



The Liquefaction of Nitrous Oxide Gas By Rufus Ross*

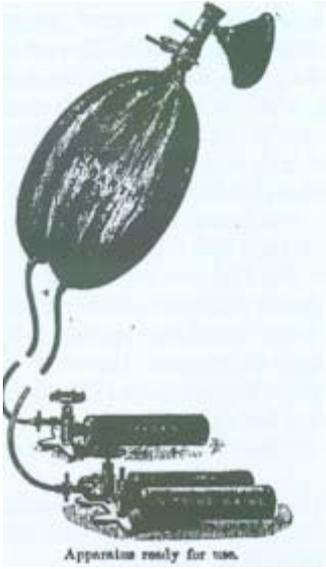
According to Archer, (1) the first suggestion to compress nitrous oxide to a liquid form so that it might be transported and stored appeared in an article in the *British Medical Journal* of 1868. But there is a considerable amount of evidence to suggest that the process was discovered much earlier. Like many discoveries, there are many claimants and confusing reports to muddy the waters, but Michael Faraday appears to have a good claim to have been the first to describe the method he used in the process. Faraday (1791-1867) is quoted in an article in the *British Journal of Anaesthesia* (2) as having liquefied several gases including nitrous oxide in 1823. This is considerably before nitrous oxide was re-introduced to Great Britain as an anaesthetic by Dr Evans of Paris. According to an article in the *British Medical Journal* of 1868, (3)

"...Dr Evans administered the gas in a liquid state to several patients at the Dental Hospital, Soho Square, [London] ... he had brought the gas in this state in a bronze bottle, a suitable valve being attached by means of which the required quantity of gas was allowed to escape into an ordinary bag."

In 1872, the Johnston Brothers were producing nitrous oxide in bottles, but again there is an earlier report that George Barth was producing gases in liquid form in 1856. His signature is to be found in an anonymous booklet, *Pneuma Therapeia* published by the Medical Pneumatic Company, Piccadilly. (4) The booklet advertises oxygen and other gases compressed in wrought iron bottles. Yet another report is to be found in the *British Journal of Dental Science* that Barth was supplying bottles of liquefied gas in 1853.(5)

Michael Faraday's description of his method of liquefaction implied that because of the pressures involved the gas had to be stored in a suitable, strengthened container. *The British Journal of Anaesthetics* (6) quotes his method described in a paper published in the *British Journal of Dental Science* in which Faraday thought that the pressure of the vapour produced was in the order of 50 atmospheres at 45 degrees F. Before the process of liquefaction was discovered, the gas had to be made in the surgery using apparatus that was primitive and unreliable. One of the drawbacks was that it could only be stored for a short time as there was no means of preserving it, consequently, fresh gas had to be made continuously.

The S.S. White Company of Philadelphia had brought out a model in 1876 but this had several drawbacks and in 1881 the same company began supplying the liquid form in cylinders that accelerated the use of nitrous oxide as an acceptable and practical anaesthetic. In their catalogue published in 1892, C Ash and Son announced a "Reduction in Prices" for Nitrous Oxide gas "bottles", apparently the word "cylinder" was not in use. The two main manufacturers were Clarkson and Coxeter, whose prices were very similar; the latter's price for a steel or iron bottle containing 50 gallons of the gas was priced at 3 1s 6d, whilst refilling the bottle would cost 5s 6d. Clarkson's gas was cheaper at 3 1s and 5s .for refills. Separate keys for the bottles could be purchased for 2s in plain steel or 3s 6d for nickel- plated. Oxygen was slightly dearer costing 37s for 30 gallons, refilling the bottle cost 2d per gallon.



The apparatus, described as portable, consisted of a face-piece, regulating stopcock and two India-rubber bags with tubing - one bag for oxygen the other for nitrous oxide. The illustration shows two nitrous oxide bottles joined to provide for an uninterrupted supply when one bottle emptied. The bottles were joined by a tube known as an "union" which was purchased separately as were the foot pedals used to regulate the supply of the gases. The writer has personal experience of finding a similar, foot operated apparatus in 1950 whilst serving in the Royal Air Force but cannot recall ever having used it.

The catalogue contains a note on the advantages of using a mixture of oxygen and nitrous oxide:

1. That the natural colour of the features is preserved.
2. That the so-called "stertor" and "jaccitation" of ordinary nitrous oxide administration are prevented.
3. That a longer period of anaesthesia results than with nitrous oxide alone - the average duration is 44 seconds.
4. That, so far as present experience has gone, the mixture is absolutely free from risk to life, the presence of oxygen preventing the asphyxial phenomena which in the case of nitrous oxide alone, have sometimes led to alarming symptoms.⁷

It is often not appreciated just how much the development of dentistry owes to the manufacturers and suppliers of dental equipment. Every discovery and advance required the use of suitable instruments and apparatus and the liquefaction of nitrous oxide is just one example of the skill and inventiveness displayed by scientists, chemists, engineers and allied craftsmen.

*Rufus Ross LDS, BA, PhD, retired dental practitioner and historian, Glasgow

- (1) Archer Harry W. "Historical Sketch of Anaesthesia", in *History of Dentistry*, p332, 2nd Ed. Lufkin Arthur Ward, Lea & Febiger London 1948
- (2) Br J Anaesth. 1967;**39**:351-381
- (3) Br. Med J, 1868;**2**:10
- (4) Br. J. Anaes. 1954: **26**: 40
- (5) Br. J. Dent. Sct. "Miscellanea. Barth's portable protoxide of nitrogen" 1868a;**11**: 394.
- (6) Br. J. Anaes. 1967;**39**:351-381
- (7) C Ash, Catalogue, 1893, p.447