current machine by removing the commutator, thereby producing a very effective machine.

All theoretical determinations of the efficiency of machines are complicated by the retardation of magnetisation of the magnets, which necessitates a change of position of the commutator or brushes in the direction of the rotation of the armature. The practical determinations of efficiency which have been made show that from 86 to 88 per cent. of the energy communicated to a dynamo-machine is converted into electrical energy, and that from 44 to about 50 per cent. of the total work may be converted into useful work in the external circuit. Among the more recent continuous current machines are the Brush and the Bürgin machines, which promise to give good results.

At intervals during the lecture the room was lighted by various electric lamps, the peculiarities of each of which were explained. The Brockie lamp, lent by the British Electric Light Company, and served by one of their Gramme machines; the Siemens pendulum-lamp lent by Dr. Siemens, and the Crompton lamp lent by Mr. Crompton, were each tried in turn, and attention was drawn to the Siemens' differential lamp, the Brush lamp, and other lamps and electric candles which were also exhibited.

The subject of the fourth Cantor lecture was the subdivision of the electric current and lighting by incandescence. Prof. Adams showed that objections raised to the electric light were similar to those which had been urged with regard to gas when it was first introduced. He then compared the energy of Grove's cells with the energy derived from a small Gramme machine, and showed how impracticable it was to attempt to do by means of batteries the work which can be done by such machines. He then explained how the same amount of energy might be spent in two classes of machines, those of low internal resistance and low electromotive force which send a strong current through small external resistance, or quantity machines, and those of high internal resistance and high electromotive force sending a smaller current through large external resistance, or tension-machines. For very high resistances the discharge of an induction-coil is taken, the action of which was compared to the action of the hydraulic ram. Prof. Adams proceeded to describe the Werdermann and the Joel lamps, and explained the kind of machine specially suited for such lamps, and regretted that it would not be possible to show them to the best advantage, or to give them a fair trial, because the machine actually in use at the speed at which it was running was not adapted for them. An electromotive force of 130 volts will send 50 webers through 10 lamps in series, and give an illumination of 320 candles in each lamp for an expenditure about 10 h.p. Taking Mr. A. Siemens' facts as to the cost, it appears that the electric light from the Joel lamp would be as cheap as gas at the rate of 2*s.* per 1000 cubic feet. The laws of the subdivision of the electric current were discussed, and their application to the system of incandescent lighting adopted by Swan, and by Lane-Fox and Edison was clearly shown. With the Bürgin machine, then in use, giving at 1620 revolutions a minute an electromotive force of 160 volts, and a current of 24 webers through an external resistance of about 7 ohms, it was shown that 24 rows of two Swan lamps in series or 48 lamps could be lit up: each lamp being of 80 ohms resistance, and giving a 48 candle-power light. If the resistance of each lamp be 40 instead of 80 ohms, then double the number of lamps might be taken in series, giving about 100 lamps from the machine.

With the Brush machine at least 140 lamps might be lit up in 10 parallel rows of 14 lamps in series. The early attempts of King, and Staite, and Konn to light by incandescence were then explained, and experiments made to illustrate the phenomena seen in high vacua, such as are necessary to enable Mr. Swan and Mr. Lane Fox to preserve their carbons from wasting when rendered incandescent by means of the electric current.

The room was well lighted by means of 20 Swan lamps, each giving a pleasant and steady light of about 40 or 50 candle-power, the lamps being arranged in 10 rows of two in series. Two table-lamps were placed on the lecture-table, which could be put out separately or made to glow at pleasure, and these lamps could be lifted off their stands and others put in their places without disturbing other lights which were arranged in multiple arc and worked from the same dynamo-machine.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT ALGIERS[1]

II.

Algiers, April 17

On Friday afternoon various papers on local subjects were read to a general audience in the *foyer* of the theatre. They related to the geology, geography, and demography of Algeria, but the most interesting paper was by our Consul-General, Col. Playfair, on a visit to the country of the Kroumirs—interesting not only because the aggressions of this tribe have led to the present complications in Tunis, which will probably end in war, but also because Col. Playfair and Lord Kingston are the only Europeans who have visited their country. They inhabit the district near Le Calle, that is to say, the northern portion of the boundary between Algeria and Tunis, and they only nominally acknowledge the suzerainty of the Bey of Tunis.

On Friday evening a discourse was delivered in the theatre "On Paludisme from a Surgical Point of View." It was of such a very technical character that many members of the Association did not attend. In fact the Congress is to a great extent medical. While the Physical and Botanical Sections are positively languishing for want of papers, and will probably come to a premature ending on Monday, the papers waiting to be read before the Medical Section fill two pages of yesterday's programme.

More activity was manifested in the sectional work on the second day of the Congress; the papers in most of the sections were more numerous and the audiences larger. The physical section is the most neglected of all. Long after the proper time of commencement the president had not made his appearance, and at length Mr. Siemens, the only honorary vice-president, was requested to take the chair. Of the four papers read three were by Englishmen, and on the first day of meeting one paper alone was read by a Dutchman. Pure physics in France is unfortunately quite unrepresented at the Congress. In the Chemical Section M. Baunhauer read a paper "On the Crystallisation of the Diamond," and M. de Foreland "On a New Apparatus for Gas Analysis." There were several good papers on meteorological subjects. Only three papers were read in the Geological Section, the most important of these by M. Villanova, "On the Unification of Geological Nomenclature." The Anthropological Section was well attended, and papers of considerable local interest were read. The Sections of Geography and Political Economy mainly discussed the Sahara—on the one hand its physical geography, and on the other its colonisation.

In the Agricultural Exhibition one of the most interesting machines is the solar engine, the boiler of which is placed in the axis of a mirror 14 feet in diameter, and formed of three portions of hollow truncated cones, so as to get a close approximation to the parabola. When the sun shines a pressure of from three to four atmospheres is produced in the boiler, and a force of one-horse power is produced through the intervention of an

[1] Continued from p. 583.

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ordinary steam-engine. The mirror is of silvered copper; the boiler is blackened and is surrounded by a glass cylinder, which of course permits the passage of the sun's heat through it, but obstructs its escape after absorption. The whole thing costs 4000 francs, and it could be used in many countries for at least 200 days in the year.

G. F. RODWELL

THE HERRING [1]

IT is now nineteen years since my attention was first specially directed to the natural history of the herring, and to the many important economical and legal questions connected with the herring fisheries. As a member of two successive Royal Commissions, it fell to my lot to take part in inquiries held at every important fishing station in the United Kingdom between the years 1862 and 1865, and to hear all that practical fishermen had to tell about the matter; while I had free access to the official records of the Fishery Boards. Nor did I neglect such opportunities as presented themselves of studying the fish itself, and of determining the scientific value of the terms by which, in the language of fishermen, the various conditions of the herring are distinguished.

Diligent sifting of the body of evidence thus collected and passed under review, led to the satisfactory clearing away in my own mind of some of the obscurities which, at that time, surrounded the natural history of the fish. But many problems remained, the solution of which was not practicable by investigations which, after all, were only incidents in the course of a large inquiry, embracing a vast number of topics beside herrings and herring fisheries; and it is only within the last few years that the labours of the German West Baltic Fishery Commission have made such large additions to the state of our knowledge in 1865, that the history of the herring is brought within measurable distance of completeness.

Considering the vast importance of the herring fisheries of the Eastern Counties, it occurred to me when the President of the National Fishery Exhibition did me the honour to ask me to address you, that nothing could be more likely to interest my audience than a summary statement of what is now really known about a fish which, from a fisherman's point of view, is probably the chief of fishes.

I am aware that I may lay myself open to the application of the proverb about carrying coals to Newcastle, if I commence my observations with a description of the most important distinctive characters of a fish which is so familiar to the majority of my hearers. And perhaps it is as well that I should at once express my belief that most of you are as little likely to mistake a herring for anything else as I am. Nay, I will go further. I have reason to believe that any herring-merchant, in a large way of business, who may be here, knows these fish so much better than I do, that he is able to discriminate a Yarmouth herring from a Scotch herring and both from a Norway herring; a feat which I could not undertake to perform. But then it is possible that I may know some things that he does not. He is very unlike other fishermen and fish-merchants with whom I have met, if he has any but the vaguest notions of the way of life of the fish; or if he has heard anything about those singularities of its organisation which perplex biologists; or if he can say exactly how and why he knows that a herring is not a sprat, a shad, or a pilchard. And all kinds of real knowledge and insight into the facts of nature do so bear upon one another and turn out in strange ways practically helpful, that I propose to pour out my scientific budget, in the hope that something more may come of it than the gratification of intelligent curiosity.

If any one wants to exemplify the meaning of the word "fish" he cannot choose a better animal than a herring. The body, tapering to each end, is covered with thin, flexible scales, which are very easily rubbed off. The taper head, with its underhung jaw, is smooth and scaleless on the top; the large eye is partly covered by two folds of transparent skin, like eyelids—only immovable and with the slit between them vertical instead of horizontal; the cleft behind the gill cover is very wide, and, when the cover is raised, the large red gills which lie beneath it are freely exposed. The rounded back bears the single moderately long dorsal fin about its middle. The tail fin is deeply cleft, and on careful inspection small scales are seen to be continued from the body, on to both its upper and its lower lobes, but there is no longitudinal scaly fold on either of these. The belly comes to an edge, covered by a series of sharply-keeled bony shields between the throat and the vent; and behind the last is the anal fin, which is of the same length as the dorsal fin. There is a pair of fore-limbs, or pectoral fins, just behind the head; and a pair of hind-limbs, or ventral fins, are situated beneath the dorsal fin, a little behind a vertical line drawn from its front edge, and a long way in front of the vent. These fins have bony supports or rays, all of which are soft and jointed.

Like most fishes, the herring is propelled chiefly by the sculling action of the tail-fin, the rest serving chiefly to preserve the balance of the body, and to keep it from turning over, as it would do if left to itself, the back being the heaviest part of the fish.

The mouth of the herring is not very large, the gape extending back only to beneath the middle of the eye, and the teeth on the upper and lower jaws are so small as to be hardly visible. Moreover, when a live herring opens its mouth, or when the lower jaw of a dead herring is depressed artificially, the upper jaw, instead of remaining fixed and stationary, travels downwards and forwards in such a manner as to guard the sides of the gape. This movement is the result of a curious mechanical arrangement by which the lower jaw pulls upon the upper, and I suspect that it is useful in guarding the sides of the gape when the fish gulps the small living prey upon which it feeds.

The only conspicuous teeth, and they are very small, are disposed in an elongated patch upon the tongue, and in another such patch, opposite to these, on the fore part of the roof of the mouth. The latter are attached to a bone called the vomer, and are hence termed vomerine teeth. But, if the mouth of a herring is opened widely, there will be seen, on each side, a great number of fine, long, bristle-like processes, the pointed ends of which project forwards. These are what are termed the gill rakers, inasmuch as they are fixed, like the teeth of a rake, to the inner sides of those arches of bone on the outer sides of which the gills are fixed. The sides of the throat of a herring, in fact, are as it were cut by four deep and wide clefts which are separated by these gill arches, and the water which the fish constantly gulps in by the mouth flows through these clefts, over the gills and out beneath the gill covers, aërating the blood, and thus effecting respiration, as it goes. But since it would be highly inconvenient, and indeed injurious, were the food to slip out in the same way, these gill rakers play the part of a fine sieve, which lets the water strain off, while it keeps the food in. The gill rakers of the front arches are much longer than those of the hinder arches, and as each is stiffened by a thread of bone developed in its interior, while, at the same time, its sides are beset with fine sharp teeth, like thorns on a brier, I suspect that they play some part in crushing the life out of the small animals on which the herrings prey.

Between these arches there is, in the middle line, an opening which leads into the gullet. This passes back into a curious conical sac which is commonly termed the stomach, but which has more the character of a crop.

[1] A lecture delivered by Prof. Huxley at the National Fishery Exhibition, Norwich, April 21, 1881.

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