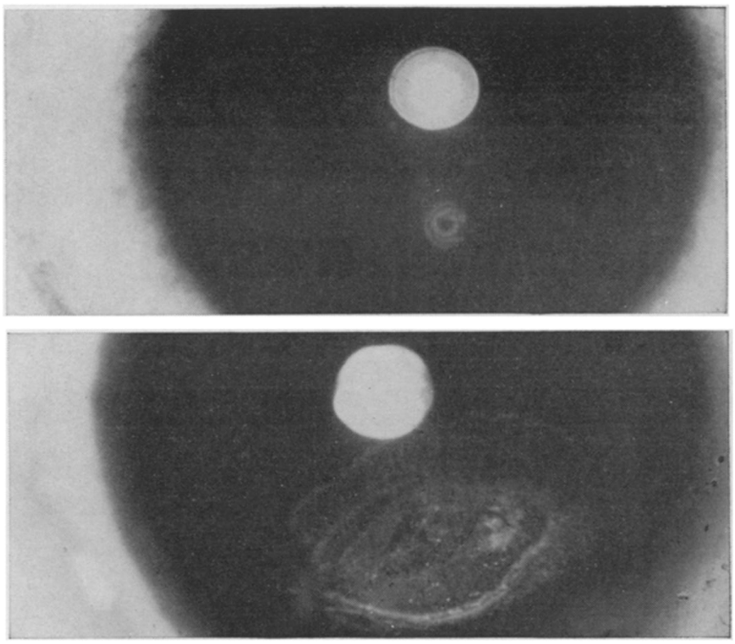


HEW

Cataract growths in rabbit eyes: normal eye (top left), cataract after single exposure to microwaves (top right), after 4 daily exposures (lower left) and after 15.

Microwaves and

Scientists are pondering the effects of very-low microwave levels on human beings

by Edward Gross

Nestled snugly between ordinary radio waves and the infrared in the electromagnetic spectrum is the wilderness of microwaves. Even the boundaries are not clearly defined: Just where the microwave region begins and ends is still not universally agreed upon since measurements of it are influenced by the technique used. But the National Bureau of Standards places microwaves, which are really a type of high-frequency radio waves, between 300 million and 300 billion cycles a second.

The first major application of radio frequencies in this range came in the 1930's, when they were used in radar. World War II gave them a boost, but their real growth came after the war. Today 90 percent of all TV transmission and two-thirds of all long-distance communication, including telephone data transmission and fascimile, are done by microwave.

Microwaves are the medium for radio telescopes and for satellite communications. A linear accelerator at Stanford is unraveling the nature of matter with their help. Because they produce intense heat by molecular agitation, they are being drafted for industrial processes: Microwaves cure plastics, dry lumber, drugs and textiles, precook foods, warm food in canteens and cafeterias and cook it at institutions and in a growing number of private homes.

Some British newspapers are drying newsprint with them; a microwave pasteurization process for bakery products has been developed; and in September, a microwave kiln for enameling glass, ceramics and metal was patented. Their medical applications have been mainly relegated to the area of diathermy treatments where deep heat penetration is required.

For the future, the big promise of microwave technology will be in electric power transmission and production. Some plans call for harnessing the sun's energy with microwaves and transporting billions of watts underground (SN: 4/12, p. 353).

But there is one black cloud on an otherwise bright horizon: safety.

It has been known for a long time that microwaves in sufficient amounts and over a long enough period can be harmful to biological systems; cataracts and damage to the testes are two of their reported effects in humans.

And despite the fact that there are an estimated 10,000 people working directly with microwave devices and untold numbers coming in contact with them in schools, hospitals, cafeterias and even the home, information on the biological effects of microwaves is about as scanty as are precautions against undue exposure.

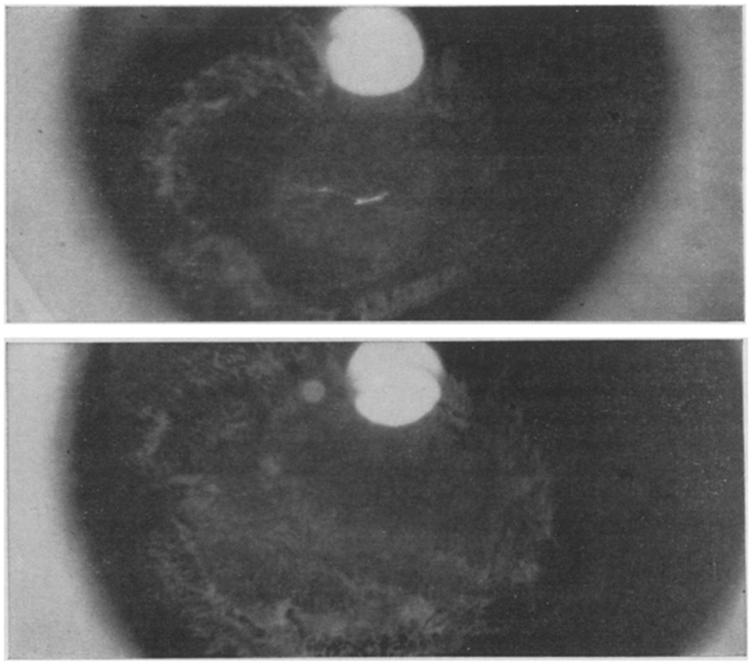
"The knowledge of biological effects is inadequate," biophysicist Dr. Stephen F. Cleary of Virginia Commonwealth University said in Richmond, Va., at a recent symposium on microwaves' biological effects. "We don't know the biological mechanisms. The main problem is the effect on the central nervous system. We don't know if microwaves interfere with neural transmissions."

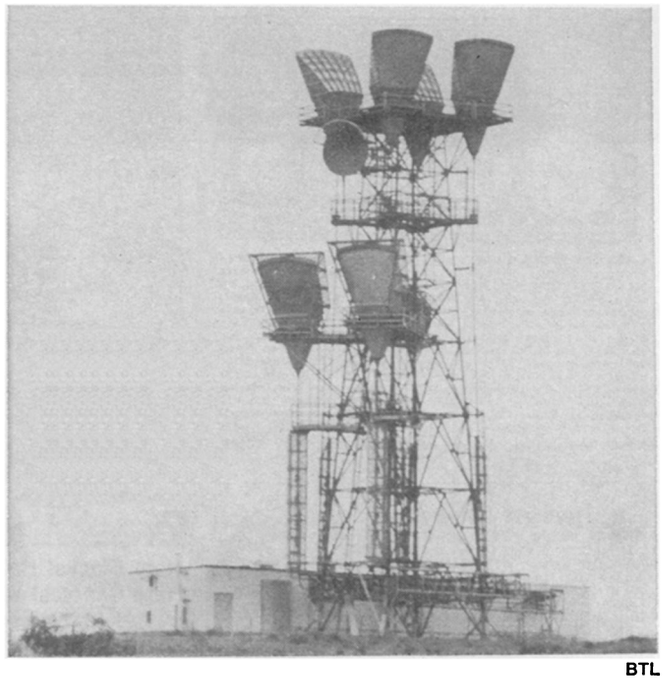
It was in an effort to learn more about the potential hazards of microwave radiation, as well as the mechanism of damage, and to set future research directions, that 400 scientists, medical and health specialists and engineers from all over the United States came to Richmond.

The meeting indicated that certain organs, such as the eyes, testes, gall and urinary bladders and the digestive tract, show more susceptibility to microwave damage than other organs; the smaller blood vessels of these organs make them less able to cool themselves after exposure to the heat produced by microwaves. And, since water is a microwave absorber, it makes tissues such as eye, skin and muscle, more susceptible to microwave damage than bone marrow or fat, which have less water.

Microwave heat works against the body by heating it to the point where the metabolic rate is raised. This results in a compensatory increase in respiration and blood circulation. At the same time that the blood is speeding more quickly through the lungs, the ability of hemoglobin, the blood's oxygen carrier, to transport oxygen diminishes. Furthermore, the blood hurtling through the lungs now has less time to load up on oxygen. The effects observed are similar to those of a high fever in extreme cases: degeneration and death of heart tissue and bleeding in the digestive tract, lungs, liver and brain.

But these and other known effects stem from large doses of microwaves. Scientists are not certain about the effects—either short term or cumulative —of low-level doses of microwaves.





BTL

A microwave relay tower for long-distance phone calls.

health effects

Nor is it certain that all of the radiation effects are thermal.

Some researchers, mainly Soviet though they have some allies, contend that low-level microwaves can produce clinical biological effects without any significant temperature increase. Soviet bloc scientists such as L. I. Minecki and A. A. Letavet report changes in heart rhythm and neurological activity in the brain.

The prevailing view among many Western scientists is that without significant heat, there can be no clinically significant biological effects from microwaves.

Dr. Herman P. Schwan of the University of Pennsylvania points out that the nonthermal effects cannot presently be explained on the basis of any known physical principles.

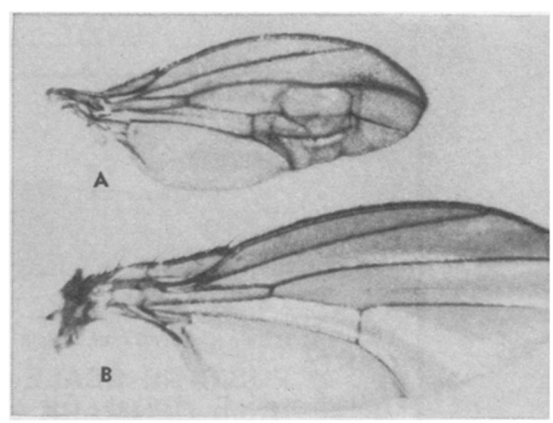
The biological effects the Soviets are talking about, says his colleague, Dr. Lawrence D. Sher, would require microwave levels that could produce dangerous overheating first.

Though the Soviets have claimed cures of epileptic mice with microwaves, Dr. Schwan's calculations show that even if 10 milliwatts per square centimeter, the commonly accepted safe level for microwaves, impinges on a person, the absorbed electrical energy still will be much too small to stimulate a nerve fiber.

But Dr. John H. Heller of the New England Institute for Medical Research in Ridgefield, Conn., believes the Russians might have a point. Besides reporting chromosome damage and cell changes in plants and animals from non-heat-producing radio frequencies (SN: 9/27, p. 276), Dr. Heller has recently obtained 100 percent germination in a gladiolus plants with such waves, as opposed to a normal 40 to 50 percent sprouting. The radiation also doubled plant size, and reduced germination time, though the mechanism of the phemonenon is still unknown.

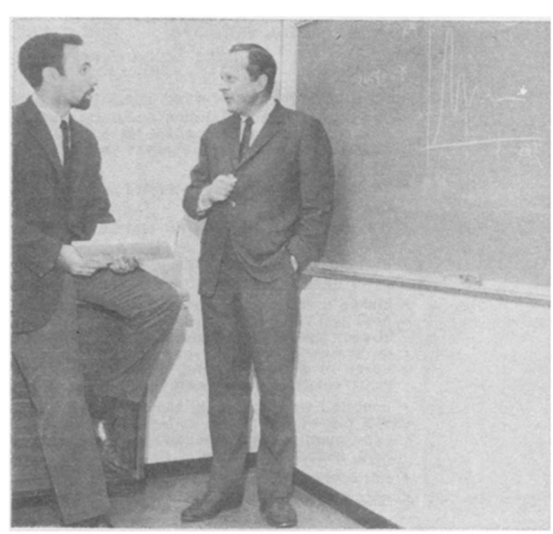
Further support for the nonthermal view comes from electrical engineer Dr. Paul O. Vogelhut of the University of California at Berkeley. Dr. Vogelhut's research suggests that radio-frequency waves can produce biological changes by a process similar to the one in which latent heat melts ice. When ice melts, there is no temperature rise at first because the heat has gone into breaking down the ice's molecular structure. By his calculations, Dr. Vogelhut indicates that microwaves could work in the same way: Instead of raising temperature, the microwave energy would go into disrupting the molecular orientation of water bound to protein molocules, thus producing biological changes.

Although microwaves are not regarded as dangerous as ionizing radiation, they pose enough of a potential health hazard to be mentioned in the 1968 Radiation Control for Health and Safety Act. The act empowered the Department of Health, Education and Welfare to set up standard safety levels for microwaves and find ways to control their emission.



New England Institute

Mutated (A) and normal fly wing.



Univ. of Pennsylvania

Schwan and Sher: Thermal effects.

Singled out for mention in the act were microwave ovens, for which there are no mandatory standards. just as there are none for any microwave device. A number of local health

agencies have run tests on the ovens and found that some 10 to 20 percent leaked radiation above the commonly accepted 10 milliwatt-per-square-centimeter level.

The Government and the manufacturers have so far not clashed violently on safety matters, but the question of maximum permissible levels divides the regulators from the regulated, as it has in setting a level for coal dust in coal mines and for radiation in uranium mines.

An advisory committee to the Secretary of HEW, at present holding meetings on a safety standard for ovens, favors a one milliwatt-per-square centimeter standard recommended to it by the Bureau of Radiological Health, while manufacturers and many microwave authorities say the 10-milliwatt level is safe. The argument isn't only over the safe level per se—the manufacturers say they can easily meet that—but over the lifetime of the standard.

The Radiation Control Act requires that the one milliwatt standard would have to remain in effect for the lifetime of the oven. The manufacturers argue that during normal operation and servicing there are bound to be some changes, hence possible emissions, as there are in television sets (SN: 7/19, p. 46), above the original design limits. Thus, they contend, a realistic standard for the lifetime of the oven must take this fact into consideration.

Says William Comstock of the Association of Home Appliance Manufacturers, "Industry is not only concerned with its ability to control equipment coming off the production line. We're concerned with changes during the lifetime of the equipment. Over a period of extended use, there's a question if we could meet the one milliwatt level."

In the meantime fear of microwave effects has cut into the growth of appliances using them. At present, there are an estimated 50,000 home ovens. A 500,000 figure for annual production by 1975, once projected by the Government, now appears unattainable because of the unfavorable publicity.

"We don't know if setting a standard will help any," worries Comstock. "I don't anticipate a growth of 500,000 a year unless there's a change so microwave ovens could develop in a normal product environment. Foreign markets are growing faster—five times more ovens are sold in Japan than in the United States—probably because there hasn't been any adverse publicity there." ◻