PHYSICS

Optical Maser Amazes

Optical masers are predicted that will map the moon, serve as radar, communication in space and act as a surgeon's scalpel, Ann Ewing reports.

➤ CONCENTRATING LIGHT several million times more than a flashlight does, an extraordinary optical device—the heart of which can be gem rubies or gas mixtures—is about to perform amazing tasks. Among them:

Map the moon, make detecting radar operate on light, communicate in space, act as a surgeon's knifeless scalpel—and it may become that seemingly impossible of warfare, a death ray. It may also be used in the future to transfer power from the ground to a satellite.

The optical maser, as this device is called, is a mere baby among scientific laboratory devices. It was invented less than two years ago. Maser gets its name from Microwave Amplification by Stimulated Emission of Radiation. You pronounce "maser" somewhat like "amaze" which it does. It is also called a laser (the "l" being for light).

The laser is an offspring of the maser, which performs wonders with radio waves.

The optical maser, of which there are at least eight now being tested in laboratories around the country, is likely to revolutionize many everyday activities in the future. The device amplifies and sharpens weak light waves to produce a very narrow, intense beam of a single, extremely pure color. As a result of this development, light waves can now be used in the same way as radio waves.

Boy on Swing Comparison

To understand how and why a maser works, Dr. Francis T. Byrne of the U. S. Navy's Office of Naval Research compares its actions to a boy on a swing. If the boy sits perfectly still on a moving swing, the amplitude of the swing's motion gradually decreases owing to frictional losses. However, by moving his body in unison with the swing's motion, the boy can "pump up," or amplify the swinging motion. By opposite body motions—against the rhythm of the swing's motion—he can decrease the amplitude and stop the swing much more rapidly than by waiting for friction to cause the motion to cease.

These three different effects of the boy's motion on the swing's motion correspond respectively to spontaneous emission, absorption and induced emission. And these three effects are why masers operate.

Radiation energy is used to force the maser's atoms into excited energy states, since they have absorbed the energy. Some of the atoms will then spontaneously emit radiation and fall back to the lower energy state. However, by hitting the active material with radiation of precisely the energy that would be emitted spontaneously, the atoms can be stimulated to emit their radiation in one great cascade. This induced radiation is the secret of the maser's operation.

If a strong beam of light from an optical maser were directed at the moon, it would not widen more than ten miles while traveling the 240,000 miles of intervening space. An ordinary searchlight of the same intensity would throw a beam 25,000 miles wide at that distance.

The optical maser beam could therefore be used to map the moon, by recording the time that light takes to travel from earth to the moon and back for all visible areas of the moon.

Another possibility of moon use, after man gets there, would be to put a series of masers on the moon and shine them toward the earth. They could be made to cover regions as small as 100 feet in diameter, and messages could be sent on them. Provided there were no clouds, one could look up and find letters saying, "Go to the Bijou Theater." At at adjoining town, the message might instead say, "Please come home, George."

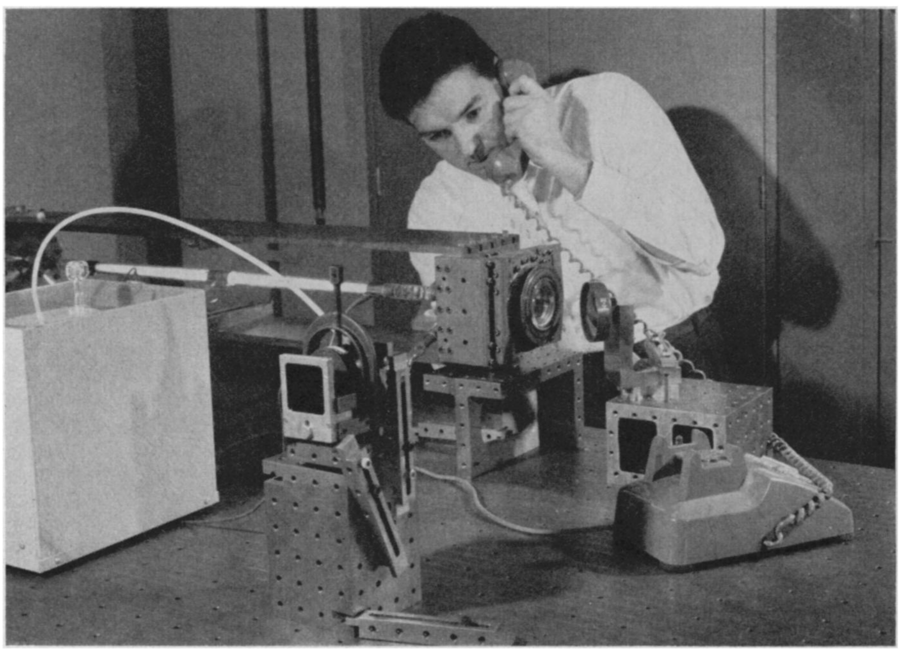
Such an application has been tentatively suggested by Dr. Charles H. Townes, provost at Massachusetts Institute of Technology, who discovered the maser principle. About three years ago, Dr. Townes and Dr. A. L. Schawlow of Bell Telephone Laboratories predicted that masers could be made to operate in the optical instead of microwave frequencies.

The first successful optical maser, or laser, was made in July, 1960, by T. H. Maiman of Hughes Aircraft Company, Malibu Beach, Calif., who used a ruby crystal. Between July and the end of the year, four other substances, including uranium, were successfully tested and lasers can now operate at a dozen wavelengths. The brightness of lasers, within each laser's narrow color band, is millions of times that of the sun. Its beam will intensely heat an object on which is is focused, hence the future possibility for death ray use.

Gas Makes Laser

A different way to obtain excited atoms for an optical maser is using gas atoms in an electric glow discharge. Drs. Ali Javan, W. R. Bennett Jr. and D. Herriott of Bell Telephone Laboratories built such a device using helium and neon gas. This laser operates continuously and with very low energy input.

Dr. Townes also suggests that another civilization on a distant planet developing slightly differently than the earth's civilization would have discovered laser action and decided this was the natural way to communicate. With ten kilowatts of power and using a 200-inch telescope beyond the earth's atmosphere for an antenna, he calculates that detectable amounts of light could be sent tens of light years into space. A light-



CONVERSING BY LIGHT BEAM—One use of optical masers, carrying telephone conversations on a light beam, is demonstrated here by Donald R. Herriott of Bell Telephone Laboratories.

year is about six million million miles. He suggests looking now in the optical region in a program similar to Project Ozma, during which radio astronomers listened for intelligent radio signals from space.

If masers could be made to generate real power, the resulting directed beam would be almost as good as a wire that conducts light and not electricity. Power might in this way be transferred from the ground to a satellite.

Light waves can also carry communications, and scientists at Bell Telephone Laboratories have used infrared light from an optical maser to do this. In one ten-thousandth of the frequency, the optical light band width can carry as much traffic as all previously available communication links.

In medicine, optical masers promise a wide range of applications. By passing the beam through a lens, it could be made to penetrate most body tissues, coming to a focus where needed for such tasks as delicate cutting, fine stitching, sterilization, cauterization or radiation treatment.

The intense heat spot produced by focusing the coherent light from optical masers could also be used for fabricating all sorts of electronic devices. It would even be possible to weld a joint sealed in a glass envelope.

Other uses suggested for lasers include the highly selective control of chemical reactions. This is because laser radiation of the right frequency could be made strong enough to excite vibrations in a particular kind of molecule that would then react more vigorously than the others.

Since lasers are so new, the list of possible applications must be left unfinished. However, in laboratories here and abroad, scientists are intensively investigating the properties and limitations of coherent light generated by optical masers.

Although the search for the second harmonic of coherent ruby light is purely scientific at this point, it may lead to a new and precise method of determining crystal structure. Another purely scientific development at this point is the generation of giant light pulses from a ruby laser.

As Dr. Schawlow said, "With the advent of the optical maser, man's control of light has reached an entirely new level. Indeed, one of the most exciting prospects for workers in this field is that this new order of control will open up uses for light that are as yet undreamed of."

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GENERAL SCIENCE

News From Science Clubs

➤ SUCCESSFUL science and community activities continue to be reported to Science Clubs of America by its affiliated clubs.

BI-PHY-CHEM SCIENCE CLUB of Jordon Vocational High School, Columbus, Ga., stimulates interest among its members by presenting annually a Most Valuable Science Club Member Award. They help finance their activities by selling school book covers and sponsor their district science fair.

The members of the SCIENCE AND MATH CLUB, Booker T. Washington Jr. High, Mobile, Ala., present assembly programs, conduct a local science fair, have specialists give demonstrations to parents and students, sponsor science field trips. They are developing special projects concerned with holidays such as Christmas, Thanksgiving and Easter.

The POST HIGH SCHOOL SCIENCE AND MATH CLUB, Post, Texas, finds that their most effective club programs are on careers in science, math and engineering presented by community speakers.

The successful activities of the SCIENCE CLUB at Brazil Sr. High School, Brazil, Ind., include an Indiana CAA licensed rocketry range, ham radio, electronics, field trips and project work days.

The HENRY HUDSON EXPLORERS at Junior High School 125, Bronx, N. Y., are raising mice for their genetic studies, mathematically solving science problems and making bacterial counts of the air.

The PATH FINDERS of East Dover Elementary School, Dover, N. J., are busy with experiments and debates on science.

Let Science Clubs of America know what your club is doing this year. Send reports to SCA, 1719 N Street, N.W., Washington 6, D. C.

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GENERAL SCIENCE

Ford Foundation Grants

➤ THE FORD Foundation granted $48,-922,372 for the betterment of education, science and engineering in 1961, the Foundation announced.

Out of the $155,700,000 granted by the Foundation during the fiscal year ended Sept. 30, 1961, more than $34,000,000 was directed for education in the United States. Grants for the Midwest Program on Airborne Television Instruction reached $6,000,-000 in 1961. Illinois, Indiana, Kentucky, Michigan, Ohio and Wisconsin schools participated in the program.

Case Institute of Technology received $8,000,000 of the nearly $15,000,000 granted for the furthering of science and engineering. Cornell University received a grant of more than $4,000,000 to develop as a center of engineering education and research.

A five-year grant of $240,000 was also made to the Marine Biological Laboratory, Woods Hole, Mass., to establish a program to train biologists in the classification of marine organisms.

The complete listing of grants from Ford Foundation during the 1961 fiscal year was presented in the annual report.

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