

ix.

TABLE OF CONTENTS.

CHAPTER I.

PAGE THE APPEARANCE OF THE ARC Colours of Different Parts of Arc.-General Shapes of Arc and Carbons.—Influence of Current and Length of Arc on Shape and Size of Arc and Shapes of Carbons.—Positive Crater.— Effect of Core on Colour, Size and Shape of Arc.-Crater in Negative Carbon. CHAPTER II. 19 A SHORT HISTORY OF THE ARC..... Uncertainty of Discoverer and of Date of Discovery of Arc.-Mutual Attraction between Arc and Magnet.—First Observation of Crater, "Mushrooms," Smell of Arc, and Difference of Temperatures of Electrodes. - Application of Laws of Electrolysis to Arc.—Experiments on Arcs in Various Gases.-Photographic Power of Arc. - First Experiments on Arcs between Carbons Steeped in Metallic Salts.—Hissing.—Transference of Matter from One Pole to the Other.-Electric Blowpipe.—Water as One Electrode.—Edlund's Discovery of Straight Line Law of Resistance and Length of Arc, and Suggestion of a Back E.M.F.-Fall of P.D. with Hissing .-Internal Pressure of Arc.-Measurements of P.D. and Current with Constant Lengths of Arc.-Measurements of Supposed True Resistance of Arc.—Tests for Back E.M.F.—Determinations of Temperatures of Electrodes.—Arcs under Pressure.—Measurements of Light.—Rotation.—Apparent Negative Resistance.— Attraction of Solid Carbon Particles out of Arc.—Suggested "Thomson Effect" in Arc.-List of Original Communications.



X.

Cambridge University Press 978-1-108-05268-9 - The Electric Arc Hertha Ayrton Table of Contents More information

TABLE OF CONTENTS.

CHAPTER III.

PAGE

"Striking" the Arc and Sudden Variations of Current Impossibility at First of getting Definite P.D. with Fixed Current and Length of Arc.—Cause of Difficulty.—Low P.D. and Subsequent Rapid Rise on Striking Arc with Cored Positive Carbon.—Influence of Current, Length of Arc, and Shapes and Temperatures of Carbons on Time Required for P.D. to become Constant after Striking Arc.—First Rise of P.D. with Increase of Current with Cored Carbons.—Peculiar Changes of P.D. with Sudden Changes of Current, and their Causes.—Summary.

CHAPTER IV.

General Character of Curves for P.D. and Current with Constant Length of Arc for Solid Carbons.—Same with Positive Carbon Cored.—Discussion of Variations Caused by Core.—Different Positions of Hissing Points with Solid Carbons and with Positive Carbon Cored.—Influence of Strength of Current on Diminution of P.D. due to Core.—Hypothesis as to Action of Core in Modifying P.D.—Curves showing Straight Line Law connecting P.D. with Length of Arc, for Constant Current, with Solid Carbons.—Curves for Same Connection with Cored Positive Carbon, showing P.D. Practically Independent of Current for One Length of Arc.—Discussion of Differences between the Two Sets of Curves, and Explanation, on Abovementioned Hypothesis.—Soft and Hard Crater Ratios.—Deductions from them as to Influence of Current and Length of Arc on Area of Crater.—Summary.

CHAPTER V.

Measurements of Diameter of Crater with Arc Burning.—Curves of Area of Crater and P.D. between Carbons for Various Currents and Lengths of Arc.—Curves of Area of Crater and Length of Arc, of Soft Crater Ratio and Length of Arc, and of



TABLE OF CONTENTS.

хi.

Hard Crater Ratio and P.D.—Curves of Area of Crater and Current.—Measurements of Depth of Crater.—P.D. Uninfluenced by Depth of Crater.—Comparison of P.Ds. for Same Current and Length of Arc but Different-sized Carbons.—Curves of Apparent Resistance and Length of Arc.—Constant P.D. Curves.—Summary.

CHAPTER VI.

Two Fundamental Straight Line Laws Found to Exist with Solid Carbons.—Power and Length of Arc with Constant Current, and Power and Current with Constant Length of Arc.—Equation for Power, Current, and Length of Arc found by Combining these.—Equation for P.D., Current and Length of Arc, Deduced from it, having Four Constants Depending Solely on Nature of Carbons.—Straight Line Power Laws Shown to Fit Experiments of Edlund, Frölich, Peukert, and Cross and Shepard, and Equations for P.D., Current and Length of Arc similar to Above, Deduced from their Results.—Summary.

CHAPTER VII.

THE P.D. BETWEEN EACH CARBON AND THE ARC, AND THE FALL OF POTENTIAL THROUGH THE ARC 207

Repulsion and Attraction of Arc, and other Disturbances caused by Third Carbon.—Definitions of Positive Carbon P.D., Negative Carbon P.D., Vapour P.D.—Variation of Positive Carbon P.D. with Current and Length of Arc.—Resemblances and Differences between Positive Carbon P.D. Curves and Total P.D. Curves.—Variation of Negative Carbon P.D. with Current, but not with Length of Arc.—Curves and Equation for Positive Carbon P.D., Current and Length of Arc; Negative Carbon P.D. and Current; and Sum of Carbon P.Ds., Current and Length of Arc.—Similarity between Independent Constant in the Last Equation and Similar Constant in Equation for Total P.D., Current and Length of Arc, Showing that if this Latter Represents a Back E.M.F., it must be Located at Junctions of the Two Carbons with the Arc.—Equation for Total P.D., Current and Length of Arc with Third Carbon in Arc.—Location of P.Ds. Represented by Three out of



xii.

TABLE OF CONTENTS.

PAGE

Four Terms of Equation for Total P.D., Current and Length of Arc.—Measurements of Carbon P.Ds., Plus Vapour P.D.—Carbon and Vapour P.Ds. with Cored Carbons.—Diminution of P.D. due to Core Traced to Junction of Positive Carbon and Arc, and to Lowering of Resistance of Vapour Column.—Summary.

CHAPTER VIII.

Graphical Method of Finding Relations between E.M.F. of Generator, Resistance in Series with Arc, P.D., Current and Length of Arc.—Impossibility of Keeping either Current or Length of Arc really Constant.—Greatest Length of Arc possible with Given Resistance in Series.—Reason for Difficulty frequently found in Maintaining Long Arcs with Small Currents.—Necessity of "Steadying Resistance" in order that Silent Arc may be Maintained at all.—Variation of Minimum Value of Steadying Resistance with Current and Length of Arc.—Longest Silent Arc and Smallest Current that can be Maintained with Given E.M.F. and Resistance in Series with Arc.—Largest Resistance and Smallest Current that can be Used with Given E.M.F. and Length of Arc.—Largest Resistance and Longest Arc that can be Maintained with given E.M.F. and Current.—Summary.

CHAPTER IX.

General Conditions for Ratio of Power Expended in Arc to Power Developed by Generator (Power Efficiency) to be Greatest Possible.—Conditions for Power Efficiency to be Greatest Possible (1) when Length of Arc alone is Fixed, (2) when E.M.F. alone is Fixed, (3) when Current alone is Fixed, (4) when Resistance in Series alone is Fixed, (5) when P.D. alone is Fixed.—Minimum Resistance that can be used in Series with Arc varies Inversely as Square of Current for Fixed Length of Arc.—Minimum Resistance Required to Maintain Silent Arc at all Depends only on Nature of Carbons.—Summary.



TABLE OF CONTENTS.

xiii.

CHAPTER X.

PAGE 977

Variety of Hissing Sounds.-Hissing Arc not necessarily Short .-Instability of Arc about Hissing Point.—Laws of Hissing from P.D.-Current Curves.—Cross and Shepard's and Luggin's Experiments.—Equation to Curve on which Hissing Points Lie.— Largest Current with which Arc, however long, can Remain Silent-Equation for P.D. and Length of Arc with Hissing .-Fall of P.D. at Positive Carbon, and Diminution of Resistance of Arc, with Hissing.—Equation Connecting Change of P.D. when Hissing Begins with Length of Arc.—Smallest Hissing Current with given Length of Arc.-Connection between Largest Silent and Smallest Hissing Current of same Arc.—Change in Appearance of Crater, Arc, and Carbons with Hissing. - Crater more than Covering End of Positive Carbon with Hissing.—Laws of Hissing Deduced from Shapes of Positive Carbons with various Currents. -Cause of Hissing.—Experiments on Arcs enclosed in Crucible.— Blowing Various Gases against Crater.—Different Behavour of Arc when Hydrogen is Blown against Crater in Open Air and in Crucible.—Cause of Hissing Sound.—Summary.

CHAPTER XI.

THE LIGHT AND LUMINOUS EFFICIENCY OF THE ARC. ... 313

Sources of Light in Arc.—Obstruction of Crater Light by Negative Carbon.—Trotter's Theorem.—Quantity of Light Obstructed by Negative Carbon Estimated from Diagrams of Arc and Carbons.— Reason for Light being Greater with very short Arcs than with longer ones, with Large Currents.-Measurements of Mean Spherical Candle-Power of Arc (W. E. Ayrton) and Total Light of Arc (Blondel)-Simultaneous Discovery of Certain Length of Arc and Certain P.D. with which the Light is a Maximum for a Constant Current.-Curves Connecting Crater Light with Length of Arc, Deduced from Diagrams of Arc and Carbons.-Distinction between Polar Light Curves, Rousseau's Curves, and Curves connecting Illuminating Power with Length of Arc.-Suggested Absorption of Crater Light by Arc.-Facts tending to show that Arc does Absorb Light.—Experiments on Shadows of Candle and Gas Flames. -- Arc Shadow. -- Refractive Power of Arc Mist.—Arc Vapour turning into Carbon Mist.—Violet Colour of Long Arcs as Proof of Absorption.-Light, Length of Arc Curves, from Diagrams of Arc, allowing for Absorption of Crater Light in Arc.—Similarity between these and Experimental Curves.-Effect of Variation of Current on Total Light emitted by Arc.—Very small Luminous Efficiency of all sources of Light, Even Arc. - Distribution of Power supplied to Arc between



xiv. TABLE OF CONTENTS.

PAGE

Carbon Ends and Mist.—Waste of Power in Mist in Long Arcs.—Conditions for Light to be Maximum for given Power developed by Generator.—Influence of Cross Sections of Carbons on Lighting Power.—With Solid Carbons Light Efficiency is greater, and Arc with which Maximum Light Efficiency is obtained is Shorter the Smaller the Carbons.—Low Efficiency of Commercial Arc Lamps due to Thickness of Carbons.—Variation of Light Efficiency with Current.—Effect of Composition of Carbons on Light Efficiency.—Arcs in Series.—Only Fair Method of Comparing Light Efficiency of Two Sources.—Summary.

CHAPTER XII.

THE MECHANISM OF THE ARC—ITS TRUE RESISTANCE—HAS
IT A LARGE BACK E.M.F.?—THE REASON FOR THE
DIFFERENT EFFECTS OF SOLID AND CORED CARBONS... 3

How Are forms on Separating Carbons.—Changing of Vapour into Carbon Mist.—Resistivities of Vapour, Mist, and Flame.—Source 39**1**

of Heat of Arc.—Hollowing of Crater.—Shaping of Carbons.—Dependence of Area of Crater on both Current and Length of Arc.—Imitation of Back E.M.F. by Vapour Film.—Time-Change of Resistance of Arc.—Effect of Frequency of an Added Alternating Current on Value and Sign of $\frac{\delta V}{\delta A}$.—Curve of $\frac{\delta V}{\delta A}$ and Frequency.—Frequency with which $\frac{\delta V}{\delta A}$ Measures True Resistance of Arc.—Tests for this Frequency.—Two Ways in which Cores in Carbons may Affect Resistance of Arc.—How Cores Affect Mean Cross Section of Mist.—How they Affect Resistivity of Arc and thus Alter Shapes of P.D.-Current Curves.—Influence of Cores on Value of $\frac{\delta V}{\delta A}$, (1) in Change of Cross Section, (2) in Change of Specific Resistance—Curves Connecting $\frac{\delta V}{\delta A}$ with Current, for Constant Length of Arc, with Length of Arc for Constant Current, and with Frequency of Alternating Current, for both Solid and Cored Carbons.—

APPENDIX.

445

Apparent Area of Disc Viewed from Any Distance.—Our Method of Estimating Brilliancy of a Source of Light.—Assumptions Made in Photometry.—Mean Spherical Candle Power and Total Light.— Measurement of Either, by Means of Rousseau's Figures.—Why Area of Polar Light Curve Cannot Measure Either.—Candle and Gas Shadow Experiments.—Supplementary List of Original Communications.

Summary.



LIST OF ILLUSTRATIONS.

FIG.		PAGE
1	Image of Arc and Carbons, Five Times Full Size	3
2	Section of Positive Carbon Showing Outer Crust Curling Away	5
3	Drawing of Arc and Carbons with both Carbons Solid-4 mm.	_
	20 ampere Arc facing	6
4	Drawing of Arc and Carbons with both Carbons Solid—7 mm.	_
_	20 ampere Arc facing	6
5	Drawing of Arc and Carbons with Cored Positive and Solid	
	Negative Carbon—7 mm. 20 ampere Arc facing	7
6	Drawing of Arc and Carbons with Cored Positive and Solid	
	Negative Carpon—18 mm. 20 ampere Arc facing	7
7	Diagrams of Arcs of various Lengths and with various Currents,	
	between 18 mm. Cored Positive and 15 mm. Solid Negative	
	Carbons (W. E. Ayrton)	9
8	Diagrams of Arcs of various Lengths and with various Currents,	
	between 13 mm. Cored Positive and 11 mm. Solid Negative	
	Carbons (W. E. Ayrton)	10
9	Diagrams of A cs of various Lengths, and with various Currents,	
	between 9 mm. Cored Positive and 8 mm. Solid Negative	
	Carbons (W. E. Ayrton)	12
10	Diagrams or Carpons before and after Sudden Changes of	
	Current (W. E. Ayrton)	15
11	Diagrams of Arcs between Solid Carbons (W. E. Ayrton)	15
12	Diagrams of Arcs between Solid Positive and Cored Negative	*0
	Carbons (W. E. Ayrton)	16
13	Horizontal Arc copied from "Davy's Elements of Chemical	10
10	TO 1 1 11	27
14	Figure sho ing the Rotation of the Arc at the Pole of a Magnet	29
		49
15	Vertical Parallel Carbons showing the Position the Arc takes	7.0
	up near the ends (W. E. Ayrton)	36
16	Apparatus for Measuring the Resistance of the Arc (Von Lang)	43
17	Apparatus for Testing for a Back E.M.F. in the Arc (Lecher)	52
18	Curves showing Conditions for Arc to be Stable (Blondel)	62
19	Apparatus for Testing the Conductivity of the Arc (Fleming)	70



xvi.	LIST OF ILLUSTRATIONS.	
FIG.		PAGE
20	Apparatus for Measuring the Resistance of the Arc (Frith)	73
21	Apparatus for Measuring the Resistance of the Arc (Frith and	7/
00	Rodgers)	76
22	Curves Connecting the Instantaneous dV/dA with the Current	=0
07	for a Constant P.D. (Frith and Rodgers)	79
2 3	Curves Connecting the Instantaneous dV/dA with the P.D. for	
•	a Constant Current (Frith and Rodgers)	80
24	Apparatus for Measuring the Back E.M.F. of the Arc (Arons)	82
25	Illustration of Experiments on Particles Shot out from Carbons (Herzfeld)	85
26	Apparatus for Testing for a Back E.M.F. in the Arc (Blondel)	88
27	Apparatus for Testing for a Back E.M.F. in the Arc (Granquist)	92
28	Hand Fed Arc Lamp	98
29	Plan of Arc Lamps, Lens, Mirror and Diagram Screen for	
	Magnifying the Image of the Arc	99
30	P.D. and Current Curves drawn before the Time-Variability of	00
•••	the P.D. was Realised (W. E. Ayrton)	101
31	Curves for Time-Change of P.D. with Constant Current and	101
02	Length, after starting the Arc between Cored Positive and	
	Solid Negative Carbons (W. E. Ayrton)	103
32	Curves for Time-Change of P.D. with Constant Current and	100
04	Length, after starting the Arc between Carbons of various	
	kinds, with ends variously shaped (W. E. Ayrton)	105
33	The same (W. E. Ayrton)	103
34	Curves showing the Influence of the Shape of the Negative	101
04	Carbon on the Time-Change of P.D. (W. E. Ayrton)	109
35	Curves for Time-Change of P.D. with Solid and Cored, Flat and	103
00	Normal, and Hot and Cold Carbons (W. E. Ayrton)	110
36	Curves for Time-Change of P.D. with Sudden Changes of Current,	110
00	showing the Influence of a Core in the Positive Carbon	
	(W. E. Ayrton)	113
37	Curves for Time-Change of P.D. with Sudden Changes of Current,	110
01	Showing the Influence of the Length of the Arc (W. E. Ayrton)	114
38	Curves connecting the P.D. with the Current for various	114
00	Constant Lengths of Arc, with Solid Carbons	120
39	The same, with 18 mm. Cored and 15 mm. Solid Carbons (W. E.	140
00	Ayrton)	128
40	The same with 13 mm. Cored and 11 mm. Solid Carbons (W. E.	120
70	Ayrton)	129
41	The same with 9 mm. Cored and 8 mm. Solid Carbons (W. E.	123
.41	Ayrton)	130
42	Curves showing the Changes in the P.D. produced by Coring	100
74	the Positive Carbon (W. E. Ayrton)	132
43	Hypothetical Curves of P.D. and Current, for a Constant	102
70	Length of Arc, showing the Effect of Coring the Positive	
	Carbon	134
44	Curves connecting P.D. and Length of Arc for various Constant	104
7-7	Currents. Solid Carbons	136
	Owner-10- 10-11-11-11-11-11-11-11-11-11-11-11-11-1	100



	LIST OF ILLUSTRATIONS.	xvii.
FIG.		PAGE
45	The same with 18 mm. Cored and 15 mm. Solid Carbons (W. E. Ayrton)	139
46	The same with 13 mm, Cored and 11 mm. Solid Carbons (W. E. Ayrton)	140
47	The same with 9 mm. Cored and 8 mm. Solid Carbons	
	(W. E. Ayrton)	140
48	The same with both Carbons Cored (W. E. Ayrton)	142
49	Hypothetical Curves of P.D. and Length of Arc, for a Constant Current, showing the Effect of Coring the Positive Carbon	144
50	Curves connecting the Area of the Crater with the P.D. between	
51	the Carbons, for various Constant Currents Curves connecting the Area of the Crater with the Length of	153
31	the Arc, for various Constant Currents	1.55
52	Curves connecting the Soft Crater Ratio with the Length of the	
-	Are, for various Constant Currents	156
53	Curves connecting the Hard Crater Ratio with the P.D. between	
	the Carbons, for various Constant Currents	157
54	Curves connecting the Area of the Crater with the Current, for various Constant Lengths of Arc	159
5 5	Curves connecting the P.D. between the Carbons with the	
••	Length of the Arc, for Cored Positive and Solid Negative	
	Carbons of various Diameters	163
56	Curves connecting the Apparent Resistance of the Arc with its	
	Length, for various Constant Currents, with 18 mm. Cored and 15 mm. Solid Carbons	164
57	The same with 13 mm. Cored and 11 mm. Solid Carbons	165
58	The same with 9 mm. Cored and 8 mm. Solid Carbons	166
59	Curves connecting Current with Length of Arc for various	
	Constant P.Ds	16 9
60	Curve connecting Current with Time for a Constant P.D. and	
	Length of Arc	171
61	Curves connecting P.D. with Current, for various Constant	
	Lengths of Arc, with Solid Carbons	177
62	Curves connecting Power expended in Arc with Length of Arc, for various Constant Currents, with Solid Carbons	180
63	Curves connecting Power with Current, for Lengths of Arc 0 mm.	100
00	and 7 mm., with Solid Carbons	182
64	Hyperbola connecting P.D. with Current, for a Constant Length	
	of Arc, with Solid Carbons	187
65	Curves connecting Power with Length of Arc, for various Constant Currents, from Peukert's Experiments	194
66	Curves connecting Power with Current, for Lengths of Arc 0 mm.	
	and 10 mm., from Peukert's Experiments	196
67	Curves connecting Power with Length of Arc for various	
	Constant Currents, from Cross and Shepard's Experiments	199
68	Curves connecting Power with Current for Lengths of Arc 0	
	and $\frac{10}{32}$ inch, from Cross and Shepard's Experiments	200



xviii	. LIST OF ILLUSTRATIONS.	
FIG.		PAGE
69	Diagrammatic Representation of Apparatus used for Finding	
	the P.D. between each Carbon and the Arc	209
70	Diagrammatic Representation of various Arrangements of	
	Main and Exploring Carbons	213
71	Curves connecting Positive-Carbon P.D. with Current, for	
	various Constant Lengths of Arc	215
72	Curves connecting Positive-Carbon P.D. with Length of Arc, for	
	various Constant Currents	216
73	Curves connecting Negative-Carbon P.D. with Current, for	
	various Constant Lengths of Arc	218
74	Curves connecting Negative-Carbon P.D. with Length of Arc, for	
	various Constant Currents	219
7 5	Curves connecting Positive-Carbon Power with Length of Arc,	
	for various Constant Currents	220
76	Curves connecting Positive Carbon Power with Current, for	
	various Constant Lengths of Arc	221
77	Curve connecting Negative-Carbon Power with Current for any	
=0	Length of Arc	224
78	Curves connecting Positive-Carbon P.D. plus Negative Carbon	001
50	P.D. with Current, for various Constant Lengths of Arc	226
79	Curves used for determining graphically the Relations between	
	the E.M.F. of the Dynamo, the outside Resistance in the Circuit, the P.D., Current, and Length of Arc with Solid	
	Carbons	242
80	Curves connecting P.D. with Current, for various Constant	444
CU	Lengths of Arc, with Solid Carbons	280
81	Photographs of Arcs—immediately after Hissing has begun,	200
-	after Hissing has continued some time, and when the Arc has	
		292
82	become Silent again facing Diagram of a Short Hissing Arc	293
83	Diagrams of a Silent and a Hissing Arc	294
84	Diagrams of Arcs and Carbons with Current increasing from	
	6 amperes, silent, to 30 amperes, hissing	295
85	Diagrams of Arcs and Carbons with the same Current and	
	Length of Arc, but different sized Carbons	296
86	Crucible Employed for Experiments on Enclosed Arcs	302
87	Curves connecting P.D. with Current for a nearly Constant	
	Length of Arc when the Arc was enclosed in a Crucible	304
88	Disc Viewed from a Distance	317
89	Tracings of "Normal" Arc (Trotter)	318
90	Tracings of Short Arc (Trotter)	319
91	Polar Curves of Apparent Area of Crater and Candle Power in	
	"Normal" Arc (Trotter)	320
92	Polar Curves of Apparent Area of Crater and Candie Power in	
	Short Arc (Trotter)	321
93	Curve connecting Apparent Area of Crater with Light of	
	"Normal" Arc (Trotter)	322



	LIST OF ILLUSTRATIONS.	xix.
FIG.		PAGE
94	Diagrams of Arcs and Carbons for showing the Variation in the Shape of the Negative Carbon with the same Current but	
95	different Lengths of Arc	324
	Candle Power of the Arc (W. E. Ayrton)	326
96	General Plan of Apparatus for Measuring the Mean Spherical Candle Power of the Arc (W. E. Ayrton)	327
97	Curves connecting Mean Spherical Candle Power with Length of Arc, for various Constant Currents (W. E. Ayrton)	329
98	Curves connecting Total Light emitted with Length of Arc for a Constant Current	330
991	Apparatus employed in Measuring the Total Light emitted by	
100)	the Arc (Blondel)	331
101	Curves connecting Total Light with Length of Arc for a Constant Current with Solid Carbons of various sizes (Blondel)	333
102	Curves connecting Total Light with Length of Arc, for a Constant Current, with Cored Positive and Solid Negative Carbons of	
	various Sizes (Blondel)	334
103	Diagrams of Arcs of different Lengths, with the same Current, between the same Carbons	33 6
104	Area proportional to Total Light that would be received from the	770
105	Crater if none were obstructed by the Negative Carbon	338
106	Area proportional to Total Light actually received from Crater Diagram of Arc and Carbons with Lines for finding the Quantity	339
100	of Light Obscured by the Negative Carbon in any one	
105	direction	340
107	Geometrical Construction for the Area of Crater Obscured by the Negative Carbon in any one direction	341
108	Curves connecting Light received from Crater with Length of Arc, obtained from Diagrams in Fig. 103	343
109	Photograph of Candle Flame	350
110	Section of Apparatus used for Observing the Shadow of the Arc	353
111	The Light from the Crater, the Arc Mist, and the White Spot, passing through a narrow Slit on to a White Screen	358
112	Band of Violet Light, bordering a Shadow made by intercepting the Light of the Crater of an Arc	359
113	Arc with Mist divided into Layers of Equal Thickness	361
114	Hypothetical Curves obtained from Fig. 108 by allowing for	-
	the Absorption of Crater Light by the Arc Mist Diagrams of Arc and Carbons, showing the Effect on the	363
115	Shapes of both Carbons of varying the Current with a Constant Length of Arc	365
116	Curves connecting the Mean Spherical Candle Power of the Arc with the Current, for Constant Lengths of Arc of 1 mm. and 4 mm. (W. E. Ayrton)	366
117	Curves connecting the Total Light emitted by the Arc with the	
	Current, for a Constant P.D. of 45 volts (Blondel)	367
	A	*



XX.	$LIST\ OF\ ILLUSTRATIONS.$	
FIG.		PAGE
118	Curves connecting the Power supplied to the Arc and the Power absorbed by the Mist with the Length of the Arc, for	
	a Constant Current of 10 amperes	373
1 19	Curve showing the proportion of the whole Power supplied to the Arc that is Wasted in the Mist, with a Constant Current	
	of 10 amperes	373
120	Diagrams of Arc and Carbons with the same Current and Length of Arc, but different sized Carbons	376
121	The same	379
122	Curves connecting Light Efficiency with Length of Arc for a Constant Current of 10 amperes with Solid Carbons (Blondel)	381
123	The same with Cored Positive and Solid Negative Carbons (Blondel)	382
124	Curves connecting Light Efficiency with Length of Arc for a Constant P.D. (Blondel)	385
125	The Shaping of the Negative Carbon with Large and Small Craters and with Long and Short Arcs	395
126	Hypothetical Areas of Volatilisation and Non-volatilisation in Crater	397
127	Shapes assumed by the Positive Carbon, with the same Area of Volatilisation, but with a Long Arc in the one Case and a Short Arc in the other	398
128	Diagrams of Arc and Carbons with Mist and Flame very carefully Outlined	401
129	Curve connecting the Power Expended in the Arc Mist with	401
130	the Current, for a Constant Length of Arc of 2 mm. Curves showing Simultaneous Time-Changes of P.D., Current	403
131	and Resistance	405
101	Curves showing the Effect of the Frequency of an Alternating Current, Superimposed on a Direct Current Arc, on the Simultaneous Time-Changes of P.D. and Current	408
132	Curves connecting Values of $\frac{\delta V}{\delta A}$ with the Frequency of the	
133	Superimposed Alternating Current	412
134	Solid, Solid-Cored, Cored-Solid, and Cored-Cored Carbons Hypothetical Curves Exemplifying the Changes, in the Curve connecting P.D. with Current for a Constant Length of Arc,	420
	caused by a Core in the Positive Carbon	423
135	Hypothetical Curves connecting $\frac{\delta V_s}{\delta A}$ with the Current, for a Constant Length of Arc	
136	Hypothetical Curves connecting $\frac{\delta V_c}{\delta A}$ with the Current, for a	
	Constant I anoth of Ama	470
137	Hypothetical Curves Connecting $\frac{\delta V}{\delta A}$ with the Current, for a Constant Length of Arc	4 3 4



	LIST OF ILLUSTRATIONS.	xxi.
FIG.		PAGE
138	Hypothetical Curve of Time-Change of P.D. Accompanying a Sudden Change of Current	435
139	Sudden Change of Current	
	for a Constant Current	436
140	Hypothetical Curves Connecting $\frac{\delta V}{\delta A}$ with the Frequency of an	
	Addel Alternating Current	438
141 } 142 }	Figures Used in Finding the Apparent Area of a Disc \dots \dots	{ 416 447
143 /	Figures Used in Finding an Area Proportional to the Mean Spheri	
144 (cal Candle Power of an Axially Symmetrical Source of Light	453
145	Polar Light Curves of Two Similar Sources, the one having	
	twice the Illuminating Power of the other	455
146	Photograph of the Shadow of a Candle Flame	457





xxiii.

LIST OF TABLES.

	PAGE
I. Current, Resistance, and E.M.F. of Arc (Schwendler)	
II. Areas of Crater with Different Currents	39
III. P.Ds. with Silent and Hissing Arcs (Niaudet)	40
IV. P.D. Current and Length of Arc (Nebel)	48
V. P.Ds. for Different Conditions of the Arc (Lecher)	53
VI. P.Ds. with Constant Current and Varying Lengths of Arc	:
(Luggin)	55
VII. P.D. between Carbons with and without a Sprinkling of	:
Soda (Luggin)	56
VIII. Current Density and Area of Tip of Positive Carbon	
(Luggin)	61
IX, Experiments to Find Back E.M.F. of Arc (Blondel)	90
X. Experiments to Find Back E.M.F. of Arc (Granquist)	93
XI. P.D. for Normal 5mm. Arc with Various Constant	;
Currents (Solid Carbons 11/9)	121
XII, P.D. and Current with Various Constant Lengths of Arc	
(Solid Carbons 11/9)	
XIII. Same as above (Cored Positive and Solid Negative	
Carbons 18/15) (W. E. Ayrton)	125
XIV. Same as above (Carbons 13/11)	126
XV. Same as above (Carbons 9/8)	127
XVI. Diameter of Crater, Square of Diameter, P.D., and	
Current for Various Lengths of Arc	
XVII. Diameters of Crater, Observed and Calculated, for Various	
Currents and Lengths of Arc	154
XVIII. Crater Ratios for Various Currents and Lengths of Arc	156
XIX. Depth of Crater with Different Currents and Lengths of	
Arc	
XX. Influence of Diameters of Carbons (Positive Cored) on P.D.	
XXI. Comparison of Observed and Calculated P.Ds. for Different	102
Currents and Lengths of Arc (Solid Carbons 11/9)	
XXII. Edlund's Results referred to General Equation for P.D.	
Current and Length of Arc	190



xxiv. LIST OF TABLES.

XXIII.	Frölich's Results referred to General Equation for P.D.,	PAGE
VVIII	Current, and Length of Arc Peukert's Results referred to the same Equation	192
	Cross and Shepard's Results referred to the same Equation	
	Duncan Rowland and Todd's Results referred to the same Equation	201
AAVI.		204
vvvII	Positive Carbon P.Ds. for Various Currents and Lengths	404
AA V 11.	· · · · · · · · · · · · · · · · · · ·	214
vvviii	Negative Carbon P.Ds. for Various Currents and Lengths	214
AA V 1111.	of Arc (Solid Carbons 11/9)	217
YYIY	Calculated Values of Positive Carbon P.Ds. (Solid	211
AAIA.	Carbons 11/9)	223
XXX.	Calculated Values of Negative Carbon P.Ds. (Solid	
<u> </u>	Carbons 11/9)	225
XXXI.	Sum of Positive and Negative Carbon P.Ds., for Various	
14141111	Currents and Lengths of Arc (Solid Carbons 11/9)	227
XXXII.	Calculated Values of Sum of Positive and Negative	
	Carbon P.Ds. (Solid Carbons 11/9)	227
XXXIII.	P.D. between Carbons with Third Carbon in Arc near	
	Positive Carbon (Solid Carbons 11/9)	229
XXXIV.	P.D. between Carbons with Third Carbon in Arc near	
	Negative Carbon (Solid Carbons 11/9)	229
XXXV.	Mean P.D. between Carbons with Third Carbon in Arc	
	(Solid Carbons 11/9)	230
XXXVI.	Calculated Values of P.D. between Carbons with Third	
	Carbon in Arc (Solid Carbons 11/9)	231
XXXVII.	Positive Carbon P.D. plus Vapour P.D. (Solid Carbons	
	11/9)	23 3
XXXVIII.	Negative Carbon P.D. plus Vapour P.D. (Solid Carbons	
	11/9)	234
XXXIX.	Comparison, with Solid and Cored Carbons, of P.D. between	
	Carbons with Third Carbon in Arc	235
XL.	Comparison, with Solid and Cored Carbons, of Positive	
		236
XLI.	Comparison, with Solid and Cored Carbons, of Negative	
	Carbon P.Ds	237
XLII.	Conditions to obtain Maximum Power-Efficiency with	
	E.M.F., P.D., Current, Length, and Series Resistance	
*** ***	fixed, in Turn (Solid Carbons 11/9)	270
XLIII.	P.D. between Carbons at Hissing Points (Solid Carbons	
V I II	11/9)	
		283
ALV.	Comparison of Calculated and Observed Values of P.Ds. at Hissing Points (Solid Carbons 11/9)	005
VI 17T	at Hissing Points (Solid Carbons 11/9)	285
ALIVI.		OOT
XI.VII	Diminution of Total and of Positive Carbon P.Ds. Accom-	287
AL/ V 11.	. TT: 1 (0 111 0 1 44 0).	287
	panying Hissing (Solid Carbons 11/9)	201



	LIST OF TABLES. xxv.	
	PAGE	Ċ
XLVIII.	P.D. and Length of Arc for Hissing Arcs (Cored Positive	
	and Solid Negative Carbons) 291	L
XLIX.	Effect of Blowing Hydrogen against Crater of Arc 306	ć
L.	Mean Spherical Candle Power of Arcs of Different Lengths	
	with Constant Currents (W. E. Ayrton) 328	3
LI.	Crater Light with and without Absorption by Arc, for	
	Arcs of Various Lengths, with Constant Current 362	2
LII.	Data of some Commercial Arc Lamps 383	í
LIII.	Cross Section of Arc Mist, Current, P.D., and Resistance of,	
	and Power Expended in Mist (Solid Carbons 11/9) 402	•
LIV.	Currents and P.Ds. with Small Alternating Current	
	Superimposed on 10 Ampere Arc (Solid Carbons 11/9) 415	j
LV.	Mean Cross Section of Mist for Different Currents and	
	Lengths of Arc with Various Carbons 419)
LVI.	Cross Section of Mist Close to Crater for Different Currents	
	and Lengths of Arc with Various Carbons 421	
LVII.	Ratios of Cross Section of Mist with one Current to Cross	
	Section with Smaller Current 426	,
LVIII.	Ratios of Cross Section of Mist Close to Crater with one	
	Current to Cross Section with Smaller Current 426	,
List of	Original Communications Concerning the Arc 94	
	nentary List 458	
·- ·- F-F-		