you for the speed with which you have relieved me of a heavy burden."

"It is my business, and you pay me for my services, Mr. Brooke; and remember your burden is only shifted from one shoulder to the other. You will have to meet heavy bills in three months."

"Ah, that is nothing," I said lightly, and I felt that one had only to work hard and all would come right as far as the business was concerned, for, as I have said, I knew nothing of finance with its delicate machinery. Then I added as I shook hands with the kind old lawyer, "You spoke of your services being paid for, Mr. Clifford; this is one which no payment can compensate. I must always be your debtor." I felt what I said.

We parted in the street, Mr. Clifford going towards Gray's Inn, I to Lombard Street.

I paid in the cheque, saw it entered by the clerk, and then walked to the station at Ludgate Hill with a light heart. For though I had not made the entire restitution I contemplated, I had at least paid back the sum I had taken from the Abbey, and so looking at it in one way I had enriched Harold. His grandfather's letter had come too late for him to benefit by its communication. With Crastock Abbey he sold his right to all it contained, and he had not now the power to ascertain the truth of Lord Grandison's statement. Had I never seen the money he would clearly have been a loser.

"I have nothing now to fear," thought I; "I have restored the principal, and the interest shall follow. Encumbered as it is with debt, the pottery is still a fine property; and when I have cleared it of debt, it shall be his. And he shall have my loving, beautiful Iris, and then indeed he will owe happiness and fortune to me."

I was happy enough that night, and Granny, after once tidying up the fireplace, forgot all about her sliding brush for the rest of the evening. A vision of happiness came before me when I closed my eyes at night.

Ah! how hard, how almost impossible it is for a man to escape the punishment of his evil act. He eludes pursuit in one direction only to rush into another difficulty. He is never safe.

I was sitting in my office the next afternoon when a clerk brought word that an old gentleman wished to see Sir Harold Grandison.

"Lord Grandison, I should ha' said," said a thin high-pitched voice in the rear of the clerk. "It takes an old man like me who knowed his grandfather when he first came to his title, like, a mortal long while to understand how Mr. Harold and Lord Grandison's one and the same party, like."

The clerk stepped back and made way for the speaker, an old, old man, thin and bent, in a faded livery, with a shiny old hat coming down to his ears; he supported the weight of his body with a stick which he held in his right hand; his left hand lay palm upwards on his bent back. His face was lean and wrinkled, and the few straggling hairs upon his chin and cheek were quite white.

I knew him at once, old Adams, the gardener of Crastock Abbey.

END OF CHAPTER THE TWELFTH.

FROM CANDLES TO GAS.

BY J. MUNRO, C.E.

TO satisfy his wants, man takes at first the means which lie nearest to his hand; but as these become spent, or as his art increases, he brings into requisition deeper stores of material and more occult sources of energy. Thus it is that to supply himself with artificial light he has successively advanced from the torch and rush-light of early times to the modern candle and oil-lamp, and from these again to the gas-jet and electric light. For public illumination, oil-lamps have in turn superseded torches, gas has superseded oil-lamps, and the time may possibly come when electricity will take the place of gas.

Before considering these different sources of light, let us first see what is the nature of a flame. Flame is a stream of gaseous matter in a state of ignition, or at a very high temperature. Where the flame is produced by burning, or combustion, as with candles, oil, and gas, the high temperature is created by chemical combination of hydrogen and carbon in the fuel with the oxygen of the surrounding air to form water on the one hand, and carbonic acid gas on the other. In the case of oils and candles, the hydrogen and carbon are liberated by the destructive distillation under heat of the fats which they contain. The flame of a candle, which is a type of other flames, consists of three parts, one within the other: an interior cell or reservoir of unignited gases surrounding the wick, a middle zone of bright white flame, and an outer shell of dimmer flame. The middle zone is the principal source of light, and owes its brilliance to the fact that the combustion is incomplete there, and

particles of solid carbon are heated to whiteness; while the outer shell or fringe, where the ignited gas meets the air and the carbon is completely burned, gives off little or no light. Of the products of combustion, water is, of course, harmless; but the carbonic acid poisons the air, and if it be in excess will in time impair vitality, as well as the strength of the flame, by stinting both of their proper meed of oxygen. It is the same gas which is given off by a person in breathing, and it has been estimated that two burning candles give off as much of it as a living adult. Smoke, or unconsumed particles of carbon, are also shed by an oil or candle flame, but only when it is getting an insufficient supply of oxygen. This supply of oxygen is maintained by the indraught of cold air from below to fill the place of the uprising heated air over the flame. The fuel, or liquid fat, to be distilled into its constituent gases is fed to the flame through the *wick* by capillary suction.

In the ancient torch, which was usually made by steeping a strand of tow in melted resin or pitch, the tow was the wick, and the pitch the fuel; and in the Anglo-Saxon rush-light grease was consumed by means of a wick of rush-pith. Both of these illuminators in time gave place to the modern candles, which were formerly made of tallow and wax alone, but since Chevreul's discovery, in 1825, that all fats are composed of certain fatty acids and a comparatively uninflammable substance termed glycerine, a variety of materials, such as stearine, paraffin, spermaceti, ozokerit, or mineral wax, palm oil, and cocoa-nut oil, have been used for candles.

These inflammable acids are separated from the glycerine by stirring the melted fat with lime and water, whereat the lime combines with the acids to form a soap and leaves the glycerine free. The soap is then decomposed under heat by adding sulphuric acid to unite with the lime, and the oleic acid after being purified is ready to be moulded into stearine candles.

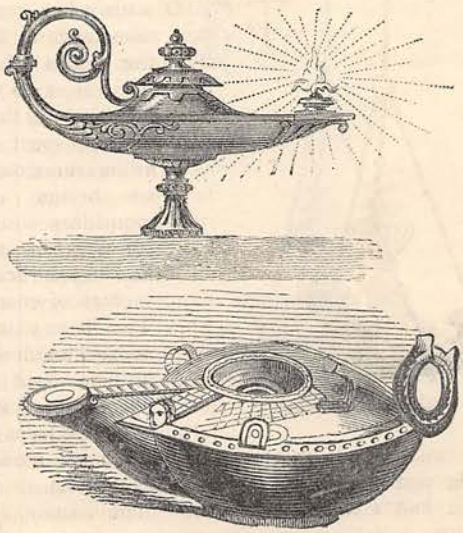
Candle-wicking is usually a loose spiral of cotton yarn, but plaited wicks to obviate snuffing, and wicks of spun glass, and felting, have also been introduced. In stearine candles the combustion is sometimes aided by impregnating the wick with boracic acid.

Candles are made by either dipping the wicks again and again into the melted fat, by means of a simple rotating frame, or moulded by immersing sets of polished pewter moulds, each charged with its wick, in the vat of melted fat. Wax candles, being liable to crack, are made by ladling the fluid wax on the wick. Presses have been invented for making a continuous candle, which was then cut into lengths, but they are not in general use. Wax tapers, however, are made in this way, and shaped by drawing them through draw-holes, like metal wires. Paraffin, which is obtained from petroleum, or by distillation of peat, lignite, and ozokerit, is made into candles by mixing it with stearine and moulding it hot, then cooling in cold water to preserve the transparency. Spermaceti, a solid substance filtered from the oil of the sperm whale, is mixed with wax or paraffin before being moulded, and the result is a costly but very fine candle. Composite candles are a mixture of the acid from palm-oil and the stearine from cocoa-nut oil. Belmont sperm candles are made of palm-acid hot-pressed into shape; and the well-known *night-lights* are short, thick cylinders of wax shod with tin, and provided with a cotton wick forced up a hole in their centres.

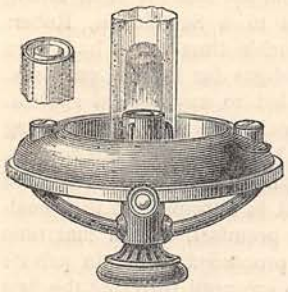
We have seen that the candle is a means for burning those fats which are solid at ordinary temperatures; the lamp, on the other hand, is a contrivance for burning those fats, or oils, which are fluid at ordinary temperatures. The kind of oil burned varies very much with the sources of supply; for example, in England whale oil was for a long time used, until the introduction of coal-gas and the later mineral oils. In Paris oil from rape and poppy seeds is still employed; in Italy they make use of oil from the grape-pip; in Piedmont, oil from the walnut; in China, oil from the sesamum seed; and in tropical countries, oil from the cocoa-nut; while, as is well known, the Eskimo of the Arctic regions burn seal oil.

Naphtha, the most liquid of all the oils, was once distilled from coal and burned in the London street lamps. Alcohol is chiefly used as a source of heat in spirit lamps on account of its sootless flame.

The antique lamp was a flat cruse or dish, beautifully shaped and having an unspun wick rising through a hole in the beak; but it gave a very poor smoky flame. The requirements of a good lamp are that there shall be as complete combustion of the hydrogen and carbon of the oil as possible, that the wick shall be fed with a constant and regular supply of oil, and that the form shall be such as to throw as little shadow as possible. All the earlier lamps were more or less imperfect, especially as regards the first of these conditions; and it was not until the year 1789, when Ami Argand invented what is now known as the Argand burner, that a really brilliant lamp was known.



ANCIENT LAMPS.



ARGAND'S BURNER.

Argand's discovery created such a revolution in this mode of lighting that he was publicly persecuted by the tinners, locksmiths, and ironmongers of his time, who disputed his right to infringe the charter of their vocation by any improvements soever. This invention simply consisted in forming the burner of two concentric cylinders, the intermediate space being filled by the wick, which was of a hollow cylindrical form, and the oil to be consumed. The interior cylinder was left open at top and bottom, so that a current of air could enter at the bottom and supply a constant stream of oxygen to the *centre* of the flame. In ordinary lamps the middle part of the flame is taken up with unconsumed gases, which pass away in smoke, but Argand directed a current of oxygen through these so as to effect their combustion. The difference between the common lamp and the candle flame has, indeed, been aptly compared to the difference between a fire made in the open air without any forced method of supplying it with oxygen, and a fire made in a furnace to which a rapid supply of oxygen is furnished by means of the central tube and the draught of the chimney which encloses the whole. Argand's burner has become so general over the world, not only for oil lamps, but for gas lamps, and for heating in chemical analysis, that it is entitled to be reckoned a first-rate invention.

Lamps are so various in their forms and qualities, that we can only briefly describe a few of the better-known modern kinds. In order to get rid of shadows the Fountain Reservoir lamp was early introduced, and still exists in the Student's Reading-lamp, in which the oil-vessel is removed to one side of the burner, so that its shadow may fall to that side of the room where the light is least wanted. In this lamp the Argand burner is adopted.

To abolish the shadow entirely, however, the reservoir is now generally placed below the flame, and in order to supply more oil to the latter than can rise by capillarity, different processes have been applied. For instance, in the Carcel lamp the oil is pumped up from the bottom of the lamp by clock-work, in such a quantity as to exceed that consumed during the whole period of burning, and the unconsumed portion flows back to the reservoir over the outside of the burner. This lamp gives an excellent light, but is somewhat expensive. In the Moderator lamp, the oil is forced up the wick by means of a spiral spring, pressing on a disc immersed in the oil. The spring of this lamp, like the clock-work of the Carcel, requires to be periodically wound up. The flow of the oil to the wick is *moderated* by means of a tapering rod of iron wire which is placed in the ascending tube, and as the pressure of the oil increases it is forced more into the tube, thereby checking the ascent of the oil.

Owing to the extreme fluidity of the mineral oils, such as naphtha, camphine, petroleum, and paraffin, the capillarity of the wick is sufficient of itself to raise enough oil to the flame. Naphtha is sometimes burned in lamps without a wick, such as the Steam and Vapour lamp, in which a current of air traverses the naphtha and becomes saturated with it; or the lamp, so common on our hucksters' stalls, where the flame proceeds from a knob perforated with a circle of holes. Camphine, or turpentine deprived of its water and smell, is a powerful illuminant if well supplied with air, but very obnoxious owing to the disagreeable fumes and soot which it gives off if stinted of oxygen.

Among the most serviceable lamps now in use are the Silber lamp, the Indicator, the Paragon, the Duplex, and the Triplex. The Silber is a Moderator lamp, made to burn petroleum and colza. It has an Argand burner, and a large cylindrical split wick with a metal cone over it, to converge the outer draught on the flame, and various minor improvements. It yields a light at full power equal to twenty-four candles, and will burn for seven hours or more without replenishing with oil. The Indicator, also a form of Moderator, has an adjustable funnel for regulating the combustion. It burns colza oil, and yields a smaller light than the Silber. The Paragon, a petroleum lamp very common in the colonies and America, has a single flat wick made very wide, so as to give a large flame, and a cone over it. It gives a light of twenty-three candles, and burns for seven hours. The Duplex lamp, as its name implies, has two flat wicks, side by side, both movable by one thumbscrew, and a cone over them. It burns crystal oil, or purified petroleum, and yields a full light of twenty-five candles. Opinion is divided as to the relative merits of the Silber, the Paragon, and the Duplex lamps, but we may mention that a recent writer on the subject gives the palm to the improved Silber, and deems the Paragon somewhat more economical than the Duplex in point of oil, though it is more difficult to manage, and its chimneys are apt to break; on the other hand, we have seen the Duplex preferred to the other two. All three are good lamps, and the Duplex and Silber are the best known in this country. The Triplex lamp has three wicks arranged so as to give a Δ section. Like the Cylindrical and Duplex wicks, it is not so economical as a single flat-wicked lamp—that is, it does not give so much light for the same quantity of oil—but it yields a very large flame, and is suitable for dining and billiard-rooms, where expense is not so much the object as a good light. And here, before leaving the subject, let us recommend consumers of paraffin and petroleum to buy it from a respectable firm.

We have seen that the flame of a candle or an oil lamp is fed by inflammable gases yielded by the destructive distillation of the wax, tallow, or oil. In the

manufacture of coal-gas those hydro-carbon gases are produced on a large scale by the destructive distillation of coal; and they are consumed in the flame of a lighted gas-burner just as they are consumed in the flame of a candle or a lamp. In fact, the only essential difference between oil or candle-lights and gas-jets is that in the case of the former the destructive distillation is immediate, and takes place at the light itself, whereas in the case of the latter it is a general process apart, the gases being generated and stored at a distance from the points where they are consumed.

Inflammable gas occurs in nature in great quantities among certain carbonaceous deposits in America, the Caspian Sea, and elsewhere, as well as among beds of rock-salt in China and Hungary. The merit of discovering and utilising artificial gas belongs among the nations to our own country, and the chief credit, as is well known, is due to a Scotchman, Robert Murdoch. Before Murdoch's time there had been many attempts to use coal-gas for lighting purposes, but none of these trials led to any marked success. In 1792, however, Murdoch, who was then residing at Redruth in Cornwall, began to study the subject, and five years later lighted up the workshop of Messrs. Boulton and Watt in Birmingham with coal-gas manufactured on the premises. From that time the introduction of gas proceeded apace in private establishments, but it was not until 1810 that the first public company, the Gaslight and Coke Company, was formed by Act of Parliament for the manufacture and supply of gas for streets and homes. In 1813 Westminster Bridge was first lighted with gas; and three years later gas was common in London.

A TOWN OF CORAL-FISHERS.

THE pleasant town of Torre del Greco, now numbering nearly 5,000 inhabitants, was once celebrated for its fertile fields and vineyards. But repeated eruptions of fiery lava from the neighbouring volcano gradually changed the district into an arid desert of scoria and sand, repeatedly destroying the town, which, however, as repeatedly rose again from its ashes. After the celebrated eruption of 1631, it had been rebuilt in little more than a century by the 3,000 remaining inhabitants and their descendants, when, in the year 1737, another fiery torrent destroyed its eastern part. In 1749 the western quarter was overwhelmed by a stream of lava which overtopped the roofs. The last time that the town suffered from this terrible scourge was in 1861, when, on the opening of several new craters not far off, the houses which had been built on the old lava-beds of 1784 suddenly crumbled like the walls of Jericho at the blast of the trumpet.

The inhabitants, prevented by such disasters from gaining riches from the earth, sought for them in the sea. It is now about a century since the prows of the Torre coral-boats first made their way into Tunisian waters, and we may yet recall to mind the struggle which took place between the African company and the fishermen of Torre del Greco when, in less than seven years, the latter, approaching the coasts of Barbary, made themselves masters of more than sixty miles of sea.

At the present time a large proportion of the inhabitants of Torre derive their subsistence from the coral trade. The number of coral-boats belonging to the town is from 500 to 600. The vessels are generally about eight tons burden, and when new are worth from 300 to 500 francs, according to size. When a bank of coral is discovered, it is fished by boats from all parts, the laws as to right of property in a newly-discovered bank not having yet been fixed. The coral merchants of Torre del Greco trade almost exclusively with foreign countries, very little business being done with Naples or other parts of Italy.

We visited the largest coral merchant and manufacturer in Torre del Greco, who may be taken as the representative of his class. He alone possesses a fleet of boats, consisting of five schooners, two *martinganes*, and thirty-seven *corallinas*. The other merchants of the town have one, two, or three boats. The above-mentioned merchant has gradually accumulated a fortune of 10,000,000 francs, beginning life as a common coral-fisher.

Every year, towards the end of January, his little fleet leaves Torre del Greco for an eight months' cruise. Each boat carries a captain—commander—and nine men, who live during the time of their absence on dried peas and beans, macaroni, and wine. They carry provisions for about a fortnight, and when these are finished run into the nearest port for more. They sleep in the small cabins below the level deck, the captain alone under the prow, the men at the stern. In October they return home and rest during the four winter months. Very rarely one or the other undertakes a winter voyage in some ship in the interests of his employer. The men are paid for the whole season; the commander earns from 600 to 1,000 francs, the men from 300 to 400 according to age and ability.

The manner of fishing the coral is as follows:—Every boat is provided with one or two chests in