

---

# **The Electrical Equipment of Collieries**

**Duncan William Galloway**

---

**Title: The Electrical Equipment of Collieries**

**Author: Duncan William Galloway**

**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.**



not 10/6

THE ELECTRICAL EQUIPMENT  
OF COLLIERIES

## STANDARD WORKS ON MINING.

---

Demy 8vo. 175 pages. 10s. 6d. net.

**RECOVERY WORK AFTER PIT FIRES.** By ROBERT LAMPRECHT, Mining Engineer and Manager. Translated from the German. Illustrated by 6 Large Plates containing 76 Illustrations.

---

Royal 8vo, with 30 Plates and 22 Illustrations. 240 pages.  
10s. 6d. net.

**VENTILATION IN MINES.** By ROBERT WABNER, Mining Engineer. Translated from the German.

"We feel bound to confess that, after a careful study of Herr Wabner's treatise, his ideas are in the main correct. So far as we can judge, Mr. Salter's translation is, as we should expect, most creditable."—*Coal and Iron*.

---

With 6 Plates and 148 Illustrations. Royal 8vo. 150 pages.  
8s. 6d. net.

**HAULAGE AND WINDING APPLIANCES USED IN MINES.** By CARL VOLK. Translated from the German.

"It is the earnest conviction of a great many estimable persons that the practice of the Continent should be more closely studied by students and practical men. The publishers, in issuing German text-books in our own language, are preparing the way whereby the greater number may, if they so wish, acquaint themselves with the methods and practice appertaining to German mining operations."—*Science and Art of Mining*.

THE  
ELECTRICAL EQUIPMENT  
OF COLLIERIES

BY

W. GALLOWAY DUNCAN

ELECTRICAL AND MECHANICAL ENGINEER  
LATE LECTURER IN ELECTRICAL AND MECHANICAL ENGINEERING, PIPE MINING CLASSES  
MEMBER OF THE INSTITUTION OF MINING ENGINEERS; AUTHOR OF "HANDBOOK FOR  
ENGINEERING STUDENTS," "GUIDE TO THE ENGINEERING PROFESSION," ETC.  
HEAD OF THE GOVERNMENT SCHOOL OF ENGINEERING, DACCA, INDIA

AND

DAVID PENMAN

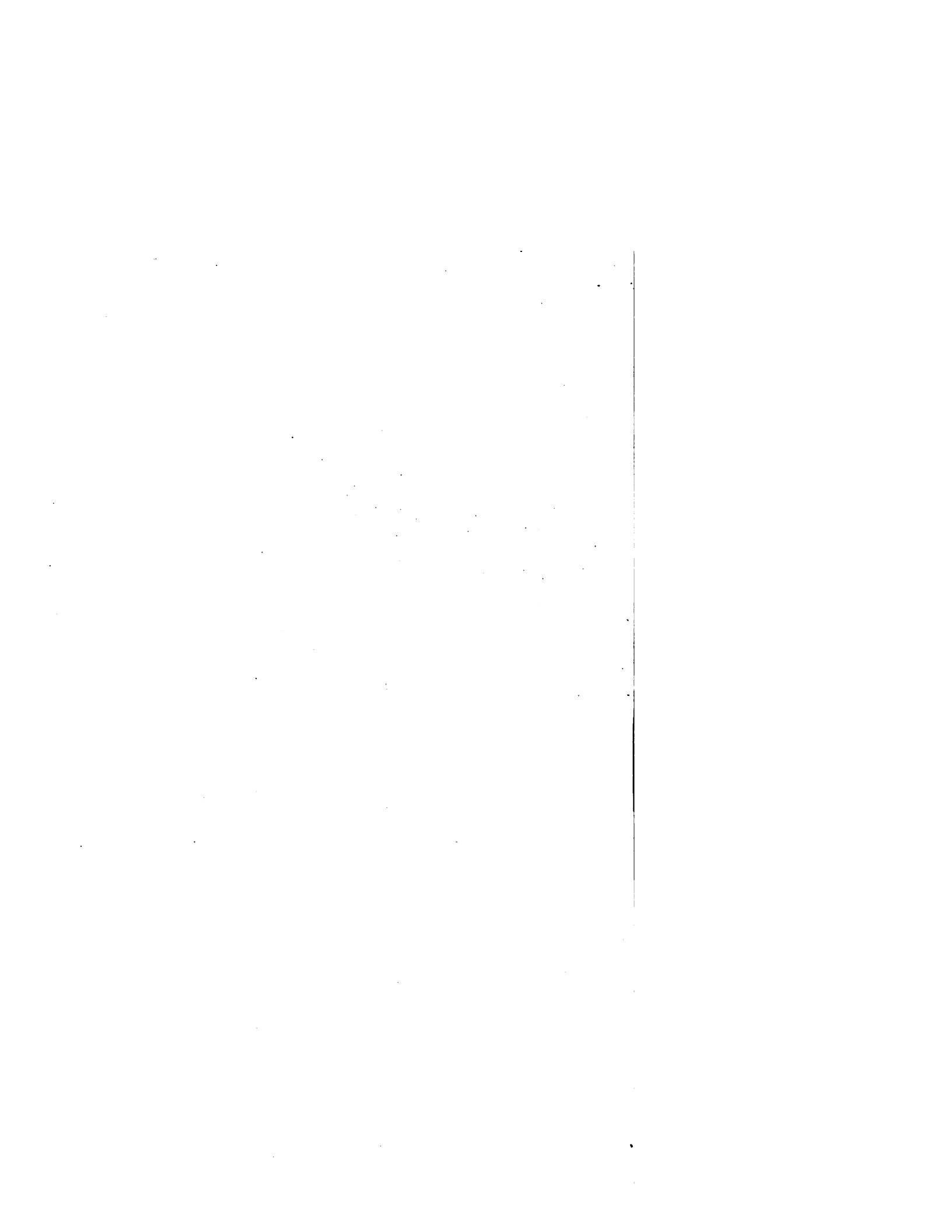
CERTIFICATED COLLIERY MANAGER  
LECTURER IN MINING TO PIPE COUNTY COMMITTEE  
MEMBER OF THE INSTITUTION OF MINING ENGINEERS  
PREMIER PRIZE-WINNER, "SCIENCE AND ART OF MINING,"  
NATIONAL COMPETITIONS, 1906-7

WITH ONE HUNDRED AND FIFTY-SEVEN ILLUSTRATIONS

LONDON  
SCOTT, GREENWOOD & SON  
8 BROADWAY, LUDGATE HILL, E.C.

1908

[All rights reserved]



6054121

142716

MAY 31 1910

MLHR  
.D91

## PREFACE

THE importance of electricity as applied to mines has been so fully established that the authors of this work have taken little trouble to argue the necessity for its installation in all cases where the circumstances permit or justify its use.

Prejudice played its usual part during the early period of the advent of electricity into the region of mining. Insufficiency of precautions against failure, or actual ignorance of essential requirements, did much to set abroad a spirit of antagonism, with the consequence that the development of electricity in its application to mining was greatly retarded. Even at the present time, when so many collieries have adopted electricity for haulage, pumping, coal-cutting, lighting, and other purposes, occasional accidents directly traceable to failure in one form or another of the electrical plant give rise to adverse comment and wholesale condemnation of the electric current as a suitable form of power for colliery work. It is to be feared that the true explanation of such events could be traced to insufficiency of knowledge on the part of men whose position requires of them a fuller understanding of the nature and possibilities of the power under their control. However, be this as it may, the fact remains that electricity is far and away the most efficient and economical form of power as yet within our reach for transmission down the mine.

Sometimes a statement is made to the effect that the installation of electric plant means considerable additional initial expenditure, which would be avoided were direct steam transmission adopted. This of course is undeniable, but then the ultimate saving in working cost, the economy in power transmission, the greater flexibility of the electric power in the diversity of uses to which it can be applied, will very soon more than repay the extra first cost. Besides, apart from any electrical consideration whatever, it is obvious that in a steam-driven generator set, supplying power to the whole mine or even to a group of mines, the engines can be worked at a considerably



lower cost per horse-power hour than can a number of smaller steam plants working independently, and operating different gears direct. In the first case, the most modern type of engine may be employed, while, in the second case, that would probably be impracticable owing to the smallness of the power required.

In consequence of the vast and ever-increasing growth of electric power in mines, it is absolutely imperative that not only the colliery manager, the mining student, and the colliery electrician, but everyone who at any time has occasion to come into contact with electrical apparatus of any description, should possess a clear grasp of the fundamental principles underlying the generation, transmission and utilisation of the electric current. Apart, however, from the purely scientific aspect of the subject, there remains, in the application of electricity to mining operations, numerous problems which call for special consideration, and which in themselves form a study, all-important to the student of mining.

Having regard, therefore, to this twofold aspect of the subject, the authors of the present treatise have devoted their attention, firstly, to the inclusion of sufficient electrical teaching as may be presumed to be necessary for the training of a thoroughly practical and competent manager of a colliery; and secondly, to the description of every application of electric power to mining that has yet been successfully attempted.

In a work of this nature, in which the knowledge of the electrician must be linked to the experience of the mine manager, it will be readily granted that joint authorship is very desirable, if not altogether essential.

Throughout this book the special requirements of the student have been recognised. A feature of the book is the tables of cost and productive results, which are given in a special chapter and elsewhere. That the book will prove of use to those for whom it has been designed is the authors' earnest wish.

W. GALLOWAY DUNCAN.  
DAVID PENMAN.

October 1908.

Our thanks are due the following for information given in their writings: Davidge and Hutcheson, Maycock, Ayrton, Ripper, Dawson, and others. To those firms who kindly supplied information and illustrations of their specialities, and to the Editor of *Science and Art of Mining* for permission to reprint portions of certain articles written by one of the authors, we are deeply indebted.

# CONTENTS

## CHAPTER I

### GENERAL PRINCIPLES, MAGNETISM, UNITS, CELLS, ETC.

|  | PAGES |
|--|-------|
| Introductory—Production of electricity by chemical action—Magnetism—<br>Lines of magnetic force—Electro-magnetism—Conductors and in-<br>sulators—Units of measurements—Volt—Ampere—Ohm—Coulomb—<br>Farad—Joule—Watt—Henry—Board of Trade unit—Derived units—<br>Primary cells—Leclanché—Carporous—Dry cells—Obach—Accumu-<br>lators: E.P.S., Hart, Headland, Chloride, Edison—Efficiency of<br>accumulators—Charging and maintenance . . . . . | 1-16  |

## CHAPTER II

### DYNAMOS AND MOTORS

|  |       |
|--|-------|
| Principle of the dynamo—Continuous current dynamos—Series, shunt, and<br>compound wound—The alternating current—Period—Frequency—<br>Amplitude—Lag and lead—Phase difference—Single-phase generator<br>Two-phase generator—Three-phase generator—Electro-motors—Direct<br>current electro-motors—Back E.M.F.—Types of motors—Alternating<br>current electro-motors—Motors for coal-cutting machines—Motors<br>for haulage and pumping—Motor-generator—Static transformers—<br>Rotary converters—Care of electrical plant—Earthing of dynamos<br>and motors—Coupling dynamos together . . . . . | 17-39 |
|--|-------|

## CHAPTER III

### TRANSMISSION AND DISTRIBUTION OF POWER

|   |  |
|---|--|
| The switchboard—Switches—Circuit-breakers—Time-lags—Fuses and cut-<br>outs—Measuring instruments—Locating a fault—Testing insulation—<br>Lightning conductors—Systems of distribution—Economy of high<br>tension—Colliery electric cables—Tensile strength of conductors—<br>Sizes of cables—British standard wire gauge—Current density in<br>cables—Loss of pressure in cables—Details of copper-stranded con-<br>ductors—Insulation of cables—Protecting the insulation—Types of |  |
|---|--|

|  | PAGES |
|--|-------|
| cables used in collieries—Suspension of cables in shafts—Fixing of cables in shafts—Jointing of cables in shafts—Suspension of cables in roadways—Callender's cable clip or suspender—Joint-Boxes—Disconnecting boxes—Solid system or troughing—Howard's asphalt system—The Simplex system . . . . . | 40-88 |

## CHAPTER IV

## PRIME MOVERS

|  |        |
|--|--------|
| Introductory: the steam engine—Corliss—Trip gear—High speed—Steam-engine indicator—Indicated horse-power—Brake horse-power—Comparisons between single, compound, and triple-expansion engines—Transmission of power by belting, ropes, etc.—Steam turbines: Parsons, De Laval, Curtis, Rateau—Gas and oil engines—Water-power—Single and double vortex turbines—Pelton wheel . . . . . | 89-113 |
|--|--------|

## CHAPTER V

## LIGHTING BY ELECTRICITY

|  |         |
|--|---------|
| Advantages and disadvantages—Arc lamps (open and enclosed)—The mechanism of an arc lamp—Alternating current arc lamps—Choking coils—Economy coils—The Excello flame arc lamp—Incandescent lamps—The filament—Efficiency and illuminating power—The Nernst lamp—The Osmium lamp—The Tantalum lamp . . . . . | 114-120 |
|--|---------|

## CHAPTER VI

## INITIAL OUTLAY AND WORKING COST OF ELECTRICAL INSTALLATIONS

|   |         |
|---|---------|
| Steam boilers: Cornish, Lancashire, and Galloway tube—Water tube—Prime movers: Horizontal coupled engines—High-speed vertical—Compound condensing and triple expansion—Steam turbines—Gas and oil engines—Water turbines—Generating plant: Continuous current dynamos and motors—Alternating current dynamos and motors—Transformers—Cables—Electric lighting—Cost of gas-driven plant to generate 1200 H.P.—Cost of steam turbine plant of 1200 H.P.—Actual costs of electrical plants of 120, 550, 900, and 1800 H.P.—Cost of working colliery electrical installations—Comparison of motor and steam driving—Costs of steam power and electrical power—Actual cost of producing electricity at a colliery under normal conditions—Results of steam turbine tests—Cable losses and motor efficiencies—Cost of working a gas-power plant of 1200 H.P.—Costs of working turbo-generating plant at Hulton Colliery . . . . . | 121-135 |
|---|---------|

## CONTENTS

ix

### CHAPTER VII

#### ELECTRICITY APPLIED TO COAL-CUTTING

|  | PAGES   |
|--|---------|
| Advantages and disadvantages of electrical coal-cutters as compared with compressed air machines—Arguments for and against the adoption of coal-cutting machinery—Advantages of machine-mining over hand-holing—Objections to electrical coal-cutting machinery—Conditions best suited to machine coal-cutting—Control of the roof—Position of undercut—Depth of cut—Shallow undercut—Deep undercut—Stone-holing <i>v.</i> coal-holing—Comparative costs of machine-holing in stone and in coal—Direction and length of machine face—Comparative costs of machine mining with gate roads differently spaced—Machinemen—Stowers—Gummers—Timbermen and fillers—Types of electric coal-cutters—The Pick machine—Revolving-bar machines—The “Pickquick” machine—The Hurd coal-cutter—Disc machines—The Diamond coal-cutter—Anderson-Boyes electric coal-cutter—The Crescent machine—Performance of a Crescent coal-cutter—The Jeffrey disc machine and other disc coal-cutters—Electric coal-cutters of the chain type—The Goodman electric chain coal-cutter—Jeffrey chain machine—Anderson-Boyes chain machine—The Diamond patent longwall chain machine—The Jeffrey electric shearing machine—Goodman low-type breast machine—Power truck—The Stanley heading machine—Power consumed by coal-cutting machines—Cost of electric driving of coal-cutters—Haulage arrangements—Gate-end panels—The trailing cable—Coal-cutter motors—Cost of coal-cutting machines . . . . . | 136-180 |

### CHAPTER VIII

#### ELECTRIC HAULAGE, WINDING, AND LOCOMOTIVES

|   |         |
|---|---------|
| Advantages of electric over steam haulage—Systems of electric haulage—Endless rope haulage—Main-and-tail rope haulage—Comparison of power required in endless rope and main-and-tail haulages—Single rope haulage—Endless chain haulage—Portable haulage gears—Motor-driven creeper belts—Liquid starting switches for haulage motors—Polyphase haulage plants—Electric winding—Comparison between steam and electric winding—Systems of electric winding—Westinghouse converter-equaliser system—The Ilgner system—The Siemens-Ilgner system—Peebles-Ilgner system—Tests of electrical winding plant—Estimate of the cost of electric winding plant—Electrical locomotives, advantages and disadvantages—Trolley system—Rack rail system—Goodman gathering locomotive—The Jeffrey type—Mather & Platt underground type . . . . . | 181-214 |
|---|---------|