A Laboratory for Manufacturers

A German Scientific Institution That Tests a Manufacturer's Raw Material and Products and Gives Him Scientific Advice

By Waldemar Kaempffert

THIS is the first of a series of articles intended to show the part that science plays in German industry and commerce. The author of the article, Managing Editor of the SCIENTIFIC AMERICAN, *was sent to Europe by the publishers to study German industrial conditions with this object in view.*

A Saxon manufacturer of silk cravats found that his orders were steadily diminishing, although the season and the market were both in his favor. He made an investigation and discovered that his customers were buying silk cravats from a Prussian manufacturer at a price fifty per cent less than that at which he could produce them. To the Saxon's eye and touch the cheaper cravats were as good as his own. He could detect nothing in the material that could explain why cravats exactly the same in appearance should be sold at two widely different prices. He spent a month in thoroughly overhauling his factory. He found that he was buying his raw material at the lowest possible prices; that his wages were not higher than they should be; that his overhead charges were not excessive, and that his organization was good. Yet the fact remained that the Prussian was underselling him and was apparently making money.

The Saxon was an expert in cravats—at least he thought he knew all about them, because he had been making them for the better part of his career. Yet for the life of him he could not explain why it was impossible for him to compete with the Prussian. One day a salesman of his suggested that it might be well to have the Saxon and the Prussian cravats scientifically compared by the Koenigliches Material-Pruefungsamt—the Royal Laboratory for Testing Materials at Gross Lichterfelde, near Berlin. The examination would cost but little and might explain the mystery. As a manufacturer, the Saxon was convinced that he knew more about cravats than any scientist in any government testing laboratory, and that his trained eye and his sensitive thumb were more to be relied upon than lenses and chemicals. Still he consented. Samples of the Prussian and Saxon cravats were sent to Gross Lichterfelde. Two weeks later he received a formal report. His own cravats were pure silk. The Prussian's cravats were half genuine silk and half artificial silk (nitro cellulose). A chemist and a microscopist, neither of whom had ever made a cravat in his life, had not only discovered in an hour or two a deception that a manufacturing experience of thirty years had failed to note, but even revealed what particular process had been used in making the artificial silk employed.

The Technical Problems of Commerce.

It would not be difficult to relate a hundred instances such as this, all of them typical of the work done at the most remarkable testing laboratory in the world. At Gross Lichterfelde I saw not only cravats undergoing a rigorous scientific investigation, but chains, girders, paper, textiles, wood, dyes, copper, rubber, ink, typewriter ribbons—almost every kind of material that is used in our daily lives. Sometimes, as in the case of the Saxon manufacturer of cravats, the manufacturer was puzzled by a rival's success; sometimes he found himself with oxidized metal or faded goods on his hands, unable to discover the cause of the defects; sometimes he thought the customs officers had wrongly appraised his importations, because they had misjudged the character of the material; sometimes he wanted to know which of several raw materials should be employed for a specific purpose and was unable to decide himself.

The Royal Laboratory for Testing Materials works hand in hand with the German industrial For a sum of money that must seem slight to Americans it places at his command a staff of two hundred and twenty-two men, seventy-two of whom are technically trained and the highest authorities in their respective departments of science. These men have at their disposal an equipment that includes the best obtainable apparatus for testing and analyzing any given material.

In Germany, indeed in Europe, the Laboratory is regarded as a court of last resort in matters involving the application of science to business. It is frequently difficult for a scientific man in the employ of a large corporation to deliver an absolutely impartial opinion on his firm's product. Inevitably there is a tendency to underestimate the products of a rival manufacturer and to view his own with favor. There is no such tendency in the Royal Testing Laboratory. Every chemist every engineer, every microscopist, every physicist, is a government official, and, as such, he is enabled to assume an absolutely impartial and judicial attitude toward the problem given him for solution. Indeed, impartiality is insisted upon, not only in the testing and examination of materials, but also in the phrasing of the reports submitted to an applicant for information. The manufacturer who can use one of the Royal Testing Laboratory's colorless opinions for advertising purposes would be miraculously ingenious. To restrain him, however, from exercising too freely what average ingenuity Nature has endowed him, and to prevent him from quoting with approval a report which is many years old and not at all applicable to his present goods, the Director of the Laboratory refuses to furnish certified copies of opinions more than one year old, and sometimes goes to the trouble of checking up advertisements in which reference is made to the favorable opinion of the Royal Testing Laboratory.

Scientists Who Study Factory Methods in Factories.

In order that the Laboratory may keep in close touch with industrial developments, members of its staff are sent from time to time to factories in order to study the exact manner in which textiles, cement, paper, ink, and the like are made. Thus, when it was decided to elaborate the equipment for testing caoutchouc and electric insulators, the exact manner in which rubber goods are made industrially was carefully studied, so that machinery could be designed which would enable a chemist or physicist to determine those facts which would be most useful to a rubber manufacturer. What manufacturer, for example, can tell definitely whether or not rubber goods should be stored in moist or dry rooms; whether that room may be indifferently hot or cold, dark or light; whether a rubber strip should be stored stretched or unstretched? These and similar questions Gross Lichterfelde will soon answer for him definitely, as the result of a long series of most practical experiments.

German manufacturers have not been slow to recognize the immense value of a government laboratory which solves for them the technical problems of commerce. A number of manufacturers of electric insulating materials jointly supplied the necessary funds for a painstaking study of insulating materials and of the insulating properties of rubber substitutes. The many compositions submitted were tested at various temperatures to determine their readiness of manipulation in the factory, their behavior under tension, torsion, and traction; their hardness; their ability to withstand exposure to weather and chemical corrosives. When the results of these studies are published. the Society of German Electro-Technicians will frame specifications for electric insulating materials, in which for the first time some admirable substitutes for rubber will receive their due.

How very impartial is the attitude assumed by the Laboratory is apparent when it is considered that manufacturers of competing materials may appeal for scientific information to Gross Lichterfelde at the same time. Sand-lime brick and clay brick are competitive building materials. Yet a powerful association of sand-lime brick manufacturers and an equally powerful association of clay brick manufacturers simultaneously consulted Gross Lichterfelde for the purpose of improving their respective bricks. The comparative tests which were made proved immensely valuable to both associations and gave the ultimate consumer a far better building material than he would otherwise have been able to purchase.

Perhaps the Laboratory has done its most efficient work in co-operation with the technical associations of Germany—associations of engineers, manufacturers and technical men. Thus in conjunction with the Society of German Cement Manufacturers, the Laboratory conducted an exhaustive investigation which has resulted in a scientific standardization of Portland cement, and has definitely settled such nice points as the influence of high temperature on concrete, the effect of copper, lead and zinc on cement, and the comparative merits of Portland cement and iron slag Portland cement. Similarly, in co-operation with the Society of German Bridge and Structural Iron Builders, a painstaking study of the strength of rivets in steel girders was made.

A Study of Paper and Ink.

It must not be supposed that all German manufacturers have been broad-minded enough to submit their products to Gross Lichterfelde for approval. An attempt to analyze the various kinds of automobile gasoline sold throughout the German Empire, and to induce the wholesale dealers in gasoline to standardize liquid fuel so that the motor car owner could buy gasoline in Southern Germany exactly similar in quality to that sold in Northern Germany, was met by a flat refusal on the part of the dealers to assist the Laboratory. It is only a question of time when the Laboratory will succeed in carrying out its plan. Similar opposition was encountered when Gross Lichterfelde was commissioned by the government to analyze German papers and to determine their availability for bank notes, public documents and the like, an opposition that may be understood when it was discovered that only a very small percentage of German papers were found to answer the government's requirements. As the result of the work done at Gross Lichterfelde, the German paper manufacturer has so far improved his product that rarely indeed has he failed to fulfill government conditions. Opposition to the scientific investigations of the Laboratory has given place to the heartiest co-operation.

It was but natural that after paper was studied for the government the thousand and one inks sold in the German market should have been carefully analyzed and tested to determine their chemical composition and their ability to withstand light, fire, and weather. That investigation has only recently been completed. The government can now specify with scientific precision the characteristics of a wellnigh perfect ink to be used on its wellnigh perfect paper.

The standardization of manufactures is thus undertaken only for the government. The Laboratory, as a government institution entrusted with the scientific examination of material used by the government, can dictate the requirements which that material must fulfill; but it would not set up standards for the manufacture of articles for ordinary consumption. When a manufacturer requested the Laboratory to determine for him the qualifications that an asphalt should have for insulating purposes, he was told that the asphalt industry must frame its own standards, but that the Laboratory would assist him by giving scientific advice.

A Scientific Court of Last Resort in Technical Disputes.

As an impartial institution for scientifically passing upon the commercial availability of manufactured products, Gross Lichterfelde is required by law, when requested to do so, to settle technical disputes. Instead of wasting time and money in asking the courts to decide whether or not a contract has been carried out according to the spirit and the letter, the disputants often submit their case voluntarily to the Laboratory for decision. A builder ordered a large quantity of roofing tiles and specified that they were to be waterproof. When the tiles were delivered he refused to pay for them on the ground that they failed to comply with the conditions of the contract. The dispute was submitted to the Laboratory for decision. The tiles were tested and it was found that they were sufficiently waterproof to come within the meaning of the contract.

Even if a case does go to court, the Laboratory may be asked by the presiding judge to decide the technical point at issue. The decision is binding upon both sides—a veritable boon to a court confronted with a mass of conflicting expert testimony. In one case it appeared that in the construction of a wall a stone composed of crushed slag had been employed together with lime mortar. The mortar failed to harden. The dealer who had delivered the slag stone insisted that the wrong kind of mortar had been employed. The mortar maker retorted that the slag stone was worthless. The experts summoned by both sides failing to agree, as might be supposed, the court submitted the whole matter to Gross Lichterfelde. There it was decided that the mortar had failed to harden, not because it had been made with the wrong kind of sand (as one expert had declared) nor because the slag was of the wrong kind (as another expert had insisted), but because many lime mortars harden only when exposed to the air, and then only after they have been alternately moistened and dried. Hence, said Gross Lichterfelde, the core of a wall, as in the case in question, is not likely to harden at all, whether or not a slag stone or good brick is employed.

In another case the court called upon the Laboratory

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Retrospect of the Year 1911

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plane. On January 30th, McCurdy attempted to fly from Key West to Havana. After covering ninety miles out of the one hundred in two hours, he fell in the sea, owing to a burned-out bearing on his motor. Mr. Glenn Curtiss first succeeded in rising from the water, with his biplane equipped with floats, at San Diego, on January 26th. Thus was born America's first hydro-aeroplane. Curtiss constructed a number of these machines, several of which have been supplied to our navy and one to that of Russia, which is very active in aviation. Using one of them, Hugh Robinson flew several hundred miles down the Mississippi from Minneapolis, carrying mail, which he left at the towns *en route*. The mail-carrying experiments made on a larger scale at the aviation meet at Nassau Boulevard, together with Robinson's demonstration, convinced Postmaster-General Hitchcock that the aeroplane can be used successfully for delivering mail to inaccessible places. Many exhibition flights have been made in America this year, the most daring and thrilling of all having been Lincoln Beachy's dip over Niagara Falls and flight through the gorge, which he made with a "headless" Curtiss biplane.

The chief development in aviation this year has been the change from the exhibition flight to the long-distance, cross-country race or tour. A half dozen big races, such as the Paris-Madrid, Paris-Rome, European Circuit, Circuit of Britain, etc., were flown successfully abroad and were practically all won by monoplanes, which appeared to be faster and safer than the biplanes. In America, however, Beachy and Ely gave some marvelous exhibitions of flying in strong winds with the latter type of machine. A Maurice Farman biplane, on March 7th, made the 225-mile flight from Paris to the Puy-de-Dome Mountain, without a stop, and carrying two men. Eugene Reneaux, the pilot, thus won the Michelin $20,000 prize which had been offered exactly three years before. Vedrines, on a Morane monoplane, won the Paris-Madrid race and secured second place in the 1,060-mile Circuit of Britain. This English event, as well as the Paris-Rome and the European circuit, was won by Lieut. Conneau, of the French navy, while Roland Garros was second in the two latter races. Both of these aviators used Blériot monoplanes. The Paris-Madrid race of 900 miles was covered in four days, and the Circuit of Britain required but three days' flying by Conneau and Vedrines. The two other machines which finished required thirteen and fourteen days respectively. M. Garros, on September 4th, made a new height record of 4,252 meters (13,950 feet), thus beating by 2,370 feet the record of Beachy at Chicago, and climbing some 750 feet more than 2½ miles above the earth's surface.

Last summer, Harry N. Atwood flew from Boston to Washington with his Wright biplane, carrying a passenger most of the way. Later, he flew from St. Louis to New York, by way of Chicago, in fourteen days. Enthusiastic over his success, Calbraith P. Rodgers and Robert G. Fowler started to fly across the continent from New York and San Francisco respectively. Both aviators used Wright biplanes, and were accompanied by special trains, carrying spare parts. After three unsuccessful attempts at climbing over the Sierra Nevada Mountains, Fowler finally flew by the southern route, which was the one chosen by Rodgers. Rodgers left Sheepshead Bay on September 17th. His route was *via* Chicago, St. Louis, San Antonio, and El Paso, Texas, from which State he followed the Southern Pacific Railroad. He finally reached Pasadena on November 5th. In flying the 25 miles from there to the Pacific Ocean, he sustained a bad fall and was laid up several weeks. Finally, on December 10th, he finished the first trans-continental aeroplane flight. He passed Fowler at Tucson, Ariz., and the latter has now progressed almost as far as New Orleans.

Orville Wright conducted some experiments with a 145-pound glider at Kitty Hawk, N. C., late in October. These experiments were of great interest from the fact that Mr. Wright succeeded in rising in the teeth of a 50-mile gale and remaining aloft once for 7¼ minutes, and again for 9¾ minutes. In the shorter flight, he hovered for five minutes above a given spot. Mr. Wright obtained valuable information relative to the designing of a machine with flattened surfaces, capable of flying in the strongest winds.

To the death list of flyers, numbering this year 76 should be added the loss of Octave Chanute, who was known as America's "Father of Aviation," and also that other pioneer, Prof. John J. Montgomery, of Santa Clara College, Cal. The latter was killed while experimenting with a new glider. A large number of the fatal accidents were due to recklessness and foolhardiness in making exhibition flights; but there have also been accidents from breakages of machines. The causes of the various accidents have not all been determined, but the proportion of deaths to the number of miles flown is without doubt less than in 1910. The carrying of as many as six passengers on cross-country flights of one hour, and the development of an aerial taxicab, which has flown successfully, has put heart into those who believe the aeroplane has a future as a means of public rapid transit. It will also undoubtedly be used for the regular carrying of mail in the near future. The severe tests for French military aeroplanes resulted in seven machines making a flight of 186 miles without a stop, when carrying two men and 660 pounds of dead weight. The winner was a Nieuport monoplane, piloted by Weymann, the American aviator, who also won the International Cup race for this country with the same make of machine on July 1st last. He made an average speed of 72 miles an hour in the military contest, with a 70-horse-power monoplane, whereas, in the International race, he made 78.1 miles with a 100-horse-power motor.

The development of the dirigible balloon has resulted, in Germany, in a passenger-carrying rigid airship, the "Schwaben," which has made numerous sight-seeing trips about the Fatherland, running, on schedule, with a regularity which has strengthened the belief in the commercial and military future of the dirigible. The "Schwaben" developed a speed of practically 43 miles an hour, with 450 horse-power, when accurately tested over a measured course. In France, the non-rigid dirigible has been developed to a point of gratifying efficiency, and the government is building additional Lebaudys for the use of the army. For scouting, the aeroplane is simpler and, in many ways, superior to the clumsy airship. At Tripoli recently, Italian aeroplanes are reported to have dropped bombs upon the Turkish troops, with disastrous effect. The huge English dirigible, the "Mayfly," broke in two when being drawn out of its shed, and as a consequence opinion in Great Britain is more favorable to the aeroplane. Two airships, the "Suchard" and the "Akron," were constructed this year in Germany and America for the purpose of crossing the Atlantic. The former is to start from the island of Teneriffe, and the latter from Atlantic City. Neither was completed in time to attempt a flight this year; but it is probable that next spring both will start in this great attempt. Mr. Vaniman, after his experience with the "America" in 1910, has constructed a new and larger airship, from which he believes he has eliminated the troubles which led to his previous failure.

A Dark Substance in Space

IN the vicinity of the star S Coronæ Australis Innes and Worsell have found a patch of sky 25 minutes of arc in diameter where no star can be seen with a 9-inch refracting telescope. According to Innes, who discusses the subject in "Transvaal Observatory Circular No. 5," the apparent absence of stars in this region is due to the occurrence of some absorbing medium, interposed between us and distant parts of the universe. Stars in the neighborhood of the dark region are enveloped in nebulæ; while just on the border of it there is a star which has been observed to fluctuate in magnitude between 11.0 and 12.2, and which was invisible during the years 1899-1901. The latter fact is accounted for on the supposition that the absorbing medium was for a time in front of the star, but has since withdrawn from it.

The Most Remarkable Testing Laboratory in the World

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to decide whether or not a certain lubricant had spoiled a suit of clothes. The judge washed his hands of the matter and submitted the lubricant to the Royal Laboratory for Testing Materials. With characteristic thoroughness the Laboratory experimented with stains which were produced by the lubricant. First, it determined whether the stains could be eradicated by washing or only with the aid of special solvents, or not at all. Then it determined whether the color of the cloth had suffered as the result of attempting to remove the stains. Finally, it ascertained whether the strength of the cloth fiber had been impaired by the process of cleaning. It reported to the court that stains made with the lubricant on cotton, wool and linen could be easily removed; that the lubricant had no injurious effect on the dyes employed, and that the lubricant did not weaken the fiber, even after prolonged intimate contact—in a word, that the cloth was not irretrievably spoiled.

Settling Patent Infringement Suits.

In patent infringement suits, as might be expected, the Laboratory does yeoman service for the court. It does not construe claims, for that is a matter of law; but it determines matters of technical fact, with the result that a judge is spared the necessity of considering a mass of testimony which, to a layman in science, even though he be a lawyer, must seem a hopeless jumble of cryptic phrases. One such case turned upon the point whether or not a certain brand of soap was so greatly superior to another in washing qualities as to be patentably different. On behalf of the court, the Laboratory made a study of the two soaps to determine their solubility in water, acids and lime solutions, and their effect on dyes and on fabrics. It showed conclusively that the one soap was no better than the other.

These opinions of the Laboratory on matters of technical fact are by law made binding upon the courts. A judge must accept the technical decision of the Laboratory and rule accordingly.

Germany has a tariff, which, like our own, is intended to protect the home producer. Disputes with the customs authorities are therefore as frequent in Germany as in the United States. The American appraiser submits imported goods for scientific examination either to chemists or physicists in the employ of the customs service, or else he employs outside experts. The German customs authorities call upon the Royal Laboratory for Testing Materials for assistance. In a controversy which arose between the customs authorities and an importer of mercerized cotton, the government maintained that the fabric was dyed and therefore subject to a higher duty than if it were undyed. The importer insisted that the cotton was undyed. Gross Lichterfelde examined the fabric scientifically and supported him in his contention.

An American Appeals for Scientific Help.

Foreigners, too, resort occasionally to the Laboratory when the questions at issue affect German industry. I was told of an American importer of German paper who had been compelled, as he thought, to pay a higher duty in the United States than the Dingley tariff required. Because the importation was an oily German paper substitute for parchment, he asked the Laboratory to tell him how treated papers could be scientifically distinguished from untreated papers. He received an exhaustive description of the turpentine oil test, armed with which he intended to appeal to the American customs authorities again. Another foreign firm wished to ascertain whether its steel hydrogen flasks met the requirements of the German police regulations governing the traffic in liquid and compressed gases. Flasks were sent to Gross Lichterfelde. There it was found that the wrong kind of metal had been employed, and that the police requirements had by no means been fulfilled.

Whenever any department of the German Imperial Government is confronted with a technical problem for solution it is

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