
Flow and Measurement of Air and Gases

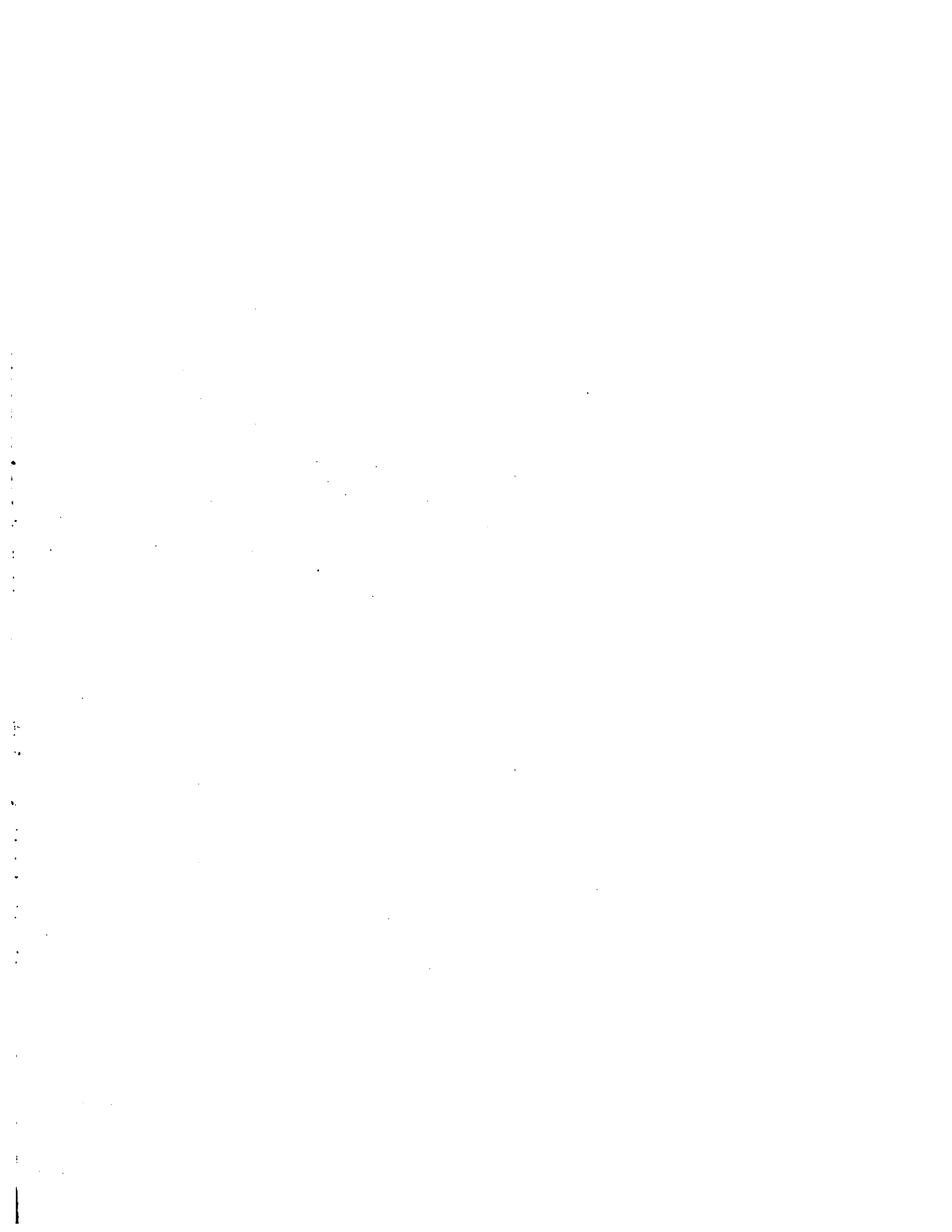
Eason Alec Birks

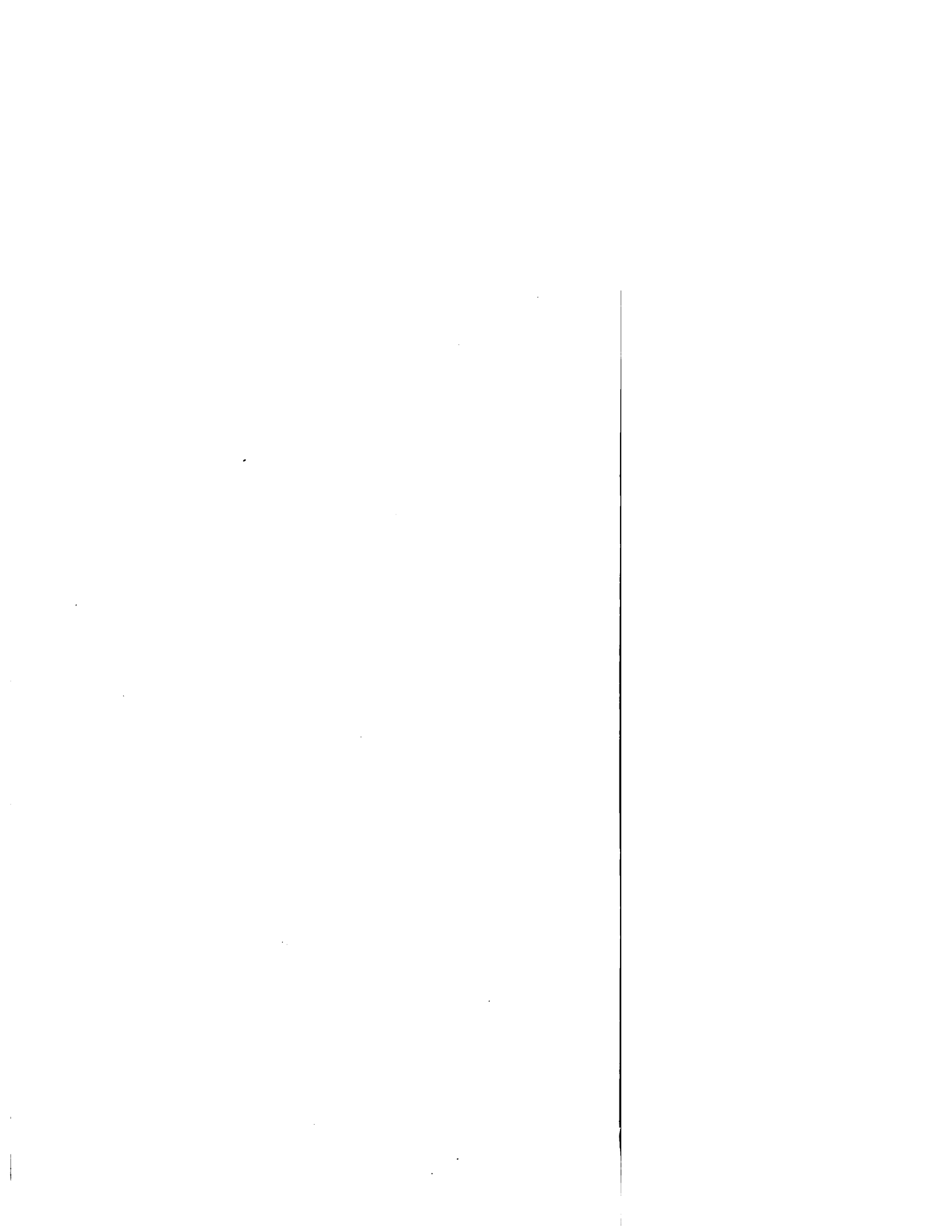
Title: Flow and Measurement of Air and Gases

Author: Eason Alec Birks

This is an exact replica of a book. The book reprint was manually improved by a team of professionals, as opposed to automatic/OCR processes used by some companies. However, the book may still have imperfections such as missing pages, poor pictures, errant marks, etc. that were a part of the original text. We appreciate your understanding of the imperfections which can not be improved, and hope you will enjoy reading this book.







FLOW AND MEASUREMENT
OF AIR AND GASES.

BY

ALEC B. EASON, M.A.,

ASSOCIATE MEMBER OF THE INSTITUTE OF ELECTRICAL ENGINEERS.

With Folding Plate and other Illustrations.



UNIVERSITY OF
CALIFORNIA

LONDON:

CHARLES GRIFFIN AND COMPANY, LIMITED,
PHILADELPHIA: J. B. LIPPINCOTT COMPANY.

1919.

TJ1025
E3

NO. 1000
ALBANY, N.Y.

PREFACE.

THE object of this book is to give information to engineers upon air and gas flow, and to indicate where more detailed information on the various subjects may be found: the references are purposely given fully, so that readers may consult the originals if they wish. An attempt is also made to co-ordinate the results of various tests and formulæ, so that the reason for variations may be appreciated. For instance, there are many references to the coefficient of friction in reports, but the extraordinary variations in its value may be seen in fig. 2'1 to 2'4 and in Tables 2'2 to 2'4: some authorities take it as constant.

For those who are ready to accept any formula without caring how it is arrived at or what values of the constants are included, this book will not perhaps be of much interest, as it is largely concerned with those very points. But for those who want to know upon what foundations graphs and formulæ are based it should be of value.

As regards subject-matter: Chapters II. and III. deal with the flow in pipes; Chapters IV. to VII. deal chiefly with pneumatic tube problems; Chapters VIII. to X. deal with the measurement of air and gas, about which little information is given in books on air compressors, and include a description of the recent development of hot-wire anemometers; Chapters XI. to XIV. deal shortly with some subsidiary questions relating to air flow.

Some of the graphs are plotted on logarithmically ruled paper, which deserves to be much better known in this country. A few abaci are included, these being a very convenient form of graphical chart.

The metric symbols cm, kg, m are printed without a full stop, as is customary in French and German journals.

The numbering of figures, equations, and tables is done consecutively for each chapter, not for the book as a whole. Use is made of the ' to differentiate between the chapter number and figure number, viz. 2'1, 3'1, etc.

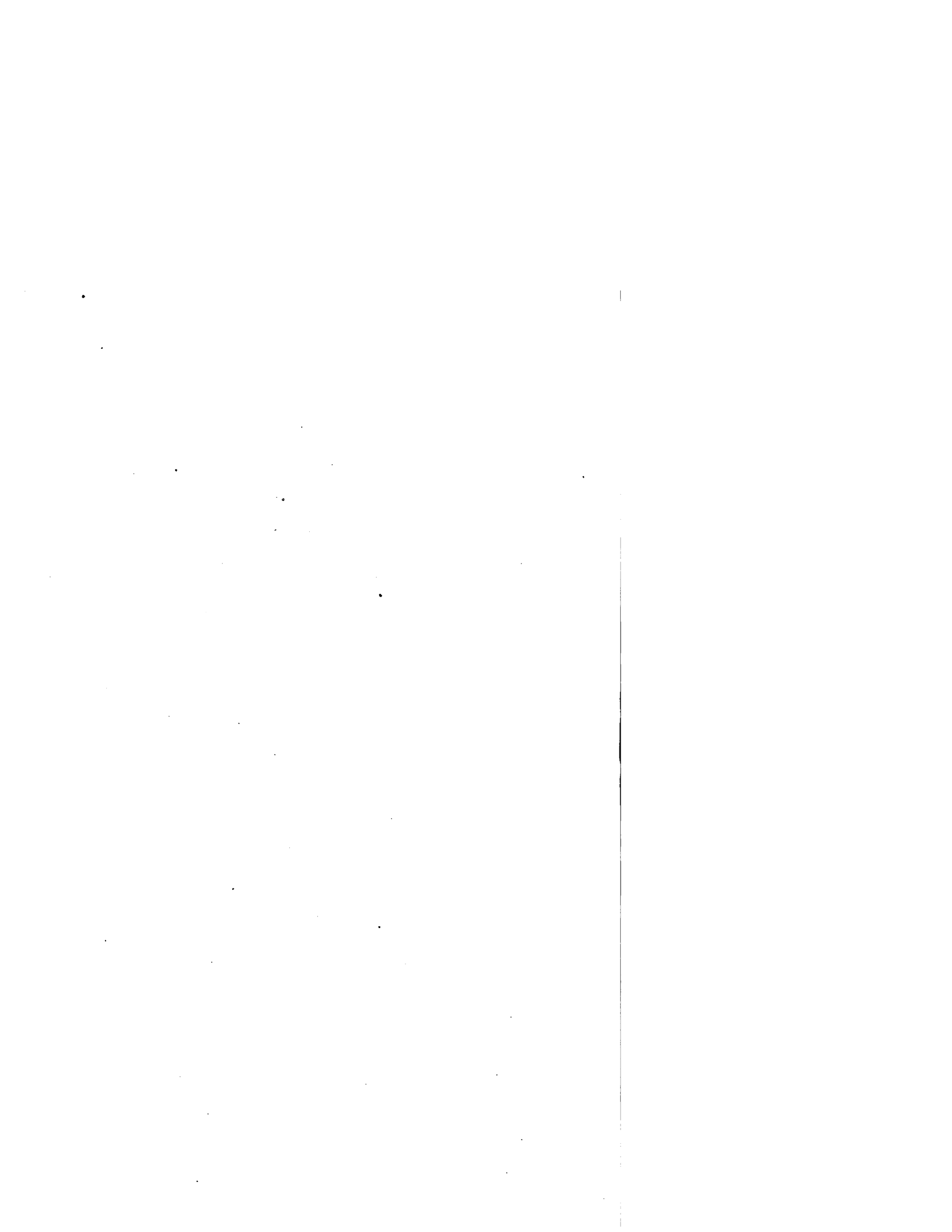
I shall be glad if attention is drawn to any mistakes and errors which may have crept into the formulæ and tables: in this connection it may be stated that the constants in the formulæ have only been calculated upon a slide rule and may be $\frac{1}{2}$ per cent. out. Such inaccuracy is immaterial in ordinary air and gas work, as the varying conditions of the atmosphere cause the specific volume of air to vary much more than $\frac{1}{2}$ per cent. from day to day, or even from hour to hour.

Any suggestions as to the rearrangement of tables and graphs which would make them of more use will be welcomed.

A. B. EASON.

LONDON, August 1919.

415269



LIST OF CONTENTS.

CHAP.	PAGE
I. PROBLEMS DEALT WITH, AND SOURCES OF INFORMATION	1
II. COEFFICIENT OF FRICTION IN PIPES	17
III. LOSS OF PRESSURE AT FITTINGS	66
IV. PNEUMATIC TUBE PROBLEMS	77
V. THEORIES OF AIR FLOW IN PIPES	95
VI. TRANSIT TIME OF CARRIERS	105
VII. INTERMITTENT FLOW OF AIR IN TUBES	114
VIII. METERS FOR GAS AND AIR	123
IX. MEASUREMENT OF AIR BY PITOT TUBES	155
X. ELECTRIC VELOCITY METERS AND HOT-WIRE ANEMOMETRY	177
XI. FLOW FROM ORIFICES	198
XII. AIR FRICTION ON MOVING SURFACES	221
XIII. GENERAL DESCRIPTION OF PNEUMATIC TUBES	228
XIV. METHODS OF PRODUCING AIR CURRENTS	236
NAME INDEX	243
SUBJECT INDEX	246

LIST OF TABLES.

TABLE	PAGE
1'1. Critical Velocities of Air	2
1'2. Gases : Molecular Weights, Specific Heats, etc.	6
1'3. Air : Densities of Dry and Moist Air, etc.	7
1'4. Conversion Factors for English and Metric Units	8
1'5. " " for Pressures	9
2'1. Functions of Diameters and Coefficient of Friction, etc.	24
2'2. Coefficient of Friction, ζ : Fixed Values	26
2'3. " " Values dependent on D	27
2'4. " " " " on m, u, D	27
2'5. Viscosities of Air, Coal Gas, Steam	54
2'6. Conversion Factors for Air, Coal Gas, Steam Flow ($M/D\eta$)	55
2'7. Correction Factors in Formulæ if $dP \neq Au^2$	62
3'1. Resistance of Pipe Fittings, k	71
3'2. " of Elbows and Globe Valves	72
4'1. Quantities of Air circulating in Pneumatic Tubes	82
4'2. Air : Work of Isothermal and Adiabatic Compression	93
6'1. Transit-Time Functions	113
7'1. Time taken to empty Tubes	122
8'1. Particulars of Wet-drum Station Meters	128
8'2. Pressure required to meter Various Quantities of Air	138
8'3. Coefficients of Delivery from Orifices (Müller)	140
8'4. Electrical Energy required to meter Various Quantities	150
9'1. Velocity Distribution in Pipes, R' and U/U_c	161
10'1. Conductivity of Air	179
10'2. Radiation from Hot Bodies	180
10'3. Metals : Specific Resistance, etc.	193
10'4. Convection Losses from Hot Tubes (Hughes)	196
10'5. " " from Platinum (Hartmann)	196
11'1. Functions of n for Air Flow	201
11'2. Coefficients of Delivery from Orifices, c	207
12'1. Coefficient of Air Pressure on Surfaces, K	222