NAVSWC MP 90-72

NAVAL SURFACE WARFARE CENTER DOMESTIC TECHNOLOGY TRANSFER REPORT (FY89)

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CENTER TECHNOLOGY BASE PROGRAM OFFICE

1 OCTOBER 1989

NAVAL SURFACE WARFARE CENTER

Dahlgren, Virginia 22448-5000 • Silver Spring, Maryland 20903-5000

FOREWORD

The Naval Surface Warfare Center (NAVSWC) Domestic Technology Transfer Report (FY89) has been prepared in accordance with the format and content formulated by the Office of Naval Technology for Navy inputs in meeting the reporting requirements of the Stevenson-Wydler Technology Innovation Act of 1980 (Public Law 96-480) as amended by the Federal Technology Transfer Act of 1986 (Public Law 99-502).

The objectives of Navy domestic technology transfer are (1) to disseminate non-critical technology, originally developed in support of military applications, for potential alternative uses in the public and private sectors; and (2) to promote joint cooperative development programs that address problems of mutual concern to the Navy and other agencies or organizations. In pursuit of these objectives, the Navy transfers technical expertise to other Federal Government agencies; state and local governments; small and large businesses; nonprofit organizations; and such public service organizations as schools, hospitals, and foundations. In addition, technologies that have direct impact on the Navy mission and programs are transferred within, or into, the Navy. Transfers of hardware, software, management practices, and expertise are made in diverse fields, such as analysis and testing, communications, energy, environment, transportation, and marine technology. The Navy Domestic Technology Transfer Program provides unique services not available from, or in competition with, the private sector. Content is limited to non-militarily critical technical material that is approved for public release. Keywords: Naval research; Naval equipment; Naval warfare; Technology transfer (EDC)

The transfer process functions as a "two-way street" and thus also serves to infuse the Navy R&D community with new ideas, techniques, and information from outside sources. The underlying philosophy and approach of this report are to derive national benefits through technology transfer by capitalizing on recent scientific developments to promote technical and economic growth within the U.S.

A substantial portion of the information in the Appendices of this report was contributed by NAVSWC technical staff members engaged in Center technology transfer tasks. Questions or requests for additional information should be referred to NAVSWC, Code D4, Mr. Ramsey D. Johnson, (301) 394-1505 or Autovon 290-1505.

Approved by:

D. B. Colby

D. B. COLBY
Associate Technical Director

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ORGANIZATIONAL STRUCTURE FOR TECHNOLOGY TRANSFER

BACKGROUND

From a historical perspective, NAVSWC has been involved in technology transfer activities even prior to participating as a charter member of the Department of Defense Technology Transfer Consortium in 1971. This organization has subsequently evolved into the Federal Laboratory Consortium, of which NAVSWC continues to be a contributing member. NAVSWC's role is necessarily limited since its R&D efforts are principally directed toward Navy requirements in the national security arena. Consequently, considerations of security classification and export control of unclassified critical technologies can severely constrain the release of technical information on an unrestricted basis. Furthermore, the work is often intrinsically oriented to naval applications, and considerable adaptive engineering (necessitating non-DoD funding sources and redirection of in-house resource allocations from mission areas) would be required to redirect the R&D to non-Navy uses. Within these general constraints, NAVSWC endorses and pursues technology transfer activities involving Center-wide R&D efforts.

PROGRAM IMPLEMENTATION

Management

The Center's domestic technology transfer policy is administered by the Technology Base Program Office (Code D4). This office provides policy planning and guidance on technology matters impacting the role, mission, and long-term commitments of the Center. Policy implementation vehicles for technology transfer include the Center's Office of Research and Technology Applications (ORTA), the Navy Potential Contractor Program, and the Federal Laboratory Consortium for Technology Transfer. The Industry Independent Research and Development (IR&D) Program is also a contributor to technology transfer activities, since the transfer process can involve a two-way exchange between Government and non-government organizations. The IR&D Program serves to inform government technologists about industry-initiated research and it also serves as a mechanism for government researchers to appraise the progress and relevance of industry-initiated efforts. Guidance regarding technology transfer constraints is provided by the Militarily Critical Technologies List (MCTL), and the Center contributes to the technical review of export license applications received by the Navy Office of Technology Transfer and Security Assistance (NAVOTTSA). Technology transfer management functions include:

- managing the program within the Center;

- maintaining external liaison (with the Office of the Chief of Naval Research, the Federal Laboratory Consortium for Technology Transfer, the Department of Commerce, other Federal agencies, state and local governments, universities, and private industry);
- preparing Technology Application Assessments;
- assisting potential user organizations in formulating their problems;
- providing and disseminating information on federally owned or originated products, processes, and services having potential application to state and local governments and private industry;
- providing technical assistance in response to requests from state and local governments;
- functioning as Center manager for MCTL matters; and
- serving as Center manager for review of Navy-related export license applications.

Technical Effort

Project Work. Directly attributable and quantifiable technology transfer work performed by Center technical departments is generally represented by those projects funded by other Government (non-DoD) sponsors and private parties (excluding that effort funded under DoD contracts). This type of effort, identified as project work, has manpower and funding allocations that are directed towards a specific objective or requirement per sponsor request.

Technological Disclosures. In its role as a major Government R&D center, NAVSWC also serves as a significant contributor to Federal technology transfer in a more generic nature via technological disclosures in the open literature such as patents, reports, journals, and participation in symposia. The benefits from this type of activity accrete as spin-offs from DoD mission-related projects that are supported by Federal R&D appropriations. Although it is less tangibly measurable than technology transfer contributions of direct project work involving end-products, the long-term benefits are more highly promising since they provide the innovative community with a broad spectrum of new stimuli to promote economic, technical, and quality-of-life growth in the private and public sectors.

Navy-wide Services

The Center manages, edits, and publishes the "Navy Domestic Technology Transfer Fact Sheet." This monthly publication highlights Navy-wide technology and developments that have the appropriate approval for public release and are of potential benefit to public and private organizations, individuals, and other Federal laboratories. The program is sponsored by the Office of Naval Technology (Code ONT-26) to provide a highly visible source and focus for the dissemination of domestic technology transfer contributions from the Navy laboratory community.

In FY89, NAVSWC supported the Navy Domestic Technology Transfer Program Office (ONT-26) with a full-time senior staff member under the Navy Scientific and Technical Exchange Program (NSTEP). The purpose of the assignment was to develop Navy policy, guidance, and procedures for implementing technology transfer legislation.

PROGRAM FUNDING SOURCE

A summary of FY89 funding support for management activities and project work performed by the Center is presented below:

	FY89 ($K)
(1) Administrative Functions	
ORTA and NSTEP position	125
Other Technology Transfer	25
Technical Publications Division	237
	FY89 ($K)
(2) Technical Projects	
Engineering Department	549
Protection Systems Department	154
Strategic Systems Department	23
Research and Technology Department	130
Underwater Systems Department	21
Total	1264

The following technology transfer related policy directives are in effect at NAVSWC:

(1) NAVSWCINST 5700.2A of 6 Jan 1986; Subj: Office of Research and Technology Applications (ORTA). The purpose of this instruction is to establish the Center ORTA.

(2) NAVSWCINST 3900.3 of 13 October 1981; Subj: Industry Independent Research and Development (IR&D) Program.

(3) NAVSWCINST 3900.1A of 22 December 1981; Subj: Navy/Industry Cooperative Research and Development (NICRAD) Program (being reestablished as the Navy Potential Contractor Program (NPCP)). The purpose of this instruction is to establish procedures for processing NPCP agreements in accordance with Navy direction. The NPCP is technically not an element of the Navy's Domestic Technology Transfer Program. Frequently it involves the exchange of sensitive and classified information to authorized contractors. Nevertheless, transfer of technology is involved. Therefore, for administrative purposes this program is included as a functional element of the NAVSWC Technology Transfer Program.

The Center manager for ORTA/Technology Transfer, the IR&D Program, and NPCP is Mr. Ramsey D. Johnson, Code D4, (301) 394-1505 or Autovon 290-1505.

ACCOMPLISHMENTS AND CURRENT EFFORTS SUMMARY

Narrative summaries of NAVSWC technology transfer related projects involving FY89 effort are presented in Appendix A.

The following report, which describes recent Center accomplishments, efforts, and technology transfer related resources, was published for public release:

NAVSWC MP 89-38, Naval Surface Weapons Center Technology Transfer Report (FY88).

In FY89, 14 Technology Application Assessments were submitted to the Office of the Chief of Naval Research as input for the Department of Commerce, National Technical Information Service. These items are presented in Appendix B and listed below:

(1) Lithium Battery
(2) Electronic Analog Active Filters
(3) Security Device for Safes
(4) CMS-2 Software Metrics Tools
(5) Method and Device for Measuring Resistivity
(6) Method of Eddy Current Depth Measurement
(7) Device for Inspection of Materials by Eddy Current
(8) Silver Oxide (AgO) Cathode
(9) Magnetostrictive Sensors and Actuators
(10) Method of Measuring Magnetic Effects Due to Eddy Currents
(11) Gravity Global Positioning System
(12) Method of Determining the Orientation of a Moving Platform
(13) Data Acquisition and Reduction Processor System
(14) Freezer Alarm

INFORMATION DISSEMINATION AND WORKING RELATIONSHIPS

NAVSWC is a member of the Federal Laboratory Consortium for Technology Transfer and participates in meetings, symposia, and exhibits related to technology transfer activities involving the Navy, state and local governments, and private industry.

NAVSWC publishes and contributes to the "Navy Domestic Technology Transfer Fact Sheet." FY89 inputs to this document are listed below:

(1) Lightweight Nickel Composite Electrode
(2) Data Acquisition and Reduction Processor
(3) New Software Tool for Navy Development
(4) Electronic Security Indicating Attachment Developed
(5) High Energy Lithium Battery

NAVSWC has prepared an exhibit to publicize and promote the "Navy Domestic Technology Transfer Fact Sheet." This exhibit is displayed and manned at conventions such as the American Society for Naval Engineers (ASNE) and the National League of Cities. New subscribers are identified to expand the diverse range of scientists, engineers, and municipalities which participate in the information exchange medium. The publication is currently distributed to approximately 10,200 subscribers.

NAVSWC entered into the following NPCP Agreements in FY89:

	Company	Agreement Title
(1)	OPTO Electronics	TAIC Multi-color IR Chips
(2)	Honeywell Inc. Underseas Systems Division	Advanced Deep Water Concepts
(3)	AAI Corp.	Technology Exchange
(4)	Sperry Marine Inc.	Naval Space Integration
(5)	Lockheed Missiles & Space Co.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(6)	Textron Defense Systems	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)

	Company	Agreement Title
(7)	AT&T Bell Laboratories	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(8)	GE Aerospace (GE Company)	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(9)	Rocketdyne Div. - Rockwell International	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(10)	TITAN Systems Inc.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(11)	ORI, Inc.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(12)	VISIDYNE, Inc., New Jersey	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(13)	THE BDM Corp.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(14)	FMC Corp. Advanced Systems	Employment and Control for Fleet Tactical Systems
(15)	General Dynamics	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(16)	Textron Marine Systems	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(17)	The Analytic Sciences Corp. (TASC)	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(18)	Vitro Corp.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(19)	Boeing Aerospace	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(20)	The Charles Stark Draper Laboratory, Inc.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(21)	SRS Technologies	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(22)	Triton Defense Group, Inc.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(23)	Systems Exploration, Inc.	Naval Space Tactical Awareness Brief

	Company	Agreement Title
(24)	Kaman Sciences Corp.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(25)	Booze, Allen & Hamilton	Short Range AAW Systems Analysis and Design
(26)	Honeywell, Inc.	Torpedo Warhead Systems
(27)	McDonnell Douglas	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(28)	Martin Marietta	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(29)	Allied Signal, Inc.	Mine Delivery, Propulsion Systems
(30)	Newport News Shipbuilding Inc.	Naval Space Integration
(31)	Newport News Shipbuilding Inc.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(32)	Specialized Systems, Inc.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(33)	FMC Corp.	Cooperative Engagement Systems Concept
(34)	Avaren Microwave, Inc.	Passive Target Detection/Tracking for Naval AAW Applications
(35)	McDonnell Douglas Electron Systems Co.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(36)	Ingalls Shipbuilding	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)
(37)	FMC Corp.	Naval Combat Systems Warfare Analysis
(38)	Kollmorgen Corp. Electro-Optical Div.	Navy's Contribution to Nation's Strategic Defense (Stratplan 2010)

In FY89, there were 33 inventions and patent disclosures by NAVSWC with potential technology transfer applications. These are listed in Appendix C. NAVSWC also contributed approximately 420 unrestricted information disclosures via various media such as symposia, workshops, journals, and other publications.

In 1989, 21 NAVSWC technical publications were entered into the National Technical Information Service (NTIS) data base.

In support of individuals, industry, government, and academic institutions, the NAVSWC ORTA responded to information inquiries in the following technology areas:

(1) Composite materials
(2) Battery electrodes
(3) Software reliability analysis
(4) Eddy current non-destructive inspection
(5) Eddy current depth measurement
(6) Testing facilities
(7) Magnetostrictive sensors and actuators
(8) Electronic thermostat
(9) Freezer alarm

Numerous inquiries are also made directly to Center staff members within the various technical departments. The resultant responses significantly contribute to the Center's technology transfer process, although they are not identified and reported individually within the formal ORTA function.

APPENDIX A

NARRATIVE SUMMARIES FOR NAVSWC FY89 TECHNOLOGY TRANSFER RELATED PROJECTS

MANUFACTURING TECHNOLOGY

The Navy Manufacturing Technology Program requires that technology transfer to the private sector and Government agencies be a major activity of each funded project. Accordingly, upon completion each project is required to have an end-of-project demonstration for potential users or vendors, and to issue a final report. In both instances, efforts are made to disseminate the information to the widest possible audience. However, while some of the information is classified and some is unclassified, all is associated with critical, sensitive technologies. This information is not releasable for public information and such requests are individually assessed based on distribution restrictions. Each project manager is encouraged to actively communicate with interested parties during the project to transfer the developing technology.

In addition to technical project work, NAVSWC also provides technical and administrative program support to the Office of Naval Acquisition Support; the Naval Sea Systems Command; and the Office of the Assistant Secretary of the Navy, Shipbuilding and Logistics (OASN, S&L) for manufacturing technology programs.

The following Manufacturing Technology programs are ongoing at NAVSWC:

(1) Cast Projectile Program
(2) Spin Form Discontinuous Metal Matrix Composites (MMCs)
(3) Composites for Passive Thermal Management

SPACE SHUTTLE STUDY

NAVSWC completed a study for NASA (Marshall Space Flight Center) to determine the complete break-up process of the Space Shuttle's solid rocket boosters (SRBs) in a "command destruct," and further, to determine whether the process would also destroy the external tank (ET). This information was necessary to support a decision regarding the necessity of retaining the ET Range Safety System (RSS).

The most significant conclusion reached was that with the current SRB RSS design and with the ET RSS inactivated, no direct infliction of damage to the liquid oxygen (LOX) tank could be expected, i.e., LOX tank damage is possible but not probable. It was also determined that, when the SRBs are attached to the ET at destruct, the damage to the liquid hydrogen (LH_2) tank from SRB debris is considerably greater than that due to the ET RSS. Based on the conclusion regarding the LOX tank, the ET RSS has been retained.

As an outgrowth of this research, NAVSWC proposed a switch from the current design of an axially running linear shaped charge (LSC) to two circumferential LSCs. The potential advantages of the proposed redesign include increased chances for crew survival, decreased risk of breaching the containment vessel for nuclear powered payloads, and the capability to destroy the LOX and LH_2 tanks from the destruct of one SRB with the ET RSS inactive. The redesign effort was funded and is still in progress.

OTHER NASA/MARSHALL SPACE FLIGHT CENTER SUPPORT

Ultrasonic assessment of Large Solid Rocket Motor Bondline Integrity Using Time Delay Spectrometry. Included in the effort are tasks to:

- Evaluate Time Delay Spectrometry (TDS) for thru-transmission bondline inspection on Titan Solid Rocket Motors (SRMs), and transition existing NAVSWC TDS inspection system design parameters to the manufacturer.
- Survey the applicability of TDS reflection mode resonance technique to inspection of bondlines in existing NASA SRMs.
- Initiate a study on the effect of variations in solid rocket motor case and insulator design options on the ultrasonic inspectability of bondlines.

Carbon-carbon process investigation for the applicability of eddy current testing towards assuring proper manufacturing processes for carbon-carbon composite materials.

MAGNETICALLY SUSPENDED BALANCE

Under support from the National Aeronautics and Space Administration (Langley, VA), NAVSWC is developing a floating element skin friction balance for instrumentation in wind tunnel experiments. In this device a small segment (a disc) of the surface on which the skin friction is to be measured is electromagnetically isolated from the surrounding surface. This floating element of the balance is held in place by the balanced magnetic fields generated by twelve solenoids, allowing control of the motion of the floating element in six degrees of freedom. As varying viscous forces and pressures are applied to the disc of the balance, the magnetic fields are adjusted to hold the floating element in a fixed null position.

At present, a computer program has been completed, checked-out, and exercised to simulate balance dynamics for a one-dimensional case. This supports development of a completely operational simulation that will lead to the fabrication of an actual working balance, laboratory calibration of the balance, and check out in a controlled wind tunnel test.

NASA, GODDARD SPACE FLIGHT CENTER SUPPORT

Stepping motors that are small, have a high energy density, can microstep, and are self-locking upon removal of power are desirable for a wide variety of NASA's space-based applications. Stepping motors with these characteristics can be designed around the magnetostrictive material "Terfenol" (invented at NAVSWC). The

Goddard Space Flight Center (GSFC) requested NAVSWC technical assistance for design support and magnetic circuit analyses during the preliminary design phase of a stepping motor project.

NAVSWC inspected and performed non-destructive evaluation on specified Spartan spacecraft structural parts.

NAVSWC defined and specified networking requirements for computer-related design software for facility planning.

PARACHUTE TECHNOLOGY CONSULTATIONS

In FY89, NAVSWC contributed consulting services and, in some cases, technical assistance to the following government and industrial firms in the areas of aerodynamics, structures, packing, and deployment:

- NASA/Langley Research Center
- EPIC Engineering, Inc.
- IDMPC Company

SYSTEMS RESEARCH CENTER AT VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY (VPI&SU)

In 1983, NAVSWC; the Naval Sea Systems Command (NAVSEA), Combat Systems Directorate (SEA-06); and VPI&SU established the Systems Research Center (SRC) at the university. The SRC is intended to augment the technology base of NAVSWC in serving the research and development needs of surface combat systems, recognizing that the benefits derived can extend to subsurface and air platforms as well. The SRC has also expanded the technology base for other U.S. Navy R&D activities serving the research and development needs of surface combat systems. The SRC, NAVSWC, and NAVSEA's (SEA-06) joint effort emphasizes computer science and computing technology, key elements in modern naval applications. The SRC was established to perform only research and development.

By the close of FY89, the SRC had received nearly $4.52 million to perform 41 separate tasks. In FY89, there were ten active tasks with the SRC. Of these, five began in FY88 and five in FY89. Of the ten projects, NAVSWC sponsored nine at a cost of over $764K.

In late September 1989 an Indefinite Delivery Indefinite Quantity (IDIQ) contract was signed with VPI. The contract calls for performance from 30 September 1989 through 30 September 1994. The IDIQ contract has a potential value of nearly $7.78 million if fully funded. As of January 1990, four delivery orders valued at $466,568 have been initiated under the IDIQ.

COMPUTER SCIENCE RESEARCH CONSORTIUM

The Computer Science Department at VPI&SU has formed a Computer Science Research Consortium (CSRC) program. This program strengthens existing interactions and creates new professional interactions between VPI&SU professors, the Government, and the industry technical community. NAVSWC is a member of this

consortium and provides a representative for CSRC's steering committee. Mutual benefits of the program include:

- Providing a resource of quality graduates to academia, industry, and Government.
- Promoting Government/academia personnel exchanges.
- Providing feedback for orienting teaching requirements toward real-life applications.
- Providing an increased awareness of outside requirements to help focus academic research efforts.

During 1989, the Consortium sponsored the following events that promoted technology transfers:

- A semiannual newsletter containing articles on current research activities.
- A catalog of technical reports from VPI&SU's Computer Science Department.

DEPARTMENT OF TRANSPORTATION (COAST GUARD) SUPPORT

NAVSWC's Survivability Program Office provided engineering and technical support in the design, specifications, and procurement package preparation for a Collective Protection System to be used by the U.S. Coast Guard. The Coast Guard intends to install the CPS aboard the lead ship for the Heritage Class Patrol Cruiser.

NAVSWC conducted structural test firings on board Coast Guard cutters during FY89. This program ensures that the ships meet safety and structural requirements in the 75 mm gun blast areas. Additional 76 mm gun firings were conducted to gather engineering data on ship structure and carbon monoxide entry into ship compartments.

The following weapons system safety support was provided for the Hamilton class and Bear class Coast Guard cutters:

a. design of firing cut-out cams for the MK 75 and CIWS weapons;
b. fabrication of cut-out cams;
c. training of Coast Guard personnel to install cams; and
d. verification and certification of safety zones.

NAVSWC provided technical support and conducted electromagnetic interference (EMI) surveys of communications and radar systems onboard several U.S. Coast Guard ships. Benefits included EMI fixes and configuration changes to minimize EMI problems with follow-on ships of the same class.

NAVSWC's Ft. Lauderdale, FL, facility provided test range services for calibrating the speed, direction, and maneuvering instrumentation of a Coast Guard cutter.

TOURMALINE GAUGES

The original tourmaline gauge was designed and developed under Navy contract at Woods Hole Oceanographic Institute during World War II. These gauges are used to measure shock wave phenomena from underwater explosions. After the war, scientists formed Crystal Research Company to market the gauge; the company closed in 1972. NAVSWC purchased the company assets and began producing gauges to fill the void left by the defunct company. Improvements have been made to the gauges in relation to evolving technology.

NAVSWC constructs and calibrates the gauges which are sold at fixed price to various Government and industry research activities. Gauges and related information are exchanged with foreign governments with whom the U.S. has information exchange agreements. The Elda Trading Corporation purchased gauges in FY89.

DEPARTMENT OF TRANSPORTATION/FHWA

Under previous Federal Highway Administration (FHWA) sponsorship, the NAVSWC has developed a prototype battery-operated motor vehicle detection system. This Self-Powered Vehicle Detector (SPVD) may be buried in any type of road surface and uses RF transmission rather than hardwiring for communication with its control unit. The detector reads a vehicle's magnetic signature, processes it, and transmits the vehicle's presence to the remotely located control unit. Details of this device are provided in NAVSWC Technology Application Assessment NSWC-TAA-85-002.

In FY89, NAVSWC provided design consultation for pre-production SPVD units being manufactured by private industry under FHWA contract.

UNIVERSITY RESEARCH ASSIST

NAVSWC participates in a continuing cooperative effort with the Catholic University of America by providing Van de Graff accelerator and computer assistance for the development of an improved data base and predictive capabilities in heavy ion stopping powers and ion-induced K-shell ionization probabilities. The effort has applications in materials modification through ion implantation and surface layer alloying, and ion materials analysis through ion-induced X-ray production.

APPENDIX B

NAVSWC FY89 TECHNOLOGY APPLICATION ASSESSMENTS

Title	Lab No.
Lithium Battery	NSWC-TAA-88-001
Electronic Analog Active Filters	NSWC-TAA-89-002
Security Device for Safes	NSWC-TAA-89-003
CMS-2 Software Metrics Tool	NSWC-TAA-89-004
Method & Device for Measuring Resistivity	NSWC-TAA-89-008
Method of Eddy Current Depth Measurement	NSWC-TAA-89-009
Device for Inspection of Materials by Eddy Current	NSWC-TAA-89-010
Silver Oxide (AgO) Cathode	NSWC-TAA-89-011
Magnetostrictive Sensors & Actuators	NSWC-TAA-89-012
Method of Measuring Magnetic Effects Due to Eddy Currents	NSWC-TAA-89-013
Gravity Global Positioning System	NSWC-TAA-89-014
Method of Determining the Orientation of a Moving Platform	NSWC-TAA-89-015
Data Acquisition & Reduction Processor System	NSWC-TAA-89-016
Freezer Alarm	NSWC-TAA-89-018

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4 Technology Name LITHIUM BATTERY

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____
CONSUMERS

A. Date: 13 JANUARY 1989
B. CUFT #: _____
C. LAB #: NSWC-TAA-89-001
D. Descriptors:
Battery
Lithium
Non-Aqueous Primary Cell
Halocarbon Cathode Depolarizer
Electrochemical Cell

E. Applications:
Battery Companies:
Duracell
Union Carbide
SAFT
Honeywell
etc.

7. Potential Support: exclusive license, (consulting), joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? This invention solves the problem of the dangerously high acute toxicity of present Lithium batteries. This is achieved by the use of a halocarbon cathode-depolarizer.

9 Other Uses: None

10. Main Advantages: The battery design provides for a safe, stable, long life high energy lithium battery.

11. Production Information: Small capitalization costs.

12. Descriptive Literature: References are cited in the "Description" of item 13b.

13a. Literature Available From: Dr. Patricia Smith, Dr. Stanley James, NAVSWC/WO Code R33, (301) 394-2948
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Since the early '60s, there has been a great deal of research and development work seeking the "ideal lithium battery." The effort has centered on achieving high energy and power density. Two oxysulfur cathode systems, Li/SO_2 and Li/$SOCl_2$, assumed importance during the '70s. They have proven to be very successful in yielding high energy density with excellent discharge characteristics. However, safety problems persisted with these systems. Under some conditions, they are prone to fires and explosions with the venting of toxic gases. The objective of NAVSWC's task was to investigate various alternatives to current lithium systems that are of equal energy density, but would be much safer and less toxic.

One approach to finding alternative oxidants is to explore fluorochlorocarbons whose properties include low toxicity and/or a relatively low shock sensitivity toward lithium. This seems a likely choice since many halocarbons have high calculated free energies for their reaction with lithium. For example, the two-electron reduction of 1,1,2,2,-tetrachloroethane coupled with lithium oxidation has a theoretical voltage of 3-4 volts ($CHCl_2CHCl_2$ + 2Li→CHClCHCl + 2LiCl,$\Delta G^{\bullet}_{cis}$ = -155.8 kcal/mole, ΔG°_{trans} = -154.5 kcal/mole).

In this investigation, 26 halocarbons were characterized as potential cathodes for lithium batteries. Testing and characterization included. (1) screening the halocarbon's chemical stability with lithium, (2) comparing the shock sensitivity of lithium plus halocarbon versus lithium plus oxychlorides ($SOCl_2$, SO_2Cl_2), (3) measuring conductivity of halcarbon/cosolvent electrolytes, (4) discharging lithium battery packs, and (5) analyzing discharge products of the most promising systems.

A wide range of commercially available halocarbon liquids has been characterized as potential cathode materials for safer Li batteries. Alkyl halides are adequately stable to Li and (compared with sulfur oxychlorides) are very much less acutely toxic and show a much smaller shock-sensitivity toward metallic Li. Electrolyte conductivity sufficient for low and medium rate discharges was achieved in $LiAsF_6$ solutions in 50 percent 25/25 halcarbon/ cosolvent (normally THF). Lithium/50 percent halocarbon THF, 1.5M $LiAsF_6$/Shawinigan Acetylene Black cells discharged at 1mA.cm^{-2} displayed mid-discharge voltages ranging from 1.2-1.5V. Doping cathodes with transition metals or their complexes increased working voltages by up to 1V, apparently by redox catalysis of halocarbon reduction. The most promising halocarbon identified in the investigation is 1,1,2,2,-tetrachloroethane, $CHCl_2CHCl_2$ (TCE), whose catalyzed voltages were 2.3-2.4V at 1mA.cm^{-2} and 2.0-2.1V at 5mA.cm^{-2}. Electrolyte-limited discharges with Li/TCE showed electrical capacities equal to that of Li/$SOCl_2$ were achieved using 69 percent TCE/31 percent THF. Energy density of the Li/TCE battery is estimated to be comparable with that of Li/SO_2. Product analysis and coulometry of Li/TCE discharges are consistent with a 2 electron/TCE reduction to cis- and trans-dichloroethylene.

Discharges performed on Li/$CHCl_2CHCl_2$-THF,1M $LiAsF_6$ cells where the amount of electrolyte was limited, indicated that capacities equivalent to 1.5M $LiAlCl_4$-$SOSl_2$ cell could be achieved when the halocarbon/THF ratio equaled 69/31 volume percent.

It is further noted that lithium halocarbon cells should be considerably safer than many existing lithium systems. Although $CHCl_2CHCl_2$ is carcinogenic, it is certainly less noxious and less acutely toxic than SO_2 and

13b. Description: (Cont.)

various sulfur oxychlorides. This is an advantage if a cell should vent in an enclosed space. In addition, the lack of sulfur is considered to be an advantage since under certain conditions sulfur may act with lithium producing thermal runaway conditions.

The following table provides a comparison of the operational characteristics of conventional battery types to the NAVSWC Lithium batteries.

COMPARISON OF NAVSWC'S LITHIUM BATTERIES WITH TYPICAL PRIMARY BATTERIES

Cell Type	Open Circuit Voltage	Working Voltage	Energy-Density WH/LB, Battery	Charge-Density AH/LB, Battery
Conventional				
Common Dry	1.6	0.9-1.4	20-30	23
Alkaline Dry	1.5	0.9-1.4	30-40	32
Mercury	1.35	1.3	35-45	31
Magnesium	1.8	1.5-1.6	40-45	27
First-Generation Lithium				
Sulfur Dioxide	2.9	2.7-2.8	150	55
Thionyl Chloride	3.6	3.4-3.5	300	87
NAVSWC'S Lithium*-Catalyzed Tetrachloroethane (TCE)				
75% TCE	3.2	2.2-2.3	160	71
50% TCE	3.2	2.2-2.3	130	58

* Energy and charge densities are based on the assumption that cell construction would be similar to the $Li/SOCl_2$ battery.

The resulting product, of this NAVSWC investigation, provides for a new non-aqueous high energy lithium battery. The properties of this lithium battery design are. safe storage, does not ignite or explode, does not vent toxic gases, and has a high output voltage and a high storage capacity.

These design aspects are achieved by the use of a non-aqueous electrochemical cell. The cell consists of:

a. a lithium anode

b. a non-aqueous electrolyte comprising a lithium electrolyte salt and a solvent mixture of.

(1) a halocarbon solvent cathode depolarizer, and

(2) an inert, slightly polar cosolvent which increases the solubility of the lithium electrolyte salt,

13b Description: (Cont.)

c. a catalyzed carbon cathode comprising from more than zero to 30 weight percent of a catalyst (e.g., transition metal organic complexes like cobalt tetraazaannulene).

The halocarbon cathode-depolarizer was selected to provide a safe, stable, long life high energy lithium battery. In general, iodocarbons and bromocarbons are too reactive to produce the desired stability in the present battery system. As a result, chlorocarbons and chlorofluorocarbons are selected as the halocarbons to obtain this stable, energetic lithium battery.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

Descriptive Literature:

a. "New Liquid Cathodes for Lithium Batteries,"
Part A, Halocarbons, K. M. O'Neill,
S. D. James, and P. H. Smith, Technical Report TR 84-178,
Naval Surface Warfare Center, White Oak, MD

b. "A Survey of Halogen - Containing Liquids as Lithium Battery Cathodes,"
Part I: Uncatalyzed Systems, and
Part II: Catalyzed Systems, Journal of Electrochemistry,
13b, 1625, 1631 (1989).

c, Invention Disclosure, . atent #4, 751, 161, 14 June 88.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name ELECTRONIC ANALOG ACTIVE FILTERS

5. Technology Type: (a) Process ((b)) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: ((a)) Federal Government (b) State Government (c) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry ((g)) Consultant (h) Other: _____

A. Date: 3 FEBRUARY 1989
B. CUFT #: _____
C. LAB #: NSWC-TAA-89-002
D. Descriptors:
Amplifiers
Analog Circuitry
Active Filters
High-Frequency Filter
Improved Active Filter
Frequency Limit Extension

E. Applications:
Analog Circuitry
Active Filters

7. Potential Support: exclusive license, (consulting), joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng , other: _____

8. What Problem Does It Solve and How? Current active filters are normally made using operational amplifiers (op-amps) which must have very high gain, but yet be stable with the output connected directly to the input. Op-amps have stability problems and do not work well at high frequency. This active filter does not use the unstable, very high-gain op-amps

9 Other Uses: Any high-frequency filter applications

10 Main Advantages: A high-frequency active filter which is stable at high frequencies

11 Production Information: Prototype has been built and is working

12 Descriptive Literature: References cited in the "Description" of item 13b

13a Literature Available From Mr Arthur D Delagrange, NAVSWC/WO, Code U25, (301) 394-2475
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

A high-frequency action filter is presented having an amplifier providing an open loop gain between one and three. The filter configuration consists of pole-zero pairs with no intentional connection between the negative input terminal of the amplifier and the output terminal of the amplifier. The active filter design provides active filters at high frequencies using low-gain amplification stages.

In order to appreciate the advantages of the below discussed high-frequency active filter design, a comparison between active and passive filters is presented:

a. Passive filters have virtually no high-frequency limit, but become bulky below 10 KHz and are virtually unacceptable below 1 KHz. Active filters suit the mid-range from 1 Hz to 1 KHz, but also can be used with some care to 10 KHz, and in limited applications can be used as high as 100 KHz.

b. Passive filters usually must be impedance-matched on both input and output, while active filters normally have a high enough input impedance and a low enough output impedance that impedance is not a problem.

c. Some types of passive filters can have many sections (e.g., 23 pole crystal filter). Active filter design becomes difficult beyond 10 poles.

d. Passive filters have no inherent limit beyond practical considerations such as the size of inductances on the low end and parasitic capacitance or load and other inductances at the high end. Active filters are limited by the power supply on the high end and semiconductor noise on the low end.

e. Passive filters often show large discrepancies between calculated and actual performance. The calculations of active filters tend to be good, especially if tolerance errors are accounted for.

Active filters are normally made using operational amplifiers (op-amps). Op-amps must have very high (virtually infinite) gain, but yet be stable with the output connected directly to the (inverting) input (negative feedback). This is a difficult requirement and, thus, op-amps have stability problems and do not work well at high frequency.

Therefore, it is desirable to provide a simple, concise, unified method for building any type of high frequency active filter without using unstable, very high gain op-amps. The herein presented design provides a high frequency active filter, without the use of high gain op-amps, which is stable at said high frequencies. This design permits the raising of the high frequency limit normally imposed on the use of active filters. Building active filters without op-amps can virtually eliminate stability problems and provide much larger bandwidths.

An amplifier having an open loop gain between one and three is provided with appropriate electrical components of appropriate values for generating the desired filter configuration of pole-zero pairs with no intentional connection between the negative input terminal of the amplifier and the output terminal of the amplifier.

13b. Description: (Cont.)

Figure 1 shows a general schematic of an exemplary embodiment of this design for generating pole-zero pairs.

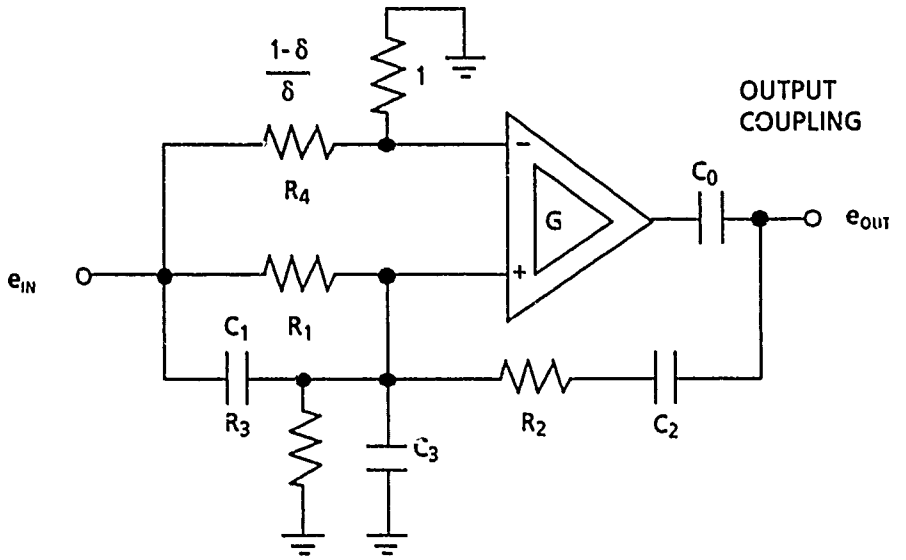

FIGURE 1

Figure 1a allows one to generate pole-zero pairs using a fixed-gain amplifier (represented by a double triangle) The complete single circuit, including the voltage-divider components, is shown in Figure 1b.

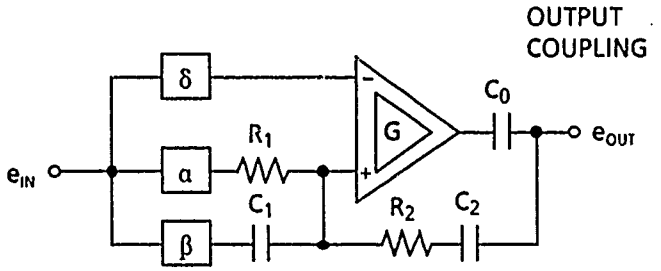

FIGURE 1a

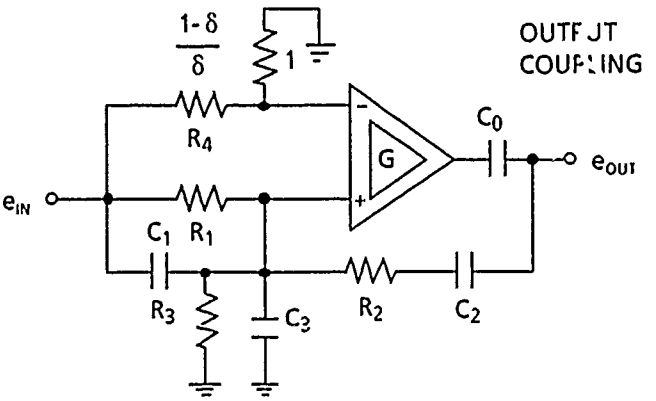

FIGURE 1b

13b. Description: (Cont.)

Figure 2 shows a plurality of amplifiers shown in Figure 1 connected for providing a filter configuration, and in particular, a bandpass filter.

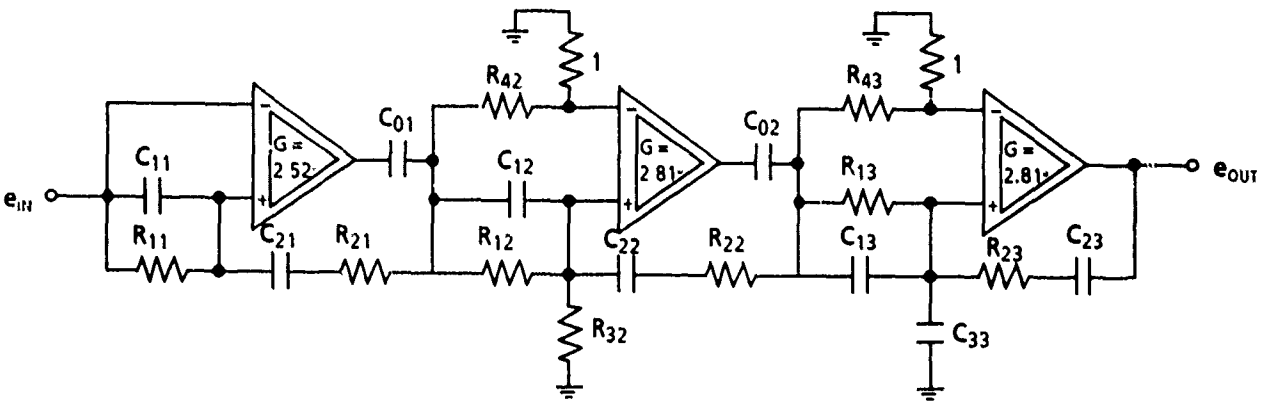

FIGURE 2

Figure 3 is a graph showing the frequency response of the bandpass filter of Figure 2 having a high center frequency of 160 KHz and without the respective amplifiers being provided with negative feedback.

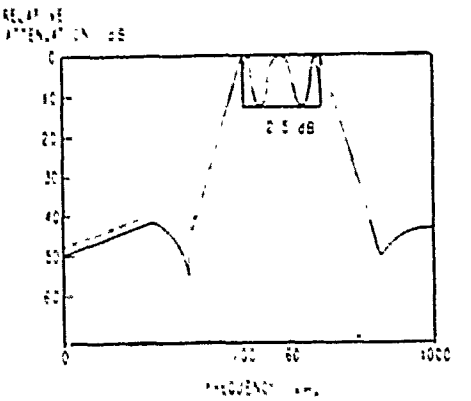

FIGURE 3

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

Descriptive Literature:

a. EDN Magazine, 20 February 1986, pages 247-248.

b. United States Patent Disclosure, #4,767,998, 30 August 1988.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name SECURITY DEVICE FOR SAFES

5. Technology Type: (a) Process ((b)) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: ((a)) Federal Government ((b)) State Government ((c)) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry ((g)) Consultant ((h)) Other: All Owners of safes or vaults

A. Date: 10 MARCH 1989
B. CUFT #: _____
C. LAB #: NSWC-TAA-89-003
D. Descriptors:
Security Devices
Safe Security
Vault Security
Door Security

E. Applications:
Safes
Vaults
Security Containers
Doors

7. Potential Support: exclusive license, ((consulting)), ((joint venture)), ((drawings)), tooling, computer prog., economic study, training, adaptive eng., other: circuit diagrams, flow charts

8. What Problem Does It Solve and How? This device removes the uncertainty that a safe or vault has been opened or is still unlocked. This device alerts the safe or vault user audibly and visually that the safe or vault is open and also ensures the user that the safe or vault has been properly locked.

9. Other Uses: The device readily lends itself to be incorporated into a master computerized control system for monitoring a plurality of safes/vaults.

10. Main Advantages: Audio and visual monitoring of security containers. Low cost. Adaptability for use with multiple number of units.

11. Production Information: Easily producible. Prototype model has been built.

12. Descriptive Literature: U.S. Patent #4,772,877, 20 September 1988.

13a. Literature Available From: Mr. Gregory H. Drescher, NAVSWC/DL, Code K43, (703) 663-8542
Naval Surface Warfare Center
Dahlgren, VA 22448-5000

13b. Description:

This device is an improved electronic security indicating attachment for use with safes/vaults which provides an indication that a door has been opened and also whether a closed door is properly secured.

Various types of devices have been designed for indicating, in numerous ways, whether a safe/vault has been properly secured. However, none of the earlier designs provide for a construction where the attachment can be readily attached to the safe/drawer and required low power usage.

This device readily lends itself to being easily attached to a door/drawer and because of its low power needs, it uses a simple battery pack for its power supply and minimal servicing such as merely replacing the battery. The device is designed to be an inexpensive, adaptable aid to safe security that can be attached to almost any safe. The device turns itself "on" when the safe is opened and turns itself "off" when the safe is properly secured. This automatic on/off feature conserves battery energy.

The safe/vault security device consists of a power supply, a means for sensing the position of the drawer, an audio alarm, and a visual door status indicator. A micro-processor is electrically connected to the power supply, the sensing means, and to the indicating and detecting means. The drawer sensing unit actuates the audio/visual alarm indicator when the drawer/door is opened or when the closed drawer/door has been improperly or properly secured. This security device could be made virtually "tamper proof" by building it into the safe. Figure 1 highlights the various features of the device.

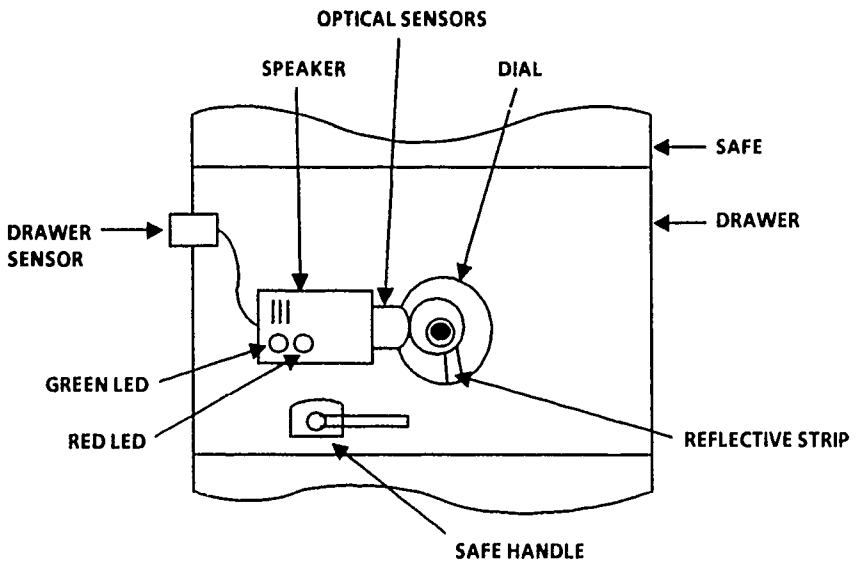

FIGURE 1. DIAGRAM OF SAFE ATTACHMENT

13b. Description: (Cont.)

When the safe is opened, the device indicates power up by sounding a tone and lighting a red LED. It does this periodically the entire time the safe is open to inform the user that the safe is not secure. When the safe is closed, the dial must be rotated at least four times in the same direction to be fully secured. A reflective piece of tape is attached to the dial so that the device can sense the dial rotation. The device then counts the rotations of the dial to ensure at least four complete rotations. When four rotations have been sensed, it sounds a secure tone, lights the green LED, and shuts itself off. If the user does not rotate the dial after closing the safe, or fails to rotate the dial four times in the same direction, the device lights the red LED and sounds an alarm tone.

This device offers many advantages as an attachment to a safe or as a built-in device. With minor software changes or additions, the device could be attached to a standard serial or parallel port to lend itself to attaching into a network of safes that are attached to a PC to monitor all safes in a building. It could also be attached to some type of keypad so that the user(s) of the safe could enter an identification number, and the device could then keep track of safe accesses.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name CMS-2 SOFTWARE METRICS TOOL

5. Technology Type: (a) Process (b) Apparatus (c) Material
   (d) Service (e) Study (f) Other: SOFTWARE TOOL

6. Users: (a) Federal Government (b) State Government
   (c) Local Government (d) Small Industry (e) Medium Industry
   (f) Large Industry (g) Consultant (h) Other:
   USN Software Developers/Contractors

A. Date: 14 APRIL 1989
B. CUFT #:
C. LAB #: NSWC-TAA-89-004
D. Descriptors:
Software Metrics
Software QA
Software Tools

E. Applications:
Software Development for Navy
CMS-2 Based Projects

7. Potential Support: exclusive license, consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng , other:

8. What Problem Does It Solve and How? CMSTOOL allows for automated collection of software metrics for CMS-2 based programs (Navy). This software tool extracts qualitative metrics and programming standards indicators directly from CMS-2 source code. Previous method would be manual extraction. Principal application is in software development phase of project.

9. Other Uses: CMSTOOL can be used in program management, software quality assurance, and software testing disciplines as well as programming.

10 Main Advantages. Present methods would require manual extraction of data by desk checking and software audit reports. Productivity and resource utilization will be much higher by using an automated tool for software metrics collection.

11. Production Information: CMSTOOL VERSION 1.2 is VAX Pascal based. It is portable and customizable. The product includes all software and documentation.

12 Descriptive Literature: NSWC CMSTOOL Program Description Document, Ver. 1.2, 21 March 1989. NSWC On-The-Surface article dated 17 Feb 1989.

13a. Literature Available From: Mr. Michael Peeler, NAVSWC/DL, Code E32, (703) 663-8836
Naval Surface Warfare Center
Dahlgren, VA 22448-5000

13b. Description:

CMSTOOL Version 1.2

CMSTOOL was developed by the U.S. Navy to provide a range of software quality measurements, including CMS-2 source code complexity, programming standards and style checking, and software maintenance indicators.

CMSTOOL is an automated software metrics tool for the analysis of CMS 2 computer programs. The tool provides a McCabe based software complexity, measurement, subtasking level, percentages of commenting, direct code usage, and HOL in the source code, program size, and a number of programming standards and style indicators. Specifically, there are seven (7) quantitative metrics and twelve (12) standard flags generated by CMSTOOL. This tool will support Software Quality Assurance (SQA) efforts involved in CMS-2 based projects.

CMSTOOL analysis of CMS-2 embedded computer programs allows the system programmer/analysts to evaluate the software's characteristics in terms of modularity, understandability, complexity, portability, and maintainability. Data from the tool can also be useful in software test plan phases to ensure that testing priority/effort is focused on the high complexity modules.

Present methods for extracting metrics from CMS-2 programs would be manual. Not only does CMSTOOL automate this process but it is also highly customizable in terms of tailoring the standards and style indicators to specific, project defined software development guidelines.

The software package for CMSTOOL includes source program, executable code, VAX Command Files to support both interactive and batch processing, installation/user notes, and a Program Description Document (PDD) formatted for laser printing.

CMSTOOL Version 1.2 is operational and ready for release.

Patent rights are currently under investigation. A Patent Rights Questionnaire and Record and Disclosure of Invention document will be filed.

For information on licensing of this subject, contact the Naval Surface Warfare Center,
Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4 Technology Name METHOD AND DEVICE FOR MEASURING RESISTIVITY

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____
Aerospace Industry and Foreign Allies

A. Date: 7 JULY 1989

B. CUFT #: _____

C LAB #: NSWC-TAA-89-008

D. Descriptors:
Resistivity Measurement
Conductivity Measurement
Radar Absorbing Materials Characterization
Eddy Current Nondestructive Inspection

E. Applications:
Resistivity Measurement
Characterization of Radar Absorbing Materials

7. Potential Support. (exclusive license) (consulting) joint venture, (drawings) tooling, computer prog., economic study, training, adaptive eng., other: _____

8 What Problem Does It Solve and How? Solves the problem of measuring the electrical resistivity of components which may fall in one or both of two categories, 1) either a protective coating or the composition of the material prohibits the formation of good electrical contact, and 2) the resistivity falls in a range for which no calibration standards are available The method is based on the universal impedance curve associated with all ferrite pot core eddy current probes It relates the tangent of the lift off angle to a reference number of which
(Continued on Page 2 of 3)

9 Other Uses: _____

10 Main Advantages Does not require calibration standards With proper probe and frequency selection the method covers an unlimited range of resistivities

11 Production Information The method can be applied with modified laboratory instruments Technology ready for design of commercial instrument Low capitalization costs

12 Descriptive Literature: Vernon, S N , "A Single sided Eddy Current Method to Measure Electrical Resistivity," Materials Evaluation, Vol 22, No 12, Nov 1988, pp 1581-1587, and Vernon, S N , "The Universal Impedance Diagram of the Ferrite Pot Core Eddy Current Transducer," IEEE Transactions on Magnetics, Vol 25, No 3, May 1989, pp 2639-2645

13a Literature Available From The Journals and from Susan Vernon, NAVSWC/WO, Code R34, (301) 394 1029
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Method and Device for Measuring Resistivity--The method provides the ability to measure resistivity of materials ranging from metals to weakly conducting fiber reinforced composites without recourse to calibration standards. The method is nondestructive and not hindered by the presence of a nonconducting coating. The method can be used to identify materials by their resistivity, to estimate fiber density, to evaluate radar-absorbing characteristics, and to insure adequate nondestructive inspection by eddy current methods. The technology is proven and the market identified (military and commercial aviation). The patent was filed on 9 January 1989 and is pending.

For information on licensing of this subject contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (202) 394-1505.

8. (Cont.)

resistivity is a part. The tangent of the lift-off angle is the ratio of the change, due to the test material, of the imaginary component of the impedance to the change in the real component. The reference number is the ratio of the mean radius of the eddy current probe to the skin depth. Available commercial eddy current instruments do not provide accurate phase detection capabilities over the wide frequency range required to inspect carbon fiber reinforced composites. The device provides for accurate phase detection over the necessary wide range of frequencies.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3 Address SILVER SPRING, MD 20903-5000

4 Technology Name METHOD OF EDDY CURRENT DEPTH MEASUREMENT

5. Technology Type: ((a)) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: ((a)) Federal Government (b) State Government (c) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry ((g)) Consultant ((h)) Other: _____
Aerospace Industry and Foreign Allies

A. Date: 7 JULY 1989
B. CUFT #: _____
C LAB #: NSWC-TAA-89-009
D. Descriptors:
Nondestructive Inspection
Flaw Characterization
Composite Material Inspection

E. Applications:
Inspection of Both Carbon Fiber Reinforced Composites and Metal
Subsurface Defect Characterization

7. Potential Support. ((exclusive license)), ((consulting)), joint venture, ((drawings)), tooling, computer prog., economic study, training, adaptive eng , other: _____

8. What Problem Does It Solve and How? Solves the problem of estimating the extent of damage in materials, particularly carbon fiber reinforced composites for which calibration standards are impractical or impossible to design and fabricate It is based on the universal impedance curve associated with all ferrite pot core eddy current probes It relates the depth of the detected defect to the phase of the eddy current response at the point of maximum response magnitude

9 Other Uses Can be used to measure the distance between the surface and subsurface damage in any electrically conducting material

10 Main Advantages Does not require calibration standards Unlike other nondestructive methods used to inspect composites, eddy current is sensitive primarily to damage involving broken fibers

11 Production Information The method can be applied with modified laboratory instruments The technology is ready for design of a commercial instrument Capitalization costs would be low

12 Descriptive Literature Vernon, S N , "Parametric Eddy Current Defect Depth Model and its Application to Graphite Epoxy," NDT International, Vol 22, No 3, June 1989, pp 139-148; and Vernon, S N , "The Universal Impedance Diagram of the Ferrite Pot Core Eddy Current Transducer," IEEE Transactions on Magnetics Vol. 25, No 3, May 1989, pp 2639-2645

13a Literature Available From: Susan Vernon, NAVSWC/WO, Code R34, (301) 394-1029
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Method of Eddy Current Defect Depth Measurement--This method provides an estimate of the distance between the scanned surface and subsurface damage in any electrically conductive material. It is particularly useful in the nondestructive inspection of carbon fiber reinforced composites where it is impractical to design and fabricate calibration standards. The estimates provide a basis for determining the extent to which the component has been weakened by the damage and it may aide in repair assessment of aerospace structures. The technology is proven and the market identified (military and commercial aviation). The patent was filed on 9 January 1989 and is pending.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name DEVICE OF EDDY CURRENT INSPECTION OF MATERIALS

5. Technology Type: ((a)) Process ((b)) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: ((a)) Federal Government (b) State Government (c) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry ((g)) Consultant ((h)) Other: _____
Aerospace Industry and Foreign Allies

A. Date: 7 JULY 1989
B. CUFT #: _____
C LAB #: NSWC-TAA-89-010
D. Descriptors:
Eddy Current Nondestructive Inspection
Filament Wound Carbon Fiber Reinforced Composites

E. Applications:
Nondestructive Inspection of Filament Wound Carbon Fiber Reinforced Composites and Any Other Material Having Conducting Paths in the Circumferential Direction

7. Potential Support: ((exclusive license)), ((consulting)), joint venture, ((drawings)), ((tooling)), computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? Solves the problem of using eddy current methods to inspect materials which are conductive only in the circumferential direction and where both circumferential and axial resolution of the detected anomaly is required The device comprises an encircling coil transmitter and a receiver When applied to filament wound carbon fiber reinforced composites, the transmitter induces eddy current flow in the circumferentially wound fibers The receiver detects localized variations in this current flow which may be due to
(Continued on Page 2 of 2)

9. Other Uses: _____

10 Main Advantages Provides for the eddy current inspection of components which could not be inspected with the same degree of defect resolution by existing eddy current coils and coil combinations

11 Production Information The method can be applied with modified laboratory instruments The technology is ready for design of a commercial instrument Capitalization costs would be low

12 Descriptive Literature: _____

13a. Literature Available From: Susan Vernon, NAVSWC/WO, Code R34, (301) 394-1029
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Device for Inspection of Materials by Eddy Current Methods--The device comprises an encircling coil transmitter and a receiver. When applied to filament wound carbon fiber reinforced composites, the transmitter induces eddy current flow in the circumferentially wound fibers. The receiver detects localized variations in this current flow which may be due to localized variations in this current flow which may be due to fiber breakage or to variations in fiber density. The receiver may be a U-shaped eddy current probe, or possibly a Hall probe, or a SQUID. The device can be used for the inspection of any component which has conductivity in the circumferential direction, conduction paths need not be limited to this direction. The patent was filed on 30 June 1989 and is pending.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

8. (Cont.)

fiber breakage or to variations in fiber density. The receiver may be a U-shaped eddy current probe, or possibly a Hall probe, or a SQUID. The device can be used for the inspection of any component which has conductivity in the circumferential direction; conduction paths need not be limited to this direction.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4 Technology Name SILVER OXIDE (AgO) CATHODE

5. Technology Type: (a) Process (b) Apparatus (c) Material
(d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government
(c) Local Government (d) Small Industry (e) Medium Industry
(f) Large Industry (g) Consultant (h) Other: _____
Aerospace Industry and Foreign Allies

A. Date: 11 JULY 1989
B. CUFT #: _____
C. LAB #: NSWC-TAA-89-011
D. Descriptors:
Cathode
Silver Oxide
Battery
Electrode

E. Applications:
Batteries

7. Potential Support: exclusive license, consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? The thermal decomposition of AgO cathodes during storage of AgO/Zn reserve batteries causes discharge problems. Such batteries need to be replaced periodically at great expense to the Navy. The high thermal stability of the new AgO cathode may solve this problem

9 Other Uses: None

10 Main Advantages. Higher thermal stability than conventional, electroformed silver oxide electrodes.

11 Production Information: None

12 Descriptive Literature: Patent Disclosure, Navy Case No. 71677

13a. Literature Available From: Dr. Steven Dallek, NAVSWC/WO, Code R33, (301) 394-1364
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Silver oxide/zinc (AgO/Zn) primary reserve batteries are in widespread use for various military applications. The AgO cathodes are electrochemically formed by anodization of sintered silver plates. In the reserve configuration, the KOH electrolyte is separated from the remainder of the cell to prevent self-discharge of the battery during storage. Nevertheless, the high decomposition (self-discharge) rate of many AgO cathode materials during reserve battery storage remains a problem of great concern. This thermal instability can result in severe degradation in battery discharge performance. For instance, AgO decomposes to form Ag_2O which has a much higher ohmic resistance, causing a voltage regulation problem. The evolved O_2 increases the internal cell pressure which can cause an activation problem by preventing adequate injection of the KOH electrolyte into the cells. Furthermore, the reaction between the evolved O_2 and the Zn anode, forming a film of ZnO, results in increased polarization after activation. Capacity losses at both electrodes are also an obvious consequence of these processes. It is apparent that performance degradation problems with these batteries are related, ultimately, to the decomposition of the AgO cathode during storage of the battery in the weapon. As a result, such batteries need to be replaced periodically at great expense to the Navy.

We have developed a new AgO cathode material that has extremely high thermal stability. The standard charging procedure for sintered silver plates was modified by performing the charging at elevated temperatures (70°-110°C). It was postulated that AgO material formed at high temperature should possess superior thermal stability; the formation of less stable modifications of the material would be impeded during the preparation procedure. Additionally, it is well known that thermally stable, chemically prepared AgO material, used in low-rate batteries, is synthesized at elevated temperature.

The new material was found to have extremely high thermal stability with a decomposition activation energy, E_a, of 146 kJ/mol determined by thermogravimetry. The E_a values of other AgO materials ranged from 100 to 133 kJ/mol. The excellent thermal stability of the new material was confirmed by an accelerated-aging study. Details of the preparation procedure and properties of the new AgO material can be found in the patent disclosure (Navy case no. 71677).

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name MAGNETOSTRICTIVE SENSORS & ACTUATORS

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____
Aerospace Industry and Foreign Allies

A. Date: 12 JULY 1989
B. CUFT #: _____
C. LAB #: NSWC-TAA-89-012
D. Descriptors:
Actuator
Magnetometer

E. Applications:
Magnetometer
Tactile Sensor and Actuator

7. Potential Support: (exclusive license) consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? Tactile Sensor and Actuators for fields such as sonar and active vibration damping.

9. Other Uses: Materials may be used in magnetometers.

10. Main Advantages: Highest figures of merit known.

11. Production Information: _____

12. Descriptive Literature: _____

13a. Literature Available From: Dr. Howard Savage, NAVSWC/WO, Code R45, (301) 394-4904
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Most ferromagnetic materials show the phenomena of magnetostriction; a simple example is a ferromagnetic parallelepiped changing length when a magnetic field is applied along its axis (Figure 1). The change in length with magnetic field allows the parallelepiped to be used as an actuator. The change in length with field implies that an imposed change in length will change the magnetic moment of the material which can be detected in several ways. Thus magnetostrictive materials can also be used as stress and strain sensors.

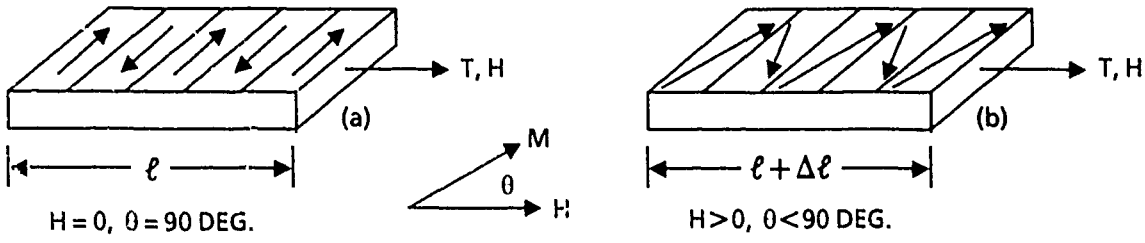

FIGURE 1. (a) THE MAGNETIZATION OF A SIMPLE FERROMAGNETIC PARALLELEPIPED. (b) AS THE MAGNETIC FIELD H INCREASES, THE MAGNETIC MOMENT M ROTATES AND THE PARALLELEPIPED ELONGATES. A STRESS T (OR STRAIN) WILL ALSO ROTATE THE MOMENT.

We will discuss two materials: (1) the amorphous ferromagnetic materials (made by rapid quenching) which show great promise in sensor applications; and (2) alloys of $TbFe_2$ and $DyFe_2$ that have a "Watts/meter^3" figure of merit equivalent to hydraulic actuators but with much higher frequency response and positioning accuracy. In (1) we can "engineer" the physical characteristics of the amorphous materials to achieve properties more extreme in nature than in crystalline solids. This has lead to the development of prototype magnetostrictive strain gauges, torque sensors, pressure sensors, and accelerometers. Certain amorphous materials are being used in prototype magnetometers because of lower Barkhausen noise. Power transformers exploit the low (but still metallic) conductivity. The material has the highest figure of merit known for hydrophones (devices for underwater sound detection). Magnetostrictive strain gauges show a figure of merit 1000 times higher than semiconductor strain gauges. Amorphous wires have externally controlled magnetization characteristics (and other features) that make them useful in torque transducers. We will discuss material preparation, prototype sensors and the reasons for their high performance and possible problems that may arise in utilization.

With material (2) active vibration damping is the most prominent actuator application (the material is rather expensive to be used as a sensor). The material is capable of strains of 1.2×10^{-3} with potential strains of 3×10^{-3} with further material development. Stresses up to 7000 psi can be handled under steady state conditions. In magnetostrictive materials there are two contributions to the strain, one due to the imposed stress and the other is the magnetostrictive strain due to the imposed magnetic field. Thus the strain is not necessarily zero if the stress is zero. Utilizing this and the nonlinear nature of the material, we will show a new kind of active vibration control.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4 Technology Name METHOD OF MEASURING MAGNETIC EFFECTS DUE TO EDDY CURRENTS

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____
Aerospace Industry and Foreign Allies

A Date: 12 JULY 1989
B. CUFT #: _____
C LAB #: NSWC-TAA-89-013
D Descriptors:
Magnetic Effects
Eddy Currents

E. Applications:
Detecting Conductive Objects

7. Potential Support: (exclusive license), consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? This method is used to measure magnetic effects due to eddy currents induced in relatively large objects. A reference sensor is located to measure applied fields only. Then an estimate of applied field at the locus of a plurality of measurement sensors is constructed and stored. Next, a conductive object is placed in the vicinity of the measurement sensors, in the applied field, and measurements are made of the applied field and eddy current effects Finally, the stored estimate is used to compensate the applied field so that eddy current effects can be observed

9 Other Uses: Degaussing Mine-Sweepers; Detecting conductive objects

10 Main Advantages: The method is fully automatic, fast, and accurate

11 Production Information: Technology items now available

12 Descriptive Literature: US PATENT #4,648,041; March 3, 1987

13a Literature Available From: Mr Paulo Tarr, NAVSWC/WO, Code H32, (301) 394-1563
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

This invention relates to the measurement of magnetic effects due to eddy currents, but more specifically, the present invention relates to a discrete-time method of measuring the magnetic effects due to eddy currents induced into conductive material by sinusoidally time-varying magnetic fields.

Magnetic effects due to eddy currents can be measured by applying a large sinusoidally varying magnetic field to the conductive material being measured. This applied field induces an alternating current in the conductive material which in turn induces an alternating magnetic field that is 90° out of phase with the applied field and at the same frequency.

A previous method used to measure eddy current effects required cancellation of the applied field by using an analog signal to drive a "compensation coil" wound around the measurement magnetometer. This signal was derived from the current being used to produce the applied field and passed through a "compensation circuit" consisting of an amplifier and phase shifter. The amplitude and phase of the compensation signal were manually adjusted so as to cancel the applied field at the measurement magnetometer.

In test facilities where it is desired to use over 100 measurement sensors, for example, the manual adjustment of all compensation circuits becomes a difficult and time-consuming task. In addition, variation in the values of analog components of the compensation circuit due to temperature and aging cause a loss of applied field cancellation, requiring that all compensation circuits be adjusted before every test.

The objects of this invention are to:

(1) eliminate the necessity of having to manually cancel or compensate, in measuring the magnetic effects due to eddy currents, the component of the applied field at the measurement sensor of sensors before an accurate measurement can be made;

(2) use digital signal processing to, inter alia, avoid the short and long term noise problems normally caused by the need to apply large magnetic fields in the measurement method; and

(3) decrease measurement time by eliminating all time consuming manual adjustments and replace them with a fast, computer-implemented linear least-mean-squared (LMS) estimation, in an improved manner.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name METHOD FOR DETERMINING THE MAGNITUDE OF EARTH'S GRAVITY

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: Method

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: Other Governments, Oil Industry

A. Date: 14 JULY 1989
B. CUFT #:
C. LAB #: NSWC-TAA-89-014
D. Descriptors:
Gravity
Global Positioning System

E. Applications:
Geophysical Surveys
Oil Exploration

7. Potential Support: exclusive license, consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other:

8. What Problem Does It Solve and How? This method combines Global Position System (GPS) satellite relative position, velocity, and acceleration techniques with accelerometer measurements to measure the magnitude of earth's gravity. Here, GPS determines accelerations due to all forces. Accelerometer measurements, with certain corrections, determine accelerations due to all forces except gravity. Consequently, differencing the two estimates produces the gravity value

9 Other Uses:

10. Main Advantages: The procedure can be used on a dynamic vehicle like a balloon or an airplane to obtain gravity values rapidly and over rugged terrain

11. Production Information:

12. Descriptive Literature: (1) A. R Lazarewicz and A. G. Evans, "GPS Aided Gravimetry at 30Km Altitude from a Balloon-Borne Platform," Proceedings of the Chapman Conference on Gravity, Fort Lauderdale, FL, Sep 1988 (2) A Kleusberg and A Goodacre, "On the Use of GPS for Airborne Gravimetry," Fifth International Geodetic Symposium on Satellite Positioning, Las Cruces, NM, Mar 1989

13a. Literature Available From: Dr. Alan G. Evans, NAVSWC/DL, Code K13, (703) 663-8405
Naval Surface Warfare Center
Dahlgren, VA 22448-5000

13b. Description:

NAVSTAR Global Positioning System (GPS) satellites are currently being placed in orbit to form a constellation which will enable a user to determine the position of a receiver's antenna anywhere over the Earth during all weather conditions. Discussed below is an extended application of GPS which has commercial potential.

This application combines GPS with accurate accelerometers to determine magnitude of gravity values. Here, the accelerations due to all forces on a moving platform are determined by dynamic GPS relative positioning, velocity, and acceleration techniques with respect to a fixed antenna location. The acceleration due to all forces except gravity is obtained by the accelerometers. Corrections are made for Coriolis and earth spin using GPS obtained values. The desired magnitude of the gravity vector is approximately equal to the magnitude of the vector difference between the GPS and accelerometer determined accelerations. For a very stable vehicle platform, such as a balloon, differencing the vertical component is sufficient. This gravity determination procedure can be used for balloon or aircraft vehicles flying over rugged or inaccessible terrain. Also, aircraft have the potential to perform rapid, less expensive gravity surveys, which may be used, for example, by the oil exploration industry.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4 Technology Name METHOD OF DETERMINING THE ORIENTATION OF A MOVING PLATFORM

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: Method

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other:

A Date: 14 JULY 1989
B. CUFT #:
C. LAB #: NSWC-TAA-89-015
D. Descriptors:
Orientation Roll
Altitude Pitch
Navigation Yaw
Heading
Global Positioning System
GPS

E. Applications:
Vehicle Navigation

7. Potential Support: exclusive license, consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng, other:

8. What Problem Does It Solve and How? The method finds the orientation, for example, ship's heading, using satellite navigation This is done by moving antenna in a plane The plane is defined by the change in position of the antenna as it moves through the plane

9 Other Uses: Artillery azimuth

10 Main Advantages. Requires only one receiver with standard hardware [note two receivers would improve accuracy]

11 Production Information:

12 Descriptive Literature: A G Evans, "Roll, Pitch and Yaw Determination Using a Global Positioning System Receiver and an Antenna Periodically Moving in a Plane," Marine Geodeny, Vol 10, No 1, pp 43-52,, 1986

13a Literature Available From: Dr Alan G Evans, NAVSWC/DL, Code K13, (703) 663-8405
Naval Surface Warfare Center
Dahlgren, VA 22448-5000

13b. Description:

NAVSTAR Global Positioning System (GPS) satellites are currently being placed in orbit to form a constellation which will enable a user to determine the position of a receiver's antenna anywhere over the Earth during all weather conditions. Discussed below is an extended application of the GPS which has commercial potential.

This application extends the GPS to determine a vehicle's orientation in addition to standard position. Here, an antenna is moved in plane. This movement could be on a plate or a windshield wiper arm-type movement. Since GPS antennas can be small, the mechanical motion can easily be accomplished. The mechanical motion must be aligned to the vehicle and synchronized to the GPS measurements. Orientation, for example, a ship's heading, can then be determined based on differences in antenna position.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name DATA ACQUISITION AND REDUCTION PROCESSOR SYSTEM

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: Software and Hardware System

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: Aerospace Industry and Foreign Allies

A. Date: 14 JULY 1989

B. CUFT #:

C. LAB #: NSWC-TAA-89-016

D. Descriptors:
Data Acquisition
Reduction Processor
Time tagging
Data Correlation

E. Applications:
Evaluation and debugging of computer software (and hardware) through the capture and time correlation of parallel data words from multiple asynchronous sources within one or more computers.

7. Potential Support: (exclusive license,) consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other:

8. What Problem Does It Solve and How? Provides a means of evaluating and debugging computer software (and hardware) through the capture, time-tagging, display, and reduction of parallel data words from multiple asynchronous digital data sources with provisions for irregular sampling rates for the data from each source. Time-tagging allows time correlation of multiple asynchronous data sources over long time periods. Operator selected criteria reduce in real-time the volume of data captured. Developed for use with the Performance Monitor Interface (PMI) of the AN/UYK-43 computer. Current implementation limits system to eight 32-bit data sources.

9. Other Uses: Can be adapted to any parallel digital data source (32 bits maximum in current hardware) which accompanies the data with a data sampling clock signal that does not exceed 6.67 MHz (limited by current hardware implementation).

10. Main Advantages: Time correlation of data from multiple asynchronous sources. Real-time data quantity reduction. Large data sample storage space (1M words per data input in current implementation). Data captured from one or more sources can control data capture from one or more other sources.

11. Production Information: Technology items now available.

12. Descriptive Literature: (1) Patent Application Papers, June 1988.
(2) Data Acquisition and Reduction Processor, Technical Description and User Guide, 1 June 1989

13a. Literature Available From: Mr. James M. Deatherage, NAVSWC/DL, Code N322, (703) 663-1656
Mr. John C. Edwards, NAVSWC/DL Code N32, (703) 663-1661
Naval Surface Warfare Center
Dahlgren, VA 22448-5000

13b. Description:

The Data Acquisition and Reduction Processor (DARP) is a system of hardware components controlled by custom software and hardware resident in the DARP Control Computer (DCC). The DARP attaches to and captures data presented on the Performance Monitor Interface (PMI) of the AN/UYK-43 large-scale militarized computer.

Although the DARP was designed for the AN/UYK-43 PMI, the DARP can be adapted to any interface which provides a signal to define that data is valid for sampling at a frequency not to exceed 6.67 MHz. DARP systems are currently in use with AN/UYK-44s and ROLM 1666Bs as well as AN/UYK-43s.

The AN/UYK-43 computer is the state-of-the-art replacement for the AN/UYK-7 large -scale militarized computer. The requirement for an optional PMI, on each Central Processor Unit (CPU) and each Input/Output Controller (IOC), was included in the original procurement requirements for the AN/UYK-43. The PMI provides passive access to numerous types of data which reflect the operation of the CPU and IOC. Special Performance Monitoring instructions are included in the Instruction Set Architecture (ISA) of the AN/UYK-43 to allow programs to pass specific data to the PMI.

The DARP provides the capability to capture AN/UYK-43 PMI presented data at the presentation speed of the AN/UYK-43. A time-tag is associated with each captured data word to allow correlation of data captured on multiple PMI data busses or to measure the time between the capture of multiple data items or events. Captured data is stored in the resident DARP memory for later retrieval and into First-In-First-Out (FIFO) buffers for immediate retrieval and processing.

The AN/UYK-43 PMI and the DARP combine to open enormous possibilities for the evaluation of AN/UYK-43 hardware performance, overall system performance, and the support of software debug and analysis for AN/UYK-43 hosted combat system elements. Some general functions include. (1) passive program trace, (2) monitoring the Active Status Register, (3) capture of program generated data using the performance monitor instructions, and (4) evaluation of CPU and IOC loading in a particular system configuration. Although the PMI can operate with no AN/UYK-43 resident program support, detailed evaluations will be greatly enhanced with carefully selected support mechanisms included in the system executive.

Methods utilized to evaluate system timing and performance in previous systems included. (1) performing an Input/Output (I/O) process, under system software control, on an unused I/O channel, and performing timing measurements with an oscilloscope, or (2) accessing a one-microsecond accurate external clock via an I/O channel and extracting the timing information, via another I/O channel, to magnetic media for later analysis. The first method requires little processing support from the system under test but, due to varying frequencies, large sample periods and oscilloscope operator interaction, yielded fairly gross timing results. The second method yields accurate results but places a processing burden on the system under test, which can adversely impact the system as well as the timing results. Application of the DARP on an AN/UYK-43 should provide accurate timing data with little or no impact on the system under test.

13b. Description:

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

NAVSWC MP 90-72

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name FREEZER ALARM

5. Technology Type: (a) Process ((b)) Apparatus ((c)) Material (d) Service (e) Study ((f)) Other: Medical

6. Users: ((a)) Federal Government ((b)) State Government ((c)) Local Government ((d)) Small Industry ((e)) Medium Industry ((f)) Large Industry (g) Consultant (h) Other: _____

A. Date: 20 JULY 1989
B. CUFT #: _____
C. LAB #: NSWC-TAA-89-018
D. Descriptors:
Nitinol
Shape Memory Alloy
Temperature Sensitive Actuator

E. Applications:
Temperature Sensitive
Alarm/Actuator

7. Potential Support: exclusive license, (consulting), joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? Detects rising temperatures in the range of -30°C to 100°C and activates alarms or actuators. It is simple and can replace bi-metallic actuating devices. It can be in wire or strip form, re-setting, and exerts great force.

9. Other Uses: Heat engines, shrink fit pipe couplings.

10. Main Advantages: This alloy recovers to a prior shape and exerts considerable force while doing so.

11. Production Information: The alloy is commercially available in the U.S.

12. Descriptive Literature: _____

13a. Literature Available From: Mr. David Goldstein, NAVSWC/WO, Code R32, (301) 394-2468
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

General Purpose: This is an alarm device to audibly or visually (or both) signal the "over-temperaturing" of a cold chamber such as a domestic freezer.

Background: Inexpensive, simple devices that detect and announce the failure of a cold chamber to maintain its temperature are not currently available. Loss of cooling may be due to a variety of causes. Some causes are power outages, which may go unnoticed in the absence of attendants; malfunctioning or non-operating refrigeration systems, incomplete door closure, leaking gaskets in closed doors, or improper resetting of a thermostat following a defrost cycle.

Description and Operation: The device described here will automatically announce, by a continuing audible and/or visual signal, that a cold chamber has not maintained a desired sub-ambient temperature. The signal itself is an intermittent beep and/or a panel light from a light emitting diode.

The heart of this invention is a shape memory alloy such as Nitinol. This alloy recovers its previously set-in shape by being warmed. The temperature for shape recovery can be arbitrarily pre-selected. As an example, it could be selected to recover its shape when the alloy reaches a temperature of +10°C and in so doing, close an electrical circuit.

The battery which powers this circuit may be chosen from the large variety of those commercially available and already used for similar long life, low power uses.

Advantages and New Features: The device has economic advantages in that it can be mass produced at very low cost. This feature should be attractive to users of domestic food freezers. Such domestic and commercial freezers often contain significant quantities of food which is perishable, which may be subject to spoilage, and to causing food poisoning (as a result of brief periods of elevated temperatures). Prompt alarms would save the food and could preclude troublesome clean-ups following freezer failures.

Since these systems utilize an independent power (battery) source they are independent of an external electrical power failure. Their maintenance cost is minimal, limited to a new battery every few years. Furthermore, in the event of an external power failure this alarm system indicates maintained temperature within the chamber without the necessity of opening the chamber door to visually inspect the freezer contents.

The temperature of alarming can be set, within limits, by selecting the Nitinol alloy composition. Alarm activating temperatures for cold chambers can be set for temperatures from -30°C to +20°C.

For information on this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4, or (301) 394-1505.

APPENDIX C

NAVSWC FY89 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Metal Coatings	70,866	Metal Film Coatings on Amorphous Metallic Alloys	Magnetostrictive transducers, control wires
Semiconductors	71,914	Sensitization Pretreatment of Pb-Salt Epitaxial Films for Schottky Diodes by Sulfur Vapor Exposure	IR Sensors
Transducers	70,382	Terbium-Dysprosium Magnetostrictive High Power Transducers	Use in combination with high temperature ceramic superconductors to convert electrical energy into mechanical energy efficiently
High Temperature Superconductors	72,264	Silver Coated Superconducting Ceramic Powder	High temperature superconducting materials which can be cold worked (e.g., swagged, forged, etc.)
Batteries	71,884	Silver Composite Cathodes for Alkaline Secondary Batteries	Lightweight silver coated graphite electrodes
Batteries	71,677	Electrochemical Preparation of Silver Oxide Electrodes having High Thermal Stability	Silver oxide batteries
Batteries	71,979	Silver Composite Cathodes for Alkaline Secondary Batteries	Alkaline Batteries
Metal Work	71,958	Method of Soldering Aluminum	Method of soldering aluminum to aluminum or to other metals

APPENDIX C (Cont.)

NAVSWC FY89 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Ceramics	71,310	Preparation of Mullite Whiskers from AlF_3, SiO_2, and Al_2O_3 Powders	Manufacture of good quality mullite whiskers for use in ceramic/ceramic or ceramic/metal composites
Laser Detection	71,090	Laser Detection and Discrimination System	Radiation identifying sensors
Material Reinforcement	70,865	Injection Molded Projectile Cartridge Case with Continuous Fiber Reinforcement	Strength enhancement of lightweight materials
Laser Communication	72,040	Laser Communication System with Wide Band Magnetostrictive Modulation	Optical Fiber Signal Modulation
Semiconductors	4,853,339	Method of Sensitizing Pb-Salt Epitaxial Films for Schottky Diodes	IR Sensors
Semiconductors	4,870,027	Sensitization Pretreatment of Pb-Salt Epitaxial Films for Schottky Diodes by Sulfur Vapor Exposure	IR Sensors
Electromagnetic	4,845,508	Electric Wave Device and Method for Efficient Excitation of a Dielectric Rod	Waveguide antennas
Nuclear Explosion	4,827,414	Monitoring System and Method for Nuclear Weapons Effects Detection and Damage Assessment	Condition signal detection and data processing for monitoring effects of nuclear explosions
Test and Evaluation	71,637	Counter EMF Armature Velocity and Position Indicator	Any mechanical application where it is necessary to determine motor speed or coarse armature position

APPENDIX C (Cont.)

NAVSWC FY89 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Ordnance	71,907	Versatile Nonelectric Dearmer	Use in demolition and bomb squads
Test and Evaluation	71,599	Chemical Agent Monitor and Control Interface	DEA Detectors
Pressure Systems	70,365	CPS Alarm System	Space
Ordnance	71,047	Monolithic RF/EMI Desensitized Electro-explosive Device	Blasting
Test and Evaluation	71,000	Method and Device for Measuring Resistivity	Inspecting materials
Materials Science	70,823	Method of Eddy Current Defect Depth Measurements	Inspecting materials
Coatings	H601	Ceramic Fiber Thermal Protection Coating	Fire protection coating
Infrared Science	69,397	Infrared Detector Array	Heat sensitive manufacturing processes, space development, broad spectrum application
Materials Science	71,966	Device for Inspection of Materials by Eddy Current Methods	Materials inspection aerospace application
Surveying	71,242	Method for Determining Astronomic Azimuth	Tectonic plate science, general surveying

APPENDIX C (Cont.)

NAVSWC FY89 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Ordnance	70,986	RF and DC Desensitized Electroexplosive Device	All electric explosive devices, blasting demolition
Ordnance	4,848,233	Means for Protecting Electroexplosives Devices Which are Subject to a Wide Variety of Radio Frequency	Demolition and blasting
Ordnance	71,644	Nonvolatile, Fast Response Wire Cutter	Use in demolition and bomb squads
Manufacturing	4,870,244	Method and Device for Stand-Off Laser Drilling and Cutting	Robotic Assembly
Test and Evaluation	71,001	Method of Laser Discrimination Using Stimulated Luminescence	Use in multilaser processing or manufacturing environments. Possibly medical application where different laser frequencies are used, i.e., bone, fluid, tissue discrimination in surgery
Computers	71,445	Reconfigurable N-Dimensional Computer Memory	Broad application in computer memory application

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