Table of Contents

Page

Preface V

List of symbols X

Part 0. **Preliminary remarks. Singularities** 1

1. General properties and remarks on analytic functions 1

Part I. **General theory of subsonic flow** 6

1. Physical and hodograph planes, system of equations, Chaplygin's equation 6
2. Transformation of Chaplygin's equation, pseudologarithmic plane 7
3. Isentropic flow 8
4. The duality between the flows of an incompressible and a compressible fluid. Logarithmic plane 9
5. Method of generating stream functions 11
6. The domain of convergence of the development for Ψ^* 13
7. Discussion of the domain of convergence of the series representing Ψ^* .. 15
8. Transformation to the physical plane 17
9. Alternative formulas, additional remarks 17

Part II. **Simplified pressure-density relation** 23

1. Definition of a series representing a stream function Ψ^* regular in the whole half-plane 23
2. The physical relations corresponding to the assumption $f = C\ \lambda^{-2}$ 25
3. Discussion of the obtained results 28

Part III. **Supersonic flow** 30

1. Some remarks on different types of equations 30
2. Differential equation in the supersonic flow 31
3. Solution of the differential equation 31
4. Operator obtained by the use of Riemann's function 32
5. Evaluation of the function $R^{(1)}(\xi, \eta; \xi_0, \eta_0)$ 34
6. Second type of integral operator 34
7. The proof of the uniform convergence 36
8. The domain of convergence 38
9. Solution regular at $\Lambda = \tau = 0$ 38
10. Transformation to the physical plane 39
11. Alternative formulas 40

Part IV. **Transonic flow** 42

1. General remarks 42
2. Behavior of the G_n at $m = 1$ 42
3. Recursion formula for the functions r_n 44
4. Methods of analytic continuation 45
5. Application of integral operators to transonic flow. Basic equations 49
6. Integral operator of the second kind in the case of the simplified compressibility equation 52
7. Integral operator of the second kind in the case of the "exact" compressibility equation 55
8. Combination of the integral operator and Chaplygin's solution 58
9. Tables for the determination of transonic flow patterns. Alternative formulae 60

Page

Part V. **Axially symmetric flow** ... 64
1. General equations, explanation of the method of infinite approximations by a sequence of linear equations ... 64
2. Determination of $\Phi^{(0)}$ ... 66
3. Determination of the solution of the equation in the transonic case ... 68
4. Determination of the solution in the sub- and supersonic regions ... 71
5. Determination of $\Phi^{(1)}$ in N_μ belonging entirely to the sub- or supersonic region ... 73
6. General remarks ... 75

Part VI. **Singularities** ... 76
1. General properties and remarks on analytic functions ... 76
2. Properties of Bergman's operator in the subsonic range ... 76
3. The behavior of certain types of flows in the case of an incompressible fluid 79
4. The behavior of a subsonic compressible flow at infinity ... 80
5. Fundamental solutions in the subsonic range ... 81
6. Modified integral operator in the subsonic range ... 83
7. Subsonic compressible fluid flows with singularities of type S ... 83
8. The transition from the pseudo-logarithmic to the physical plane in the subsonic range ... 84
9. Generalization of Blasius' formulae in the subsonic range ... 86
10. An integral formula representing a subsonic flow inside a domain in terms of its values on the boundary ... 87
11. A proof of an auxiliary lemma in the subsonic range ... 87
12. Singularities in transonic flow ... 88

Part VII. **Review of other methods** ... 90
1. Methods of expansion in powers of the Mach number ... 90
2. Methods of expansion in powers of a thickness parameter (small perturbations) 93
3. Variational methods ... 93
4. Hodograph method ... 97
5. Slender bodies and bodies of revolution ... 106
6. Southwell's method ... 107
7. General remarks ... 107

Part VIII. **Review of tables and particular formulas** ... 108
1. Subsonic flow ... 108
2. Supersonic flow ... 109
3. Transonic flow ... 110
4. General remarks ... 110

Part IX. **General remarks** ... 111
1. Application of the hodograph method in the three-dimensional case and to flows with shocks ... 111
2. The method of orthogonal functions and the theory of integral operators 111
3. General remarks ... 113

Part X. **List of tables** ... 113
1. Subsonic flow ... 113
2. Transonic flow ... 115

Part XI. **Examples** ... 116
1. Subsonic flow ... 116
2. Use of punch-card machines ... 119
3. Flow past an oval-shaped obstacle ... 122
4. Transonic flow ... 124

Part XII. **Errata in previous papers** ... 125
Additional contributions ... 127

Part XIII. **Generalization of Bergman's method to diabatic flow** ... 128
1. Basic equations ... 129
2. The stream function equation ... 130

Page

3. The "generalized" potential equation 131
4. Hodograph transformation 132
5. General considerations 133
6. Generalized Chaplygin's equation and its transformation 134
7. Computation of f for diabatic flow 135
8. Method of generating stream functions 137
9. The domain of convergence of the development for ψ^* 138
10. Discussion of the domain of convergence of the series representing ψ^* ... 140
11. Behavior of G_n near $m = m^*$ 140
12. Recurrence formula for the functions $r_n(T_1)$ 142
13. Discussion and conclusions 143
14. Discussion of Q 145

Part XIV. **Integral operators in the case of certain differential equations in three variables** 146

1. Some examples 146

Part XV. **Some SEAC computations of subsonic fluid flows by Drs. P. Davis and P. Rabinowitz** 148

1. Introduction 148
2. Basic equations of flow 149
3. Generation of particular solutions of the differential equation 150
4. Fluid flow of type S 152
5. Singular solutions of type S 153
6. Numerical computation of particular solutions and singular solutions 155
7. Computation of F and P as functions of a complex variable 156
8. Estimation of truncation errors in the computation of particular solutions 157
9. Computation of particular solutions. Method A 157
10. Local development of the solutions. Method B 159
11. Development of the singular solutions 160
12. Computation of particular solutions. Method B 162
13. Computation of singular solutions. Method B 163
14. Method for the solution of the boundary value problem in the pseudo-logarithmic plane 163
15. Sources of error in Method B 166
16. Concluding remarks 166
17. Tables 167

Final remarks 173

Additional bibliography 177

Index of authors 185

Subject index 186