tensive relations insects bear to many human and plant diseases. The activities of insects as parasites and as carriers of disease organisms are, however, noted here and there throughout the text in appropriate connection with the species concerned.

The remaining pages of the book are devoted to a discussion of the characteristics of the different orders of insects with an account of the life histories, habits, and control of a well-selected list of common, representative, and mostly economic species of each order. The author uses commendable and conservative judgment in recognizing and discussing but twenty-four orders with a brief mention of an additional one, the *Zoraptera*. An economic entomologist often wishes the author had been a little more specific regarding control measures. For example, paradichlorobenzene is briefly mentioned as having "given fair success recently" in the control of the peach-tree borer. This seems hardly an adequate statement in view of the widely successful use of this substance by the Federal Bureau of Entomology and by the New Jersey Experiment Station.

The book is fully illustrated with numerous original photographs and many familiar illustrations. It is certainly preferable to use good familiar figures in a text-book rather than poor original ones but great pains should be taken to reproduce the old figures with distinctness and fidelity. For example, figures 130, 131, 135, and 242 have lost much of their original clearness and detail. Moreover one is apt to be momentarily a bit shocked to find an illustration in a dignified text-book with the legend "Samples of Anoplura greatly enlarged" without any attempt to give the reader an inkling of the species figured. These, however, are small matters.

The book has few typographical errors and closes with an excellent index of twelve pages. Altogether the author has written a well balanced, well arranged text of applied entomology for the beginning student and many teachers will find it very useful with their classes.

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SPECIAL ARTICLES

HIGH SPEED HIGH VACUA MERCURY VAPOR PUMPS

THE writer has on several occasions[1] described two types of high speed mercury vapor pumps capable of producing exceedingly high vacua in reasonably short intervals of time and yet not demanding of the fore pumps pressures less than .01 to .005 mm. of mercury. These mercury vapor pumps were made of pyrex glass and are still in use.

Since then slight modifications have been introduced which considerably reduce the time required in glass blowing though not altering the speed of either pump or the vacua obtainable. The two types in modified form are shown in Figures 1 and 2, and are each drawn approximately one sixth full size. In Figure

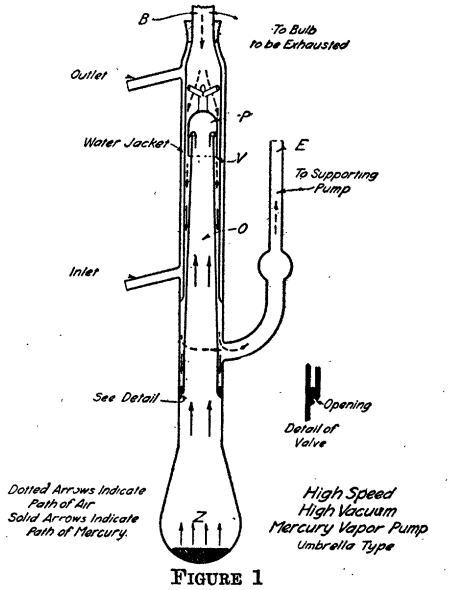

FIGURE 1

1 we have the umbrella type in which the bulb to be exhausted is attached to B, and the supporting pump to E. The hot mercury vapor reaches the umbrella P through the large diameter thin-walled central delivery tube O. The throat at V is large and annular (no central dead space) and hence the issuing mercury vapor comes into immediate contact with the outer water cooled walls. This construction

[1] *Phys. Rev.*, II, 9, 311; 12, 492.

augurs for speed. The water packet is an integral part of the pump. The condensed mercury vapor is returned directly to the boiler through a pin-hole valve shown in the figure.

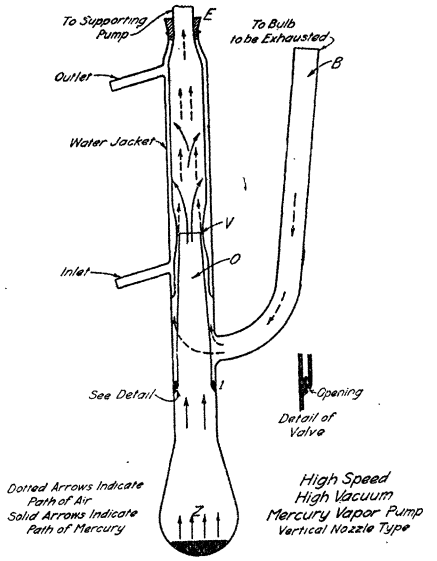

FIGURE 2

In the second type, Figure 2, the umbrella is omitted, the delivery tube O is short and ends in a central vertical nozzle, and hence the bulb to be exhausted and the fore pump are interchanged. The throat at V through which the hot mercury vapor issues is large but not annular. The water jacket and mercury return are the same as in the umbrella type.

Some idea of the speed of either pump may be obtained from the following data taken recently: With a Cenco-Hyvac oil pump, as a fore pump, a discharge tube of 2.8 liters volume was exhausted from the point at which the mercury vapor pump began to take hold (approximately 1 cm. dark space) to where the tube began to darken (the X-ray stage) in 30 seconds. If a mercury vapor trap is interposed between the pump and B the time in the above may be reduced to 15 seconds or even less!

Comparing the two types it was found that the umbrella type seems, in general, to be the more speedy, possibly for two reasons: first, the water jacket reduces the amount of mercury vapor that finds its way into the bulb B (this of course may be entirely eliminated by the mercury vapor trap mentioned above), and second, the issuing mercury vapor stream is annular. On the other hand the vertical nozzle type is somewhat easier to construct. An advantage of the former, especially for lecture table demonstrations, is that the bulb B to be exhausted is supported centrally over the pump. These pumps are made of Pyrex glass.

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DECEMBER, 1921

THE NEUROMOTOR APPARATUS OF PARAMECIUM

This study which commenced with microinjection experiments on *Paramecium* has led to the discovery of a complex neuromotor system in the animal. This discovery is important because *Paramecium* is a generalized ciliate and yet has attained a degree of structural complexity and functional diversity in respect to one organ system comparable at least with that of the lower Metazoa. It is thus again exemplified that the unicellular state is plainly not an essential condition for evolutionary specialization and functional efficiency, except as it places limits on the size of the organism and the developmental processes arising therefrom.

The neuromotor apparatus consists of a neuromotor center situated near the anterior end of the cytostome and at the posterior end of the oral groove; a set of cytopharyngeal fibers which run from the neuromotor center to the membranelles of the cytostome and cytopharynx; an oral whorl of peripheral fibers which diverge from the neuromotor center and run to the cilia and trichocysts of the oral side of the body; an aboral whorl of peripheral fibers which diverge from the same center to the cilia and trichocysts of the aboral side. The cilia of the organism arise from grooves in the pellicle which run in nearly parallel lines from the anterior to the posterior end of the body. Those on the oral side are slightly oblique, meeting in a series of V's in a line, the oral suture, which runs obliquely through the cytostome from the anterior to the posterior end of the body. The trichocysts are arranged with reference to the neuromotor