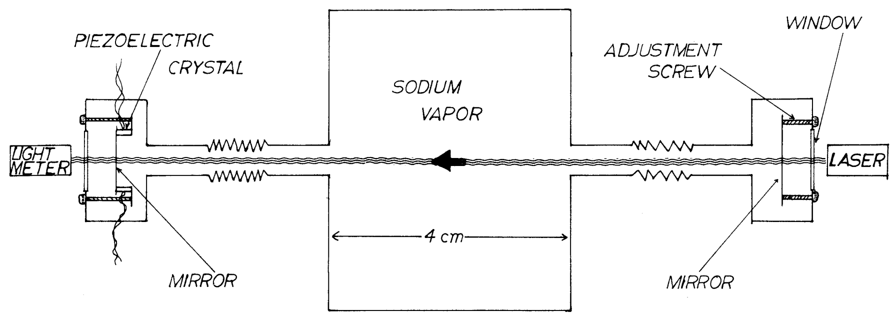
First optical transistor demonstrated



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 lightbeam 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 anti-emetic 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