and it is in the connection now to be mentioned that the theory probably is most important for quantum theory and for theoretical physics in general. In spite of successes the present laws of quantum physics have their defects, and so it is necessary to find new and better ones. In the search for these, certain broad general requirements are laid down by the restrictions of invariance under different groups. The theoretical physicist need not waste time looking for laws outside the bounds thus set. More positively he finds on looking inside these bounds that the researches of pure mathematicians there have already provided a store of possibilities that await application to physics. This is the line of attack which will probably prove most fruitful in future modifications of the present quantum theory. It is for stimulation in this direction that a study of Weyl's book is perhaps most profitable.

To conclude, I can not refrain from giving wider circulation to an interesting historical point connected with the modern theories of chemical valence. In 1878, Sylvester, then professor of mathematics at Johns Hopkins, was worried about a lecture he had promised to give. He writes, "Casting about, as I lay awake in bed one night, to discover some means of conveying an intelligible conception of the objects of modern algebra to a mixed society . . . and impressed as I had long been with a feeling of affinity if not identity of object between the inquiry into compound radicals and the search for "Grundformen" or irreducible invariants, I was agreeably surprised to find, of a sudden, distinctly pictured on my mental retina a chemico-graphical image . . ." He then goes on to expound a very close analogy between his algebraic researches in invariants and the theory of chemical valence. He concludes with the sentence, "Thus we see that chemistry is the counterpart of a province of algebra as probably the whole universe of fact is, or must be, of the universe of thought."

This paper[3] does not seem to have attracted much attention: it was probably too mathematical for the chemists and too chemical for the mathematicians. It is mentioned, however, by Study,[4] in the Encyclopädie der Mathematischen Wissenschaften, who is somewhat inclined to sneer. "Formal analogies to the chemical structural formulas which occur in the theory of invariants of binary (and other) algebraic forms, have given rise to the fantastic hope," he writes, "that chemistry has something to gain from this branch of algebra. M. Noether has rightly, in a report on such attempts, pointed out the superficiality of the whole relationship and the lack of an actual analogy."

But the point of the story is that just exactly Sylvester's analogy and detailed calculations now play a rôle in quantum mechanical theories of valence, as Weyl has shown. The moral is obvious.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INEXPENSIVE MICROGRAPHIC PROJECTOR

A PROJECTION and drawing apparatus which embodies many desirable features not found in commercial machines can be made after the design in Figs. 1, 2 and 3 accompanying this article.

An ordinary microscope is fastened to a vertical stand and inverted so that the light from a powerful lamp passes through the microscope projecting the image on a table to which the stand is attached.

The support is made of such material as is available to every laboratory. Ordinary ¾ inch galvanized pipes (B) are attached to a 47″ x 10″ x 1¼″ board by means of the collars (B′). The lamp is bolted to the wooden carrier (C) and the microscope is attached to a similar carrier (E) by means of a bolt and a strip of metal (D). Back and top views of a carrier are shown in Fig. 2, to show the location of the grooves which fit around the pipes (B). The carriers are held in place by tightening the bolts with wing nuts. The stand is held in a vertical position by the stove bolts (F) which hold it to the boards (H). These boards are fastened to the table by means of wood screws. The table top is made of white pine.

The microscope should be equipped with a substage condenser and interchangeable oculars of different magnifications. A loose ocular is held in place by inserting a very small piece of paper between it and the draw tube. A Bausch and Lomb light with a six-volt ribbon filament bulb gives very satisfactory illumination.

To operate the microscope and lamp, attach as illustrated. A slide is clamped on the microscope stage in the usual manner. A mechanical stage may be used to good advantage. Next the lamp is adjusted to obtain the maximum illumination. For low power work better illumination is secured when the substage condenser is removed. The image is brought into focus on a sheet of white paper on the table top. The size of the image may be regulated by changing the distance between the microscope (E) and the paper. To absorb the heat from the lamp a water

[3] Sylvester, "Mathematical Papers," 3, 148.
[4] Encylopädie, VI, 389.

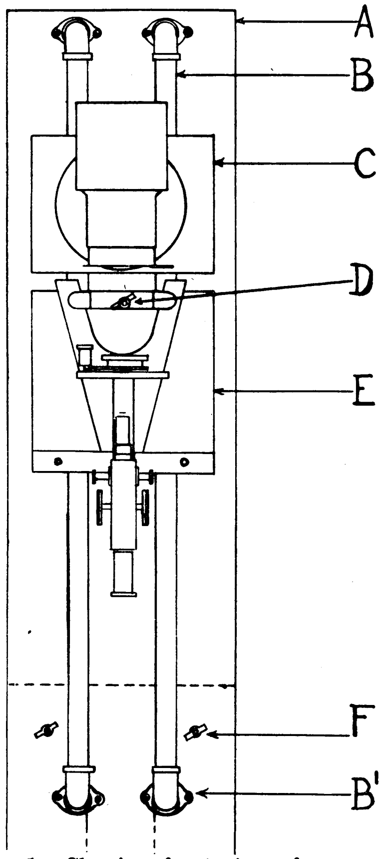

FIG. 1. Showing front view of apparatus.

bath may be interposed between the microscope and lamp.

In addition to projecting images from prepared slides, the apparatus offers numerous other applications. For example, material which must be maintained in a liquid may be placed on a slide or in a petri dish and set on the base of the microscope, after the substage condenser has been removed, and projected with the low power objective. The apparatus can be used to demonstrate to a small class the circulation of the blood in a frog's foot. It can also be made to serve for short distance projection. To accomplish this, the wing nuts (F) are removed and the apparatus is placed on the table in a horizontal position. A camera may be fitted to the microscope for taking photomicrographs.

To my knowledge no commercial drawing apparatus is equipped for projection of large transparent objects, such as long insect wings. To adjust the apparatus for large field projection the same stand as shown in Fig. 3 is used, but a large lens (I) and a portrait lens (J) are substituted for the microscope (E). An image of the object, which is placed on the flat surface of the lens (I), is projected through the lens (J) to the table. The support illustrated was made to accommodate the lens equipment of an old Leitz photomicrographic machine. For the lens (J) a 72 mm Bausch and Lomb-Zeiss Tessar lens as well as other close-range camera lenses were found to give good results.

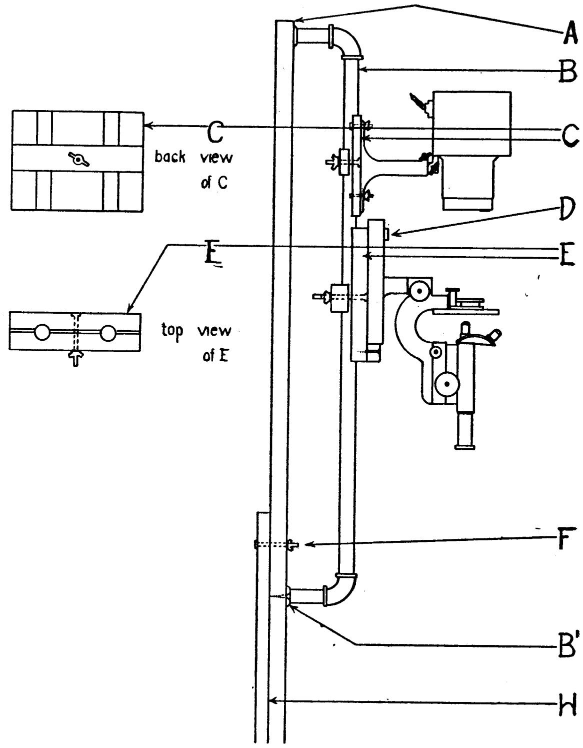

FIG. 2. Showing side view of apparatus.

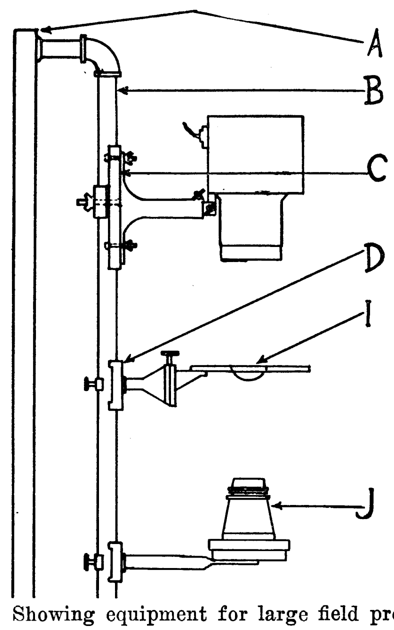

FIG. 3. Showing equipment for large field projection.

In addition to the distinct advantage of projecting images of objects ranging in size from those as large as butterfly wings to objects for which high power objectives must be used, the apparatus has other desirable features. It projects images which are in every respect equal to those of commercial machines. Only the higher priced devices are equipped with nose pieces as found on microscopes. Little time is lost in adjusting the parts of the machine for projection, because its operation is very simple. The cost for materials and labor to construct the support and table was less than eight dollars.

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DEVICE FOR WASHING MICROSCOPICAL TISSUES

DEVICES for washing microscopical objects are legion. However, there is no method, so far as we know, that is satisfactory from every standpoint. Any device for washing tissue should meet certain requirements. In the first place it should be simple of construction so that the student of microscopy can prepare one in short order from the materials found around the average laboratory. In the second place the apparatus should thoroughly wash the objects, subjecting them to a constant stream of fresh water.

The following method is convenient to construct and has certain other advantages. A wooden block about 12 inches by 6 inches by 1 inch is provided with holes 1 inch in diameter and about $\frac{3}{4}$ inch deep, spaced at intervals of about $1\frac{1}{2}$ inches, in which vials $\frac{7}{8}$ inch in diameter are set. These vials are fitted with 2-holed rubber stoppers which fit tightly. The glass tube D (Fig. 1) is run through one hole nearly to the bottom of the vial. The other tube C projects through the stopper into the vial only a short distance. These are connected in series with rubber hose as shown in Fig. 2. Pieces of cheesecloth are tied over the inner ends

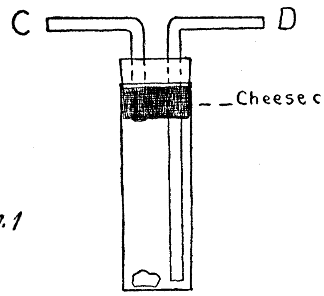

Fig. 1

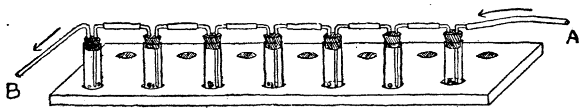

Fig. 2

of the rubber stoppers so as to cover the ends of the outlet tubes and prevent the objects from washing out. The hose A (Fig 2) is connected to the spigot and the other, B, is the outlet. A steady, gentle stream of water is allowed to flow through the vials for the desired length of time. This device insures thorough washing, for the objects are constantly agitated and revolved by the current of water. The whole apparatus may be placed out of the way at one side of the sink. A varying number of vials may be used according to needs.

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SPECIAL ARTICLES

THE EVOLUTION OF A CAROTID SINUS REFLEX AND THE ORIGIN OF VAGAL TONE

REFLEX inhibition of heart rate has been observed in elasmobranchs upon mechanical or electrical stimulation of sensory endings distributed widely over the body, both externally and internally, including the gill region and the heart itself.[1] In mammals the sensory areas from which reflex cardiac inhibition may be obtained are limited, the most important being located in the aorta and in the carotid sinus.[2] Since in mammals an alteration of pressure within these blood vessels may be a physiological stimulus, the writers tried the effect of alterations of pressure within the branchial vessels of elasmobranchs.[3]

The ventral aorta of *Squalus acanthias,* with the cord destroyed, was ligated between the first and second branches and a cannula connecting with a burette, containing a physiological solution, was inserted anterior to the ligature. Cardiac inhibition was obtained when the pressure within the gill vessels was suddenly increased. A series of threshold determinations showed that an average increase of 10.7 mm Hg above the average systolic pressure in the dorsal aorta was found to constitute an effective stimulus for the inhibitory response. The response was found to be reflex, with afferent pathways located in the branchial nerves and efferent fibers in the vagus supply to the heart. Determinations of the blood pres-

[1] B. R. Lutz, *Biol. Bull.,* 59: 170, 1930.

[2] J. A. E. Eyster and D. R. Hooker, *Am. Jour. Physiol.,* 21: 373, 1908; G. V. Anrep and H. N. Segall, *Jour. Physiol.,* 61: 215, 1926; C. Heymans, "Le sinus carotidien," Louvain and Paris, 1929.

[3] B. R. Lutz and L. C. Wyman, *Biol. Bull.,* 62: 10, 1932.