

**ALEMBIC CLUB REPRINTS - NO. 3;
EXPERIMENTS ON AIR.
PAPERS PUBLISHED IN THE
PHILOSOPHICAL TRANSACTIONS**

Published @ 2017 Trieste Publishing Pty Ltd

ISBN 9780649297573

Alembic Club Reprints - No. 3; Experiments on Air. Papers Published in the Philosophical Transactions by Henry Cavendish

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

HENRY CAVENDISH

**ALEMBIC CLUB REPRINTS - NO. 3;
EXPERIMENTS ON AIR.
PAPERS PUBLISHED IN THE
PHILOSOPHICAL TRANSACTIONS**

Clarendon Club Reprints—No. 3.

EXPERIMENTS ON AIR.

PAPERS PUBLISHED

IN THE

PHILOSOPHICAL TRANSACTIONS

BY

THE HON. HENRY CAVENDISH, F.R.S.

(1784-1785.)

STANFORD LIBRARY

EDINBURGH:

WILLIAM F. CLAY, 18 TEVIOT PLACE.

LONDON:

SIMPKIN, MARSHALL, HAMILTON, KENT & CO. LTD.

1893.

W.

PREFACE.

THE two papers contained in this reprint both appeared in the Philosophical Transactions under the title "Experiments on Air." The first paper, which was published in 1784, contains Cavendish's account of his investigations into the composition of water. This paper is of great historical interest and importance in connection with "the Water Controversy," as the discussion concerning the first discovery of the composition of water was called. For the benefit of students of that controversy it may be mentioned that the two "interpolations" of Cavendish's secretary, Sir Charles Blagden, and the addition made to the paper by Cavendish, after it was read and before it was printed, comprise the paragraph on page 20, beginning "All the foregoing experiments"; the paragraph on page 25, beginning "As Mr. Watt"; and the latter paragraphs of the paper from and including that on page 35, beginning "There are several memoirs of Mr. Lavoisier."

The second paper, which was published in 1785, contains the account of the discovery of the composition of nitric acid.

L. D.

EXPERIMENTS ON AIR.

FIRST PAPER.

Philosophical Transactions, Vol. 74 (for 1784), pp. 119-153.

Read January 15, 1784.

THE following experiments were made principally with a view to find out the cause of the diminution which common air is well known to suffer by all the various ways in which it is phlogisticated, and to discover what becomes of the air thus lost or condensed; and as they seem not only to determine this point, but also to throw great light on the constitution and manner of production of dephlogisticated air, I hope they may be not unworthy the acceptance of this society.

Many gentlemen have supposed that fixed air is either generated or separated from atmospheric air by phlogistication, and that the observed diminution is owing to this cause; my first experiments therefore were made in order to ascertain whether any fixed air is really produced thereby. Now, it must be observed, that as all animal and vegetable substances contain fixed air, and yield it by burning, distillation, or putrefaction, nothing can be concluded from experiments in which the air is phlogisticated by them. The only methods I know, which are not liable to objection, are by the calcination of metals, the burning of sulphur or phosphorus, the mixture of nitrous air, and the explosion of inflammable air. Perhaps it may be supposed, that I ought to add to these the electric spark; but I think it much most likely, that the phlogistication of the air, and production of

fixed air, in this process, is owing to the burning of some inflammable matter in the apparatus. When the spark is taken from a solution of tournsol, the burning of the tournsol may produce this effect; when it is taken from lime-water, the burning of some foulness adhering to the tube, or perhaps of some inflammable matter contained in the lime, may have the same effect; and when quicksilver or metallic knobs are used, the calcination of them may contribute to the phlogistication of the air, though not to the production of fixed air.

There is no reason to think that any fixed air is produced by the first method of phlogistication. Dr. Priestley never found lime-water to become turbid by the calcination of metals over it*: Mr. Lavoisier also found only a very slight and scarce perceptible turbid appearance, without any precipitation, to take place when lime-water was shaken in a glass vessel full of the air in which lead had been calcined; and even this small diminution of transparency in the lime-water might very likely arise, not from fixed air, but only from its being fouled by particles of the calcined metal, which we are told adhered in some places to the glass. This want of turbidity has been attributed to the fixed air uniting to the metallic calx, in preference to the lime; but there is no reason for supposing that the calx contained any fixed air; for I do not know that any one has extracted it from calces prepared in this manner; and though most metallic calces prepared over the fire, or by long exposure to the atmosphere, where they are in contact with fixed air, contain that substance, it by no means follows that they must do so when prepared by methods in which they are not in contact with it.

Dr. Priestley also observed, that quicksilver, fouled by

* Experiments on Air, vol. I. p. 137.

the addition of lead or tin, deposits a powder by agitation and exposure to the air, which consists in great measure of the calx of the imperfect metal. He found too some powder of this kind to contain fixed air* ; but it is by no means clear that this air was produced by the phlogistication of the air in which the quicksilver was shaken ; as the powder was not prepared on purpose, but was procured from quicksilver fouled by having been used in various experiments, and may therefore have contained other impurities besides the metallic calces.

I never heard of any fixed air being produced by the burning of sulphur or phosphorus ; but it has been asserted, and commonly believed, that lime water is rendered cloudy by a mixture of common and nitrous air ; which, if true, would be a convincing proof that on mixing those two substances some fixed air is either generated or separated ; I therefore examined this carefully. Now it must be observed, that as common air usually contains a little fixed air, which is no essential part of it, but is easily separated by lime-water ; and as nitrous air may also contain fixed air, either if the metal from which it is procured be rusty, or if the water of the vessel in which it is caught contain calcareous earth, suspended by fixed air, as most waters do, it is proper first to free both airs from it by previously washing them with lime water †. Now I found, by repeated experi-

* *Exper. in Nat. Phil.* vol. I. p. 144.

† Though fixed air is absorbed in considerable quantity by water, as I shewed in *Phil. Trans.* vol. LVI. yet it is not easy to deprive common air of all the fixed air contained in it by means of water. On shaking a mixture of ten parts of common air, and one of fixed air, with more than an equal bulk of distilled water, not more than half of the fixed air was absorbed, and on transferring the air into fresh distilled water only half the remainder was absorbed, as appeared by the diminution which it still suffered on adding lime water.

ments, that if the lime water was clean, and the two airs were previously washed with that substance, not the least cloud was produced, either immediately on mixing them, or on suffering them to stand upwards of an hour, though it appeared by the thick clouds which were produced in the lime water, by breathing through it after the experiment was finished, that it was more than sufficient to saturate the acid formed by the decomposition of the nitrous air, and consequently that if any fixed air had been produced, it must have become visible. Once indeed I found a small cloud to be formed on the surface, after the mixture had stood a few minutes. In this experiment the lime water was not quite clean; but whether the cloud was owing to this circumstance, or to the air's having not been properly washed, I cannot pretend to say.

Neither does any fixed air seem to be produced by the explosion of the inflammable air obtained from metals, with either common or dephlogisticated air. This I tried by putting a little lime-water into a glass globe fitted with a brass cock, so as to make it air tight, and an apparatus for firing air by electricity. This globe was exhausted by an air-pump, and the two airs, which had been previously washed with lime-water, let in, and suffered to remain some time, to shew whether they would affect the lime-water, and then fired by electricity. The event was, that not the least cloud was produced in the lime-water, when the inflammable air was mixed with common air, and only a very slight one, or rather diminution of transparency, when it was combined with dephlogisticated air. This, however, seemed not to be produced by fixed air; as it appeared instantly after the explosion, and did not increase on standing, and was spread uniformly through the liquor; whereas if it had been owing to fixed air, it would have taken up some short time before it appeared,