It should not be forgotten that economic science differs in essential respects from the physical sciences. In those sciences we find forces which work according to fixed laws. Even in them we find the effect of those laws mitigated or offset by friction and opposing forces. In the world of economic science we do not deal with conditions so unvarying. The so-called laws of economic science are simply the interpretation of what is likely to be the action of men under the stimulus of self-interest in the field of free competition for the acquisition of goods and the accumulation of capital. But while two streams of water act in exactly the same way under similar physical laws, no two men act in precisely the same way under the operation of mental laws. At least, if laws exist which compel such uniformity of mental action, they are too abstruse to have yet been discovered and formulated.

From the standpoint of existing conditions, therefore the psychological element is an important factor in mitigating the operation of so-called economic law. To acquire commodities and save capital is not man's sole impulse. On the contrary, in the midst of the most highly developed civilized society to-day, a large percentage of men are influenced by other motives than the desire to achieve the greatest result by the utmost exertion of their labor. Some prefer idleness to labor; others prefer spending to saving; others pursue ambitions which have their roots only remotely in the acquisition of money. And if this is so in civilized communities, how much more is it so in those where commerce is feebly developed, where the church or the state, or immemorial custom prescribe the routine of each man's life, and where competition in our modern American sense is almost a thing unborn.

Economic law does not operate in a vacuum or in anything approaching a vacuum even in the most advanced modern society. It gropes blindly in a mist of disturbing forces, and with many digressions from its true objective, even where its operation is most nearly unhampered. The political economist, therefore, can afford to admit that the man of practical affairs sees in some respects as clearly as himself regarding existing requirements, even though his eyes are fastened upon the ground while his own are uplifted to the stars.

Charles A. Conant

SCIENTIFIC BOOKS

Ice Formation, with Special Reference to Anchor-Ice and Frazil. By Howard T. Barnes, M.A., D.Sc., F.R.S.C. New York, John Wiley and Sons. 1906. Pp. 260.

To persons living in moderate climates, the statement of Dr. Barnes, in his introduction, is very striking that where surface ice is prevented from being formed "as in a rapidly flowing river we meet with the worst effects from the presence of ice"; notwithstanding the fact that the temperature of the water never varies more than a few thousandths of a degree from its freezing point, even when the air is 30° or 40° lower. The account which Mr. Barnes gives of the difficulties which the ice causes in the St. Lawrence River at Montreal entirely substantiates the statement. There are three kinds of ice which are met with; the surface ice, the anchor-ice, which is formed in the bed of the river and the frazil, which is formed as small individual crystals at the surface of the swiftly flowing water. The frazil is formed in the rapids and is carried under the surface ice in the quiet water below and adheres to its under surface. Thus the ice becomes thick enough to choke up the channel of the river and cause a serious flood. Frazil also interferes with the water power used at Montreal by choking up the machinery, and a commission has existed for some time for the purpose of studying the condition leading to the formation of frazil and the best methods of preventing the damage done by it. This commission had made many determinations of the temperature of the

water with mercury thermometers and had failed to discover any real variations from the freezing point, but the Callendar platinum resistance thermometer makes it possible to determine the variation of the temperature easily to a thousandth of a degree centigrade, and Dr. Barnes's familiarity with this instrument enabled him to make extremely accurate observations showing the condition existing when frazil and anchor-ice are formed.

The first few chapters of the book are devoted to a compilation of the laws of the transfer of heat, the various methods of determining the different constants of ice and water, and the general structure of ice. In referring to the various workers in these fields, Dr. Barnes gives their names and the year of their work but does not give references to their original publications, which would be very useful for students of the subject. The platinum resistance thermometer is then described and the degree of accuracy obtainable with it is shown to be in the neighborhood of 1/10,000 of a degree centigrade, under good laboratory conditions; these were not obtainable at the river bank where Dr. Barnes made his observations, but he considers that the water temperatures which he determined are accurate to a thousandth of a degree. The rest of the book is devoted almost entirely to the study of anchor ice and frazil, and their occurrence in the St. Lawrence River.

Many observations and opinions regarding the formation of anchor ice are cited and Dr. Barnes wisely makes a long extract from two papers by the Rev. Dr. Farquharson, in the *Philosophical Transactions* for 1835 and 1841. His observations were made on the rivers Don and Leochal in Aberdeenshire, and they were so well made that one is entirely convinced that he is right in ascribing the formation of anchor-ice to the cooling of the bottom of the streams by radiation. The absorption of water for radiation of long wave-lengths is not well known but Dr. Barnes made a preliminary experiment to show that bodies at low temperatures can radiate through water and glass; a coil of platinum wire covered with a layer of water between glass, was exposed to radiation on a clear night; the coil became cooler by radiation.

Careful observations made near Montreal show that anchor-ice is not formed except on cold clear nights and in situations permitting free radiations into space. Anything interfering with this radiation, such as a bridge or a clouded sky, will entirely prevent the formation of anchor-ice, and a very short period of bright sunshine is sufficient to loosen the ice from the bottom and cause it to rise, sometimes in great quantities, to the surface.

Frazil, on the other hand, is formed at the surface, where the water is so disturbed by currents or strong wind as to prevent the formation of a surface sheet. All that is necessary for the formation of this kind of ice is very low temperature and rough water. The water becomes undercooled to a few thousandths of a degree and small crystals of ice are formed and carried down with the current. Bright sunshine is sufficient to prevent the formation of frazil; and the experiment of Dr. Barnes shows how quickly the undercooled water is brought up to the freezing point when the sun shines upon it. His experiments were carried out in a small hut on the shore of the river. It is necessary in these experiments to have as a basis for comparison a mixture of snow and water exactly at the freezing temperature; some difficulty is found in obtaining this to the degree of accuracy required. Dr. Barnes found that when the water was freezing the temperature of the mixture was slightly lower than the freezing point; on the other hand, when the ice was melting the temperature was slightly higher, and he found that the variations from the freezing point depended upon the relative proportions of ice and water in the mixtures. This led him to the suggestion that "a freezing point mixture must be defined as an intimate and equal mixture of ice and water, neither gaining nor losing heat."

The final chapter in the book tells of the difficulties attending the use of water-power machinery at Montreal on account of the formation of frazil ice, and the way these have been met. One very simple method, which has served pretty well, is to take the water from

a quiet part of the river which freezes over entirely in cold weather rather than from a point on or below the rapids where frazil is formed in great quantities.

The most important parts of the book are those dealing with the formation of anchor-ice and frazil, and Dr. Barnes's temperature observations. The small section on glacier motion is hardly in accord with the present ideas of glacialists.

To any one interested in the engineering problems brought about by ice, or in the general phenomena of ice formation this book will be extremely interesting and useful.

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The Chemistry of Commerce, A Simple Interpretation of some new Chemistry in its Relation to Modern Industry. By Robert Kennedy Duncan. New York and London, Harper and Brothers. 1907.

This is a book intended by its author "to interpret into simple terms and for educated lay-folk some new science in its relation to modern industry." The author seems to have realized the difficulty involved in this problem which he had planned for himself or which had been submitted to him by others. Whether the "one object of the book" indicated in the opening sentence of the introductory chapter, "to convince the manufacturer, through instances taken here and there, how absolutely applicable is modern science, to the economy and progress of manufacturing operations" will have been attained through it remains to be seen. Certainly it is not easy to make a manufacturer, prosperous in spite of his wastes, realize the importance of the economies which may be discovered and applied through the aid of thoroughly educated men, and lead him to the practical application of such economies. Adversity and active competition are the influences which are most effective in bringing about such policy, wise, at all times, and it is exceedingly doubtful if it can be brought about by even the most attractive presentation of generalities—carefully prepared balance sheets are far more interesting and intelligible to the manufacturers of this country at least; and while the author has made a most interesting and readable book, it will, we fear, be read with closer attention and appreciation by those lay-readers who least need it, in view of the object of its preparation. In twelve chapters the following subjects have been treated: Catalysis, Fixation of Nitrogen, Rare earths and their uses, High Temperatures and Modern Industry, Modern Chemistry and Glass-making, Industrial Alcohol, Floral Perfumes, Making of Medicines, Microbe Inoculation, Cellulose, Industrial Fellowship. Each subject furnishes the author with illustrations of the importance of the application of scientific methods and the truths they develop, in industrial work. Manufacturers who are inclined or are desirous to proceed in rational ways to attain the best results in quantity and quality of product and in cost of operation, must certainly be attracted by what the author has presented. But those who most need the book will not, we fear, read it; while those who will read it need it least. Yet those of us who know the full truth of all that is presented in the book will at least hope that it may be widely read and that the suggestions it offers may find extended application not only for the good of manufacturers, but for the world at large. The book then is generally acceptable, but it may be criticized by some readers on account of the statement to be found on page 177. "But this was in the days long ago . . . when experimental medicine was carried on by physicians like Paracelsus, who stood by the bedside of his patient, watch in hand," etc. Many readers will remember that the first watch was made one hundred years or more after the death of Paracelsus. Such pleasantries seem out of place in such a book and the technical description of the analytical method for standardizing drugs involving "dissolving out with chloroform and ultimately titrating them with sulphuric acid" will scarcely attract the lay-reader. The use of the word "dubiety," when the more familiar "doubt" would serve, may unfavorably affect some of the lay-readers the book is specially intended to influence favorably.