SOME FORMS OF APPARATUS USED IN THE COURSE OF PRACTICAL INSTRUCTION IN PHYSIOLOGY IN THE UNIVERSITY OF PENNYSILVANIA

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SOME FORMS OF APPARATUS USED IN THE COURSE OF PRACTICAL INSTRUCTION IN PHYSIOLOGY IN THE UNIVERSITY OF PENNSYLVANIA.

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The development of practical instruction in medical teaching during the last decade has been so extensive as to necessitate a reconstruction of the curriculum. In no branch has this been more marked than in physiology, and in the University of Pennsylvania the teaching of this subject has undergone such progress and reached such standards in methods and equipment as to attract attention in this country and abroad, and the frequency of inquiries by letter, and of visits to our laboratories by many who are particularly interested in this and kindred subjects have suggested that a brief sketch of at least certain of the forms of apparatus should find acceptance.

The general characters of the equipment must depend, apart from the matter of the cost, largely upon the main objects sought—whether the chief aims are, the illustration of the didactic course, the exhibition of physiologic apparatus and methods, etc. (which can satisfactorily be done in the lecture and demonstration rooms); or whether they are, the training in the use of instruments of precision with especial reference to clinical and experimental medicine, the cultivation of the individual powers of observation and deduction, the encouragement of and insistence upon accuracy of method and expression, the prosecution of collateral work with the view of the co-ordination of facts and their broad application, etc. If the latter, they cannot satisfactorily be attained with crude instruments, which at best are unscientific makeshifts and very

often merely toys, and generally so regarded by the student. Aside from any other consideration the moral effects attending the use of instruments of pre cision and the pursuit of broad objects are far more salutary than the inexperienced, as a rule, are apt to believe, and it is perhaps needless to state that this course in the University has been based upon such views, and that time, labor and expense have not been spared to secure the highest results. It must not be supposed, however, that thoroughly satisfactory apparatus and expensive apparatus are necessarily synonymous terms.

The portion of the equipment particularized in this article does not include many instruments which are comprised within the student's individual outfit, or which are used in demonstration or section work, such as muscle and heart clamps, perfusion cannulæ, microscopes, live stages, small centrifugal machines for blood, etc., hemocytometers, hemoglobinometers, urinometers, lactometers, plethsphygmographs, ergographs, dynamographs, galvanometers, electrometers, condensers, polarimeters, artificial eye models, color mixers, gas pumps, chemical apparatus and reagents, etc., most of which are common articles of commerce.

The most important of the fundamental elements in the design and construction of apparatus for a systematic course of practical exercise are: Simplicity, compactness, strength, ease of manipulation, adaptation to a variety of uses, the co-ordination of the designs of the different instruments, precision of operation, and cost. Such a collection of apparatus must necessarily be planned upon a broad and systematic basis: The various instruments should be so methodically designed as to constitute co-ordinate systems, that is, the arrangement of all of the elements of design and construction should be so orderly that each piece and each system is mutually related to the

others, and forms an integral part of the whole scheme. Moreover, the scheme should be so laid out as to afford the student a well-balanced course in all important parts of physiology, and not, as is often illogically the case, the concentration upon a single subject to the subordination or exclusion of the others.

A part of a set of apparatus constructed upon the above lines and supplied to each of our students will be considered under three headings: I. THE LABORATORY TABLE; II. THE SYSTEM OF RECORDING APPARATUS; III. THE SYSTEM OF EXCITING APPARATUS. All of the instruments were made in our laboratories, and number over 2,000 pieces.

I. THE LABORATORY TABLE.

The design of the laboratory table to be used in practical physiology is worthy of more consideration than is usually given to it, and especially so if, as in our great medical schools, a large number of tables and sets of apparatus are in constant use. The details as to the area and thickness of the top, the height of the table, the size of the drawer or drawers, the kind of wood to be used, etc., are usually the sole matters of concern, yet there are others of not less importance. For instance, in courses of instruction which necessitate the changing of apparatus from day to day, the transportation of dozens or hundreds of instruments between tables and store-room is, even with ordinarily careful handling, very injurious to apparatus. When a large number of sets are to be cared for, as in our own laboratories, in which fifty are in constant use throughout the session, the time, labor and injury involved in these repeated changes become more or less serious matters. In fact, experience gained in the teaching of large classes has shown that an essential feature of an ideal laboratory table is a suitable pro-

vision for the storage of all, or practically all, of the apparatus used in the entire course of instruction. Apart from the manifest advantages indicated, the

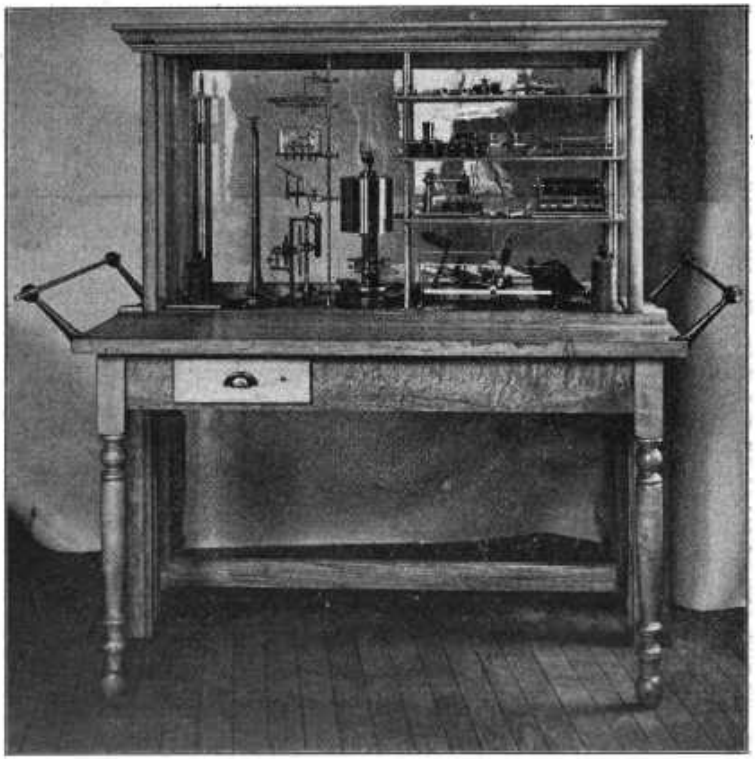

Fig. 1.—The Laboratory Table.

convenience of having every instrument immediately at hand must of itself be a strong recommendation.

A table which admirably meets the requirements of modern instruction is illustrated in the accompanying cut (Fig. 1). It is 3 feet high—a height convenient for the student to work standing. The top is 2 feet

10 inches deep by 5 feet long, and is made of strips of kiln-dried maple 1¼ inches square, glued together, and pinned through and through with three iron rods, and so clamped to the sides, front and back of the table that neither warping nor cracking is likely to occur. The top projects 2 inches on all sides to permit of the attachment of certain forms of apparatus to the edges. A shallow drawer is placed low in front to the left, so as to be as much out of the way as possible and yet be conveniently located. On each end is a countershaft, the two being coupled by cone pulleys and round belting, thus affording power at both ends of the table and also permitting of the two countershafts being run coincidently at different speeds.

The top of the table to a depth of 2 feet is used for the "setting up" of the apparatus and operative procedures, while upon the back is built a glass case for the storage of the apparatus. The case is 10 inches deep, 30 inches high, and 5 feet long. It has three shelves which extend one-half the length of the case, and a sash in front, which is nicely counterpoised with lead weights and readily moved vertically through an opening in the top of the table. The glass forming the top of the case is flush with the framework, thus avoiding corners for dust to collect in. The arrangement of the apparatus is methodical, with especial reference to convenience and economy of space—"a place for everything, and everything in its place"—each piece being assigned to a definite place, which is labeled with the name of the instrument. To further economize room, one or more vertical rods are provided upon which a number of pieces are clamped. The case is built of glass with the view chiefly of the unobstruction of light.

II. The System of Recording Apparatus.

One of the most important parts of the equipment for practical instruction is the apparatus used for

making graphic records. Among the instruments included in this system are the following: A kymograph, an adjustable stand, four universal adjustable holders, a small electromagnet for recording comparatively long intervals of time, a Pfeil's or Deprez's sig-

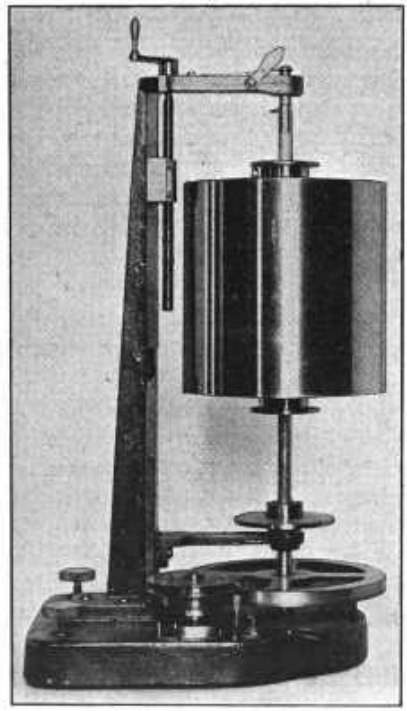

Fig. 2.—The Kymograph.

nal for recording hundredths or two-hundredths of a second, a vibrating reed, muscle and other levers, a frog table with accessories, a muscle chamber, a moist chamber with electrodes, etc., a water manometer, a sphygmograph, a plethsphygmograph, an artificial

circulation schema, and a tambour. In the kymograph is supplied a desirable form of recording surface, and in the instruments associated with it a variety of means of transmitting and recording movements.

The Kymograph.—The wide range of work to which the kymograph is subjected, in both practical instruction and research, is sufficient of itself to justify a most careful consideration as to its design, and particularly so if a large number are to be provided and the question of expense is a matter of moment. Such problems as the source of power, the form and area of the recording surface, the adaptation to a wide range of speed, the starting and stopping device, simplicity, durability, and cost are not always readily disposed of, and almost invariably certain important points are necessarily more or less sacrificed for gain in others.

A form of kymograph (Fig. 2) which combines a maximum of the most desirable features was devised by the author nearly three years ago, and since that time has been in constant use in our laboratories, over fifty now being employed in class instruction. The upper portion of the instrument, with its devices for holding and permitting the ready removal, the replacement, and the vertical movement of the drum, is essentially a duplicate of that so familiar in the Ludwig apparatus; while the lower portion, in which are the devices for the transmission of power and for the starting and stopping the drum, is but a trifling modification of Sherrington's. This combination of the best qualities of Ludwig's and Sherrington's kymographs makes an instrument that is very simple in construction, compact, strongly built, and with low centre of gravity; that can be used with the drum in either the horizontal or vertical position; that can be started and stopped instantaneously at any part of the revolution of the drum; that permits the drum to be re-