Senate panel wants a probe

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Effects of non-ionizing radiation given priority status by Congress

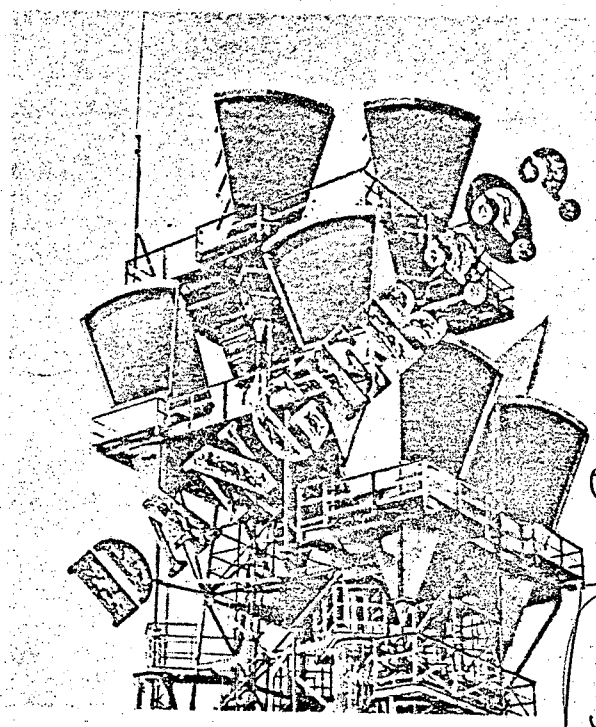
The National Academy of Sciences is expected to be given the green light by Congress this fall to conduct a comprehensive study of the current state of knowledge of the health effects of non-ionizing radiation. Included in this study, the first overall probe ever conducted, will be an evaluation of current radiation standards and a look at likely hazards of emerging technologies.

The assignment was recommended by the Senate Subcommittee on Commerce, Science and Transportation following three days of hearings last month on the issue that has recently caught the imagination of national magazines and television networks. Although the hearings were cued in part by the disclosures that the Soviet Union has been bombarding the US embassy in Moscow with low-level microwave radiation for 15 years, they also display the panel's continuing interest in the field since the passage of the Radiological Control for Safety and Health Act in 1968. Hearings were last held three years ago.

The subcommittee, chaired by Sen. Wendell Ford (D-KY), heard from some 19 witnesses during the three-day skull session, received written responses to inquiries from 30 government agencies, and adjourned with a not-unexpected consensus: although the general public is not in any great danger from non-ionizing radiation, the scientific community is in the early stages of an important, long-term study that must be coordinated.

Of far more immediate concern to the panel—and the subject of future hearings and probable legislation—are the biological effects of ionizing radiation to the general public from such sources as medical devices and coal conversion processes. "These issues, such as the use of X-ray machinery by untrained personnel, are extremely troublesome ones which we expect to spend plenty of time on in the coming months," explains one subcommittee counsel.

A signal that the microwave industry has nothing to fear from Uncle Sam? Not necessarily. For example, a spokesman said the appliance industry could be targeted for further questioning because spokesmen, who told the lawmakers of the flawless safety record of microwave ovens (no injuries on record from emissions), failed to explain why General Electric Co. recalled 36,000 of its microwave ovens last year.



A potential threat to industry, too, could conceivably come from the Labor Dept.'s powerful Occupational Safety and Health Administration (OSHA), although to date it has not been overly zealous in checking for radiation hazards. In 1976, OSHA made only 28 inspections for ionizing radiation, 25 microwave inspections, and four inspections involving lasers.

OSHA shares those duties with the Energy Research and Development Administration (ERDA) and the Nuclear Regulatory Commission (NRC), both of which are primarily concerned with ionizing radiation, and is itself admittedly interested in cracking down only where recognized hazards cause death or serious physical harm (such as X, gamma, alpha, beta and neutron types). "We don't expect much help here from OSHA," candidly admits a Science Subcommittee counsel following testimony from Grover Wrenn, OSHA's director for health standards programs, whose words signaled no industry cause for alarm.

Some work in the area, however, is being done by the Dept. of Health, Education and Welfare, whose National Institute for Occupational Safety and Health (NIOSH) includes a division of Biomedical and Behavioral Sciences. "Workers are potentially exposed to RF and microwave radiation from a large number of sources and devices," division director Dr. Elliott Harris told the lawmakers. "Consequently, NIOSH is planning a criteria document for occupational exposure to RF and microwave radiation, (and) is updating an extensive bibliography of world literature on the subject."

Of all people to be quoted on this point!

Some of its concerns: the possibility of cancer induction by Tacan systems, the result of a workman's compensation filing by an FAA Tacan repairman who had been diagnosed as having carcinoma of the pancreas. NIOSH has been interested in the RF radiation band (specifically 10 to 300 MHz) since 1972, when it noticed a dearth of information on industrial uses of RF generators as well as survey instruments to make field measurements. For this reason, estimates of workers exposed to RF and microwave radiation vary from as few as 50,000 to as many as 21 million, he said.

Other studies in the area were detailed during the hearings by an

(continued on p. 10)

Paul Harris, Washington Editor

Senate probes RF hazards

(continued from p. 9)

alphabet soup of agencies from military and government, most attesting to indications, but citing little evidence of health hazards. "For example, it appears that microwave exposure will produce cataracts only at very high power levels," claimed Maj. Lawrence Larsen, who is assigned to Walter Reed Army Institute of Research as associate chief of medical biophysics in its Department of Microwave Research.

He said the study is part of an Army microwave research program that includes investigations of frequency-dependent energy absorption in physical models (scaled figurines of a man), animals and in organ-specific studies.

Other witnesses outlined similar studies—such as the Navy's probe of microwave and extremely low frequency (ELF) radiation in support of its Project Seafarer Communications System—but the pattern of testimony was consistent. Compared with research into ionizing radiation, the non-ionizing area is an infant where there are no accepted theories as to damage production by any mechanism other than thermal. Yet, there are experiments whose results cannot be explained by thermal means.

William Thaler, acting director of the White House Office of Telecommunications Policy, summed the situation for the Senators. "Non-ionizing EMR research is far more complex than ionizing radiation. There are difficulties in relating how much energy is absorbed from incident radiation or 'exposure.' It is even more difficult to determine the distribution of that energy within the body.

"In assessing the impact of this radiation on man one must first develop a realistic picture of actual exposure environments and the populations which are involved," Thaler explained. "It appears that radiation levels in most environments normally encountered by the general public are well below 10 mW/cm², although levels of a few milliwatts/cm² do occur in some occupational situations."

Thaler also indicated that the problems concerning the US embassy in Moscow are more worthy of headlines than headaches. The level of radiation has dropped considerably since the State Dept. complained, and the two countries have recently signed an agreement to conduct collaborative research in the microwave area.

If the National Academy of Sciences is given a mandate to coordinate studies in the field, it already has a head start. It has previously carried out studies on the effects of microwaves on samples of Korean war Navy veterans who were exposed to microwaves from radar, and will intensify the probe concerning the mortality of the vets. Late last year, the National Aeronautics and Space Administration asked it to perform an assessment of a research plan to determine the biological and ecological effects of energy transmission by microwaves, a proposal it has broadened and discussed with a number of agencies.

The Academy is also developing a proposal to study the impact of over-the-air communications systems and on other microwave utilizing systems that would result from taking regulatory action on non-ionizing radiation.

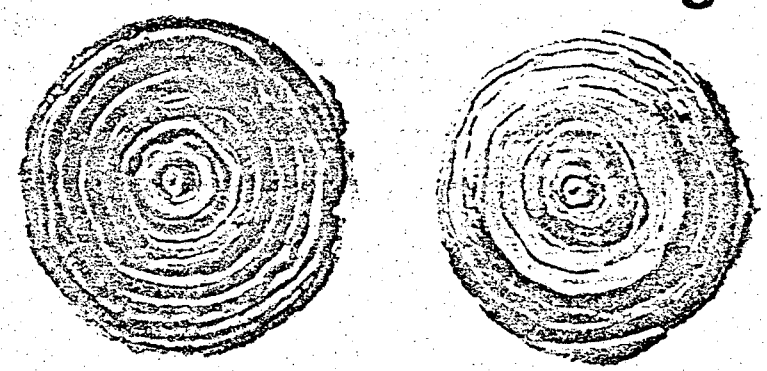
"A Congressional mandate to the Academy to coordinate these efforts would be invaluable," remarked the subcommittee counsel. "It would add greater prestige and visibility to the project, assure Federal money and probably increase activity here. It's early in the study, and there's no better time to coordinate so we can begin answering the many questions."••

Meterless monitoring of radiation now in sight

Commercial broadcasting, radar, portable transmitters and a multitude of industrial sources bathe us in radiation, the effects of which are not yet fully determined. The possibility that some of this non-ionizing radiation may be hazardous spawns the need for an effective radiation monitor that can be inexpensively mass produced in large quantities.

With this in mind, Dr. Glenn Fanslow and Dr. D.T. Stephenson of Iowa State University have developed a novel, entirely passive device to monitor non-ionizing radiation. The approach takes advantage of the temperature-dependent light scattering properties of cholesteric liquid crystals—the substance used in passive digital thermometers. The liquid crystal, painted on plastic disks, indicates power densities as low as 1 mW/cm² without any batteries, moving parts, circuits, or meters of any sort.

"The goal in this work," Dr. Fanslow relates, "is to provide an effective but convenient means of monitoring radiation. The calorimetric radiation monitor needs no electronics, no meters and no power source. The simplicity of the device suggests that it can be produced at low cost and made readily available to anyone who wants to measure radiation and locate radiation leaks."



1. Without radiation present, color indication is shown by circles of equal radius. When radiation is present, the metalized disk displays a color circle of larger radius than the non-metalized disk. Increments on the indicator give a level of the radiation present (in this case, 4mW/cm²).

The prototype radiation monitor consists of two plastic temperature sensing disks. One disk, coated with metal, absorbs radiation when it is present. The second disk, unmetalized, acts as a control element. Both disks are first coated with black paint to absorb light scattered by the liquid-crystal material. Various compounds of the liquid-crystal substance are then

Could load a few pages

Steven Peliotis, Western Editor

RF hazards: What we don't know *can* hurt

Questions concerning the biological effects of non-ionizing radiation were once reserved for scholarly dissertations presented at obscure symposia. This summer, however, the subject has been headlined by the national press, debated in prime-time television newscasts and aired at Senate subcommittee hearings. In short, it has been thrust upon a skeptical public, still reeling from the technological horror stories of tried-before-tested food additives, abused pesticides and nuclear power-plant accidents.

Public interest in RF health hazards was sparked by 1975 reports that the US embassy in Moscow was being irradiated by high levels of microwave energy. Most opinions I've heard concur that the RF bombardment was aimed at jamming an American intelligence listening post in the basement of the embassy building. But there is a minority of scientists, such as Dr. Milton Zaret, professor of optomology at New York University and consultant to the CIA, who feel that the Soviet motive was not jamming, but behavior modification. Recently published Soviet studies claim that low-level RF can cause a wide variety of ailments ranging from depression, anxiety and loss of memory, to coronary disease and sexual impotence. In fact, the Soviet safety standard for RF emission is three orders of magnitude tougher than the US level of 10 mW/cm².

"We have duplicated some of the Soviet experiments and analyzed Soviet literature," Zaret told newsman Mike Wallace on a nationally televised edition of "60 Minutes" (6/19/77). "The multiple frequencies they were using, the wavelengths they were using, all fit into the pattern (where) they would expect a behavioral effect on people."

The hard-hitting CBS news broadcast, which raised questions regarding the safety of microwave ovens, RF transmitters and air traffic control and military radar, came on the eve of a Senate subcommittee investigation into the 10 mW/cm² standard. After questioning a long list of authorities representing industry and government, the Senators asked the National Academy of Science to probe into the question (see p. 9). The NAS is not alone in their mission. Wallace reported that the government will invest about $9 million this year in experiments designed to check the Soviet conclusions.

It's far too early to say what effect, if any, this increased level of public interest and scientific investigation will have on the design and manufacture of microwave components and systems. But there are some ominous indicators. There seems to be an increasing number of suits brought by ex-military men and air traffic controllers who claim they have developed cataracts due to exposure to radar emissions. One former radar operator who served aboard an EC-121 recently collected $50,000 in an out-of-court settlement with Lockheed. (Last month, a Supreme Court decision confirmed that a manufacturer sued over a faulty system designed for the government has no legal right to counter-sue the agency that sponsored and approved the project.)

Even more menacing is the distinct possibility that studies will confirm the Soviet contention that a safety standard of 10 mW/cm² is dangerously high. Officials of the US Occupational Safety and Health Administration (OSHA), present at the Senate hearing, left the impression that any new standards would be rigidly enforced. To the microwave industry, a tighter standard could mean millions of dollars in redesign. To the health of the veteran microwave worker, it could mean much worse.

We're entering a period that could change the complexion of the microwave industry. Storm warnings have definitely been raised, the public has been exposed to the controversy and Government agencies are springing into action. The findings of the biological studies could spell trouble for the microwave industry. But the facts, when they are found, cannot be ignored.

Stacy Beane

Editor

Technical University of Aachen, Aachen, Germany—Researchers at the Institute of Semiconductor Electronics are using GaAs FETs under switching conditions to regenerate and amplify fast pulses and modulate semiconductor lasers in the Gbit/s range. Researchers Beneking, Klein and Filensky report, "Because of its excellent switching behavior, the GaAs FET seems to be the favorable solution, not only for pulse amplitude modulation but also for regeneration and amplification of electrical pulse code signals. In contrast to bipolar transistors, minority carrier storage effects are not present. Thus, the use of FETs in fast digital systems is substantially simpler than unsaturated bipolar circuitry. Furthermore, the intrinsic jitter can be neglected." The researchers have attained sharpening factors of three at output pulse risetimes of nearly 50 ps and voltage amplification factors of two at 50 ohms for output pulses up to 100 mA. Details are presented in *IEEE Journal of Solid-State Circuits,* Vol. SC-12, No. 3, pp. 276-280, June, 1977, (IEEE members: $5, nonmembers: $10). IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854.

Is that microwaves you hear?

Wayne State University, Detroit, MI—Audible sounds appear to originate from within or just behind the head when a human subject is exposed to pulsed microwave radiation, according to recent research findings. Interest is increasing in this area because the densities needed to create the response are many orders of magnitude smaller than the current safety standard of 10 mW/cm². Human subjects describe the microwave-generated sounds as clicking, buzzing or chirping depending on such factors as pulsewidth and repetition rate. Dr. James C. Lin comments, "We assume that the auditory effect arises from the miniscule but rapid temperature rise in the brain resulting from absorption of microwave energy. We believe the temperature rise that occurs in a very short time creates thermal expansion of the brain matter which then launches the acoustic wave of pressure that is detected by the cochlea." Dr. Lin suggests that microwave-induced sounds are transduced by a mechanism similar to that responsible for conventional acoustic reception. Absorbed energy exhibits characteristic oscillations along the outer portion of the head and reaches a maximum near the center. Numerical results indicate that pulsed microwave-induced sound pressure amplitude depends on both pulsewidth and peak power density. Details appear in *IEEE Transactions on Microwave Theory and Techniques,* Vol. MTT-25, No. 7, pp. 605-612, July, 1977, (IEEE members: $5, nonmembers: $10). IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854.

Varactor shows strongly nonlinear C/V characteristics

Osaka University, Osaka, Japan—A new type of varactor diode shows much stronger nonlinearity in capacitance variation with applied bias voltage than does a conventional varactor. The nonlinearity, not previously obtained without special doping profiles, can be readily increased by proper selection of material parameters, or by adjusting the diode dimensions. Use of the varactor may result in more efficient generation of millimeter waves by direct frequency multiplication. The diode consists of multilayer p-n junctions. All junctions are in series with metal contacts attached perpendicularly to the semiconductor layers having either uniform or non-uniform doping profiles. Voltage applied to the contacts causes a two-dimensional movement of depletion region, resulting in the C/V characteristic. The applied voltage not only enables variation of depletion width, as in the conventional varactor, but also variation of the cross-sectional area of the depletion region. "New Type of Varactor Diode Having Strongly Nonlinear C/V Characteristics," appears in *Electronics Letters,* Vol. 13, No. 12, pp. 360-361, June 9, 1977, (£5.50). Electronics Letters, P.O. Box 8, Southgate House, Stevenage, Herts., SG1 1HQ, England.

news/Washington

Paul Harris—Washington Editor

OTP to be scuttled by White House

The Ford White House tried it and failed, but for the Carter Administration it's a fait accompli. **The Office of Telecommunications Policy, formed by President** Nixon to set policy in the growing field, **is slated for extinction as part of Carter's program to streamline the White House.** Plans, submitted to the President last month by the White House Reorganization Task Force, call for eliminating the 59-man office and its $8.2-million budget, but transferring its duties to other departments in such a way that few jobs will be lost. **The Commerce Dept.'s Office of Telecommunications will absorb most of the duties and Presidential assistant Barry Jagoda will watch over some of the chores.**

The office has strong support by House and Senate Communications Subcommittees that appreciate its accomplishments. Their members were able to derail a similar attempt two years by President Gerald Ford. While some resistance is coming from Capitol Hill again, the Democrats will be given their way. "It's a shame this is where they chose to make good on campaign promises," House Communications Subcommittee Chairman Lionel Van Deerlin (D-CA) told *MicroWaves*. But he said the office has far too little Congressional support to blunt the move. Reason: Designed as a bipartisan office, OTP has been politicized ever since its first director, Clay T. Whitehead, once used it as a platform to criticize the broadcast industry. Since then, succeeding chieftains have gotten little Congressional respect. The office has written legislation affecting the broadcast industry and cable television, and has opposed the "Bell Bill" which would eliminate competition for the American Telephone and Telegraph Co.

Carter outlines NASA space goals

Robert A. Frosch, new head of the National Aeronautics and Space Administration, has been given his orders by President Carter: Be an imaginative administrator, especially toward practical applications of space technology, but **think twice before proposing any major space initiatives.** Unlike his Republican predecessors, Carter has shown strong interest in the activities of NASA—which is why he chose its new chieftain carefully—and NASA insiders expect plenty of guidance from the White House. In recent remarks, the President said that realizing the fullest potential of the space shuttle will be the top priority, which probably rules out any plans for a space station in the immediate future. Manned lunar or exploratory missions will also remain on the drawing board. **One key Carter interest: use of space technology as a foreign policy tool.** He recently told the Organization of American States that the South American people will find educational and cultural dividends from television transmissions from US satellites.

Western Union proposes interchangeable satellites

Western Union Space Communications has filed an application with the FCC for authority to construct advanced satellites that could be used with several spacecrafts. Included would be the tracking and data relay satellite system (TDRSS) for NASA and its own Westar system. The agency has previously turned down WU requests to build satellites in orbit by 1979. **Plans call for two in-orbit satellites to be used exclusively for NASA, a third for advanced Westar, and a fourth in-orbit satellite as backup for the other three.** The fourth would also have limited use in the Westar system.

Business employs fewer scientists, engineers

Employment of scientists and engineers in US industry dropped five per cent from 1970 to 1975, according to the National Science Foundation, a decline that compares to a 14-per cent gain from 1965 to 1970 and a 19-per cent boost from 1960 to 65. Latest NSF talley shows a 13-per cent drop of the two job categories in manufacturing industries, a 12-per cent drop in R&D activities, but an 11-per cent jump in non-manufacturing employment. NSF says private industry is by far the largest employer of scientists and engineers in the US, employing some two-thirds of the total. Engineers made up 72 percent of both groups in private industry in 1975. Among the specialties, most were electrical engineers (292,000) and mechanical/aeronautical engineers (201,000). Energy related activities claim 186,000 or 16 per cent of all scientists and engineers.

(continued on p. 24)

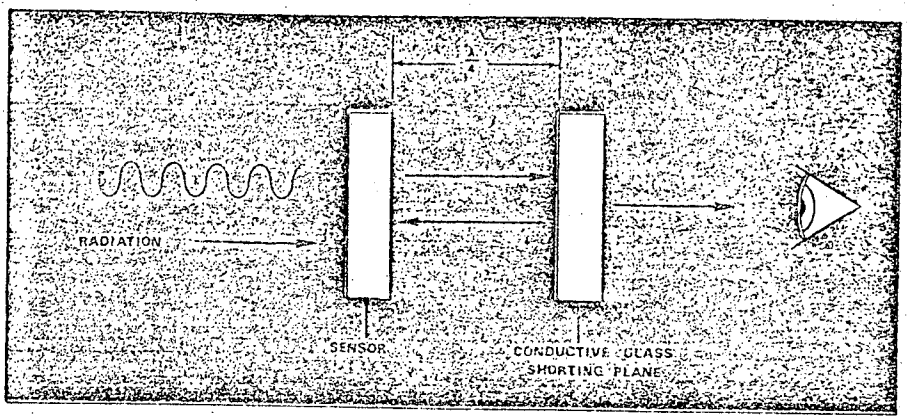
Meterless monitoring of radiation (continued from p. 10)

painted on the disks in concentric circles.

"A change in the temperature of a material coated with liquid crystals causes a change in color," Dr. Fanslow comments. "In general, the color will pass from red to green to blue as the temperature increases, and it will be limited to a temperature range. This range is determined by the compounds or mixtures of compounds used."

Thus, with no radiation present, the circles on both disks displaying color would have the same radius (both indicating ambient temperature). When radiation is present, the metalized disk absorbs energy, heats up and displays a liquid-crystal circle of larger radius. Using the non-metalized disk as an ambient temperature representation, the difference between temperature indications on the two disks can be used as a measure of radiation.

An experimental version described by Dr. Fanslow at June's International Microwave Symposium in San Diego, CA, is fabricated with 10 concentric liquid-crystal circles (Fig. 1). The temperature required for a color change is 88°F at the outermost circle, and decreases in 2°F increments with each smaller circle. A green color on circle number eight, for example, would indicate a temperature of 84°F. Since liquid crystal compounds change in color from red to green to blue with increasing temperature, it is possible to estimate temperatures that fall on either side of a ring's center temperature.



2. A conductive glass shorting plane reflects energy back into the radiation monitor. Sensitivity is enhanced and a clear view of the sensor is provided.

Temperature rise indicates radiation

A proposed configuration for a practical radiation monitor utilizes a movable indicator in a stationary guide. The non-metalized disk provides the reference for ambient temperature. By moving the indicator's reference point to the appropriate circle on the non-metalized disk, the level of radiation can be read on the incremented end of the indicator.

Several designs for the radiation monitor are being considered. A simpler approach would be to configure it as a linear sensor/indicator, akin to passive liquid crystal thermometers. Dr. Fanslow explains that a linear device would be more understandable. Future efforts will explore various forms of the sensor to optimize performance.

One modification that shows promise is the placement of a piece of conductive glass one-quarter wavelength away from the liquid-crystal film (Fig. 2). The system takes on the look of a transmission line with a $\lambda/4$ matching stub. The conductive glass shorting plane reflects energy back to the sensor. Sensitivity is increased without obscuring the view of the sensor.

Liquid crystal calorimeters exhibit the beauty of simplicity. Properly used, the lifetime of the device is expected to be without limit.••

Licensees sought to produce NBS-developed RF power meter

Manufacturers can now obtain a license and design package to produce a new RF power meter recently developed and patented by the National Bureau of Standards (NBS).

The meter, designated by the NBS as Type IV, is an improvement over the Type II power meter that has been produced commercially since a similar design package for it was offered in 1971. The Type IV meter retains the accuracy of the self-balancing bridge portion of the Type II, in a smaller package, and at about one-third the cost. It was designed specifically for use in automated measurement systems in which as many as 10 power meters would be under the control of a computer, and would share a single digital voltmeter and digital-to-analog converter. This is in contrast to the Type II (a manually operated system) in which every power meter assembly usually included a "reference voltage generator" module. The new approach reduces total system cost, and it has important operating advantages.

Wheatstone bridge eliminated

Like its predecessors, the new power meter uses the DC-RF substitution method for measuring power. Unlike Types I and II, however, it does not use a Wheatstone bridge. The Type IV uses two operational amplifiers to automatically maintain equality between the resistance of a thermistor mount and the meter's internal standard resistor to within one part in 10^5. Doing away with the bridge and the use of four-terminal resistor connections eliminates the lead-resistance errors inherent in thermistor-to-bridge connections. It also permits the convenience of longer connecting lines between meter and thermistor.

The design package includes working drawings, a complete parts list with names of suppliers, specifications for non-standard parts required, photographic negatives for printed circuits and artwork (front and back panels and meter scale) and an operating manual. The package and a license are available through the National Technical Information Service, U. S. Department of Commerce, 425 Thirteenth Street, N. W., Washington, DC 20004 (202) 724-3374. ••*SVB*