

**FORGECRAFT**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649586585

Forgecraft by Charles Philip Crowe

Except for use in any review, the reproduction or utilisation of this work in whole or in part in any form by any electronic, mechanical or other means, now known or hereafter invented, including xerography, photocopying and recording, or in any information storage or retrieval system, is forbidden without the permission of the publisher, Trieste Publishing Pty Ltd, PO Box 1576 Collingwood, Victoria 3066 Australia.

All rights reserved.

Edited by Trieste Publishing Pty Ltd.  
Cover @ 2017

This book is sold subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out, or otherwise circulated without the publisher's prior consent in any form or binding or cover other than that in which it is published and without a similar condition including this condition being imposed on the subsequent purchaser.

[www.triestepublishing.com](http://www.triestepublishing.com)

**CHARLES PHILIP CROWE**

# **FORGECRAFT**



---

# FORGECRAFT

BY

CHARLES PHILIP CROWE

OHIO STATE UNIVERSITY

UNIV. OF  
CALIFORNIA

COLUMBUS, OHIO  
R. G. ADAMS & COMPANY  
1913

TS 225

C7

Engineering  
Library

*Mech. Dept.*

COPYRIGHT 1911  
BY  
CHARLES P. CROWE

UNIV. OF  
CALIFORNIA

THE HEER PRESS  
COLUMBUS, OHIO

---

300

## PREFACE

This book is intended for the student, the apprentice, and the artisan who works at the forge. For any one who cares to understand forgecraft, some things explained here will be found profitable.

The author has found it impossible to complete many of the themes begun in this book, and had no intention of attempting to exhaust the theme when he began writing.

Forgecraft is a fundamental subject and the only argument that fully proves many of its principles is a piece of iron or steel shaped and treated properly. Intelligence rather than great strength is now recognized as the chief requisite for success in this trade. But skill can not be acquired without experience, and while knowledge of the theory is more valuable to the possessor than practical skill, the latter ought to be gained first in order that the understanding may be correct.

To all who would acquire more information on the subject of this ancient art, which is the same now as in the days of Tubal Cain, this book is respectfully dedicated.

C. P. C.

( iii )

266993

## CONTENTS

	PAGE
Introduction . . . . .	xi
Definition . . . . .	xi
Forgecraft — Forming — Welding — Fixing — Knowing . . . . .	xi

### PART I

#### CHAPTER I

##### THE FORGE

Heating Place — Oxidation — Placing Tuyers — Air Pressure — The Fire — Fuels . . . . .	5
--	---

#### CHAPTER II

##### TOOLS

Hammers — Anvils — Tongs — Swages — Fullers — Cutting Tools — Flatter — Set Hammer — Punches — Heading Tools — Sledges — Special Tools . . . . .	10
--	----

#### CHAPTER III

##### MATERIALS USED

Wrought Iron — Machinery Steel — Crucible Steel — High Speed Steel (Metallurgy — Manufacture — Chemistry) . . . . .	22
---	----

#### CHAPTER IV

##### FORMED WORK

Bending Rings and Curves — Stock Calculations — Allowance for loss in Welding — Ornamental Iron Work — Drawing out and Forging Sections — Drawing Tapers . . . . .	33
Forging Angles and Corners . . . . .	41
Bolts — Solid Forged — Upset Head — Weld Head — Hand Forged Nuts . . . . .	45
Reference Tables . . . . .	51-65

#### CHAPTER V

##### HOOKS AND CHAINS

Design — Calculation of Stock — Hand Forged Chain Hook — Grab Hooks — Gate Hook — Hook Formula — Chain Making — Stock — Tests — Heat Treatment . . . . .	75
--	----

### PART II

#### CHAPTER VI

##### WELDING

Definition — Fluxes — Butt, Split, Lap, T, Corner, Fagot Weld — Ring on Shaft — Eyebolt — Allowance to Weld On — Loss in Welding — Oxidation — Strength — Forging the Weld . . . . .	85
--	----



## CONTENTS

CHAPTER VII	
SPECIAL WELDS	
The Swivel—Rope Hook—Turn Buckle—Socket Wrench—Shank Weld—Ornaments—Welding Steel to Iron—Using a Flux— Electric Welding—Thermit Welding—Hot Flame Processes— Cost of Welding—Oxidation Value . . . . .	PAGE 98
PART III	
Introductory Steel Working—Heat Treatment—Temperature Color Names . . . . .	109
CHAPTER VIII	
TOOL SMITHING	
The Heating Fire—Proper Heats—Hammering Steel—Cutting Steel —Machine Tool Forging—Clearance Angle—Bent Tools—Off- set Edges—Shank Tools—High Speed Tools—Time and Tool Used . . . . .	112
CHAPTER IX	
HARDENING AND CARBONIZING	
Why Steel Hardens—Hardening Crucible Steel—Oxidation Scale— Liquid Baths for Heating Steel—Effect of Heat on Steel—Ex- amination of Fracture—Right Hardening Heat—Critical Tem- perature—Recalescence—Cooling Baths—Hardening in Oil— Warping and Cracking—Pack Hardening—High Speed Steel— Mushet Steel—Treatment of—Case Hardening—Carbonizing Materials—Guide for Hardening . . . . .	126
CHAPTER X	
TEMPERING	
Heat Treatment Summary—Oxidation Color—Graduation of Hard- ness—Oil Tempering for Tools—Oil Tempered Forgings— Liquid Baths and Methods—Special Tempering Methods—Case Hardening for Colors—Annealing—The Cooling Rate—Guide for Tempering . . . . .	146
ADDENDA	
CHAPTER XI	
METALLOGRAPHY	
Drawing Showing Critical Points and Recalescence . . . . .	162
Theoretical Drawings Showing how Iron and Carbon mix forming different Structures in Steel—Cryohydrate—Eutectic Alloy . . . . .	170
Alpha Iron—Beta Iron—Gamma Iron—Hardenite—Martensite— Austenite—Carbide of Iron—Cementite—Pearlite—Sorbite— Troostite . . . . .	172

## ILLUSTRATIONS

	PAGE
Steam hammer, 5 ton.....	2
Forge and fires.....	6
Cutlery making.....	8
Cross pein hand hammer, 2 lb.....	10
Cross pein hand hammer, 3 lb.....	10
Hammer, ball pein.....	11
Hammer, carriage ironers.....	11
Hammer, straight pein.....	11
Hammer, cross pein.....	11
Hammer, fitting, Fig. 4.....	12
Hammer, turning, Fig. 5.....	12
Anvil model.....	13
Anvil shape.....	13
Tongs, pick up.....	15
Tongs, bolt.....	15
Tongs, machine tool.....	15
Tongs, V jaw.....	15
Tongs, curved jaw.....	15
Tongs, flat stock.....	15
Swage, bottom, Fig. 7.....	16
Swage, top, Fig. 8.....	16
Fuller, top, Fig. 9.....	17
Fuller, bottom, Fig. 10.....	17
Set hammer, Fig. 11.....	17
Flatter, Fig. 12.....	17
Square punch.....	18
Round punch.....	18
Cold chisel, Fig. 13.....	18
Hot chisel, Fig. 14.....	18
Hardie, Fig. 15.....	18
Blacksmith's punch.....	19
Hand chisel.....	19
Sledge, cross pein.....	20
Sledge, double faced.....	20
Heading tool.....	20
Special forging tools.....	21
Forming dies and jigs.....	21
Iron Ore, loading.....	22
Ore, digging, Fig. 2.....	23
Ore pile, Fig. 3.....	23
Blast furnace.....	24
Pig iron bed.....	24
Puddling furnace.....	26

	PAGE
Puddler at work.....	26
Pouring crucible steel.....	27
Bessemer converter.....	29
Steel billets, Fig. 10.....	30
Steel grain, Fig. 12.....	30
Grain size in steel, Fig. 12.....	30
Wrought iron fiber, Fig. 11.....	30
Bending over anvil horn.....	33
Median line, Fig. 2.....	34
Effect of bending, Fig. 3.....	34
Ornamental piece.....	37
Scrolling tools.....	37
A bending fork.....	37
Bending a scroll.....	37
Hammering to make square bar.....	39
Hammering to draw out end.....	40
Sharp pointed piece.....	41
Upsetting a piece.....	42
Flowing stock to corner, Fig. 9.....	43
Finishing the outside of a corner, Fig. 10.....	43
Finishing the inside of a corner, Fig. 11.....	43
Holding for corner weld.....	44
Bolt making, Fig. 14.....	46
Upsetting for a bolt, Fig. 13.....	46
Making six sides on a bolt head.....	47
Changing the shape of a round head on a bolt.....	47
Making a hexagon shape.....	47
Punching holes.....	48
Driving a blacksmith's punch through iron.....	49
Shear cutting with a hot chisel.....	50
Cutting off with the hot chisel and hardie.....	50
Expansion curve of iron and steel.....	59
Photograph of a chain hook.....	66
Drawing of a chain hook.....	66
Fullering position.....	68
Holding to hammer a tapered section.....	63
Holding to forge an eye for a chain hook.....	69
Striking to bend a hook.....	70
Holding to complete the bend for a hook.....	70
Hammering a wedge shape and turning a hook.....	71
Grab hook with eye at 90 degree angle.....	72
Standard grab hook (Left hand in Fig. 8).....	72
Forging a shoulder.....	73
Twisting a square bar.....	73
Scarfing the end of a piece.....	76
Ready to weld a ring.....	76
Ready to finish a ring.....	76
Holding for a lap weld.....	88
Holding for a T weld.....	88
Holding for a corner weld.....	89