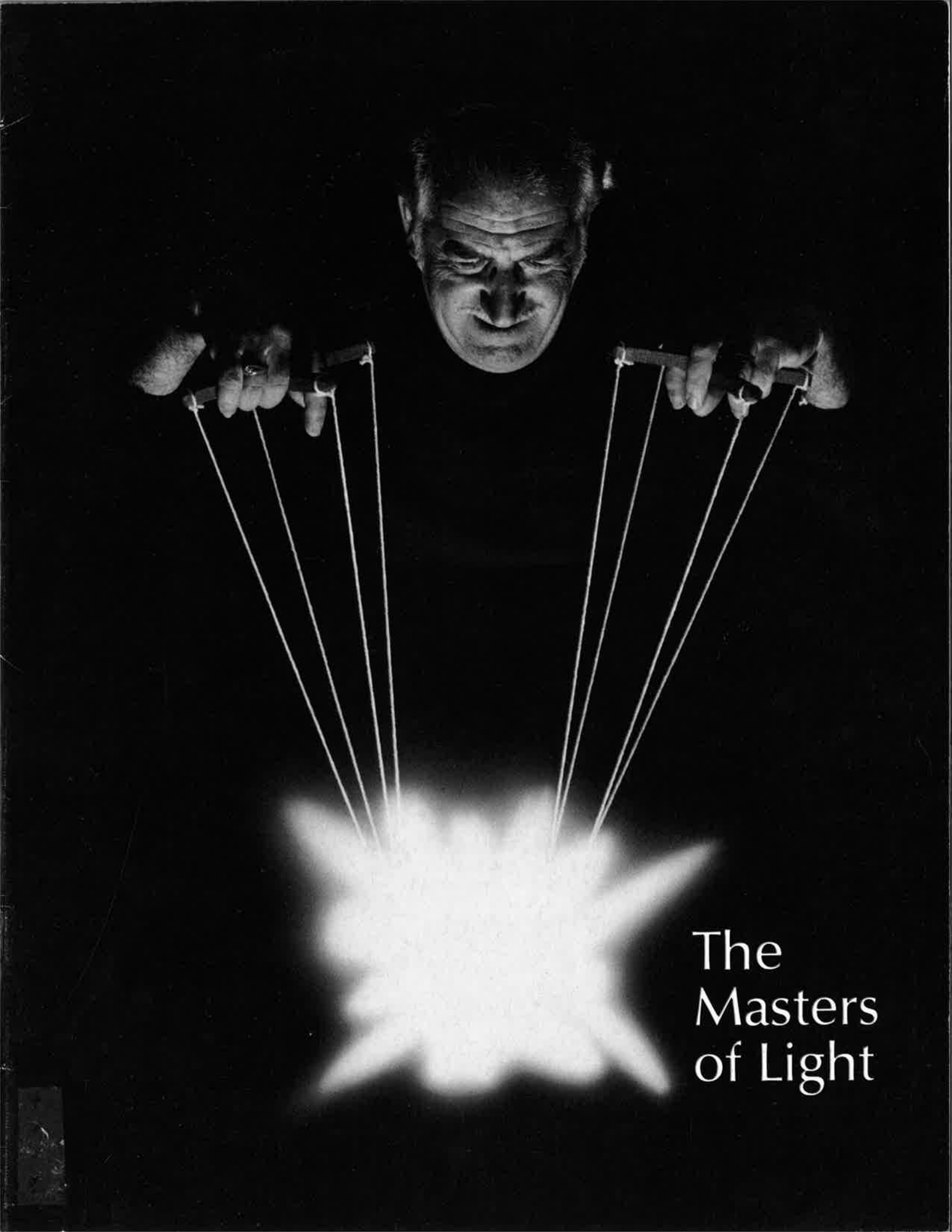
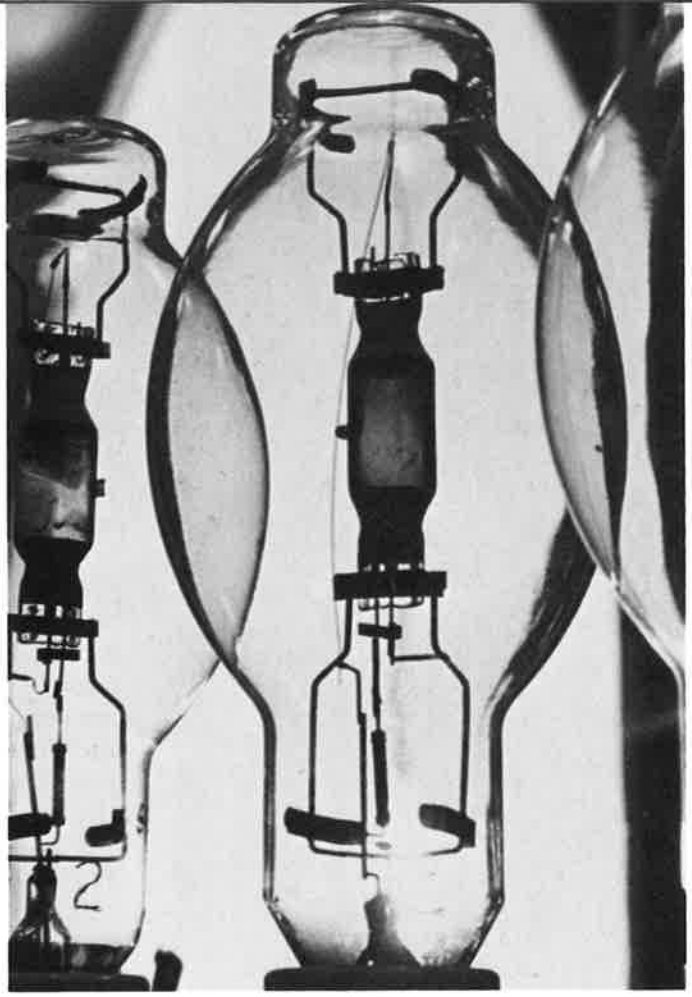

The
Masters
of Light



Headquartered in Danvers, Massachusetts at the Sylvania Lighting Center, GTE Lighting Products (a part of General Telephone and Electronics Corporation) is a recognized leader in lighting. GTE designs, manufactures, and markets Sylvania lighting products worldwide. The group has 48 plants and 10 laboratories in 13 countries.

Behind the success of its products stands the Lighting Laboratory where basic and applied research provide a broad base for product development.

This brochure gives an insight into the research activities and experience of our skilled group of men and women.

Dr. Bernard Kopelman,
Vice President, Research and Engineering, GTE Lighting Products

We have found over the years that the highly competitive nature of our industry is the driver which stimulates our creative and productive energies. We believe this stimulus is a major factor in attaining our position as a world leader in lighting.

. . . Our Background

GTE, as world leader in Lighting Products, has continuously broadened its product lines and strengthened its manufacturing operations as the result of fundamental research and innovative engineering.

GTE's Lighting Laboratory is dedicated to developing new and improved light sources involving advanced materials and energy savings concepts. In addition, it is involved with the physics and chemistry of light producing fluorescent and arc discharge materials and energy conversion mechanisms.

For the past 50 years, the laboratory's skilled scientists and dedicated engineers have worked to attain a scientific understanding of lighting. The scope of the work includes research in incandescent, fluorescent, and high intensity discharge lamps, chemical flash products, lighting fixtures, control devices, specialty products and radiant energy sources.

The Laboratory's expertise extends far beyond those areas normally related to lighting sources. It is active in electrical ceramics such as positive temperature coefficient devices, polycrystalline materials including anistropic pyrolitic boron nitride, and high purity fused quartz for semiconductor applications.

Efforts are heavily oriented to materials, including the chemistry of high temperature materials, pyrotechnics, and coatings. Plasma physics, as well as atomic and molecular physics, are also important capabilities of this laboratory. Of special significance is the activity in vacuum deposition by sputtering and evaporation, for thin films and dichroics, along with special skills in glass and ceramics.

GTE's Lighting Laboratory as a leader in the design and manufacture of energy saving lighting products, has done pioneering work in automobile halogen headlamps, has been in the forefront of photoflash since its infancy and has made important contributions to the development of remotely controlled machinery.

. . . Our Technical Skills

Chemical
- High Temperature
- Vapor Deposition
- Pyrotechnics
- Coatings

Physics
- Plasma
- Atomic & Molecular
- Gas Discharge

Plastics
- Selection/Specification
- Analysis
- Application

Mechanical/Optical
- Vacuum Systems
- Molding
- Metal Fabrication
- Design
- Projectors (Compact)
- Non-Imaging Systems

Electrical
- Magnetic Ballasts
- Electronic Ballasts
- Starters
- Systems

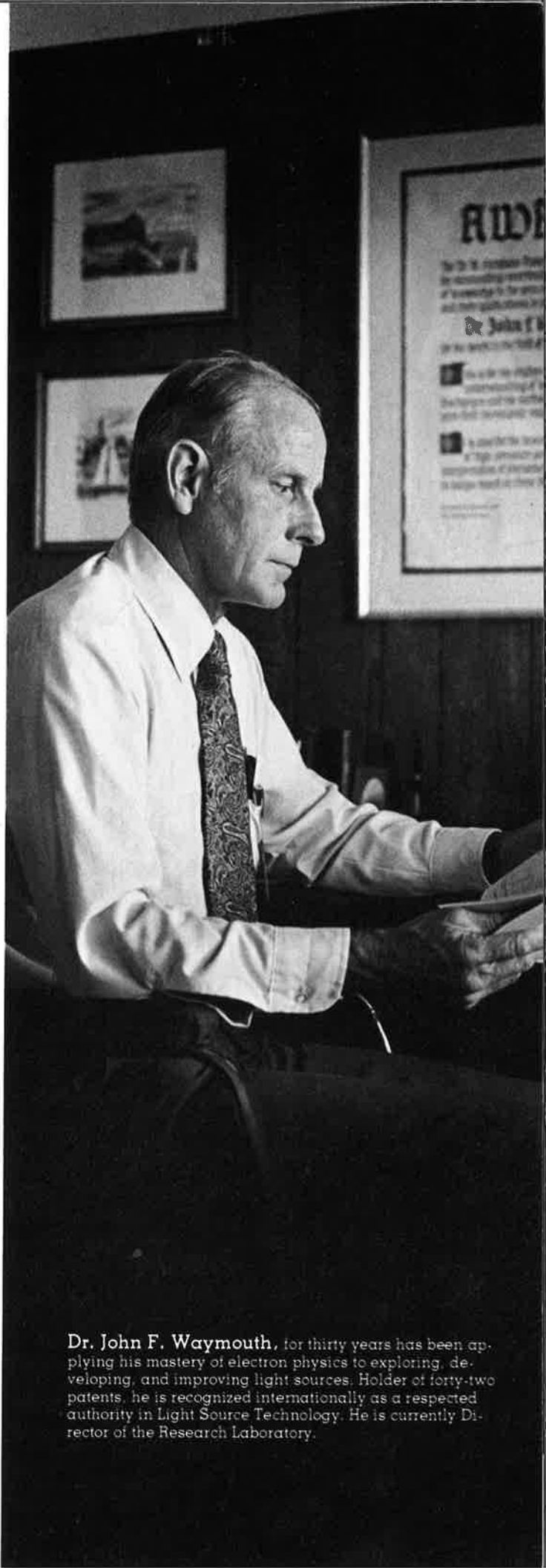
Vacuum Deposition
- Sputtering
- Evaporation
- Thin Film
- Dichroics

Glass/Ceramics
- Formulation
- Fabrication
- Seals
- Fracture Analysis
- Pressing
- Equipment

Solar
- Panels

Services
- Analysis
- Testing
- Spectroradiometry
- Scientific/Engineering Computations
- Computer-Interfaced Measuring Equipment

Intermetallics and Refractories
- Vacuum Hot Pressing
- Pyrolytic Technology



Dr. John F. Waymouth, for thirty years has been applying his mastery of electron physics to exploring, developing, and improving light sources. Holder of forty-two patents, he is recognized internationally as a respected authority in Light Source Technology. He is currently Director of the Research Laboratory.

Physics

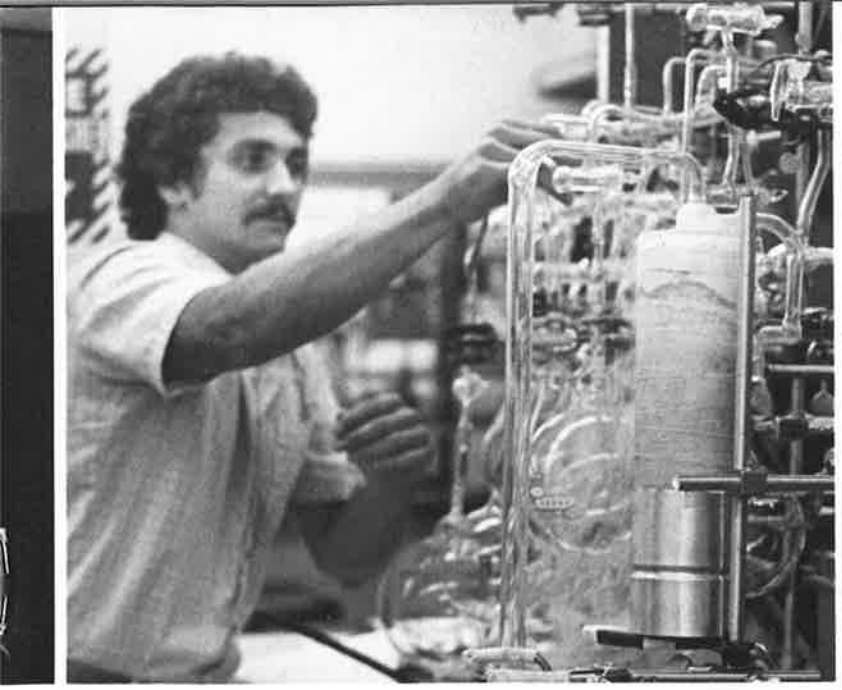
Plasma Physics

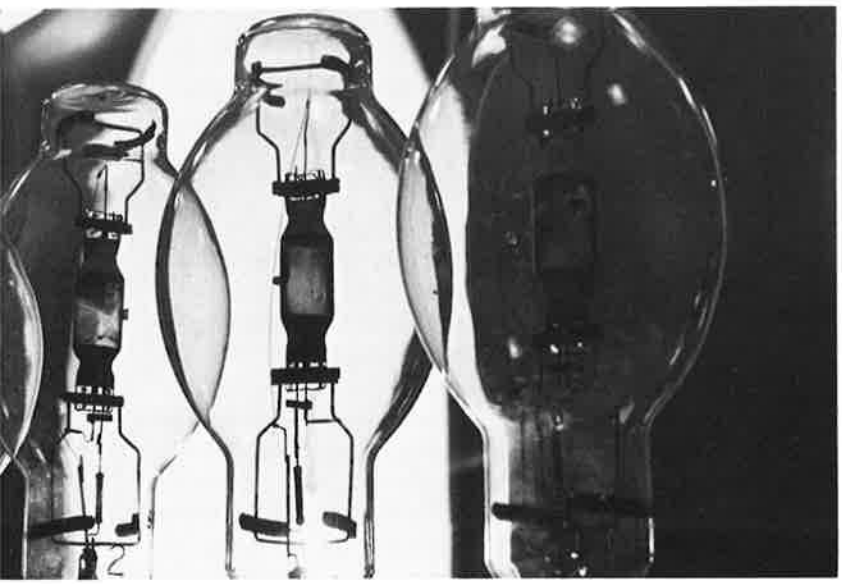
☐Experimental and theoretical capability to measure and analyze key variables of electron temperature and density, spectral radiation outputs and decay constants of high and low pressure plasmas, both those in local thermodynamic equilibrium and those which are kinetically controlled ☐Application of these measurements and analysis to understand the energy budget of such plasma and predict the effect of changes in input parameters, as well as diagnostic tools.

This capability has resulted in the development of the following: ☐ a new family of very high output fluorescent lamps ☐ the development of an additive system for metal halide high intensity discharge lamps that has displaced all competitive systems in this country ☐ a family of HID lamps with specially-shaped arc tubes for control of convective transport ☐ and most recently, the extension of metal-halide lamp development to the under-50-watt power domain, potentially replacing incandescent lamps in many applications. An additional recent development resulting from this capability has been the discovery of a method to increase the efficiency of high pressure sodium lamps.

Atomic and Molecular Physics

☐Study of atomic and molecular spectroscopy of ensembles of gaseous atoms and molecules to determine emission properties and optical excitation properties as well as excitation by selected discharge plasmas ☐ Study especially the interaction between molecules and atoms of such systems with special attention to the energy storage and transfer by carrier species and the efficiency of conversion of input energy into radiant emission.





This has led to the discovery of a gaseous phosphor system of quantum efficiency greater than unity, and in the discovery of novel sources of ultraviolet and visible radiation.

Materials

The limiting factor in performance of most light sources is the high-temperature capability of the materials from which it is made. GTE manufactures most of its most critical materials, including glass, quartz, polycrystalline alumina, tungsten and fluorescent phosphors. In addition to extensive development programs for improving the capabilities of these existing materials, GTE's Lighting Laboratory actively searches for materials of optimum performance. Recent successes in this area include fused quartz tubing free of airlines and striations and when coupled to additional vacuum treatment results in a quality of material useful for all lamp types.

Vacuum Deposition

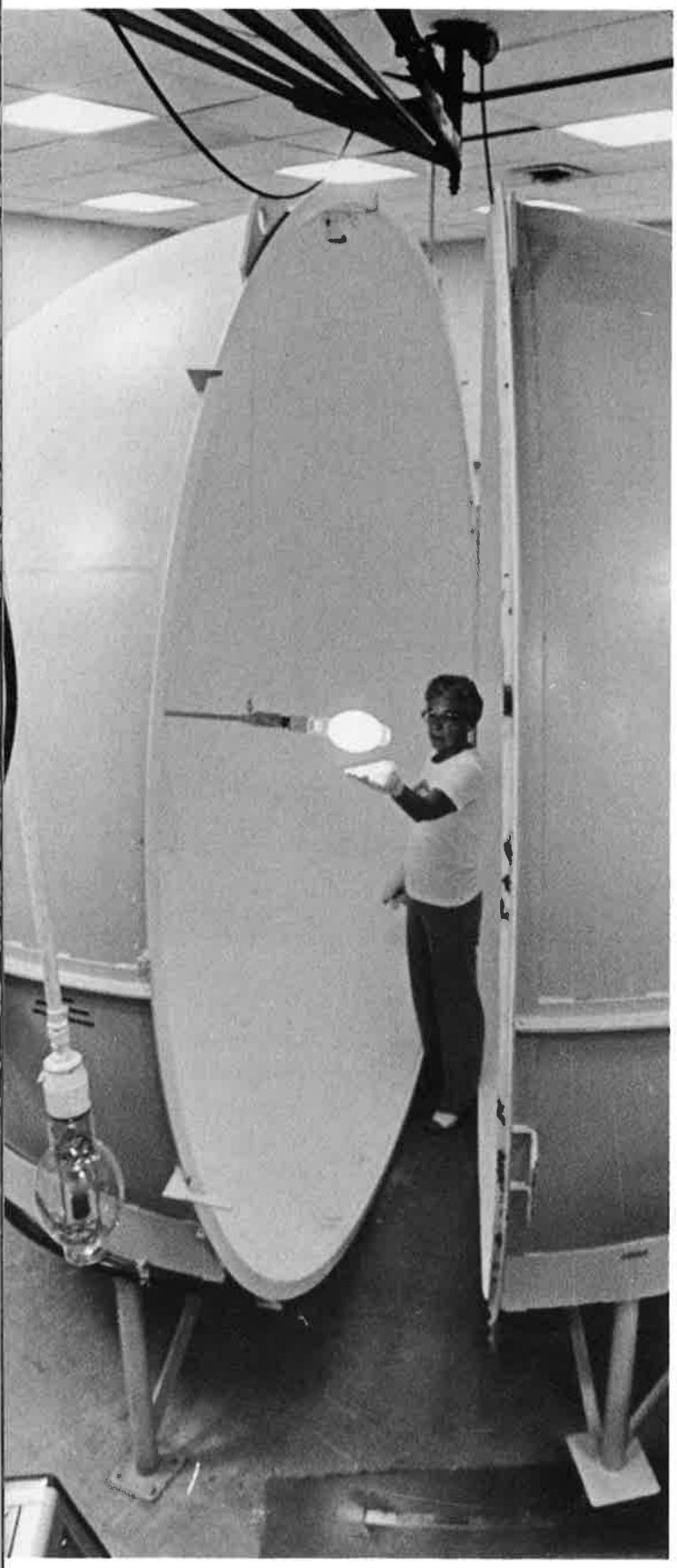
GTE Lighting Laboratory has done extensive work in the highly technical areas of vacuum deposition.

Evaporation

☐ Specify, develop, and run equipment for evaporating thin films for optical layers, dielectrics, phosphors, electrodes, and reflectors.

☐ Design thermal and electron beam evaporation systems ☐ Develop processes for evaporation films using optical and resonant crystal means for process control ☐ Control purity, uniformity, thickness, rate, and pinhole density ☐ Specify quality, and handle evaporation materials ☐ Use diagnostic equipment in process optimization.

Process flexibility of electron beam evaporation systems has led to a useful technique in the study of thin film growth processing.



Sputtering

☐Specify, develop and run equipment for sputtering dielectrics, phosphors, electrodes, and other thin films ☐ Specify targets and substrates ☐ Design IR, magnetron, bias, and substrate rotation and transfer systems ☐ Develop processes (including reactive) for sputtering films within specifications for stoichiometry, purity, uniformity, thickness, rate, and pinhole density ☐ Use residual gas analysis, plasma diagnostics, and other tools to understand effects of changes in materials or sputtering parameters.

Control of the interactions of the process parameters has lead to capabilities in deposition and analysis of thin films as well as fabrication of devices to convert electrical energy to light for information displays, for example, thin film electroluminescent displays of extremely high contrast ratio.

Thin Films

☐Theoretical and experimental capability to predict and measure optical, electrical, chemical, and mechanical properties of thin films and interfaces between films ☐ Design films and film stacks to meet performance specifications ☐ Select appropriate deposition process and deposit films ☐ Carry out tests to locate cause of any deviations from predicted performance ☐ Understand role of crystal lattice effects, doping effects, substrate material and condition, and film surfaces in film performance.

This capability has enabled us to fabricate display devices with built-in high-contrast absorbers and high electrical breakdown protection dielectric layers for phosphor efficiency maintained over long life.

Dichroics

☐Dichroic stacks of TiO_2 (rutile) and SiO_2 films with excellent adhesion to glass substrates are designed to optimize heat and light separation ☐ The attainment of high refractive index TiO_2 films in reactive E-beam deposition chambers requires controlled gas flow and evaporation rates, as well as substrate temperature regulation ☐ Sophisticated monitoring and control systems are used for on-line feedback control.

This capability has led to the use of color corrective filters, cold mirror coating and heat reflecting films in lighting products.

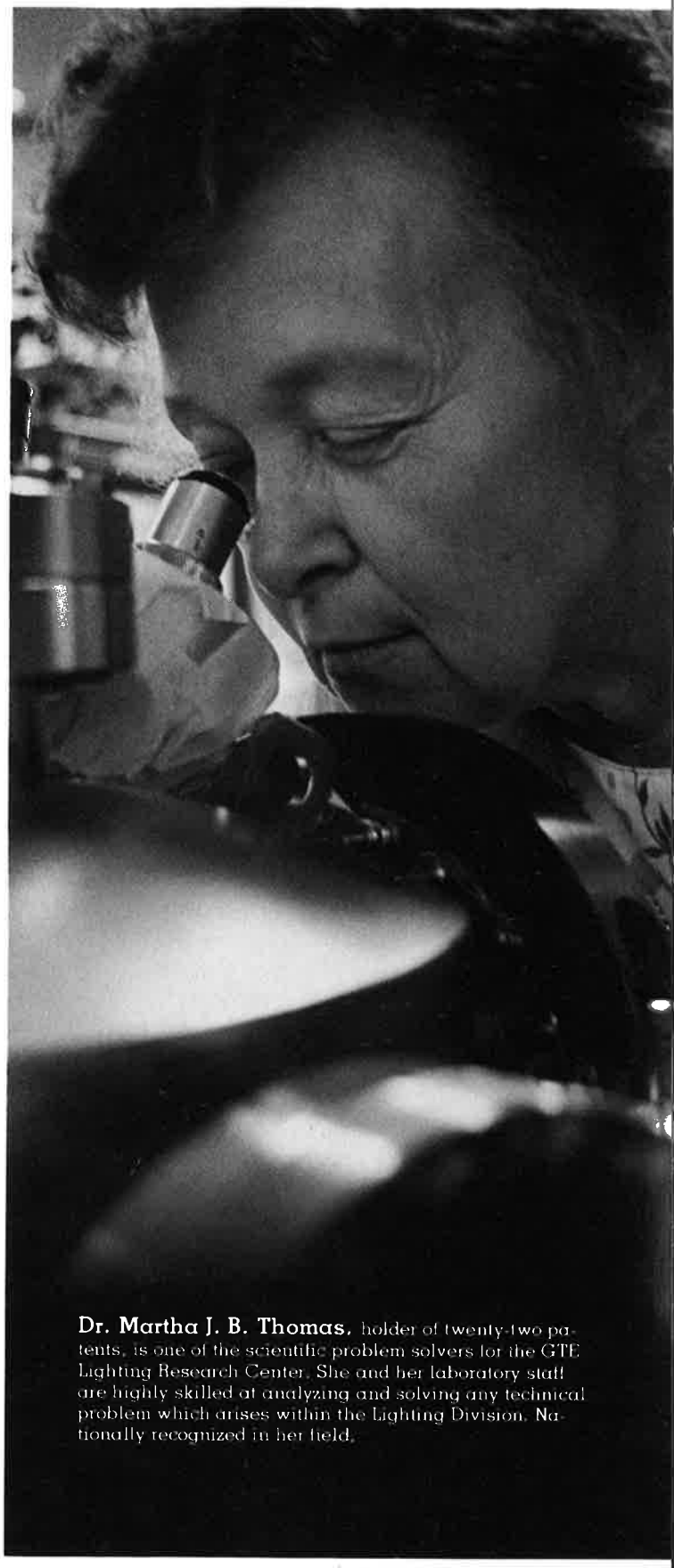
Services

Analysis

All types of materials can be analyzed and characterized at the laboratory, both by chemical techniques and by the most modern physical instrumentation. Materials are characterized by bulk and by surface (10Å depth) from elemental to species content; solid, liquid, or gaseous; sized or surface characterized; metallurgically or chemically — to name a few. Data collection is often done and calculated through a direct tie to an engineering computer. In addition to detailed identification, interaction of materials under various conditions can be surveyed with instrumentation, interpreted, and conditions modified, if desired.

Instruments for Analysis

- *Auger Spectrometry (AES)*
- *ESCA (Electron Spectroscopy for Chemical Analysis)*
- *X-Ray Diffraction (XRD)*
- *X-Ray Fluorescence (XRF)*
- *Electron Probe*
- *Scanning Electron Microscope (SEM)*
- *Particle Size Distribution (Sedigraph)*
- *Surface Area Measurement (Monosorb)*
- *Mass Spectrometer (Gas Fill and Pressure)*
- *Mass Spectrometer (UTI)*
- *Fourier Transform Infrared (FTIR)*
- *Laser Raman*
- *Transmission and Reflection Measurement (Carey)*
- *High Pressure Liquid Chromatography (HPLC)*
- *Ellipsometry (Index of Refraction)*
- *Film Thickness Measurement (Dektak)*
- *Differential Thermal Analysis (DTA)*
- *Thermal Gravimetric Analysis (TGA)*
- *Differential Scanning Calorimetry (DSC)*
- *Low Carbon Analyzer*
- *Metallography*
- *Microhardness Test (Tukon)*
- *RCA Bend Tester*
- *Hardness Tester (Kentrall)*
- *Shore Durometer*
- *Instron Tensile Tester*
- *Argon/Nitrogen Gas Fill Tester*
- *Atomic Absorption (A.A.)*
- *Ion Selective Electrode*
- *Vacuum Leak Detector (Helium Mass Spectrometer)*



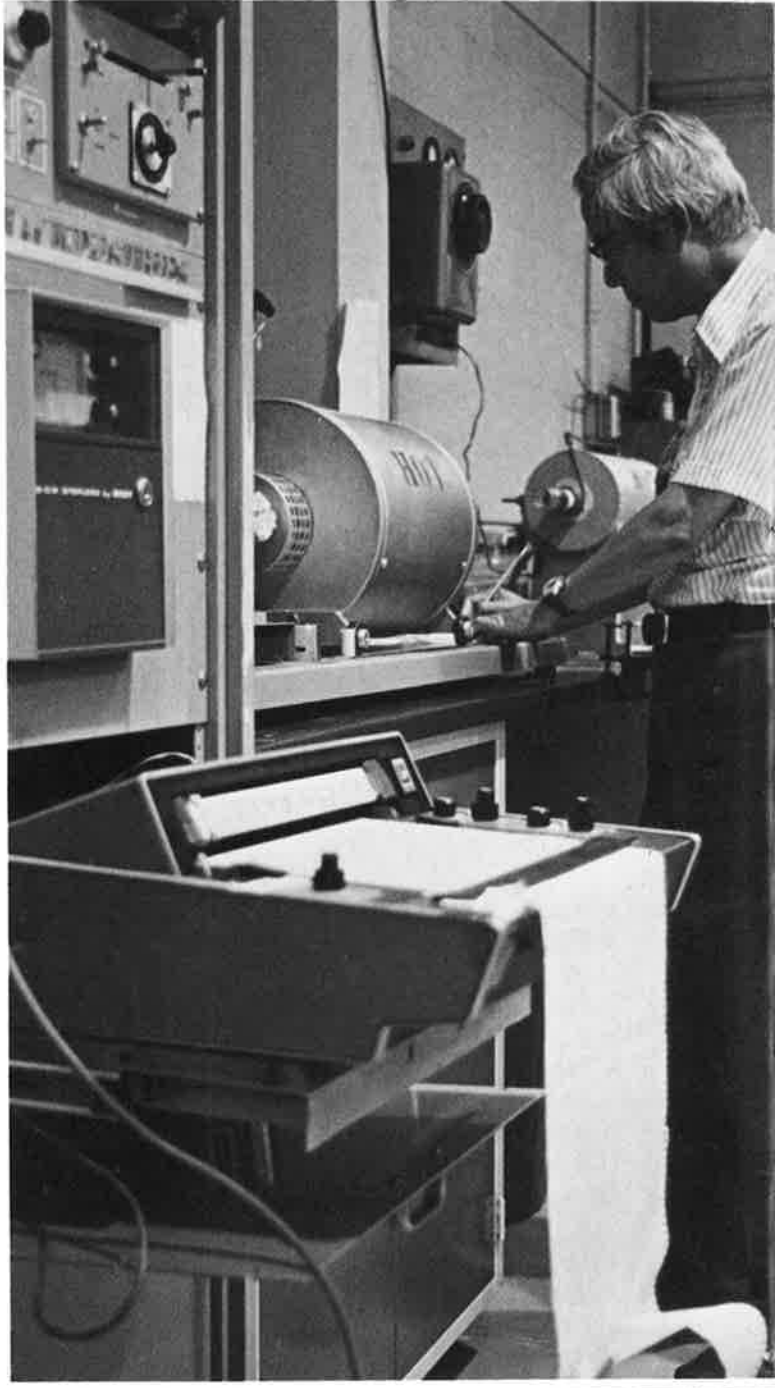
Dr. Martha J. B. Thomas, holder of twenty-two patents, is one of the scientific problem solvers for the GTE Lighting Research Center. She and her laboratory staff are highly skilled at analyzing and solving any technical problem which arises within the Lighting Division. Nationally recognized in her field.

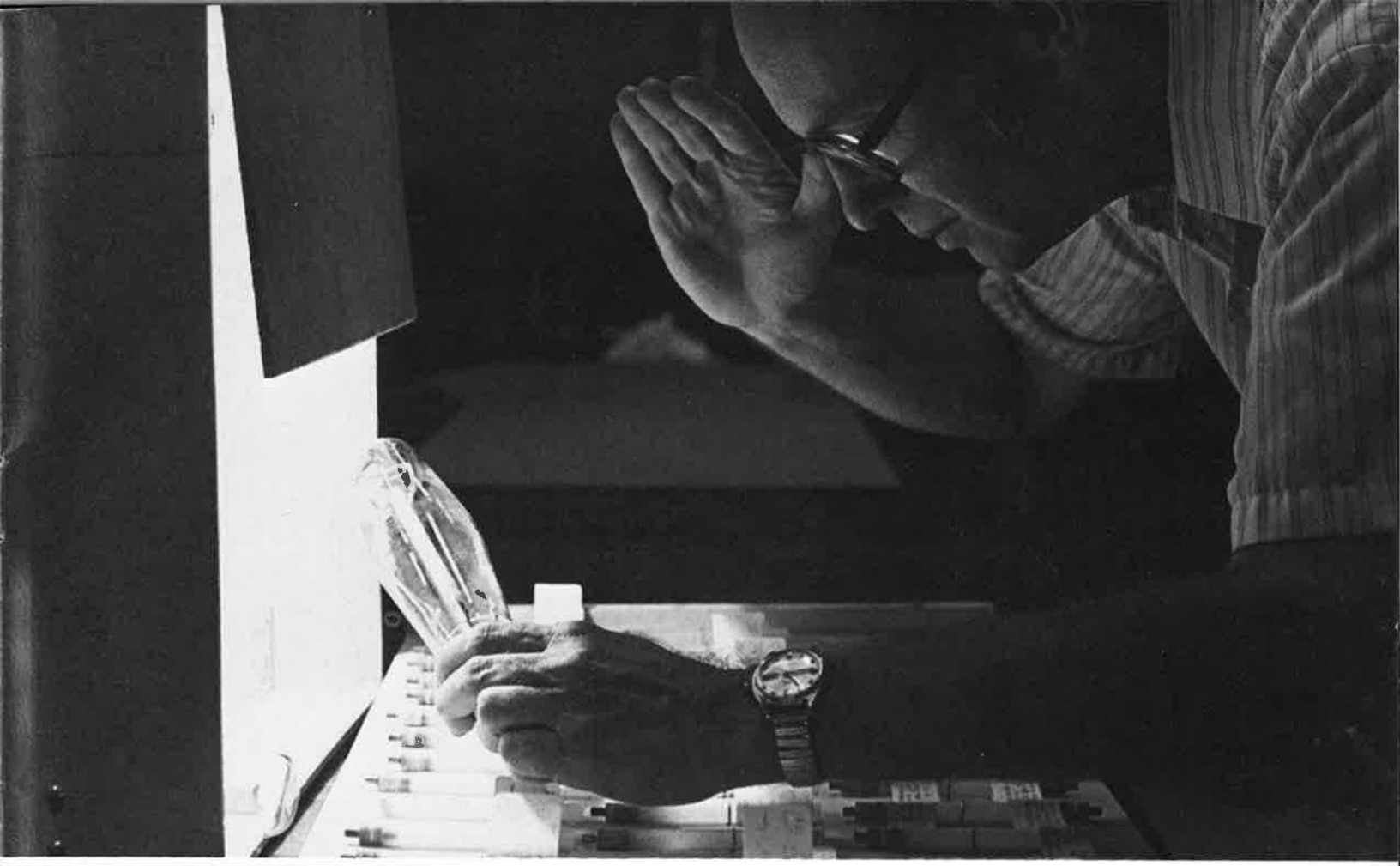
A Partial List of our "Firsts"...

- *First electroluminescence on the market.*
- *First solution to aperture blackening problem makes possible aperture fluorescent photocopy lamps.*
- *First plant growth lamps.*
- *Discovery of zirconium as a photoflash fuel.*
- *First use of dichroic reflectors for projection lamps.*
- *First use of tungsten halogen lamp for projection.*
- *First good-color-rendition metal halide arc lamp.*
- *First application of yttrium vanadate phosphor to lamps.*
- *First hard glass tungsten halogen incandescent lamps.*
- *First electronic flash airport approach system.*
- *First tungsten mesh element heaters.*
- *First stranded tungsten wire evaporation sources for the metalizing industry.*
- *First deuterium ultraviolet light source.*
- *First photoflash using pressure sensitive chemical igniter.*

. . . First in energy saving lamps:

- *Impedance modified fluorescent lamps.*
- *High efficiency high pressure sodium lamps operable on mercury lamp ballasts.*
- *High efficiency metal halide lamps operable on mercury lamp ballasts.*
- *Miniature metal halide lamps.*
- *Super high output metal halide lamps.*
- *First reduced wattage automotive headlamps using hard glass halogen.*





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