the section at A, another cubic centimeter leaves it at B. The entering liquid carries into the section kinetic energy $\varrho v^2/2$ and potential energy ϱgh. But it also does work on the liquid ahead of it equal to the pressure times its volume or to p, while at the same time the liquid behind does an equal amount of work upon the cubic centimeter itself in pushing it into the section; thus an amount of energy equal to p is transmitted past A through the entering liquid into the section, in addition to the kinetic and potential energy which is simply carried in. The total energy transferred past A as one cubic centimeter enters the section is thus $E_A = \varrho v_A{}^2/ + \varrho gh_A + p_A$. At the same time an amount of energy $E = \varrho v_B{}^2/2 + \varrho gh_B + p_B$ is transferred out of the section at B; while no energy at all is transferred across the sides. The total amount of energy inside the section must, however, remain constant, for the flow is steady. Hence $E_A = E_B$ and Bernouilli's Principle follows.

This deduction brings out the true meaning of the quantity E that is constant along a tube of flow; it represents, not the energy that is stored in each unit volume of the liquid and carried along with it, but rather the total amount of energy that is transferred past any point as each unit volume of the liquid moves past that point. The first two terms in the expression for E represent what we may call a convection current of energy, in which the energy is simply carried along by moving matter. The last term, p, then represents an additional current of energy that is transmitted through the liquid.

If we wish, we can imagine the transmission current of energy, represented by p, to arise from a streaming through the liquid of the energy of compression. The latter energy is never quite zero, but it is always small, and so we shall have to suppose it to move enormously faster than the liquid. A similar current of energy flows along a moving belt, only there the energy moves in one direction while the matter through which it streams is moving in the opposite direction.

In gases the energy of compression need not move so fast in order to account for the transmitted stream of energy, but in this case the energy of compression contributes appreciably to the convection current as well.

This view of the Bernouilli Equation would seem to be just as useful and suggestive as any other, and it seems quite simple enough for presentation in a freshman text. As a matter of fact, examination of a number of elementary engineering books shows that most of the ideas here presented are actually to be found in one or two of those!

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CAMPBELL'S DEFINITIVE UNITS

REFERRING to the paper of Dr. George A. Campbell, "A system of 'definitive units' proposed for universal use," published in the issue of SCIENCE for April 3, 1925, the writer realizes that there are many advocates of alternative universal systems of units and is therefore hesitant about entering the lists. It would appear, however, that two modifications of Dr. Campbell's proposal would be of great assistance in the practical introduction of such a system of definitive units. These are:

The retention of the C.G.S. unit of length, the centimeter, instead of the meter; and the use of the true ohm (or "practical" ohm, as Dr. Campbell calls it) instead of the international ohm. These modifications are independent of one another, and will be considered separately below.

USE OF THE CENTIMETER

It is believed that in scientific and engineering work a unit, such as the centimeter, which is smaller than most pieces of apparatus, is more convenient than the meter. It is already in such wide use and has been the basis of so many physical data that a great saving in labor and mental effort would be occasioned if it were retained. The consequence of its retention would be that the unit of force would become 10^7 dynes and the unit of mass would be 10^7 grams. This unit of force has been used in certain[1] texts for a number of years. Being approximately equal to 22.5 lb., this unit is fully as convenient as the value 10^5 dynes proposed by Dr. Campbell, which is approximately equal to 0.225 lb. The writer recognizes that the corresponding unit of mass, 10 metric tons, is not so convenient as the kilogram, but in this connection it should be pointed out that mass in its direct aspect as a measure of inertia enters into relatively few practical and scientific calculations. Mass as a measure of the quantity of matter—that is, mass from the chemist's point of view—is a distinct idea and can continue to be measured in grams or kilograms with little confusion. These latter units of mass may be considered as derived from the large unit by the factors 10^{-7} and 10^{-4}, in much the same way that the customary electrical unit, the microfarad, is derived from the farad by the factor 10^{-6}. All electrical engineers are quite reconciled to the fact that the farad is an enormous unit and are not con-

[1] See Karapetoff, "The Electric Circuit" (1912), p. 217: "*Force ought to be measured in joules per centimeter length,* to avoid the old multiplier. Such a unit is equal to about 10.2 kg. and could be properly called the *joulcen* (= 10^7 dynes)."

fused by the use of the microfarad with its numerical factor of 10^6. As a matter of fact, the kilogram itself is too large for convenience in most scientific work. Both Dr. Campbell's proposal and that of the writer lose what was considered an advantage of the C.G.S. system, that the density of water is approximately equal to unity; so there is no choice on this point. A great convenience of the writer's proposal is that energy, power, force, mass and other quantities directly derived from them all have units larger than the C.G.S. units by the same factor 10^7. This would result in great convenience in referring to existing tables of physical data, since the reader would only have to decide whether to introduce this single factor; whereas with Dr. Campbell's proposal factors of 10^{-2}, 10^{-3}, 10^{-5} and 10^{-7} are given in his Table I, and other factors would enter with subordinate quantities, such as pressure and density. It is believed by the writer that these conveniences far outweigh the inconvenience of a large unit of mass.

USE OF THE TRUE OHM

Dr. Campbell's proposal to use the international ohm, coupled with the use of the mechanical watt, requires many of the electrical quantities to be expressed in units which have never heretofore been employed. While it is true that these units differ to a very slight degree from either the international units or the true (practical) units, nevertheless it is felt that the results would be decidedly confusing. The writer's proposal is to use the true practical electrical units throughout, which is consistent with the mechanical watt. These units are all related to the C.G.S. electromagnetic units by factors which are exactly powers of 10; so that conversion from the C.G.S. electromagnetic system would be greatly facilitated. For engineering purposes, of course, the differences between the international electrical units, the practical electrical units and the electrical units proposed by Dr. Campbell are insignificant.

The units proposed by the writer seem to require a minimum of change from existing practice and yet to have the broad advantages of definitive units as expressed by Dr. Campbell. With the exceptions of the units for force and mass and their derivatives, these units are all in wide use at present. The complete system has for several years been employed by the writer in his electrical engineering classes[2] and for his own computation in fields where electrical and mechanical quantities continually occur together in a variety of ways.

In the writer's opinion, the most important consideration in the introduction of a system of definitive units, assuming the units to be consistent and of *reasonable* magnitudes, lies in *the convenience of the transition from present practice.* The system proposed permits of a gradual adoption of the few new units, as fast as their advantageous features become appreciated; whereas Dr. Campbell's proposed system requires more radical changes.

[2] See L. A. Hazeltine, "Electrical Engineering," The Macmillan Company (1924).

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TIME MEASUREMENTS

THE fact that a watch keeps correct time over a period of twenty-four hours is not a sufficient indication of its accuracy in the measurement of short time intervals where the second hand is used. A slight misplacement of the watch dial may cause the pivot of the second hand to be located "off center," thus causing an error of as much as two seconds in measuring an interval of twenty, or twenty-five seconds. Readings on one half of the dial will be too short and those on the other half correspondingly too long.

A similar source of error may be looked for in any dial-reading instrument where particular care has not been taken in fixing the dial position.

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ARTIFICIAL CULTIVATION OF FREE-LIVING NEMATODES

IN SCIENCE, N. S. Vol. 60, No. 1548 (Aug. 29, 1924), pp. 203–204, under the above title, Asa C. Chandler describes a method dependent on the standard culture-methods of bacteriology. So far as developed, this method does not apparently differ from that described by me in the *Trans. Amer. Mic. Soc.*, Vol. 24, pp. 89–102, 1 pl., 1903.

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SCIENTIFIC BOOKS

The Story of Early Chemistry. By JOHN MAXSON STILLMAN, late professor emeritus of chemistry, Stanford University, xiii + 566 pages, $5\frac{1}{2} \times 8\frac{1}{2}$ inches. D. Appleton and Co., New York, 1924, Price $4.00.

THE amiable author of this scholarly volume (whose recent death was lamented by a host of friends) has long been known as a contributor to the history of medieval chemistry—more particularly of that transitional Paracelsian epoch which was contemporary with various other great movements of exploration, renaissance and reform. It was only natural, therefore,