periences in this country and abroad as regards filtration in intermittent sand filters, contact beds and trickling filters.

The remaining chapters, pp. 375–409, contain first a full statement of the recent work done in this country in the sterilization or disinfection of sewage, with data as to the efficiency and cost, while the book is concluded with a brief summary of the main features of sewage analysis with particular reference to those tests of most benefit in practical operations.

The book is very attractively written and is well indexed. There are 113 figures illustrative of the various distinctive features of the principal processes. The more one studies the book the more apparent it is that there has been a vast amount of study given to the compilation of a wide fund of information so as to embody it compactly for convenient reference. The book is free to an unusual extent of statements to which exceptions will be taken by experienced sanitarians. The principal points on which there would be differences in opinion are in reference to the residual quantity of dissolved oxygen which would be found in a stream into which sewage has been discharged, and the disparaging reference to automatic controlling devices for the operation of contact beds.

Taking the book as a whole, it may be safely said that it will be of much assistance in the class-room in teaching this subject to students and especially to the public hygienist desiring to get a general insight into the subject in its broader phases, with ample opportunity to ascertain where the various results with different styles of plants have accomplished definitely recorded results.

GEO. W. FULLER

The Practise and Theory of the Injector. By STRICKLAND L. KNEASS. Third edition, revised and enlarged. New York and London, John Wiley and Sons. 175 pages, 53 illustrations and diagrams.

This book possesses the great merit of having been written by one who is a master of his subject. It is no ordinary compilation; it is the reflection of a life work. Its author for more than a quarter of a century has given serious attention to the problem of perfecting the injector. He has made it a part of his business to study the fundamental principles underlying its action, to conduct experiments which would supply data with which to embellish the theory, and to contribute to the working out of actual designs which from time to time have become the standards of a great manufacturing company; yet such is his modesty that nothing which is printed suggests his personal activity in the development of the instruments he describes. The book presents in logical order the fascinating story of the development of the steam injector, an instrument which serves to feed water to a steam boiler through the action of a jet of steam drawn from the boiler which is fed. In the language of the book, "'its mode of action, extraordinary in appearance, contrary to that which we are in the habit of seeing or supposing, is explained by the simplest laws of mechanics and has been foreseen and calculated in advance.'" The book is interesting throughout because its story is well told. It deals with a subject which can not be freed from mathematical theory, in a manner which is sufficiently complete to satisfy the most fastidious lover of equations, and yet the work is so admirably arranged that no one who is interested in the subject is likely to find difficulty in reading it.

The introductory chapter on the early history of the development of the injector, from which the lines quoted above were taken, is chiefly a story of the achievements of Henri Jacques Giffard, who as early as 1850 had succeeded in developing the principles underlying the design of the present-day instrument. The injector, as a device for feeding boilers, was introduced into England in 1859, and into this country by William Sellers and Company the following year. The story of a demonstration of its action in England by one who had received a sample instrument from France is graphically told as follows:

I set to work at once, and by good luck coupled up the correct pipes to their proper flanges, but

was a great deal bothered what to do with the overflow flange. After a few nights' work I got my Injector fixed and got up steam, and to some extent began clumsily experimenting as the pressure rose to 60 pounds, the full working pressure of the boiler. I had the Injector fixed over a tank fed by a ball-tap and closed by the boiler. I turned steam on and was staggered by the rush of water into the tank from the overflow pipe, and thought something was wrong. However, I continued to turn the steam spindle, and the escape from the overflow sensibly diminished until I could turn no further. In the meantime the ball-tap started running furiously into the tank, showing me that water was going somewhere, and I knew it could go nowhere else but into the boiler. I then began to operate with the four-thread screw at the side, and found that it adjusted the water supply, and succeeded in getting the overflow "dry." I then opened the peep-holes opposite the space between the combining and the receiving nozzles, and saw the white steam passing from one to the other on its way to the boiler. I then ceased operations, and had a pipe of tobacco, . . .

The second chapter deals with the development of the principle of automatic regulation, by the adoption of which the injector was made to adjust itself automatically to conditions imposed by changes in steam pressure. The evolution of the various devices, which have been employed in the accomplishment of this function, is well set forth. Following this are several chapters dealing with the elements of design underlying each of the more important details of the injector, such as the delivery tube, the combining tube and the steam nozzle. These chapters, while constituting the more technical portion of the volume, are nevertheless so clearly expressed that the reader emerges from them with interest undiminished. A chapter entitled "The Action of the Injector" presents an analysis of the action of the entire instrument with numerical examples. It constitutes a basis for the design of such instruments, and it supplies the means for determining what are the limiting factors under conditions that may be prescribed or assumed. The longest chapter in the book, entitled "Applications of the Injector" presents excellent descriptions of the different well-known types of injectors now obtainable, with some discussion as to their adaptability to the requirements of different service. Another chapter discusses methods of determining the size of an injector and methods of testing, and presents data derived from tests. A chapter on the requirements of modern railway practise deals chiefly with matters affecting repairs and renewals, and a final chapter discusses certain problems which arise in practise, in connection with the use of injectors in locomotive service.

At a single point only does it appear that the author slips and this is when he discusses a detail in locomotive practise rather than one affecting injector design or operation, and when a book, as a whole, is strong and true, it is perhaps ungracious in the reviewer to call attention to half a dozen lines which are in no way essential to the purpose of the book and which constitute, in fact, no more than an unguarded suggestion. There are other relations, however, in which the statement becomes one of some importance, and consequently it should not go unchallenged. Under the head of "Feeding Locomotive Boilers," the author advises that "in approaching a station at which a short stop is made, especially between long and fast runs, it is advantageous to stop the injector a short time before the station is reached, to permit a slight checking of the fire, and then, when the station is reached, to feed the boilers quickly with one, or even with both injectors if necessary, to prevent blowing off at the safety-valve." The practise here outlined is one which has been often suggested and sometimes practised. It is, however, objectionable from several points of view, and as a practise should not be tolerated. The water in a locomotive boiler when the throttle is closed is in a quiescent state. Feed water entering under these conditions is not as rapidly mixed with the water already in the boiler as it is when the throttle is open and the process of ebullition is active. As a consequence the feed entering the boiler while the locomotive is stopped at a station, being comparatively cool, settles in the lower portions of the boiler,

where it cools the metallic parts with which it has contact, and by so doing induces strains which complicate the problem of boiler maintenance. Moreover, a locomotive which is thus filled is not in good condition for the start, notwithstanding the fact that the gauge may show full working pressure; for at the start there is imposed upon the boiler the double task of supplying steam and of raising to the maximum temperature of the boiler the water which was fed into it during the stop. The result is that the boiler pressure soon falls, and considerable time is required in which to restore it.

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SOIL PRODUCTIVITY

IN a discussion of the "Secular Maintenance of Soils" before the Geological Club of the University of Chicago on January 9, the undersigned expressed views as follows:

That the era of soils began at an early but indeterminate period in the history of the earth; that the Proterozoic lands were probably mantled by soils and clothed with vegetation; that soils certainly prevailed on the land in the Paleozoic era; that sufficient soils and vegetation mantled the earth through all later eras to support the continuous evolution of land life; that the total eon of productive soils may be assigned a period of at least tens of millions of years; that therefore there must be some efficient natural process for the maintenance of soils.

That the origin of the soil body lies chiefly in the granulation of rock; that soils are wasted at the surface by wind and wash; that wind and wash also distribute granules and mix soils and give to nearly all soils some of the essential soil constituents; that progressive granulation of rock adds soils below; that progressive solution removes soil matter from soils and from the rock beneath; that by these composite processes the body of the soil is at once enriched and impoverished; that so long as the *body* of the soil is maintained, any impoverished or anemic condition that may arise can be rectified; but if the *body* be lost, its restoration is tedious, laborious, or expensive.

That the film-water that surrounds the granules of the soil when in a normal moist state is the specific soil water; that this is to be distinguished from the ground water that lies below the water-table, though these grade into one another; that the soil swells with the growth of the films in thickness; that there is an optimum of film-water when the soil is most swollen; that addition of water beyond the optimum destroys the surface tension of the films and leads to the shrinkage of the soils, the packing of the granules and to unproductivity;[1] that the solutions in the film-water are formed with facility because of the greatness of the surface contact relative to volume; that the concentrations of the solutions are controlled by the laws of equilibrium.[2]

That the soil air is inversely proportional to the soil water approximately; that the soil air is to be distinguished from the earth's atmosphere, though grading into it and interchanging with it through diffusion and soil breathing; that, occupying the spaces between the film-coated granules of the soil, the soil air has great relative contact; that it acts at special advantage on both films and granules; that the union of minutely granulated earth, film-water under tension and interstitial air gives a combination of exceptional solvent and reactive power.

That the soil is the home of minute life, plant and animal; that these intensify and modify the inorganic activities; that the forms of life are with little doubt more or less predatory and parasitic on one another; that these relations are probably in some cases pathogenic, and that these give rise to unsanitary states of the soil which affect its productivity; that progress is being made by Whitney and his associates in the discovery of toxic exudations that affect productivity; that plant societies are perhaps in part a result of mutually beneficial relations in respect to exudations and by-products; that the soil thus is little less than a world in itself; that its

[1] Cameron, *Journal Physical Chemistry*, 1910.

[2] Cameron, *loc. cit.*