

CONTENTS

	<i>Page</i>
PREFACE	xi
TRANSLATOR'S PREFACE	xiii
LIST OF FREQUENTLY EMPLOYED SYMBOLS	xv
CHAPTER I GENERAL PRINCIPLES	1
1. Fundamental equations of frictionless compressible flow	1
2. Bernoulli's equation	2
3. The equations of vorticity	4
4. The velocity potential	6
5. The stream function	8
6. Characteristics	8
7. Plane potential flow	13
8. Examples	15
9. The application of the method of characteristics to transonic flow	16
10. General considerations related to the concept of characteristics	18
11. Some remarks on the formulation of boundary value problems in subsonic and supersonic flow	18
12. A method of derivation of the approximate equations	22
CHAPTER II SIMPLIFIED EQUATIONS AND THE SIMILARITY RULE FOR TRANSONIC FLOW	26
1. Preliminary remarks	26
2. The Prandtl-Glauert equations	26
3. The simplified differential equations of flow	28
4. The shock conditions	31
5. The boundary conditions	34
6. The similarity rule	38
7. Applications of the similarity rule	41
8. A simplified method of description of the flow	42
9. The equations of continuity and momentum for transonic flow	43
CHAPTER III THE LINEARISED THEORY OF TRANSONIC FLOW	46
1. Preliminary remarks	46
2. The linearised theory of two-dimensional and axisymmetric transonic flows	46
3. Three-dimensional flows	49
4. A body of finite thickness	52
5. The linearised theory of non-steady transonic flow	55
6. The limits of applicability of the linearised theory	63

	<i>Page</i>
CHAPTER IV EXACT SOLUTIONS OF THE POTENTIAL EQUATION OF TRANSONIC FLOW	65
1. Introductory remarks	65
2. The flow in a De Laval nozzle	95
3. The parallel sonic jet	69
CHAPTER V FUNDAMENTALS OF THE HODOGRAPH TRANSFORMATION	73
1. The equations in the hodograph plane	73
2. The Jacobian of the hodograph transformation	78
3. Limiting lines	81
4. Chaplygin's particular solutions	88
5. The solution of a boundary value problem	90
6. Approximate representations of Chaplygin's solutions	92
7. Tricomi's equation	96
8. Examples of hodograph transformations	100
9. Branch lines in the hodograph plane	109
10. The lost solutions	111
11. Boundary value problems in the hodograph plane	112
CHAPTER VI DISCUSSION OF TRANSONIC FLOWS ON THE BASIS OF THE HODOGRAPH TRANSFORMATION	123
1. Introductory remarks	123
2. The discharge from a vessel	124
3. The flow around a sharp corner	127
4. Supersonic flow past a wedge	128
5. The analysis of the flow near the edge of a wedge with an attached shock	130
6. The wedge with curved surfaces	133
7. Transition from an attached to a detached shock	136
8. Forked shocks	144
9. A new type of forked shock	147
10. The meaning of the "second" solution for the supersonic flow past a wedge	149
CHAPTER VII PARTICULAR SOLUTIONS OF TRICOMI'S EQUATION	153
1. Chaplygin's particular solutions	153
2. Another type of particular solutions	156
3. Alternative form of solution	158
4. The G solutions	161
5. The special solutions G	170
6. Relationships between solutions for various values of μ	175
7. Approximate expressions for large values of $ \mu $	175
8. The Jacobian of the above particular solutions	182
9. Systems of particular solutions	184
10. The representation of appropriate solutions of Tricomi's equation by the superposition of particular solutions constructed from eigenfunctions	189
11. The eigenfunctions and eigenvalues in the limiting case of $c_2 \rightarrow 1$	190

CONTENTS

ix
Page

12. The representation of an arbitrary function in the limiting case $c_2 \rightarrow 1$	192
13. The expansion of a solution ψ in terms of particular solutions	196
14. The particular solutions of Tamada and Tomotika	204
15. The particular solutions of Falkowich	206
CHAPTER VIII FLOWS WITH $M = 1$	212
1. General considerations	212
2. The hodograph representation	213
3. An example of flow with $M = 1$	217
4. Sonic flow past a wedge	225
5. The interpretation of certain solutions corresponding to other values of μ	228
6. Unsymmetrical profiles at $M = 1$	230
7. The flow past an inclined wedge	230
8. The boundary value problem for an arbitrarily shaped profile at a small angle of attack and related problems	238
9. The inclined flat plate at $M = 1$	241
10. Particular solutions which can be calculated by similar methods	253
CHAPTER IX FLOW FIELDS WHICH DEVIATE ONLY SLIGHTLY FROM FLOWS WITH MACH NUMBERS OF UNITY	258
1. Introductory discussion	258
2. Examples of flows which deviate only slightly from a flow with Mach number of unity	259
3. Solutions which satisfy the boundary conditions at the surface of the body	261
4. The boundary conditions in the vicinity of the point 0	263
5. Flows which are antisymmetric in ψ with respect to the x axis	267
6. Unsymmetric flow fields	268
7. The expansion of a flow field in terms of the deviation of the undisturbed flow Mach number from unity	271
8. The flow past a rhombic profile in a choked closed-circuit wind tunnel	274
9. The flow past a rhombic profile in a free jet at critical velocity and the flow in a supersonic unbounded air stream	281
10. The flat plate in a choked closed-circuit wind tunnel	282
11. Further cases of two-dimensional flow fields	287
CHAPTER X SPECIAL CASES IN WHICH THE PARTICULAR SOLUTIONS GIVEN BY EQ. VII. 3 (3) ARE EMPLOYED	291
1. The hodograph solution at a non-degenerate point of the sonic line	291
2. The reflection of a discontinuity at the sonic line	292
3. The flow in the throat of a De Laval nozzle	298
4. Discussion of special boundary value problems of Tricomi's equation	299
CHAPTER XI AXISYMMETRIC FLOWS	306
1. Flows with $M = 1$	306
2. An improved analysis of the solution at infinity	314
3. Applications	319

	<i>Page</i>
4. Special two-dimensional and axisymmetric flow with compression shocks	322
5. Applications	323
6. Description of flow fields whose approach Mach number is close to 1	329
BIBLIOGRAPHY	333
1. Articles cited in the text	333
2. Textbooks	336
3. Additional references	336
INDEX	342