ON SOME EARLY FORMS OF ELECTRIC FURNACES.—

No. 1, PEPYS' ELECTRIC FURNACE.

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The broad idea of utilizing the intense heat produced by powerful electric currents traversing conductors of comparatively high resistance, or of the even higher heat of the voltaic arc, for performing such metallurgical operations as require a high and yet readily regulable temperature, is quite old. The comparative ease with which such heat can be obtained in any required space, as well as the powerful chemical affinities of the terminals of a powerful electric source, led, at quite early dates, to the utilization of electric heat for furnaces. These early furnaces either combined electrical heat with heat of ordinary combustion, or employed the electric heat entirely separate from that of any other source.

The numerous ingenious applications that have recently been made of heat of electric origin, may render a brief reference to the early applications of electric heat to a few furnace operations not without general interest.

We therefore propose giving in successive issues of the *JOURNAL* a brief notice of a few of the more interesting of these earlier electric furnaces.

When J. G. Children, F.R.S., was experimenting between 1809, and 1815, with his powerful voltaic batteries, he noticed, in common with other investigators, the intense heat he could readily obtain from electric currents.

At a meeting of the Royal Society of London, held on June 15, 1815, he gave an account of an interesting experiment in which Mr. Pepys established the now well known identity of chemical composition of the diamond and ordinary carbon. Pepys' demonstration of this identity was founded on the fact that a diamond, heated in contact with pure iron, under circumstances where admixture with foreign matters was prevented, converted the iron into steel. Such experiments had previously been made, but the certainty of the exclusion of carbonaceous materials, in the opinion of

many, had not been assured. Pepys therefore arranged the experiment in such a manner as to place such exclusion beyond all peradventure. The apparatus devised for this purpose constitutes one of the earliest electric furnaces.

The following description is taken from Vol. 105 of the *Philosophical Transactions* for 1815, p. 370.

"In the year 1796, M. Clouet converted iron into steel, by cementation with the diamond, with the view of confirming the nature of that substance, and of ascertaining the exact state in which carbon exists in steel. Clouet had previously formed steel by cementation with carbonate of lime. Mr. Mushet repeated this experiment, using instead of the carbonate, caustic lime, and obtained also what he considered to be cast steel: whence he concluded that the carbon necessary to cement the iron into steel had not been furnished as Clouet supposed, by decomposition of the carbonic acid, but that it had found its way from the ignited gas of the furnace to the iron. This result occasioned suspicions of the accuracy of the deductions from the experiment with the diamond: and Mr. Mushet accordingly, at the suggestion of the editor of the *Philosophical Magazine*, repeated the experiment made at the Polytechnic school, *only keeping out the diamond*. The results (for he made several experiments) uniformly gave him good cast steel, whence he concludes that we are still without any satisfactory or conclusive proof of the steelification of iron solely by means of the diamond." * * * * *

"It occurred to Mr. Pepys, that the battery would afford an *experimentum crucis* on the subject: and his ingenuity readily suggested a mode of making it, every way unobjectionable. He bent a wire of pure soft iron, so as to form an angle in the middle, in which part he divided it longitudinally, by a fine saw. In the opening so formed, he placed diamond powder, securing it in its situation by two finer wires, laid above and below it, and kept from shifting, by another small wire, bound firmly and closely around them. All the wires were of pure, soft iron, and the part containing the diamond powder, was enveloped by thin leaves of talc. Thus arranged, the apparatus was placed in the electrical circuit, where it soon became red hot, and was kept so for six minutes. The ignition was so far from intense, that few who witnessed the experiment, expected, I believe, any decided result—On opening the wire,

however, Mr. Pepys found that the whole of the diamond had disappeared: the interior surface of the iron had fused into numerous cavities, notwithstanding the very moderate heat to which it had been exposed; and all that part which had been in contact with the diamond was converted into perfect blistered steel—a portion of it being heated red and plunged into water, became so hard as to resist the file, and to scratch glass.”

As will be seen the above is an excellent description of an electric furnace pure and simple. Bearing in mind the date of the publication it shows very considerable ingenuity.

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THE JAPANESE MAGIC MIRROR.*

The interesting apparatus, familiarly known by this name, is a circular, metallic, hand-mirror, having figures in relief upon its back. The reflecting surface is highly polished, and reflects the face as well apparently as mirrors of silvered glass; but when it is used to reflect the direct rays of a powerful light upon a screen, the reflection shows, with a moderate degree of distinctness, the figures that are at the back of the mirror. It is a popular belief that the cause of this phenomenon is unknown, and that the Japanese metal workers must have exercised a marvellous degree of ingenuity in the production of such a mirror.

Having recently had an opportunity to examine and experiment with one of these mirrors, I observed that it was slightly convex, and that when it was placed several feet from the eye, objects reflected in it appeared irregularly distorted, as if seen through a bad piece of common window glass. The conclusion arrived at was that there were irregularities in the convexity of the mirror quite sufficient to account for the striking irregular reflection of the sun's rays which is observed. It would be sufficient, in order to reproduce the figures at the back of the mirror, to have its face very slightly less convex on those parts, and such a condition may readily have been produced by means incidental to the quick and economical production of a metallic hand mirror.

* The substance of remarks made at the Stated Meeting of the Institute, held November 16, 1885.