ALTHOUGH none of the work done by the eighteenth-century scientists forms a direct link with anaesthesia, yet knowledge of any kind is bound to influence the future. The discovery of gases in the second half of the century was not only of profound consequence to chemistry, but also to medicine and the world. In order to understand how the discovery of anaesthesia is placed in history, it is necessary to know something of the medical and scientific background from which it evolved. In this connection the work of Priestley, Beddoes and Davy is of paramount importance.

Pneumatic medicine—the treatment of disease by the inhalation of gases—arose out of gas (or “pneumatic”) chemistry and foremost in this study was the dissenting minister, Joseph Priestley (1733–1804). Like so many intellectual men of his time, his interests were wide. He concerned himself not only with theology and philosophy, but also with chemistry and physics, and he had his own laboratory. It was through his work on gases that many advances in chemistry were made possible, but he himself was hampered by being a staunch believer in the Phlogiston Theory.*

He discovered both nitrous oxide and oxygen: the first though it supported the flame of a candle yet destroyed animal life; but the second not only rekindled a glowing taper, but caused it to burn with a flame of extraordinary brilliance. Finding that mice lived a long time in it, Priestley (Vol. 2, p. 102) then had the temerity to breathe this gas himself. He fancied that his breast felt “peculiarly light and easy for some time afterwards”, and this experience convinced him of the “superior goodness of this kind of air” (Vol. 2, p. 47). Carbon dioxide (the first gas to be isolated) had been inhaled as a cure for consumption since 1772 and now “dephlogisticated air” (oxygen) was found which, it could be argued, would be of help in reviving flagging spirits and a broken constitution. However, Priestley considered that healthy people should take care not to breathe too much of it because through its strength their lives might be burnt out too fast.

Priestley was in Paris in the autumn of 1774 and communicated his discovery of oxygen to the great French scientist Lavoisier (Priestley, 1774–7). With this knowledge, Lavoisier was able to make sense of the phenomenon of combustion and to demonstrate the fallacies in the old Phlogiston Theory, which had been holding back the progress of chemistry for so long (Lavoisier, 1799). He also did much work on respiration with his assistant Seguin (Grimaux, 1899). The function of the lungs was now much easier to understand and so gradually the idea grew up that by breathing the newly discovered gases (oxygen, nitrous oxide, hydrogen, etc.) pulmonary diseases, and other disorders as well, might be cured.

In 1792, on account of his sympathies with the French Revolution, Thomas Beddoes, a friend of Priestley, withdrew from the conservative atmosphere of Oxford where he had held the Readership in Chemistry since 1778. In the following year he settled in Bristol where he built up a flourishing practice and, always alive to new developments, began to treat many of his patients with “factitious airs” (manufactured gases) from his laboratory. These gases were mixed with large quantities of atmospheric air and breathed out of silk bags or bladders by means of a special mouthpiece. Beddoes soon began to publish accounts of this mode of treatment, also entering into detailed correspondence on the subject with

* Phlogiston was a hypothetical substance with a negative weight, which was supposed to be the combustible principle in all chemical bodies and to be released on burning.
others of the medical profession, and it was not long before he became the acknowledged leader of the new school of "pneumatic medicine". In the next few years pneumatic medicine had become widely known and extremely popular and the use of "factitious airs" even reached the ears of the King himself. Sir William Chambers (Knight of the Polar Star of Sweden) who, as architect to George III, had built diverse temples and the famous pagoda in the gardens of the royal palace at Kew, wrote to Beddoes of his recovery from dropsy by inhaling oxygen. "I was able to pay my respects to his Majesty, who complimented me much on my good looks, and made many inquiries respecting the vital air" (Beddoes and Watts, 1794) but, alas, in less than a year Sir William was dead.

Beddoes had taken James Sadler, "the aeronaut", with him from Oxford as "machinist" for his laboratory, but the apparatus he made for it was unnecessarily complicated (Stock, 1811). Later the famous engineer, James Watt, joined Beddoes and designed the required equipment for making and inhaling the gases (Slatter, 1960a). Watt also designed smaller apparatus which could be purchased by practitioners and the public alike, so that everyone should have the benefit of inhalation therapy.

THE MEDICAL PNEUMATIC INSTITUTION

Three of Beddoes' friends* "conceived that some good might arise from an experimental investigation of those physiological conjectures" which he had published, and planned an Institution to combine both laboratory and clinic. They were also prepared to help him financially. "They agreed to risk with me [Beddoes] the sacrifice of two hundred pounds each", and public subscriptions were canvassed. "Such an Institution should be conducted with a view to the attainment of two objects.—1. To ascertain the affects of these powerful agents in various diseases; and 2. To discover the best method of procuring and applying them."

Bristol, a very important and wealthy city close to the Spa of Clifton, which attracted an unending flow of invalids, seemed therefore an ideal situation in which to start the venture, but although these suggestions were first made "at the close of 1792", funds were slow to accumulate and it was not until the end of the century that money, staff and accommodation were all available. The post of Superintendent of the Pneumatic Institution Beddoes gave to a young man who seemed to possess exceptional ability, whom he had met through mutual friends while on holiday at Penzance, Cornwall, in 1798. As soon as arrangements were settled, the new Superintendent—Humphry Davy—commenced his duties at Bristol.

The Medical Pneumatic Institution, opened in 1799, was at first a great success and patients flocked to its doors, but the vogue of pneumatic medicine was already declining in favour, although Beddoes himself was still enthusiastic about it. He was so sure of the healing powers of the gases that he published accounts of their supposed virtues on very flimsy evidence. Unfortunately he did not make a sufficient distinction between the different kinds of gases or, even less excusably, between the different types and stages of disease, and as so often happens when new medical treatments are introduced, doubt and prejudice also stood in the way of progress, aided by the disappointment of the many who, already incurable but ever hopeful of miracles, in their disillusionment caused others, who might have been helped, to turn away. Little by little the numbers of patients fell. Beddoes' radical politics had aroused adverse public opinion, and, as there was no evidence to support his rash claims for the factitious airs, all reports from the Institution were received with suspicion. Curious happenings suggested charlatanism or, even worse, co-operation with the devil. Beddoes "prevailed on a courageous young lady (Miss —) to breathe out of his pretty green bag, this delightful nitrous oxide. After a few inspirations, to the astonishment of everybody, the young lady dashed out of the house, when, racing down the square, she leapt over a great dog in her way, but being hotly pursued by the fleetest of her friends the fair fugitive, or rather the temporary maniac, was at length overtaken and secured, without further damage" (Cottle, 1837, p. 37). Such scenes did not inspire confidence from an already distrustful public.

* Mr. William Reynolds, and Mr. Joseph Reynolds, of Ketley, and Mr. William Yonge, surgeon of Shifnal, Shropshire.
The reader, however, must not be misled by this amusing anecdote (and by others that are quoted later on) into thinking that the work of the Pneumatic Institution was not seriously concerned with the clinical treatment of disease. This would be very far from the truth. Yet no conclusive proof was gained of the good of pneumatic medicine and Beddoes' spirits became sadly dampened as time went on. He had anticipated that many cures would result from inhaling the new gases and was bitterly disappointed when none resulted. After Davy's departure to the Royal Institution in 1801, Beddoes took less interest in pneumatic medicine, turning his attention instead to the possibilities of preventive medicine. Two years later he opened a new "Institution for the Benefit of the Sick and Drooping Poor", with a clinic right in the slums of Bristol (Stock, 1811, p. 318). Here he was able to bring medical aid to the lower classes, whose welfare had always been of great concern to him.

**NITROUS OXIDE**

While at the Pneumatic Institution, Davy tended perhaps to neglect his clinical duties by spending too much time in the laboratory. Although this practice may have contributed in some measure to the failure of the Institution, yet it was these studies that started Davy along the path to fame and, by another way, led to the discovery of anaesthesia. Beddoes and Watt had equipped their laboratory with all the latest and best apparatus for research into gas chemistry. Here, encouraged by Beddoes, Davy was free to indulge his flair for chemistry, and his first major contribution to the world of science—*Researches... chiefly concerned with Nitrous Oxide* published in 1800—contains details of the work he did at the Institution. In this book Davy describes not only the chemistry of this gas, but also discoveries on its respirability.

Since the work of the Institution lay primarily in the breathing of gases, Davy had conscientiously tried them all on himself. The bookseller and writer, Joseph Cottle (1837) states that "no personal danger restrained him from determining facts, as the data of his reasoning", and his zeal sometimes overstepped the bounds of common sense. "He seemed to act, as if in case of sacrificing one life, he had two or three others, in reserve, on which he could fall back, in case of necessity." Davy was particularly delighted with the "highly pleasurable thrillings" produced by inhaling nitrous oxide. He had at first breathed the gas out of scientific curiosity and was so surprised at the results that he felt the need to repeat the trials under different circumstances to prove its "powers". From these repeated inhalations one physiological result soon became clearly obvious; that nitrous oxide can cause addiction.

"Between May and July, I habitually breathed the gas, occasionally three or four times a day for a week together; at other periods, four or five times a week." (ibid., p. 493). Nor was he the only one to be thus affected for, from their accounts, the other members of the staff and his friends all breathed nitrous oxide on a good many occasions, a few of them even attaining Davy's addicted state. "The desire of some individuals acquainted with the pleasures of nitrous oxide for the gas has been often so strong as to induce them to breathe with eagerness, the air remaining in the bags after the respiration of others" (ibid., p. 556).

Beddoes (quoted Cottle, 1837, p. 37) "was desirous of collecting the testimony of others, for which purpose he persuaded several of his friends to breathe this innocent, but exhilarating nitrous oxide" and to record their experiences. "Many of the individuals breathed the gas from pure curiosity. Others with a disbelief of its powers" (Davy, 1800, p. 533 et seq.). This plan commenced as a scientific study with the control measure of giving to some, without their knowledge, a bag of common air to breathe instead, "to ascertain the influence of imagination". But these laudable trials soon degenerated into mere sport with the additional joke of the common air bag being played on the sceptics. Mr. M. M. Coates said: "When I sat down to breathe the gas, I believed that it owed much of its effect to the predisposing agency of the imagination, and had no expectation of its sensible influence on myself. Having ignorantly breathed a bag of
common air without any effect, my doubts then arose to positive unbelief.” However, on breathing nitrous oxide, this rather pompous-sounding gentleman goes on to say: “After a few seconds, I felt an immoderate flow of spirits, and an irresistible propensity to violent laughter and dancing, which, being fully conscious of the violence of my feelings, and of their irrational exhibition, I made great but ineffectual efforts to restrain; this was my state for several minutes. During the rest of the day I experienced a degree of hilarity altogether new to me. For six or seven days afterwards, I seemed to feel most exquisitely at every nerve, and was much indisposed to my sedentary pursuits” (Davy, 1800, p. 531); such an exhibition must have appealed strongly to Davy’s boyish sense of fun.

Cottle (1837) related that “The Pneumatic institution, at this time, from the laughable and diversified effects produced by this new gas on different individuals, quite excited philosophical gravity, and converted the laboratory into the region of hilarity and relaxation”. The reader may be amused by further extracts from the testimonies of some of Beddoes’ and Davy’s friends, many of whom were famous men.

Detail of Mr. J. W. Tobin, who “experienced sometimes sublime emotions with tranquil gestures, sometimes violent muscular action, with sensations indescribably exquisite” (quoted Nicholson’s J., 1800). “I threw myself into several theatrical attitudes, and traversed the laboratory with a quick step; my mind was elevated to a most sublime height.

Letter from Dr. Peter Roget: “I seemed to lose the sense of my own weight, and imagined I was sinking into the ground. . . . My ideas succeeded one another with extreme rapidity, thoughts rushed like a torrent through my mind, as if their velocity had been suddenly accelerated by the bursting of a barrier which had before retained them in their natural and equable course” (Davy, 1800, p. 509).

Detail of Mr. S. T. Coleridge: “I could not avoid, nor indeed felt any wish to avoid, beating the ground with my feet; and after the mouth-piece was removed, I remained for a few seconds motionless, in great exctasy” (ibid., p. 517).

Detail of Mr. Wedgwood: “I became as it were entranced, when I threw the bag from me and kept breathing on furiously with an open mouth and holding my nose with my left hand, having no power to take it away though aware of the ridiculousness of my situation. . . . I had a very strong inclination to make odd antic motions with my hands and feet. When the first strong sensations wore off, I felt as if I was lighter than the atmosphere, and as if I was going to mount to the top of the room” (Davy, 1800, p. 519).

Detail of Mr. Lovell Edgworth: “I . . . felt a strong propensity to laugh, and did burst into a violent fit of laughter, and capered about the room without having the power of restraining myself” (Davy 1800, p. 527).

Patrick Dwyer had “always exhibited a ludicrous struggle between a propensity to laugh, undoubtedly produced by the air, and an eager desire to continue the inhalation” (quoted Nicholson’s J., 1800).

Mr. George Burnet “had never heard of the effects of the nitrous oxide” but after inhaling six quarts of it felt “a delicious tremor of nerve, which was rapidly propagated over the whole nervous system” until he all but “fainted in extacy”. This was succeeded by a state “uncommonly serene and tranquil. Every nerve being gently agitated with a lively enjoyment”, and for the rest of the day he experienced “a flow of spirits not merely cheerful, but unusually joyous” (Davy, 1800, p. 520).

Mr. Robert Southey “has since poetically remarked, that he supposes the atmosphere of the highest of all possible heavens to be composed of this gas” (quoted Nicholson’s J., 1800).

Beddoes himself said: “Immediately afterwards I have often caught myself walking with a hurried step and busy in soliloquy. The condition of general sensation being as while hearing cheerful music, or after good news, or a moderate quantity of wine” (Davy, 1800, p. 544); and Davy “Sometimes I manifested my pleasure by stamping or laughing only; at other times, by dancing round the room and vociferating” (Davy, 1800, p. 461)*. It is of small wonder, therefore, that the public looked askance at the “work” of the Institution.

But Davy and Beddoes were both hard workers, and it must not be thought that no serious observations were made. Davy had been apprenticed to a doctor before moving to the Pneumatic Institution and had planned a medical career. He breathed the various gases made in the laboratory on different occasions to see if they had any effect on the digestion, capacity for work, ability to sleep, etc. With regard to nitrous oxide he records that the pain of the wisdom tooth he was just then cutting was “always diminished after the first four or five inspirations . . . and uneasiness . . . swallowed up in pleasure”; headaches were either “wholly removed” or at least eased. Often he lost consciousness for a few moments (Researches, p. 465). Among his conclusions Davy made the now famous observation, “As nitrous

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* Beddoes (1760–1808) and Davy (1778–1829) both died in middle life and the quantity and variety of gases they tried out on themselves may well have contributed to their early demise.
oxide in its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place” (loc. cit., p. 556). In the light of subsequent knowledge, he appears to have been on the threshold of anaesthetic discovery. But, on reflection, it is obvious that Davy was not the one to make it, as his thoughts were so much concerned with chemistry and science. Why others should not have perceived and followed up these hints is less understandable. Yet Davy had not stressed them in any way and the majority of doctors of that period would not have been sufficiently mentally prepared to notice and act on these implications, for Georgian England was still basically a harsh and brutal age in which pain was of very little moment.

After his appointment as Assistant Lecturer in Chemistry at the newly formed Royal Institution in London, Davy seems to have settled down to serious work, but his pranks with nitrous oxide were not forgotten. He had demonstrated the effects of inhaling the gas in one of his lectures and other chemists followed suit. So began the era of “frolics” both private and public; demonstrations with the “laughing gas” drew crowded audiences in much the same way as hypnotism on the stage filled the theatres a few years ago. Curiously enough in the years immediately preceding the birth of anaesthesia, hypnotism had been tried with some success for performing painless operations.

The inhalation of “factitious airs” as a general means of curing disease seemed to die out gradually with the passing of the eighteenth century. William Wright (1829) surgeon-aurist to Queen Charlotte, used carbonic acid gas (carbon dioxide) in his practice—directing a stream of it into an ulcerated ear—as he knew of its pain-killing and sweetening properties (Slatter, 1960b). He also gave his patients ether to inhale as a sedative, finding it particularly useful to allay the pain attendant on the examination of a sensitive ear. Wright had started his career in Bristol, the centre of pneumatic medicine, and clearly knew of the work done there with “factitious airs”. His remarks on this subject were very shrewd: “Such has been the quackery relative to the administration of aerial fluids, that it has disgusted most of the medical profession and caused agents that are probably very useful, under proper modifications, to be abandoned.”

None the less it was through Beddoes’ fanatical enthusiasm for “factitious airs” and Davy’s zest for nitrous oxide that the great blessing of anaesthesia ultimately came into being. Thomas Beddoes, however, the “great Empiric of Bristol” (“Amicus”, 1809), died in 1808 only forty-eight years old, a sad and disappointed man and, in his own opinion, a failure. Had he lived to a ripe old age he would have seen that not only were several of the “factitious airs” of real value in medicine, but that two of them possessed an outstanding quality, a power that had been searched for in vain for centuries and that would revolutionize the medical and surgical world. Beddoes was a humanitarian and it would have rejoiced his heart had he lived to see the advent of anaesthesia.

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