

# CONTENTS

<i>Preface</i>	ix
<i>Preface to the English Edition</i>	xi
CHAPTER I. INTRODUCTION	1
CHAPTER II. FORMULATION OF PROBLEMS	9
§ 1 Heating of electrodes in graphitization furnaces	10
§ 2 Heating of metals in continuous furnaces	15
§ 3 Efficient exploitation of oil-fields	17
§ 4 The problem of underground gasification of coal	20
§ 5 The plane contact problem of the theory of elasticity	21
§ 6 The computation of a magnetic field	27
§ 7 Flow of an incompressible fluid past a body	28
§ 8 Computation of an electron lens	30
§ 9 Investigating the operation of deep-pumping installations	31
CHAPTER III. MATHEMATICAL PRINCIPLES FOR THE SOLUTION OF BOUNDARY-VALUE PROBLEMS	35
§ 1 Types of equations	35
§ 2 Boundary and initial conditions	38
§ 3 Some exact solutions of boundary-value problems	41
§ 4 The finite-difference method for the solution of boundary-value problems	45
§ 5 The method of straight lines	67
§ 6 The basic formulae of the theory of potential functions and the basic properties of harmonic functions.	69
§ 7 The integral form of solution	72
§ 8 Integral equations	78
§ 9 The Monte Carlo method	80
§ 10 Connexion between the methods of solution of boundary-value problems and the domain of their application	82
§ 11 Combination of finite-difference and integral methods in the solution of boundary-value problems	86
§ 12 The characteristic equation. Characteristic values and characteristic functions	87
§ 13 Variational principles for the solution of boundary-value problems	90
CHAPTER IV. INSTRUMENTAL METHODS OF SOLVING BOUNDARY-VALUE PROBLEMS	100
§ 1 Fundamental laws of electricity employed in solving boundary-value problems	100
§ 2 The principles of constructing electrical circuits for the solution of boundary-value problems	102
§ 3 Approximation to the Laplacian by electrical networks	103
§ 4 Poisson's equation	122

§ 5	Fourier's equation	126
§ 6	The equation of heat conduction	128
§ 7	The wave equation	129
§ 8	Pockels' equation	131
§ 9	The telegraph equation	132
§ 10	The general case	133
§ 11	The biharmonic equation	136
§ 12	Assigning the boundary and initial conditions	139
§ 13	The use of two potential dividers in the solution of boundary-value problems	142
§ 14	Integrating stars	146
§ 15	Instrumental solution of integral equations	147
§ 16	The characteristic equation	149
§ 17	The Schrödinger equation	155
§ 18	Instrumental approximation to complex expressions	156
§ 19	Determination of Green's function by instrumental means	158
§ 20	The limiting precision of measurements on grids	161
CHAPTER V. MEASUREMENTS		164
§ 1	Methods of measurement	164
§ 2	The null indicator	177
§ 3	Determination of the scale factor	182
§ 4	Measurements in "absolute" units	189
CHAPTER VI. UNIVERSAL GRID ANALOGUES		192
§ 1	The EI-11 electrical analogue	192
§ 2	The EI-12 electro-integrator	203
§ 3	The EI-22 electrical analogue	207
§ 4	The EI-21 electrical analogue	219
§ 5	The EI-31 electrical analogue	223
CHAPTER VII. SPECIAL-PURPOSE GRID ANALOGUES		230
§ 1	The EM-1 and EM-2 analogues	230
§ 2	The EM-5, EM-7 and EM-8 analogues	243
§ 3	The EP-41 electrical analogue for determining a magnetic field in a half-space	263
§ 4	Solution of plane problems of the theory of elasticity. The EM-6-BU analogue	282
CHAPTER VIII. STAR INTEGRATING NETWORKS		307
§ 1	The need for a further type of instrument to cover the solution of boundary-value problems for unbounded domains	307
§ 2	Design principles of circuits of the "integrating star" instruments	308
§ 3	The IZ-3 instrument	318
§ 4	Errors arising in the use of IZ instruments	337
§ 5	Problems solved	345
CHAPTER IX. METHODS OF PHYSICAL SIMULATION FOR THE SOLUTION OF CERTAIN BOUNDARY-VALUE PROBLEMS		367
§ 1	Analogues for the electrohydrodynamical analogy EGDA	368
§ 2	Magnetic analogue	374

§ 3 Capacitor analogue	375
§ 4 Optical analogues	377
§ 5 Hydraulic integrator	380
CHAPTER X. FUTURE IMPROVEMENTS TO ANALOGUES FOR THE SOLUTION OF BOUNDARY-VALUE PROBLEMS	383
§ 1 Extension of the class of problems which can be solved	383
§ 2 Acceleration of the process of solution	385
§ 3 Modernization of the design of analogues and their components	385
CHAPTER XI. FURTHER DEVELOPMENTS—SUPPLEMENTARY CHAPTER TO THE ENGLISH EDITION	387
§ 1 Introduction	387
§ 2 Development of integral analogue methods of solving boundary- value problems	388
§ 3 Iterative method of defining boundary conditions in the solution of some boundary-value problems	433
§ 4 Electronic apparatus for defining variable boundary conditions in the solution of non-stationary boundary-value problems	439
§ 5 On the theory of substitution in electrical network analogues for the solution of boundary-value problems	444
<i>Bibliography</i>	453
<i>Index</i>	455
<i>Other Titles in the Series</i>	461