United States and perhaps in the world. It has the further advantage of not being owned by a local institution, as is the case with the summer stations of universities of this part of the country. There is every reason why it should become the most important center of summer biological work in the Mississippi Valley."

At all three of the bureau's stations, laboratory privileges, including either a private laboratory or a research table, the use of aquaria, glassware, the simpler laboratory apparatus and chemicals or reagents in moderate quantities, as well as dormitory space in the residence quarters, are provided to qualified independent investigators without charge. The Woods Hole laboratory will be open to private investigators from June 17 to September 14, but both the Beaufort and Fairport laboratories will be open for research in the future throughout the entire year. At Woods Hole the privileges of the Marine Biological Laboratory mess are accorded to the workers at the fisheries laboratory, while at the other two laboratories a cooperative mess is in operation during the summer season. The government provides fuel and labor for the preparation of meals, and the cost of the food is divided proportionately among the investigators. Applications for research privileges in these laboratories may be made direct to the Commissioner of Fisheries, Washington, D. C.

Henry O'Malley,
Commissioner

Washington, D. C.

SCIENTIFIC BOOKS

Hydraulic Laboratory Practice, edited by John R. Freeman, consulting hydraulic engineer. Published by the American Society of Mechanical Engineers, 1929. Cloth 9 x 12 in., pp. xxi + 868. 996 illustrations. $10.00.

The flow of water, even in the simplest case, is a very complex phenomenon, and consequently the laws derived from theoretical hydrodynamics furnish only to a very limited extent a means of solving the hydraulic problems arising in practice, because the conditions must be highly idealized if the problem is to be amenable to mathematical treatment. Hence hydrodynamics has been called upon to furnish formulas which apply approximately to general types of problems, these formulas containing coefficients whose values can not be determined theoretically but can be found from experiment for a given set of conditions. Hydraulic engineers have used such laws in the design of hydraulic structures ever since hydraulics first merited the name of a science. However, in hydraulic design it frequently happens that the conditions to which a given formula apply differ so widely from those for which numerical values of the coefficients in the formula have been determined experimentally that the selection of the proper values for these coefficients is nothing more than an intelligent guess.

A more powerful method of solving complicated hydraulic problems, that of conducting model tests on a small-scale copy of the full-scale structure, was first utilized in a scientific way about sixty years ago, when William Froude applied this method in his epoch-making advance in the science of ship resistance. This was followed in 1875 by tests of a model of the Garonne River by Fargue in France and about ten years later by tests of a model tidal estuary by Osborne-Reynolds. In order that the results from such model tests may be used scientifically to predict the characteristics of the full-scale structure it is necessary that all parts of the model structure and the processes taking place in it shall be dynamically similar to the corresponding parts of the prototype in nature.

The nucleus of the theoretical foundation of dynamical similarity exists in Newton's "Principia" (1687) and was utilized in physics by Savart (1825) and by Cauchy (1829). In 1847 Bertrand clothed Newton's definition of dynamical similarity in mathematical language and derived the fundamental relation between the ratios of corresponding lengths, times, masses and forces in the natural structure and in the model. The theoretical foundation for model experiments was thus laid. The theory has been developed still further in Germany, England and the United States from somewhat different points of view, the Germans proceeding from a consideration of the differential equations of motion or from the dimensional forms of the forces involved, while the English and Americans have used the methods of dimensional analysis.

With the opening of the twentieth century, model experimentation in connection with fluid flow increased by leaps and bounds. The applications to aerodynamics are too well known to require comment here. But only since about 1926 has it become generally known in this country that a corresponding development has been going on in Europe in connection with hydraulic problems under the leadership of Engels, of Dresden; Möller, of Braunschweig; Rehbock, of Karlsruhe; Krey, of Berlin; Thoma, of Munich, and others.

In 1926 appeared the German edition of the book "Die Wasserbaulaboratorien Europas" sponsored by the eminent American hydraulic engineer, John R. Freeman, who brought about its publication in his desire to make known to the engineers of the United States the progress in hydraulic science in Europe which he had observed during his travels abroad. This book contained descriptions of fourteen of the most prominent hydraulic laboratories of Europe, together with a description of the most important researches conducted in them, written by the directors of these laboratories. "Hydraulic Laboratory Practice," which appeared in January of this year and which Dr. Freeman sponsored and edited, is destined to have a profound influence upon the future of hydraulic science in the United States. The book is essentially a translation of "Die Wasserbaulaboratorien Europas," but has been enlarged by the description of the most recent research work conducted in the laboratories described in the German edition, by the description of many other European and several American hydraulic laboratories and by the inclusion of several chapters dealing with the theory of dynamical similarity as applied to hydraulic problems.

The laboratories described include river structures laboratories, pump and turbine laboratories and ship model research laboratories, of which the first class is treated most fully. The special apparatus developed for testing hydraulic structures in these laboratories is very interesting, particularly the glass-walled flumes in which studies are made of the flow over dam and weir sections, as well as scour at the foot of overfalls, the glass walls making it possible to watch the stream filaments and the scour in a way which can never be done in nature. The immense river flumes, shallow, but of wide extent, are capable of containing models of entire hydraulic projects. Models are also frequently built out-of-doors in order that the scale may not be too small when the structure in nature is extremely large. For example, in the out-door laboratory of the Experimental Institute at Berlin, a model of a fifty-mile stretch of the Havel and Elbe Rivers is being built to a scale of about 1:75, so that the model is approximately 3,600 feet long.

Of interest also to water-power engineers are the descriptions of equipment available in many European turbine laboratories for the study of cavitation. This is the foremost problem facing the hydraulic turbine designer to-day, yet there is not one laboratory in the United States equipped to study this phenomenon. Such a condition can not continue to exist if we are to keep abreast of foreign progress in this field. The attitude of several manufacturers of hydraulic turbines toward research is commendable, but the heads of other American concerns still can not see what part experimentation has in turbine design, although European design has been based upon experimental research for a long time.

Much space is given to the flow of water in open channels, a subject which was dealt with in a very unsatisfactory manner when the writer first studied hydraulics. Only during the last fifteen years has the existence of a third flow régime in open channels, that of "shooting" flow, been recognized generally, with many of its effects exactly the opposite of those involved in ordinary turbulent flow. The utilization in the United States of the hydraulic jump in a scientific way as a destroyer of the energy of water at the foot of an overfall dates only to the work of the Miami Conservancy Board, and as yet its possibilities are scarcely appreciated by most engineers, although its laws are now well established.

Another striking feature of "Hydraulic Laboratory Practice" is the evidence to be found throughout as to the great interest which is being shown in Europe in the study of the effect of flowing water on the form of stream beds. Not only are numerous fundamental researches being made continually in regard to this phenomenon, but the results of experiments are being applied in actual construction every day. In contrast to this activity abroad, we are practically standing still in the United States in the study of the formation of fluvial beds. Granted that this is probably the most difficult field of hydraulic research; granted also that the subject has hardly been scratched as yet; nevertheless, the possibilities are so tremendous and our river problems are so great that we should be bending every effort to acquire more scientific information, such as can be best obtained through laboratory experimentation combined with observations on our actual rivers.

It is impossible to undertake a discussion of the researches described in the book, for they cover all phases of hydraulics imaginable. Even the casual reader can not fail to be impressed with the evidence there given of the extent to which scientific methods have been applied in Europe during the past quarter century to the solution of the difficult problems arising in hydraulic engineering.[1]

HERBERT N. EATON

BUREAU OF STANDARDS

SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN IMPROVED THERMOPILE VESSEL FOR THE ELECTROMETRIC DETERMINATION OF THE VOLUME FLOW OF BLOOD

IN an earlier paper Gesell and Bronk[1] described a continuous thermoelectric method of recording volume

1 Publication approved by the director of the Bureau of Standards of the U. S. Department of Commerce.

1 Gesell and Bronk, *Amer. Jour. Physiol.*, 1926, 79: 61.