

CONTRIBUTIONS FROM THE PHYSICAL LABORATORY OF THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, ON THE REL-
ATIVE EFFICIENCY OF KEROSENE BURNERS.

By C. J. H. WOODBURY.

The laws of the State of Massachusetts declare that illuminating gas, when burning in an Argand jet at the rate of five feet per hour, shall furnish light of intensity equal to twelve times that given by one sperm candle, consuming one hundred and twenty grains an hour.

Therefore, it has been for the interests of both manufacturer and consumer to introduce burners which will give the greatest light with the least expenditure of gas. Much skill and ingenuity has been devoted to the attainment of this result. MM. Audoin and Berad investigated this subject very thoroughly, and came to the decision that there is a design of burner adapted to every rate of consumption.

These researches have been very valuable to all using this source of artificial light; but this is restricted to those living near the centre of population in cities; the greater part of our population, residing in suburban towns, unable to procure gas, are obliged to use kerosene.

The comparative worthlessness of the lighter products of petroleum tempt the unprincipled manufacturer to add them to kerosene, making a product which, on account of its extreme volatility, is *cleaner* than pure kerosene; the flame is of greater brilliancy, and, on these grounds, it recommends itself over the pure oil to those who have not been able to give attention to this subject. Many of these compounds are quite as dangerous as gunpowder.

As kerosene has been in use only a few years, a sufficient interval has not elapsed to enable us to burn it with the greatest possible economy.

The laws for the protection of persons using kerosene must be directly antithetical to those concerning illuminating gas, because the deterioration of the first, causes it to better serve the purposes of illumination at the expense of safety to those using it. This protection is afforded by the declaration that the vapor of the oil shall not be inflammable below a certain temperature.

The writer, in the following series of experiments upon various kerosene burners, has endeavored to ascertain the most favorable forms of burner for an economical expenditure of oil compared to the light

given. The results given for each lamp are the mean of from one hundred and fifty to two hundred and fifty observations.

Flat Wicks.

No.	Manufacturer.	Name.	Chimney.	Wick.	Candle Power.	Hours required to consume 1 gallon.	Candle power to gallon.
1	Scovill Manuf. Company.....	Standard.	Bulge	$\frac{5}{8}$ "	8.169	99.06	594
2	"	XL.	"	"	6.426	127.53	815
3	Perkins and House.....	Hinge.	"	"	6.587	125.35	823
4	Scovill Manuf. Company.....	Imperial.	Sun	"	5.138	163.93	820
5	Collins.....	Sun.	"	"	4.829	171.89	830
6	Scovill Manuf. Company.....	Imperial.	"	$\frac{3}{8}$ "	4.810	174.87	835
7	"	Hinge.	Bulge	$\frac{3}{8}$ "	7.398	115.23	887
8	Holmes, Booth and Hayden.....	Sun.	Sun	"	7.371	131.19	964
9	Scovill Manuf. Company.....	Phoenix.	"	"	5.997	188.67	1110
10	Jones, McDuffee and Stratton....	Calcium.	Bulge	1"	10.754	113.17	1299
11	Downer Company	Dual.	"	$\frac{1}{8}$ "	19.48	As these lamps were made to burn mineral sperm oil, we do not give the results.	
12	"	Dual.	"	$\frac{1}{2}$ "	10.03		

Circular Wicks.

13	Holmes, Booth and Hayden.....	Argand.	Cylindrical.		8.387	101.20	833
14	Jones, McDuffee and Stratton....	"	"		8.824	103.68	911
15	W. H. Batchelder.....	Defiance.	"		10.905	123.68	1347

The list could have been made much longer, but it would serve our purpose no better.

The oil used was Downer's kerosene; sp. gr. 0.801. One gallon, at 62° F., weighing 3025.3 grammes. The first column of results shows the candle power given by the lamp when burning with a full flame, but below the smoking point.

The second gives the number of hours required to consume one gallon of oil.

The object of the third column is to give the economy of the lamp, by a unit, which is the candle power given by an ideal lamp, exactly similar to the one under observation, with the exception that it shall consume precisely one gallon of oil an hour.

This result is constant for all except extremely high or low flames.

Such a unit is very empirical, but no more so than the modulus of elasticity, or absolute zero.

If we merely show the phenomena of some lamps differing from others, without the probable circumstances tending to produce such differences, we should not have accomplished our object.

A simple inspection of the above lamps shows their economical re-

sults to be in the direct ratio to the facilities afforded the air for approaching the base of the flame. Where the air cannot enter freely, much of the oil seems to be volatilized without combustion.

The best example is given by cases 5, 8, 9 and 10. The lamps are all similar, except in the difference noted below, and are of the pattern generally known as "sun burners."

In the first example, the air must pass through two horizontal brass diaphragms at the base of the chimney; one is pierced with holes $\frac{3}{8}$ " diameter, the other about $\frac{1}{16}$ ". Case 8, one fine diaphragm at base of chimney. Cases 9 and 10, the base of the chimney is open; a diaphragm is near the base of flame.

Although the two lamps are different in size, they are identical in principle, the following being the cause of difference in the result:

A certain portion of the light is shaded by the top of the burner. This conceals an equal amount (not proportion) of the flame, whether it is high or low. Also, a large flame makes a much more powerful draught than a smaller one. If we have two similar lamps, the larger one will give the best results.

In the four lamps just cited, if we remove the coarse diaphragm from the first lamp, we increase its efficiency 16 per cent.; in addition, taking away the fine one, we increase it 18 per cent. more; make the draught more powerful by a bulge chimney, and we have a further increase of 12 per cent. Lamps like 9 and 10, from their open construction, are extremely sensitive to currents of air.

The Perkins and House lamp (No. 3) is a metallic lamp, and very thoroughly constructed. The air is supplied from the base of the lamp, the burner being closed; it is not sensitive to currents of air, and gives the most steady and agreeable flame of any that have come under observation. If the entrance to the air passage was made larger, and the diaphragms in the burner were pierced with larger holes, the efficiency of the burner would be increased greatly, while it would probably retain its steadiness of flame.

In lamp No. 15 the air is introduced into the centre of the flame with less obstruction than in the two previous cases, and this lamp gave the most economical results.