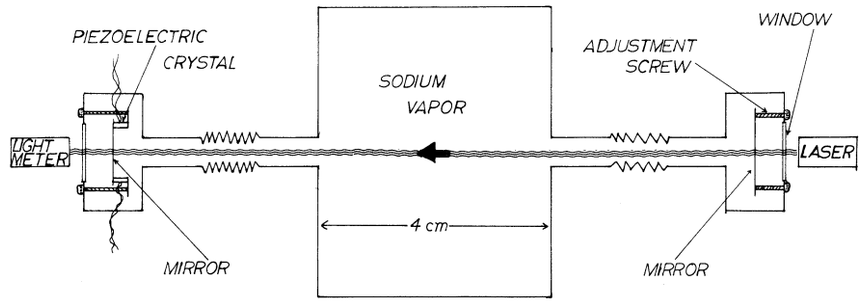
First optical transistor demonstrated



The gas tank in the middle is where Bell Labs' optical transistor does its thing.

In the drive to develop a high-capacity communications system based on light transmission (SN: 7/19/75, p. 44 and 7/26/75, p. 60) a missing ingredient has been an equivalent to the electronic transistor—a device that can amplify and restore definition to weak signals, perform switching operations, and be joined into circuits for logic and memory functions, using only light energy. The first experimental optical transistor has now been successfully demonstrated at Bell Laboratories by physicists Hyatt M. Gibbs, Sam L. McCall and T. N. C. Venkatesan.

In an interview with SCIENCE NEWS, McCall described the apparatus in which the properties of an optical resonating chamber are used to control transition, reflection and absorption of a laser beam. The chamber consists of two parallel, partially reflecting mirrors, spaced so that an exact number of lightwave peaks fit between them. (Called a "Fabry-Perot interferometer," such an arrangement is also used in laser operation.) By carefully manipulating the mirrors or the gas confined between them, a beam of light passing through the chamber can be controlled in some surprising ways.

By changing the mirror spacing very slightly, a "differential gain mode" of the transistor is established, in which a weak, low frequency signal on the incoming light beam is amplified as it leaves the chamber. At a slightly different mirror spacing and gas pressure, a "bistable mode" is created, in which a given intensity of entering light can result in either a very high or a very low intensity transmitted beam, depending on how previous inputs have affected the gas. Such properties are useful in switching and memory circuits. Other transistor-like functions the apparatus can perform include "clipping" (used to discriminate weak signals from background noise) and "limiting" (stabilization of a signal to a desired level).

Many problems must be overcome and other possible functions explored before optical transistors are ready for practical application. For one thing, the experimental Bell apparatus weighs more than 50 pounds and uses as its active gas sodium vapor, which slowly deposits itself on the mirrors. Also, the spacing of the mirrors is so critical that final adjustments, to tolerances of about a hundredth of a wavelength, must be made by passing a current through piezoelectric crystals supporting the mirrors, making the crystals expand very slightly. Says McCall: "We would walk out of the room, come back, and it would be mistuned."

But some exciting possibilities for future experiments also exist. The scientists have not yet tried tuning the resonant chamber with an external radio-frequency field. McCall says that applying such a field would affect the light output by changing the energy state of the enclosed gas, thus modifying its transmission and absorption properties. Input laser beams of different frequency and varying internal gases might also give different results. Perhaps most important, a second light-beam shone into the device from the side is expected to control the transmitted beam so as to achieve a gain in signal energy—as well as the gain in amplitude already observed—or to switch states in the bistable mode. A similar process is used to "pump" lasers, and McCall says that the extra light beam might be used to "twiddle" energy levels of the optical transistor. He adds, however, that the experiment has not yet been tried and that the whole phenomenon is too new to predict definitely the outcome of future experiments.

Bell scientists also declined to speculate on possible eventual uses or forms of the optical transistor, but some directions for research seem obvious. If optical transistors are ever to be used with the fine, hair-like glass fibers now being developed for communications systems, a miniaturized, solid-state version must be invented. Again, lasers have passed through a similar evolution, taking somewhat more than a decade to change from bulky experimental devices to tiny machined crystals the size of a salt grain.

The rewards of such an extended research effort could be very great, however. In theory, optical transistors could remove the need for the external wires and electronic components that have retarded development of miniaturized integrated optical circuits. Such circuits would have great information-carrying capacity and might respond more quickly than existing electronic counterparts. Thus, if optical transistors can evolve into practical devices that control the information passing along one light beam using only the energy from another, a whole new generation of communication and data-processing circuitry could be created. □

Marijuana: Possible use as medicine

"Smoke two of these and call me in the morning." Prior to its outlawing in the 1930's, marijuana was often prescribed for its calming and sedative effects. Now there are indications that the socially frowned-upon drug may once again be found useful by the medical profession. Researchers have found marijuana to be an effective medication for controlling vomiting and nausea and for stimulating the appetite.

Such findings might be of relatively minor importance if it were not for the fact that there is a legitimate need and use for such a drug. Vomiting, nausea and loss of appetite are among the serious side effects frequently experienced by cancer patients undergoing certain types of chemotherapy. Since control of this condition with traditional antiemetics is not always successful, a more reliable drug is needed. And according to a report in the Oct. 16 NEW ENGLAND JOURNAL OF MEDICINE, marijuana might be that drug. The research was conducted by Stephen E. Sallan, Norman E. Zinberg and Emil Frei of the Peter Bent Brigham Hospital and Harvard Medical School.

Twenty-two cancer patients took part in the study. They were told they would receive either a placebo or a marijuana-like drug. THC, the active ingredient in marijuana, was administered in capsule form. Patients received it or a placebo two hours before and two and six hours after treatment with antitumor drugs. The placebo had no effect, but in 70 percent of the cases when THC was given an antiemetic effect was observed. In five of the patients the response was complete. The vomiting and nausea that had been moderate to severe when the placebo was given was completely avoided when THC was used.

Of the patients who received THC, 81 percent experienced the type of "high" usually reported by marijuana smokers. Two of the patients reported adverse effects. One had visual distortions lasting a few seconds, and the other reported visual hallucinations of 10 minutes duration and a depression of several hours.

Patients on THC became high 20 to 60 minutes after taking the capsule and remained high from one to five hours. In most cases, the nausea did not appear as

long as the high lasted. When the high did wear off between doses the nausea and vomiting began. This, say the researchers, may be due to the manner in which the marijuana was taken. Smoking the drug, they suggest, might be a more efficient method of administration because it gives the patient greater control over the dosage and makes it easier to maintain the high.

The fact that marijuana has a calming effect is certainly not news. The fact that a therapeutic use for marijuana is being reported in a medical journal is, however, somewhat of a departure. For years, legal and social strictures have kept physicians from prescribing marijuana, and bureaucratic entanglements still make it difficult for researchers to thoroughly investigate the drug. But these facts do not completely explain the one-sided stance the medical profession seems to have taken against a drug that has long been known to have possible therapeutic effects.

Zinberg offers another possible explanation. He told SCIENCE NEWS that, "Generally speaking, doctors have taken quite a hard line against illicit drugs, and this may be basically out of self interest." Illicit drugs do not come under their control, he explains, and doctors may fear losing their privileges to grant or withhold drugs. A physician, for instance, might warn a patient against marijuana or cocaine and then turn around and prescribe tranquilizers. This situation is irrational, says Zinberg, whose "basic contention is that drug abuse is prevented by social control, not by legal control." In other words, people must learn how to use or avoid drugs. And they can best learn with the help of valid inputs from the medical profession. Zinberg and his colleagues hope that the work they have done with marijuana and cancer patients will lead to a more open-minded approach to the study of illicit drugs. The fact that cancer patients were involved, of course, helps. Any therapy (even one involving an illegal substance) that alleviates their suffering is likely to be taken seriously. And as they say in their carefully-worded study, this research "deserves being reported."

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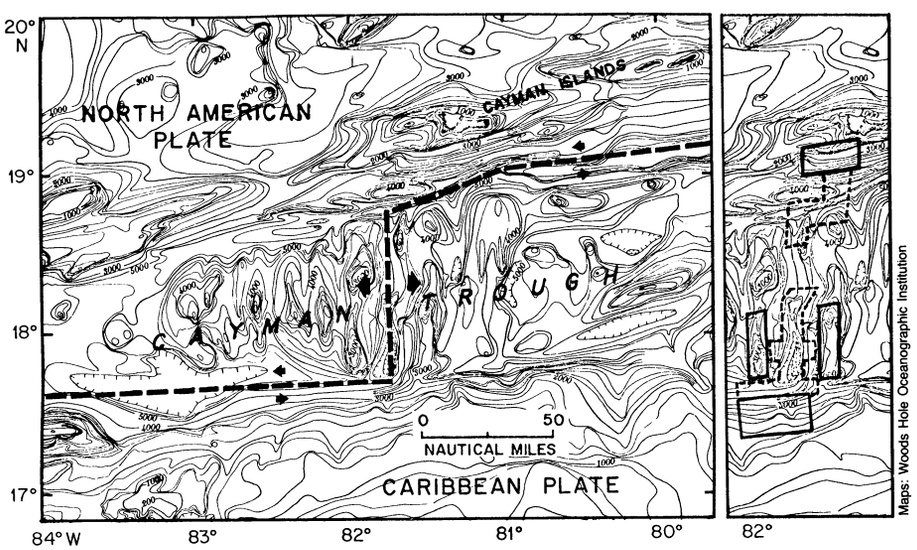
Changing attitudes toward marijuana continue to be apparent in several areas. The Domestic Council Drug Review Task Force has now suggested, in a white paper for the President, that Federal drug strategies and priorities might have to be changed to meet current needs. "The task force recommends that priority in Federal efforts in both supply and demand reduction be directed toward those drugs which pose a greater risk to the individual and to society—heroin, amphetamines (particularly when used intravenously), and mixed barbiturates—and toward compulsive users of drugs of any kind." Cocaine, the task force finds, ranks relatively low in seriousness as an individual and social problem. Marijuana, the task force concludes, is the least serious on all counts of any of the currently abused drugs. □

Return to the deep: The Cayman Trough

Following the success of Project FAMOUS's exploration of the Mid-Atlantic Ridge (SN: 8/24/74, p. 118), a second major manned deep-sea expedition is preparing to visit a vast ocean-bottom chasm believed to lie on the juncture of two of the major plates of the earth's crust. Unlike FAMOUS (the French-American Mid-ocean Undersea Study), which probed the floor of the chilly North Atlantic near the Azores, the upcoming effort will plumb the Caribbean to study a monumental canyon known as the Cayman Trough.



Map shows Cayman Trough region (contours in meters), while inset (right) shows route plans for Alvin (solid line) and Trieste with surface-ship Knorr (broken line).

The Cayman Trough is thought to be bounded by the North American Plate on its northern side and by the Caribbean Plate on the south. It was chosen, says a researcher with the Woods Hole Oceanographic Institution, which is directing the scientific aspects of the project, because it is the only plate boundary besides the Mid-Atlantic Ridge that has been studied in enough detail to give confidence that it contains an accessible "spreading center." The floor of the trough, more than four miles below the ocean surface, contains part of the boundary along which the two plates are slowly moving apart, in the inexorable shiftings of plate tectonics.

The other key word is "accessible," a matter of logistics (the project will be based in Jamaica), weather and simply the exposed nature of the evolving rift. The first human beings to actually visit the trough will be encapsulated within Woods Hole's titanium-hulled super-minisub Alvin (a major contributor to Project FAMOUS), now scheduled to make its dives in January and February of 1976. But Alvin will not be able to reach the deepest parts of the huge fissure. That task will have to wait a year until the U.S. Navy bathyscaphe Trieste can join the program.

Before either craft can get down to work, however, much more detailed mapping of the site is necessary, both because of the hazards of the tricky terrain and to be sure of getting the most from the two submersibles' finite exploration range. Early next month, the Navy's sophisticated survey ship Wyman will set out from Florida to do the job, equipped with elaborate navigation and positioning aids and a 90-channel bottom-sounder capable of profiling the sea floor in detailed swaths as much as two miles wide.

Accurate positioning will be equally important for the submersibles themselves, so that their measurements can be precisely placed on charts of the ocean bottom. To give the two submersibles a common navigational reference system, Alvin's position-recording system (which logs locations relative to sounding buoys on the sea floor) will be transferred to Trieste before the bathyscaphe begins its descents.

The major differential movement between the two crustal plates may be a sideways displacement, with the North American Plate having shifted westward relative to its southern neighbor. Most of the dives, however, will be concentrated along a north-south jog in the plate boundary, where this longitudinal motion has apparently caused a pulling-apart. Alvin, equipped with lights, cameras and a sampling arm, will spend much of its time exploring the exposed strata of the vertical trough walls and the plateaus connecting them, accompanied from above by its support ship Lulu and Woods Hole's research vessel Knorr. It will remain for Trieste to get to the bottom of the matter. □