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ference, with important and highly encouraging implications for the future. A banquet was held in the University Museum on the evening of the second day. It was a splendid occasion, cordial, hilarious, full of good fellowship and warmth which left only the surrounding Egyptian statues unmoved.

H. K. Henisch
University of Reading

Solar Energy

INTEREST in the direct utilization of solar energy is increasing rapidly. At a symposium in Wisconsin in 1953 and again in India in 1954 there was an attendance of about forty. At the conference on solar energy utilization in Arizona last November there were nearly a thousand registrants including 130 scientists from 31 foreign countries. The Ford Foundation, the Rockefeller Foundation, UNESCO and several agencies of the United States Government made possible the participation of the foreign guests.

The conferences were sponsored jointly by the newly-formed Association for Applied Solar Energy, the Stanford Research Institute, and the University of Arizona. Leaders in the organization plans were Merritt L. Kastens, Henry B. Sargent, and Louis W. Douglas. The conference attracted a great variety of people—physicists, chemists, biologists, engineers, and many observers, writers, industrialists, and businessmen who were keeping an eye on new developments in a field of expanding potentialities.

The conference was divided into three parts: The Scientific Basis at Tucson; The World Symposium on Applied Solar Energy at Phoenix; and the Solar Engineering Exhibition at Phoenix.

There was a great demand for places on the scientific programs at Tucson and it was necessary to hold several meetings simultaneously, morning, noon, and evening. It was unfortunate that these programs had to overlap in time and that there was insufficient time for discussion, but the program committee under the chairmanship of Edwin F. Carpenter did an effective job in making available many last-minute contributions. Over one hundred papers describing frontier researches were emphasized at Tucson, while thirty reviews and summaries, stressing practical applications, were given at Phoenix.

The Tucson program dealt with thermal, photochemical, and electrical processes. The thermal processes included flat-plate collectors, high-temperature furnaces, solar stoves, house-heating and cooling, solar power, and solar distillation of saline water; the photochemical processes covered algal culture and higher plants and nonbiological systems; and the electrical processes contained papers on thermal, photogalvanic, and photovoltaic systems.

There were many controversies, such as that between the advocates of flat-plate collectors for heating water and other liquids and the advocates of converging reflectors which can give higher temperatures. It may

turn out that the flat plates will be best for cloudy areas and that the converging collectors will be best for high temperatures in sunny countries even with their handicapping requirement that they must be moved to follow the sun. Another lively controversy involved the use of higher plants as against the mass culture of algae for the biological utilization of solar energy.

One session was devoted to instruments and techniques for the measurements of solar radiation. If an expansion is to be considered in the use of the sun's energy in nonindustrialized countries, it will be necessary to have information concerning the solar radiation in areas where records are not now available. The type of records and practical instruments for use by untrained scientists were discussed.

The more general papers at Phoenix included solar machines, high-temperature furnaces, solar stills, and mechanical energy from solar energy. A day was devoted to solar house heating and cooling with descriptions of houses built by Hottel in Boston, by Telkes in Dover, Mass., by Löf in Denver, and by Bliss in Arizona.

The cooling of houses was discussed by Löf, and the architectural problems of solar collectors were stressed. One paper by Sporn and Ambrose described the present status of the heat pump combined with solar house heating.

In general, it seemed to be accepted that solar house heating is expensive and that supplementary heating with fuel is advisable for the practical, economic use of solar energy, at least in the northern half of the country.

A session on the utilization of solar energy through plants and algae by Brooks, Fisher, Myers, Tamiya, Thimann and others brought out engineering possibilities in the growth of algae. One of the chief difficulties in the mass culture of algae is keeping the algal suspensions cool enough. An important development reported is the finding of a strain of algae which will grow rapidly at 40° C and thus reduce the expensive cooling requirements.

At the final session the possibilities of converting solar energy directly into chemical energy and into electricity were presented. A paper by V. A. Baum was read describing progress in solar energy research in the USSR. In this paper plans were proposed for generating electricity for a city of 20 000 with the help of a steam boiler on a tower 130 feet high surrounded by semicircular tracks carrying large flat mirrors mounted on cars which were moved with the sun.

One of the most significant contributions was made by H. Tabor of the National Institute of Physics of Israel, who described thin coatings of nickel oxide and other black materials which absorb efficiently throughout the whole solar spectrum but which do not absorb and hence do not radiate in the long infrared. With these coatings it is possible to obtain considerably higher temperatures for a water boiler because, although the solar energy is completely absorbed, the heated boiler does not lose its heat so quickly through re-irradiation in the far infrared.

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Professor Trombe described experiments with his large 35-foot mirror. At the close of the session it was announced that a much larger solar furnace is to be built in France capable of producing 1000 kilowatts of heat at temperatures above 3000° C for use on a semi-production scale.

An important feature of the symposium was the outdoor exhibition of solar devices which included measuring instruments, collectors of solar energy, cookers, house-heating and cooling units, high-temperature furnaces, solar engines, saline water stills, photovoltaic cells, photosynthesis, and agricultural aids. Of the nearly one hundred exhibits, some bordered on gadgeteering, but the 30 000 visitors to the exhibition certainly came away with a good realization of the present status of attempts to utilize solar energy. Several different types of solar cookers were exhibited. They were developed in India, Lebanon, Japan, and Burma, as well as in the United States.

Both parabolic reflectors and flat-plate collectors were demonstrated. A five-foot furnace converted from an army surplus searchlight was melting tungsten, and a small plastic fresnel lens was fusing fluxes for making jewelry. Professor Trombe exhibited an accurate model of his 35-foot solar furnace in France.

An Italian company demonstrated a vapor engine for pumping water, in which sulfur dioxide is vaporized in a flat-plate collector. Dr. Charles G. Abbot exhibited a model of his cylindrical mirror focused on a vacuum-jacketed tube with a high boiling liquid which generates steam in a heat exchanger. Pulsating mechanical energy generated in a water column, and small pin wheels, showed less conventional methods of converting solar energy into useful work.

The use of thin plastics for the solar distillation of salt water was exhibited and plans for large-scale developments in solar distillation of sea water were described.

The silicon solar battery of the Bell Telephone Laboratories was shown and the visitors were given an opportunity to talk over telephones operated by solar batteries.

At the general sessions, the economics of solar energy were discussed by J. E. Hobson who gave the costs of conventional fuels in various parts of the world and compared them with anticipated costs of solar energy.

The dinner speaker, John Jay Hopkins, stressed the importance of an international energy agency to raise the standards of living throughout the world.

Two policy questions were raised at the meetings—the desirability of starting a new journal of solar research and engineering, and the advisability of encouraging an international organization of solar energy utilization research.

It was made abundantly clear at this Arizona conference, as at previous conferences on solar energy, that solar energy cannot now compete with conventional electricity and fuel in highly industrialized areas where these are abundant and that there is nothing now in sight which approaches costs of 2 cents per kilowatt

hour of electricity or \$50 for a one-horse power gasoline engine. The competition with animal power and manpower in nonindustrialized countries, however, is attractive, and intensive research is to be encouraged along many different lines. New materials, new plastics, new ways of fabricating large, cheap reflectors, mass production of small steam engines, simplified ways of pumping water, and new types of storage batteries may well accelerate the utilization of solar energy. The short-range researches involve new ways of utilizing the sun's energy as heat, the long-range researches should encourage the photochemical and photoelectrical conversion of solar energy. The field is one which calls for intelligent cooperation between scientists, engineers, economists, industrialists, business men, and the governments of many nations.

The Geneva "Atoms for Peace" conference and the Arizona "Sun for Man's Use" conference taken together, give hope through research of adequate energy sources throughout the world, not only for the future when conventional fuels become scarce, but for the present in the nonindustrialized areas where fuel is expensive and difficult to transport.

Atomic energy can supplement conventional fuels in large units near cities, and solar energy can supplement them in small units in sunny, rural areas, but intensive research by many people is needed to make them economically attractive.

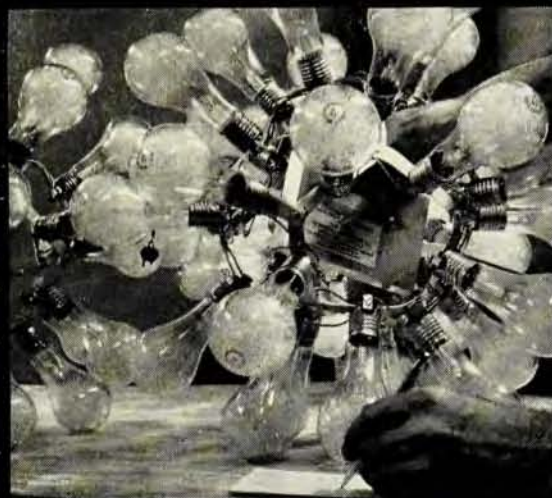
The Proceedings of the World Symposium on Applied Solar Energy in Arizona have already been published and the Tucson papers will become available later.

Farrington Daniels
University of Wisconsin

Naval Hydrodynamics

A SYMPOSIUM on Naval Hydrodynamics, sponsored by the Office of Naval Research (Mechanics Branch) in cooperation with the National Academy of Sciences and National Research Council, took place in Washington, D. C., September 24-28. The first of a series to be held on a yearly basis, the symposium is described as being an outgrowth of a continually growing need for meetings devoted exclusively to developments in the rapidly advancing field of hydrodynamics, particularly in the areas basic to naval and marine applications. The meeting was unclassified and open to all those interested.

The following speakers and their topics were listed in the program: C. C. Lin (boundary layer stability), S. Corrsin (turbulence in shear flows), G. K. Batchelor (wave scattering due to turbulence), M. J. Lighthill (river waves), W. H. Munk and M. Tucker (ocean wave spectrum), D. Gilbarg (free streamline theory and steady state cavitation), M. S. Plesset (physical effects in cavitation and boiling), H. Snay (hydrodynamics of underwater explosions), G. P. Weinblum (seaworthiness), H. Lerbs (hydrodynamics of marine propulsion), J. V. Wehausen (ship wave phenomena), M. Strasberg



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