WHAT CHEMISTRY CAN DO.

PROF. DEWAR DESCRIBES HOW HE SOLIDIFIES AND LIQUEFIES AIR AND GAS.

The Solidification of Nitrogen and Air Frozen Gas—The Marvels of Chemistry in the Workshops of Davy, Faraday, and Dr. Thomas Young Described—An Interview with James Dewar Described.

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The science of chemistry, like that of geography, has its undiscovered North Pole. Four hundred and sixty-one degrees below the freezing point of the Fahrenheit thermometer (−274° C.) lies almysterious, specially indicated degree of cold which science has long been gazing toward and striving to attain, wondering meanwhile what may be the conditions of matter at this unexplored point. Its existence has long been indicated and its position established in two different ways, viz., the regularly diminishing volumes of gases and the steady falling off in the resistance made by pure metals to the passage through them of electricity under increasing degrees of cold. This point, to which both these processes tend as an ultimate, is called the zero of absolute temperature. By more than one eminent observer it is supposed to be the temperature of interstellar space, the normal temperature of the universe. Whether or not this supposition be correct, the efforts which have been made and are still in progress to reach this degree of cold have been many, diverse, and ingenious, the equipment of the explorer being not boats, condensed foods, and the general machinery of ice exploration, but all the varied resources of mechanics and of chemistry which can be combined to compass the extremest degrees of cold.

All the world has heard of Prof. James Dewar, and of his late great triumphs in the liquefaction of oxygen gas and the solidification of nitrogen and air. The sensation caused by his extraordinary results won him at once the congratulations of many scientific men, the profuse encomiums of the press, and the flattering recognition of appreciative royal personages. This was largely due to the fact that in the search for this unknown and mysterious point he had plunged much deeper than any chemist before him into the regions of low temperature, and had arrived within sixty degrees centigrade of the point itself. This exciting and not uneventful journey downward did not take him beyond the confines of his own laboratory, but his description of it, as well as of the properties of matter under extreme cold, has something of the fascination, to the mind possessed of ordinary chemical curiosity, of the story of a Stanley, a Nansen, or a Peary, describing the peculiarities of countries in which they, of all men, have been first to set their feet.

Prof. Dewar, who was born in Kincardine-on-Forth in 1842, was educated at the University of Edinburgh, where his natural and special gifts as a chemist were developed by Dr. Lyon Playfair, at that time professor of chemistry in the university. The perspicacity and tenacity of purpose which are characteristic of so many Scotchmen were eminently the inheritance of Dr. Playfair's assistant, and between that period and the present a long series of original investigations in all departments of chemistry have won for Prof. Dewar at his prime the Jacksonian professorship of natural experimental philosophy at Cambridge University, the Fullerian professorship of chemistry at the Royal Institution, the Fellowship of the Royal Society, the degree of doctor of laws, and other dignities, which make great alphabetical richness after his name upon scientific occasions of state. Personally he is of middle height and strong build, with a clearly cut face, full of character. His speech, faintly flavored with the accent of Scotia, is exact and emphatic, and his manner, whether he is concentrated upon a scientific demonstration in his laboratory or traversing the speculative questions of the hour in ordinary conversation in his drawing room, has the earnestness of the profound scientist, very agreeably tempered by the polish of the traveler and cosmopolitan man of the world. His absorption in scientific pursuits has not denied him a very marked æsthetic development, and his residential suit of apartments at the Royal Institution is filled with treasures, rare tapestries, bronzes, and carvings, picked up at continental depots or purchased at the sale of great collections, which would make a highly interesting article in themselves. To her husband's scientific sense of the value of age in wines Mrs. Dewar adds her original researches in the matter of choice teas, and it is averred by the eminent membership of the Royal Institution that the degree of domestic civilization which prevails on the third floor of the building is quite as high and more potentially attractive than the stage of scientific civilization which rules in the theatre, the libraries, and the laboratories of the floors below. Like most Scotchmen, however, Prof. Dewar is simple in his tastes, and is more deeply stirred by a frozen gas or an antique bronze than anything in the way of bisques or supremes. His heart, which shows no signs of low temperature, is mainly in his laboratory, and he leads the way there, down a flight of stone steps to the basement, with a readiness that very clearly exhibits his latent enthusiasm.

Moreover, it is a laboratory eminently calculated to excite the enthusiasm of anybody, being, in fact, the most famous laboratory known to chemical science. The workshop of Sir Humphry Davy, Michael Faraday, and Dr. Thomas Young, to say nothing of lesser and still famous men, is a nest in which more great discoveries have been hatched than any other of its kind on earth. Here it was that Young conducted the experiments which gave us the undulatory theory of light. Here Davy, covering, nearly one hundred years ago, almost the whole field of chemistry and electricity, made clear those principles which science and applied science since his time have developed to the marvelous degrees of to-day. A little room leading to the right of the main laboratory was the scene of all of Faraday's experiments in magnetism, and a cellar on its south side is known to this day as "Davy's Froggery," from the fact that Davy kept in it hundreds of live frogs for use in his experiments. Prof. Dewar, whose sense of the inspiration of his surroundings is deep, dwells upon them with interest, and tells how, on one occasion, a barrel of live frogs, imported by Davy from France, burst at the docks, causing astonishment there and consternation in the laboratory when Davy learned of his loss. In this laboratory that Faraday first liquefied chlorine gas, sending thereupon that famous note to Dr. Paris, the biographer of Davy, in 1823:

DEAR SIR: The oil you noticed yesterday turns out to be liquid chlorine. Yours faithfully,

MICHAEL FARADAY.

All of Faraday's work in the liquefaction of gases, the discovery of new hydrocarbons, the study of the changes of steel through the slight admixture of other metals, the improvement of optical glass, and the long list of results which are to-day represented in millions of tons of products from thousands of factories, were obtained within these four walls. And nothing could better illustrate the earnestness and modesty of the great chemist than a little anecdote which Prof. Dewar, standing in the centre of the room, calls to mind. "I never met Faraday," says he, "but Tyndall told me this story of him: The first time Tyndall entered this laboratory Faraday led him to this point and said: "Tyndall, this is a sacred spot. This is the spot on which Davy separated sodium and potassium."

The laboratory of to-day, however, looks very little like a scene of chemical industry. It has more the air of a machine shop, equipped with power and mechanical appliances of a very heavy kind. Instead of bottles and multi-colored liquids, all is metal and steam. The room is about 30 feet wide and 50 deep, the north front consisting entirely of glass windows, opening on a well-lighted interior court. In the left-hand corner, at the back, is a large steam engine, while the smaller one occupies the corner diagonally across. Shafts, wheels, and belting run to two large air pumps and three steel compressors, each about the size and shape of a small travelling trunk, and used respectively for compressing oxygen, nitrous oxide, and ethylene. A fourth compressor, of double compressing chamber, is cylindrical in form, and is wrapped in thick white flannel. This is the source of the liquefied oxygen. The system which Prof. Dewar has followed is not novel in its general principles, as he explains. Specifically, however, it contains many new inventions which he does not wish made public. They are mainly in the nature of stopcocks and valves, which it took long study to invent, and which became perfect only after many failures and costly experiments. To liquefy oxygen he simply used pressure at low temperatures; but as, up to 1878, both oxygen and nitrogen, after repeated trials, were looked upon as permanent gases, it may be imagined that the attainment of temperatures low enough was a problem which required an extraordinary command of mechanics as well as of chemistry to practically solve.

"The process of liquefying oxygen, briefly speaking," says the Professor, "is this. Into the outer chamber of that double compressor I introduce, through a pipe, liquid nitrous oxide gas, under a pressure of about 1,400 pounds to the square inch. I then allow it to evaporate rapidly, and thus obtain a temperature around the inner chamber of −90° C. (−130° F.). Into this cooler inner chamber I introduce liquid ethylene, which is a gas at ordinary temperatures, under a pressure of 1,800 pounds to the square inch. When the inner chamber is full of ethylene, its rapid evaporation under exhaustion reduces the temperature to −145° C. (−229° F.). Running through this inner chamber is a tube containing oxygen gas under a pressure of 750 pounds to the square inch. The 'critical point' of oxygen gas, that is, the point above which no amount of pressure will reduce it to a liquid, is −113° C., but this pressure, at the temperature of −145° C., is amply sufficient to cause it to liquefy rapidly. In drawing off the liquid under this pressure I lose nine-tenths of it by evaporation, and I have not yet seen how to diminish that loss. Every pint of it which I collect, therefore, represents ten pints manufactured. In all, I have thus far collected and used about fifty gallons, and the cost of machinery and experiments, very generously met by subscription among members of the royal institution and others, has been about £5,000 sterling." It should be stated that one of the most generous contributors to the fund has been Prof. Dewar himself, a large fraction of the sum coming out of his own pocket.

Going more into detail, he makes clear some of the mechanical and chemical difficulties which beset him in the work. "The secret of my success," he continues, "has been the mechanical arrangements combined with the use of ethylene. This is a volatile hydro-carbon, and is the chief illuminating constituent of coal gas. The only means of keeping it liquid for any length of time is to surround it with solid carbonic acid. Faraday was the first to call attention to the properties of ethylene, and we manufacture it by heating sulphuric acid in a glass retort, protected by an iron cover to 160° C. Alcohol heated to 160° C. is allowed to drip into it, and ethylene results, passing off as a gas, which is stored, after being purified. It is then compressed by two pumps, the first with a six-inch plunger and six-inch stroke, and the second a two-inch plunger and six-inch stroke. This liquefies it under the pressure stated. It is nasty stuff to handle, as, whenever it becomes mixed, by leakage or otherwise, with nitrous oxide of air, an explosion is imminent, and we have not had a few explosions in the course of the work. It liquefies at −103° C. (−152.4° F.), and when boiled in a partial vacuum absorbs a large amount of latent heat. The failure of preceding attempts to liquefy oxygen is due to lack of knowledge of its 'critical point,' and the law which that phase describes. As long ago as 1861 Natterer subjected oxygen to a pressure of 2,800 atmospheres, or over thirty tons to the square inch. He obtained no result, because, as I have said, no amount of pressure will affect it above −113° C. I liquefy it at −145° C. for two reasons. The lower the temperature at which it is liquefied the less is the pressure required upon the oxygen and the greater is the amount of latent heat which it absorbs in evaporating. By evaporating under exhaustion oxygen liquefied at −145° C. I get as low as −200° C., which I could not do were it liquefied at a higher temperature.

"Having obtained the liquid oxygen," he continues, turning to the long table below the windows, "the question was how to store it for working purposes, with the least possible loss by evaporation." After various trials and experiments, we devised a set of vacuum vessels, each consisting of a tube or bottle for the liquid oxygen, sealed at the neck in a second tube or bottle, from which the air had been exhausted. I found the cheapest and best method of getting a vacuum to be the old Torricellian one of driving out the air with mercury vapor and then condensing the vapor. This had the further advantage. The tube containing the liquid oxygen was so cold that it froze the mercury vapor, and coated itself with a perfect metallic mirror, which by its reflection still further diminished the loss by radiated heat from the outside." Without more ado he lifted from a small frame one of the vacuum vessels referred to. It was a white glass jar, inside of which was what seemed to be a round metallic ball. Open at the neck this ball was a bottle nearly filled with liquid oxygen, and by the light which reached it through the neck of the bottle it was a very clear pale blue liquid, which was evaporating quietly in a single thread of tiny bubbles, like a glass of champagne which has become nearly still.

It was one of those moments which Faraday would doubtless have regarded as solemn. To behold, for the first time, a liquid which your professors of chemistry have assured you was a gas and always would be a gas, is an experience which does not occur many times in a lifetime. After that, a sight of perpetual motion or the square of the circle would leave you calm. To know, furthermore, that this strange gas, which is the prime agent of all life, which is eight-ninths of all water and three-fourths of the entire earth, has been laid captive by science, reduced to a form which cannot fail to shed a flood of light on any number of abstruse problems in chemistry and mechanics, excites a deeper feeling. The pale blue liquid, which is strangely lustrous, seems almost magical. Moreover, it is a great surprise to see the liquid, which you expect to find under great pressure and ready to blow its containing vessel to pieces, evaporating quietly in the air, protected from heat by a vacuum on one side and its own cold vapor on the other. And so you can do nothing but stare at it in amazement, and gently shake the bottle, and turn from it to its discoverer with a feeling which is not entirely dissociated from awe. It has lost all its impressiveness to the professor, however, for he is busy preparing to illustrate some of its properties—an interesting introduction in themselves to the conditions which prevail twice as far below the freezing point of water as its boiling point lies above.

He begins by pouring some of the oxygen into a test tube, white fumes appearing as he does so from the freezing of the moisture in the surrounding air. Then he drops into the liquid oxygen in the test tube a bit of phosphorus. Despite the flaming energy with which these two combine at ordinary temperatures, there is no action. The phosphorus is as unaffected as a chip of wood in water. He takes it out and pours in some pure alcohol, whose freezing point is much below that of mercury. It freezes with a slight sputter into what you can only call alcohol ice. He takes out the ice and holds a match to it. There is no sign of combustion. Placed in a glass dish the alcohol ice melts into a thick, oily liquid, which also declines to burn. In a few seconds, however, it warms to its ordinary thinness and burns as hungrily as ever. Then comes an exhibition of the "spheroidal state." A drop of water thrown on a red-hot stove does not touch the stove, because the evaporation is so rapid that the forming gas lifts the water and keeps it moving about. Precisely the same thing occurs when the oxygen is dropped on a flat glass dish at the temperature of the air, which is red-hot to the oxygen, comparatively speaking. It dances about, shaking and boiling furiously. As he pours it, a tiny drop splashes on the Professor's hand and he flings it off with a quick jerk. "It makes a sore worse than a burn," he explains, "if it ever touches the skin." Then he drops some of it into water. It floats quietly, and as it boils off into gas freezes a cup of water around it, floating about comfortably in its own boat. Then came curious evidence of its magnetic properties. Pouring a little into a flat cup of rock salt, he placed the cup between the poles of an electro-magnet, the one which Faraday used. The boiling liquid, the moment that the circuit was complete, flew to the two terminals en masse and clung there, still boiling away rapidly on the two points. A piece of cotton wool soaked in the liquid was held closely to one of the points until all the oxygen had been sucked out of it, when it hung suspended between them. Liquid oxygen has a magnetic property, he said, which is about 1,000 as compared with 1,000,000, the magnetic property of iron. It is a non-conductor of electricity, and a spark one-tenth of a millimetre long from a coil machine, which would give a long spark in the air, would not pass through the liquid. It gave a flash now and then as a bubble of oxygen vapor came between the terminals. Liquid oxygen is, in fact, a high insulator.

Liquid oxygen at atmospheric pressure boils at −184° C. (−299.2° F.). By evaporating it under a diminished pressure he gets much higher degrees of cold, and these have enabled him both to liquefy and solidify nitrogen and air. The experiment illustrating this was not only interesting; it was difficult to believe. In a double vacuum vessel, the centre of which was an open-test tube and the second compartment a reservoir of liquid oxygen connected with an exhaust pump, he so lowered the pressure that the oxygen boiled tumultuously. As it did so, drops of clear liquid began to form on the sides of the test tube and gather at the bottom. It was liquid air, the oxygen and nitrogen of the atmosphere liquefying together at a temperature of −197.2 C. (−322.9 F.). He poured some of the liquid air into a second tube, and then showed how the nitrogen, which liquefies at a temperature 14 degrees below oxygen, boiled off first. A smouldering splinter of wood held at the mouth of the tube was extinguished. A few moments later, when it was again held, it burst into brilliant flame. The nitrogen had all evaporated, and the oxygen was coming off. He explained that air became solid under pressure at −207 C. (−340.6 F.). It was a structureless glass, and he had not determined whether or not the oxygen in it was solid or was held suspended as a jelly. Nitrogen solidified under pressure at −210 C. (−346 F.). It was a white crystalline substance. He had no knowledge as yet whether oxygen crystallized in solidifying, but his belief was that it would not.

Concerning hydrogen, most elusive of all the gases, he had no present expectation of obtaining liquefaction. Its critical point was below −210 C., and its boiling point −250 C. He had no means as yet of attacking the problem. In fact the only thermometer he was able to use at these low temperatures was one which used hydrogen expansion as a measure of temperature. His main reliance in measuring low temperatures was a thermo-electric junction. Deeply interesting also was his description of liquid ozone, that strange form of oxygen which, though identical with it in constitution, is different in molecular arrangement. He obtains 20 per cent. of ozone from liquid oxygen by electrical stimulation, the ozone being of a very dark blue color, as dark as concentrated indigo. It is highly unstable, a beam of light having caused it to explode on one occasion, and its study even in small quantities requires all the delicacy of manipulation which is one of the special directions in which Prof. Dewar as a chemist occupies the foremost rank.

Through all these explanations, and others too elaborate and too technical for these pages, he had spoken in the clear, emphatic way which is characteristic of men who deal with abstruse subjects, and desire, from long habit, to present them with the maximum of clearness and the minimum of words. His speech is incisive, the utterances of an energetic and concentrated mind. Over a cup of tea up stairs, however, he spoke more slowly and dwelt with interest upon some of the many strange results which have already met his eyes in the region of −200 Centigrade.

"As we approach the zero point of absolute temperature," said he, "we seem to be nearing what I can only call the death of matter. Pure metals undergo molecular changes, which cannot yet be defined, but which entirely alter their characteristics as we know them. Tensile strength, electrical resistance, in fact, the whole character of the metal, as we are acquainted with it, appears to change. At −200, for instance, iron becomes as good an electrical conductor as copper, while it is more than probable that at the zero of absolute temperature, if not before, the electrical resistance of all metals reaches its zero mark. The alloys do not follow the same rule, being much less affected. Carbon is a strange exception, its electrical resistance increasing with cold, and decreasing with heat. The effect upon colors is also remarkable, and opens up a wide field for experiment and investigation. I have the results marked and immediate of my experiments will appear, I think, in the field of magneto-optics. You have seen a red oxide of mercury turn yellow when cooled to the temperature of liquid oxygen and regain its original color upon returning to the temperature of the air. In the same way sulphur becomes white. Bichromate of potash becomes also white. A solution of iodine in alcohol becomes colorless, as does ferric chloride a deep red at the temperature of the air. They all regain their colors upon returning to the ordinary temperatures. At these low temperatures chemical action ceases, as you have seen. I supposed the rule was invariable, but I found that a photographic plate placed in liquid oxygen was still acted upon by energy from the outside and at even −200 C. was sensitive to light.

"The effect upon bacterial life is also not what one would have thought. If it be destroyed by boiling in water at a temperature of 100 C., it can still endure unaffected a degree of cold much greater in proportion. I have submitted putrefying blood, milk, seeds, &c., for the space of an hour to a temperature of −182 C., but found that they afterward went on putrefying or germinating as the case happened to be. This is interesting in one way, as it gives color to Lord Kelvin's suggestion that the first life might have been brought to this planet by a seed-bearing meteorite, though it does not explain," he added with a smile, "how the meteorite was originally charged with life. It does, however, that spores may live upon a planet through long periods of low temperature. In the phenomena of diminishing electrical resistance and its final disappearance, I look for much new light upon electricity itself. The changes in the characteristics of metals already observed enlock lessons whose scope we have not yet begun to measure. In fact," said he, "for a long time to come I shall confine myself to the many fields of research which the temperatures already attained have opened up."

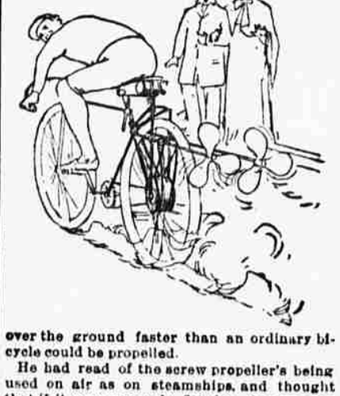
Concerning the zero of absolute temperature Prof. Dewar was disinclined to theorize. As to its being the temperature of the interstellar space, he has not yet come to any final conclusion, though he expressed the view that the strange white and shining night clouds which have puzzled the astronomers were composed of carbonic gas frozen solid. Nor does he yet, despite the temperature he reached, see how the zero is to be attained. He, like the Arctic explorers of the past, has reached a point beyond which no appliance of modern science can carry him. The mysteries which cluster about this point are so many, however, that the efforts to reach it will be untiring from this time forth. That its discovery will be a key to many unsolved problems in electricity, in matter in light, and the great inscrutable mystery of life itself, is not to be doubted. This is an age of constant change in scientific conceptions and traditions, every marked advance in any one science tending to cause more or less of a readjustment of existing views in every other. Science has long been editing the Book of Genesis with an unsparing pen, and with the attainment of the zero of absolute temperature the command "Let there be light" may take on a meaning which the profoundest philosopher or scientist of the present time cannot remotely conceive.

J. W. DAM.

A TWIN-SCREW BICYCLE.

How a Jerseyman Has Applied the Propeller Principle to the Tandem Wheels.

Frederick Heller, a plumber, living in Caldwell, N. J., who is a prominent cyclist in that place, has devised a scheme for the auxiliary propelling of bicycles, which, he thinks, will, with a good man above the pedals, revolutionize all existing records. In addition to the plumbing business Mr. Heller is engaged in the putting up of gas fixtures, and has to ride from house to house through the town. Realizing the necessity for speed, he set about to devise some scheme that would get him



GLAD TO TAKE A WALK.

over the ground faster than an ordinary bicycle could be propelled.

He had read of the screw propeller's being used on air as on steamships, and thought that if it were properly fitted to the rear of a bicycle and connected with a driving wheel by some light contrivance for transmitting power the benefit derived would more than compensate for the power expended in driving it.

His first apparatus consisted of a single screw, set in a steel frame and driven by a leather belt, which passed round a large drum at the axle of the rear wheel. This arrangement worked fairly well, and, he says, helped him materially in the propelling of the bicycle, but as it had to set on one side of the wheel, he found that it affected the steering to such an extent that if he did not pay careful attention to his work the course of his bicycle would be changed and he would fetch up against a fence or trees alongside of the road. He then thought of the feasibility of twin screws, as he had heard that they were used on steamships with considerable success. The difficulty presented, however, was that the gearing required would be too heavy, but he overcame that obstacle by having the different parts made of aluminum.

Mr. Heller uses a light wheel of standard manufacture, but has not altered it to any considerable extent in fitting it to work the screws. Fastened to the frame that holds the rear axle are two upright rods. These are turned at the top, and run into the heavy brace that holds the saddle post. The light steel shafts that have the propellers affixed to their ends pass through bearings in these rods. The power is derived from leather belts that pass around drums at the axle. The propellers used are made of brass, and are similar to those used as electric fans. They are driven at a high rate of speed, as the wheel on the shaft is not more than one-eighth the size of the drum, and they look like balls of gold when the cyclist whirls along the street.

Mr. Heller is not a crack rider, and he has only recently perfected his invention, but he says that within the past week he has beaten most of the local riders and some pretty good horses. He has made an application for a patent on his scheme, and says he would not sell it for big money.

Mr. Heller took his machine out Monday and gave a SUN reporter an exhibition of speed through the principal streets of Caldwell. The road was muddy, and the rain poured down steadily, and the cyclist claimed he could not give the device a proper showing. He came down the street, however, at a rattling rate, and the fans made a noise not unlike a miniature wind storm. They revolved so fast, indeed, that a steady stream of water could be seen shooting out from behind, and that, mixed with the mud that the back wheel threw up, made the rider look like a comet, for a trail of mud and water extended for some distance in the air behind him as he whizzed along. Two people in a carriage, who were driving in the same direction as the bicyclist, appreciated the fact that something unusual was attached to the wheel, for a shower of the muddy water flew up in their faces as he dashed past, and it frightened their horse so that it looked for a time as if a runaway would ensue. Heller says he has invited Champion Zimmerman to try his wheel and believes that he will decide in its favor.

IN A PARIS BOARDING HOUSE.

PERSONAL, SCENIC, AND SOCIAL ASPECTS OF THE FRENCH PENSION.

It is a Business Enterprise Pure and Simple Where Boarding in Private Families is Unknown—What it Gives the Guest to Eat and Drink—Madame, the Calculating and Benignant—Happy Girls and Experienced Old Maids—Bad Fires and Lights, Chilly Draughts, and Admirable Service—All Minor Discomforts Obliterated by the Peculiar Charm of Paris.

PARIS, Oct. 20.—For foreigners to find board in desirable French private families is practically next to impossible. Frenchmen, who actually have no word for "home," have the fiercest kind of jealousy for the thing itself. And it is by reason of this fact that mutual mistakes are so often made by English-speaking people and Frenchmen when they sit in judgment on each other.

The American or Englishman in Paris, stunned at first by the beer-garden-like life of the streets and parks and public resorts, thinks: "Really, these people have no homes!" Then he remembers the old saying that the French language has no word for "home." Poor Frenchmen! He does not reflect that it is partly because French home life is so

THE LANDLADY.

on the principles of any other business. What the private family cannot well do as a private family it can easily go into as a downright business speculation. The home life is put aside; children, if they exist, are packed off to boarding schools; the husband gives up his clerkship and devotes himself to supervising the new venture, several floors of a large apartment house are taken, they advertise constantly, and their establishment becomes a well-recognized and honorable business enterprise, like any other.

These boarding houses are very much given over to tourists and other foreigners. In the mind of the present writer they divide themselves roughly into six species. There are the high-class establishments, so high as to be slightly tainted with affectation. They very often go under the title of hotel, and are affected mainly by English and Americans. You can live in one of them for anything you please above $2.50 a day. The Grand Hotel, a real hotel, and one of the greatest in Paris, has a complete pension for $4 a day. Then there are professedly "family" boarding houses on a large scale, less formal and slightly less expensive. They are also mainly supported by English and Americans, according to their name of "family" boarding house. A separate table for exclusively French conversation is their mark. Thirdly, there is the ordinary high-class cosmopolitan boarding house, with a few English-speaking people and many Spaniards, Hungarians, Chinese, Turks, and Austrians and all the rest, whose atmosphere is a trifle bohemian. An American negro, should he have money and good manners, would be treated in such a company as well as anybody else. Fourthly, there are the small boarding hotels, all dirty, with a great deal to eat and of very ordinary quality. Then there is boarding in a struggling family in the suburbs or the Latin Quarter (husband and wife only), and, last, the boarding house run by Americans in Paris.

IN THE LOUVRE.

Among these varying establishments the heart of the American abroad will most naturally turn to the one of the French conversation table. There is something charming in its use of Baedekers and illustrated handbooks of French history, and in the ice-cream-soda flavor of its salon. On the day of an American meal the house is all agog. There is never a morning you cannot join a party on its first trip to the Louvre.

"Is it Gothic or Renaissance?"

"Louis XIV. and Colbert."

"Where is the window from which Charles IX. shot down his subjects?"

They prefer the modern paintings in the Luxembourg to Hebera's ancient waxy saints and Rubens's beefy damsels; and their joy is unconfined when some grave person assures them they do well. And in the Egyptian room of the Louvre, before the big stone feet of the colossus of Amenophis III., one of the pilgrims will always be able to quote:

I met a traveller from an antique land
Who said: "Two vast and trunkless legs of stone," * *

where his memory will regularly fail him so that he cannot add

Stand in the desert. Near them on the sand,
Half sunk, a shattered visage lies. * *

It is a pleasure to show them the way to George Washington's church—Protestant Episcopalian, as Americans are wont to call it. Church of England Mission, as it actually is, or "English Catholic," according to the more ritualistic on both sides of the water. The Rev. George Washington is of the English Washington family, and so gains a species of collateral reverence from all Americans. And when Sunday comes to pay a visit to the fountains at Versailles, this boarding house's population simply shoves the dinner back two hours.

"You have had a long promenade!" cries madame, beaming, as they come trooping in, blinking and yawning at half past 8 o'clock at night. "Have you had a beautiful promenade?"

That night they eat boiled beef (*sauce piquante*) as if it were tenderloin steak, and when the chicken legs and wings come on it is music to hear the ladies sigh with pleasure.

The life in such a pension has neither beginning, end, nor middle. The most diverse Americans find it easy to tolerate each other, for one is here to-day and gone to-morrow. Pretentious people, who would like to crush enthusiasm and innocence, find no leverage on which to use their strength. Madame, the wife of the proprietor, is a woman of fine presence, with an air of dignity tempered with good will. When some experienced old maid, the scourge of European pensions for twenty years, begins her harangue against the breezy ways of some of these American girls in their first days of Continental living, madame has her

AFTER THE BALL.

answer ready: "I find the young girls charming. They are unaffected and think no evil. I prefer them to difficult women."

In this pension there is one fine big blonde from out some Western capital. Each night in the blue-gray Paris autumn gloaming she celebrates her triumphs of the day, whether they be of the Louvre, of the Sainte-Chapelle, the Bon Marché or Sèvres or Père-Lachaise, by singing "After the Ball" to her own accompaniment at the piano in a rich contralto voice. The salon rings with song. Our old maid sniffs and walks away, and then the blonde sits placidly beside a rickety but highly ornamental brazen lamp stand and begins to read her Baedeker. "I only sing to drive that dear old creature out," she says. "She was just about to begin her lecture on the art treasures of Paris and how we should strive to utilize our time."

II.

This pension lies in the heart of that new and rich quarter of Paris which has come to be called American. In Paris all the houses are apartment houses. Here they are handsome and regular, about six stories high. They are built of a creamy white stone, so soft when it is first quarried that it may be carved with a penknife. Exposure to the weather hardens and darkens it, and the blue-gray haze of Paris spring, autumn, and winter weather gives it a yet more sober hue. There is great regularity in height, construction, and decoration, which contributes to the dignity of the streets. One of the special marks of these houses is the ever-present iron and stone balcony around the windows of the first floor (our second or third floor), and often on each floor above. These are the airing places of the denizens. Below, it is the asphalt sidewalk and the asphalt street, on which the apartment houses' wide and high portes-cochères yawn throughout the daytime.

Entering this great common doorway for half a dozen families, a winding marble staircase will be seen upon the right, handsome to pretentiousness, and taking up a deal of space. Behind it is an open court, gloomy but clean, whose only purpose is to light the hall. Upon the left you have the concierge's lodge. When the concierge is not eating or sleeping, he is walking about with a broom in his hand. His wife appears only to eat and sleep and answer questions. The two live in this one small room, directly beside the great door. Their bed is visible throughout the day, covered with a decent blue silk *edredon* and canopied in in some red stuff, like the bedstead of some ancient king. Beside the bed, on a little shelf, hangs a pneumatic tube connected with the catch of the big door of the street. When you come in at night you invariably stand outside and ring at first. You continue ringing until the concierge wakes up. He reaches sleepily over to the shelf, pushes the button, and the compressed air does the rest. The big door swings open, you shut it behind you, and then, walking past the concierge's door, you call out loudly your name, "Jackson!," "Smithers!" "Vasseur!" or whatever it may be.

It is the concierge's business to know the voices and names of all the people in the house. The name, age, nationality, and previous last residence of each newcomer is reported to the concierge by the *locataires* of the different apartments, who transmit them on regulation printed forms to the police. Apart from these duties the concierge must receive all letters and packages and "mount" them to their destination three times each day; must answer the questions of callers, "Is Mme. X. chez vous?" and keep the stairway and the big hall clean.

Because the house is comparatively new it has an elevator. There is no elevator boy; you work the thing yourself. It can only take two people going up, and you are forbidden to use it at all going down—it wastes the power. An immense iron rod, as thick around as a girl's waist and as long as a liberty pole, supports

CONVERSATION.

the car for safety, and its ponderous weight dragged up and down, after a fashion that seems to us Americans so useless, forbids anything like speed. The elevator crawls.

The elevator is only for the use of "masters"; all servants, laundresses, shop runners, and the like must take the stairs. These come to our pension in inconceivable numbers, with boxes, bundles, bags, and packages. From the Louvre, the Bon Marché, the Printemps, and the choicer, smaller shops, especially of the Rue de la Paix and Rue de Rivoli, the uniformed delivery men come daily to this tourist camping ground; and this in spite of the assertion you hear each evening in the salon, that nothing is cheap in Paris, except gloves.

The pension has four floors of the apartment house. The *bel étage* (the premier above the entresol) is given over to the public life. There is a wide hallway where gentlemen may smoke after lunch and dinner for a half hour or so, but at no other time; two dining rooms, not too handsome, and often crowded, and one large parlor. The floor is in hard wood, polished and laid out in patterns. Its furniture is handsome, if formal, in rococo style, with lavish gilding and pale silk.

It must be confessed that the conversation of this salon is not always of the arts and sciences. An American corporation has recently established itself in France. The wife of one official, living in this pension, was wont to count the weeks until the wife of another official should arrive to bear her company. They had never met before, but on the second day they were as thick as capitalists, until a difference arose.

"My dear, I would buy that hat."

"I can't afford it."

"Why, your husband has a good salary. He is cashier."

"He is treasurer," replied the first.

"Cashier."

"Treasurer!"

"He is cashier! And my husband is Vice-President! And my husband can send yours back to America if he pleases, madame!"

Now they do not speak, but their husbands grin mutually as they pass each other in the corridor; and neither in their official intercourse nor in their little jaunts about the town, picking up conversational French, has any lack of harmony been brought about.

SCOLDING HER HUSBAND.

The wife of the proprietor of the pension is such a charming lady, with a mouth so full of those platitudes in which the French delight, so good-natured and so sympathetic, that a lonely American widow with a disposition to chronic sadness and theological questionings became captivated with her goodness in two short weeks. Contrary to European practice, she made a friend of madame. It was summer time, and the two small children of the pension were home on their school vacation. Like nearly all French people who disputate as to religion at all, their mother is a Roman Catholic. The American widow, having been Methodist, Presbyterian, and agnostic in turn, with a year of theosophy and a shy at Swedenborgianism, found a peculiar restfulness in hearing the little ones say their prayers at night. The half-darkened bedchamber, the mother kneeling by the two, the dignity and sobriety of the function, with the clear French words falling from their infant lips in balanced sentences, gave her a thrill she had not felt for years. The American widow bought a catechism; and the children, with the fervor of youth, began to hear her lessons. In answer to the alarmed questionings of a ritualistic Anglican pastor—they call them all "pastors" in French, to their disgust—she said: "I judge a tree by its fruits. Madame is so good that I am sure her religion must be the true one." Others, who saw an inevitable disturbance ahead from this mixing up of business, social intercourse, and religion between people so unfitted to understand each other as an American widow and a French wife, warned her she was placing madame at a disadvantage.

The inevitable arrived. The house that was builded on the sands succumbed to a tiny freshet. The American found the Frenchwoman scolding her husband for having bought two pounds of beef too much at market, which straightaway decided her against the Catholic Church. And now at every extra added to her weekly bill, every mistake in the numbering of the wash, every time she gets a chicken leg when her neighbor gets a wing, she feels that religion is a mockery in Paris.

Nine francs a day ($1.80) is the cheapest board one gets in such a pension. This includes meals without wine, attendance, a candle, and a small room heated by an open grate fire, whose fuel is extra. This heating is assisted, or made less necessary excepting in the coldest weather, by a fearly working system of hot-air registers, whose ineffectual zephyrs cost you nothing. To keep a good fire in the grate you must expend some thirty cents a day for soft coal, coke, and handsome little briquettes; briquettes are coal dust cemented into cakes. For lighting you have kerosene, some fifteen cents each time your lamp is filled. You are requested to patronize madame's laundress; it is advisable to "gratify" the servants punctually.

The first breakfast consists of chocolate, tea, or *café-au-lait*, with butter and a roll, served in your room. The lunch, *déjeuner à la fourchette*, brings fish or eggs, a chop or steak, a vegetable, and fruit and cheese. At this meal, as at dinner, the final cup of black coffee is charged extra. Dinner comes along at half past 6 P. M. with soup, fish, boiled meat, a vegetable, roast chicken or turkey—never "stuffed," but with its scattered members sprawling in a sea of watery gravy in the usual French style—then a sweet and a fruit follow a salad, with cheese and coffee and the little glass. The table wine, as will be found in every Paris pension, is acid to the sharpness of vitriol when it is white, heating to the strength of mustard when it is red, and always without pleasant flavor, always dear in proportion to both its worth and outside price.

III.

The servants in this pension are jewels. The ladies are never tired of praising them. Like all French servants, they are handy and cheerful, with a great capacity for enthusiasm. By a little tipping the lady can have the parlor maid transform herself into her private femme de chambre for the moment; another tipping will find the cook sending up surreptitious dainties to your room, and a third gratification will send the *bonne* a-smuggling brandy, tea, and cigarettes.

AID FROM THE MAID.

The points of superiority these Paris pensions have over those of a similar class in America are cleanliness, the presence of solid and handsome furniture that does not look so obviously factory made, tasteful wall decorations, fine windows of plate glass, reaching almost to the floor on each story, and the cheerfulness with which private services, out of their regular routine, are rendered by domestics. The disadvantages, from the American point of view, consist in inevitable draughts from the handsome door-like plate glass windows, in the incapable but æsthetic heating apparatus of the open grate, in the perfunctoriness of the bathrooms, and in the enforced drinking of wine, beer, and table waters instead of the free and open fountain of the silver-plated ice pitcher. In spite of the new aqueduct from the river Arve, everybody has a tenderness about drinking the Paris water. The pension claims to boil and filter it, but no one drinks the stuff.

The use of the bath, in all but houses of the highest fashion, is not prized in France. The thing is so slowly coming into vogue that fine apartment houses, built ten years ago, have ordinarily but one tub to each apartment, and that a little metal coffin, into which the water must be thrown from a bucket. Illuminating gas is next to unknown. The sickly, yellow-burning French petroleum smells and smokes. It is high in price, being taxed on coming into the country crude, taxed in its manufacture, with an extra *octroi* or municipal tax on coming into Paris after it is refined. The Standard Oil Company, which has established itself at Rouen, is about to make a new departure and give the French good oil. But they have the Russian oil to compete with, a bad thing in these days of Franco-Russian enthusiasm.

Draughts in winter, day and night, give unaccustomed Americans in this pension coughs and colds. The insincerity of the open grate is a cause of rheumatism in many; and the polished wood floor, with its handsome rugs, is often cold. But the Paris winter is so comparatively mild that these unpleas