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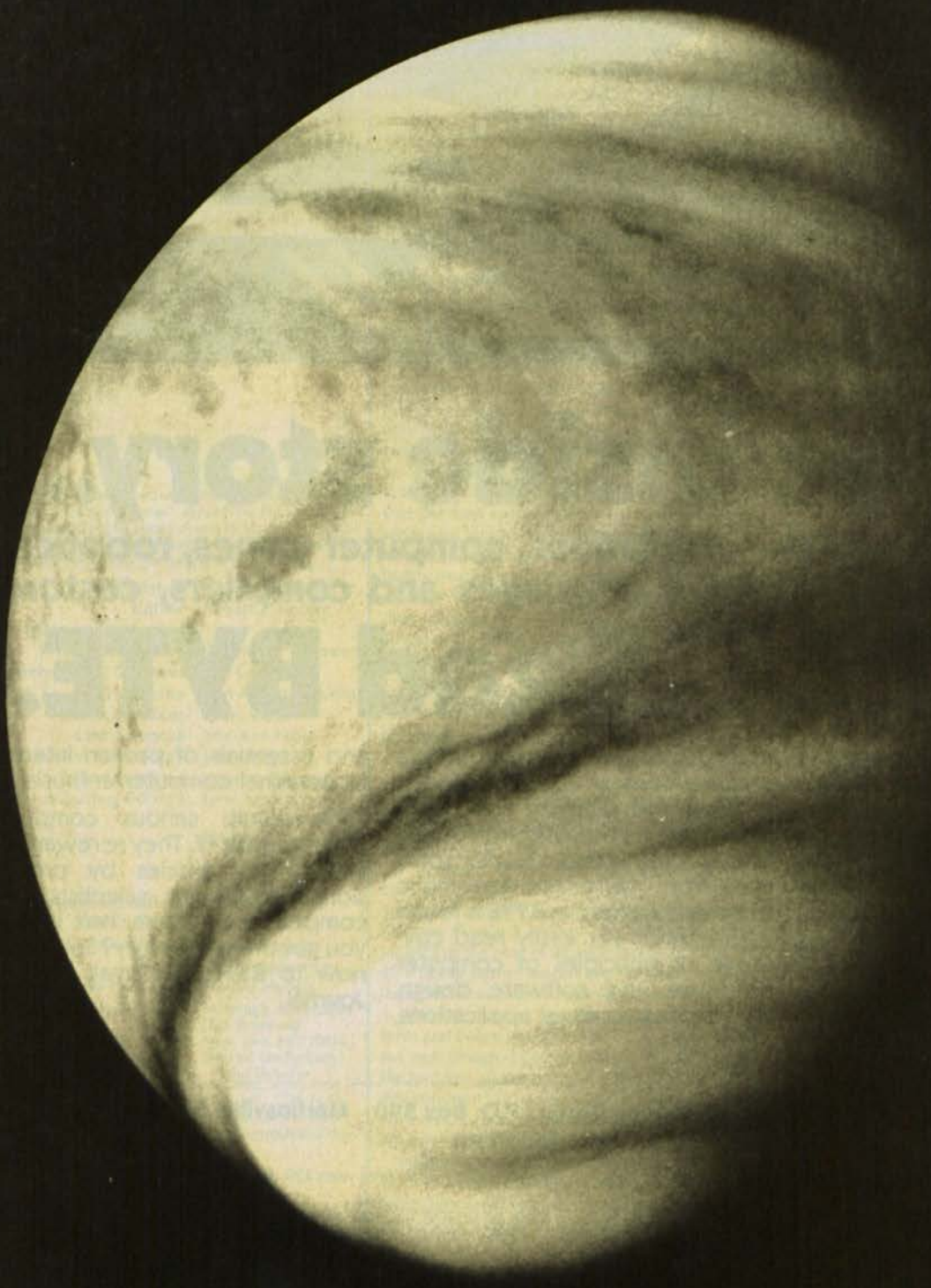
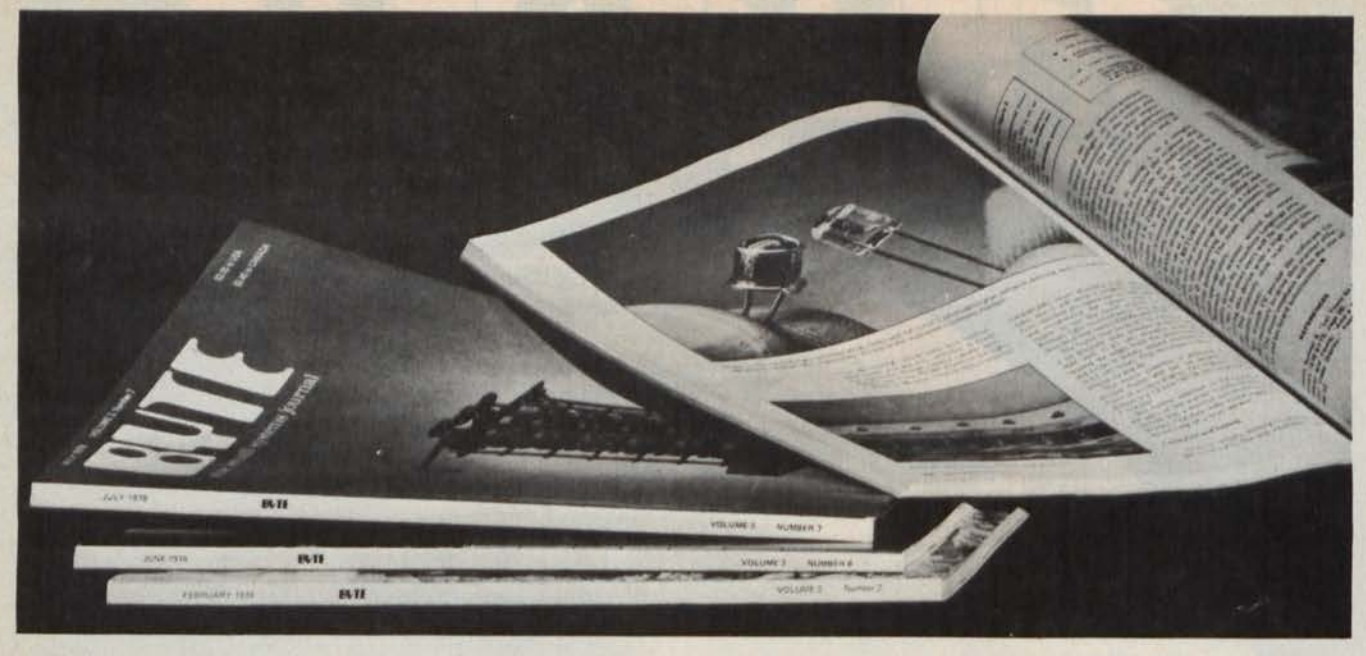


VENUS



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COVER: The planet Venus, recorded in ultraviolet light by the "cloud photopolarimeter" aboard the Pioneer Venus orbiter now circling the planet. A wealth of detail shows in what was once considered a mere featureless fluffball. For more details, see p. 100. (Image: NASA)

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LETTERS

Refining the voiceprint

Use of voiceprints to enable the deaf to understand speech (SN: 1/13/79, p. 20) requires the viewer to perform two transformations simultaneously: from voiceprint to phoneme and from phoneme to word. The task would be much easier if symbols (rather than voiceprints) representing the successive phonemes were displayed. Such symbols, easy to learn and having an invariant one-to-one relationship with the phoneme, would impose far less burden on the user. Technology for phoneme recognition is available from several companies at reasonable cost.

The past few seconds of phonemes should be displayed at any time to allow for blinks and other distractions. Either a sweep or a display updated once a second or so could provide this desired short-term storage.

Educated adults can read prose or comprehend speech several times as fast as it is usually spoken. Hence, some additional task effort can be imposed on educated adult viewers of a visual display representing continuous speech. The additional effort required for voiceprint interpretation appears to be such that the task can barely be accomplished by a virtuoso (Victor Zue). By providing a display containing phoneme symbols that can easily be highly overlearned, the system could serve not just the virtuosos, but the substantial fraction of deaf viewers whose reading comprehension speed is at least a notch faster than the spoken speech being processed.

Edwin Cohen, Ph.D.
Binghamton, N.Y.

Differing dietary needs

We are being taught that diet affects our resistance to heart disease and cancer. We are shown the low-cholesterol and high-fiber diets of other populations as if to say they should be models for our own.

I question the assumption that all peoples can best subsist on the same diet. I think we must also account for difference in climate and lifestyle. Surely a human being living for nine months of the year at an average temperature of 45°F needs more calories and fat than someone living at an average temperature of 70°F.

With reference to the article "Dietary cholesterol and colon cancer" (SN: 1/20/79, p. 37), can we not design experiments to accommodate the fact that all people do not live in an identical environment? Could we simulate and correlate various conditions of temperature, altitude and activity?

I think we may well be on the right track when we link our daily habits with our resistance to many illnesses, but I think it is false to assume that everyone's dietary needs are identical.

Jane Worley
Silver Spring, Md.

Nuclear benefits vs. risks

Janet Raloff's article "Radiation: Can a Little Hurt?" (SN: 1/20/79, p. 44) clearly implies that the radiation levels from commercial exploitation of nuclear radiation sources, including nuclear energy, pose no threat to the health of the public. Perhaps all statisticians and health physicists may eventually agree that low-level radiation does increase the risk of cancer. However, the public health threat from low-level radiation seems minuscule if it requires a "brilliant mathematician" to develop a new mathematical technique in order to identify a very small increase in the number of cancers over that which would be expected among a large population, had the population not been exposed to low-level radiation. Furthermore, not everyone agrees with the validity of the inferences drawn by some epidemiologists from low-level radiation studies, despite the application of sophisticated mathematical statistics.

When viewed in the perspective of all the risks of daily living, including social and economic considerations as well as health considerations, it seems that the benefits from utilization of nuclear technology for medical purposes, energy production and other useful applications far outweigh the postulated but not yet accepted health risks from such applications.

Herman Cember
Evanston, Ill.

Precession changes

In the article on ice ages (SN: 1/13/79, p. 22), reference is made to an earlier article (SN: 12/4/76, p. 356), which attributes ice ages to orbit changes. One of these orbital changes referred to is a precession change with a period of 23,000 years. However, I have yet to see an explanation of the discrepancy between the geological figure of 23,000 years and the astronomical value of 25,725 years.

Lee T. Shapiro
East Lansing, Mich.

(James D. Hays of Lamont-Doherty Geological Observatory replies that the term precession includes a number of different measurements taken from different astronomical reference points:

"The precession cycle with respect to the stars has a period of 26,000 years. However, what is climatically important is the season of the year the earth reaches Perihelion [closest to sun] or Aphelion [farthest from sun]. Since the major axis of the earth's orbit is cycling in the opposite direction to the precession cycle with its period being about 96,000 years, the time between successive Perihelions or Aphelions at the same time of year is less than 26,000 years. Over the time period we studied [the last 500,000 years] it averaged 23,000 years." —Ed.)

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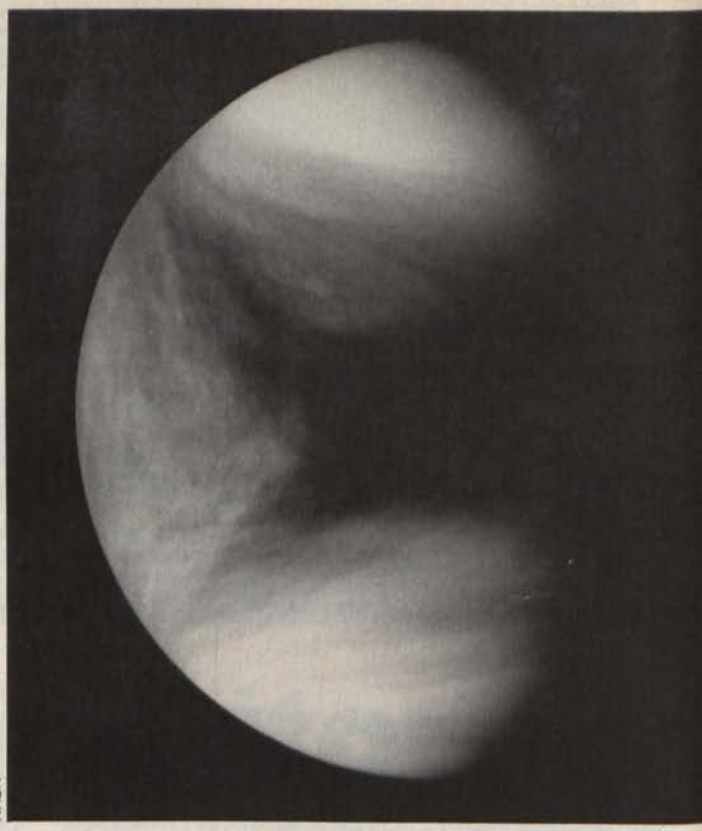
Pioneer's Venus: Sizzle and Crack



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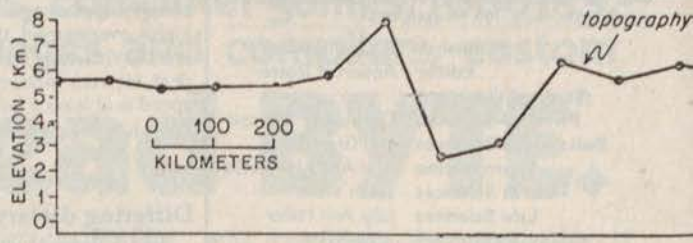


Venus by ultraviolet light shows dark absorption features such as the horizontal "Y" shape also seen by Mariner 10, but the Pioneer Venus orbiter's recurring view reveals that the "Y" actually moves through *the subsolar point rather than being locked to it. Other features (see cover) include bright sub-polar rings, extensive "cellular" features suggestive of convection cells, numerous bow-like waves and linear features, some of them nearly disk-wide. Radar-altimetry trace (at right) shows what may be major tectonic rift on the surface.*

The Pioneer spacecraft now orbiting Venus is barely a fourth of the way through its 243-day mission of studying the planet from on high, yet the venture has already received the NASA go-ahead to try for 243 more. And when the project's Science Working Group reconvened at NASA's Ames Research Center in California last week to discuss its rapidly evolving findings (from five atmosphere probes as well as the orbiter), it seemed clear that Venus has more than enough wonders to fill the extra time.

The planet has now shifted to where the lowest point of the orbiter's path (which has gotten as close as 142 kilometers to the ground) is on the nightside, and night has turned out to be just the place for checking out a spectacular claim from two recent Soviet Venera missions.

Frederick Scarf of TRW, Inc., at first thought that ionospheric absorption would forever keep his orbiting electric-field detector from being able to confirm reports from the Soviet landers that numerous intense lightning flashes were blitzing the planet (SN:1/6/79, p. 4). Venera 11 reportedly detected as many as 25 lightning impulses per second during its descent, and Venera 12 is said to have noted 1,000 impulses between the altitudes of 11 and 5 km. The radio emissions caused by such zaps might well have been blocked by the ionosphere from reaching the orbiter, but, says Scarf, the nightside ionosphere turns out to be punched full of "holes" — low-density regions — that let the signals through. "We don't have *proof* that this is lightning," he says, but the signals began showing up as soon as the orbiter began getting low over the nightside, and their spectra are consistent with lightning-triggered "whistlers" propagating through a thinned ionosphere to the instrument. Still a mystery, unfortunately, is a Soviet report of a *loud* (82 dB) audio signal, possibly thunder, picked up by one of the landers 32 minutes after touchdown.

Another nightside mystery, reported by the two Pioneer Venus probes that went down in darkness, was a "glow" detected during the last 12 to 20 km of their descent. The answer may result from improved understanding of the atmosphere's exotic chemistry, or it may take some future spacecraft. At least one of the project's scientists, however, believes that some kind of atmospheric luminescence is more likely than suggested "chemical fires" on the surface, since the light would have to be bright indeed to be seen so high up.

One of the orbiter's major instruments has had major problems, but they seem to have been largely resolved, and even the earliest results are dramatically intriguing. A ground-scanning radar apparently began malfunctioning during the orbiter's 14th revolution, but data from the previous 13 revs have indicated what Gordon Pettengill of Massachusetts Institute of Technology believes may be an immense tectonic crack in the planet's surface. The 250-to-300-km portion of the feature seen by the orbiter showed as much as 7 km of vertical relief, putting the feature more in a class with titanic Valles Marineris on Mars than with earth's comparatively tiny Grand Canyon. This week, the radar will begin passing over a region known as "Beta," which earth-based radar studies suggest may include a 700-km-wide shield volcano bigger than any other known in the solar system.

Pioneer Venus is basically an atmosphere-oriented mission, however, and a key question is what makes Venus so hellishly hot, considering that it actually absorbs less solar energy than does the earth (98 percent is reflected away by the atmosphere). The leading candidate is the much-cited "greenhouse effect," in which incoming sunlight is converted to longer thermal wavelengths that cannot escape the atmosphere. The planet is so much hotter than could be explained by an ordinary greenhouse effect, however, that the Venus version must be particularly efficient, sealing off almost every wavelength "window" to space. The atmosphere's dominant carbon dioxide does much of the work by sheer numbers (about 96 percent), but that may not be enough. A vital 0.1 percent may be due to water vapor, says James Pollack of NASA Ames, with a surprising—and important—0.02 percent from sulfur dioxide. "If it weren't for the SO_2," says Pollack, "I would start to become pessimistic." But with its help, and that of heat-absorbing particles in the clouds, "the greenhouse effect does seem viable."

Perhaps the largest and most difficult question despite — or because of — the new data is that of the atmosphere's (and thus to a large extent the planet's) evolution. Although various orbiter and probe instruments disagree about precise amounts of key elements such as primordial argon 36, that and other noble-gas isotopes (neon 20, krypton 84) are substantially enriched over the earth's proportions — yet reactive volatiles such as carbon, oxygen and nitrogen are not. Says University of Michigan's Thomas Donahue, "I can't imagine why." Stay tuned. □

Smog and emotions: NO 2 ways about it

The effects of high levels of air pollution on respiration and other physical conditions are well known. Now, some of the first published data on a possible link between pollution and emotional disturbances have been reported in the February American Journal of Psychiatry.

For a 149-day period in the summer and fall of 1972, researchers in St. Louis recorded mean daily levels of various pollutants, including carbon monoxide, nitrogen dioxide and nitrogen oxide. Those figures were then matched against the daily number of emergency room visits and inpatient admissions to Malcolm Bliss Mental Health Center, a psychiatric hospital serving the population of St. Louis. Patients were then categorized according to their diagnoses.

The results have yielded some intriguing possibilities. "It appears from our data that certain psychiatric conditions may be sensitive to specific air pollutants," report Meir Strahilevitz and Aharona Strahilevitz of the Bliss Center (both now at the University of Texas Medical Branch in Galveston) and John E. Miller of the Southern Illinois University School of Medicine. Moreover, they found that at least one pollutant, NO, may have a *positive* effect on specific conditions.

The findings indicate that on days when NO_2 levels are high, a corresponding rise is seen in total emergency room visits and inpatient admissions of persons with nonpsychotic or unknown diagnoses. And CO is also associated with increased emergencies. In addition, "It is possible that patients with diagnoses of alcoholism and organic brain syndrome are particularly sensitive to the level of NO_2 in the air, since these two groups showed correlations that approached significance," say the researchers, who caution that such correlations may not necessarily "indicate a causal relationship."

Perhaps more significant, those groups who appeared to be adversely affected by NO_2 showed a negative correlation with NO levels — indicating a possible positive effect. "The protective effects of NO on the damaging biological effects of NO_2 are known," say the researchers. "NO is a known anesthetic and also has analgesic qualities.

"Our data suggest that it may be worthwhile to evaluate the possibility of a therapeutic effect of low levels of NO on certain psychiatric illnesses, in particular alcoholism and organic brain syndrome," they conclude. □

Human clones: Partially achieved?

Last spring a book was published in which it was claimed that a millionaire, with the aid of scientists, had created an infant in his exact genetic image — the first cloned human being. The book caused a public uproar because of the ethical questions surrounding such an experiment and also because few scientists believed the book was based on fact. Author David Rorvik refused to document his assertions or to give the names of the scientists involved in the alleged cloning, and there had never been, up to that time, any concrete evidence of cloning of any vertebrate, much less a human (SN: 3/18/78, p. 164).

But the cloning hoopla is just warming up, it seems. A successful first step in the cloning of a human is reported in the Jan. 15 American Journal of Obstetrics and Gynecology by Landrum B. Shettles of Gifford Memorial Hospital in Randolph, Vt. Many scientists, however, are as skeptical of this claim as they were of Rorvik's book, primarily because Shettles has been embroiled in controversial frontier medical research more than once. He left New York City's Columbia-Presbyterian Medical Center after a dispute over his attempt to help a couple conceive a test-tube baby (SN: 7/22/78, p. 51). In 1970, with no less a co-author than Rorvik, Shettles published a book telling couples how to conceive children of the desired sex. Nonetheless, if Shettles has really done what he claims, it would be a feat unprecedented in reproductive biology (assuming, of course, that Rorvik's cloning claim was more fiction than fact).

In his article, Shettles describes experiments conducted on germ cells taken by permission from women undergoing a variety of gynecological procedures and from men undergoing testicular surgery. Specifically, eggs were withdrawn from the follicles of women operated on near the time of their ovulation and incubated in follicular fluid. After about three hours it was possible to remove the zona pellucida (outer layer) from the eggs, to detect polar bodies in them (signaling that an egg is ready for fertilization) and to draw nuclei (genetic material) from the eggs. This left eggs intact but without their nuclei.

The next step in cloning would be to replace the nuclei with genetic material from the person to be duplicated. For this, Shettles used spermatogonia — precursors of sperm cells — from the testes of male volunteers. Spermatogonia were used because they are less active than mature sperm cells. Shettles isolated nuclei from the spermatogonia and inserted them into the denucleated eggs. He reports that, of his many attempts, three sperm nuclei transfers were successful and resulted in fertilization of eggs and egg division to the multi-celled blastocyst stage (the stage at which an egg fertilized the usual way would leave a woman's fallopian tube and become implanted in the womb). Although Shettles discontinued his experiments at this point, he says that "there was every indication that each specimen was developing normally and could readily have been transferred in utero [into a womb] ...," to continue on into development of a human containing genetic material exclusively from a male sperm donor.

Shettles's paper leaves some important questions unanswered, though. As Luigi Mastroianni Jr., chief of obstetrics at the University of Pennsylvania Medical School and head of one of the leading test-tube fertilization labs in the United States, points out, mature eggs can be obtained from women only after careful monitoring of their ovulatory cycle, and there is no evidence from Shettles's paper that Shettles did that. A Northwestern University Medical School researcher raises another objection. A blastocyst would have to be analyzed to determine that each of its cells contained chromosomes matching those of the donor male before Shettles could really prove that the blastocyst was the start of a clone. Shettles does not mention such an analysis in his article. Nor does the article make clear or even speculate how a nucleus from a precursor sperm cell might have fertilized an egg without a nucleus and thus have led to egg cell division. In normal fertilization, a sperm cell enters an egg, its nucleus merges with the egg's nucleus, and chromosomes present in both nuclei merge. The egg then divides into two cells, four cells and so on, and each cell contains genetic material from both sperm and egg.

Whether Shettles has done what he purports, of course, will rest not only on confirmation of his technique by himself, which he is now seeking, but what is more crucial, on confirmation by other researchers using his technique. □

Test-tube baby funding

Because test-tube babies are now a reality, a U.S. Department of Health, Education and Welfare Ethics Advisory Board, which had halted HEW funding of human test-tube experiments in 1975, reconvened last fall to decide whether HEW should fund such research after all. From September through November, the 14-member board heard testimony pro and con from a parade of witnesses (SN: 9/23/78, p. 212). Earlier this month the board agreed that HEW should support animal *in vitro* fertilization research. And on March 16 and 17 the board will decide whether or not HEW should underwrite human test-tube procreation efforts.

The board is particularly concerned about whether HEW should fund the creation of human test-tube embryos solely for research purposes, since Pierre Soupart of Vanderbilt University, a leading *in vitro* fertilization scientist, is seeking HEW funds for such experiments. □

Target of the error in myasthenia

Misdirection in the ranks of the body's defense system produces debilitating autoimmune diseases. In the case of myasthenia gravis, where antibodies attack the receptors necessary for normal communication between nerves and muscles, the problem appears to be compounded by a case of mistaken identity. Crispin B. Weinberg and Zach W. Hall report that the destructive antibodies in myasthenia gravis seem to be specifically targeted to a receptor primarily present in embryonic muscle. But because of the similarities between embryonic and adult forms, receptors at adult nerve-muscle junctions are destroyed.

Extrajunctional receptors are scattered along the surface of embryonic muscle. Junctional receptors are tightly packed in the areas where a nerve contacts adult muscle. The two receptors act somewhat differently, but are identical in most structural aspects so far examined. The work of Weinberg and Hall, in addition to adding a clue to the puzzle of myasthenia gravis, provides evidence that the receptors differ in composition (rather than just in their placement) and gives a tool for distinguishing them further.

Patients with myasthenia gravis suffer from a shortage of receptors for the neurotransmitter acetylcholine at the nerve-muscle junction. A few years ago several research groups demonstrated that blood sera from the patients contain antibodies to receptors. Daniel Drachman and collaborators at Johns Hopkins University found that if serum from a myasthenia gravis patient is injected into a healthy mouse, the animal develops the muscular weakness that characterizes myasthenia.

Weinberg and Hall, in work at the University of California in San Francisco, have now examined the reaction of patient sera to purified samples of extrajunctional and junctional receptors. Each patient's serum contains a collection of antibodies that bind to specific regions of target molecules. The investigators found sera reacted more strongly with extrajunctional receptors than with the junctional form. Experiments in which receptor molecules compete for limited antibody showed that some antibodies bind to both receptors, some bind only to extrajunction receptors, but no detectable antibody from myasthenia serum binds only to the junctional form. Hall and Weinberg thus deduce the antibody collection is tailor-made to extrajunctional receptors.

The implications of this finding for the perplexing origin of myasthenia gravis are not obvious. "It appears to be a clue, but we're not sure to what," Hall says. He speculates that myasthenia gravis, which generally appears in adults, may involve the reappearance of immune system cells that were incompletely suppressed early in life. The immune tolerances probably are worked out before junctional receptors have supplanted the embryonal extrajunctional receptors. Alternatively, the antibody specificity may be a clue emphasizing the role of the thymus in the disease. Many myasthenia gravis patients have thymus abnormalities, and thymus removal is sometimes an effective treatment. The adult thymus contains cells resembling embryonic muscle, and those cells may have extrajunctional receptors. It is even possible, Hall says, that myasthenia gravis victims have extrajunctional receptors at their nerve-muscle junctions.

The results of Weinberg and Hall, published in the January PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, offer a tool for further exploration of the distribution of the receptors. Because there is at present no method for easily identifying the receptor types in the membrane, no one knows, for instance, whether normal adult muscle has a low concentration of extrajunctional receptors. To obtain specific antibodies that recognize extrajunctional receptors, Weinberg and Hall are now selecting patient sera that discriminate strongly between the two receptor forms and are also making monoclonal antibodies (SN: 12/30/78, p. 444) against the receptors. With an antibody that binds to only one receptor type, investigators could address such questions as at what point in development junctional receptors take over and whether there are ever extrajunctional receptors at the junctions. The researchers suspect that an enzyme converts extrajunctional receptors to the junctional form, but no laboratory treatment so far has mimicked that transformation. □

Drug therapy without peaks and valleys

The traditional means of administering medicines ("take two tablets four times a day") yields fluctuating levels of the drug — slight overdose, effective level, underdose, slight overdose, and so on — as the medicine is taken, wears off and is taken again. These variations are even more exaggerated when a patient takes medication irregularly.

A solution to the drug roller coaster effect is to develop devices that provide a constant dose. A device that gradually provides medicine over a long period allows little chance for the patient to make mistakes. John Urquhart of Alza Corp. in Palo Alto, Calif., described some such devices to the National Academy of Sciences conference, Pharmaceuticals for Developing Countries (SN: 2/10/79, p. 86).

The Food and Drug Administration recently approved a device that sticks, like a Band-aid, behind the ear and delivers, through the intact skin, a drug effective against motion sickness. Scopoline administered this way was more effective than dramamine in tests on people in a Navy wave-simulating hydraulic oscillator, which Urquhart describes as "an elevator run amok." Scopoline taken orally frequently causes intolerable side effects, but the constant level of drug that diffuses out of the adhesive device is too low to cause those problems.

One constant-dose therapeutic system is already being marketed by Alza. It is a reservoir of antiglaucoma drug, pilocarpine, enclosed by a membrane. The reservoir floats on tear film in the patient's eye, while the drug gradually diffuses. Investigators are now working on other devices for eye diseases, including one that provides a constant dose of antibiotic.

Antihypertensives and antiasthmatics are also among the systems Alza has in the works. The controlled dose response allows them to re-examine old drugs, which might have been rejected because of side effects that are now avoidable. Urquhart says they have developed an intrauterine contraceptive device that delivers 65 micrograms of progesterone daily for 400 days. Currently Alza is working jointly with the National Institutes of Health and the World Health Organization on an injectable polymer that would deliver a systemic contraceptive. □

Smoking *is* dangerous

The mountains of statistical evidence linking cigarette smoking to higher death rates, particularly from coronary heart disease, continue to be challenged by critics who suggest that the data do not prove that smoking shortens life span. Any number of other causes might contribute to a higher death rate among persons who happen to smoke, they argue. But in an 11-year follow-up study of 4,004 men and women, researchers from the Kaiser-Permanente Medical Care Program in Oakland, Calif., report that smoking indeed appears to shorten life span. The study, in the Feb. 1 NEW ENGLAND JOURNAL OF MEDICINE, accounts for 48 other individual and environmental characteristics among the 35- to 54-year-old subjects. The results "failed to eliminate the association of smoking with mortality" from all causes and specifically, heart disease, report Gary D. Friedman, Loring G. Dales and Hans K. Ury. The adjusted data still showed death rates significantly higher among smokers, as compared with nonsmokers. "This analysis did not support the counterhypothesis that the association of cigarette smoking with mortality is secondary to some underlying characteristic," say the researchers. □

Something wrong under the sun

Lately Chicken Little has been concentrating on keeping track of Skylab. She goes in fact from artificial satellite to UFO to meteorite to comet to the planet Jupiter and back again, but for the last ten years she has consistently failed to take note that the sun might fall. If the sun should fall, metaphorically and theoretically, that is, the destruction in astrophysics would far outreach the loss of fish if Skylab were to plunge into Lake Ontario with a thunderous hiss. Astrophysicists' whole basic notion of how stars generate energy would have to be redone.

Such a fall of solar theory seems imminent. An experiment that has been measuring the flux of neutrinos from the sun for the last ten years indicates that something is drastically wrong. Basically, the chain of thermonuclear reactions by which energy is produced in the sun according to the "standard theory" should produce a certain flux of neutrinos as a byproduct. That flux is not being recorded. If standard solar theory doesn't fall, it seems standard neutrino theory must. The experiment is also based on that, especially the belief that neutrinos are not subject to radioactive decay and therefore all survive the 8-minute journey from the sun. If standard neutrino theory goes, the repercussions in particle physics could take an antitextbook to list. Experiments are being proposed to find out which is wrong.

The experiment now running, which has been a major effort of Raymond Davis and several colleagues from Brookhaven National Laboratory for the last 15 years can tell that something is wrong, but not what. It consists of a large tank (100,000 gallons) of the cleaning fluid perchlorethylene located deep in the Homestake mine near Lead, S.D. If a neutrino is captured by a chlorine 37 nucleus in the perchlorethylene, it changes that nucleus to a radioactive form of argon. The radioactivity of the argon is proportional to the flux of neutrinos that made it. The argon is flushed from the liquid by a carrier gas and taken away for counting. Deep burial is necessary. The process shields the apparatus from almost all other radiation that is not solar neutrinos.

When Davis first began reporting results, eight or nine years ago, they were upper limits and consistently too small. Davis and colleagues went back to watch some more. They watched for a decade, refining the results. Now they come up with "an actual number, not an upper limit," says John Bahcall of the Institute for Advanced Study in Princeton, N.J. It is 2.2 SNU. The experiment should see 6 or 7 SNU. (One SNU, solar neutrino unit, is defined as a neutrino capture per atom of target per second multiplied by 10^{-36}.)

The reaction of closely watching physicists is exemplified by R. S. Raghavan of Bell Laboratories in Murray Hill, N.J. "Looking for neutrinos from the sun's *core* is the first critical and direct test of the theory [which was built on evidence from the surface]. Much to our consternation, the experiment has failed to reassure us that the sun works in the way we thought it did." In case anyone wonders, Israel Dostrovsky of the Weizmann Institute of Science remarks: "The experiment is beyond reproach."

These are both men with the confidence to stake a large part of their own futures and propose expensive experiments to answer the questions raised. Davis's experiment was designed to be a simple and inexpensive way of finding a solar neutrino flux. It is sensitive to the most energetic neutrinos, those from the heavy element end of the solar thermonuclear chain, particularly those from boron 8.

Raghavan proposes to set up a kind of neutrino spectrometer using indium 115 as a detector. When the indium nucleus captures a neutrino, it emits an electron and turns into an excited tin 115 nucleus. After a few microseconds the tin loses its excitation by emitting a pair of gamma rays. The energy of the electron depends (beyond a small threshold energy) on the energy of the neutrino that produced it, so if the energy of the electrons can be measured, the device is a spectrometer. It may then be able to tell the flux of neutrinos from specific reactions in the chain. This could help distinguish among the several nonstandard models of the sun that have grown up recently, and with which Davis says his results agree. As he puts it, "These models postulate continuous mixing, high internal rotation, internal magnetic fields, and low heavy-element composition. All of these nonstandard models lead to lower internal temperatures, and consequently a lower production of ^{8}B neutrinos."

But suppose it's not the solar models. Dostrovsky, speaking for a group from the Weizmann Institute, Brookhaven, the Institute for Advanced Study, the University of Pennsylvania and the Max Planck Institute in Heidelberg, proposes a detector using gallium. When gallium captures a neutrino, it becomes germanium. This is a process sensitive to low-energy neutrinos, those from the basic proton-proton fusion process. Proton-proton fusion is in all solar models, so if those neutrinos don't appear, the conclusion would be that something is wrong with neutrino physics.

Right now Dostrovsky's group is working with small amounts to determine whether gallium or gallium chloride, solid or in solution, will be the best form of target. Eventually they will need 50 tons, which will cost about $20 million. The indium that Bell Labs is making into thin sandwiches with sheets of electron detector isn't cheap either, but the answers to these questions seem worth the price, and the gallium will be recoverable for other uses. □

Ethics law result: Some resignations?

Since many federal jobs require expertise found most readily in the private sector, government often "borrows" that expertise for a few years, leading many officials to pass through a so-called "revolving door" between employment in and out of government. To prevent conflicts of interest, laws were instituted 15 years ago to restrict the contact former officials could have with their old agencies and colleagues once they returned to jobs in industry and academia. But the laws aren't generally known since they weren't enforced. A new law that goes into effect July 1, and which will be enforced, expands restrictions on post-employment contact for certain science policymakers to such a degree that some are already considering resigning.

Born out of the era of Watergate and Korean-influence buying, the much-misunderstood Ethics in Government Act of 1978 applies in varying degrees to all federal workers. It requires detailed reporting of all outside income and disclosure of participation in organizations outside government. But it is changes in the revolving-door policy that worry high-ranking science and technical decision-makers most.

There are three tiers of restrictions. The first is a lifetime ban on contact between former employees and their agencies on matters with which they were personally and substantially involved. For example, if an official who wrote specifications for a laser to be developed by a specific company later joins that company and works on the contract, that employee can never represent the contract before the agency in any but technical matters. In addition, there is a two-year ban on aiding or assisting others in representing the contract. For instance, the employee can discuss the laser but not which former colleague is most partial to viewgraph presentations.

The second restriction is a two-year ban on employees representing others on matters once their official responsibility.

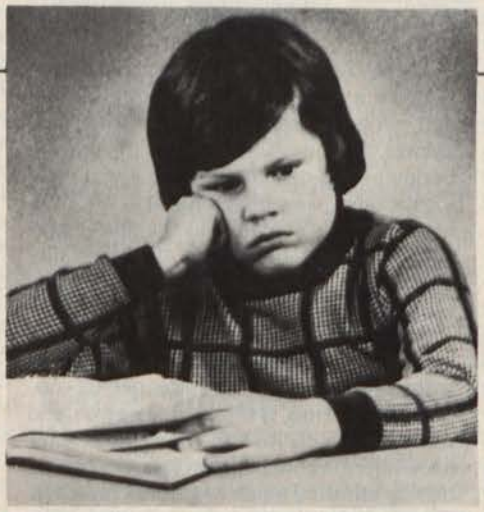
Both restrictions apply to all federal employees. At least initially, the third applies only to top-level policy-setting officials. It bans them from representing anyone before their former agency for one year.

The bans are to restrict unethical influence of policy or decisions based on inside knowledge of an agency or its personnel. At no time will bans prohibit the solely technical participation of an individual before a former employer.

A new Office of Government Ethics, created under the law, is already writing regulations to implement these rules. It is also working on a "plain English" interpretation of them, including examples, which it hopes to issue in a month. □

Can your child read these words?

napkin	fuzzy	liquid	punch	camel
misty	chicken	velvet	whisper	zigzag



Your child will learn how to read these and more than 300 other words after working with the *very first record* of The Sound Way to Easy Reading.

Try out this Phonics Course FREE FOR TWO WEEKS with your child in your own home — without risking a penny. Mail the coupon below.

If your child is a poor reader, if he has not been able to keep up with his class in school—here is a way that *you* can help him. Many parents have seen their poor readers gain up to a *full year's grade in reading skill* in just six weeks with the Sound Way to Easy Reading.

As soon as your child starts playing the records and using the charts of The Sound Way to Easy Reading you will know why it works so well. It takes the mystery out of learning to read because it teaches your child by the *phonics* method (the method by which most parents learned to read years ago).

Teaches with records

With this course your child discovers that letters have *sounds*. When he starts sounding out the letters he hears himself *saying* the word. He's *reading!*

The records *drill him in the sounds of the 26 letters of the alphabet* and their blends. By the time he completes the *first* record (about two weeks for the average child) he can read 300 words. After finishing all four records he has been taught 123 basic phonics sounds.

Once he knows these sounds he can read up to 85% of the words in the English language. It works for children of all ages—in the earliest grades and even in high school. Its records tell your child exactly what to do, so he can teach himself without any help from you.

Tested and Proved

In a pilot study by university psychologists, children gained up to a full year's grade in oral reading skill after only 30 lessons with The Sound Way to Easy Reading.

A semester-long study involving 214 pupils in four Chicago schools proved that the classes given The Sound Way to Easy Reading showed marked improvement in reading and spelling over the control groups.

Don't think it's all your child's fault if he hasn't learned to read. Many of our brightest children are not able to grasp some of the current methods taught in most schools today. Many educators insist that at least 40% of our children *must* have formal training in *phonics*—that they will never master reading without it!

These unbreakable records and self-quizzing cards can help your child gain a full year's grade in reading in just a few weeks.

Help Your Child Now

So don't wait for your poor reader to reach high school before coming to his aid. By starting your child on The Sound Way to Easy Reading now, you can change his entire attitude toward school—turn his sense of failure into the joy of success. Try it free for two weeks. You send no money—just mail coupon.

Bremner-Davis, Dept. P-207-IC
1512 Jarvis, Chicago, Ill. 60626

USED BY 500,000 PARENTS
who send many letters like these:

Advanced two years—"Your course has made my son *want* to read. No more frustration with words he doesn't know, he just concentrates and sounds them out. In 7 months, Steve's reading level advanced two years."
Mrs. R. Collins, Ft. Lauderdale, Fla.

Better report cards—"If I had known about your course before, Gregory would not have had to repeat 3rd grade. In only 7 weeks, he reads and spells much better, and is bringing home better report cards."
Mrs. R. Quinn, Cheektowaga, N.Y.

From D to A in 6 weeks—"Terry has made great progress in reading and spelling with your course. In 6 weeks his grade came up from D to A."
Mrs. Ed Marsh, Ladson, S.C.

IN 47,000 SCHOOLS
teachers are highly enthusiastic

Second grade—"Your course is the best teaching aid a teacher could have. I have been using it for the past 2 years for my basic second grade reading course. My class looks forward to the record quizzes. Their improvement in reading and spelling has been outstanding."
Mrs. Diane Williamson, Chickasaw, Ala.

Remarkable improvement—"I have seen my remedial groups advance 1½ to 2½ levels in reading in 6 months and show 85% to 90% improvement in spelling. A low achievement 6th grade group showed remarkable improvement. I have convinced many teachers in our school to use your course."
Mrs. Angus Bates, Los Angeles, Calif.

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Please send the Sound Way to Easy Reading, *on approval*. After 2 weeks, if I see encouraging results, I will send $5.75 as first payment and $5.75 each month for the next 7 months, only $43.00 plus postage and handling of $3.00. Or, save $6.00 by sending $40.00 total cash price. If not satisfied after first 2 weeks, I will return the course and owe you nothing.

Name _____

Address _____

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☐ TEACHERS: Check for prices and facts on Classroom Edition.

ENVIRONMENT

Unpaid costs of electricity

Electricity accounts for about 15 percent of the energy used in the United States. While consumers pay a regulated charge for each kilowatt-hour (kWh) they consume, there are a number of environmental and health costs in producing and delivering power that are not figured into one's bill. William Ramsay of the Washington-based Resources for the Future estimates these charges and the uncertainties associated with determining each in a 180-page report released last week: "Unpaid Costs of Electrical Energy — Health and Environmental Impacts from Coal and Nuclear Power."

What are the damages? For coal, each two trillion (10^{12}) kWh (an amount roughly equal to the total kWh generated from all sources in 1976) results in an estimated near-zero to 6,000 deaths from air pollution; near-zero to 1,250 deaths from occupational accidents and disease (such as black lung); 10,000 to one million cases of lower-respiratory-tract disease in children; 60,000 to six million cases of chronic respiratory disease; 600,000 to 60 million person-days of aggravated heart-lung symptoms in the elderly; and 100,000 to 10 million asthma attacks. From 100,000 to 200,000 acres of land must be reclaimed. In addition, the 1.6 billion metric tons of carbon dioxide emitted to the atmosphere during combustion could lead to a 0.001°C warming of the environment, Ramsay says.

Nuclear impacts for the same power are estimated to cause 20 to 200 deaths from occupational radiation exposures, 0.3 to one death from routine radioactive atmospheric emissions and 4,000 to 7,000 nonfatal accidents and illnesses. Some 20,000 acres are used in mining and processing, another 2,000 in storing wastes, and an unknown additional quantity for burying decommissioned plants and contaminated materials on reactor sites. These are for routine operation; the "worst possible accident" could result in another 48,000 deaths, Ramsay says — 3,000 from radiation poisoning, 45,000 from cancers. The threat of nuclear-weapons proliferation is another social cost.

Which is better? Society must choose, Ramsay says, because neither is clearly preferable. Nuclear impacts present the greater immediate threat; coal's are more gradual and regional.

Environmental quality declining

Despite many legislative and legal conservation victories, the quality of life in the United States, as measured by seven environmental indicators, has declined over the last 10 years, according to the National Wildlife Federation's tenth annual study. During the decade, only air quality improved. Forests held their own while the quality of water, wildlife, soil, minerals and living space has deteriorated, even over last year. Resources are rated as a percentage of what would constitute the "best possible environment," based on objective measurements and the judgment of a field of experts, NWF says. Forests got the highest rating — 75 percent — while water, at 33 percent, was ranked lowest.

NRC's nuclear nuggets

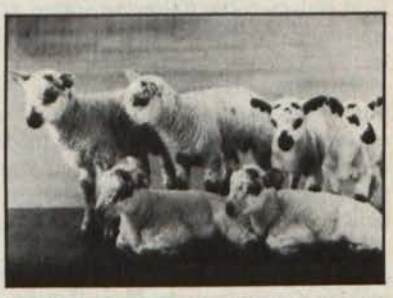
"The Nugget File" is what the Nuclear Regulatory Commission's Stephen H. Hanauer calls his personal, internal file on U.S. reactor accidents and deficiencies. The Union of Concerned Scientists unearthed it under the Freedom of Information Act and last week published a 95-page abstract of more than 100. Robert Pollard, formerly a nuclear-safety engineer for NRC and now a UCS staff scientist, edited them. "Nuggets" are "unadorned" except for paraphrasing (Hanauer's file was 12 inches thick), spelling out initials and abbreviations, and providing background on systems and components mentioned, UCS says.

ZOOLOGY

For twins: Cut the embryo in half

In most species of mammals, very young embryos will not survive if their thick, elastic envelope has been substantially damaged. S. M. Willadsen of the Animal Research Station in Cambridge, England, reports in the Jan. 25 NATURE a method for protecting early embryos after micromanipulation, and he describes his success in producing, with that technique, sets of identical twin sheep.

The recipe for twins involves collecting a two-celled embryo from a pregnant ewe, slitting open its coating and separating the cells by gentle passage through thin tips of glass pipettes. Willadsen then reinserts each cell into an empty coat and embeds the cells in a cylinder of gelatinous agar, like two cherries in a dessert mold. Each agar cylinder is transferred to the oviduct of a ewe for about four days. For sixteen out of twenty embryo pairs Willadsen recovered, both embryos had developed at a normal rate. In a few cases, an embryo degenerated or showed retarded growth. Willadsen next manipulated the normal embryos out of their agar mold and transferred each pair to another ewe. The final result was five single lambs and five sets of identical twins. Because the rate of embryo survival was just below that for transfer of ordinary sheep embryos, Willadsen concludes that each cell of a two-celled sheep embryo has the potential to develop into an entire lamb. He predicts that the agar embedding method will open the way for experiments manipulating early embryos of other species, such as the pig and the cow.



The privileges of being a fetus

A fetus in the uterus has special exemption from attack by the mother's immune system. Yet an organ transplanted from child to mother will usually be quickly destroyed. In experiments with rats and mice, researchers at the Weizmann Institute of Science in Rehovot, Israel, have found evidence for a two-phase embryo protection system that interferes with each major mechanism of the mother's immune system.

The special layer, the decidua, formed in the uterus to receive a fertilized egg, contains factors that depress maternal antibody production, Amiela Globerson, Sara Bauminger and collaborators find. The factors are not present in a nonpregnant uterus or other organs and tissues. The investigators are now working to isolate and identify the antibody suppressive substances. Lack of those substances may be a cause of certain forms of infertility and miscarriage.

Other researchers, Hans Lindner and Yacob Weinstein, have evidence that pregnancy thwarts the activity of thymocytes, the precursors of killer lymphocytes, which engulf and destroy foreign tissue and thus are responsible for tissue rejection. Lindner and Weinstein demonstrated that the hormone progesterone, which builds up in the fetoplacental unit, inhibits thymocyte proliferation. The mouse fetus itself has a progesterone-destroying enzyme in its thymus gland, the researchers find, so it could be protected against the high concentration of progesterone filtering into its bloodstream. The researchers suggest that antibody suppression may be particularly important at the initial stages of pregnancy and the thymocyte inhibition is the stronger protection later in fetal development. Mechanisms of immune suppression during pregnancy may give clues to how malignant tumors outwit the body's immune surveillance.

CLOSE ENCOUNTERS
All in the Mind?

Researchers using hypnosis have found surprising parallels between UFO "abduction" reports and hallucinatory sequences triggered by drugs or near-death experiences

BY JOEL GREENBERG

Jim, a 16-year-old high school student in Oklahoma, thought he may have seen an unidentified flying object in the fall of 1976. Although he did not seem to remember much about the incident, he soon began having nightmares about being watched and abducted, and about death. The following is an excerpt from his account, given under hypnosis, to psychologist H. Kent Newman the following spring at the University of Oklahoma Counseling Center:

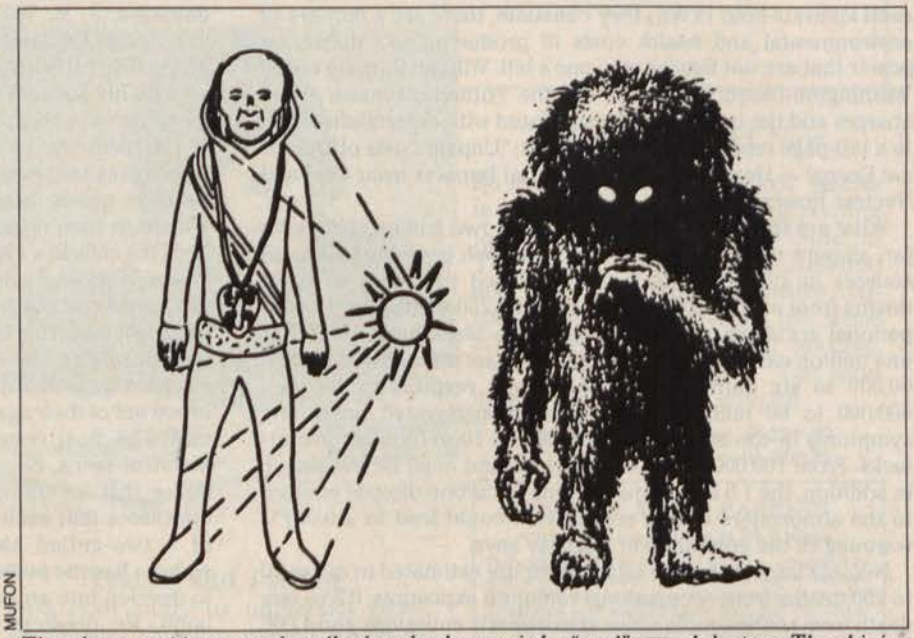
Jim: "Thursday night ... October ... October 18th. Walking into my room ... I relax myself before going to bed. I was meditating about 10 minutes, got up, did some pushups and situps then turned off my light ... it was about 11:30 ....

"I look outside my window at the sky and saw a light going 'round in the sky ... making a wavy pattern, near Polaris, and then it split into two lights ... and there is something in my yard. It was someone ... a peeping Tom? The dogs didn't bark and I got scared ... a gun, but it was in my grandad's room but I was too scared to get that.

"Then one walked to my window ... four feet away from me ... I take a step back ... just froze there, looking at it. It had two eyes like—long way from each other. Then I felt a numbness go over my body."

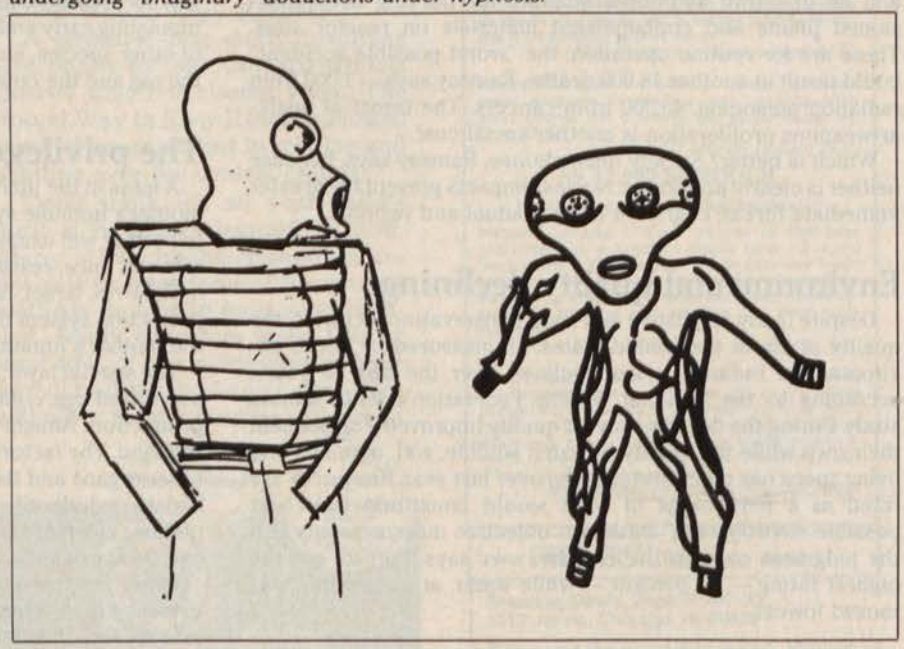
Jim went on to report that he felt "something electrical" going through him as three of the creatures approached. One held his arms while another placed a light to his forehead. He said he felt like he was dying and blacked out. When he came to, the creatures were dragging him along the ground to their ship, which was in a large ditch. He told of lying on a hard table with a light above it that seemed to be scanning his body. Two of the creatures lifted him and returned him outside; one of them again placed the light on his head and communicated that he was to forget this experience. He blacked out and woke up in bed again the next morning, recalling only seeing the lights in the sky and something looking through his window.

"I do not feel that Jim's report was a conscious attempt at a hoax," Newman, now at Southwest Montana Mental Health Center, told his colleagues at last August's American Psychological Association meeting in Toronto. "I feel that he experienced the events reported, but I do not know if they are real, a fantasy or a dream. But I feel he has honestly reported what he experienced."



MUFON

The above entities were described under hypnosis by "real" UFO abductees. The shining object next to left figure is commonly reported. Figures below were sketched by subjects undergoing "imaginary" abductions under hypnosis.



Newman's encounter with Jim is just one example of the growing involvement of psychologists and other behavior experts in Ufology. Much of the research has involved hypnotizing UFO "abductees" — there are some 200 reported cases — to determine the authenticity of their reports. And, like Jim, many of those tested appear to have "experienced" such encounters — on a psychological level. Newman and others concede, however, that their work cannot answer the ultimate question of whether or not the alleged event may actually have taken place.

The UFO controversy has been fueled by a recent outbreak of sightings, including

photographs taken in Italy, Australia and New Zealand (many of which have been explained in terms of atmospheric phenomena), and the release of CIA documents reporting sightings by military personnel in 1975 at several missile installations in the United States.

Have all these people been imagining things? Sightings have been explained as results of atmospheric abnormalities, electrical charges and other physical phenomena. M. A. Persinger of Laurentian University in Sudbury, Ontario, hypothesizes that "surface manifestations of tectonic pressures ... markedly enhanced electromagnetic charges ... enormously enhanced physical properties in highly localized geometries" may interact with the weak electrical and magnetic fields of a human being to produce the UFO image, as well as, perhaps, its unusual pilots.

"Movement of the [electrical] field towards the observer, or of the human observer towards the [electrical] column could induce currents sufficient to produce paralysis or unconsciousness," Persinger says. "The stimulation of electrically unstable portions of the brain, such as the hippocampal formation, could allow the person access to rich imagery of the epileptic, aura-like form. Such imagery could be intense and indistinguishable from reality."

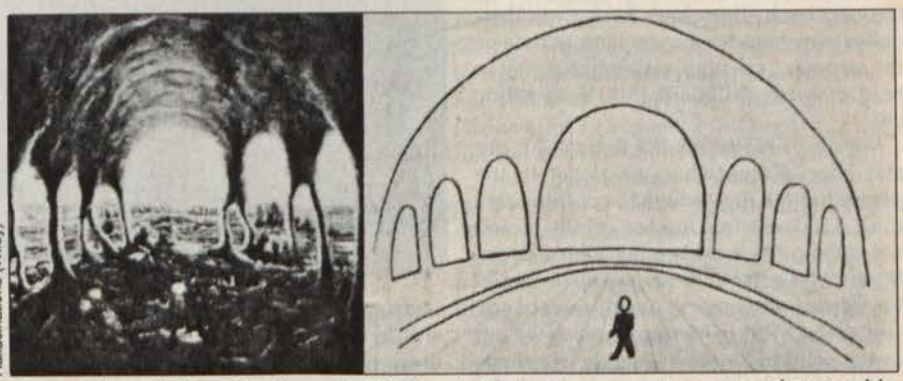
While such suggestions about the source of UFO images are intriguing, they are currently unprovable, if not untestable. Much current research centers on analyses of details of hypnotic descriptions of the encounters themselves.

Alvin H. Lawson of California State University at Long Beach has compared the testimony of four hypnotized abductees with that of four college volunteers who, under hypnosis, were the victims of an "imaginary abduction" orchestrated by the suggestions of the therapists — Lawson, W. C. McCall of Anaheim, Calif., and John DeHerrera of Fullerton, Calif.

Lawson, an English professor who teaches a UFO literature course, reports that the "encounters" of both groups are puzzlingly similar. "But more significantly," he says, the experiences reported by abductees follow a pattern that appears to parallel, strikingly, those described by persons undergoing drug-induced hallucinations or those who have had a "death experience," where they almost died yet recovered.

Working primarily with psychologist McCall during the past four years, Lawson has found that persons who have never had any of the three encounters — UFO's, drug hallucinations or near-death — can describe, under hypnosis, visions and happenings almost identical to those detailed by their "real" counterparts. "The brain's monolithic response to the various stimuli," Lawson says, produces an "encounter sequence" that is basically the same in all three situations. The sequence, he told SCIENCE NEWS, runs the following course:

1. Seeing a bright light.
2. Hearing humming, often of a musical nature.
3. Floating out of one's body.
4. Moving through a tunnel or tube.
5. Approaching a door or a border.
6. Encountering some type of being, frequently haloed or floating.
7. Having telepathic communication with the being.
8. Seeing a rapid review of events — as on a movie screen — in the witness's life (in the near-death experience, this would be the oft-described vision of one's life passing before one's eyes).
9. Undergoing an "examination" — usually of a physical nature in UFO abduction cases and of a moral one in death and hallucinatory situations.
10. Receiving a "message," such as a UFO inhabitant promising to return or instructing the abductee to forget the meeting.
11. Returning to normal life surroundings.



Hallucinations (Wiley)

An artist's rendering of an image in his drug hallucinatory experience strongly resembles the typical domed and windowed UFO interior described by abductees.

12. Undergoing some kind of personality change, perhaps a "new attitude toward life," in the aftermath of the encounter.

These similarities among the three types of experiences suggest the existence of "some sort of [common] matrix in the mind" that is primarily responsible for each of the phenomena, says Lawson, whose preliminary work was also reported at the APA meeting. For example, "the well-established tunnel/tube imagery of close encounter cases is also a dominant element in the alleged 'death experience,'" he says. And the visions of UFO abductees "seem to progress toward increasingly intense levels of experience," mirroring the cocaine hallucinator's progression "from simple snow lights through geometric forms to tactile sensations" (SN: 9/9/78, p. 187).

Psychologist Ernest R. Hilgard of Stanford University's Laboratory of Hypnosis Research concurs that people do seem to have a common illusionary mechanism that is fueled by "human imagination and experience. It's just the way a dream is built up — your experiences can combine in any way." But Hilgard emphasizes that he believes such "experiences" — UFO's, hallucinations, near-death imagery and reincarnation reports — are primarily products of imagination. "All that is fabrication," he says. "All this reincarnation business — people telling you where they lived and other details of their 'previous lives' ... pure fabrication."

To Lawson, though, the UFO parallel to other types of imagery means that "many people who have had UFO experiences are not lying. It's very clear to me that if there is a reality to after-life and hallucinatory sequences — as many serious psychological studies indicate — then these [UFO encounters] are also a reality.

"This is not proof that it [physically] happened," Lawson is quick to add. But neither does it rule out that possibility. "Despite the many similarities [between real and imaginary UFO encounters], there are crucial differences," he says. "First, many abduction (and other close encounter) reports involve dual or multiple witnesses, and there is scant evidence that multiple hallucinations occur spontaneously and for extended periods of time." In addition, Lawson points to reported physiological and psychological effects in UFO cases that are uncharacteristic of hallucinations. And he adds that UFO abductees seem more convinced of the "reality" of the experience than their hallucinating or "imaginary" abductee counterparts.

Finally, there is "the greatest mystery of all," Lawson says. The forces that stimulate most hallucinations and death-related visions are pretty clear cut — they include drugs and a physical brush with death (which may include anoxia) respectively. But the stimulus for a UFO encounter can only be guessed at.

"I don't know," Lawson readily admits. However, he leans away from geophysical explanations, such as Persinger's, and toward a "psycho-kinetic dimension to this whole thing." Believing in the physical reality of an encounter simply on the basis of the "truthful" testimony of an abductee is ill-advised, he says, because "I don't think we can trust the senses in this experience.

"We're getting closer to some explanation," Lawson says. "The nature of the stimulus here is a very spooky thing." □

Jupiter's Here!

The Voyagers have been studying the superplanet almost since they left the earth

BY JONATHAN EBERHART

NASA

Among the different kinds of missions that NASA devises for the study of other worlds, "flybys" are considered to be the easy ones. No global studies from orbit, no dramatic landings with soil scoops and weather stations, no samples automatically returned to earth (as by several Soviet lunar craft). A flyby mission is little more in essence than "aim and pull the trigger" — a shot across the bow. The instruments pick up what they can during the approach, then look back over their collective shoulder for some more data as the target falls behind, rather like trying to read a wordy billboard from a speeding car.

Voyager 1 is just such a flyby — in, out and gone. Except that the target is the planet Jupiter. Big enough to contain more than 1,300 earths, Jupiter totally dominates the other worlds of its solar system. Bursts of electrons from the giant planet have been detected as far in toward the sun as the orbit of Mercury and as far out as the orbit of Saturn (which is five times as far from Jupiter as earth is from the sun). Voyager 1 has been picking up Jupiter's radio emissions for 14 of its 17 months in flight.

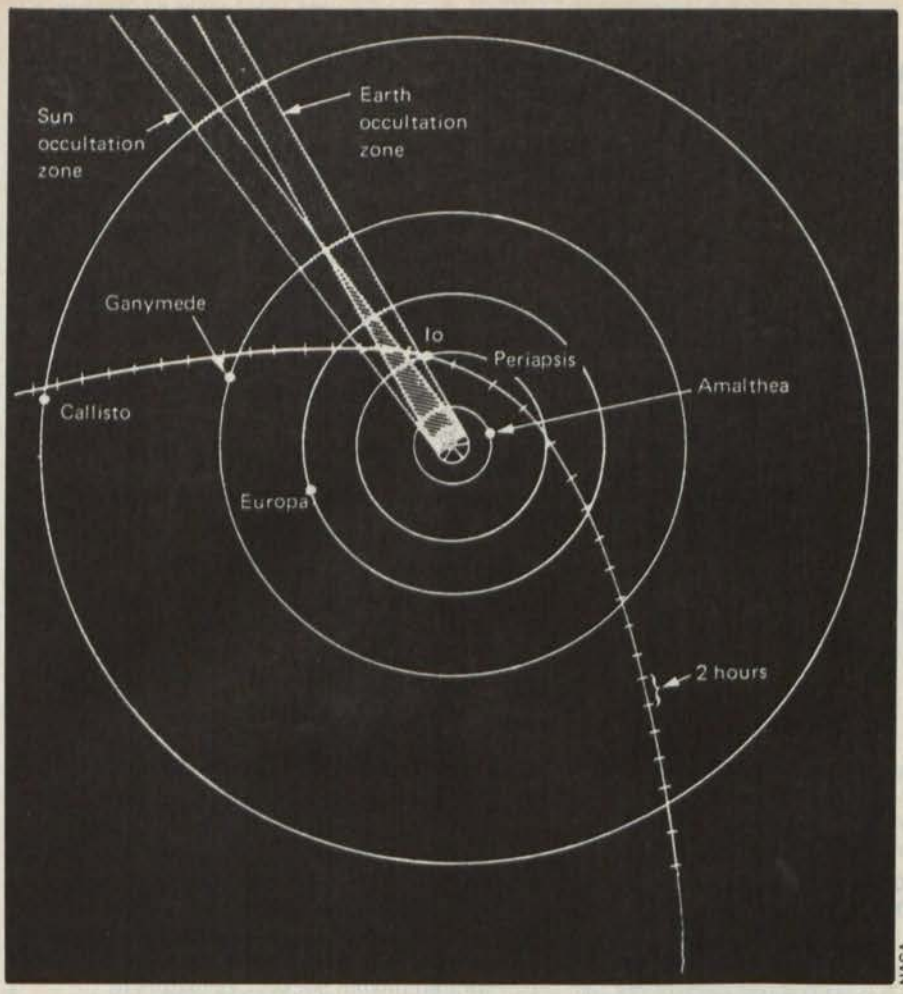
Together with its 13 or more moons, in fact, Jupiter forms an entire planetary system, and on a respectable scale. Three of its moons are bigger than earth's own, and one of them — Ganymede — is bigger than Mercury. The innermost moon, Amalthea, takes less than half a day to circle the planet; the outermost, Sinope, takes more than two years. Sinope's orbit is thus, in a sense, the boundary of the Jovian system, and it is more than 60 times as wide as the orbit of earth's moon. Voyager 1 crossed Sinope's orbit on Feb. 10, traveling nearly a million kilometers a day and still accelerating, yet it will not reach Jupiter (only *half* the width of the system away) until March 5.

The Voyager mission, in short, is far from being merely the usual quickie flyby, in which attention is focused almost entirely on the climactic period of closest approach to the target. The Jovian system is so large and diverse, and Voyager's instruments so sophisticated and far-seeing, that the mission is more of a prolonged tour, with the spacecraft hurtling past one exotic target after another, swinging its instrument-laden "scan platform" from side to side like a fascinated child running down the aisle of some cosmic toy store.

The radio outpourings were one of the first signs of Jupiter's presence detected by Voyager 1 following its launching on Sept. 5, 1977. Then, early in February of 1978, Voyager 1's twin, Voyager 2 (launched 15 days before the other craft but on a longer path that will bring it by the planet on July 9) took a remarkable photograph showing not only Jupiter but all four of its major satellites — from 437 million kilometers away. Voyager 1's cameras, following a few test shots made last year, have been at work steadily since Jan. 4, and for most of that time have been taking pictures sharper than those obtained a few years ago by the Pioneer 10 and 11 probes only one day out from the planet. One sequence of images made over several weeks is now being assembled into what amounts to a movie, showing several complete rotations of the planet so that scientists can study possible changing features in the boldly colored and patterned cloud tops. More recently, pictures of the still-tiny Galilean satellites (Io, Europa, Ganymede and Callisto) have begun to reveal distinct surface features such as color variations and polar caps. Near the encounter with Jupiter itself, the cameras will be taking such extreme close-ups that one planned sequence of 27 photos will fit within the area of the famed Great Red Spot. Other goals for the cameras will include looking for currently unknown satellites as well as for rings of dust that may exist around the planet.

Because the travel time for a one-way radio signal from earth to Jupiter is more than half an hour, and because the spacecraft is moving far too fast to allow anything resembling real-time changes to be sent by controllers at Jet Propulsion Laboratory in Pasadena, Voyager's activities are largely pre-programed. Eleven teams of scientists worked for months to get their data requirements and instrument capabilities dovetailed into a workable sequence, and the result, already in progress, is awesome in its complexity. On March 4, for example, one part of the sequence, covering little more than an hour, looks like this:

- 11:25 to 11:38 — Photomosaic of a small region of the Great Red Spot. One of many such episodes, in which researchers hope to see not only signs of circulation and structure in the huge feature, but color clues to its composition and its relationship to the deep atmosphere beneath.
- 11:38 to 11:50 — Photometry and long-exposure photos of dark space near Jupiter. They are part of Voyager's search to see if hypothesized captive dust rings exist around the planet in the plane of the ecliptic. Far more subtle than the rings of



NASA

Voyager 1 Closest Approaches

	Date	Time (PST) at Voyager	Distance (km)
Amalthea	3/4	10:23 p.m	416,942
Jupiter	3/5	4:05 a.m.	280,000
Io	3/5	7:13 a.m.	20,523
Europa	3/5	11:19 a.m.	732,245
Ganymede	3/5	6:17 p.m.	115,000
Callisto	3/6	9:08 a.m.	126,108

Voyager 1 view of Jupiter (far left) shows detail even in Ganymede (lower left of photo) from 40 million kilometers away.

either Saturn or Uranus, they would probably show only as a slight brightening against the darkness off the planet's limb.

• 11:50 to 11:53—Radio astronomy and plasma-wave observations. Jupiter has already been detected by Voyager at considerably more frequencies than were known from earth-based studies. The radio-astronomy instrument and the plasma-wave detector together have recorded Jovian emissions from 40 megahertz down to as low as about 1.2 kilohertz. The data relate to phenomena as diverse as Jupiter's huge magnetic field (the structured portion of the magnetosphere at times is millions of kilometers across) and the strange electromagnetic coupling between the planet and its strange moon Io. (Perhaps the most tense moment of the entire mission, says plasma-wave experimenter Frederick Scarf of TRW, Inc., may occur on March 5 when Voyager 1 flies directly beneath Io's south pole at a distance of barely 20,000 km, briefly passing right through the charged-particle-rich "flux tube" that connects planet and moon. Will the spacecraft be affected by the radiation and an electrical flow in the hundreds of thousands of volts? Time will tell.)

• 11:56 to 12:18—Fourteen photos of Io. The strange satellite, surrounded by rarified veils of sodium, potassium, sulfur and hydrogen, is one of the most important targets of the whole mission. An indication of its significance is that Voyager 1 will be concentrating on Io rather than Jupiter at the moment when the spacecraft is closest to the planet. Various researchers have speculated that Io's surface could look like anything from a salt flat to the Painted Desert. According to imaging team leader Bradford Smith of the University of Arizona, "We know less about what to expect from the appearance of the Galilean satellites than about any other objects to which we've sent spacecraft."

• 12:23 to 12:32—Six photos of Europa. This batch, intended for chemical composition and mineralogy studies, will be taken from about 1,783,000 km away, although the advancing flyby will enable photos a day later from barely 40 percent of that distance. Every photo will count in the months and years of analysis that are sure to follow, but for now, the ever-approaching spacecraft has the Voyager scientists impatient for each new view. Last week, for example, the imaging team was exclaiming at striking views of Ganymede, yet did not fully computer-process the pictures. "Why bother?" said Smith the next day. "We'll have better ones in a week."

• 12:33 to 12:36 — Three photos of Amalthea. Nearest to Jupiter of its known moons, Amalthea is bathed in intense radiation that would make it one of the most dangerous hard-rock objects in the solar system as an environment for human life. One goal is to seek signs of an Amalthean atmosphere.

The total elapsed time in the mini-sequence described above is only one hour and 11 minutes, yet Voyager will have photographed a planet, monitored radio noises coming from it, looked for dust rings around it, and then photographed three of its moons. And the whole episode takes but a few lines in a centimeter-thick book describing the complex reams of near-encounter activity. The book, furthermore, extends only from Feb. 26 to March 7, whereas the spacecraft has in fact been at work since the day it was launched and will keep its gaze on Jupiter until as late as April 9. (Voyager 2 will begin its own intensive observations on about April 24.)

Thus a flyby mission, usually a matter of days or weeks, has been collecting information over many months. Yet many scientists are still counting on the few days of the close encounters to shed light on a variety of hypotheses. Do Ganymede and Callisto, for example, possess oceans of liquid water covered by tens of kilometers of ice? Torrence Johnson of JPL has suggested the possibility, but Ray Reynolds and Patrick Green of the NASA Ames Research Center believe that even such large amounts of H_2O could freeze solid over a long period of time. Is Io — large, solid and close to Jupiter — so molten within from its host planet's tidal torque (as Reynolds and others propose) that the effects will show on the surface? Then there is Jupiter's huge magnetosphere, which was seen by the earlier Pioneer probes to vary in size by fully 50 percent. Researchers trying to explain the effect have considered variations in the solar wind, in the position of Io and in the face of Jupiter that happens to be turned toward the spacecraft, with the result that some scientists, such as Rice University's Alex Dessler, have undertaken to predict when Voyager 1 will cross the boundary of the magnetosphere to the nearest minute as a test of their hypotheses.

After Jupiter, Voyager 1 will head off for a 1980 encounter with Saturn, to be followed in 1981 by Voyager 2 (which may then go on to Uranus and perhaps even Neptune). Even without these further accomplishments, however, and with Voyager 1's close Jupiter encounter still to take place, "mere" flybys are mere no more. □

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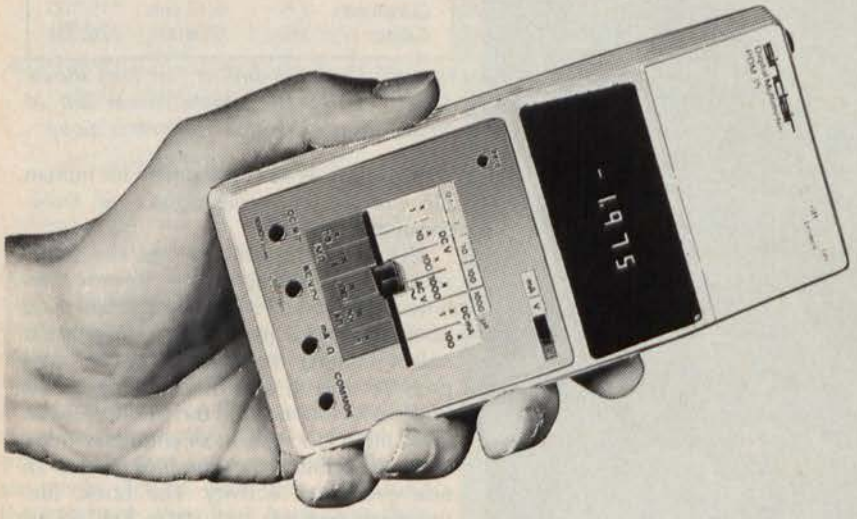

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