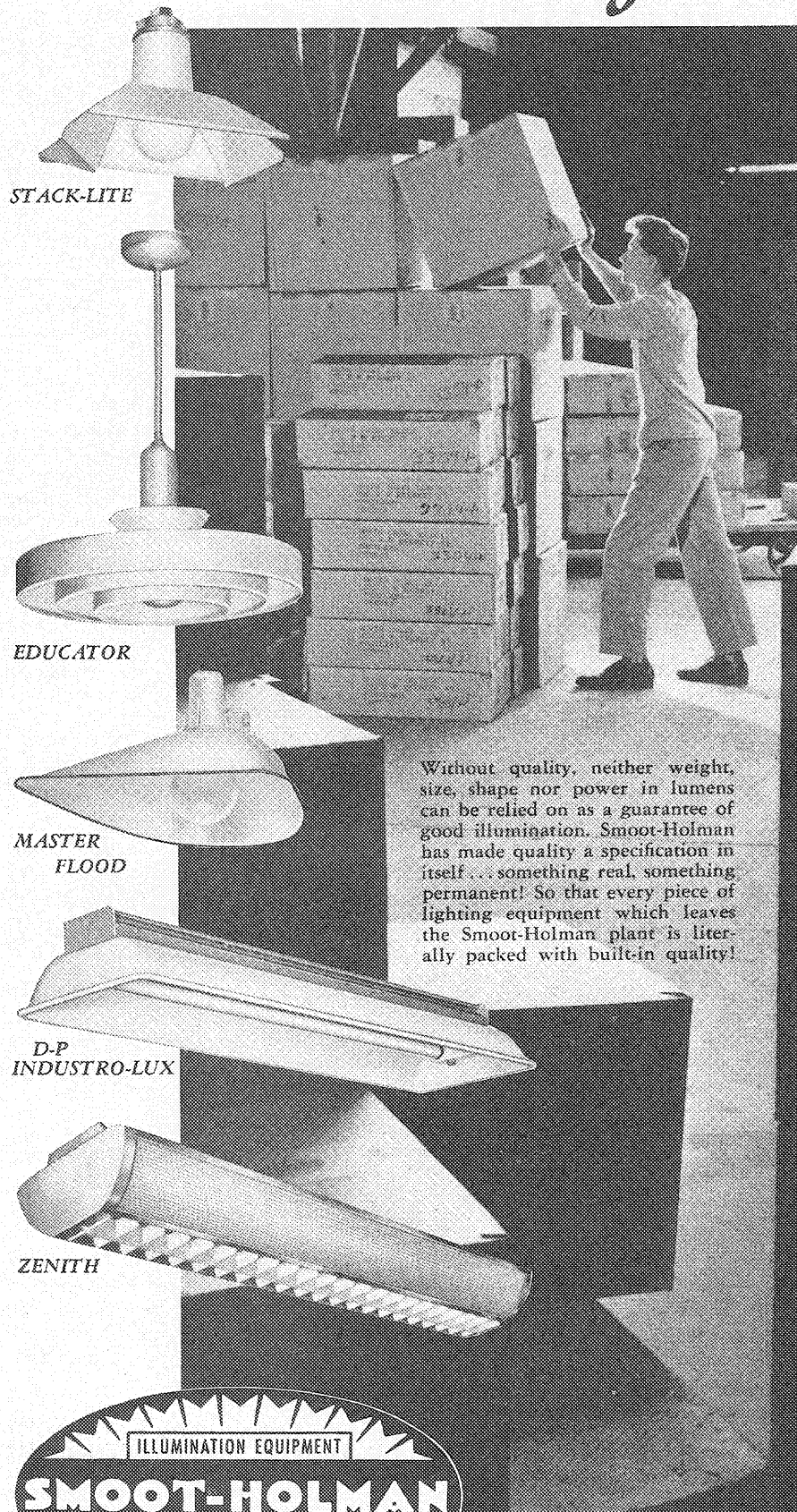


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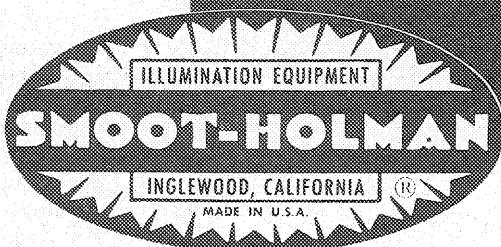
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LETTERS

Morphological Thought

SIRS: This letter is partly for the purpose of expressing my amusement and delight over Dr. Fritz Zwicky's article, "Free World Agents of Democracy," in the November issue of *Engineering and Science*. It is affording me much pleasure to circulate photostatic copies of this artful composition among the scientists of this Station's Research Department.

The other part of the reason for bothering you with fan mail concerns the morphological method of which Dr. Zwicky is a noted proponent. It has been several years since Dr. Albert Wilson first described this system of analysis and approach and since we contemplated its possibilities. I have had too little opportunity to follow the development and application of the morphological method and since it seems to suit my temperament I would consider it a great favor if you would inform me where I might obtain the literature on the subject for serious study.

G. M. Schroedter
U. S. Naval Ordnance Test Station
Inyokern, Calif.

SIRS: Of life's many small satisfactions, one of the pleasantest for me is to find my unspoken thoughts put down in black and white by someone else, past or present. Especially when it is done as entertainingly as in Dr. Zwicky's article, "Free World Agents of Democracy." It was most enjoyable, besides being astonishingly apropos.

As a matter of fact, we have been dabbling with the general problem of ship stabilization here at Stanford, and I had just begun to cast about for ways and means of bringing what little I knew of group theory and topology to bear on the general problem of classifying, reducing, and evaluating the possible solutions to this problem, when up popped your article.

As Dr. Zwicky's specific comments on the morphological method were brief, I am extremely interested to know if there are more specific, unclassified references available on the subject, and if so where and how they may be obtained.

Joseph H. Chadwick, Jr. '44
Stanford University, Calif.

P.S. As a free world agent (active chiefly in the realm of science), not on Dr. Zwicky's list, I would like to nominate Henri Poincaré engineer-mathematician-universalist.

For the benefit of Mr. Schroedter, Mr. Chadwick, and the other readers who wrote E & S for more informa-

tion on the morphological method, here are some further references:

F. Zwicky, Morphology and Nomenclature of Jet Engines, *Aeronautical Engineering Review*, June 1947; The Morphological Method of Analysis and Construction, *Courant Anniversary Volume*, Interscience Publishers, 1948; Morphological Astronomy, *Observatory*, Vol. 68, 845 (1948); Morphology of Aerial Propulsion, *Helvetica Physica Acta*, 21, 299 (1948).

E & S has a limited number of reprints of these articles on hand if anyone is unable to come by them himself.

Metachemistry

SIRS: That was a fine article of Dr. Zwicky's in your November issue but I certainly could have wished for a fuller explanation of "metachemistry" (page 13). Is this something I should know all about? Is it a new science? Or is it just something like metaphysics?

T. L. Kelly '27

New York City

Metachemistry, as defined by Dr. Zwicky, is "the science of those reactions which involve initial metastable excited states of matter."

Says Dr. Zwicky, in fuller explanation:

In the search for ever higher concentrations of "packaged" energy the idea is proposed to attempt the stabilization *in bulk* and the *exploitation in macroscopic quantities of metastable high energy states of matter*. It is for instance of vital importance to make available propellants of high energy density in order to operate long distance rockets. Generally speaking both high energy per unit mass and per unit volume are important. The best ordinary chemical propellants pack of the order of 1 to 10 Kilocalories per cubic centimeter or per gram respectively. There exist, however, metastable states of atoms and molecules of long lifetime whose energy lies in the range from 10 to 100 Kilocalories per gram, or even higher.

The excited metastable states of atoms, ions and molecules can in principle be used in two ways for

the production of power, or more specifically for the generation of propulsive power.

1. The excited particles may be used wherever they are found naturally, for instance in the upper atmosphere and in interstellar space. This involves the solution of the tricky problem of artificially de-exciting the particles and of transferring the energy gained into propulsive power, for instance to drive a missile.

2. The excited particles may be collected and stabilized in bulk into a metachemical propellant of macroscopic density and energy higher than that which is characteristic for chemical propellants. The most obvious approach to the stabilization of metachemical propellants is through the use of very low temperatures.

In addition to the importance of metachemistry for propulsion, there exist intimate relations between metachemistry and the problem of directly exploiting the radiation from the sun as well as the problem of storing energy for varying periods.

BOOKS

MODERN ARMS AND FREE MEN

by Vannevar Bush

Simon and Schuster, New York, 273 pp. \$3.50

*Reviewed by Lee A. DuBridge
President, California Institute
of Technology*

This is a most important book. It is also both a fascinating and thought-provoking one. It is at times jarring, at times reassuring. It is never dull.

The subject matter covers a field which no one but Dr. Bush could treat in so authoritative a manner. As the author states it, "This book is about science and war and democracy and their inter-relations."

Dr. Bush is not attempting in this book to write a history of the Office of Scientific Research and Development, which he headed during World War II. Rather he seeks first to *analyze* the impact of the developments in science and technology on the weapons and techniques of modern war. For this purpose he treats briefly the techniques of World War I and the developments which occurred between the two

wars. He then takes up in considerable detail the technical developments which occurred during World War II as they affected the war on land, in the air, and on and under the sea. These chapters are most illuminating for they discuss not the technical details of various new weapons such as proximity fuses, radar, rockets and the rest, but their impact on the nature of war itself and how new techniques will affect future warfare.

He devotes two special chapters to an analysis of guided missiles and atomic bombs and their effect on future warfare. In view of the extravagant claims which have been made for the future potentialities of these weapons, and in view of the equally extravagant attempts to dismiss them as unimportant, Dr. Bush's careful analysis is a contribution of surpassing importance. As might be expected, this analysis reveals that extravagant claims on either side are likely to be false, and that the truth lies along a middle road. The atomic bomb is a weapon of devastating power. But the wiping out of a highly industrialized country by sending dozens or hundreds of

atomic-bomb-carrying planes may be a highly expensive business if the defending country is alert and well prepared. Dr. Bush is obviously skeptical of the thesis that the next war can be decided overnight solely by the operation of a huge fleet of atom-bomb-carrying planes. The jet plane and the guided missile offer promise of formidable defenses against fleets of strategic bombers. Though there may be no specific defense against the atomic bomb itself, there are potentially powerful defenses against the planes that must carry them.

But the heart of Dr. Bush's book is not his discussion of the techniques of warfare. Rather it lies in the chapters where he contrasts the ways in which these techniques can be developed and used by a democratic nation as compared with their development and use by a dictatorship. Here he presents a convincing case for the thesis that free men in a democracy are in a far better position to develop and perfect the techniques and instrumentalities of war and to achieve the industrial power needed to win a war than men whose freedom is suppressed under