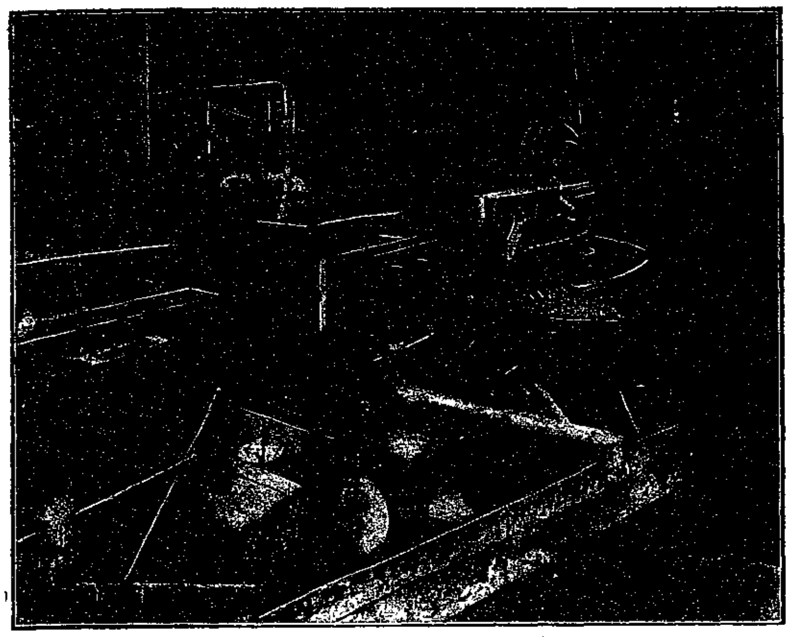

ROUND TABLE AND JIGS.

METALLURGY

By PROF. H. O. HOFMAN.

Metallurgy may be defined as the art of extracting metals from the ores and of refining them and fashioning them for use in metal industries. In order to cover the field it is necessary to have a knowledge of mineralogy to identify the character of the ore, of chemistry and physics to recover the metal and free the product from impurities, and of mechanical engineering to give the metal or alloy produced the forms that are required by the trade.

The progress that has been made during the last seventy-five years in metallurgical practice has greatly increased the demands upon the metallurgist. Some fifty years ago, metallurgical establishments were small, the processes carried out were the outcome of many years of practical experience, the whole was an art with a slight infusion of science. The older metallurgists, however, were keen observers and by persistent endeavor obtained a practical insight into the behavior of metals aad metallic compounds that astonishes the more scentifically trained metallurgist of today when he determines by precision measurement the limits within which the chemical re-actions of the processes can take place. As late as thirty years ago, the main equipment of the metallurgist was a general knowledge of mathematics, physics and chemistry, with some mineralogy and perhaps a smattering of mechanical engineering in addition to an acquaintance with the metallurgical operations carried out in different works. This was sufficient for the European metallurgical plants of that date, small in size and working along beaten paths. With the opening up of the mining districts in this country, new conditions had to be met; the established European methods of ore treatment failed when transferred bodily to this continnent, they had to be adapted to new surroundings or, in many cases, thrown over entirely and new means devised to attain given ends. This required going more deeply into the general sciences. The high cost of labor became the cause of the introduction of mechanical handling of materials in place of the customary working by hand. The enlargement of individual metallurgical establishments and the concentration of metallurgical work in places centrally located for the receipt of ores, fluxes and fuels and for the distribution of the products, made it necessary for the metallurgist to become more familiar with mechanical engineering than was formerly thought necessary; competition forced him also to increase the yield of metal from his ore, to enlarge the duty of his apparatus, and to improve the character of his product.

In recent years electrical transmission of power has made it necessary for the metallurgist to have a training in the fundamentals of electrical engineering; the application of electricity to the treatment of ores and refining of metals calls for some knowledge of electro-chemistry. The modern methods of thermal measurement have made it possible to control processes to a considerable degree; this control has opened up a comparatively new field, the application of thermo-chemical considerations to metallurgical practice; lastly, the laws of solutions as applied to the constitution of alloys combined with thermal measurements, microscopical examination and mechanical testing have furnished the guiding line for the explanation of the mass of heterogeneous information accumulated by years of rule-of-thumb practice and for future research in the attempts to improve the physical and chemical properties of metallic products.

The metallurgist of today, therefore, must have some knowledge of mechanical and electrical engineering, of electro-chemistry in addition to the old-established auxiliary requirements of mathematics, physics, chemistry and mineralogy to assist him in his special study of metallurgy; he must have made his own some of the fundamental teachings of theoretical chemistry and the microscopical examination of metallurgical products must not be new to him.

The Institute aims to give its students in four years a general and a technical training. Regarding the latter, this instruction can cover in the available time only the leading principles and illustrate their application in metallurgical practice by brief discussions of characteristic examples. The corner-stone of Institute-instruction, a combination of lecture and laboratory, is well represented in the metallurgical laboratories in which the student carries out the leading metallurgical operations with apparatus smaller than working-size, but always large enough to give quantitative results. The laboratory runs parallel with the lectures or recitation, thus one supplements the other; the weekly conferences held to discuss the class experiments or the research that is carried on by individual students, vitalize all metallurgical work.

The subject of metallurgy is so large that it is impossible to cover the whole field in any adequate manner within the time allotted to it in the undergraduate course. Of the two ways open, trying to cover the whole superficially or a part thoroughly, the latter has been chosen. It is therefore advisable for the student to stay one additional year after graduating and become thoroughly grounded in all the studies which form the foundations of modern metallurgical engineering.

The prospects of the graduate to find employment are good. There is a large field as to the character and place of work. Iron and steel, lead, copper, zinc, nickel and some of the minor non-ferrous metals are treated near the centres of civilization; the precious and associated metals are worked in the isolated locations where they occur. Employment in populated centres, where competition is large, gives smaller pecuniary reward than in mining districts proper. A graduate from the Institute, however, receives in either case, more than is required to make his living and to be independent. The future success, professionally as well as pecuniarily, depends largely upon the man himself and on the manner in which he meets the demands of his employers and the requirements of his surroundings.

METALLURGICAL LAB.

By PROF. H. O. HOFMAN AND C. R. HAYWARD.

The conception of having a metallurgical laboratory is in harmony with the general principle of teaching followed at the Institute. There was no precedent, something new had to be created. There existed assay laboratories, but investigations into ore-treatment on a laboratory scale had not been thought of, much less the placing of students in touch with the operations discussed in the class-room. The beginnings of the laboratory were modest indeed; assaying and ore-treatment were confined to the present furnace department in the "pit." In time the whole basement of Rogers building was occupied, the addition of a sub-basement division had become necessary. Any one seeing the crowded condition that prevails at present could easily recognize why the plans for the future call for three times the area occupied at present.

The aim followed in carrying out the work in a metallurgical laboratory is to make the student personally familiar with the leading metallurgical operations, to teach him their physical and chemical control, and to induce him to carry on independently metallurgical investigations. Until within about two years, work in a metallurgical laboratory was confined to ore-treatment. This branch has been fully developed here and has served as a model for most laboratories that have been erected since in technical schools, and there is hardly an institution that has not followed the example of laboratory instruction set by the Institute. The second branch of metallurgical laboratory work, the study of the constitution and physical properties of metals and alloys and their changes as effected by heat treatment and mechanical working, is not as yet as fully developed as the first, on account of lack of space, but the facilities offered under the present cramped conditions compare favorably with those given elsewhere with institutions that started fresh with abundant space and facilities.

In the fall term characteristic metallurgical processes are carried out which embody the principal operations. The processes are worked quantitatively, in each of them the material going in is balanced against that which comes out; thus e. g., a complete account of stock of metal is taken showing the direct yield and the losses and their distribution; again a heat balance is made which gives an insight into the sources whence the necessary heat was derived and how it was expended; further there is prepared a statement of the materials consumed and of the labor and power required for a given treatment, and this furnishes the economic data essential for considerations of cost. Thus a metallurgical process is studied chemically and industrially also mechanically when this point of view forms an essential part of the whole.

In the class work the processes of roasting in hand reverberatory and the Brückner furnaces, blast-roasting, smelting in the blast furnace and the reverberatory furnace, converting matte, zinc desilverization, pan amalgamation and electrolytic refining of copper have been chosen as embodying the leading metallurgical operations with which every student ought to be familar by personal contact. Each of these processes requires a number of manipulations and observations, and every student does the necessary work and makes the records of his measurements. The individual records are then collated and the whole is presented to the class at the conference, called laboratory reports. Here the student sees his own records tabulated with those of the members of his section. The result of the work is analyzed and discussed.

In the individual work wet processes form the basis of study, as these permit the use of quantities of ore sufficiently small for the individual student to treat by himself. Thus, chlorinating, brominating and cyaniding gold ores, oxidizing and chloridizing roasting of copper, gold and silver ores in muffle-furnaces, and leaching silver ores with hyposulphite and cyanide solutions are carried through by every student. An ore is thus treated by a number of students, the treatment is the same excepting one variable, and this is changed in such a manner that when the individual tests are assembled and tabulated, the curve drawn will show the best conditions of working in regard to the variable quantity that has been under observation.

In the combined class and individual work, heat treatment and microscopical examination of metals, alloys and metallurgical products form the subject of study. Heat treatment and the determination of melting points are carried on in the heat laboratory in charge of Professor C. L. Norton. Every student does individual work upon his own specimens, each of which forms part of a series; later he polishes his specimens in the metallougraphical laboratory and examines them microscopically. The individual cooling curves are assembled to a freezing-point curve, and this is compared with the established curve. The student examines besides his own specimens, those of his colleagues as well as perfect specimens prepared elsewhere so as to compare his own work with that which is standard. He further makes sketches of the magnified surfaces seen through the microscope and thus fixes in his mind the structural features. Besides the specimens thus prepared by the members of the section or class, the microstructures of some of the leading industrial alloys are examined and their constitutions explained in connection with the established freezing-point curves. Iron, steel, copper-cuperous oxide, copper-silver, lead-antimony, brass, bronze and one or two ternary alloys are thus brought to the attention of the students.

Work in the spring term is given over exclusively to individual research which usually forms part of the thesis required for graduation. The subjects are taken from the whole range of metallurgy, depending largely upon the preference of the individual student. They usually embody the treatment of an ore by an established process, variation of an established process to suit a given ore, study of limits of chemical reactions in metallurgical processes, investigations into fuels, refractories and other re-agents commonly used in processes, tracing of freezing-point curves of metals, alloys and metallurgical products with microscopical examination of polished surfaces.

AMALGAMATING PANS.