

contrary, not cease for perhaps a quarter of a second, a tapering chemical line trailing after the last correct mark. The balance as shown in Fig. 5 effectually stops this; two secondary cells, F_1 and F_2 , are shunted on to the line through variable inductances, J_1 and J_2 , and send a reverse current into the line and variable resistances, W_1 and W_2 , while from the sliding contacts of the latter a variable capacity K is fitted. By carefully observing the character of the image on B during the first two or three revolutions, one can at once counteract the line effects by regulation. In the Thorne-Baker telegraph there are seventy-five turns of the cylinder per inch travel of the stylus, and the cylinder revolves once in two seconds. A result obtained with it over an artificial line (resistance of 2000 Ω) is shown alongside one transmitted from Manchester to London (Figs. 6 and 7). Fig. 8 shows a photograph transmitted by Korn's telautograph from Berlin to Paris, and Fig. 9 a line drawing transmitted by that system over an artificial line of resistance 1000 Ω .

Experiments are at present being made to transmit pictures and photographs by wireless telegraphy, but considerable modification of the ordinary arrangements

for their raw material, not among dusty and almost illegible manuscripts, but plainly set out in fair print and duly classified and catalogued by the librarians. Of such materials as this "Life" will future history be made.

Wilson's career was one of those which are still common in this country, but tend to get rarer and rarer with the advance of democratic ideals, a career devoted to the public service, and of the highest usefulness, unrecognised by, and almost unknown to, the ordinary world of newspaper readers. We might, if inclined to a satirical vein, say that its very obscurity is the best evidence of the value of such a career, seeing that it is often only on some shortcoming, either actual or supposed, that the outside world becomes conscious of the existence of the man in question. Thus in Wilson's case, were it not for the accusations, long since withdrawn as totally unfounded, of a failure on his part to do all that was humanly possible to relieve Khartum before its capture by the Mahdi, his name would possibly be little known.

Passing over the period of childhood and adolescence and his entry into the Royal Engineers, the first im-



FIG. 8.—Telegraphed from Berlin to Paris by Korn telautograph.

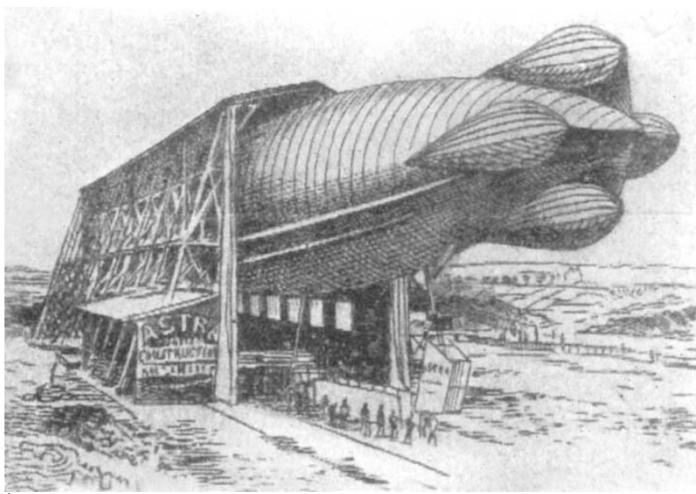


FIG. 9.—Telegraphed over an artificial line of 1000 Ω by Korn telautograph.

is necessary, as the number of signals to be sent per second is very much greater than in the case of word telegraphy. The problem is, in fact, comparable with that of wireless telephony, whilst synchronisation has also to be arranged. The later results I have obtained with purely experimental apparatus are sufficiently good technically to show that the problem is one within the limits of commercial practicability.

T. THORNE-BAKER.

SIR CHARLES WILSON.¹

THE life of Sir Charles Wilson, by his friend Colonel Sir Charles Watson; belongs emphatically to that class of biography which, as Carlyle held, ought to be written. Whether it is destined to be read by any large circle is another question. We might occupy much space in a discussion as to the, exact degree of distinction in the subject that justifies a published biography were it not a question that settles itself automatically. We may, at any rate, congratulate the future historians of the Victorian and post-Victorian epochs in that they will have to look

portant post that Wilson filled was that of secretary to the British Commission for delimiting the boundary between the United States and Canada from the Lake of the Woods to the Pacific along the 49th parallel of latitude. This line was marked out by astronomical methods, a procedure now known to be liable to the defect that the observations at each station are subject to an unknown error due to the force of local attraction or the deflection of the level. At the present day such a line would be delimited by means of a triangulation. In 1858, however, survey methods had not developed enough for this to be practicable, at all events within any reasonable limit of time, and the only possible course was taken. That the line as then marked out, and as it remains to this day, was not a true parallel of latitude, but a wavy line departing from the truth to distances of some hundreds of feet on either side, was of secondary importance. The urgent point was to get some acceptable boundary laid out upon the ground, and so marked that nobody could have any doubt as to which side of the line they were on at any given moment.

With the technical work of the Commission in the field, Wilson had, however, little to do; his duties were of a more arduous character. The

¹ "The Life of Major-General Sir Charles William Wilson, Royal Engineers, K.C.B., K.C.M.G., F.R.S." By Colonel Sir Charles M. Watson, K.C.M.G. Pp. xv+419. (London: John Murray, 1909.) Price 15s. net.

country traversed by the line was in parts almost unknown, and, as regards all the western section, of an extremely wild and mountainous character. The winters were very severe, and the difficulties of travel formidable. In such circumstances it may well be understood that the responsibilities of Wilson's position, he being then little more than a boy, entrusted

summary, the services rendered by him and other officers in this great undertaking; those curious may consult the maps and records of the Palestine Exploration Fund, or may read the account of Wilson's share of it in the work before us.

After his return to England in 1866, and his marriage in 1867, he again went to the East to carry out a special task for the same body, the survey of the Sinaitic Peninsula, with the object of illustrating and elucidating the events of Bible history. Pre-eminent among the points to be investigated was that of the identification of Mount Sinai, then a disputed question, some authorities contending for a mountain called *Jebel Musa*, and others for *Jebel Serbal*. Wilson's party, including, it should be remembered, the late Prof. E. H. Palmer, afterwards murdered by Bedouins in the same country, unanimously came to the conclusion that *Jebel Musa* was the true Sinai of the Exodus. This view is now generally accepted, and it is this mountain which is pointed out to passengers in mail steamers proceeding southward from Suez. The late Sir Richard Burton, however, always refused to accept it, and maintained that the honour belonged to one of the minor peaks to be found along the pilgrim road from Suez to Akaba.

Wilson's share in the Nile expedition of 1884, and in the attempt to relieve Khartum and rescue Gordon, is dealt with at length. We have already alluded to the abortive attack upon him for a failure in no wise his fault, and it may be fairly conjectured that the author, himself a life-long friend of Gordon, welcomed this opportunity of putting on record his version of the history of that troubled time, especially so in view of the opinion strongly held by him that Lord Cromer, in his "Modern Egypt," was less than fair to Gordon, and gave evidence of a certain want of understanding of his character.

The other work that filled Wilson's busy life we must pass by with slight notice. In 1878 he was appointed to delimit the Turco-Servian frontier, and he afterwards served as Consul-General in Servia. He was for seven years, 1886-94, Director-General of the Ordnance Surveys, a post that he filled with efficiency, though his rule was not marked by any striking advances. From 1895 to 1898, the date of his retirement from the army, he held the office of Director of Military Education. After his retirement he twice again visited Palestine, and in 1901 was elected to the chairmanship of the executive committee of the



Jebel Musa.



Jebel Serbal.

The Problem of Mount Sinai. From "The Life of Major-General Sir Charles William Wilson."

with the duties of commissariat, store and transport officer, were great.

Not long after the termination of this commission, he had an opportunity of taking up a work of a somewhat different character, a work which at intervals occupied his energies for a large part of his life—the survey of Palestine and the surrounding regions. It is not the place here to recapitulate, even in briefest

Palestine Exploration Fund, a position which he held until his death in 1905. He was the recipient of numerous honours, being elected a Fellow of the Royal Society in 1874. The present biography is written in a simple and unpretentious style. It may be cordially recommended to all those to whom the history of the events of which it treats is of interest. The general reader may also find a certain attraction

in this account of a man who possessed a personality of rare charm, and, without any commanding intellectual equipment, lived a life of high accomplishment.

E. H. H.

TECHNOLOGICAL SCIENCE IN GERMANY.

WHAT are the chief causes to which the remarkable industrial progress made by Germany in recent years is attributable? This is the question M. E. Leduc sets himself to answer in a paper¹ which, though written primarily for his compatriots, is also of much interest to others.

On the morrow of Jena the outlook in Prussia was sorry indeed. The country was poor, the population sparse; there were no manufactures, and not much commerce. Few roads, and those bad; an ill-equipped postal service; little money, and the kingdom ringed around with tax-offices: such is the picture drawn of the land which lay there bleeding after Napoleon's victory in 1806. Yet now, little more than a century after, the vanquished of Jena have not only ousted their conquerors from the position of military predominance, but are steadily forcing them, and others, from their coigns of vantage on the fields of industry and commerce.

M. Leduc first outlines the earlier steps which led to this industrial advance—the revival of national sentiment, the removal of class barriers and other mediæval restrictions upon freedom—and then deals at length with the two causes which he holds to be the principal factors in the great modern expansion of German commerce, namely, education and cooperation.

By "education" here is meant education in applied science. First, as regards the teacher; the ideal is a man possessing a thorough knowledge of his subject, a teaching aptitude, and a certain quality of industrial practicality. This last is the touchstone. In technological training the aim should be to impart the scientific spirit rather than to let the student lose himself in "pure" science. Otherwise his intellect is apt to become somewhat mummified; and so far as industrial fertility is concerned he presently, college days being over, comes to resemble the fig-tree of scripture, which bore nothing but leaves.

This leaven of practicality is traceable in all the German technical science training. The professors at Charlottenburg are not merely college dons; some, for example, are chiefs of factories, others are the proprietors of commercial laboratories. The students in the technical institutes brew beer, distil spirits, and bake bread, all on a manufacturing scale, and all for sale in the ordinary way of trade.

From the description given it appears that the German instruction in technological science may be broadly classified into four divisions. First, there is the comprehensive training which is to turn out the future captains and leaders of industry. Next, provision is made for putting trustworthy information on technological matters at the disposal of the trading community. Thirdly, central institutions are established where certain industries—e.g. brewing, sugar-production—are studied scientifically and practically. Fourthly, there are local technical schools adapted to the special needs of particular localities.

Under the first category comes the famous High School of Technology at Charlottenburg. Here a

¹ "L'Organisation syndicale et technique en Allemagne." By M. E. Leduc. (Bulletin de la Société d'Encouragement pour l'Industrie nationale, Octobre, 1909.)

complete course of instruction in any of the leading branches of technology is obtainable. The scale upon which the institution is equipped may be best shown, perhaps, by the following summary of the professorial staff:—

	Section	Prof. ssors	Privats-docent
Architecture	...	21	12
Civil Engineering	...	13	8
Mechanical Engineering...	...	20	14
Maritime Engineering and Naval Construction	...	6	1
Chemistry and Metallurgy	...	15	20
Mathematics and Natural Science...	...	18	15
Foreign Languages	...	4	—
		97	70

In M. Leduc's opinion, specialisation and the more definitely practical character of the instruction are the points on which the German system shows itself superior to the French. It was all very well a century ago to say "Technical science is one subject; every manufacturer must know it in all its branches or be dubbed incompetent"; but this, like other formulas, has become antiquated, and the world has outgrown it.

Supplementing the tuition in technological science indicated above comes the work of the laboratory at Gross-Lichterfeld. This is a large establishment, covering an area of 10,360 square metres. Its duties are (a) to carry out researches, and to make examinations and analyses of materials both for public departments and for the trading community, issuing certificates and valuations based upon the results obtained; and (b) to arbitrate, on request of both parties, in matters of litigation concerning the composition and properties of commercial products. In addition, practical instruction in the testing of materials is given to certain students from Charlottenburg; and, as far as circumstances permit, assistance is rendered to persons pursuing special researches. Fixed fees are payable for the services of the laboratory; and the certificates issued are commonly used in commercial transactions as proof of the composition and properties of the articles described upon them. There are six sections, dealing respectively with metals, building materials, paper and textile fabrics, oils, general analytical chemistry, and metallography.

In the third class come the special institutes devoted to various agricultural industries; for example, sugar production, brewing, distilling, milling, and baking. Each of these has its institute, splendidly—nay, lavishly—equipped, not only for the training of students, but for research into any special problem of the industry. One feels, says M. Leduc, speaking of the sugar institute, that money without stint has been given to assemble here everything required for the study of beet-sugar production, and everything is the most perfect of its kind.

Now, in its origin and development this industry is notably a French one, yet Germany has outstripped France in its exploitation, and produces nearly three times as much sugar. Why? Because in Germany the production is organised and unified. "Germany is the land of cartels; jealousy of one's neighbour is unknown. The sugar factories all accept one and the same guidance, namely, that given them by the Institute at Berlin, which is richly endowed by the manufacturers. Prof. Herzfeld, to whom neither money nor help is begrudged, studies for all, and everybody profits thereby."

Similarly in the milling and baking industry,