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.

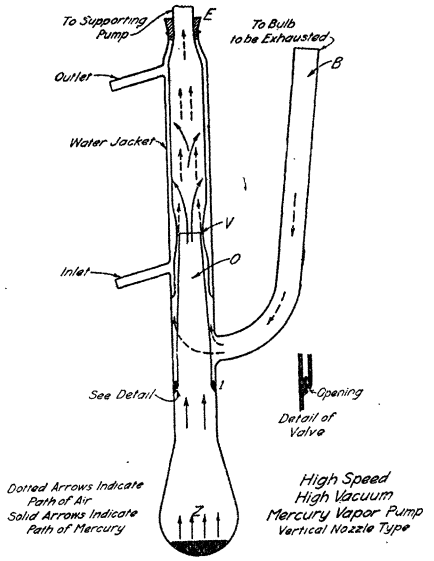

FIGURE 2

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.

CHAS. T. KNIPP

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
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

system in whorls. They reach the surface of ridges which appear as papillæ because they are cut across at regular intervals by the longitudinal ciliary grooves.

The morphology of this neuromotor apparatus shows that it is well adapted to coordinate the movements of the animal because the organelles of feeding, locomotion, and defense are all connected by a system of conductile fibers to a presumably coordinating center. Furthermore the fibers must be either supporting, contractile, or conductile. Their exceeding fineness indicates the unlikelihood of a supporting function. Their position with respect to the neuromotor center makes it unlikely that they are contractile because those, the main direction of which is longitudinal, would have to operate antagonistically to those whose direction is transverse. The only alternative is that the fibers are conductile.

Three experimental methods, that of staining by micro-injection, the determination of the axial gradient in solutions of narcotics (Child, 1915), and micro-dissection (Taylor, 1920) were used to secure additional evidence pointing towards a neuromotor function of the fibers.

Experiments with the first method were negative. An axial gradient was easily demonstrated, indicating the presence of conductile elements. A high rate of metabolism in the region of the neuromotor center could not be demonstrated, however, because *Paramecium* did not disintegrate as do annelid worms and planarians in the solutions used.

Cutting the cytopharyngeal fibers resulted in the loss of coordinated movement of the cytopharyngeal membranelles. Extensive destruction of tissue in the region of the neuromotor center resulted in the loss of coordinated movement of locomotor organelles. Equal destruction of tissue elsewhere in the body did not destroy coordinated movement.

Thus, while experimental evidence is less conclusive than the morphological it supplements the latter in demonstrating that the fibers of *Paramecium* have a conductile function.

CHARLES W. REES
ZOOLOGICAL LABORATORY
UNIVERSITY OF CALIFORNIA

THE AMERICAN CHEMICAL SOCIETY

(Continued)

SECTION OF LEATHER CHEMISTRY
John Arthur Wilson, *chairman*
G. D. McLaughlin, *secretary*

Color measurement of vegetable tan liquors: HENRY RICHARDSON PROCTER.

The color value of a tan liquor as a function of the hydrogen-ion concentration: JOHN ARTHUR WILSON and ERWIN J. KERN. The color value of a tan liquor depends upon its hydrogen-ion concentration when used. A change in pH value produces a change in color of both liquor and leather. Tan liquors change in color like indicators with change in pH value, but over a range of from 3 to 12. This change in color is completely reversible, if the liquors are not long exposed to air. Liquors exposed to air continue to darken in color, the more so the higher the pH value, but this change is not reversed by lowering the pH value. Liquors exposed to air at pH values of about 9 give bulky precipitates when their pH values are brought to 3 and such liquors tend to poison the hydrogen electrode.

Chemical and physical behavior of gelatin solutions: JACQUES LOEB.

The equilibria between tetrachrome collagen and liquors of different chrome content: ARTHUR W. THOMAS and MARGARET W. KELLY.

The adsorption of the constituents of chrome liquor by hide substance during nine months contact and the equilibria between tetrachrome collagen and various concentrations of liquor: ARTHUR W. THOMAS and MARGARET W. KELLY. Previously a tetrachrome collagen was considered the most complex chrome collagen compound obtainable. In this research an octachrome collagen was prepared. Further it was established through study of the change in composition of tetrachrome collagen in contact with liquors of different concentrations over a period of nine months that the reactions taking place in chrome tanning are chemical in nature. This paper is one of a series of contributions from this laboratory establishing the chemical nature of the combination of chromium with hide to form chrome leather.

Influence of sodium chloride, sodium sulfate and sucrose on the combination of chromic ion with hide substance: ARTHUR W. THOMAS and STUART B. FOSTER. Until four years ago it was considered that the only important features involved in the use of chrome liquors in chrome tanning was the percentage of chromium and