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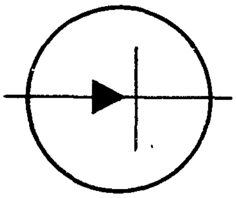

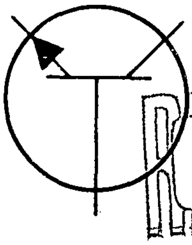

WESTINGHOUSE ELECTRIC CORPORATION

Molecular Electronics Division

Youngwood Pennsylvania

MICROMINIATURE INTEGRATED CIRCUIT PACKAGE

Unclassified Report No. 2

Signal Corps Contract No. DA-36-039-SC-90850

DA Project No. 3A99-21-002-01

Second Quarterly Progress Report

October 1, 1962 to January 1, 1963

Prepared for
U. S. Army Signal Research and Development Laboratory
Fort Monmouth, New Jersey

MICROMINIATURE INTEGRATED CIRCUIT PACKAGE

Unclassified Report No. 2

Signal Corps Contract No. DA-36-039-SC-90850

SCTR SCL-7643, October 17, 1961

DA Project No. 3A99-21-002-01

SECOND QUARTERLY PROGRESS REPORT

October 1, 1962 to January 1, 1963

OBJECT

Research work directed toward development and production of hermetic packages for semiconductor devices in accordance with contract requirements.

REPORT PREPARED BY:

E.P. Barbaro

E. P. Barbaro

WESTINGHOUSE ELECTRIC CORPORATION
Molecular Electronics Division
Youngwood Pennsylvania

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PURPOSE

The purpose of this investigation is to develop a .225 X .225 inch square planar, hermetic, integrated circuit packages for mounting on .310 inch square micromodule wafers. The packages are to be developed to contain integrated circuits of the type specified in paragraph 1.2 of Technical Requirements SCL-7643. The packages will be constructed from compatible glass and metal materials.

A minimum of twelve leads, three on each side of the .225 X .225 inch square package will be provided. A circuit mounting area of .120 inch square will be available within the enclosure. The height of the package may be adjusted up to .090 inches maximum.

ABSTRACT

Two successive design modifications were made to the graphite glassing boats in order to achieve more uniform package appearance. Fifty package samples were submitted to the Signal Corps for mechanical evaluation. Also techniques for sealing the integrated circuit package were established and fifty sealed packages were submitted to the Signal Corps. Improved cleaning techniques were established for deoxidizing kovar parts prior to gold plating resulting in less pitting of the metal. Stamped lead preforms were received during this period. The first one hundred microminiature circuit packages submitted to the Signal Corps were fabricated with etched leads. The stamped leads are more uniform in cross section.

Ceramic micromodules with pads were designed and ordered during the second quarter. This micromodule will be utilized in our continuing program to develop a integral package using the ceramic micromodule as a base.

CONFERENCES

I. Date: October 12, 1962

Place: Westinghouse Electric Corporation, Molecular Electronics Department, Youngwood, Pennsylvania.

In Attendance: Messrs. Dr. Jere Hohmann, USASRDL
K. G. Cooley, Westinghouse MED
E. P. Barbaro, Westinghouse MED
A. P. Kruper, Westinghouse MED
M. S. Saunders, Westinghouse MED

Subject:
1. The progress on package fabrication was discussed.
2. Environmental Evaluation of 200 samples with devices was discussed.
3. The possible substitution of integrated circuits for the mesa transistors was received.

II. Date: November 26, 1962

Place: Fort Monmouth, New Jersey

In Attendance: Messrs. M. Robert Miller, USASRDL
E. P. Barbaro, Westinghouse MED

Subject:
1. Discussed the status of package evaluation.
2. Reviewed the rejection of the draft of the First Quarterly Report due to omission of integral micromodule package work and technical report form.

CONFERENCES

III. Date: December 12, 1962

Place: Westinghouse Electric Corporation, Molecular Electronics Department, Youngwood, Pennsylvania.

In Attendance: Messrs. O. Pitzalis, USASRDL
K. G. Cooley, Westinghouse MED
M. S. Saunders, Westinghouse MED
A. P. Kruper, Westinghouse MED
J. D. Husher, Westinghouse MED
W. Williams, Westinghouse MED
J. M. Clayton, Westinghouse MED
T. L. Charland, Westinghouse MED

Subject:
1. Evaluation of one hundred (100) packages already shipped.
2. Return of First Quarterly Report No. 1.
3. Discussion of number and type of integrated circuits to be packaged.
4. Extension of December 31, 1962, shipping date of delivery of 200 packaged devices.

MICROMINIATURE INTEGRATED CIRCUIT PACKAGE

Second Quarterly Report

October 1, 1962 to January 1, 1963

Contract No. DA-36-039-SC-90850

I. INTRODUCTION

The investigation in the second quarter of this contract was primarily the improvement of the microcircuit package appearance and mechanical qualities. Packages made in the first quarter were not symmetrical, the frame and base were out of alignment with respect to each other. Glass flow was not proper resulting in shorting of the leads to the frame. In order to minimize the dimension problem, graphite boats were redesigned and modified to attempt to minimize part variation. Also the appearance of the deoxidized kovar is pitted, the cleaning techniques were evaluated and an improved technique has been developed. Stamped leads were obtained which resulted in more uniform lead cross sections. A sealing technique was developed for this package which yields hermetically sealed packages. Measured leak rate was $\ll 1 \times 10^{-7}$ for all encapsulated packages. Fifty integrated circuit micromodule packages were sealed by this technique and forwarded to the Signal Corps. A boat for fabricating micromodule ceramic base packages was designed and obtained. Ceramic bases with metallized pads were ordered but not received.

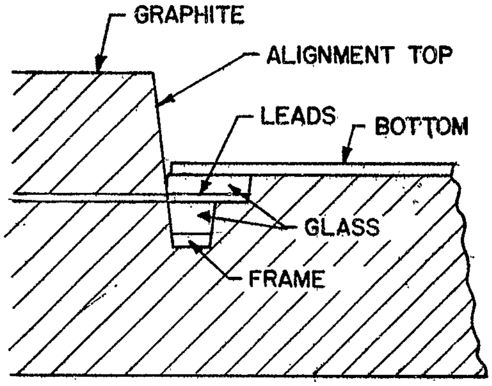
II. FACTUAL DATA

2.1 Graphite Glassing Boat Revisions

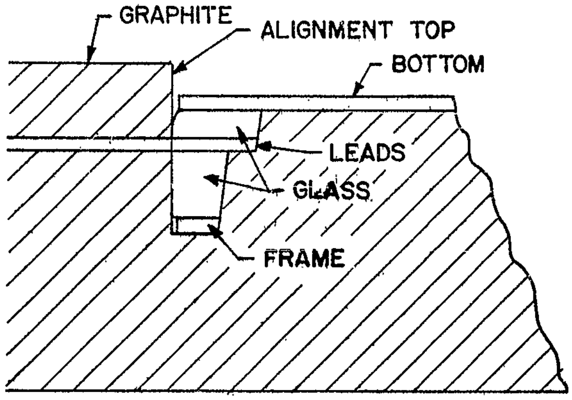
The problem of non-alignment of the frame to base was due to drift in the packaging boat cavity. The boat has a 4° drift for ease in unloading. This drift is standard for boat designs for larger Westinghouse flat packages; however, in the .220" X .220" package due to its small size, this variation which is identical for all sizes, is more noticeable. In the redesigned glassing boat, the outside walls which orient the base to the frame have no drift. See Figure No. 1. Also the height of the alignment top was reduced which resulted in ease in assembly and more assurance that all parts were properly seated. These changes worked very well resulting in more uniformity in the package as the alignment top and outside glass retaining walls held all parts in orientation.

2.2 Physical Shorts of Frame to Lead

A problem of the molten glass picking up the frame during glassing was resolved. This condition results in an electrical short between the leads and the frame. This problem was eliminated by a slower heat-up cycle during glass fusion. It is the writer's opinion that the glass softens and reaches an equilibrium condition rather than a rapid melting which changes the physical location of the glass before surface tension is minimized. However, since the slower heat-up cycle was instituted, the shorting problem has been eliminated. In fact, all packages are tested at 200 V_{DC} between the leads, frame, and bottom with no breakdown. See Figure No. 2 for test fixture sketch.

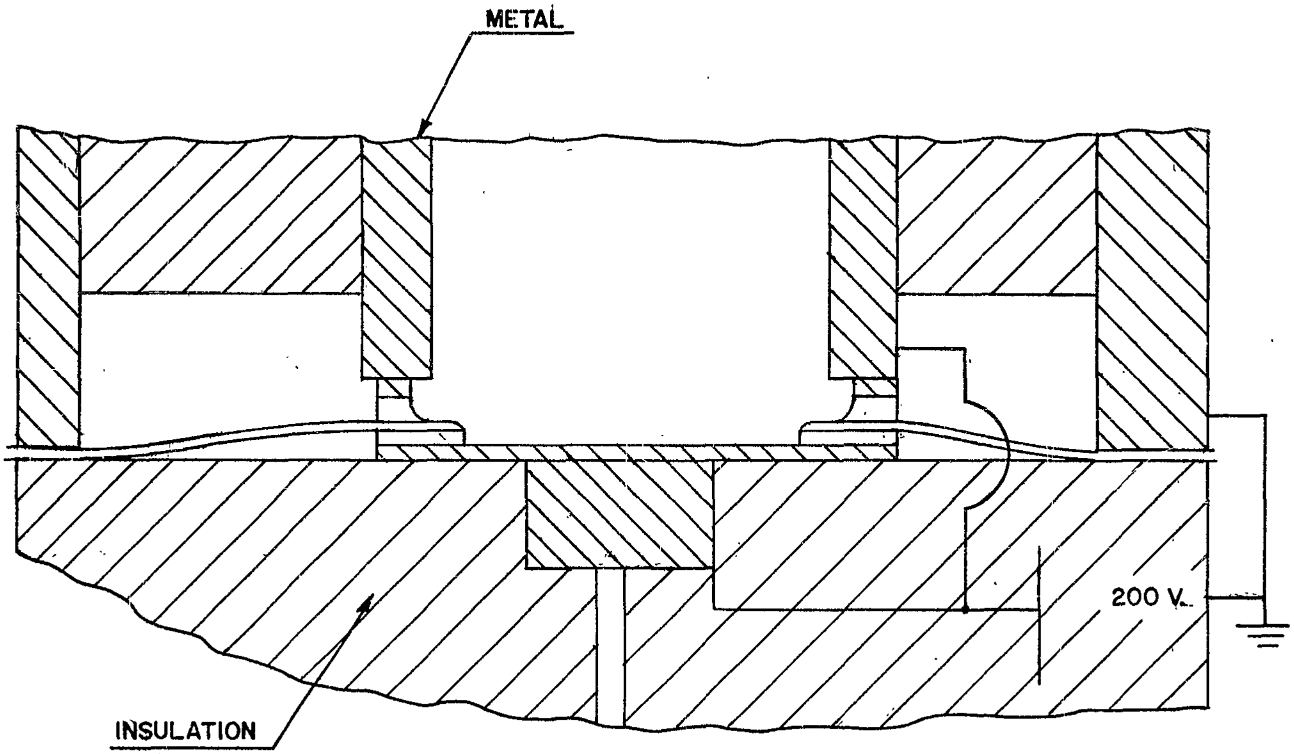


OLD DESIGN



NEW DESIGN

FIGURE I



HIGH POTENTIAL BREAKDOWN TEST FIXTURE

FIGURE 2

2.3 Pitted Kovar from Deoxidizing Process

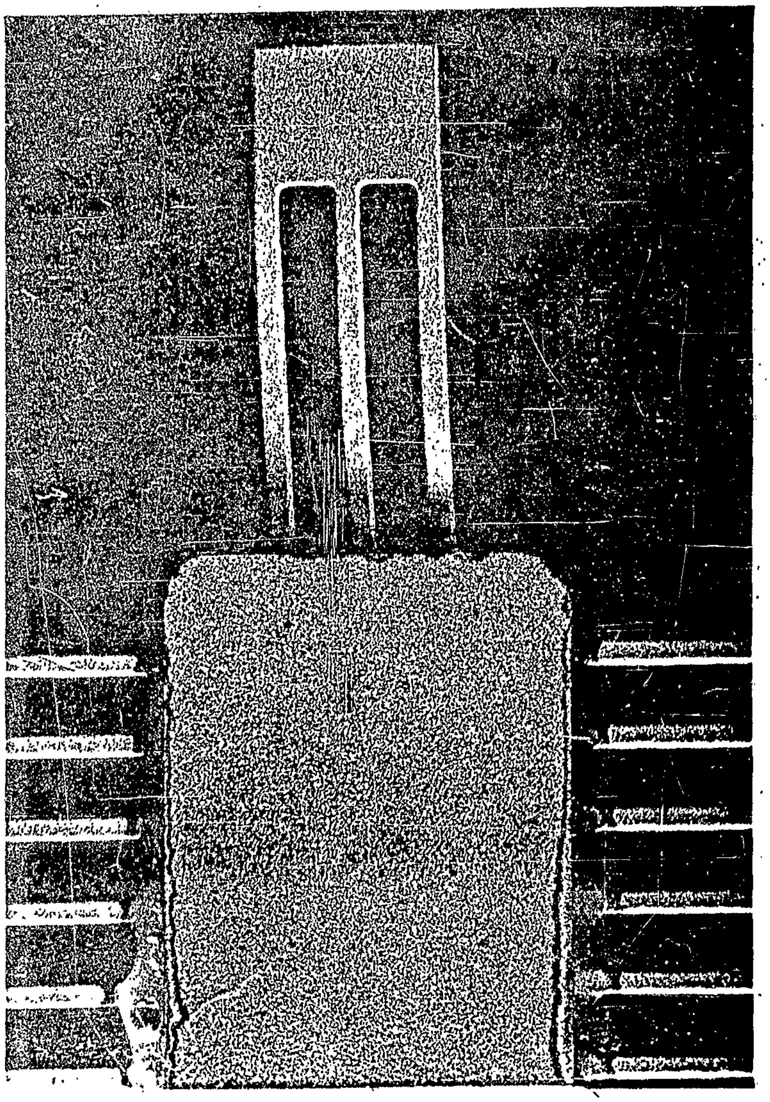
After package fabrication, the kovar parts have a heavy oxide which would hinder gold plating. This oxide is removed by cleaning in a solution of ferric ammonium sulfate, sulfuric and hydrochloric acid. The solution is quite effective in that all the oxide is removed. However, the cleaning solution leaves the metal parts in a pitted condition. This requires extreme care in etching so that pitting depth is kept to a minimum; since deep etch pits could act as stress centers in bending and result in breakage of leads during fatigue test. As a result of this problem, various deoxidizing solutions were investigated. One of the more promising cleaning solutions was 50% HCL etching at room temperature for ten (10) minutes. This resulted in considerably less pitting of the kovar parts. See photographs one and two.

2.4 Stamped Lead Preforms

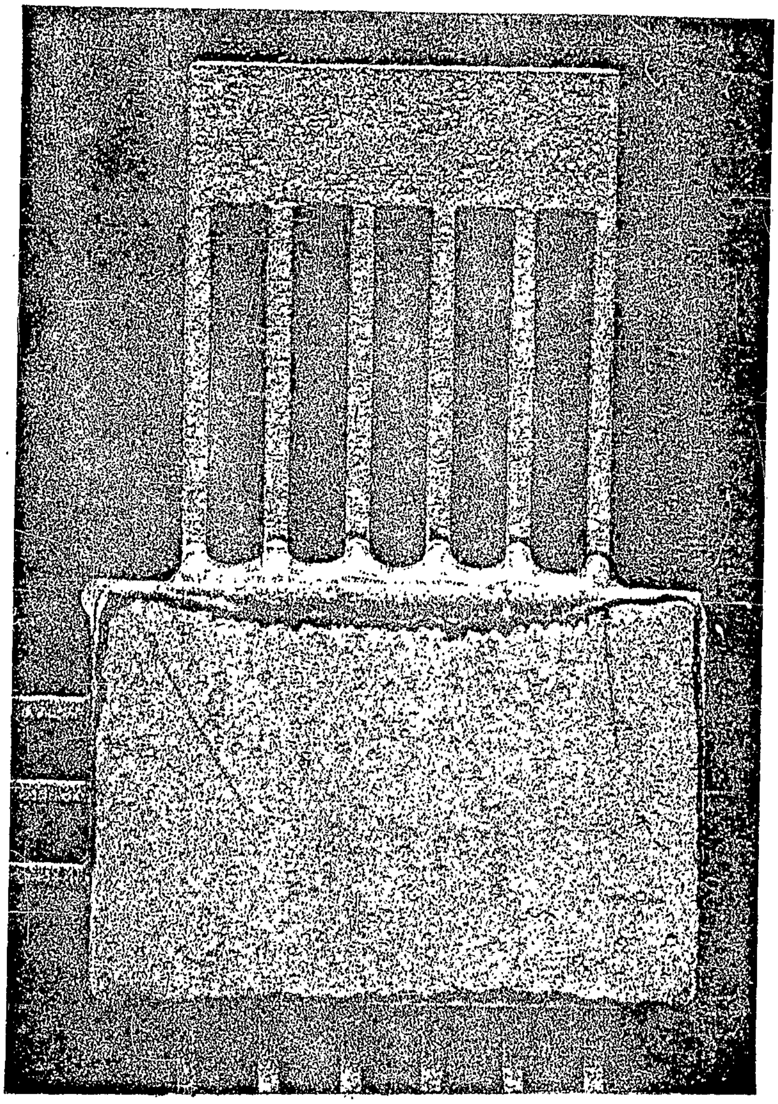
Lead preforms which were furnished in the first 100 samples were etched by the photoresist process. This resulted in an undercut lead which appear as a trapezoid. See Figure No. 3 and Figure No. 4. The stamped lead is more uniform in cross section. This is very important in lead fatigue. The etched lead with the trapezoid structure will result in more stress during bending than the stamped lead.

2.5 Lidding Technique for Microminiature Circuit Packages

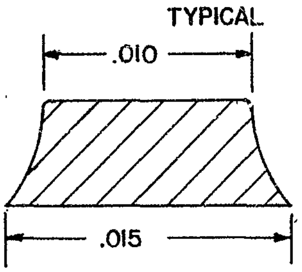
A technique for sealing lids on the package was developed during the second quarter of this contract. The packages were sealed in a non-oxidizing atmosphere in a continuous belt furnace. Many fixture innovations were



Photograph I

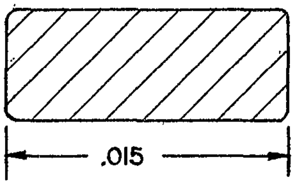


Photograph II



CROSS SECTION OF ETCHED LEAD

FIGURE 3



CROSS SECTION OF STAMPED LEAD

FIGURE 4

tried as the sealing objective is to not melt gold-germanium eutectic on the bottom of the package and have complete flow of this same solder between the lid and frame. A differential of 15°C was obtained utilizing a spring with high contact pressure, but low heat inertia and a graphite boat for positive location of the lid to the package. See Figure No. 5 for suggested lidding boat. Results in sealing were very encouraging. For all practical purposes, the lidding yield was 100%. The sealed packages were placed in a helium backfill chamber at two (2) atmospheres of pressure for a period of two (2) hours. After which they were helium-leak tested within fifteen (15) minutes and results indicated that they were $< 1 \times 10^{-7}$ cc/sec. at one (1) atmosphere in leak rate. These same sealed packages were tested to check for gross leakers in water at 90°C.

The braze used was gold-germanium obtained from Automation Alloys with a melting point of 352°C. Packages of another size were stored with no resulting leaks or physical change in the package at 300°C for 1000 hours. Fifty .220 X .220 integrated circuit micromodule packages were sealed in the aforementioned manner and submitted for Signal Corps evaluation.

2.6 Integral Micromodule Ceramic Base Package

As reported in the first quarterly report, we are continuing our efforts to fabricate a package directly to the ceramic micromodule base. In view of the objections of minimum clearance of frame and solder pads at the edge of the base, the new design utilizes the frame from the .225" X .225" package which leaves .042" clearance on a side. A new metallized base and also an

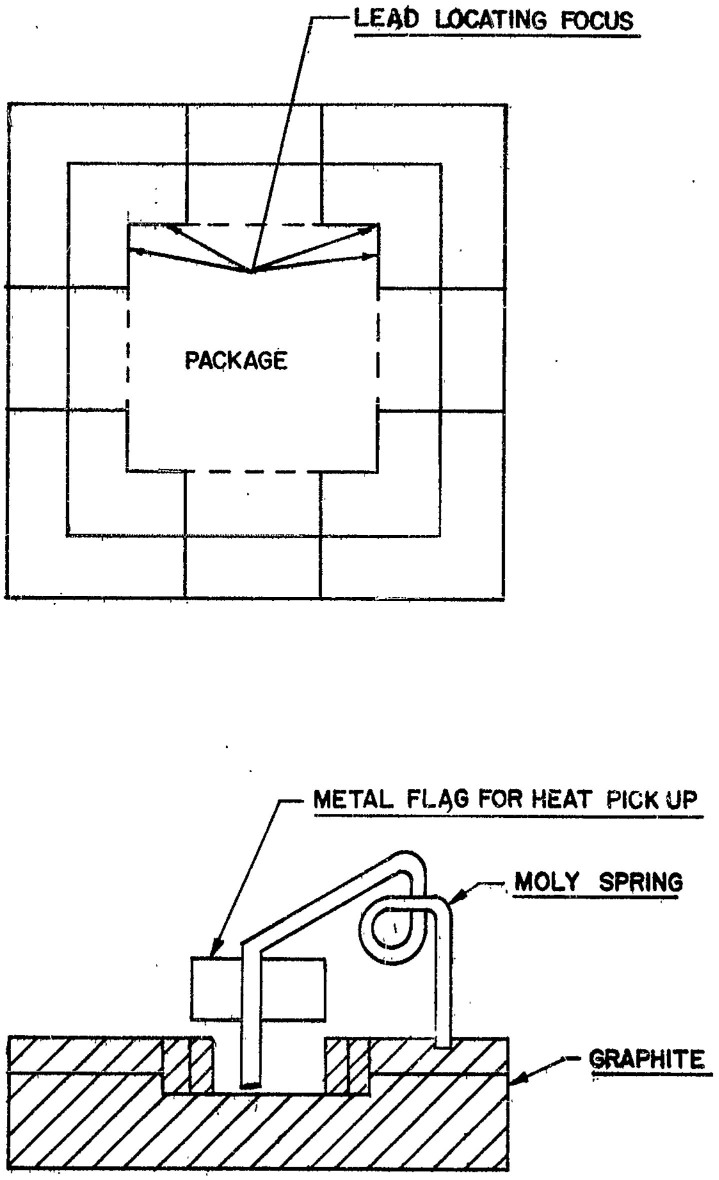

LEAD LOCATING FOCUS
PACKAGE
METAL FLAG FOR HEAT PICK UP
MOLY SPRING
GRAPHITE

FIGURE 5

encapsulation boat was designed. The boat has been completed; however, the ceramic micromodule bases have not been delivered. These were expected in late December, but the supplier has not been able to meet this schedule.

III. CONCLUSIONS

The overall appearance of the packages was enhanced by the process and package glassing fixture changes. Fifty mechanical sample packages unsealed and fifty sealed packages were delivered for evaluation. Sealing techniques were established that insure leak rates $<1 \times 10^{-7}$ cc/sec. Also volume production capabilities were proven should the mechanical samples be approved.

IV. PROGRAM FOR NEXT INTERVAL

R. F. Universal Amplifiers will be assembled into the .220" X .220" micromodule integrated circuit package for Signal Corps evaluation. Also work will be accelerated on .310 X .310 ceramic micromodule base package. If this program goes as expected, mechanical samples could be forwarded during the third quarter.

V. KEY TECHNICAL PERSONNEL

The following key personnel were assigned to the project during this report period:

E. P. Barbaro	Supervising Engineer	150 hours (*not charged to project)
T. L. Charland	Senior Engineer	325 hours
J. M. Clayton	Associate Engineer	75 hours
Others	(Technicians)	1236 hours
Total hours charged to project		1636 hours

The background of each key technical person is contained on the following separate pages:

BARBARO, ERNEST P.
Supervising Engineer, Pilot Manufacturing
Molecular Electronics Division

Born: August 21, 1929
Married: Three Children

Education:

University of Pittsburgh, B.S. in Industrial Engineering, M. E. Option, June 1951

University of Pittsburgh, M.S. in Engineering, August 1957

Experience:

July 1951 July 1953	General Motors Corp., Dayton, Ohio - Process and Design Engineer, Delco Products - Responsible for Design, Installation of Process Equipment.
July 1953 August 1956	Westinghouse Electric Corp. - Materials Division Penn Avenue, Pittsburgh, Pa. - Assistant Engineer. Responsible for miniature selenium rectifier process and design. Designed and supervised environmental test facility. Developed automatic test equipment for basic cells and final assemblies. Mechanized assemblies of miniature selenium rectifiers. Developed high voltage stack, computor diodes, and assisted in the development of high current density selenium cells.
August 1956 July 1958	Westinghouse Electric Corp. - Director Systems Penn Avenue, Pittsburgh, Pa. - Supervising Manufacturing Engineer. Responsible for processing, assembly, test, quality assurance, and applications of the manufacturing of selenium rectifiers.
July 1958 January 1959	Westinghouse Electric Corp. - Semiconductor Dept. Youngwood, Pennsylvania - Manufacturing Engineer.
	Assigned to take process of 150 watt silicon transistor from pilot to volume Manufacture. Worked with Engineering to redesign unit to lower product cost and increase reliability. Work was in areas of alloy development, gold plating process development, connector design, process assembly techniques, welding, painting and testing of the product.

January 1959 May 1962	Westinghouse Electric Corp. - Semiconductor Division Youngwood, Pennsylvania - Supervising Engineer. Responsible for product yield and quality improvement for silicon transistors and trinistors, directed large cost reduction program for all control products. Responsible for facility specification. Group contributed significantly to product improvement in the areas of diffusion, alloying, surface passivation, encapsulation design and test techniques.
May 1962 to present	Westinghouse Electric Corp. - Molecular Electronics Division - Supervising Engineer. Responsible for assembly and encapsulation of functional electronic blocks. Also, responsible for flat package design and fabrication. Responsible for push-pull amplifier engineering and processing.

<u>Societies</u>

A.I.E.E.
E.C.S.

Patent Disclosures: 15

Patents: 3

Publications: <u>A New Application of Linear Programming</u>

CHARLAND, TELESPHORE LAWRENCE - SENIOR DESIGN ENGINEER, MOLECULAR ELECTRONICS DEPARTMENT

Born: March 31, 1921 - Keeseville, New York

Education

1946-1950	Iowa State University, Ames, Iowa - BS in Ceramic Engrg.
1952-1954	Alfred University, Alfred, New York - MS in Ceramic Engrg.

Experience

1950-1952	Westinghouse, Lamp Division - engineer concerned with quality control and production of flourescent lamps.
1952-1954	Alfred University - research associate concerned with development of ceramic materials for jet engine and rocket applications.
1954-1956	Phillips Petroleum Co., Oklahoma City - development of drilling fluid materials.
1956-1961	Westinghouse - Materials Engineering - development of nuclear fuel, cermet, insulation and thermoelectric materials.
1961-Present	Westinghouse - Youngwood - development work in rare earth semiconductor materials for thermoelectric applications, piezoelectric materials for I.F. applications and ceramic materials for functional electronic block packaging applications.

Societies

The American Ceramic Society; The National Institute of Ceramic Engineers; The American Nuclear Society; The New York State Ceramic Association; Keramos; Registered Professional Engineer, Pennsylvania.

Patent Disclosures

1 - Cermet Compositions; 1 - Nuclear Fuels; 8 - Thermoelectric Materials; 8 - Patent Disclosure Awards; 7 - Patent Application Awards.

Publications

The Pressure-Carbonization of Carbon Bonded Silicon Carbide - Graphite for Use in Uncooled Rocket Nozzles

The Hot Pressing of Commercial Chrome Ores

Modification of a Ceramic Nuclear Fuel for Improved Thermal Conductivity

Development of Thermoelectric Materials

CLAYTON, JOHN M. - ASSOCIATE ENGINEER

Born: February 17, 1936
Married: one child

Education:

Carnegie Institute of Technology, BS Metallurgy, 1962

Experience:

March 1959 - September 1959: Allegheny Electronic Chemicals Co., Bradford, Pennsylvania. Lab Technician. Development of Crystal growing techniques. Development of evaluation processes such as etch pit dislocation counts, boron analysis, resistivity and lifetime determination.

June 1960 - June 1962: Westinghouse Semiconductor Division, Youngwood, Pennsylvania - Electronic mechanic. Transistor development, diffusion and alloying of large area devices, materials preparation, hard soldering. Epitaxial growth development for two groups leading to product applications, doping studies, reactor design.

June 1962 Process Design Engineer--Assembly & Encapsulation Engineering, Molecular Blocks.

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by E. P. Barbaro

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2. Micromodule Systems
3. Package Designs
4. Package Materials
5. Package Fabrication
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