and the denial of such a possibility is a fundamental postulate of many writers on thermodynamics. The following statement of the postulate[2] may serve to bring out the significance of the differences referred to above:

> No engine of any kind can by any means be made to maintain continuously or restore and maintain when changed, the state of the system which initially set it in motion; and the difference in the energy state which initially established the motion will disappear the more quickly the greater the activity of the engine.

In reply to Professor Dadourian's objection in Science,[3] I would call his attention to the preceding remarks. In addition I would say that he misinterprets my point of view if he supposes that I am opposed to defining energy. If I knew how I would define it myself. Elsewhere[4] I have stated what I conceive constitutes the laws of energy; and those three laws are as near as I can come to a "definition of energy." If he can produce a definition that will convey the necessary information and not conflict with known facts and laws the scientific world will doubtless welcome it with open arms. The field is open. But a *definition that claims to be general* and leaves out, or even is in opposition to, the most important characteristic of the thing supposed to be defined is worse than no definition at all. The absence of a "definition" does not preclude the clarifying of our thought by diligent study of the thing we wish to define. As an aid to study, a provisional, or partial definition may often be of great assistance as a working hypothesis provided it is recognized as provisional and not allowed to close our minds to evidence and dominate our perceptive powers.

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"Available Energy" vs. "Energy"

To the Editor of Science: The argument between the scientist and the engineer over the definition of energy is clearly saturated enough to crystallize out the clean-cut definition of "available energy" and leave the indefinite but exceeding rich mother-conception of "energy" for those who shall see more clearly or be able to unite our bewilderment of facts and deductions to a concrete statement.

The communication of Professor Garver in the April 21 issue is both a timely and an excellent critique. Evidently he analyzed the difficulty far better than he constructed a working presentation or Dr. Wm. Kent would not have been able to so well establish himself in the reply of June 9.

That the author of a leading engineers' handbook should express himself as Kent has done may be considered as evidence to demonstrate the narrow conceptions and limited field into which practical men continually fall. From the energy-to-sell point of view there certainly is satisfaction in the Kent definition; but we can not allow Dr. Kent to confine the use of the term "energy" to engineering; the engineer clasps hands with the scientist in every undertaking and acknowledges his past and present effort as components of his own practicability.

The men who have most carefully studied thermodynamics and energy transformations assert that one particular sort of energy manifestation can be designated as *free* energy, *available* energy or by some factor indicating *potential* or *intensity* variation. The "stored work" is to be referred to this sort of energy, but the converse is not true—that all the energy in a given system which may thus be described can be converted into work. With Garver we have to say that a certain amount of work may be done during the *transfer* or adjustment of this sort of energy. Some energy is always lost, as heat when the work is done. We find, then, that Kent is careless in using "energy" where he should say "available energy" and he is inaccurate in assuming that *all* such energy is transformable into mechanical work.

Recent writers often state the matter with much conciseness:

[2] *Journal of Physical Chemistry*, Vol. 15, p. 613 (1911).

[3] June 16, 1916.

[4] *Loc. cit.*

Bryan:[1]

We are thus led to the conclusion that under any given conditions only a limited portion of the energy of a system can be converted into mechanical work. This portion is called the *available energy* of the system subject to the given conditions. In order, however, to completely define the available energy of a system, it is necessary to specify not only the external conditions to which the system is subject, but also the means at our disposal for converting energy into useful work.

Nernst:[2]

If any system whatever is subjected to any desired changes, these are, in general, identified with the following changes in energy: firstly, a certain amount of heat is either absorbed or given out; secondly, a certain amount of external work is either performed by the system or is performed against it; thirdly, the internal energy of the system will either diminish or increase. In general in any event the diminution of the internal energy U must be equal to the external work A accomplished by the system, minus the amount of heat Q absorbed; *i. e.*, the following relation exists:

$$U = A - Q.$$

Rushmore:[3]

From a practical standpoint energy may be classified as *available energy,* or that which can be turned into mechanical energy, *and unavailable energy,* or that which is practically useless for the purpose. To the latter belong the enormous sources of energy stored in the earth's rotation, as well as the interior heat of the earth.

There are several reasons why we shall never return to any former conception of the term "energy" as Dr. Kent in his last paragraph hints might yet be done.

Every new study of the relationships only strengthens the division as made above in the three quotations. This view has been expounded so long and widely and is so firmly established in all collegiate education that there is slight excuse for combating it. It is true that investigation and deduction increase our knowledge of energy without disclosing any ultimate interpretation, exactly as in the case of gravitation, yet the laws of transfer and transformation are always found to hold most rigidly. These laws of the conservation of energy and the degradation of energy are ever becoming more valuable and firmly established.

Recent discoveries and conceptions only render a definition or unqualified statement of what *energy* IS more and more difficult.

The development of radioactivity has enormously broadened our field of knowledge on energy and set us irrevocably beyond our past. We find "energy" and "matter" meeting on common ground and know not which from t'other.

The development of quantum theory and the study of radiations again shatter any previous notion of energy and portend that energy ideas of the future must involve some aspect of granularity and distribution function.

All the studies on the constitution of matter and the structure of atoms presage radical change and new methods; in dealing with whole classes of energy we are finding the limits of the application of the gross laws of energetics. It is highly significant to follow the mathematical physicist who with much pains in logic comes inevitably to the conclusion that the ether has infinite energy—a conclusion he will likely abruptly discard as absurd!

With matter, ether and energy as possibly only different aspects of, or approaches to, the same ultimatum, who can imagine that our ideas will ever again fit into the long-discarded and outgrown definition.

Useful work may comprise the chief end of the engineer's effort, but it can do him only good to have ever present the concept that relatively only a negligible part of our energy universe concerns itself with such work. It would certainly be a great misfortune to have a statement about energy so terse as to deny the greatest and most useful of our generalizations.

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[1] "Thermodynamics," p. 35, 1907.

[2] "Theoretical Chemistry," trans. of sixth German text, p. 8, 1911.

[3] *General Electric Review,* p. 422, May, 1916.

"TYPUS" AND "TYPE" IN TAXONOMY

THERE is a general attempt among systematic zoologists and botanists to limit the words "type" and "typical" and their equiv-