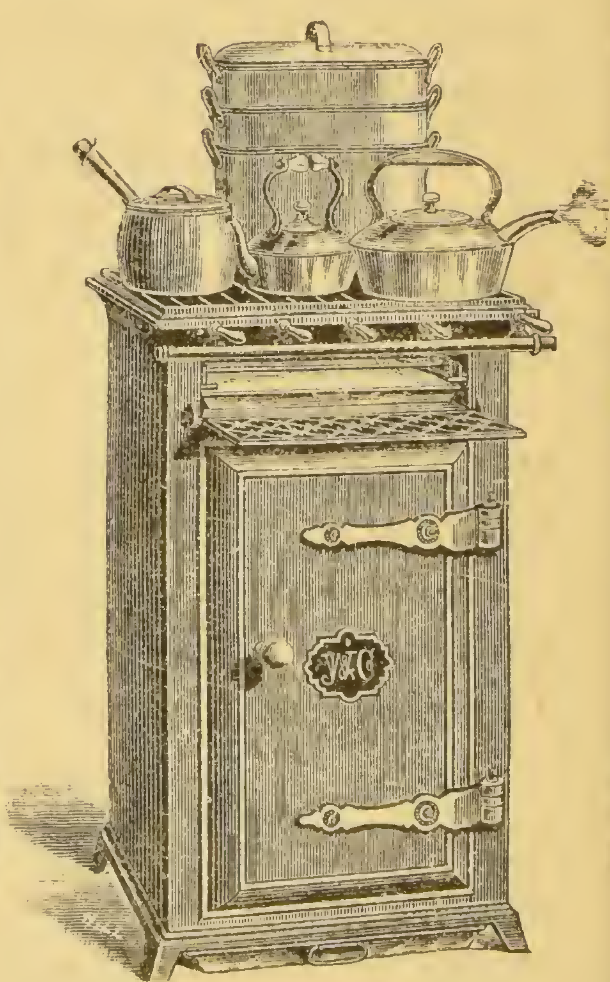
H. & C. DAVIS & Co.

Fig. 112



S. LEONI & Co.'s

Fig. 113



JOHN WRIGHT & Co.'s

Fig. 114

The above Drawings are reduced copies of plates published in the Official Report of the Smoke Abatement Committee, 1882.

Plate 34.

To face p 129

in a chamber covering the other part of the back of the oven. The burners are 12 in. long, 6 in. deep, and $1\frac{1}{8}$ in. wide, on the principle of the Davy lamp reversed, so that there is no lighting back. They give a sheet of flame $11\frac{1}{2}$ inches by $\frac{3}{4}$ inch wide, and from 4 inches to 6 inches high.

Type 4.—Atmospheric jets inside at the bottom:

G. J. Cox (fig. 111). Regenerator gas-stove. One side of the oven is coated with slag-wool; the other side is formed with an air space, in which the air for supplying the burners is previously heated. Three rows of atmospheric jets are placed at the sides and back, inside. Luminous jets at the top for boiling, &c. Encased with slag-wool 2 inches in thickness. Type 4, Cox and Co.

H. and C. Davis and Co. (fig. 112). Two rows of atmospheric jets, one at each side. Atmospheric gas is used for boiling, &c. Encased with slag-wool $1\frac{1}{2}$ inches in thickness. Type 4, H. and C. Davis and Co.

S. Leoni and Co. (fig. 113). Three rows of atmospheric jets at the sides and back. Encased with slag-wool $\frac{3}{4}$ inch in thickness. Type 4, S. Leoni and Co.

J. Wright and Co. (fig. 114). Two rows of burners, one at each side. Encased with slag-wool $1\frac{1}{2}$ inches in thickness. Type 4, J. Wright and Co.

In this Report (p. 109), one of the kitcheners exhibited by the author is classed amongst Type 4; and it is stated that "two rows of atmospheric jets at the bottom, one on each side," are used, and atmospheric gas was used for boiling. This being so diametrically opposed to the system constantly advocated by the author, it is almost needless to say that it is erroneously described, and will be set right in the next edition of the Report. No other than luminous jets, consuming pure gas, are used in any of the author's kitcheners, excepting in that mentioned on page 118, which must (as in the case of the "Charing Cross" fire) be in communication with a chimney or flue.

Only luminous jets employed.

The author of this work, being distinctly a partisan and exponent of the luminous-flame system, thinks it only fair to say that the advocates of the mixed air and gas, or atmospheric-burner system, are numerous, are well supported in their views, and have achieved good results with their kitcheners.

The merits of both systems must be judged by the public who use the apparatus; and there is little doubt that some will give their verdict in favour of one, and some of the other. With either system it is, at least, certain that the preparation of food will be materially improved, and the comfort of housekeepers very considerably augmented.

The hot water for washing up (which is always, with coal kitcheners, so fruitful a source of annoyance and constant expense) is easily provided for in gas kitchen arrangements. Fig. 115 is a Therma, or instantaneous water-heater, invented by Mr. Vernon Harcourt, Professor of Chemistry at the University of Oxford. By the aid of this

Therma, for heating water instantaneously by gas.

useful apparatus a continuous stream of water, from 40 gallons and upwards per hour (according to the size of the Therma), heated to 120° Fahr., can be obtained at any moment by simply turning on the gas-tap, which at the same time turns on the water; a small flash-jet, consuming only about one quarter of a cubic foot of gas per hour, serving to light it up immediately the tap is turned on. Thus the expense of keeping a boiler always going, in case hot water may be wanted, is avoided. The apparatus can be placed over the kitchen sink, or in a bath room, nursery, or housemaid's closet; and thus the troublesome system of laying on hot-water pipes from the kitchen boiler all over the house may be dispensed with. Hot water can be obtained in summer or winter, whether the kitchen fire is alight or not. The advantage of this system

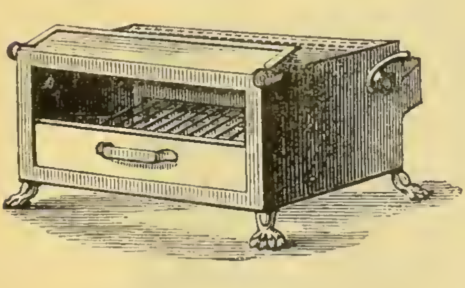


Fig. 117.

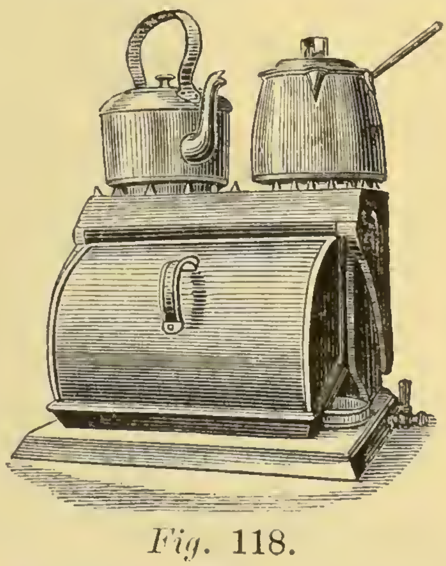


Fig. 118.

does not require to be insisted upon. The apparatus is simple, and can be readily taken to pieces to clean out when necessary.

A modified form of this very convenient apparatus will boil small quantities of water in the same rapid manner.

Towel drier. Fig. 116, Plate 30, is a Gas Towel-drying Closet; and fig. 117 (see page 131) is a Chop Griller.

Chop griller.

Bachelor's kitchener. Fig. 118 (see page 131) is a small Bachelor's Gas Kitchener, suitable for cooking chops, steaks, chickens, small pieces of meat, and at the same time boiling vegetables, &c.

The source of heat in these different apparatus is luminous gas-jets produced from burning pure gas.

Gas coffee roaster. Fig. 119 is an Automatic Coffee Roaster, worked entirely by gas, and by the aid of which any ordinary

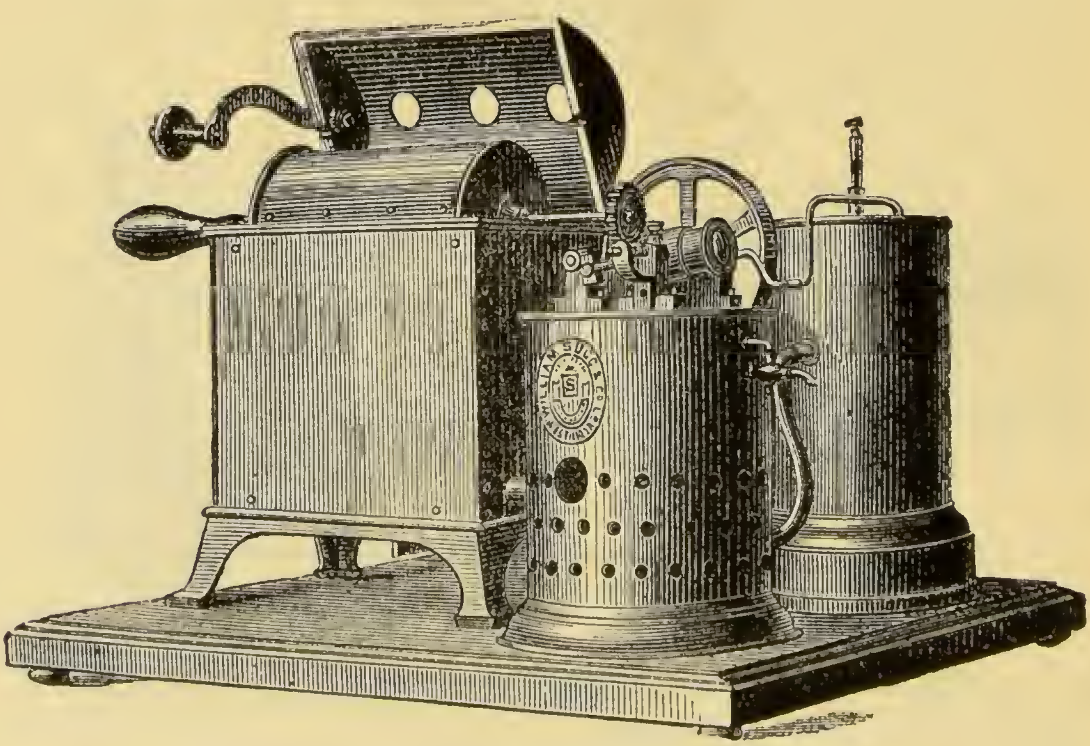


Fig. 119.

domestic may successfully perform the otherwise difficult operation of roasting coffee; and fig. 120 is a Platow's Coffee Urn, arranged for gas instead of spirits of wine.

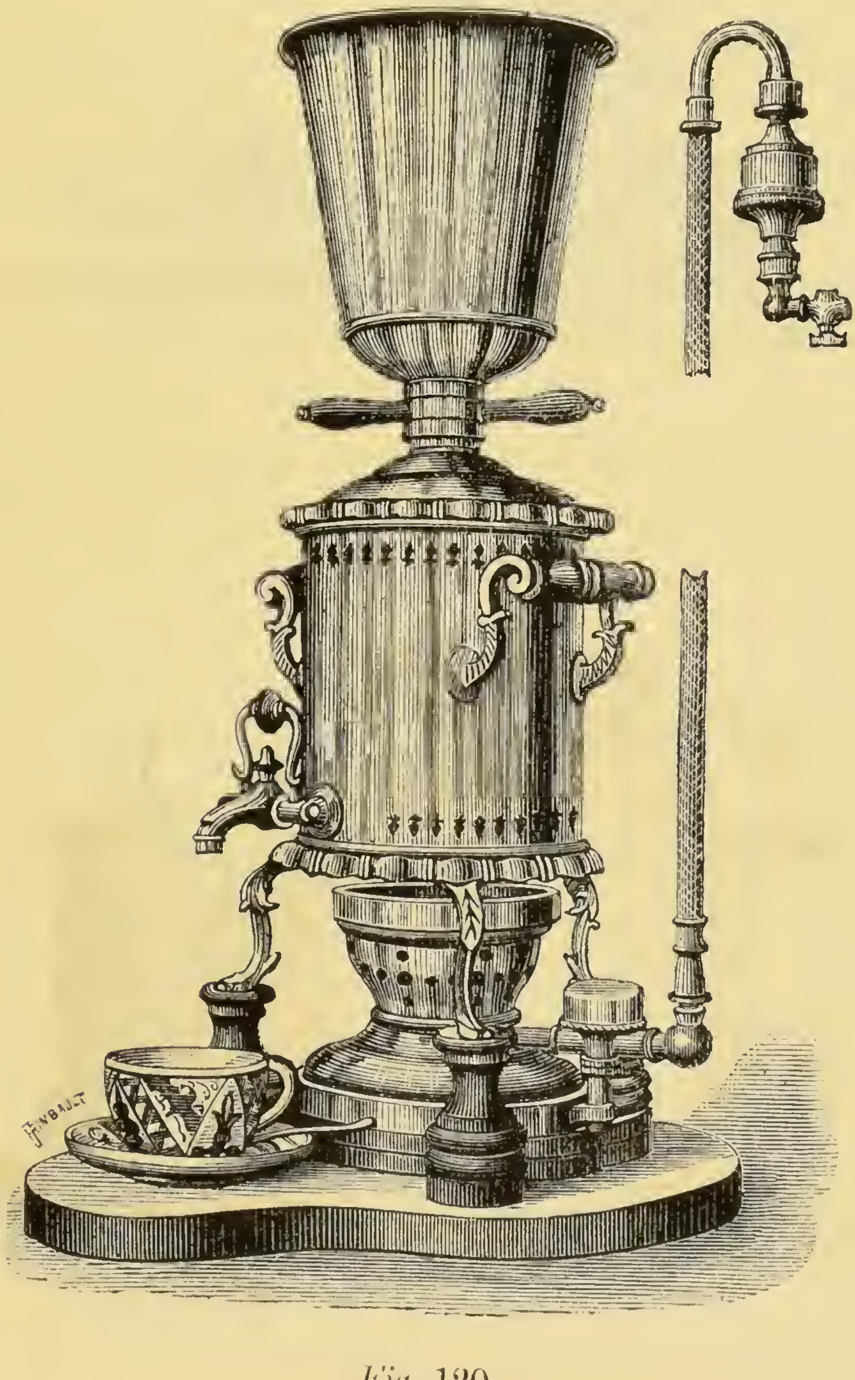


Fig. 120.

Fig. 121 is a Rapid Boiler for heating very rapidly a grog-kettle or small quantities of water.

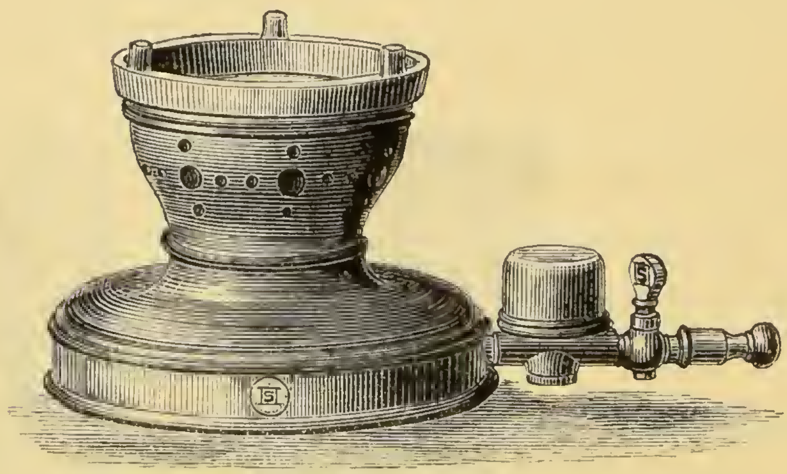


Fig. 121.

CHAPTER IX.

ARRANGEMENTS FOR VENTILATING AND WARMING.

Ventilation of the dining, drawing, and reception room.

THE ventilation of the dining, drawing, and reception rooms is a most important question, whether they are lighted by gas or not. In summer, as well as in winter, whenever a number of guests are assembled, the temperature of these rooms must necessarily become too high, unless means are available for admitting fresh cool air.

It is just on these occasions that the question of ventilation presents itself in the most disquieting manner. One of the most important subjects for the consideration of the host is how to regulate the temperature of these rooms.

Uncertainty of ventilating arrangements.

In this changeable climate it is impossible to prognosticate with any degree of certainty whether the evening will be hot or cold, windy or calm; and therefore arrangements which would be perfect in one state of the weather are simply failures in another.

For example, in winter it frequently happens that, in the anxiety to keep these rooms sufficiently warm, such precautions are taken that, with an unexpected increase in the temperature outside, they become insufferably hot about the middle of dinner. Then if the window is opened, a current of cold air comes in, which chills those who are near it, and is, in fact, extremely dangerous to their health. The fire on such occasions is sure to have burnt up splendidly during the dinner, and is hot enough to roast a sheep. It cannot be put out, nor can its heat be much diminished. The company bear it; but the host and hostess are most uncomfortable, not to say miserable.

Heat of room.

The change from the dining to the drawing room brings only a temporary relief, for this soon gets as hot as the dining-room was. The heat of the gas is complained of when there *is* gas, and when there is none the candles are declared to create *intense* heat. But, before attributing the cause of the discomfort to gas or candles, it should be first considered that the radiated heat from a few persons will very soon increase the temperature of the air of a room. And this more especially as in the majority of cases the builders have not troubled themselves to make any outlet for the purposes of ventilation, except the chimney.*

Not always attributable to gas or candles.

* Nothing would be easier if, when the house is being built, 3-inch drain pipes were buried in the wall, and carried up to the top of the house. These might be so fixed as to come within 8 feet of the floor of the drawing-room, and finish with an opening (to be utilized if required) for ventilating each of the lights placed round the room. The dining-room might also be provided with pipes in the same manner, with an opening to the middle of the ceiling.

Much has been said about the ventilating properties of the common chimney, and a very great deal of this is utterly misleading and erroneous. Whatever success the ancient "lum," or fireplace, with its enormous dimensions, and shaft open to the sky, achieved in the way of ventilation, the modern grate cannot be said to be in any way a success.

Ideas respecting the ventilating properties of the chimney, or fireplace.

The supply of air to the flue, which is in most cases required to be, with a good coal fire, not less than from 600 to 2000 cubic feet of air per hour, is drawn from the chinks of the windows and cracks of the door. It is principally by means of the space under the door that our modern builders achieve their success in ventilation. Sometimes the keyhole serves as a *most* efficient inlet for cold air. Mostly the windows may be relied on to do their fair share in providing the necessary amount of air to keep the fire going.

Coal fires require a large supply of fresh air to make them burn properly.

The usual inlets for air are cracks of doors and windows.

The only drawback to this style of ventilation (the only one that the builder of our modern houses will, as a rule, condescend to have anything to do with) is that those rapid currents of air are most disagreeable to any one sitting between the door or window and the fire.

In the line of these currents it is impossible, as a guest, to feel anything else than that you had better take a glass of something warm when you go to bed; or, if you are an abstainer, you prescribe for yourself a comfortable mustard-leaf and a basin of gruel. You accept with a certain amount of

Probable results of such defective ventilation.

resignation the cold in the head, the stiff neck, or the touch of rheumatism you are sure to get, out of respect to your host, and bearing in mind that in your own house the comfortable corner, out of the draught, is not known to everybody.

The author's experience of this kind of ventilation has been that, in a moderate-sized room, 23 feet by 14 feet, with a window at either end, it was a remarkable fact that in winter a good fire frequently made the room colder, and rendered it impossible to get out of the currents of air. The only way to sit in anything like comfort was to put on a fur-lined cloak; and yet the room was what might be called a good room, in a well-constructed, not too modern house.

Currents of cold air always converge to the fire.

There are thousands of houses like this in London and large provincial towns, which are leased or rented by the tenant, who has, therefore, to make the best he can of it, without laying out any more money than he can possibly help, as he is certain that his landlord will pay *nothing* towards any improvement, although he will accept it when it is done and the tenant leaves.

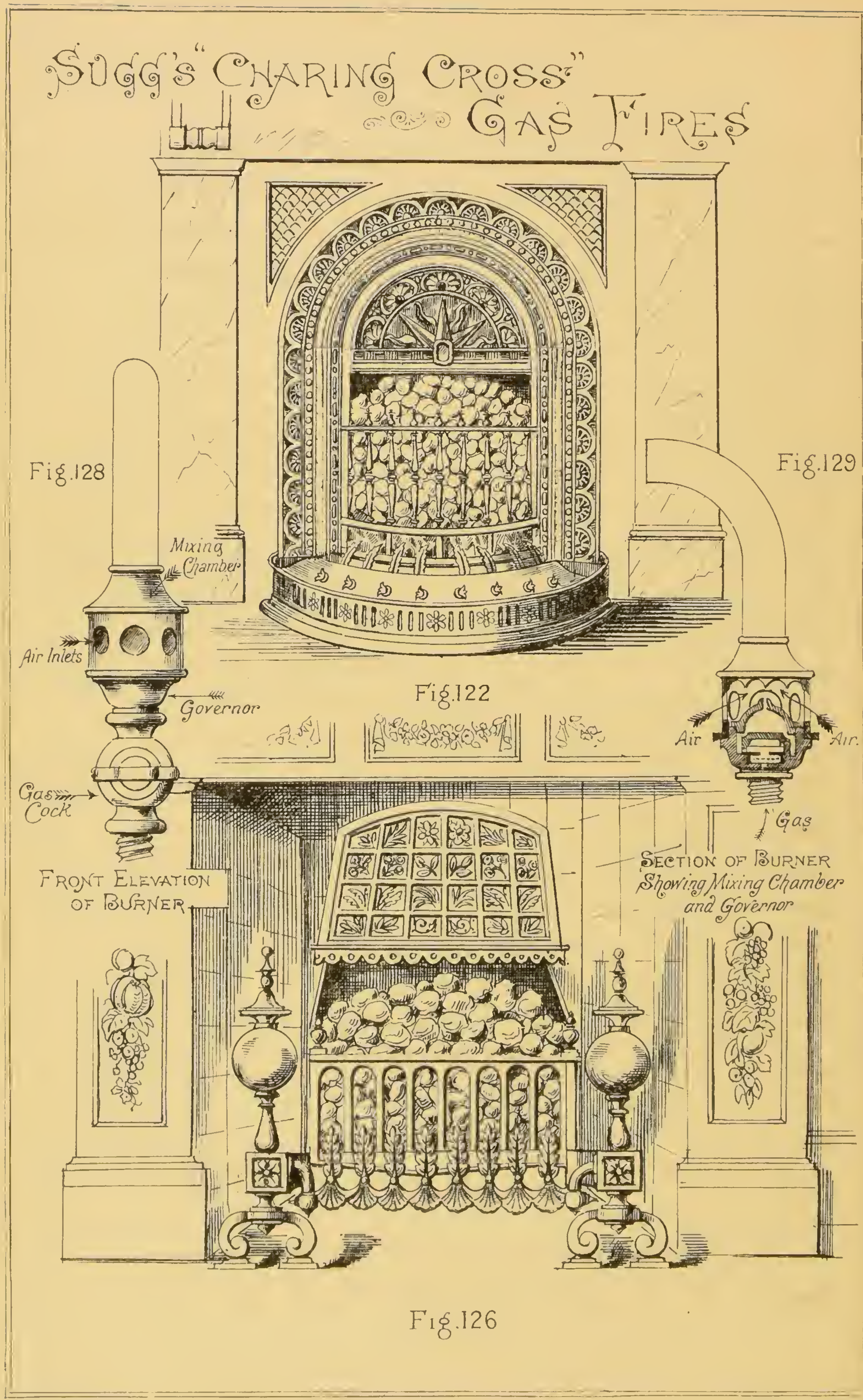
General impossibility for tenants to make structural inprovements.

The author prefers, therefore, in this work to treat generally of houses such as they are.

Heating the room.

First, with regard to the fire which takes away fresh air from the lower part of the room, and does little to remove the heated and vitiated air, which happily, by reason of its being heated, and consequently lighter than the cold fresh air, rises to the

Natural tendency of vitiated heated air to rise to the ceiling.


Sugg's "Charing Cross" Gas Fires
Fig. 128
Mixing Chamber
Air Inlets
Governor
Gas Cock
Front Elevation of Burner
Fig. 122
Fig. 129
Air
Air.
Gas
Section of Burner Showing Mixing Chamber and Governor
Fig. 126

ceiling. The fire ventilation would be effective, though disagreeable, if we were in the habit of lying on the floor; but as we prefer to sit on chairs instead, our heads are in a hot, unwholesome atmosphere, whilst our feet are being refrigerated by the cold *fresh* air.

Cold fresh air remains at floor level, because it is heavier than heated air.

The use of a properly-arranged radiant gas fire instead of the coal fire will go very far to abolish a great deal of the inconvenience resulting from draughts, and make the rooms in question more comfortable in every way. Fig. 122 is a drawing of a gas fire arranged by the author of this work, which will be found an effective, cheerful-looking, and warm fire. It has the great advantage of being always ready when wanted, and can easily be lighted by the most timorous persons without fear of any explosion, and without the necessity of making a hasty retreat from it after throwing a lighted lucifer match on the top of the asbestos. It will not waste gas if it be inadvertently left to itself at the time the evening pressure comes on, as described on pages 16 to 18, and shown on the diagram facing page 18. The heat thrown out from its glowing front is greater than that from most coal fires, radiates all over the floor, and is found to be extremely effective in warming the feet of those seated round it, which the coal fire very seldom does.

Rooms can be made much more comfortable by the use of a gas fire.

Heat of gas fire more usefully distributed.

Down-draught, or the escape of products of combustion into the room, can generally be prevented

Down-draught can be prevented, and fireplaces not practicable for coal used for gas.

by a simple arrangement at the top of the chimney-pot (see fig. 127, on Plate 37). Thus arranged, many fireplaces which cannot be used with coal fires, because of the smoke and blacks which are blown about the room when a fire is lighted in them, can be successfully used with a gas fire.

Gas easily and immediately extinguished or reduced.

Lastly, the gas fire can be extinguished at once if the room is found to be too hot, or reduced to any degree by merely turning off one or more burners. Very soon the incandescent material gets cooled, because it has nothing in itself to support combustion; and therefore the extinction of the fire at once produces a cooling effect in the room.

Many evenings in summer when gas fire is useful.

In this country, where even in summer there are days, and oftener evenings, which are cold and damp, the gas fire will be found most useful. In a very short time after it is lighted the room will be sufficiently warmed to take away that feeling of chilliness which is so dangerous, because it is usually the commencement of a cold or sore-throat. As soon as the room is warm enough, the fire may be at once discontinued.

Gas fire considered in comparison with coal fire under the head of cost.

Comparing the gas fire with a coal fire under the head of cost, it is necessary first to consider that the former gives out a constant heat from within a short time of its being lighted till it is put out. The coal fire, on the contrary, requires to be made up frequently; and after being made up it is some considerable time before it gets out of the flaring, smoky state, and becomes a really glowing, radiant fire. Frequently, from want of proper attention, it never does get into this state, but goes out or burns hollow, and remains for hours in a smouldering condition, giving no heat into the room at all, but merely warming the chimney. Hence there is, in the consumption of coal, as compared with that of gas, an apparent economy in favour of the former, which is not substantiated in practice; for, taking the case of a room in which it is required to keep up the temperature to a comfortable standard of (say) 63° to 65° Fahr. during an entire day, it is found that a large quantity of coals and great attention are required to accomplish this feat successfully.

Large quantity of coals, and great attention required to keep temperature constant with coal fire.

The destruction of furniture and carpets by dirt and ashes, as well as the labour of filling the scuttle and carrying up coals, is so great, that if the calculation in the case of coals included this, gas would be found to be far cheaper. But, generally speaking, the only thing taken into account in the comparison is the quantity of gas consumed.

Even in such a case, if the gas fire were turned down at certain times to represent the coal fire after a fresh shovelful of coals has been put on, or when it has almost burned itself out from inattention, the gas fire would most assuredly be found, in London, much below the cost of the coal fire.

But when the cleanliness of the gas fire is taken

Consideration of cleanliness and greater comfort give superiority to gas fire over coal fire.

into account, and the amelioration it causes in the general comfort of the room, there will remain no doubt about its superiority over the coal fire.

Figs. 123 to 126 are drawings of the gas fires just spoken of. They are fitted up as follows, so as to go into an ordinary grate in the place of the coal fire:—The back of the grate is filled up as shown in fig. 122A, which is a section of an ordinary fireplace. The filling up is done with fire-clay, and a fire-tile laid at a suitable angle in the bottom of the grate. At the lowest bar is fixed a grid, on which the material in lumps, consisting of fire-clay and asbestos mixed, is built up like the coals in a fire, and piled well up at the top, so as to give as much thickness of material as possible above the gas-flames. These play into the fire under the grid before mentioned, and ascend up amongst the material, which filters out the heat and radiates it into the room. Comparatively little heat escapes up the chimney from the hottest of these gas fires. The carbonic acid and other products of combustion leave the top of the fire, however, sufficiently hot to cause them to ascend and keep up a sufficient amount of warmth in the chimney to maintain a constant upward current. As the products of combustion from the gas fire do not include smoke, and are not probably one-quarter the volume of those from a coal fire, the chimney-pot should be fitted with the arrangement shown in fig. 127, on Plate 37.

Action of the fire.

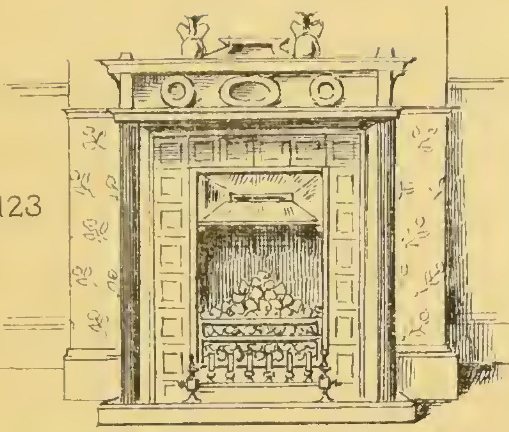


Fig. 123

SOME SKETCHES OF FIRE PLACES

Showing the adaptation of "CHARING CROSS GAS FIRE.

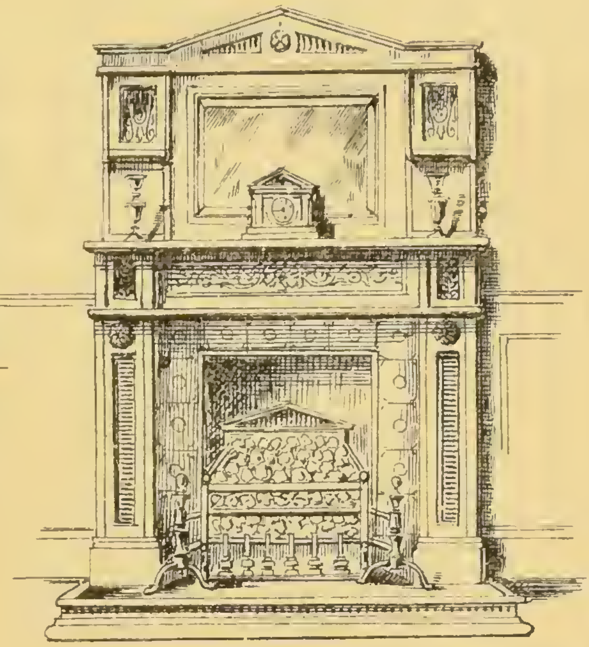


Fig 124

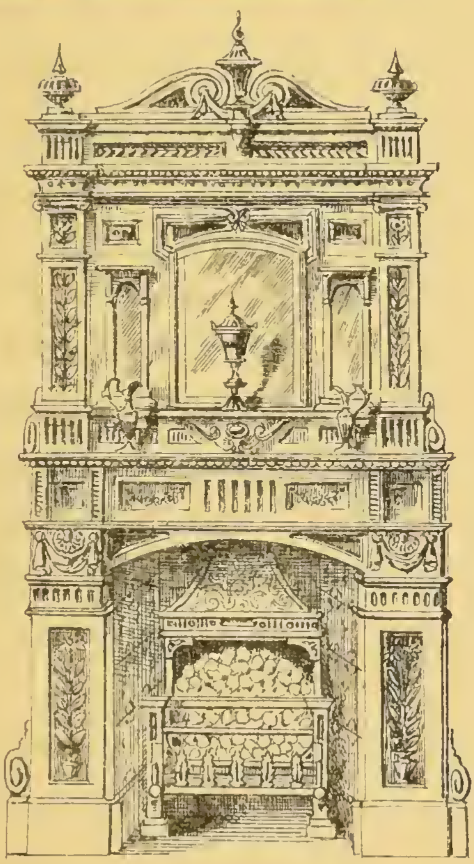


Fig. 125

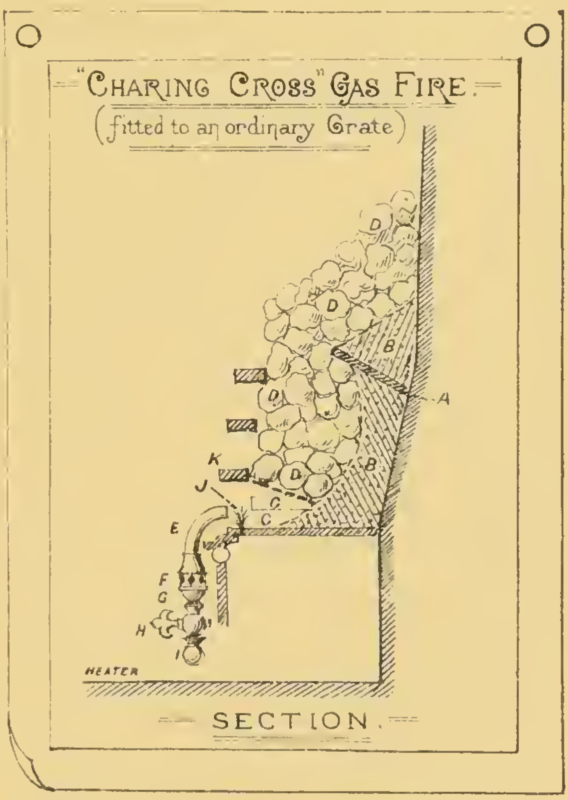


Fig. 122ª

A. Fire Tile.
B. Fire Clay.
C. Steatite.
D. Asbestos.
E. Burner.
F. Air Inlets.
G. Govenors.
H. Cock.
I. Gas Rail.
J. Thread Asbestos.
K. Grid

The gas for the supply of the fire is led from under the floor-boards of the room, where it communicates with the nearest gas-pipe (if it is large enough for both lights and fire), but preferably with a separate gas service from the outlet of the meter.

It is better for the sake of ascertaining the cost of these fires, and keeping a proper control over them, that the gas supply should come from a separate meter. Generally, gas fittings are not large enough to supply both lights and fires.

After passing through a shut-off tap, the gas flows into a gas-box containing a self-acting steatite governor, regulated so as to pass the exact quantity required for each burner when the fire is in full work, and no more, notwithstanding that the pressure may increase. From thence it passes into a tube, serving as a chamber, in which the gas is mixed with a proper quantity of atmospheric air, and directed into the fire.

Gas maintained at a fixed rate of consumption by governor

Each burner is supplied with a proper tap, so that the fire can be reduced at pleasure by shutting off one or more of the burners, leaving the rest as they were. By this means the temperature of a room can be easily maintained at any suitable degree.

Fig. 128 is a drawing of one of these gas and air mixing taps; and fig. 129 is a section of it, showing the governor and air supply.

See Plate 35, p. 139.

Any stove—either dog-stoves, as in fig. 126, or

Plate 36, p. 142.

ordinary chimney stoves as in fig. 123—can be fitted with these fires.

Apparatus for prevention of down-draught.

In order to prevent down-draught, and provide for an efficient upcast to carry off the products of combustion from the burning gas, the simple arrangement of the chimney-pot shown in fig. 129 will in most cases suffice. In those instances where the down-draught has actually prevented the use of a coal fire, either always or occasionally, according to the direction of the wind, a slightly more elaborate apparatus is required. This is shown in fig. 130, and it consists of a four-sided cap of small dimensions (as compared with the usual chimney-pot) closed at the top. Each of its four sides is fitted with a light copper or tin flap, balanced so as to open like an Arnott's ventilator valve. The cap is put on to a chimney-pot cover (fitting closely to the top of the pot). A length of tube, in communication with the square head, is made to descend a short distance down the chimney. The arrows show the direction of the current of air. So long as there is an up-current in the chimney, one or more of the valves will be open to give it exit; but if there is no up-current, then the valves will be closed against any cold down-draught.

Plate 37, p. 144.

Upward current general, if cold air is prevented from getting into the chimney.

Generally, there is a constant up-draught in chimneys so arranged, even without a fire; because the air in the chimney is warmer than the external air, and is therefore kept in motion, preventing

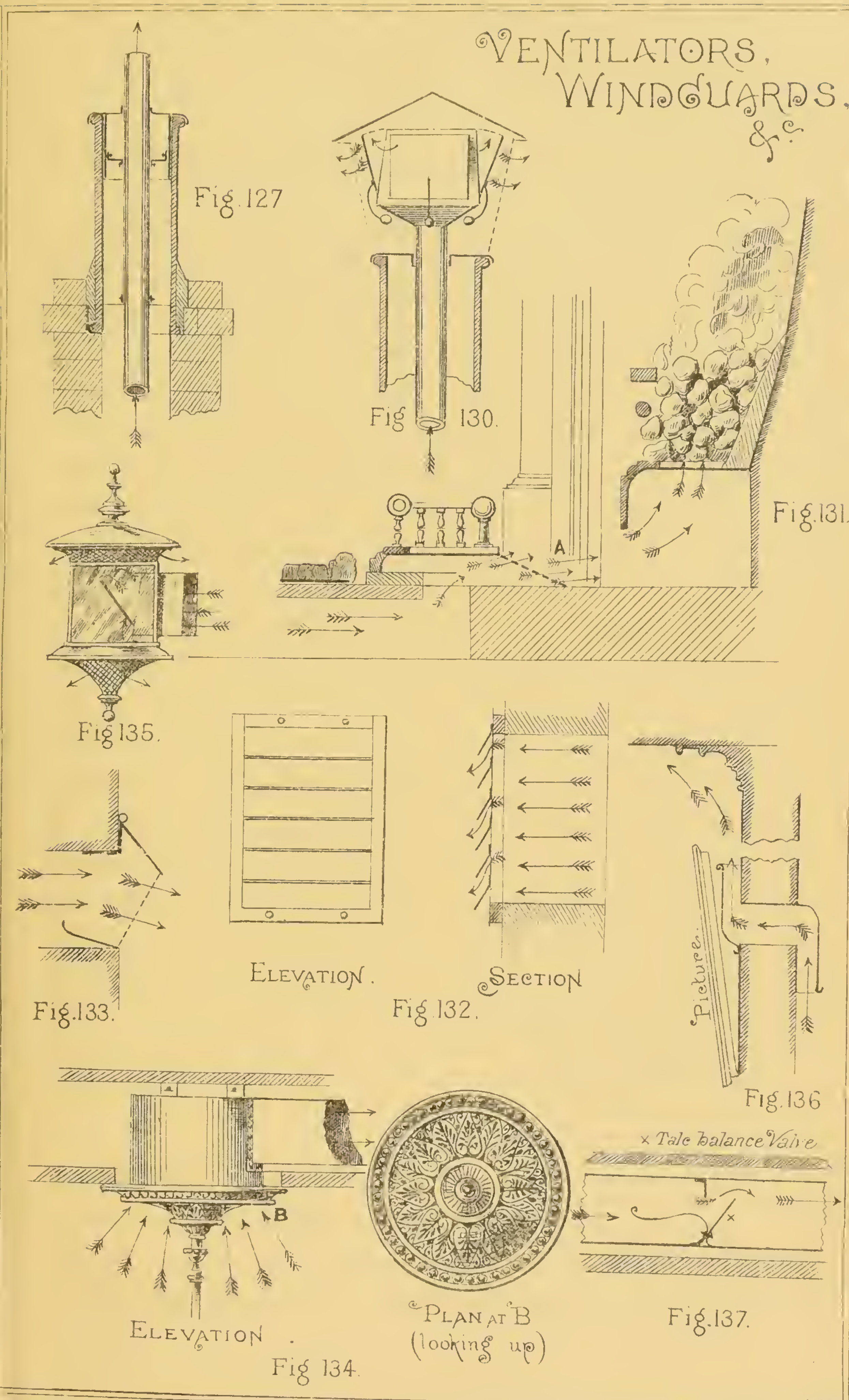


Plate 37

To face p. 144

the cold air from getting in. These arrangements will be found very effective on the sea-coast, where sometimes, during a gale, it is not possible to have fires with the ordinary open chimney-pot.

But if it is not possible to put in a gas fire, the inconvenience of the coal fire may be neutralized in the following manner:—

The fender should be raised about an inch on a wooden frame (as in fig. 131), and brought back off the hearth just sufficiently to allow it to cover an opening, or series of openings, in the nearest floor-board, supposing the joists run in a line with the fireplace. The end of the fender at A must be protected by perforated zinc, so as to prevent hot coke or pieces of partly-burnt wood from getting under it as far as the unprotected board. It is extremely probable that from these openings sufficient air will at all times be provided to supply the fire, and thus prevent it from drawing a *cold* supply through the chinks round the doors and windows. Method of giving a proper air supply to a coal fire, and neutralizing cutting draughts.

In those cases in which the building is so solidly done that no air comes into the channels formed by the joists, a communication must be made between them and the air outside the room by means of ventilating bricks.

The supply to the fire having been thus secured, it remains to devise a means of supplying fresh air to the room. Here, again, the joists will stand us in good stead if we put into each of the four corners of the room one of Tobin's tube ventilators, carrying fresh air to room.

it up some 6 or 7 feet. These tubes should be 6 in. by 4 in.—not less.

The exit of the heated vitiated air of the room can be contrived by cutting in the wall of the room, near the ceiling, a hole opening out into a staircase, if this is ventilated at the top; or by making one or two openings out into the street or garden, and fitting to them ventilators as in figs. 132 or 133.

Plate 37, p. 144.

Gurney ventilators.

The openings into the staircase can be fitted with ventilators of a simple construction, called "Gurney" or fish-gill ventilators (fig. 132). They consist of strips of calico fastened across the opening by tacks put into the two upper corners of each strip. The strips are made just deep enough for the lower part of the superior strip to cover the top part of the inferior one. When properly fixed they open like the gills of a fish; hence the name. They can be used either to let in fresh air or carry off heated air from the top of a room.

Gurney ventilators should be not less than 1 ft. by 10 in.

These useful and simple ventilators, if employed in rooms where gas is used, would tend greatly to the comfort of the public, who require a good light, but complain of the resulting heat. They work, when closed, by diffusion; the heated air passing through the porous medium of the calico, and the cooler air from outside the rooms passing in without draught. But it is of no use putting in such ventilators less than 1 foot long by 10 inches wide.

Ventilation of dining-room.

The ventilation of an ordinary dining-room can be easily effected by putting into the ceiling a perforated ventilator, as in fig. 134, and carrying a ventilating flue along between the floor joists of the room above, towards the street, if practicable; and if not, then into a staircase. The flue must be fitted with a valve which will remain shut when no upcast takes place.* (See fig. 137.) The former is frequently the only method; and, if so, the end of the flue where it goes out into the street must be provided with a guard, to keep the rain from beating in (see fig. 134 or 135).

Ceiling ventilator, Plate 37, p. 144.

Plate 37, p. 144.

The inlet for the air of the room is best made with Tobin tubes, or with short brackets fixed near the ceiling, as in fig. 136. This is sometimes better than Tobin tubes, and occupies less space.

Bracket ventilator, Plate 37, p. 144.

The warming of a dining-room (which is not used all day except for luncheon and dinner) by the ordinary method is a troublesome and wasteful process. Generally speaking, entering the dining-room in winter produces an inclination to shudder, because it is almost always colder than the reception-room. The fire is, as a rule, only lighted *just* before it is wanted, and so the room is chilly.

Warming of dining-room by window coil heated by gas.

In fact, as during dinner a room always becomes hot, the general way to obviate the inconvenience and discomfort of too much heat is to have it too

* The joists should be filled with Dennett's fireproof composition, or plaster and hair, to completely satisfy the insurance authorities. Although there can never be any heat above 90° in the flue, this simple and easy precaution will prevent any question arising.

cold at the commencement. To avoid this, and warm the room to a *just* comfortable temperature, the following method of doing it by means of gas can be readily adopted in many cases.

Warming apparatus in window, Plate 38.

Fig. 138 is a sketch of a warming apparatus which can be placed under the window. The warmth from it entirely obviates the disagreeable effect on those seated near it, caused by the continual descent of a current of cold air down the window panes, created by the condensation of the heated air against the cold glass. The consumption of gas for the window-coil need not be much more than from 10 to 15 cubic feet per hour; and if it is adjusted to this low rate in very cold weather, and left to burn all night, the room will always be found to be comfortably warm on entering it at any time.

The heating of the window-coil (which is fitted with hot-water pipes) is effected by means of a very small and simple boiler, heated by gas, fixed in the area, or in a sunk pit in the garden. It will burn constantly day and night for months, if required, without any attention. It is self-regulating, and therefore is not affected by variation of pressure in the street mains.

Ventilation of drawing-room, boudoir, and study.

The ventilation of the drawing-room, boudoir, and study may be effected in the same way as that proposed for the dining-room.

Ventilation by top of window sash.

A simple and effective method of ventilation for any of these rooms which may occasionally be

Window Ventilation, &c.

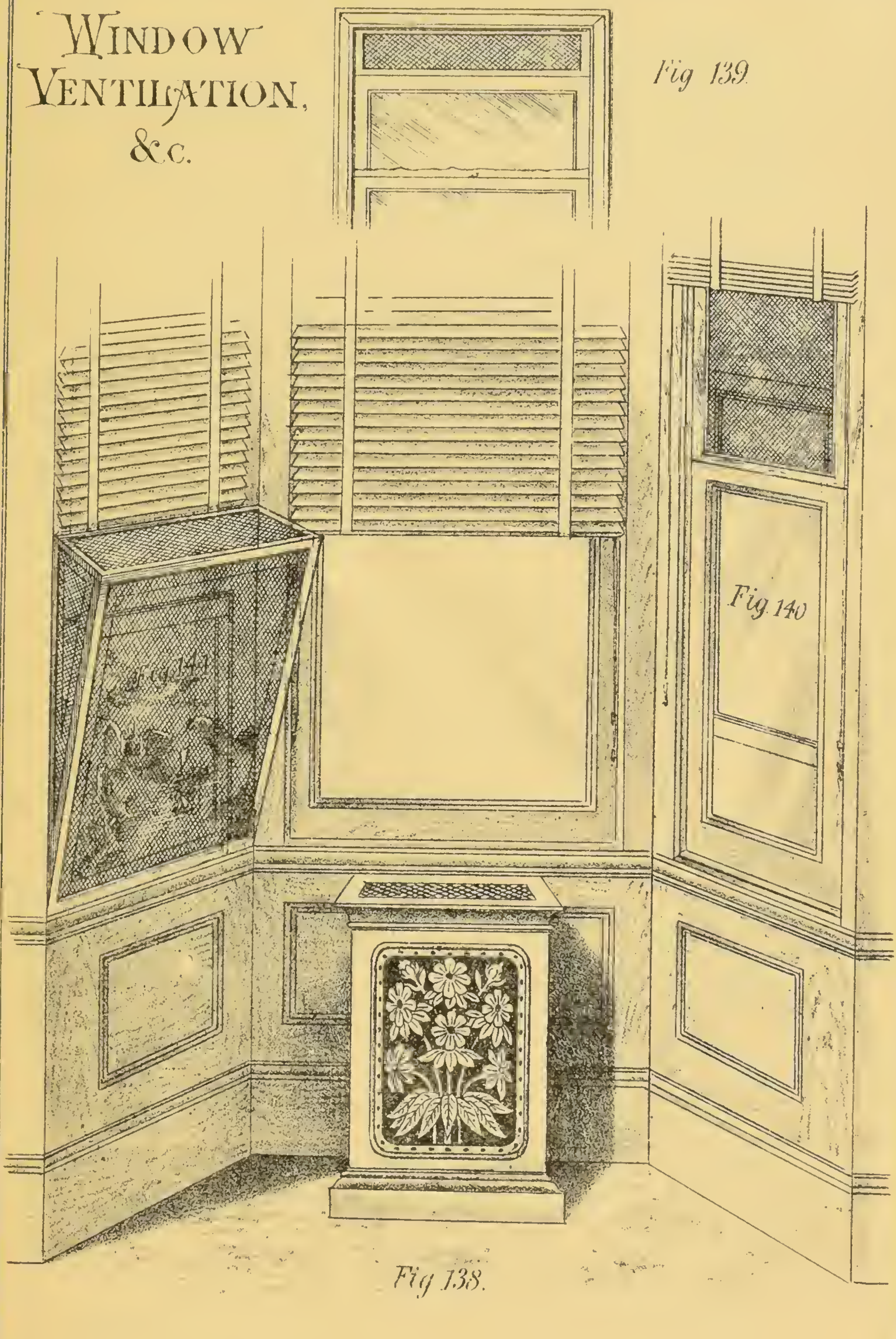


Fig 138.

It is not imperative to have the Ventilators in exactly the positions they are shown above. they can be adapted to all or any of the windows.

Plate. 38.

To face p 148.

successfully resorted to, is illustrated in fig. 139. The ventilator is simply a wooden frame, covered on both sides with finely-perforated zinc, hooked up against the window-frame, and pinched in between the top of the window and the frame. It is fitted all round with an india-rubber draught excluder. Plate 38, p. 148.

The joints of the window between the lower and upper sash must be furnished with a soft bag, so as to prevent any current of air passing in between them.

Ventilation of a ball-room or dining-room by diffusion ventilators,

For the ventilation of a ball-room or large dining-hall, when there is a numerous party present, the following temporary system will be found to work well:—Fit to the upper part of the windows a light wooden frame, as shown in fig. 140. Fill in the frame with washed calico, or in hot, close weather, with coarse muslin. The window can then be opened to any extent required according to the state of the temperature. Fig. 141 is an arrangement to be applied to the lower sash, for the admission of air. Plate 38, p. 148.

This system of ventilation works by diffusion—the heated air passing out into the cold air, and the cool, fresh air passing in through the porous medium interposed between the heated air of the room and the cooler external air.

When a room is hot, and the doors are shut, opening a window does not often result in letting out the warm vitiated air, although it always cools

Open windows not good ventilators.

some of it, and drives it down towards the floor, along with the incoming fresh air. But if the door of the room be also opened at the same time, a considerable displacement of vitiated heated air will take place. It will pass into the staircase of the house, if it is warmer than the external air; and thus the air of the room will be, to some extent, changed. One grave objection to this sweeping mode of getting rid of vitiated air is, that it exposes to great danger, from cold, all those guests who happen to be in the line of the draught.

Windows fitted with porous medium ventilate without draught.

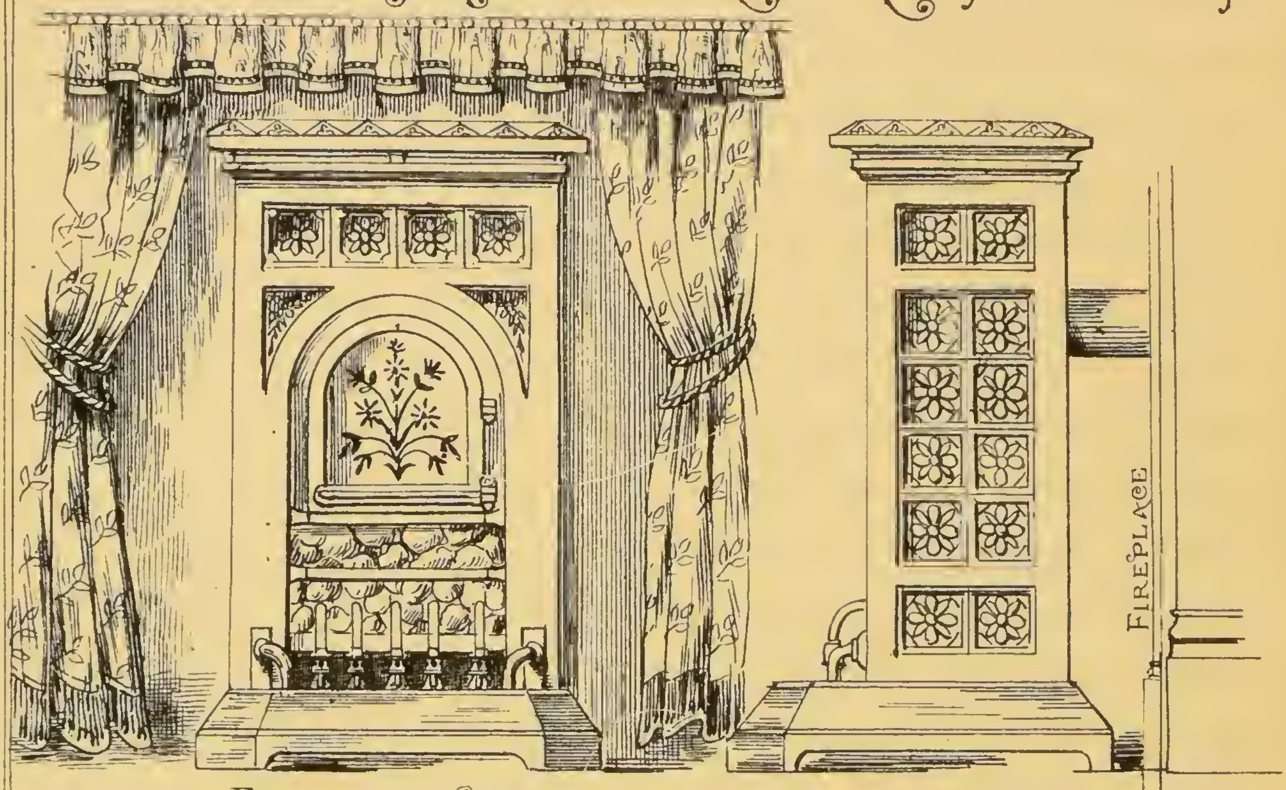
On the other hand, if the windows be fitted with a porous medium, a very different result takes place, because the natural law of diffusion then comes into play. The heated air diffuses through that medium into the colder external air, and *vice versâ*. Instead of the cold air rushing in, it is the heated air which passes out, because of its greater rarefaction, faster than the cold air can come in.

Cold fresh air should be broken up into very small streams.

In fact, it is a principle of ventilation that the cold fresh air must be broken up into as small quantities as possible, so that, instead of falling towards the floor like buckets of water, it should diffuse itself all over the room like a gentle cooling spray. Vitiated heated air will not readily mix with cold fresh air let in from the top of the room, because the former rises through the latter towards the ceiling by reason of its lightness, and from thence means should be provided to carry it off.

One of the great advantages of gas is, that the

BEDROOM AND NURSERY STOVES



FRONT ELEVATION. SIDE ELEVATION.

Fig. 142.

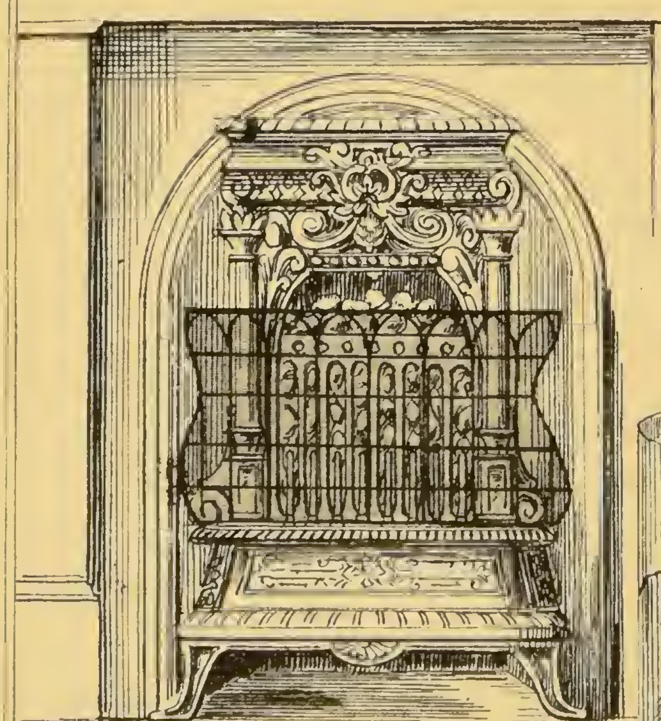


Fig. 144

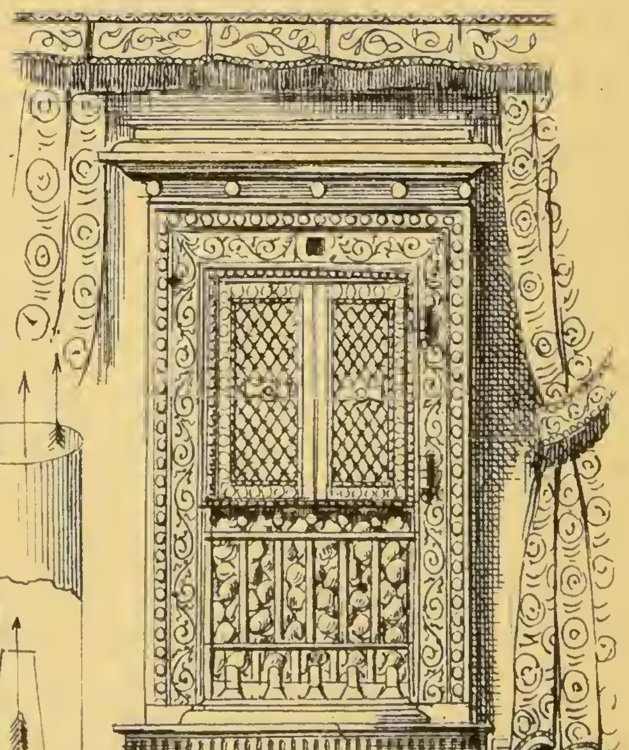
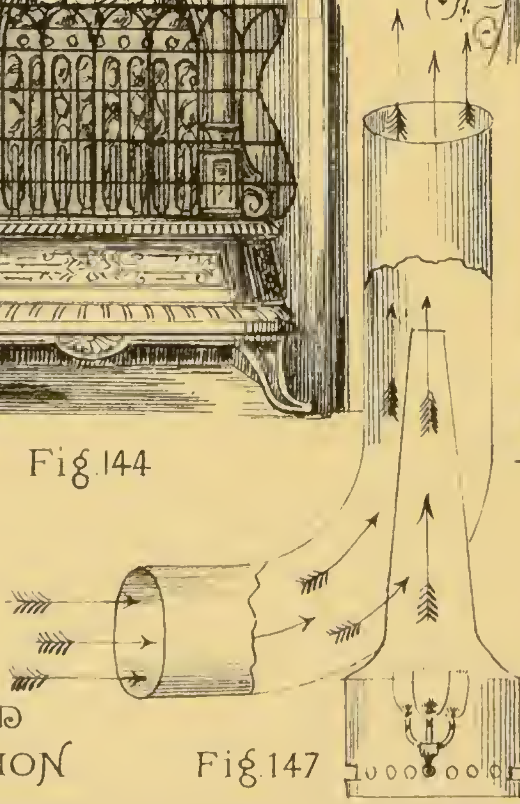


Fig. 143.



INDUCED VENTILATION Fig. 147

(7409)

products of combustion are principally steam, which, from its specific heat, maintains the warm carbonic acid produced from persons breathing in the room and from the burning gas at the ceiling level.

Advantages of gas in ventilation.

An examination of the stratum of air, at or near the ceiling level, will demonstrate the presence of an almost poisonous air in any crowded room, whether lighted by gas or not, if there are no means of taking off the vitiated air at that point.

Light for light, gas more healthy than candles or oil lamps.

It must also be noted that, light for light, the products of combustion from gas are much less injurious than those given off from oil or candles.*

It may be as well to mention here that muslin curtains simply pinned or fastened together over the window constitute an excellent extempore diffusion ventilator with the top sash let down more or less, according to the difference between the temperature of the exterior air and the heat of the room.

There is, however, an inconvenience arising from the use of window-curtains as ventilators—in large towns they get very dirty in a short time; but it may be hoped that an amelioration in the smoke nuisance may be looked for in the future, when heating and cooking will be mostly done by the aid of gas.

Charing Cross bed-room stove, figs. 142 and 143, Plate 39.

The warming of the bed-rooms and nursery is a most important consideration, because it is the

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* See remarks on the products of the combustion of ordinary coal gas, page 161.

change of temperature which frequently occurs at night, or in the early part of the morning, that

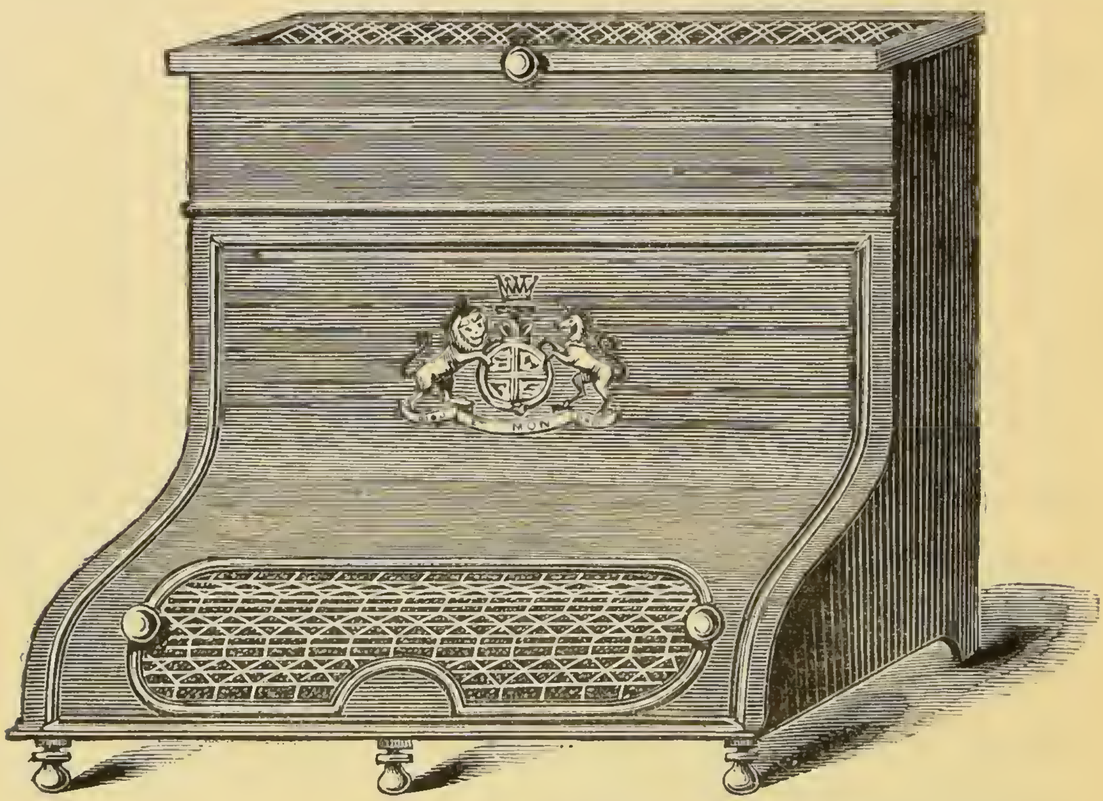

Fig. 145.

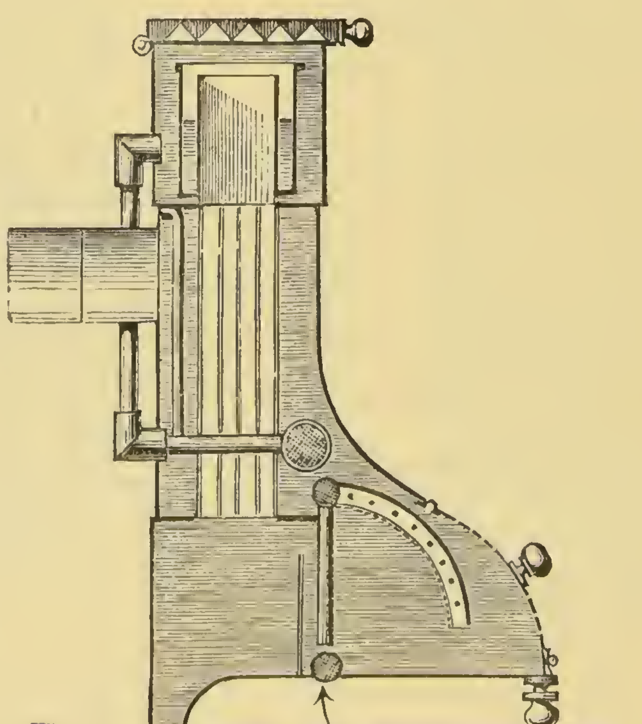

Fig. 146.

is so injurious to those who suffer from weak throats or from bronchial attacks. Also, in case of sickness, very great difficulty is experienced in keeping the room up to an even temperature, and ventilating it at the same time. Figs. 142 and 143 are drawings of a stove which the author of this work has himself tried; and they show the manner in which it is fixed in a room. It will be found to act well, and work with regularity and economy. Fig. 144 is a stove suitable for a nursery; having a guard all round it, to prevent children from burning themselves.

The Henley Instanter Stove.

The Henley Instanter Gas Stove (figs. 145 and 146) is specially made for warming dressing-rooms, &c. A gentleman who has used these stoves for several years says:—

"I cannot speak too highly of them to produce instantaneous heat. At the commencement of cold weather one very small gas-flame is lighted to enable the others to catch immediately, and the small flame is not turned off till the warm weather returns.

"To any one returning from hunting or shooting, this Henley stove is invaluable. It is also most useful for shops, passages, and such like places.

"My dressing-room is 22 ft. by 16 ft. and 11 ft. 4 in. high, and it can be raised 10° in temperature in less than an hour by the Henley Gas Stove. When the dressing-room is brought to the required temperature, a small consumption of gas maintains the heat. In a bath-room it is the extremest luxury.

"It is desirable that outside air pass through the stove, but this is not imperative. A fireplace and flue are essential. This stove should be placed an inch or two in front of the fireplace, under the mantelpiece, in order to secure the fullest economy of gas."

Open fire-place an obstacle to ventilation.

Before leaving the subject of warming and ventilation, it will perhaps be necessary to emphasize the remarks about the ventilating properties of the open fireplace, which will always be found a serious obstacle to any efficient ventilation.

The suction draught—or, to speak more correctly, the pressure of the *colder*, and consequently heavier external air on the *warmer* and lighter air of a room—set in motion by the action of a blazing coal fire, will always convert theoretical outlets for heated vitiated air into practical inlets for cold fresh air, unless this action (or "pull," as it is technically termed) is neutralized in the way explained on page 145.

Generally, any opening in a room communicating with colder external air is an inlet for fresh air, unless a superior force, such as that shown in fig. 147, is employed to convert it into an outlet.*

* The only exception to this rule is in the case of those ventilators described on pages 149 and 150, which work entirely by diffusion.

Burning gas is the motive force in the apparatus here shown; but an electric fan or a water-wheel ventilator (such as Verity's, or the Æolus water-spray ventilator) will operate in the same way. Mechanical ventilators.

The two last-mentioned mechanical ventilators may be used to supply fresh air cooled by passing through a water spray, as well as to draw off heated vitiated air.

In hot weather a fine mist spray, produced by a jet of water at high pressure dashing against a small button, or issuing from a small fishtail gas-burner, is the best means of producing a cool supply of fresh air. Water affords the readiest means of abstracting heat from the air. A very small quantity of water allowed to trickle through the inlet ventilators placed on the roof or near the ceiling of a hall or room will always ensure a cool inlet supply. As an instance of the power of water to absorb heat from air, it may be stated that compressed air at about 100 lbs. pressure on the square inch, heated by the act of compressing, and in that state brought into contact with surfaces cooled by running water, which abstracts the heat, produces a freezing temperature when suffered to expand into its original volume. Water-spray ventilators.

Evaporation also produces cold, and this means may be usefully employed to keep the air of rooms cool in hot weather. A canvas or holland blind fixed at the top of the upper window-frame, held out at the bottom by means of a light wooden frame, in Cooling air by evaporation.

the manner of a Spanish blind, and kept moistened with water, will always, even with the sun shining on it, produce a cool, refreshing supply of air. The sides of the blind must be closed by means of wedge-shaped pieces of stuff sewn on to the blind, or the side draught will carry away the cool air. If a zinc dish is fixed so as to project sufficiently outside the window to catch the spray from a water-jet as described above, a most refreshing supply of cool air may be always secured in the hottest weather. In order to prevent draught, the lower sash of the windows may be fitted with frames covered with coarse muslin.

Sun-burners as ventilators.

Sun-burners, as shown in Plate 29, are most effective as ventilators, being in principle enlargements of the eduction ventilator (fig. 147, Plate 39). The difference between them is simply that the sun-burners are also used to give light at the same time that they ventilate. Smaller sizes, such as those shown, can be used for large drawing or dining-rooms, in cases where there is sufficient distance between the ceiling and floor above to carry the ventilating shaft. Fire insurance surveyors usually insist on a slate being placed over the length of a horizontal shaft instead of floor boards. Dennett's fireproof material is the best non-conductor to use for this purpose, because the pipe can be thoroughly encased in it. When vertical shafts can be employed, little or no difficulty is found in fixing sun-burners.

The effective power of properly-arranged sun-burners, with suitable burners and reflectors, approaches nearly to that of the Argand. The author's opinion—not, however, shared by other makers of these lights—is that, in the same way as with Argand burners, it is necessary to keep the gas cool and the flame hot, and to keep the pressure of gas as low as possible at the point of ignition. Effective power of sun-burners.

Much has been said at various times about the dirt and discoloration of the ceilings of rooms in which gas is used, and this complaint is naturally greater in large towns, where there is much smoke in the atmosphere. Every lamp, whether oil or gas, projects a current of heated air up against the ceiling of the room, and with it carries up any dust or fog which may be floating about. Fog without smoke is always dissipated by the heat of a room; but when mixed with smoke, all the soot and dirt remain floating about, and are directed up to the ceiling by the heated currents of air from lamps, burners, or even hot-water apparatus. As an illustration of this, if a white porcelain plate be suspended over a lamp or gas-burner, and both be prevented from smoking, it will be found that during the summer months, when there is comparatively little smoke in the atmosphere, the porcelain plate will remain clean; but in the winter months, when the fog prevails, it will be found that the plate is blackened in one day more or less according to the quantity of smoke in the fog. Clearly, there- Discoloration of ceilings.

fore, it is not the lamp itself which does this, but the smoke and dirt in the atmosphere.

A remedy found.

It is probable that it may be many years before we shall get rid of the smoke in London and other large towns, so that it is necessary to seek a means of obviating the inconvenience of dirty ceilings. The author has found that the best practical way of doing this is to paper the ceiling and varnish it. Light oak paper looks very well; but any coloured paper will be equally effective if varnished with a clear varnish. Soot and dirt will not accumulate on it; and it can always be made perfectly clean by wiping it with a damp cloth. In modern buildings the plaster of the ceilings is often of such a porous description that a great deal of the vitiated air is diffused through it, and the mark of the rafters is soon seen. Varnished paper will to a very great extent prevent this.

Gas heating appliances.

There are a number of other gas appliances for heating rooms, churches, and mansions, and conservatories, &c., by means of hot water, which cannot, for want of space, be shown and described in the present work. The great advantage of the use of gas boilers for these purposes over the coal or coke boilers is that, the heat being regular, any required degree of temperature may be maintained, and the trouble of night stoking avoided. The burners used with these boilers are all governed, and arranged for different powers of heat, so that a greater or less number can be employed according

Gas boilers.

to the degree of heat desired. The casing of the gas boiler in brick is extremely simple. No flue is required, and no smell is produced. The heat of the burning gas is all utilized, and the apparatus can be left to work by itself for months without attention. When used for heating water for baths, or in place of the ordinary kitchener boiler, it can be fixed outside the house, and be turned on, when required, from inside. A flash-light always left burning lights up the boiler when the main supply to the burners is turned on.

Not the least useful piece of domestic gas apparatus is the Turkish or vapour bath, shown in fig. 148. (see next page.) This is one of Ellis's* bath chambers, fitted up by the author with luminous gas flames, governed by a proper regulator, so that no excessive consumption beyond what is required can be produced by any sudden increase of pressure during the time a bath is being taken. The regulating tap enables the bather to reduce the temperature to any degree; the governor maintains the consumption, and consequently the temperature, at the point fixed upon, and ensures that no greater temperature than 200° Fahr. can be produced, even though the regulating tap is turned full on. The foot-warmer is arranged to be heated by gas instead of being filled with hot water, so that a bath can be taken in the early morning, when there is generally no hot water ready. By placing a small

* Ellis & Co., Fleet Street, London.

PORTABLE TURKISH OR VAPOUR BATH FITTED FOR GAS.

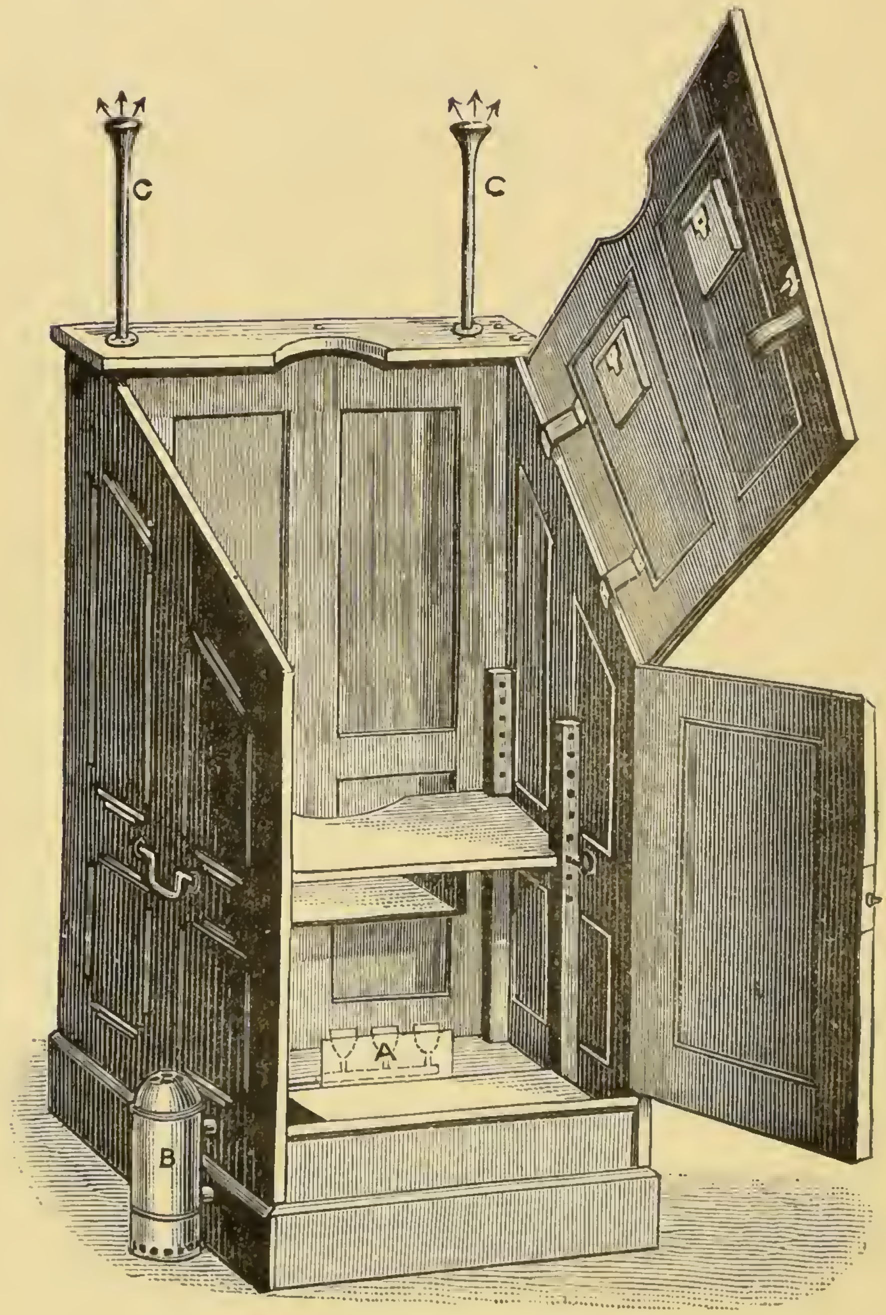

Fig. 148.

A. Gas-burners.
B. Boiler for foot-warmer.
C. Outlets for vitiated heated air.

vessel of water over the burner, a sufficient quantity of steam can be produced to make a very effective Russian vapour bath. No disagreeable odour comes from this bath, and there are no hurtful products other than carbonic acid in too small a quantity to be injurious. It can therefore be used in any bath-room, or even in a bed-room,* without the slightest interference with comfort or health.

Another very useful application of gas is the heater for laundresses' and tailors' irons, and a little apparatus for heating curling tongs for the dressing-room. All these appliances are made in a variety of ways, but mostly with arrangements for mixed gas and air; and this, in the opinion of the author, has largely interfered with their introduction into families. But fitted to burn pure gas they give off no offensive smell or any products hurtful to health. Thus they are immensely superior to the coke heated or atmospheric gas ironing-stoves hitherto used in laundries.

The products of the combustion of gas given off from luminous flames from a steatite burner†

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* Those who are in the habit of taking a cold bath in the morning will find this apparatus invaluable, because it ensures by this means that the body is in a sufficiently warm state to produce a healthy reaction after the bath. Without such sufficient warmth, the cold bath is often dangerous to health. Remaining for about ten minutes or a quarter of an hour in the Turkish bath will be sufficient to clear the pores of the skin, and produce a good warmth.

† These remarks do not apply to metal burners.

consist of steam so very slightly acidulated that it will scarcely react on the most delicate chemical test-paper, mixed with a very small quantity of carbonic acid and an infinitesimal dose of sulphur. The quantity of water produced by the combustion of 10 cubic feet of gas is, in round figures, from 15 to 18 fluid ounces. This, if condensed in clean glass vessels, will be found to be as clear and tasteless as distilled water, and quite as harmless. The other product is about 5 cubic feet of carbonic acid gas, with a trace of sulphurous (*not sulphuric*) acid gas along with it. It is therefore evident that beyond the air vitiated by carbonic acid, which from a fair-sized steatite gas-burner with luminous flame about equals the volume exhaled from the lungs of a full-grown person, in good health (in the same time), there is no noxious emanation given off; but, on the contrary, the trifling amount of sulphur present in the products of combustion from the gas-burners serves to neutralize any small amount of organic matter or dust floating about in the room.*

Bringing this statement down to a practical bearing, we find that the effect of burning 10 cubic feet of London gas (giving a light equal to 32 candles) in a room 15 ft. × 15 ft., which has an area of 225 square feet, and contains 2250 cubic feet of air, will be to produce close up to the ceiling

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* A person in good health exhales from 15 to 18 cubic feet of air per hour from the lungs.

a layer, say a foot deep, of heated vitiated air, containing rather over 2 per cent. of carbonic acid.

The products of combustion must at once be propelled to the ceiling by the draught of the burner, and being mixed with the lighter gas, nitrogen, and still lighter, steam, are kept there till they find their escape, either through the plaster or some opening in the upper part of the room.

Thirty spermaceti candles will vitiate three times the amount of air in the same time. Tallow candles producing the same amount of light as the gas-burners will vitiate four times the amount of air in the same time. In both of these, as well as in an oil-lamp, there must always be more or less imperfect combustion of the material.

It has been so frequently proved that, for an equal amount of light, ordinary coal gas vitiates the air much less than does oil or candles, that it almost seems unnecessary now to make a point of it. But the circumstance of a scientific lecturer at the Society of Arts only lately telling his audience that the gas supplied to the public is a "noxious compound," is an indication that, notwithstanding all that has been demonstrated, it is not out of place in this work to show what are really the products of combustion, as well as what are the constituent parts of that gas which is now so largely used by the public.

In conclusion, the author trusts that he has pointed out a sufficiently practicable method of using gas for domestic purposes, which will be found to increase the comfort of the public in many ways; and that the explanations given in this work will enable the consumer thoroughly to understand what has often been alluded to in the public journals as a very mysterious matter.

W. King & Sell, Printers, 12, Gough Square, Fleet Street, E.C.