to personal observation and inquiry extending from Connecticut to as far north as Hamilton Inlet in Labrador. The biology of the subject relates not so much to the habits of *Salmo salar* as it does to the behavior of *Homo sapiens*—with his specific appellation self-chosen.

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EFFICIENCY IN THERMAL PHENOMENA

To the Editor of Science: Mr. Forbes's theory of something being wrong with the commonly accepted definitions of efficiency in thermal phenomena, is provocative of comment. The question of a definition being wrong depends, obviously, on how it is interpreted.

In general the efficiency of a machine or mechanical process, is defined as the ratio of output to input. It is assumed that the output will always be less than the input, hence the efficiency will be less than unity.

It is safe to say that the difficulties alluded to by Mr. Forbes can be traced to failure to distinguish between the quantities of energy called input and output, and the units in which they are measured. In the electric heater, the input, watts, is wholly converted into heat, with efficiency of 100 per cent. In the electric motor the input, watts, is converted into 95 per cent. work and five per cent. heat, giving 95 per cent. efficiency if work output is considered, and 100 per cent. efficiency for the entire output. In the steam engine the input, heat, is converted into ten per cent. work and 90 per cent. heat, giving an efficiency of ten per cent. based on work output, 90 per cent. efficiency based on the exhaust steam for heating, and 100 per cent. for the entire output. In the refrigerating machine the output is, logically, heat carried away by the condenser water. The input, on the same reasoning, is made up of two parts, the heat removed from the brine and the work of driving the machine. The sum of the two input quantities is equal to the output, giving 100 per cent. efficiency as in all the other cases.

The refrigerating engineer recognizes the difficulty of applying the term efficiency to his machine, and substitutes for it the term "coefficient of performance," the ratio of heat absorbed to the work required to drive the machine, both expressed in the same units.

If efficiency is defined by the input-output formula, it is true that the efficiency of all machines is 100 per cent. If only a portion of the input or output is considered, it is possible to have efficiencies of less or more than 100 per cent. In this case it would be appropriate to use the term "partial efficiency," since the entire output is not considered.

E. H. Lockwood

THE HELIUM ARC AS A GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Helium as a conducting medium in a low-voltage arc may be of considerable utility as a convenient source for generating, from direct current, oscillations of moderately high frequency.

Due to its exceptionally low sparking potential arcs may be readily started from a hot tungsten cathode by 110 volts even when the gas is at atmospheric pressure. In fact it is easy to start the arc across a centimeter gap between cold electrodes by means of breaking a parallel circuit with a series reactance common to both. Perhaps a more convenient method of starting, however, is the heating of the filament by the source of supply and then a commutation of the connection to the positive terminal from the filament to the anode.

When the proper inductance and capacity are connected across the arc high frequency oscillations are produced which may be utilized in the usual way with a coupled circuit. Hitherto, hydrogen and compounds of hydrogen have been used in areas to produce high frequency and it is very difficult to produce oscillations by the use of other gases at atmospheric pressure. Helium, however, probably due to its high heat conductivity, being inferior only to hydrogen in this respect, from the rapid rate of energy dissipation in the arc, gives the type of volt ampere

characteristic which is necessary for the production of the alternating current.

From a 6-ampere arc in helium at approximately atmospheric pressure and with a centimeter gap, 50 watts or more of alternating current at 1,000 cycles may readily be obtained.

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SCIENTIFIC BOOKS

Collected Studies on the Pathology of War Gas Poisoning, from the Department of Bacteriology and Pathology, Medical Science Section, Chemical Warfare Service, under the direction of M. C. WINTERNITZ, major, M. C., U. S. A. Yale University Press, New Haven, Conn. Cloth, 165 pages, 41 color plates, 83 black and white illustrations, $20.00.

The study of the pathological lesions produced by the war gases upon animals under controlled experimental conditions was of eminent practical importance during the war, and quite justly enlisted the interest and services of many of the foremost pathologists, both here and abroad. Without such control, it would have been difficult and, in many cases, impossible, to draw conclusions as to the comparative effectiveness of different types of gas used in offense; and to estimate the protection afforded by various defensive measures. Equally important was the desirability of defining, so far as this was possible, the effects of the various gases used by the enemy against our troops, and to afford criteria to the pathologists in the field by which they might be recognized.

The studies of Winternitz and his coworkers, which were available to the Chemical Warfare Service during the war, have now been made generally accessible in a comprehensive and beautifully illustrated monograph from the Yale University Press. On the basis of a very large experimental material, the gross and microscopic changes following exposure to chlorine, phosgene, chlorpicrin, trichloromethyl-chloroformate (diphosgene, superpalite), dichloroethylsulphide (mustard gas), cyanogen chloride and bromide, arsine, and several organic arsine-halogen compounds are minutely described. Unlike most of the reports which have previously appeared, the study includes a consideration of late residual lesions as well as the acuter changes, and this phase of the work will prove of particular interest to those who still are seeking an anatomical explanation for the chronic invalidism which afflicts so many of the soldiers gassed in the war. The writers find quite regularly in the lungs after recovery from phosgene, persistent emphysema and atelectasis, associated with obliterating bronchiolitis, and with tubercle-like peribronchial nodules. On the other hand, it is stated that "chronic changes in the lungs after mustard gas inhalation were infrequent and were confined to minute areas of organization occurring in isolated bronchioles or in the alveolar tissue near the margin of the lungs. In no case was any large bronchus found organized or occluded." In a few dogs, localized ulceration or cicatricial stenosis was found in the trachea. This rarity of permanent lesions after gassing with mustard in dogs does not accord with our own experience in the human cases. Without entering into details, it may be confidently stated that the inhalation of mustard gas in man is frequently followed by chronic changes in the entire respiratory tract. These differ, of course, in their extent and severity, but in many cases there results a destruction and deformity comparable to that of chronic pulmonary tuberculosis.

In this connection, it is perhaps proper to emphasize the limitations of these and similar experimental studies on the war gases, in their application to human pathology. Whereas the experimental worker with animals was informed as to the kind of gas used, its concentration and the duration of exposure, none of these data were available to the pathologist in the field. Frequently, it happened that the same soldier was exposed to several varieties of gas within a short period; frequently, also, there were complicating traumatic injuries. Most disturbing of all were the supervening