TABLE OF CONTENTS

Personnel		vi
Publications and Reports		ix
Introduction		xiii
I.	Physical Electronics	1
	Electron Emission Problems	1
	Magnetic Velocity Analyzer Investigation of Thermionic Emission from Tungsten	1
	Photoelectric Study of Surface States on Insulators	1
	A Redetermination of the Crystallographic Variation of Electron Field Emission from Tungsten	2
	Conduction Mechanism in Oxide-Coated Cathodes	3
	Nonspace-Charge to Space-Charge Transition as a Function of Temperature in Test Diodes	4
	Physical Electronics of the Solid State	5
	Temperature Gradients Across Ionic Crystals	5
	Experimental Techniques	5
	Ionization Gauge and General Vacuum Studies	5
	Infrared Radiation Pyrometer for Temperature Measurements on Oxide-Coated Cathodes	7
II.	Microwave Gaseous Discharges	8
	Electron Collision Losses at Low Energies	8
	Electron-Ion Recombination in Hydrogen	8
	Oscillations in DC Discharges	10
	Probe Studies	10
III.	Solid State Physics	12
	The Quantum Mechanical Foundation of the Theory of Solids	12
	Soft X-ray Vacuum Spectrograph	12
	Microwave Study of Semiconductors	14
	Electrical Properties of Germanium at Microwave Frequencies	14
IV.	Low-Temperature Physics	16
	Magnetic Dipole Interactions in Crystals	16
	Determination of the Thermodynamic Temperature Scale at Very Low Temperatures by a Magnetic Method	16
	The Resistance Minimum in Metals	17
	Specific Heat of Magnesium	20
	Thermal Conductivity of Magnesium	20
	Thermoelectric Forces	22
	Study of Thermal Properties of Solids by a Pulse Technique	22
	Pressure Dependence of Second-Sound Velocity in the Demagnetization Region	24

	Second-Sound Pulse Amplitudes in Liquid Helium II	24
	Thermomechanical Effect	25
	Viscosity of Liquid Helium	26
v.	Microwave Spectroscopy	27
	Zeeman Effect	27
	High-Temperature Microwave Spectroscopy	28
	Water Molecule	28
VI.	Molecular Beam Research	30
	Cl ³⁶ Experiment	30
	The Hyperfine Structure of Cs ¹³⁴	31
	Mass Spectrometer Problem	31
	Use of a Directional Oven	31
	Experimental Procedure	32
	A Detector for Radioactive Atomic Beams	33
	An Ionic Beam Magnetic Resonance Method	33
VII.	Magnet Laboratory Research	36
	Nuclear Magnetic Resonances	36
	Nuclear Resonances in Gases	36
	The Deuteron-Proton Magnetic Moment Ratio	36
	Double Resonance Experiments	37
	Hyperfine Structure of the P _{3/2} State of Sodium	37
VIII.	Tube Research and Development	38
	Magnetron Development	38
	Testing and Design of High-Power 10.7-Cm Magnetrons	38
	Microwave Tubes	41
	Noise and Space-Charge Waves	41
	A multivelocity electron beam in a cylindrical drift tube	41
	Calculation of noise in a finite diameter beam	44
	Experiments on noise in electron beams	44
	Traveling-Wave Amplifiers	47
	Interleaved-fin slow-wave structure	47
	10-cm pulsed traveling-wave amplifier	48
	Helix surrounded by a resistance sheath	50
	1-Mev Pulsed Electron Source	51
	Injected Beam Magnetrons	52
	The Use of Ferrites at Microwave Frequencies	56
	Development of an X-band circulator	60
	Impedance of a cavity containing a generalized medium	60
IX.	Communication Research	64
	Multipath Transmission	64

	Speech and Music. Transatlantic Tests	64
	Television	64
	Simplified FM Receiver	65
	Adjacent and Alternate Channel Interference	65
,	Frequency Detector Linearity Measurement	65
	Statistical Theory of Communication	67
	Five-Channel Analog Correlator	67
	Information Theory	67
	Transmission of information through channels in cascade	67
	Pulse Code Magnetic Recorder	68
	Human Communication Systems	71
	Communication and Learning in Task-Oriented Groups	71
	Experiment on the Effect of Change in Communication Networks	71
	Results from Problem 1 on Whirlwind I	71
	A Second Problem for Whirlwind I	74
	Some Abstract Properties of Networks	75
	Replacement of Visual Sense in Task of Obstacle Avoidance	78
	Communications Biophysics	82
	Interaction of Cortical Activity and Evoked Potentials	82
	Variability of Cortical Responses to Acoustic Clicks	82
	Instrumentation	82
	Latency of Neural Components in Round Window Response to Pure Tones	83
	Neurophysiology	85
	Semantic Information and its Measures	87
	Transient Problems	91
	Basic Existence Theorems (continued from Quarterly Progress Reports, Jan. 15, 1952 and April 15, 1952)	91
	Study of Convergence Phenomena Associated with the Propagation of Impulses Through Finite Networks	91
x.	Analog Computer Research	92
	The Operation of Present Computers	92
	Integral Equation Solver	92
	The Use of Computing Elements for Noncomputational Problems	92
	The Use of Computing Elements in Nonlinear Time- Domain Filters and Multiplexers	92
	A Nonlinear Filter to Remove 60-Cycle Hum	93
	The Design of New Computing Elements	93
	A Pentode Amplifier with Direct Coupling Between Plate and Screen	93
	An Electronic Multiplier Using Carrier Pulse Techniques	95