

EUROPEAN ENGINEERING LABORATORIES.*

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During the past summer the writer had the pleasure of visiting Germany, Switzerland, England and Scotland, and made it a point to see the engineering laboratories in Brunswick, Hanover, Berlin, Dresden, Munich and Darmstadt in Germany; in Zurich in Switzerland, and in London, Birmingham, Newcastle, Edinburgh and Glasgow in Great Britain.

In Europe, more especially continental Europe, the engineering laboratory has been brought to a great state of perfection, so that probably the very best in the world are to be found there. To get even a superficial acquaintance with these one would need to spend a very considerable amount of time and energy, and I very much regret that my time was so limited that it was impossible to study the different institutions as I should have wished. It soon became evident that I must not only omit a number of the technical schools altogether, but also that the available time must be devoted to my own special work almost entirely, and it was necessary for me to confine my effort largely to the laboratories in hydraulics and mechanical engineering; i.e., heat engines and boilers and other special mechanical work. This article, therefore, deals almost exclusively with laboratories used in connection with the above special subjects.

With regard to the schools visited, it should be stated that an especial effort was made to visit the most notable in the different countries. It must not be inferred, however, that only the least important were omitted, because after it had been decided that it was essential to visit certain places, geographical location combined with other circumstances determined those that must be omitted, and some places of excellent reputation had, therefore, to be left out.

An account of these laboratories will now be given mainly in the order in which they were visited, and, as Germany was the starting point, the schools in that country will be described first.

German Technical High Schools.

The Germans are a very thorough and industrious people, who believe in doing well whatever they attempt to do. One is not, therefore, surprised to find that they have been very thorough in the matter of technical education, and that they have established engineering schools of the very highest order.

But the development of these schools is not due alone to the characteristics of the nation, but probably quite as much to the great change in the occupation of the people which has occurred in the last few years. In a report on the German Technical High Schools, made in 1903 by Dr. Rose to the British Government, it is pointed out that in 1871 the population of Germany was 38,000,000, of whom only about 15,000,000 were in the various industries, the remainder being engaged in agricultural pursuits. In 1900 the population had increased to 58,000,000, of whom about 38,000,000 were engaged in the industries, while the number in agricultural pursuits was slightly less than in 1871.

It will be self-evident that the nation which is to have a healthy industrial growth must at the same time properly prepare her people for their opportunities in this regard, and must train her men to develop the industries in the best

possible way. The importance of engineering schools in this connection is well known, and Germany has not been slow to realize this, and has established within the last forty years no fewer than ten Technical High Schools for the teaching of engineering and allied sciences. These schools are located at Aachen (Aix) Brunswick, Berlin, Darmstadt, Dresden, Hanover, Karlsruhe, Munich, Stuttgart, and Dantzig, cities pretty well distributed over the empire, many of them also being located in important industrial districts. The number of these schools is being increased from time to time as occasion demands.

It is to be noted that the above list includes only the Technical High Schools and not the great number of universities and schools of various other kinds which are engaged in a somewhat similar line of work. The term "Technical High School" must not be misunderstood in this connection, as it designates an entirely different class of institution from that to which the name is applied in this country. In Germany the name is applied to the real engineering school, the students in these being of similar standing to regular university students and the courses of instruction being somewhat more advanced than engineering courses here.

The amount of money expended on the establishment of these various schools has been very great, and the annual contribution by the State for maintenance is also liberal. It is difficult to get definite information on these points, but so far as could be learned the expenditure for buildings and equipment at Berlin (Charlottenburg) would exceed \$2,500,000, but, of course, this is far the largest institution of its kind in Germany. At Hanover the expenditure for similar purposes has been about \$500,000, at Brunswick the steam and gas engine laboratory alone cost about \$75,000, while all the buildings at Dresden and Darmstadt, both sets of buildings being new, have cost \$1,300,000 and \$1,500,000, respectively.

The cost of maintenance of these Technical High Schools is also high for various reasons, the most important of which are probably: (1) That the schools are very completely equipped and kept fairly well up-to-date; (2) that there are a great number of instructors, and (3) that the fees are comparatively low. The number of students per instructor (including professors, lecturers and assistants) in very few cases exceeds twelve and in many cases is as low as nine. According to the reports to which I have referred, the annual State support to the various Technical Schools varies from about \$178,000 in Dresden, \$98,000 in Stuttgart, \$92,000 in Hanover, to about \$50,000 in Darmstadt, and the total to five of these schools in one year exceeded \$470,000. The balance of the money required to maintain these institutions is received from students' fees and other sources, the above figures giving only the support received from the State.

An opportunity offered itself to learn something relative to this matter about Dresden, where it was found that the annual grant for apparatus and supplies for the steam, gas and hydraulic laboratories alone was \$3,000.

It may be interesting to state that for the year 1907-8 the Faculty of Applied Science of the University of Toronto cost the State about \$66,000 (allowance being made for fees received), and the total invested in buildings and equipment in engineering would not exceed \$700,000.

The German people, have not been slow to take advantage of the facilities offered along the lines of engineering education, for the total number of students in the nine older schools would considerably exceed 16,000. In Berlin alone there were nearly 5,000 students in 1901-2, in Munich in

* Abridged from an address delivered before the Engineers' Club, Toronto, Ont.