

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyral Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

THE PICTURE OF THE TAOIST GENII PRINTED ON THE COVER of this book is part of a painted temple scroll, recent but traditional, given to Mr Brian Harland in Szechuan province (1946). Concerning these four divinities, of respectable rank in the Taoist bureaucracy, the following particulars have been handed down. The title of the first of the four signifies 'Heavenly Prince', that of the other three 'Mysterious Commander'.

At the top, on the left, is Liu *Thien Chün*, Comptroller-General of Crops and Weather. Before his deification (so it was said) he was a rain-making magician and weather forecaster named Liu Chün, born in the Chin dynasty about +340. Among his attributes may be seen the sun and moon, and a measuring-rod or carpenter's square. The two great luminaries imply the making of the calendar, so important for a primarily agricultural society, the efforts, ever renewed, to reconcile celestial periodicities. The carpenter's square is no ordinary tool, but the gnomon for measuring the lengths of the sun's solstitial shadows. The Comptroller-General also carries a bell because in ancient and medieval times there was thought to be a close connection between calendrical calculations and the arithmetical acoustics of bells and pitch-pipes.

At the top, on the right, is Wên *Yuan Shuai*, Intendant of the Spiritual Officials of the Sacred Mountain, Thai Shan. He was taken to be an incarnation of one of the Hour-Presidents (*Chia Shen*), i.e. tutelary deities of the twelve cyclical characters (see Vol. 4, pt. 2, p. 440). During his earthly pilgrimage his name was Huan Tzu-Yü and he was a scholar and astronomer in the Later Han (b. +142). He is seen holding an armillary ring.

Below, on the left, is Kou *Yuan Shuai*, Assistant Secretary of State in the Ministry of Thunder. He is therefore a late emanation of a very ancient god, Lei Kung. Before he became deified he was Hsin Hsing, a poor woodcutter, but no doubt an incarnation of the spirit of the constellation Kou-Chhen (the Angular Arranger), part of the group of stars which we know as Ursa Minor. He is equipped with hammer and chisel.

Below, on the right, is Pi *Yuan Shuai*, Commander of the Lightning, with his flashing sword, a deity with distinct alchemical and cosmological interests. According to tradition, in his early life he was a countryman whose name was Thien Hua. Together with the colleague on his right, he controlled the Spirits of the Five Directions.

Such is the legendary folklore of common men canonised by popular acclamation. An interesting scroll, of no great artistic merit, destined to decorate a temple wall, to be looked upon by humble people, it symbolises something which this book has to say. Chinese art and literature have been so profuse, Chinese mythological imagery so fertile, that the West has often missed other aspects, perhaps more important, of Chinese civilisation. Here the graduated scale of Liu Chün, at first sight unexpected in this setting, reminds us of the ever-present theme of quantitative measurement in Chinese culture; there were rain-gauges already in the Sung (+12th century) and sliding calipers in the Han (+1st). The armillary ring of Huan Tzu-Yü bears witness that Naburiannu and Hipparchus, al-Naqqāsh and Tycho, had worthy counterparts in China. The tools of Hsin Hsing symbolise that great empirical tradition which informed the work of Chinese artisans and technicians all through the ages.

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyric Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

SCIENCE AND CIVILISATION IN CHINA

Among the Chinese frequent examples are to be found of discoveries, especially in the arts, which other nations made independently whereas the Chinese had come upon them long before.

WILLEM TEN RHIJNE

De Arthritide (+ 1683)

And if we look so far as the Sun-rising, and hear *Paulus Venetus* what he reporteth of the uttermost Angle and *Island* thereof, wee shall finde that those Nations have sent out, and not received, lent knowledge, and not borrowed it from the West. For the farther East (to this day) the more civill, the farther West the more salvage.

SIR WALTER RALEIGH

'History of the World', + 1614 (+ 1652)

Pt. I, Bk. 1, ch. 7, § 10, sect. 4, p. 98

I take my own intelligence as my teacher.

A-NI-KO, master-artisan of Nepal,
addressing the emperor Shih Tsu, + 1263

(*Yuan Shih*, ch. 203, p. 12a)

I hear, and I forget.

I see, and I remember.

I do, and I understand.

Ten thousand words are not worth one seeing.

Chinese proverbs.

I am not yet so lost in lexicography, as to forget that words are the daughters of earth, and that things are the sons of heaven.

SAMUEL JOHNSON

Preface to his 'Dictionary of the
English Language' (+ 1755)

By studying the organic patterns of heaven and earth a fool
can become a sage.

So by watching the times and seasons of natural phenomena we can become true philosophers.

LI CHHÜAN

Yin Fu Ching (c. + 735)

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

中國科學技術史

李約瑟著

莫朝鼎



Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

SCIENCE AND CIVILISATION IN CHINA

BY

JOSEPH NEEDHAM, F.R.S., F.B.A.

SOMETIME MASTER OF GONVILLE AND CAIUS COLLEGE, CAMBRIDGE

FOREIGN MEMBER OF ACADEMIA SINICA

With the collaboration of

HO PING-YÜ, PH.D.

PROFESSOR OF CHINESE AT GRIFFITH

UNIVERSITY, BRISBANE

and

LU GWEI-DJEN, PH.D.

FELLOW OF ROBINSON COLLEGE, CAMBRIDGE

and a contribution by

NATHAN SIVIN, PH.D.

PROFESSOR OF CHINESE IN THE UNIVERSITY OF

PENNSYLVANIA, PHILADELPHIA

VOLUME 5

CHEMISTRY AND CHEMICAL TECHNOLOGY

PART IV: SPAGYRICAL DISCOVERY AND
INVENTION: APPARATUS, THEORIES AND GIFTS



CAMBRIDGE
UNIVERSITY PRESS

Cambridge University Press
978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:
Spagyric Discovery and Invention: Apparatus, Theories and Gifts: Volume 5
Joseph Needham
Frontmatter
[More information](#)

CAMBRIDGE
UNIVERSITY PRESS

University Printing House, Cambridge CB2 8BS, United Kingdom

Cambridge University Press is part of the University of Cambridge.

It furthers the University's mission by disseminating knowledge in the pursuit of
education, learning and research at the highest international levels of excellence.

www.cambridge.org

Information on this title: www.cambridge.org/9780521085731

© Cambridge University Press 1980

This publication is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without
the written permission of Cambridge University Press.

First published 1959

4th printing 2014

Printed in the United Kingdom by Berforts Information Press, Ltd.

Library of Congress catalogue Card Number : 54-4723

British Library cataloguing in publication data

Needham, Joseph

Science and civilisation in China.

Vol. 5: Chemistry and chemical technology

Part. 4: Spagyric discovery and invention:

apparatus, theories and gifts

1. Science – China – History 2. Technology – China – History

I. Title II. Wang Ling III. Lu, Gwei Djen IV. Ho, Ping-Yu

509'.51 Q127.C5 54-4723

ISBN-13 978-0-521-08573-1 Hardback

Cambridge University Press has no responsibility for the persistence or accuracy
of URLs for external or third-party internet websites referred to in this
publication, and does not guarantee that any content on such websites is,
or will remain, accurate or appropriate.

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyric Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

To

WU HSÜEH-CHOU

*sometime Director of the Chemical Institute of
Academia Sinica*

and

CHANG TZU-KUNG

*sometime Chemical Adviser to the National Resources
Commission*

in warmest recollection of long
and enlightening discussions at
Kunming and Nan-wên-chhüan
1942 to 1946

as also in memory of an earlier friend

LOUIS RAPKINE

*sometime Professor of Biochemistry at the Institut de
Biologie Physico-Chimique, Paris*

in our youth
colleague at the Marine Station at Roscoff
compass-needle for truth and social justice
Spinoza redivivus

this volume is dedicated

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

CONTENTS

List of Illustrations *page* xiii
List of Tables xxiii
List of Abbreviations xxv
Acknowledgements xxix
Author's Note xxxi

33 ALCHEMY AND CHEMISTRY (*continued*) *page* 1

- (f) Laboratory apparatus and equipment, *p.* 1
- (1) The laboratory bench, *p.* 10
 - (2) The stoves *lu* and *tsao*, *p.* 11
 - (3) The reaction-vessels *ting* (tripod, container, cauldron) and *kuei* (box, casing, container, aludel), *p.* 16
 - (4) The sealed reaction-vessels *shen shih* (aludel, lit. magical reaction-chamber) and *yao fu* (chemical pyx), *p.* 22
 - (5) Steaming apparatus, water-baths, cooling jackets, condenser tubes and temperature stabilisers, *p.* 26
 - (6) Sublimation apparatus, *p.* 44
 - (7) Distillation and extraction apparatus, *p.* 55
 - (i) *Destillatio per descensum*, *p.* 55
 - (ii) The distillation of sea-water, *p.* 60
 - (iii) East Asian types of still, *p.* 62
 - (iv) The stills of the Chinese alchemists, *p.* 68
 - (v) The evolution of the still, *p.* 80
 - (vi) The geographical distribution of still types, *p.* 103
 - (8) The coming of Ardent Water, *p.* 121
 - (i) The Salernitan quintessence, *p.* 122
 - (ii) Ming naturalists, *p.* 132
 - (iii) Thang 'burnt-wine', *p.* 141
 - (iv) Liang 'frozen-out wine', *p.* 151
 - (v) From icy mountain to torrid still, *p.* 155
 - (vi) Oils in stills; the rose and the flame-thrower, *p.* 158
 - (9) Laboratory instruments and accessory equipment, *p.* 162

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyric Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

x

CONTENTS

- (g) Reactions in aqueous medium, *p.* 167
 - (1) The formation and use of a mineral acid, *p.* 172
 - (2) 'Nitre' and *hsiao*; the recognition and separation of soluble salts, *p.* 179
 - (3) Saltpetre and copperas as limiting factors in East and West, *p.* 195
 - (4) The precipitation of metallic copper from its salts by iron, *p.* 201
 - (5) The role of bacterial enzyme actions, *p.* 204
 - (6) Geodes and fertility potions, *p.* 205
 - (7) Stabilised lacquer latex and perpetual youth, *p.* 207
- (h) The theoretical background of elixir alchemy [with Nathan Sivin], *p.* 210
 - (1) Introduction, *p.* 210
 - (i) Areas of uncertainty, *p.* 211
 - (ii) Alchemical ideas and Taoist revelations, *p.* 212
 - (2) The spectrum of alchemy, *p.* 220
 - (3) The role of time, *p.* 221
 - (i) The organic development of minerals and metals, *p.* 223
 - (ii) Planetary correspondences, the First Law of Chinese physics, and inductive causation, *p.* 225
 - (iii) Time as the essential parameter of mineral growth, *p.* 231
 - (iv) The subterranean evolution of the natural elixir, *p.* 236
 - (4) The alchemist as accelerator of cosmic process, *p.* 242
 - (i) Emphasis on process in theoretical alchemy, *p.* 248
 - (ii) Prototypal two-element processes, *p.* 251
 - (iii) Correspondences in duration, *p.* 264
 - (iv) Fire phasing, *p.* 266
 - (5) Cosmic correspondences embodied in apparatus, *p.* 271
 - (i) Arrangements for microcosmic circulation, *p.* 281
 - (ii) Spatially oriented systems, *p.* 286
 - (iii) Chaos and the egg, *p.* 292
 - (6) Proto-chemical anticipations, *p.* 298
 - (i) Numerology and gravimetry, *p.* 300
 - (ii) Theories of categories, *p.* 305
- (i) Comparative macrobiotics, *p.* 323
 - (1) China and the Hellenistic world, *p.* 324
 - (i) Parallelisms of dating, *p.* 324
 - (ii) The first occurrence of the term 'chemistry', *p.* 339

CONTENTS	xi
(iii) The origins of the root ‘chem-’, <i>p.</i> 346	
(iv) Parallelisms of content, <i>p.</i> 355	
(v) Parallelisms of symbol, <i>p.</i> 374	
(2) China and the Arabic world, <i>p.</i> 388	
(i) Arabic alchemy in rise and decline, <i>p.</i> 309	
(ii) The meeting of the streams, <i>p.</i> 408	
(iii) Material influences, <i>p.</i> 429	
(iv) Theoretical influences, <i>p.</i> 453	
(v) The name and concept of ‘elixir’, <i>p.</i> 472	
(3) Macrobiotics in the Western world, <i>p.</i> 491	
BIBLIOGRAPHIES	510
Abbreviations, <i>p.</i> 511	
A. Chinese and Japanese books before +1800, <i>p.</i> 519	
Concordance for <i>Tao Tsang</i> books and tractates, <i>p.</i> 571	
B. Chinese and Japanese books and journal articles since +1800, <i>p.</i> 574	
C. Books and journal articles in Western languages, <i>p.</i> 596	
GENERAL INDEX	693
<i>Table of Chinese Dynasties</i>	761
<i>Summary of the Contents of Volume 5</i>	762
<i>Romanisation Conversion Table</i>	764

Cambridge University Press
978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:
Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5
Joseph Needham
Frontmatter
[More information](#)

LIST OF ILLUSTRATIONS

- 1374 Stove platform from *Kan Chhi Shih-liu Chuan Chin Tan* (Sung). *page* 10
- 1375 Stove platforms from *Tan Fang Hsü Chih* (+ 1163) . . . *page* 11
- 1376 Stove platform from *Yün Chi Chhi Chhien* (+ 1022) . . . *page* 11
- 1377 The 'inverted-moon stove' from *Chin Tan Ta Yao Thu* (+ 1333) *page* 13
- 1378 Stove depicted in *Yün Chi Chhi Chhien* (+ 1022) . . . *page* 13
- 1379 Stoves drawn in *Thai-Chi Chen-ŷen Tsa Tan Yao Fang* (a text probably of the Sung) . . . *page* 13
- 1380*a, b* Pottery stove designed to heat four containers at one time, in an excavated tomb of the Thang period, *c.* +760 . . . *page* 14
- 1380*c* A bronze 'hot-plate' of the – 11th century, for warming sacrificial wine in liturgical vessels . . . *page* 15
Reproduced by permission of the Metropolitan Museum of Art, New York
- 1381 Gold reaction-vessel, a drawing from *Yün Chi Chhi Chhien* (+ 1022) *page* 17
- 1382 Covered reaction-vessel, a drawing from the same work . . . *page* 17
- 1383 'Suspended-womb' reaction-vessel, also with three legs, from *Chin Tan Ta Yao Thu* (+ 1333) . . . *page* 17
- 1384 Aludel from the *Kan Chhi Shih-liu Chuan Chin Tan* (Sung) . *page* 18
- 1385 Furnace and reaction-vessel, from *Chhien Hung Chia Kêng*... (+ 808 or later) . . . *page* 18
- 1386 Types of aludels and reaction-vessels from *Thai-Chi Chen-ŷen*... (probably Sung) . . . *page* 19
- 1387 Reaction-chamber from the *Kêng Tao Chi* (+ 1144 or later) . *page* 19
- 1388 'Precious vase' probably of Thang date . . . *page* 20
Reproduced by permission of the Provincial Historical Museum, Taiyuan, Shansi
- 1389 Bronze reaction-vessel (*ting*) with clamp handle mechanism to permit tight sealing. From the tomb of Liu Shêng (d. – 113) at Man-chhêng . . . *page* 21
- 1390 Reaction-chamber from the *Chin Hua Chhung Pi Tan Ching Pi Chih* (+ 1225) . . . *page* 22
- 1391 Reconstruction of the *yao-fu* 'bomb' from the *Thai-Chhing Shih Pi Chi* (Liang, + 6th century, or earlier) . . . *page* 22
- 1392 A bronze *tui*, possibly used as a reaction-vessel, Chou period, *c.* – 6th century, from Chia-ko-chuang, near Thangshan in Hopei . *page* 23

xiv	LIST OF ILLUSTRATIONS
1393	Bronze <i>tui</i> , usable as a reaction-vessel, Chou period, between –493 and –447, from the tomb of a Marquis of Tshai, near Shou-hsien in Anhui. page 24
1394	Stoppered aludel of silver, from the hoard of the son of Li Shou-Li, buried at Sian in +756 page 25
1395	Neolithic pottery vessels connected with the origins of chemical apparatus, all from the –3rd millennium page 26
1396	Three-lobed spouted jug (<i>li</i>) of red pottery, from a neolithic site at Shih-chia-ho in Thien-mên Hsien, Hupei, c. –2000 page 26
1397	A <i>li</i> vessel of grey pottery, in the style of the Hsiao-thun culture, excavated from neolithic levels at Erh-li-kang, near Chêngchow in Honan, dating from the –23rd to the –20th century page 27
1398	Tripod vessel (<i>ting</i>) of coarse dark grey pottery, from a neolithic site at Shih-chia-ho in Thien-mên Hsien, Hupei page 28
1399	Bronze <i>hsien</i> of the Shang period, c. –1300 page 28
1400	Early Chou bronze <i>hsien</i> , c. –1100, photographed to show the grating Reproduced by permission of the Royal Ontario Museum, Toronto page 29
1401	Bronze <i>tsêng</i> , i.e. an apparatus of two separate vessels with a grating between them, and fitting well together. From a tomb of the –4th or –3rd century at Chao-ku near Hui-hsien in Honan page 29
1402	Bronze <i>ting</i> with well moulded water-seal rim, c. –500, from Huang-hsien page 30
1403	Characteristic pickling pot in common use in China, usually in red pottery, with annular water-seal for maintaining almost anaerobic conditions page 30
1404	Tomb-model of stove and steamer from Chhangsha; Earlier Han period, –2nd or –1st century page 31
1405	Tomb-model of stove, and chimney with roof, from a Later Han grave at Chhangchow page 31
1406	Elaborately ornamented water-bath, with grate underneath, in bronze, of middle or late Chou date (c. –6th century) page 32 Reproduced by permission from the Sumitomo Collection, Kyoto
1407	Diagram of furnace with condenser, from the <i>Huan Tan Chou Hou Chüeh</i> , a Thang text of the +9th century page 34
1408	Stove and steamer-support, from <i>Chin Hua Chhung Pi Tan Ching</i>, a Sung text, +1225 page 34

LIST OF ILLUSTRATIONS

xv

- 1409 Water-cooled reaction-vessel from the *Chin Hua Chhung Pi Tan Ching*..., +1225. The upper reservoir is prolonged into a blind finger below, so that the cold water can moderate the temperature of the reaction proceeding in the chamber *page 36*
- 1410 Water-cooled reaction-vessel, from the same work (+1225). The central tube descending from the cooling reservoir is enlarged into a single bulb *page 37*
- 1411 Water-cooled reaction-vessel, from the same work (+1225). The central tube has two bulbs flattened like radiator fins . . . *page 38*
- 1412 Water-cooled reaction-vessel, from the same work (+1225). The central tube connects the cooling reservoir with a peripheral water-jacket in the wall of the reaction chamber *page 38*
- 1413 Water-cooled reaction-vessel, from the same work (+1225). Here the peripheral water-jacket is provided with a filling tube at one side as well as the connection with the cooling reservoir through the central tube *page 39*
- 1414 Water-cooled reaction-vessel, from the same work (+1225). There is no central tube, and the cooling reservoir connects directly with the peripheral water-jacket at one point on its circumference above. *page 40*
- 1415 Water-cooled reaction-vessel, from the same work (+1225). Cooling reservoir, central tube, and two water-jackets in the form of hoods, but no peripheral cold-water walls *page 41*
- 1416 Water-cooled reaction-vessel, from the same work (+1225). Cooling reservoir with complete water-jacket horseshoe-shaped in cross-section but continuing under the floor of the chamber . . . *page 42*
- 1417 Water-cooled reaction-vessel, from the same work (+1225). Cooling reservoir prolonged below into three meridional tubes passing around the chamber and meeting at the bottom *page 42*
- 1418 A sublimatory vessel in the shape of a narrow-mouthed *ting*, from the *Hsiu Lien Ta Tan Yao Chih* (Sung) *page 45*
- 1419 Traditional Taiwanese sublimatories for camphor *page 45*
- 1420 Camphor sublimation with steam as carried out in Japan, from the *Nihon Sankai Meibutsu Zue* (+1754) *page 46*
- 1421 Camphor still of Japanese type as used in Taiwan (Davidson) . *page 46*
- 1422 Traditional sublimation-distillation apparatus for camphor used in South China *page 48*
- 1423 Diagram to illustrate the operation of this apparatus . . . *page 48*
- 1424 Bronze 'rainbow *téng*' of Later Han date (+1st or +2nd century) *page 50*

- 1425 Cross-section of another example of this apparatus, found at Chhangsha and dating from the Early Han period, *c.* – 1st century . . . *page 50*
- 1426 Figurine of an amphisbaena of two-headed serpent, probably personifying the rainbow and representing a visible rain-bringing dragon, generally beneficent . . . *page 52*
Reproduced by permission of Royal Ontario Museum, Toronto
- 1427 Rainbow *têng* with only one side-tube, Sung in date, but the bronze inlaid in Chhin or Han style . . . *page 52*
Reproduced by permission of the British Museum
- 1428 Modern still for the purification of mercury in high vacuum, lined with glass and porcelain to prevent contact with the metal . . . *page 53*
- 1429 Single-tube rainbow *têng* in the form of a serving-maid holding a lamp, from the tomb of Liu Shêng, Prince Ching of Chung-shan, d. – 113 . . . *page 54*
- 1430 Bamboo tube for descensory distillation of mercury, from *Ta-Tung Lien Chen Pao Ching* . . . (Thang) . . . *page 56*
- 1431 Stove arranged for descensory distillation; drawings from the *Kan Chhi Shih-liu Chuan Chin Tan*, a Sung work . . . *page 56*
- 1432 Furnace arranged for descensory distillation, from the *Chhien Hung Chia Kêng* . . . of +808 (Thang) . . . *page 58*
- 1433 ‘Pomegranate’ flask (an ambix) used in descensory distillation, from *Chin Hua Chhung Pi Tan Ching Pi Chih* of +1225 (Sung) . . . *page 58*
- 1434 Mercury distillation *per descensum* depicted in the *Chêng Lei Pên Tshao* of +1249 (Sung) . . . *page 59*
- 1435 Condensing the distillate from sea-water in a suspended fleece, an ancient method illustrated by Conrad Gesner in his *Thesaurus Euonymus Philatri* (+1555) . . . *page 61*
- 1436 The ‘Mongolian’ still (Hommel) . . . *page 62*
- 1437 The ‘Chinese’ still (Hommel) . . . *page 63*
- 1438 Alcohol still at Tung-chêng in Anhui (Hommel), showing the external appearance of a traditional Chinese distillation apparatus . . . *page 64*
- 1439 Pewter cooling reservoir or condenser vessel of a traditional liquor still, photographed upside down, at Lin-chiang in Chiangsi (Hommel) *page 64*
- 1440 Pewter catch-bowl and side-tube of a traditional liquor still, photographed upside down, at Lin-chiang in Chiangsi (Hommel) . . . *page 65*
- 1441 Traditional Chinese liquor still at Chia-chia-chuang Commune, Shansi *page 65*
- 1442 Traditional still from the *Nung Hsüeh Tsuan Yao* (1901) by Fu Tsêng-Hsiang . . . *page 66*

LIST OF ILLUSTRATIONS

xvii

- 1443 A wine-distilling scene from the frescoes at the cave-temples of Wan-fohsia (Yü-lin-khu) in Kansu, dating from the Hsi-Hsia period (+ 1032 to + 1227) page 66
- 1444 A late + 18th-century coloured MS. drawing of a Chinese wine still page 67
Reproduced by permission of the Victoria and Albert Museum
- 1445 Traditional-style drawing of a Chinese liquor distillery page 68
- 1446 East Asian stills from the *Tan Fang Hsü Chih* of + 1163 (Sung) page 69
- 1447 Another Chinese apparatus from *Chih-Chhuan Chen-ŷen Chiao Chêng Shu*, ascribed to the Chin period (+ 3rd or + 4th century), but more probably Thang (+ 8th or + 9th) page 72
- 1448 East Asian stills from *Chin Hua Chhung Pi Tan Ching Pi Chih* of + 1225 (Sung) page 73
- 1449 One of the forms of the *kērotakis* (reflux distillation) apparatus of the Greek proto-chemists page 74
- 1450 Sherwood Taylor's conjectural reconstruction of the long type of *kērotakis* apparatus page 75
- 1451 A drawing from the *Liber Florum Geberti*, a pre-Geberian Arabic-Byzantine MS. in Latin, probably of the + 13th century page 77
- 1452 Mercury still from the *Tan Fang Hsü Chih* of + 1163 (Sung) page 77
- 1453 A retort still for mercury, from *Thien Kung Khai Wu* (+ 1637) by Sung Ying-Hsing page 78
- 1454 Chart to illustrate the evolution of the still page 81
- 1455 Distillation and extraction apparatus from pre-Akkadian times in Northern Mesopotamia, c. – 4th and – 3rd millennia (Levey). page 82
- 1456 Aludel with annular shelf used by the Arabic alchemists as a sublimatory or 'still', from a text of al-Kāṭī (+ 1034). page 83
- 1457 Aludels with annular shelves or gutters, from a late + 13th-century MS. of Geber, *Summa Perfectionis Magisterii* page 83
- 1458 Illustration of Hellenistic apparatus from MS. Paris 2327, a copy made in + 1478 of the proto-chemical Corpus in Greek compiled by Michael Psellus in the + 11th century, and containing material from the ± 1st century onwards page 84
- 1459 Page from a + 14th-century MS. of the *Turba* and of Geberian writings page 85
Reproduced by permission of Gonville & Caius College, Cambridge
- 1460 Distillation equipment found at Taxila in the Punjab, India, and dating from the ± 1st century page 87

xviii

LIST OF ILLUSTRATIONS

- 1461 Hellenistic still with no guttered still-head but a single side-tube of large diameter leading to a receiver—the first of all Western ‘retorts’ page 88
- 1462 Drawing of a retort in a Syriac MS. copied in the +16th century but containing material going back to the +1st century, and much from the +2nd to the +6th page 88
- 1463 A *dibikos* or Hellenistic still with two side-tubes page 89
- 1464 The same as reconstructed by Sherwood Taylor. page 89
- 1465 The earliest representation of a Moor’s head cooling bath, a drawing by Leonardo da Vinci, *c.* +1485 page 90
- 1466 The Moor’s head condenser as depicted by Conrad Gesner (*De Remediis Secretis*, +1569) page 90
- 1467 The elegant picture of the Moor’s head in Mattioli’s *De Ratione Distillandi*, +1570 page 91
- 1468 Bladder still-head cooler, from Gesner’s *De Remediis Secretis*, +1569 page 92
- 1469 Reconstruction by Ladislao Reti of the dephlegmator described by Taddeo Alderotti in his *Consilia Medicinalia* (late +13th century) page 92
- 1470 The oldest representation of a water-cooling condenser surrounding the side-tube between the still and the receiver, in a MS. of +1420 by Johannes Wenod de Veteri Castro page 94
- 1471 A form of Moor’s head described by Hieronymus Brunschwyk soon after +1500 in *Liber de Arte Distillandi de Compositis* (1st ed., +1512) page 94
- 1472 An early drawing of a dephlegmator arranged for fractionation, from a Bavarian MS. dated +1519 page 95
Reproduced by permission of the Jagellonian Library, Cracow
- 1473 *a* A complex dephlegmator of five vessels depicted by Conrad Gesner in +1552, from *De Remediis Secretis* (+1569) page 96
- 1473 *b* Dephlegmator from the *Kräuterbuch* of Adam Lonicerus (+1578) page 96
- 1473 *c* Conjectural design of the most ancient Mongolian-Chinese still type page 96
- 1474 Coiled serpentine side-tube descending through a reservoir of cold water, from Gesner’s *De Remediis Secretis* (+1569). page 99
- 1475 Solar still for purifying water page 99
- 1476 Apparatus for the continuous extraction of plant or other material at the boiling temperature of the solvent page 100
- 1477 The Mongolian and Chinese stills in modern chemical practice . page 101
- 1478 Mongolian and Chinese principles in molecular stills page 102
- 1479 The Mongol still in folk use; the can of the Crimean Cossacks for distilling *arak* from *kumiss* page 104

xix

1480	Forms of still in use among Siberian peoples for <i>arak</i> .	page 105
1481	A combination of Chinese and Western designs: the extraction apparatus for materia medica used among the Algerians.	page 106
1482	A Tarasco still from the Lake Patzcuaro region in Mexico.	page 106
1483	Zapotec still, also from Mexico, one of a series set along a bench-like stove.	page 107
1484	Part of a Chinese still used by the Cora and Tarasco Indians in Mexico.	page 108
1485a	A Mongol still used by the Huichol Indians in Mexico.	page 109
1485b	'Trifid' pottery vessel from the Colima culture of north-western Mexico, c. - 1450.	page 109
1486	Western-type still with cooling-barrel condenser on the side-tube used for the distillation of <i>arak</i> by the Wotjaks in Siberia.	page 112
1487a	Reconstruction of the 'pot and gun-barrel' still described in the <i>Chü Chia Pi Yung Shih Lei Chhüan Chi</i> of +1301.	page 113
1487b	Still of Hellenistic type used in China for the industrial preparation of essential oil of cassia, from the leaves and flowers of <i>Cinnamomum Cassia</i> .	page 113
1488a	Japanese <i>rangaku</i> or +18th-century pharmaceutical extractor still.	page 114
1488b	Cross-section of the same.	page 114
1489	Chinese industrial still of Western type for the distillation of kao-liang wine.	page 115
1490	Cross-section of a <i>chhi kuo</i> for cooking foods in water just condensed from steam, without loss of volatile flavouring substances.	page 116
1491	Japanese industrial still for peppermint oil.	page 116
1492	Triple still for peppermint oil, also from a Japanese source.	page 117
1493	Vietnamese industrial still for the essential oils of star anise, <i>Illicium verum</i> .	page 118
1494a	Vietnamese alcohol still.	page 119
1494b	Another Vietnamese alcohol still.	page 119
1495	Chinese industrial still for star anise oil (<i>pai chio yu</i>).	page 119
1496	'Rosenhut' still for alcohol distillation, from Puff von Schrick's book, first published in +1478.	page 125
1497	The <i>mastarion</i> or 'cold-still' of Zosimus.	page 126
1498	Glass still-head of <i>mastarion</i> type from Egypt, datable from the +5th to the +8th century.	page 126
	Reproduced by permission of the Royal Ontario Museum, Toronto	
1499	Drawings of stills in al-Kindi's <i>Kitāb Kīmīyā' al-'Iṭr wa'l-Taṣ'īdāt</i> (Book of Perfume Chemistry and Distillations).	page 127

xx	LIST OF ILLUSTRATIONS
1500	A 'Moor's head' still from a Moorish land, cross-section of the Algerian steam distillation apparatus described by Hilton-Simpson page 130
1501	Steam distillation apparatus of compact form in tinned copper from Fez in Morocco page 130
1502	Wên Ti, ruler of the State of Wei in the Three Kingdoms period, pictured with his colleagues of the States of Shu and Wu in a MS. of + 1314, the <i>ġāmi'al-Tawārīkh</i> (Collection of Histories) by Rashīd al-Dīn al-Hamdānī, the Chinese portion of which was completed in + 1304 page 138 Reproduced by permission of the Royal Asiatic Society, London
1503	Modern alcohol vat still for <i>fēn chiu</i> at Hsing-hua Tshun, Shansi page 150
1504	Modern vat stills at Shao-hsing, Chekiang page 150
1505	Pestle and mortar, from the <i>Tan Fang Hsü Chih</i> of + 1163. page 163
1506	Cast-iron pestle and mortar, Later Han in date, from a tomb at Yang-tzu Shan near Chhêngtu excavated in 1957 page 163
1507	Bronze pestle and mortar, Hsin or Later Han in date, found during the construction of the Chhêngtu-Kunming Railway page 164
1508	Collapsible ladle in silver, part of the hoard of the son of Li Shou-Li, probably buried in + 756, at Sian page 164
1509	Origins of the gas bubbler or Woulfe bottle; typical Chinese tobacco water-pipes page 165
1510	Double-mouthed <i>kundika</i> pot or bottle, of buff clay with <i>ying-chhing</i> (shadow blue) glaze; Indian in form but Thang in date page 166 Reproduced by permission of the Royal Ontario Museum, Toronto
1511	The saltpetre (nitre) industry at Ho-chien-fu, showing the removal of the percolated earth, with old percolating jars in the foreground page 193
1512	A saltpetre works in Japan, from the <i>Nihon no Sangyō Gijutsu</i> (Industrial Arts and Technology in Old Japan) by Ōya Shin'ichi page 193
1513	A Japanese ferrous sulphate works, from the <i>Nihon Sankai Meibutsu Zue</i> (Illustrations of Processes and Manufactures), + 1754 page 200
1514	A geode (<i>yü yü liang</i>) from ferruginous clay; a page of the <i>Chêng Lei Pên Tshao</i> (Reorganised Pharmacopoeia) of + 1249 page 206
1515	The Five Elements and the Yin and Yang as phases of a cyclical process page 226
1516	Diagram to illustrate the conception of 'time-controlling substances' page 244
1517	Fire-distances prescribed in the <i>Thai-Wei Ling Shu Tzu-Wên Lang-Kan Hua Tan Shen Chen Shang Ching</i> (Divinely Written Exalted Spiritual Realisation Manual in Purple Script on the Lang-Kan (Gem) Radiant Elixir; a Thai-Wei Scripture), a text of the late + 4th century page 269

LIST OF ILLUSTRATIONS xxi

1518	Chhen Shao-Wei's linear fire-phasing system, from his <i>Chhi Fan Ling Sha Lun</i> (On Numinous Cinnabar Seven Times Cyclically Transformed), c. +713	page 272
1519a	Mêng Hsü's two-variable phasing system, from <i>Chin Hua Chhung Pi Tan Ching Pi Chih</i> (+1225)	page 276
1519b	Two of the Twelve Hour-Presidents (Spirits of the Double-hours). A pair of Han tiles Reproduced by permission of the Royal Scottish Museum, Edinburgh	page 280
1520	A page from Chao Nai-An's <i>Chhien Hung Chia Kêng Chih Pao Chi Chhêng</i> (Complete Compendium on the Perfected Treasure of Lead, Mercury, Wood and Metal). Perhaps Thang (+808) in date, but more probably Wu Tai or Sung	page 283
1521	Tshao Yuan-Yü's reconstruction of a mediaeval Taoist alchemical laboratory in a cave	page 290
1522	Drawings of native cinnabar from the <i>Chêng Lei Pên Tshao</i> of +1249	page 300
1523	Chhen Shao-Wei's mercury yields from different varieties of cinnabar	page 304
1524	A representation of the 'gold-digging ants' of Asia, from the +1481 Augsburg edition of Mandeville's 'Travels'	page 338
1525	Hellenistic Ouroboros. A representation from MS. Marcianus 299, fol. 188v.	page 375
1526	Hellenistic Ouroboros. Another representation, from Paris MS. 2327, fol. 196 (in Olympiodorus, late +5th century)	page 375
1527	Hellenistic Ouroboros on a Gnostic gem, one of the many Abraxas talismans. Date ± 1st century, contemporary with ps-Cleopatra	page 375
1528	Examples of the Chinese Ouroboros (a) Reproduced by permission of the British Museum (b) Reproduced by permission of the Museum of Far Eastern Antiquities, Stockholm (c) Reproduced by permission of the Musée Guimet, Paris (d) Reproduced by permission from the collection of Mrs Brenda Seligman (e) Reproduced by permission from the Eumorphopoulos Collection in the British Museum	pages 382-3
1529	A painting by Tung Chhi-Chhang (+1555 to +1636), one of the first Chinese painters to try the European style. St Thomas of the Indies, who in the apocryphal <i>Acts of Thomas</i> had an encounter with an Ouroboros	page 383
1530	A Chinese <i>Turba Philosophorum</i> , from <i>Shen Hsien Thung Chien</i>	page 400
1531a	Map to show the communication routes, mainly overland, between the Chinese and Arabic culture-areas, as also the relation between Chinese, Iranian and Eastern Mediterranean lands and cities	pages 406-7

xxii	LIST OF ILLUSTRATIONS
1531 <i>b</i>	Statuette of a Persian or Arabic merchant, Thang in date . . . <i>page</i> 418 Reproduced by permission of the Royal Ontario Museum, Toronto
1532	Evidence of the close relations between China and the Islamic countries in the Sung; a silver ewer of West Asian character . . . <i>page</i> 422
1533	Yin and Yang (the Moon and the Sun) as controllers of the Six Metals, an illustration from an Arabic MS. of Abū al-Qāsim al-‘Irāqī, <i>c.</i> + 1280 . . . <i>page</i> 458 Reproduced by permission of the British Museum
1534	Chart of the ‘Ilm al-Mizān (Science of the Balance) of the Jābirian Corpus . . . <i>page</i> 460
1535	The tours of the god Thai I through the spaces of the universe repre- sented by the nine cells of the magic square of three; from the Thang and Sung liturgical encyclopaedia <i>Tao Fa Hui Yuan</i> . . . <i>page</i> 466
1536	Directions for a Taoist ritual dance symbolising the circling of the Great Bear (<i>pei tou</i>) in the heavens; from the <i>Thai-Shang Chu Kuo</i> <i>Chiu Min Tsung Chen Pi Yao</i> (+ 1116) . . . <i>page</i> 467
1537	Esoteric objects still extant from the collections of Rudolf II in Prague <i>page</i> 489
1538	Chart to illustrate the multi-focal origins of proto-chemistry . . . <i>page</i> 504

LIST OF TABLES

114	Names and details of <i>Tao Tsang</i> texts useful in the study of chemical apparatus	pages 2–3
115	Technical terms of operations	page 4–7
116	Order of operations in the elixir preparation of the <i>Chin Hua Chhung Pi Tan Ching Pi Chih</i> , ch. 2 (TT907)	page 43
117	General scheme of the passages in the <i>Huai Nan Tzu</i> book about the growth and development of minerals and metals in the earth	page 225
118	Chhen Shao-Wei’s helical fire-phasing system	page 273
119	Yan Tsai’s helical fire-phasing system	page 274
	Symbolic correlations of the Five Minerals	page 287
	Symbolic correspondences of four metals and minerals	page 290
120	Chemical categories from the <i>Wu Hsiang Lei Pi Yao</i>	page 320
	Symbolic correlations among the Šābians	page 428
	Life-expectancy at birth in Europe, + 1300 to 1950	page 508

Cambridge University Press
978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:
Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5
Joseph Needham
Frontmatter
[More information](#)

LIST OF ABBREVIATIONS

The following abbreviations are used in the text and footnotes. For abbreviations used for journals and similar publications in the bibliographies, see pp. 511ff.

B	Bretschneider, E. (1), <i>Botanicon Sinicum</i> .
CC	Chia Tsu-Chang & Chia Tsu-Shan (1), <i>Chung-Kuo Chih Wu Thu Chien</i> (Illustrated Dictionary of Chinese Flora), 1958.
CCIF	Sun Ssu-Mo, <i>Chhien Chin I Fang</i> (Supplement to the 'Thousand Golden Remedies'), between +660 and +680.
CCYF	Sun Ssu-Mo, <i>Chhien Chin Yao Fang</i> (Thousand Golden Remedies), between +650 and +659.
CHS	Pan Ku (and Pan Chao), <i>Chhien Han Shu</i> (History of the Former Han Dynasty), c. +100.
CYC	Juan Yuan, <i>Chhou Jen Chuan</i> (Biographies of Mathematicians and Astronomers), +1799. With continuations by Lo Shih-Lin, Chu Kho-Pao and Huang Chung-Chün. In <i>HCCC</i> , chs. 159ff.
CLPT	Thang Shen-Wei <i>et al.</i> (ed.), <i>Chêng Lei Pên Tshao</i> (Reorganised Pharmacopoeia), ed. of +1249.
CSHK	Yen Kho-Chün (ed.), <i>Chhüan Shang-Ku San-Tai Chhin Han San-Kuo Liu Chhao Wên</i> (Complete Collection of prose literature (including fragments) from remote antiquity through the Chhin and Han Dynasties, the Three Kingdoms, and the Six Dynasties), 1836.
CTPS	Fu Chin-Chhüan (ed.), <i>Chêng Tao Pi Shu Shih Chung</i> (Ten Types of Secret Books on the Verification of the Tao), early 19th cent.
EB	<i>Encyclopaedia Britannica</i> .
HCCC	Yen Chieh (ed.), <i>Huang Chhing Ching Chieh</i> (monographs by Chhing scholars on classical subjects), 1829, contd. 1860.
HCSS	<i>Hsiu Chen Shih Shu</i> (Ten Books on the Regeneration of the Primary Vitalities, physiological alchemy), c. +1250.
HFT	Han Fei, <i>Han Fei Tzu</i> (Book of Master Han Fei), early – 3rd cent.
HHPT	Su Ching <i>et al.</i> (ed.), <i>Hsin Hsiu Pên Tshao</i> (Newly Improved Pharmacopoeia), +659.
HHS	Fan Yeh & Ssuma Piao, <i>Hou Han Shu</i> (History of the Later Han Dynasty), +450.
HNT	Liu An <i>et al.</i> , <i>Huai Nan Tzu</i> (Book of the Prince of Huai-Nan), – 120.
ICK	Taki Mototane, <i>I Chi Khao (Iseki-kô)</i> (Comprehensive Annotated Bibliography of Chinese Medical Literature [Lost or Still Existing]), finished c. 1825, pr. 1831; repr. Tokyo 1933, Shanghai 1936.

xxvi	LIST OF ABBREVIATIONS
ITCM	Wang Khên-Thang & Chu Wên-Chen (ed.), <i>I Thung Chêng Mo Chhüan</i> (Complete Collection of Works on Medicine and Sphygmology), +1601.
K	Karlgren, B. (1), <i>Grammata Serica</i> (dictionary giving the ancient forms and phonetic values of Chinese characters).
KCCY	Chhen Yuan-Lung, <i>Ko Chih Ching Yuan</i> (Mirror of Scientific and Technological Origins), an encyclopaedia of +1735.
KHTT	Chang Yü-Shu (ed.), <i>Khang-Hsi Tzu Tien</i> (Imperial Dictionary of the Khang-Hsi reign-period), +1716.
Kr	Kraus, P., <i>Le Corpus des Écrits Jābiriens (Mémoires de l'Institut d'Égypte</i> , 1943, vol. 44, pp. 1-214).
LPC	Lung Po-Chien (1), <i>Hsien Tshun Pên Tshao Shu Lu</i> (Bibliographical Study of Extant Pharmacopoeias and Treatises on Natural History from all Periods).
LS	Tsêng Tshao (ed.), <i>Lei Shuo</i> (Classified Commonplace-Book), +1136.
MCPT	Shen Kua, <i>Mêng Chhi Pi Than</i> (Dream Pool Essays), +1089.
N	Nanjio, B., <i>A Catalogue of the Chinese Translations of the Buddhist Tripiṭaka</i> , with index by Ross (3).
NCCS	Hsü Kuang-Chhi, <i>Nung Chêng Chhüan Shu</i> (Complete Treatise on Agriculture), +1639.
NCNA	New China News Agency.
PPT/NP	Ko Hung, <i>Pao Phu Tzu (Nei Phien)</i> (Book of the Preservation-of-Solidarity Master; Inner Chapters), c. +320.
PPT/WP	<i>Idem (Wai Phien)</i> , the Outer Chapters.
PTKM	Li Shih-Chen, <i>Pên Tshao Kang Mu</i> (The Great Pharmacopoeia), +1596.
PWYF	Chang Yü-Shu (ed.), <i>Phei Wên Yün Fu</i> (encyclopaedia), +1711.
R	Read, Bernard E. <i>et al.</i> , Indexes, translations and précis of certain chapters of the <i>Pên Tshao Kang Mu</i> of Li Shih-Chen. If the reference is to a plant see Read (1); if to a mammal see Read (2); if to a bird see Read (3); if to a reptile see Read (4 or 5); if to a mollusc see Read (5); if to a fish see Read (6); if to an insect see Read (7).
RBS	<i>Revue Bibliographique de Sinologie</i> .
RP	Read & Pak (1), Index, translation and précis of the mineralogical chapters in the <i>Pên Tshao Kang Mu</i> .
S/	Stein Collection of Tunhuang MSS, British Museum, London, catalogue number.
SC	Ssuma Chhien, <i>Shih Chi</i> (Historical Records), c. -90.
SF	Thao Tsung-I (ed.), <i>Shuo Fu</i> (Florilegium of (Unofficial) Literature), c. +1368.
SHC	<i>Shan Hai Ching</i> (Classic of the Mountains and Rivers), Chou and C/Han.

LIST OF ABBREVIATIONS

xxvii

<i>SIC</i>	Okanishi Tameto, <i>Sung I-Chhien I Chi Khao</i> (Comprehensive Annotated Bibliography of Chinese Medical Literature in and before the Sung Period). Jen-min Wei-shêng, Peking, 1958.
<i>SKCS</i>	<i>Ssu Khu Chhüan Shu</i> (Complete Library of the Four Categories), +1782; here the reference is to the <i>tshung-shu</i> collection printed as a selection from one of the seven imperially commissioned MSS.
<i>SKCS/TMTY</i>	Chi Yün (ed.), <i>Ssu Khu Chhüan Shu Tsung Mu Thi Yao</i> (Analytical Catalogue of the <i>Complete Library of the Four Categories</i>), +1782; the great bibliographical catalogue of the imperial MS. collection ordered by the Chhien-Lung emperor in +1772.
<i>SNPTC</i>	<i>Shen Nung Pên Tshao Ching</i> (Classical Pharmacopoeia of the Heavenly Husbandman), C/Han.
<i>SSIW</i>	Toktaga (Tho-Tho) <i>et al.</i> ; Huang Yü-Chi <i>et al.</i> & Hsü Sung <i>et al.</i> <i>Sung Shih I Wên Chih, Pu, Fu Phien</i> (A Conflation of the Bibliography and Appended Supplementary Bibliographies of the History of the Sung Dynasty). Com. Press, Shanghai, 1957.
<i>STTH</i>	Wang Chhi, <i>San Tshai Thu Hui</i> (Universal Encyclopaedia), +1609.
<i>SYEY</i>	Mei Piao, <i>Shih Yao Erh Ya</i> (The Literary Expositor of Chemical Physic; or, Synonymic Dictionary of Minerals and Drugs), +806.
<i>TCTC</i>	Ssuma Kuang, <i>Tzu Chih Thung Chien</i> (Comprehensive Mirror (of History) for Aid in Government), +1084.
<i>TFYK</i>	Wang Chhin-Jo & Yang I (eds.), <i>Tshê Fu Yuan Kuei</i> (Lessons of the Archives, encyclopaedia), +1013.
<i>TKKW</i>	Sung Ying-Hsing, <i>Thien Kung Khai Wu</i> (The Exploitation of the Works of Nature), +1637.
<i>TMITC</i>	Li Hsien (ed.), <i>Ta Ming I Thung Chih</i> (Comprehensive Geography of the Ming Empire), +1461.
<i>TPHMF</i>	<i>Thai-Phing Hui Min Ho Chi Chü Fang</i> (Standard Formularies of the (Government) Great Peace People's Welfare Pharmacies), +1151.
<i>TPKC</i>	Li Fang (ed.), <i>Thai-Phing Kuang Chi</i> (Copious Records collected in the Thai-Phing reign-period), +978.
<i>TPYL</i>	Li Fang (ed.), <i>Thai-Phing Yü Lan</i> (the Thai-Phing reign-period (Sung) Imperial Encyclopaedia), +983.
<i>TSCC</i>	Chhen Mêng-Lei <i>et al.</i> (ed.), <i>Thu Shu Chi Chhêng</i> (the Imperial Encyclopaedia of +1726). Index by Giles, L. (2). References to 1884 ed. given by chapter (<i>chüan</i>) and page. References to 1934 photolitho reproduction given by <i>tshê</i> (vol.) and page.
<i>TSCCIW</i>	Liu Hsü <i>et al.</i> & Ouyang Hsiu <i>et al.</i> ; <i>Thang Shu Ching Chi I Wên Ho Chih</i> . A conflation of the Bibliographies of the <i>Chiu Thang Shu</i> by Liu Hsü (H/Chin, +945) and the <i>Hsin Thang Shu</i> by Ouyang Hsiu & Sung Chhi (Sung, +1061). Com. Press, Shanghai, 1956.

xxviii	LIST OF ABBREVIATIONS
<i>TSFY</i>	Ku Tsu-Yu, <i>Tu Shih Fang Yü Chi Yao</i> (The Historian's Geographical Companion), begun before +1666, finished before +1692, but not printed till the end of the eighteenth century (1796 to 1821).
<i>TT</i>	Wieger, L. (6), <i>Taoïsme</i> , vol. 1, Bibliographie Générale (catalogue of the works contained in the Taoist Patrology, <i>Tao Tsang</i>).
<i>TTC</i>	<i>Tao Tê Ching</i> (Canon of the Tao and its Virtue).
<i>TTCY</i>	Ho Lung-Hsiang & Phêng Han-Jan (ed.). <i>Tao Tsang Chi Yao</i> (Essentials of the Taoist Patrology), pr. 1906.
<i>TW</i>	Takakusu, J. & Watanabe, K., <i>Tables du Taishō Issaikyō</i> (nouvelle édition (Japonaise) du Canon bouddhique chinoise), Index-catalogue of the Tripiṭaka.
<i>V</i>	Verhaeren, H. (2) (ed.), Catalogue de la Bibliothèque du Pé-T'ang (the Pei Thang Jesuit Library in Peking).
<i>WCTY/CC</i>	Tsêng Kung-Liang (ed.), <i>Wu Ching Tsung Yao (Chhien Chi)</i> , military encyclopaedia, first section, +1044.
<i>YCCC</i>	Chang Chün-Fang (ed.), <i>Yün Chi Chhi Chhien</i> (Seven Bamboo Tablets of the Cloudy Satchel), Taoist collection, +1022.
<i>YHL</i>	Thao Hung-Ching (attrib.), <i>Yao Hsing Lun</i> (Discourse on the Natures and Properties of Drugs).
<i>YHSF</i>	Ma Kuo-Han (ed.), <i>Yü Han Shan Fang Chi I Shu</i> (Jade-Box Mountain Studio collection of (reconstituted and sometimes fragmentary) Lost Books), 1853.

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyric Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)

ACKNOWLEDGEMENTS

LIST OF THOSE WHO HAVE KINDLY READ THROUGH SECTIONS IN DRAFT

The following list, which applies only to Vol. 5, pts 2–5, brings up to date those printed in Vol. 1, pp. 15 ff., Vol. 2, p. xxiii, Vol. 3, pp. xxxix ff., Vol. 4, pt. 1, p. xxi, Vol. 4, pt. 2, p. xli and Vol. 4, pt. 3, pp. xlii ff.

Dr F. R. Allchin (Cambridge)	Apparatus (alcohol).
Dr M. R. Bloch (Beersheba)	Nitre.
Prof. Derk Bodde (Philadelphia)	Introductions.
Dr C. S. F. Burnett (Cambridge)	Comparative (Latin).
Dr Anthony Butler (St Andrews)	Solutions.
Mr J. Charles (Cambridge)	Metallurgical chemistry.
Mr W. T. Chase (Washington, D.C.)	Apparatus.
Prof. A. G. Debus (Chicago)	Modern chemistry (Mao Hua).
The late Prof. A. F. P. Hulsewé (Leiden)	Theories.
Dr Edith Jachimowicz (London)	Comparative (Arabic).
Dr Felix Klein-Franke (London)	Comparative (Arabic).
Mr S. W. K. Morgan (Bristol)	Metallurgy (zinc and brass).
The late Prof. Ladislao Reti (Milan)	Apparatus (alcohol).
Dr Kristofer M. Schipper (Paris)	Theories.
Prof. R. B. Serjeant (Cambridge)	Apparatus (Arabic).
Mr H. J. Sheppard (Warwick)	Introductions, and Comparative (Hellenistic).
Prof. Cyril Stanley Smith (Cambridge, Mass.)	Metallurgy, and Theories.
Mr Robert Somers (New Haven, Conn.)	Theories.
Dr Michel Strickmann (Kyoto)	Theories.
Dr Mikuláš Teich (Cambridge)	Introductions.
Mr H. G. Thurm (Rüdesheim-am-Rhein)	Ardent Water.
Mr R. G. Wasson (Danbury, Conn.)	Introduction (ethno-mycology).
Prof. R. McLachlan Wilson (St Andrews)	Comparative (Gnostic), and Theories.
Dr John Winter (Washington, D.C.)	Apparatus and Lacquer.
Mr James Zimmerman (New Haven, Conn.)	Theories.

Cambridge University Press

978-0-521-08574-8 - Science and Civilisation in China: Chemistry and Chemical Technology: Part V:

Spagyrical Discovery and Invention: Apparatus, Theories and Gifts: Volume 5

Joseph Needham

Frontmatter

[More information](#)
