THE LABORATORY FOR THE TESTING OF MATERIALS OF THE CHARLOTTENBURG POLYTECHNIC SCHOOL OF BERLIN.

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During the course of the year 1903 the laboratory for the testing of materials of the Charlottenburg Polytechnic School was transferred from the city of Berlin to one of its suburbs, Gross-Lichterfelde, and there combined with the chemical laboratory of the Berlin Academy of Mines. The resulting institution, under the title of "Königliches Materialprüfungsamt," embraces the experimental study, in all its branches, of the materials utilized in the industries; and for this purpose, the most complete and improved modern testing machinery and instruments were installed in its buildings.

The idea of testing materials is, so to speak, as old as civilization itself. Even in primitive times, the making of a tool or a weapon must have been immediately followed by a testing of the same; and while modern science has, of course, vastly changed the *modus operandi* of these tests, the fundamental purpose of the investigations is the same to-day as it was in the bygone ages. The development, however, of this branch of engineering did not assume anything like its present proportions till toward the middle of the last century, and during this period the first great strides forward were made.

The completeness of the Gross-Lichterfelde establishment, a partial description of which follows, demonstrates the great importance that is at present attached to the question of material testing. The origin of the Charlottenburg laboratory dates back to 1863, when Wöhler conducted a number of tests at Frankfort-on-the-Oder. In 1870 it was moved to Berlin, where a series of tests by Spangenberg were made, and in 1884, when it was joined to the Polytechnic School, its staff consisted of but fourteen persons. At the time of the establishment at Gross-Lichterfelde the number of employes had been increased to one hundred and seven, and at present the services of one hundred and thirty-eight individuals are required to conduct the investigations carried on within its walls.

The purpose of the new institution is the testing of materials for scientific or general uses, as well as the carrying out of investigations upon the orders of civic administrations or private individuals. The members of its staff are employed in various ways; they investigate the properties of materials, determine the degree of safety of constructions of manifold kinds, fix the value of the coefficients to be used in calculations, scientific and otherwise, improve upon existing methods of testing, and the apparatus for the same, advise industrial manufacturers in many ways, and similarly assist administrations and boards throughout the German empire.

The work of the laboratory is carried on in six main divisions, that is: 1, metals; 2, building materials; 3, paper; 4, metallography; 5, general chemistry, and 6, oils. The institution covers an area of about 10½ acres, situated between the railway and the road from Berlin to Potsdam. The principal one of the various buildings, which are all connected by a railway, is horseshoe shaped, the machinery building and workshops being situated in the center. It surrounds two large courtyards, which are closed at the rear end by a group of secondary buildings. The arrangement and distribution of the rooms is such that the heaviest apparatus occupy positions on the ground floors, where they are all connected by railways. These railways are also used for the weigh-bridge, the coal depot, and the boilers. The two large courts mentioned above, as well as the remaining unoccupied ground, are utilized for open-air tests. Below ground all the buildings are connected by a gallery, which carries the steam, water, gas, and electric mains as well as the drains. The main building, the ground floor of which is occupied by the management, contains on the second floor the laboratory of general chemistry (fifth division); on the third, those of metallography (fourth division); and on the fourth, the photographic studio. The building forming the right wing is devoted to the testing of metals (first division) on the ground floor, and to the testing of paper (third division) on the second floor. The building forming the left wing contains on the ground floor the laboratory for building materials (second division), and those for oils (sixth division) on the second floor. These various buildings are all provided with extensive platforms, which are utilized for certain of the open-air tests.

The total surface covered by the buildings is 56,615 square feet. The surface utilized by the laboratories and offices is 40,420 square feet, while the total floor space inclusive of the upper stories is 64,930 square feet. In the construction of the laboratories and administration buildings, nothing has been neglected that could add to the hygienic condition and comfort of the employes.

The steam necessary for the heating of the rooms and for the various apparatus of the central power station is furnished by boilers located in a suitable building on the north side of the grounds. In the central power station are located two 60-horse-power steam engines, which drive two dynamos; these give 220-volt continuous current, which is used for running various motors and for lighting the establishment. Furthermore, the laboratories are supplied with water power from two separate hydraulic mains, which are under a pressure of 200 and 400 atmospheres respectively. That the various buildings are plentifully provided with measuring apparatus designed for scientific observations goes without saying.

The division for the testing of metals comprises, essentially, two large halls, 115 and 130 feet in length by 26 feet in width. In one of these halls is located the great 500-ton testing machine that was employed in the old laboratory at Berlin, and for which it was built by Hoppe in 1891. Fig. 1 of the illustrations accompanying this article shows this great mechanism, which is designed to test materials both by tension and by compression. It has effective lengths of 55.75 and 49 feet respectively, for each of these two cases. Another machine, built according to the Becker system, is used for torsional tests up to 72,500 foot-pounds, and by means of it pieces 33 feet in length may be tested. The other hall contains a machine designed according to the Borsig system for testing pipes by means of internally and externally exerted pressure. The pipes may have a length of 13 feet and a diameter of 4¼ feet. The same machine can be employed for testing blocks of masonry and concrete, and for this purpose can exert a pressure attaining 600 tons. Besides this, the hall contains a new 100-ton Werder apparatus, for the purpose of testing by tension chains and cables with a possible length of 55 feet, and at the same time for compressive tests of columns up to 50 feet in length. This machine was constructed by the Société de Nuremberg, which likewise supplied the laboratory with two 50-ton Martens machines, shown in Fig. 2 of the illustrations. These rather complicated mechanisms are designed to test materials of various kinds while they are being subjected to the action of heat or cold of various degrees.

In the same hall there are, furthermore, three Pohlmeyer machines, built by the Ehrhardt Works, of Düsseldorf. One of these has a capacity of 100 tons, and the two remaining ones each of 50 tons. They are for the purpose of studying the resistance of bodies to pressures, acting simultaneously upon all of their faces, and it is possible by means of these apparatus to submit small-sized test pieces, located in the interior of hollow steel cylinders, to hydraulic pressure reaching 4,000 atmospheres.

The apparatus described above are all supplemented by manifold measuring instruments, for the purpose of observing all possible distortions of the bodies while undergoing the various tests. Aside from the two main halls described above, the metal division comprises various laboratories for the detailed study of the resistance of materials, especially under the effect of heat or cold. In these laboratories materials are also tested by means of repeated stresses, prolonged or alternating. A special building arranged for experiments under shock contains several dropping machines, among them an apparatus which employs the fall of a 2,200-pound ram from a height of 33 feet. In the part of the installation reserved for open-air tests, there is a small hydraulic press for the testing of structural building materials of larger size and the measurement of the elastic distortions of staircases, roofs, vaults, etc. Figs. 3 and 4 show this mechanism prior to and after testing a portion of an iron staircase. The appliances for measuring the distortion of the structure while undergoing the test can be clearly seen on the photograph. The metal-testing division also includes a large and complete mechanical workshop for the preparation of test pieces, as well as for the repair of machines and instruments.

The division for the testing of building materials consists primarily of a shop in which masonry stones are cut and shaped to the dimensions necessary for submitting them to the tests. A room that is devoted to tests under low temperature contains two refrigerating apparatus, each of which is capable of holding ninety bricks or a corresponding number of stones, which in the space of five hours can be brought to a temperature of minus 4 deg., measured internally. The same room contains the machines employed for testing material by wear, especially by the action of a sand blast. In the molding shop there are mortar and concrete pugmills, as well as an apparatus used for hammering test briquettes. The former is shown in Fig. 5 of the illustrations.

Materials for conglomeration are first sent into the crushing room, where they are reduced to powder and sifted; another room is set aside for storing the briquettes during the period of setting. This, with its tanks and shelves, is shown in Fig. 6. The next hall is the large one, where the tests of resistance are made. It contains first a 10-ton hydraulic press covering a floor space of 20 x 10 feet. Another press, the capacity of which is 20 tons, is designed for the testing of concrete or stoneware pipes. Both of these machines were constructed by the Borsig Works. The apparatus supplied for this division of the establishment by the Nuremberg Company consists of a 150-ton machine for compressive tests of brick; a 400-ton machine for testing blocks of concrete in the same manner; a 40-ton machine for similarly testing cements; and finally, a 1,300-pound machine for testing the tensile strength of cements. The 400-ton press for concrete blocks is shown in Fig. 7. In addition to the new apparatus described above, the hall contains various other machines of the ordinary types.

The division devoted to the testing of building materials is completed by three laboratories intended for chemical, mineralogical, and physical investigations. Besides these, however, large open-air spaces are reserved for its use for the testing of flooring of larger size, experiments in the resistance to fire, and the study of the influence of atmospheric conditions. Figs. 8 and 9 show the beginning and the end of an experiment on fireproof building material.

The division for the testing of paper comprises two chemical laboratories, two halls devoted to microscopy and micro-photography, and a room devoted to tests of resistance. The last contains various Schopper machines, and among others one with a maximum power capacity of 2 1-5 pounds for the testing of hair, fibers, and threads; a machine developing a maximum power of 22 pounds for the testing of ordinary papers; another of 220 pounds' capacity for the testing of cardboard; and finally, one of 1,100 pounds' capacity for the testing of stronger materials, such as coarse cloths. In the same hall are installed machines for rumpling paper and an automatic resistance gage of the Martens type. This delicate instrument is shown in Fig. 10. The motive power used in this department is either electricity or hydraulic pressure.

The division of metallography consists of a polishing shop, for the preparation of the specimens to be examined microscopically; of a chamber of microscopy, including among others a splendid micro-photographic apparatus of the Martens type; of a laboratory for analytical chemical studies; and of a hall for heating by incandescence. The room for microscopic investigation is shown in Fig. 11, while that for heating by incandescence is shown in Fig. 12. This last is provided with measuring apparatus of the most highly improved and modern types. There is, furthermore, a room for measurements of the most precise kinds for the determination of small differences of potential between metallic electrodes encountered in different phases of the manipulation. Finally, there are a foundry and a forge for necessary repairs, preparation of specimens, etc.

The divisions of general chemistry and oils include different laboratories for organic and inorganic chemical research, the laboratory for electrolysis, in which are installed two accumulators and a dynamo, a special room indirectly illuminated for determining the flashing point of oils, a complete installation for the distillation of crude petroleum, lubricating oil, and residues, a laboratory for experiments in refining and for testing by low temperatures, and finally a laboratory devoted to experimental physics. The last is provided with the most highly improved instruments, such as the Vogel spectroscope, a polarizing apparatus, a photometer and refractometer, a Beekman apparatus for the determination of molecular weights, and an Oswald thermostat. These two divisions, also, have at their disposal for open-air experiments ground space and platforms connected with the majority of the buildings.

The establishment of this model institution at Gross-Lichterfelde, now without a rival in Europe, required the large sum of $664,000, and covered a period of four years. Of the sum mentioned, $516,000 was expended by the administration in charge of the construction of the buildings, while the remainder of the appropriation, $148,000, was used to provide new apparatus and instruments.

In the current number of the SCIENTIFIC AMERICAN SUPPLEMENT will be found an article with six engravings, further to illustrate the above account of this interesting laboratory. We refer the reader for additional information to the SUPPLEMENT.

New World's Kilometer Motor-Cycle Record.

A new world's motor-cycling record was established by the well-known rider, Cissac, for the flying kilometer at the recent automobile meeting at Brighton, England. There were four entries, comprising Cissac and Rignold, each mounted upon a 12-horse-power twin-cylinder Peugeot motor cycle; G. A. Barnes, on a 10-horse-power twin-cylinder Barnes, and C. R. Collier, on a twin-cylinder 7-horse-power Matchless machine. Cissac in his heat covered the flying kilometer in 27 2-5 seconds, which is a speed of 81½ miles per hour, with Rignold 4 1-5 seconds behind. Cissac's time in this heat was only one-fifth of a second behind the record time for this distance established by Guipponne a short time ago at Ostend. In the final Cissac covered the short mile in 49 3-5 seconds, and the flying kilometer in 25 seconds dead, equal to a speed of 86 miles an hour.

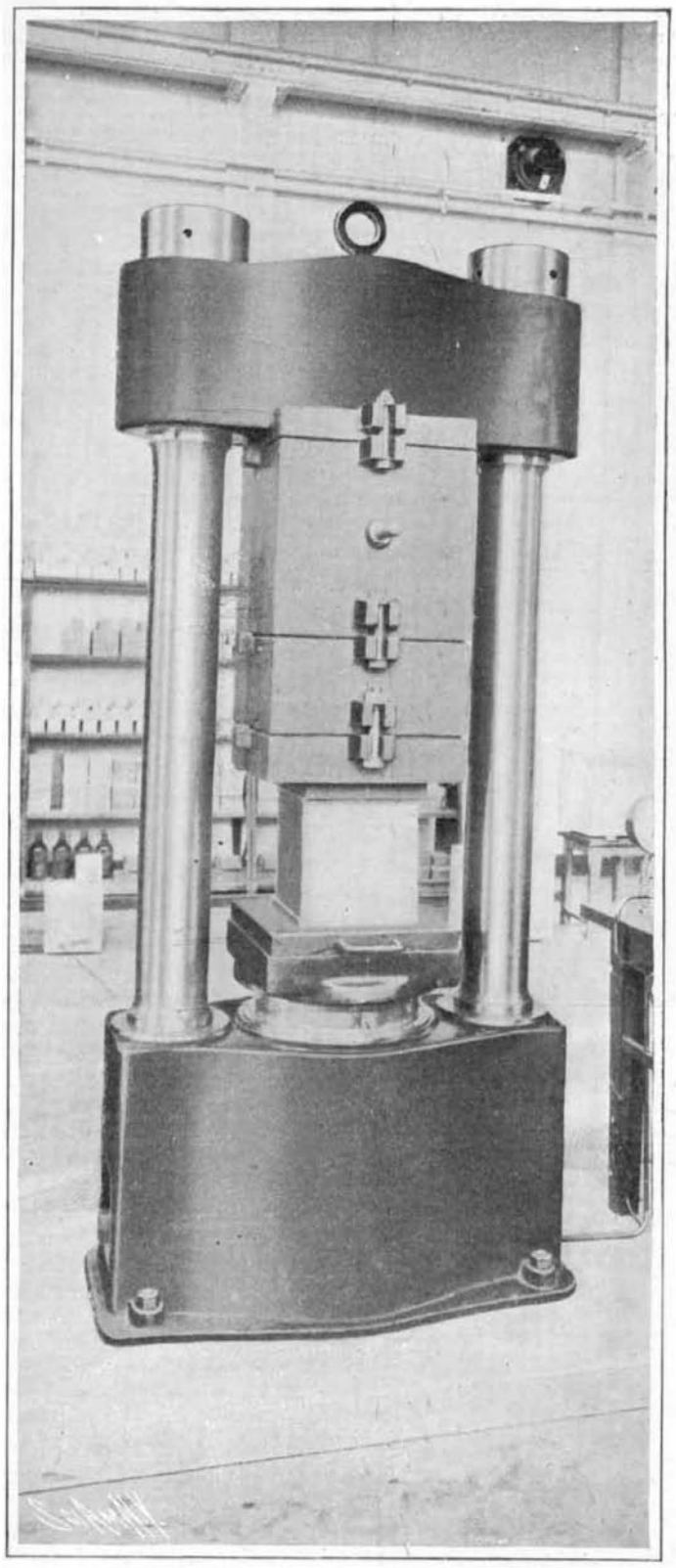

Fig. 7.—A 400-Ton Hydraulic Press for Testing Concrete Blocks Under Compression. This Forms Part of an Elaborate Equipment for Testing Conglomerates and Materials to be Used in the Form of Briquettes.

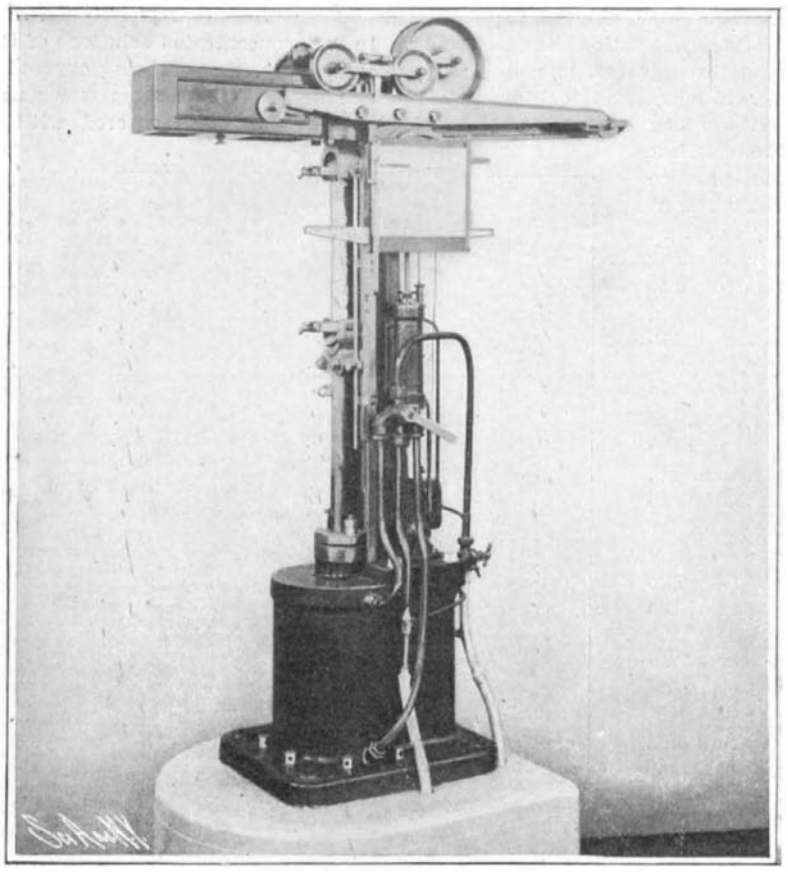

Fig. 10.—Martens Automatic Resistance Gage.

Fig. 8.—A Test of Fireproof Material Pr

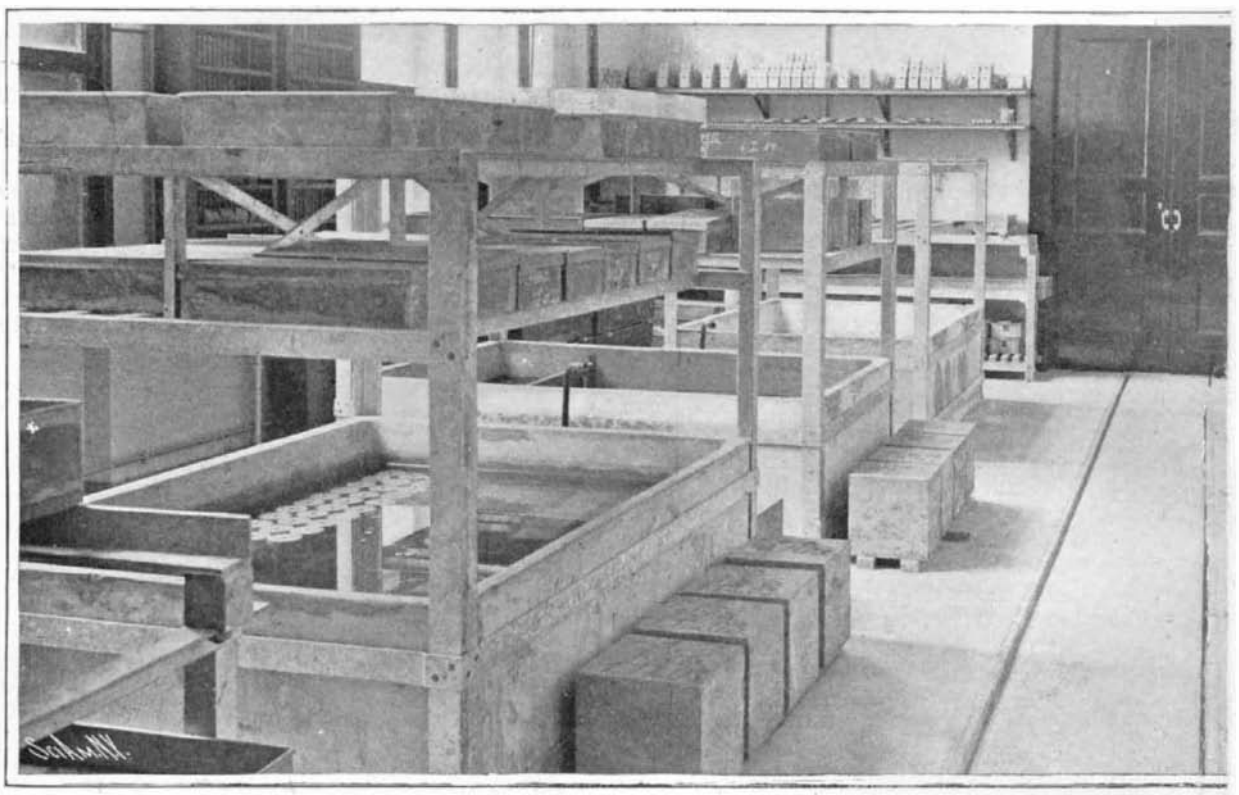

Fig. 6.—Room for the Setting of Briquettes of Hydraulic and Ordinary Cements.

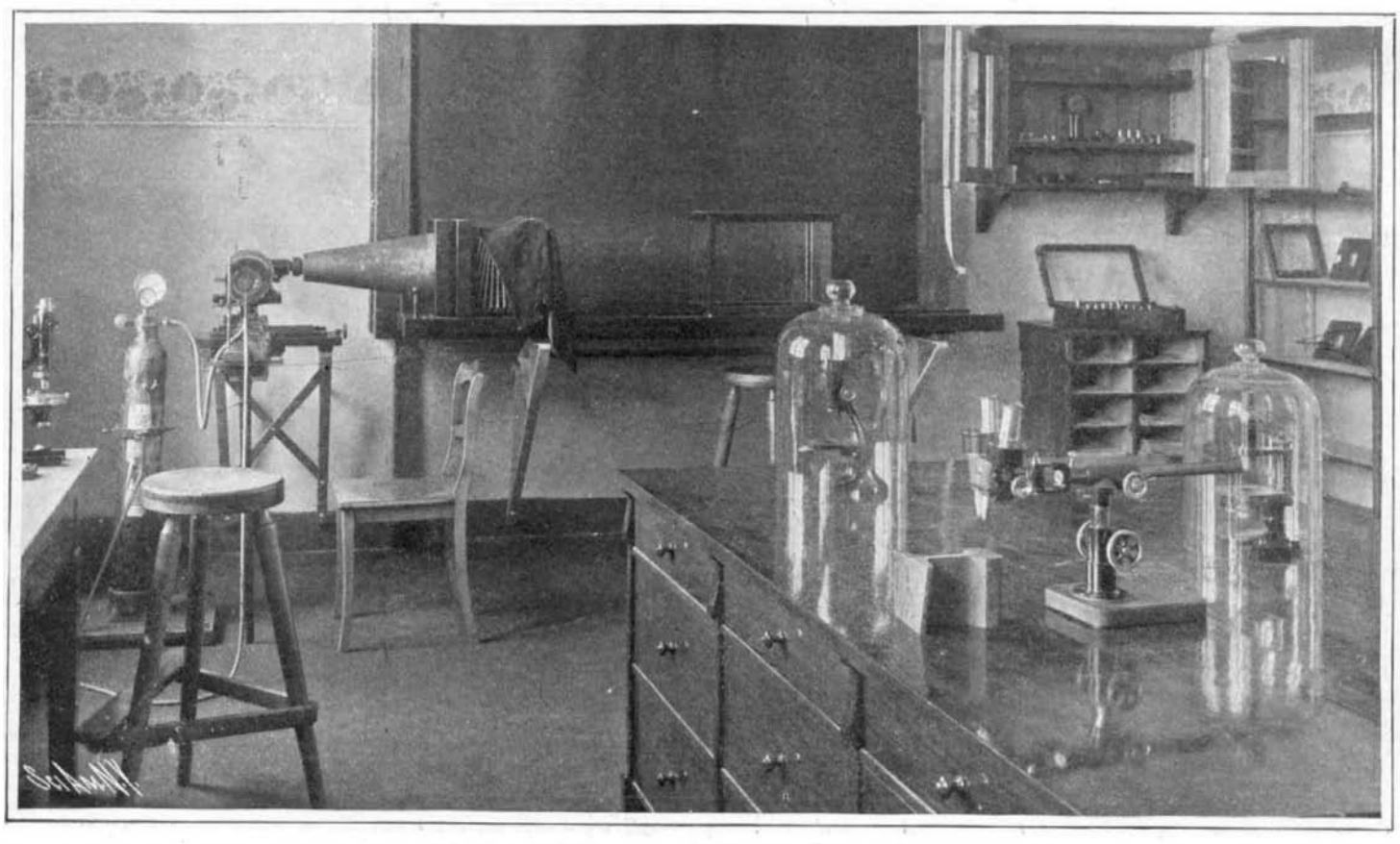

Fig. 11.—Room for Microscopic and Micro-photographic Investigations.

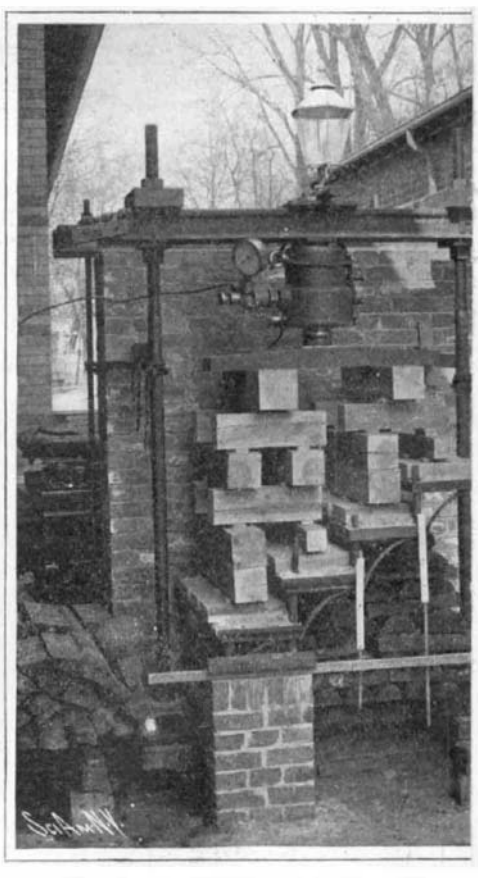

Fig. 3.—Ready to Test an Iron Stairca

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Fig. 9.—Conclusion of the Test.

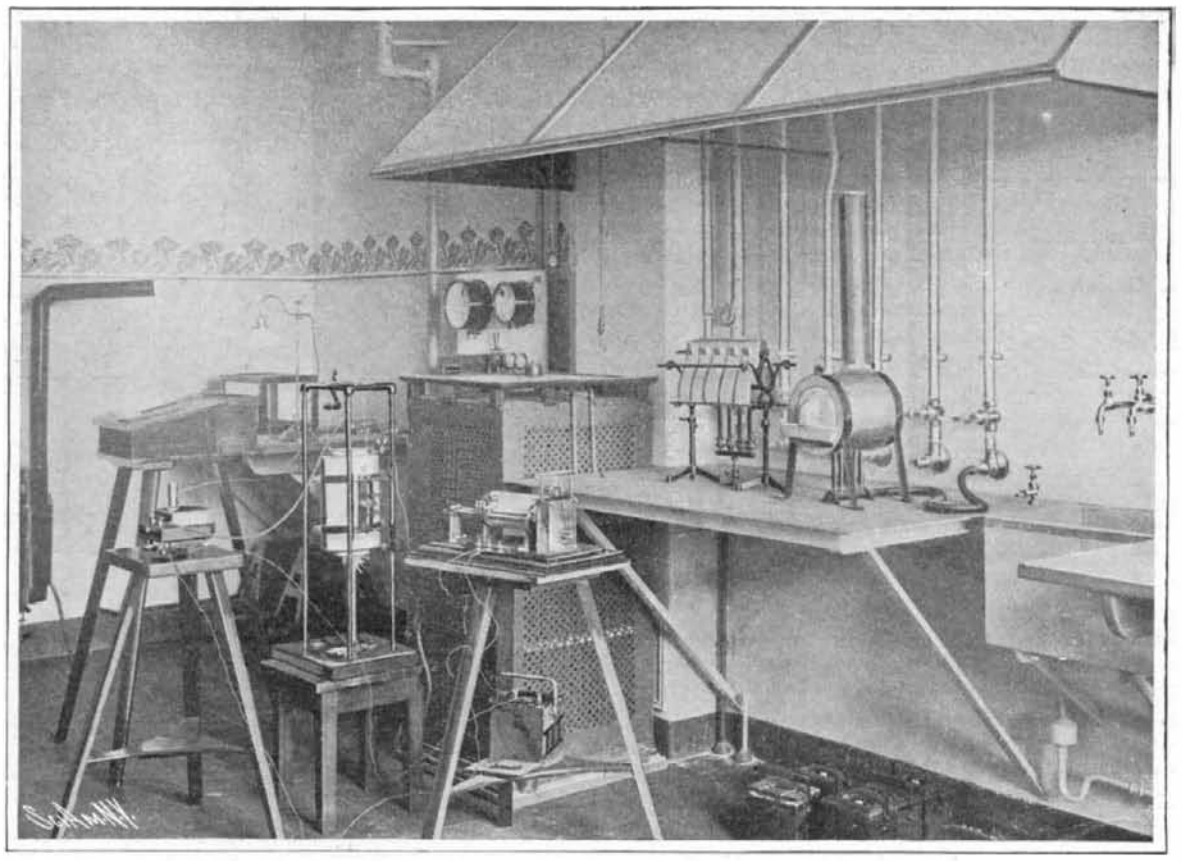

Fig. 12.—Room for Conducting Tests on Incandescent Heating.

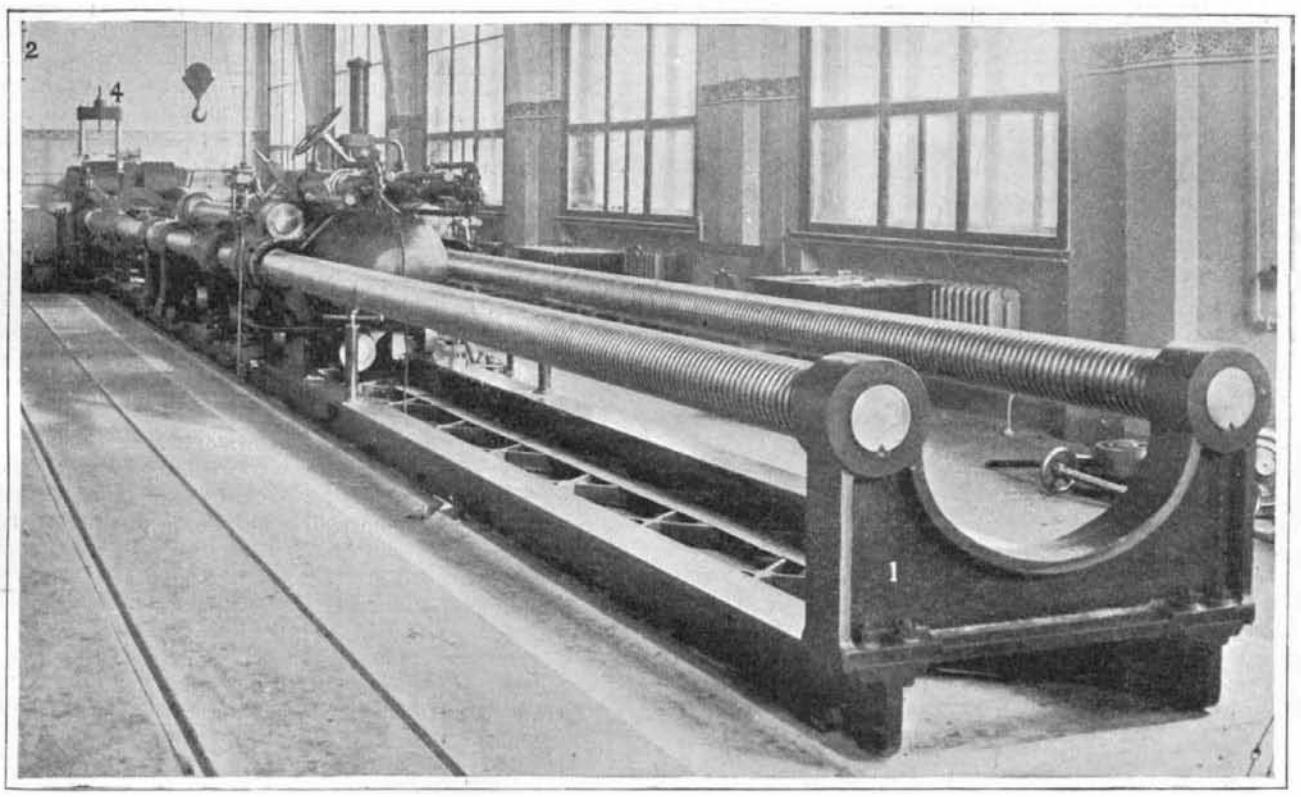

Fig. 1.—Giant Hoppe Testing Machine (1); Controlling Apparatus (4).

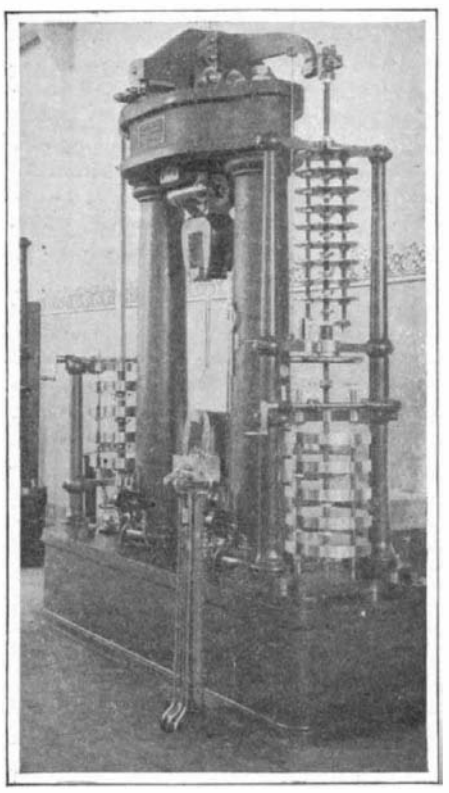

Fig. 2.—A Machine for Heat Tests.

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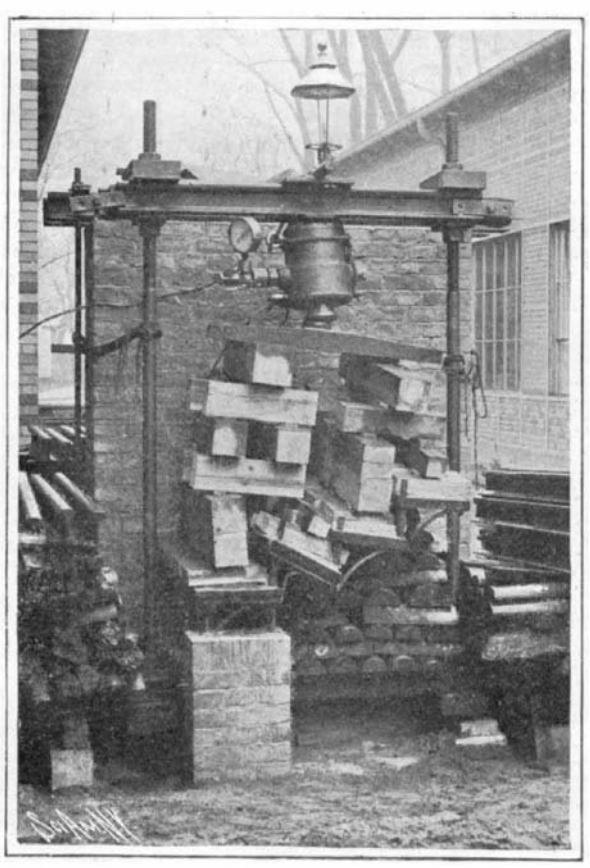

Fig. 4.—The End of the Test.

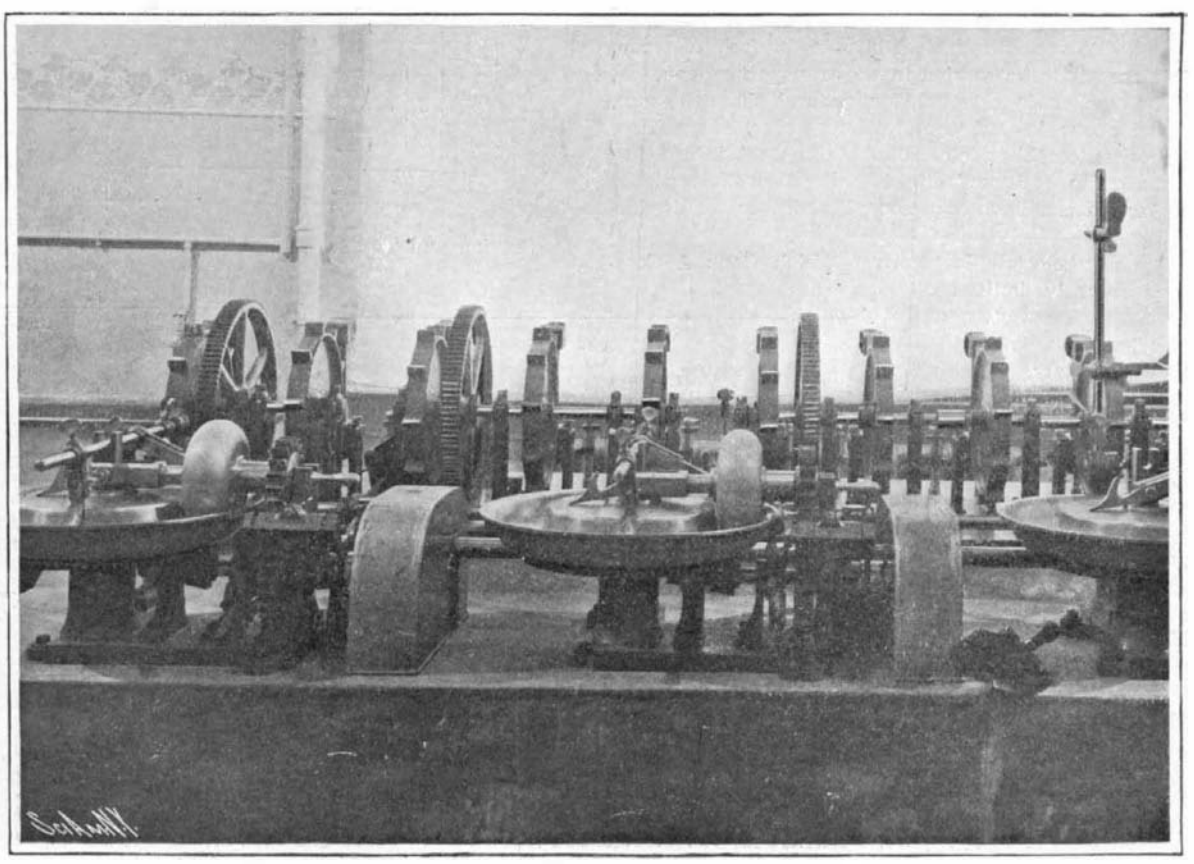

Fig. 5.—Mortar and Concrete Pug-mills for Preparing Test Specimens.

ECHNIC SCHOOL AT CHARLOTTENBURG, BERLIN.—[See page 199.]