ON

NITROUS OXIDE GAS,

AND

ITS USE AS AN ANÆSTHETIC.

BY

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ON NITROUS OXIDE GAS.

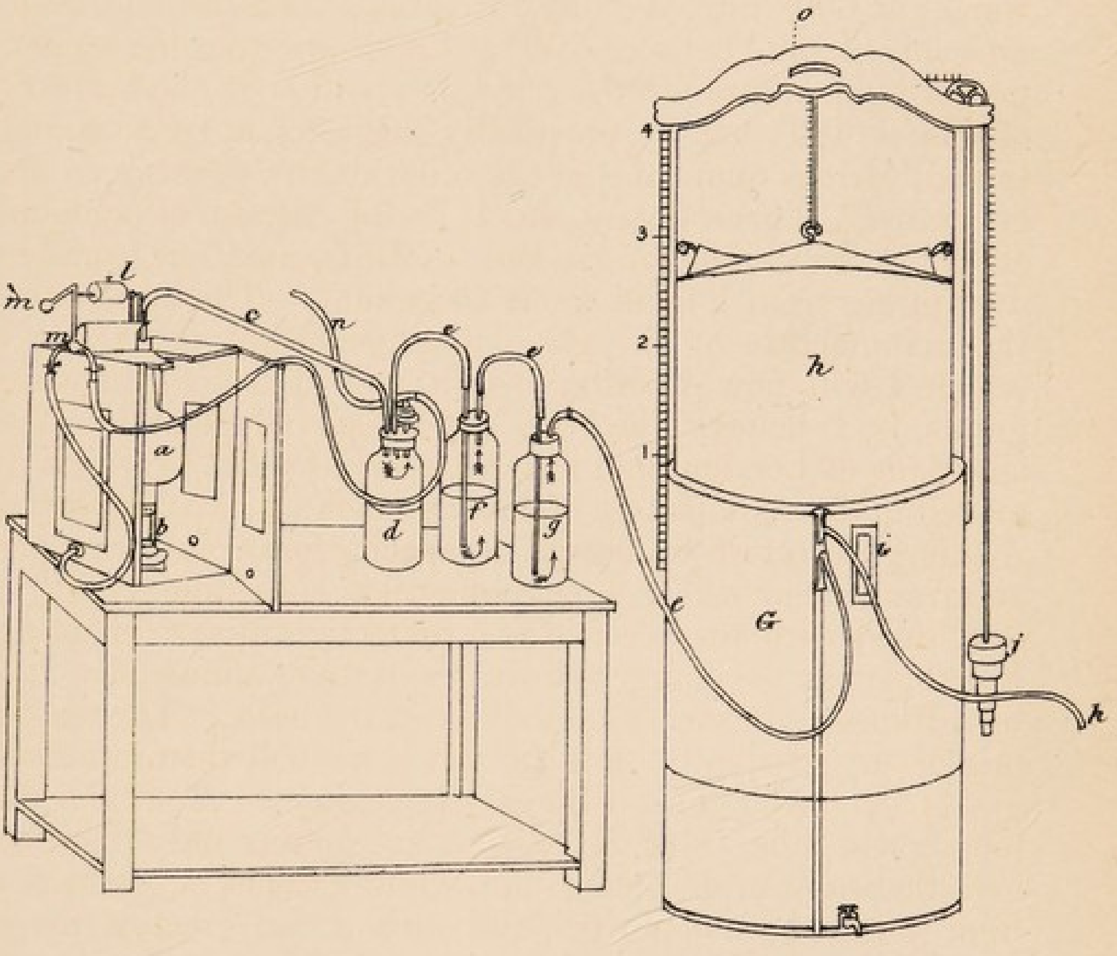
In 1776, or nearly one hundred years ago, Dr Priestley, by exposing nitric oxide to moistened iron filings, discovered a gas having distinct chemical properties of its own, and which he named dephlogisticated nitrous air. Twenty-four years later, in 1800, Sir Humphry (then Mr) Davy, first prepared this gas in a state of purity, gave it the name nitrous oxide, by which it is now known, and investigated its properties. He breathed it himself (without, however, taking the precautions which are now considered to be absolutely necessary against the admission of air), and graphically described his sensations of pleasurable excitement. Among his remarks, the following remarkable passage occurs—" As nitrous oxide in its extensive operation seems capable of destroying pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place." In 1844, Horace Wells, dentist, of Hartford, Connecticut, at a lecture by Dr Colton, observed that a person who had inhaled laughing gas did not seem to feel pain when he struck himself against the benches. Next day Wells inhaled the gas, and had a tooth extracted without pain. Wells died soon afterwards, before he was able to introduce his discovery into practice. Morton, his partner, discovered the anæs thetic properties of ether, and thus became the father of modern anæsthesia. For seventeen years after the death of Wells, the gas as an anæsthetic was forgotten, until Dr Colton, having improved the apparatus for administration, succeeding in re-introducing it in 1863. Its use spread rapidly in America. The successful introduction of it in this country dates from March 1868, when Dr Evans of Paris publicly administered it at the Dental Hospital of London, and at the Central Ophthalmic Hospital. In June of the same year, Dr Colton himself visited London, and gave demonstrations of the use of the gas; he brought with him a scroll containing the signatures of 19,108 patients, who certified that their teeth had been extracted without pain by the use of the nitrous oxide gas. These two gentlemen succeeded in procuring for it a fair trial and a careful investigation of its properties. It excited much attention among the dental profession, and among those who have devoted themselves to the administration of anæsthetics as a specialty; and soon improvements were made in the apparatus for making and administering the gas, and also in its storage by compressing it, and latterly by reducing it to the liquid form: notably by Mr Clover, Mr Coleman, and Mr Fox, and among manufacturers, by Mr Barth and by Messrs Coxeter and Son. Its position as an anæsthetic is now thoroughly well established, and its use rapidly extending.

The gas is prepared by decomposing nitrate of ammonia with heat; at a temperature of 320° F. it melts; between 340° and 480° it decomposes rapidly into two equivalents of nitrous oxide and four of water; at 600° nitrous oxide, nitric oxide, nitrous acid, and nitrogen are evolved; and between 700° and 800° an explosion occurs. So the proper temperature for the rapid production of the largest quantity of gas is 480°, but as practically this cannot be accurately maintained, various quantities of the other oxides of nitrogen are always generated. Theoretically, in 1 lb. of nitrate of ammonia there should be 28 gallons of gas and 5 oz. of water, but usually the product of gas from 1 lb. is about 25 gallons. The apparatus used for the manufacture of the gas varies somewhat in detail; but that which I will now describe to you, and of which I show you diagrams, is, I believe, the best. It is that supplied by Messrs Ash and Sons of London, and has been used by Mr Warwick Hele and myself in the manufacture of the gas which we have employed (fig. 1). A thin glass retort (*a*), having a capacity for 60 oz., is suspended, by an arrangement which I shall mention subsequently, in a wooden box, lined with tin to serve as a protection in case of an explosion. For this flask the charge is 2 lb. of nitrate of ammonia. It is heated by a Bunsen's burner (*b*) placed under the flask. The temperature is raised very gradually until the salt is melted, then rapidly until the gas is evolved. This (the gas) is conducted from the flask by a long glass tube (*c*) to jar *d*, which contains only distilled water; here the water of decomposition, which escapes in the form of steam from the flask, is deposited, and with it the greatest proportion of any free acid which may come over. The gas next passes into jar *f*. This contains a solution of protosulphate of iron, one part in ten of water, with a little free sulphuric acid. The tube which conducts the gas into this flask descends nearly to its bottom, the exit tube not much lower than its cork; thus the gas is obliged to pass through the whole depth of the solution, and is thoroughly washed by it—its function is, that any nitric oxide will yield up to it one equivalent of oxygen, becoming nitrous oxide, sesquioxide of iron being precipitated. Jar *g* has a similar arrangement of the tubes, and it contains a solution of potash; this enters into combination with any acid vapours which may not have been condensed in jar *d*, and the pure gas then passes onwards directly into the gasometer. To the apparatus are attached two pieces of mechanism, one of which automatically regulates the heat

FIG. I.

APPARATUS FOR MAKING AND STORING NITROUS OXIDE GAS.

SCALE 1/30.

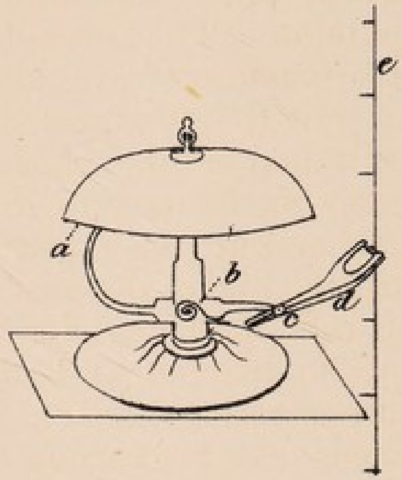


a. Flask in which Nitrate of Ammonia is heated.
b. Bunsen's Burner.
c. Glass Tube.
d. Distilled Water Jar.
e. India Rubber Tube.
f. Solution of Sulphate of Iron Jar.
g. Solution of Potash Jar.
G. Cistern of the Gasometer.
h. Bell of Gasometer.
i. Water Gauge.
j. Counter Weights.
k. Tube going to Face-piece.
l. Counter Weight to Flask.
m.m. Bent Lever & Stop-cock of Gas-pipe.
n. Pipe for supply of Coal Gas.
o. Position of Indicating Bell (Fig. 2.)

FIG 2.

MR WARWICK HELE'S INDICATING BELL.

SCALE 1/4.

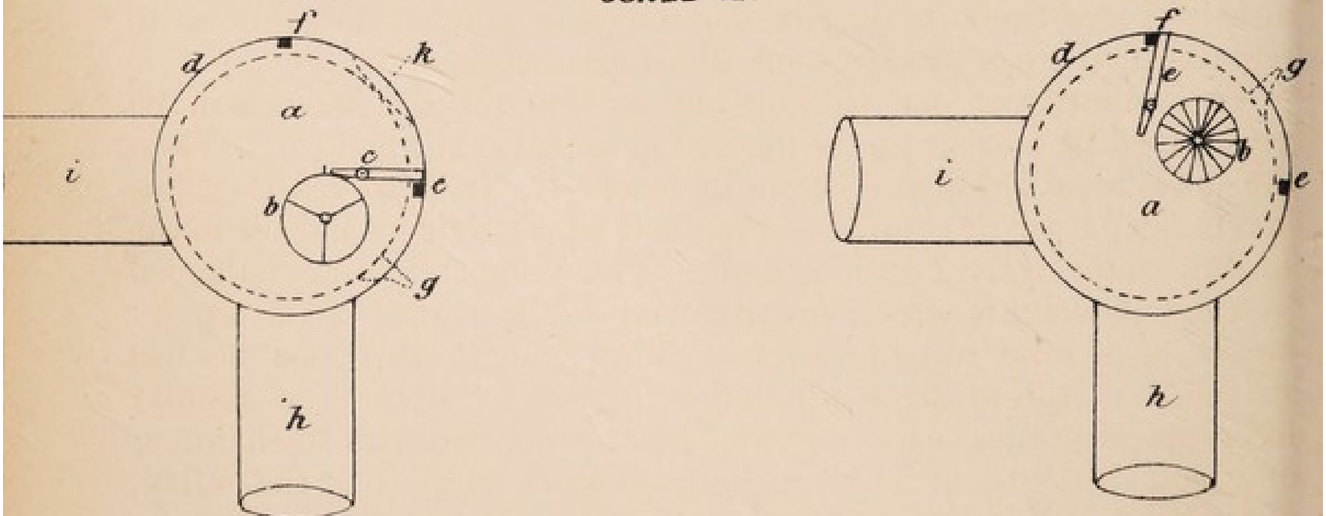


a. Hammer which strikes the bell.
b. Spring which keeps hammer nearly in contact with bell.
c. Joint.
d. Lever which exactly conterbalances spring.
e. Strap with projecting pins. (Fig. 1. j. o. h.)

FIG. 3.

DIAGRAMS
shewing action of
MR WARWICK HELE'S TIME-INDICATOR.

No 1. SCALE 1/2. No 2.



a. Watch.
b. Balance Wheel.
c. Lever.
d. Case in which the Watch revolves.
e. Pin No 1.
f. Pin No 2.
g. Handle of Two-way Stop-cock.
h. Tube for entrance of Gas.
i. Tube which joins the face-piece.
k. Position of Air-hole.

by influencing the supply of gas to the Bunsen's burner, and the other at a certain point shuts off the coal-gas altogether and stops the operation. For the former purpose, into the lid of jar *d* is inserted a brass bell divided completely into two compartments by a thin indiarubber diaphragm. The lower of these communicates with the jar, and when the pressure of nitrous oxide coming over is great, the diaphragm is raised into a sort of dome; when this occurs, it impinges against a double tube which dips down into the upper cavity. The coal-gas on its way to the burner must pass down one side of this tube and up the other, and the end of the tube being above the centre, the higher the diaphragm rises the more will it be closed; and thus if the pressure of nitrous oxide increases unduly, the coal-gas supply to the burner is diminished, the heat falls, and consequently the operation goes on less quickly, so that an equilibrium is maintained. As to shutting off the coal-gas, and finally stopping the operation, this is managed by having on a portion of its pipe which is fixed to the box enclosing the flask a stop-cock (*m*), with one of the arms of its handle produced into a long lever bent and weighted at the end (*m'*), so that if left to itself it drops down and turns the stop-cock and keeps the pipe closed; but during the manufacture of the gas it is supported by one arm of a balance, from the opposite arm of which is suspended the generating flask. This is so arranged that the flask end remains the heavier until its contents are reduced below 6 oz.; when this occurs, the distal arm, which carries a sliding counterbalancing weight (*l*), becomes the heavier and drops down, thus raises the flask from the lamp, and at the same time liberates the lever of the stop-cock, which falls, the coal-gas is shut off, and the operation stopped.

The nitrous oxide is kept in a gasometer over water. As this absorbs nearly its own volume of gas, the first time it is used a very great loss occurs, and afterwards, as the water slowly gives off the dissolved gas from its surface and more is taken into solution to replace it, there is always some diminution in keeping.

The quantity of gas passing out or into the gasometer can be ascertained by measuring the descent or ascent of the bell (*h*). When the gas is breathed directly from its reservoir, Mr Warwick Hele has invented and put in operation a method which renders audible to the administrator every 2 gallons used. The gasometer bell is balanced by counter-weights which are attached to the centre of its top by means of a rope running over a pulley; along this rope he has stretched a leather strap which has projecting from it at regular intervals pins; these catch a jointed lever connected with the hammer of a hand-bell (fig. 2) fixed in the framework supporting the pulley, so that this bell strikes every time a pin passes from the end of the lever, *i. e.*, every time 2 gallons pass into or from the gasholder. When the gasometer is being filled, the fall of the lever (*d*) when released from a pin causes sufficient jerk to make the hammer strike the bell. When the gasholder is being emptied, *d* is depressed, and carries *a* from the bell until *d* is released from a pin, when *a* strikes the bell.

The apparatus which we have used for the administration of the gas is the invention of Mr Clover of London, and is a modification of that employed by him for the administration of chloroform. There is first the face-piece made of thin sheet lead; this covers both the nose and mouth, these being protected from injury by an india-rubber air cushion which is placed on the edge of the lead. The face-piece has the general shape of a truncated cone, the base being applied to the face. In the truncated apex are placed two valves, an inspiring and an expiring one. The latter allows the products of expiration to escape into the air. The former has attached to it the tube which brings the supply of gas. This tube and the face-piece have interposed between them a two-wayed stop-cock which allows the patient to breathe air whilst the apparatus is being fitted to the face, but when the inhalation is commenced shuts out all air, and the patient only breathes the pure nitrous oxide. To the lower part of the face-piece is fixed an indianette bag which holds about 200 inches, and is provided with a stop-cock; it is called the supplemental bag, and its use is, that when the patient has breathed the pure gas for twenty seconds or so, it is opened and the next expiration fills it; the patient is then allowed to rebreathe this gas for four or five respirations, after which the bag is compressed, the lungs are again filled with pure gas, which is then breathed into the bag, and the process repeated as above. It both saves gas, and when respiration is panting gives it up more readily than when it is drawn directly from the reservoir at each inspiration through a long tube. With this apparatus the gas may either be breathed directly from the gasometer or from an impermeable bag for the purpose, which should not hold less than 7 or 8 gallons. In Mr Warwick Hele's operating-room, we give it in the former manner, a pipe being laid under the floor to the operating-chair; sufficient pressure to drive the gas over is procured by removing some of the counter-weights. For the purpose of accurately registering the time occupied by each administration, this gentleman has an arrangement connected with a watch (fig. 3), which sets it going when the gas is turned on and stops it when the administration is over. To that part of the two-wayed cock which revolves the watch is fixed, and it has projecting from its side the end of the long arm of a lever; the end of the short arm of this lever is nearly in contact with the balance wheel. In the immovable portion of the stop-cock which encloses the movable are fixed two pins at the distance from each other of $\frac{1}{4}$ of a circle, and against either of these the free end of the lever strikes according to the way the tap is turned, so that when the air-hole is open the inner end of the lever is thrown close to the balance-wheel, comes in contact with a pin projecting from its circumference, and stops it. When the gas is allowed to come over, the short end of the lever is carried clear of the wheel, and the watch starts at once. The hour hand and its train of wheels is removed. No. 1 of fig. 3 shows the air-hole open, the free end of the lever in contact with pin No. 1, the opposite end pressed close to the balance-wheel, and the watch stopped. No. 2 shows the air-hole closed, gas tube open, the free end of the lever in contact with pin No. 2, the opposite end carried off from the balance-wheel, and the watch in motion. The watch was made by Mr Storbeck, watchmaker, Carlisle.

Nitrous oxide is a colourless gas having a very faint odour and a slightly sweetish taste. Its specific gravity is 1·525. It supports combustion, but in a minor degree to pure oxygen. The test of its purity is that a match lighted and then blown out should have the red ember brilliantly re-ignited on being plunged into it. The phenomena usually observed in the human subject when the gas is inhaled, are as follows: when it has been inspired two or three times there is an increase in the force and frequency of the pulse. In about twenty seconds, if the breathing has been steady and regular to begin with, it is also noticed to increase in frequency. This, however, from the commencement is often irregular, shallow, and rapid, from the nervous condition of the patient. In about thirty seconds the patient's colour begins to turn livid. When the gas has been continued for about one minute the pulse is almost invariably noticed to fall in force and frequency, the breathing is often laboured, sometimes stertorous, though I have several times seen cases where it became feebler until the expiring valve was hardly raised; it was then either the case that the patient was completely anæsthetized, or, if not, the breathing commenced to improve in character. In the majority of cases, in one minute and twenty seconds the patient is over. This is known by different signs,—the one which is least open to mistake is a sudden change in the patient's appearance, which is difficult to describe, but readily recognised; another is a nervous twitching of the hands. It is not by any means necessary to carry the administration the length of this in every case, but when it is present for a few seconds the patient is quite insensible. In one case to which I gave the gas, this muscular twitching affected the whole body, resembling almost an epileptic convulsion; the patient was quite unconscious. The same dependence cannot be placed on the insensibility of the conjunctiva to touch as in chloroform cases. For from reflex action patients will close the eye on having it touched when they are quite insensible to pain, and, on the other hand, they will keep the eye steadily open sometimes when not unconscious. As in one of my early cases, where a patient complained that he felt the whole operation, I told him I could not understand how that came about, for when I touched his eye he gave no signs of feeling it. "Oh," he irreverently replied, "I felt you touch the eye, but I kept it open as I only thought it was part of the performance." It occasionally happens about the period of the removal of the face-piece that the pulse intermits a beat or two, and I have repeatedly seen the breathing stop, during a period equal to four or five respirations, at the time when the operation was commenced. It is very curious, and a fact which I have not seen noted by others, that the hearing remains acute frequently after the other senses are in abeyance; thus patients are able to repeat remarks made in their presence after they are apparently unconscious, and one young lady was able to repeat a hasty remark made by the operator, Mr Warwick Hele, when a tooth broke under the forceps, although she did not feel its subsequent removal, and the observation was made in so low a voice that I did not catch what it was, though I was standing beside him. There often exists considerable muscular rigidity during the later stages of the administration; so in dental cases, before the apparatus is placed on the face a plug is fixed on the teeth to keep the mouth open, as some difficulty might be experienced in effecting this afterwards, and much valuable time be lost. These plugs are made of vulcanite, with the faces so cut as to catch on the cusps or between the teeth. I have administered the gas myself upwards of forty times, I cannot tell you exactly how often, for of my earlier cases I have kept no record: all the cases have been for the extraction of teeth or fangs. Since we used the time indicator mentioned above, Mr Warwick Hele and myself have carefully registered the cases. They amount to thirty-seven; in seventeen of these he gave the gas, in the rest I gave it. The time taken to produce insensibility was as follows:—

Up to 1 m.	inclusive,	9
„ 1 m. 20 sec.	„	17
„ 1 m. 40 sec.	„	5
„ 2 m. 0 sec.	„	5
„ 2 m. 20 sec.	„	1

The shortest time was forty-five seconds; the longest, two minutes thirteen seconds. The greatest amount of work done has been four extractions of teeth or fangs, which has happened in several cases.[1] It has never happened in my experience that a patient was restless or excited while the gas was being given; in a few cases with children it has been necessary to hold the hands to prevent them catching the apparatus, but there is never anything resembling the struggling so common during the excited stage of chloroform. Recovery is usually rapid and complete, the patient waking up as from a sleep. But it does sometimes happen, usually in young ladies between the ages of fourteen and twenty, that there is an intermediate stage between that of complete unconsciousness and recovery, when some excitement is exhibited, such as tossing about restlessly in the chair and weeping, they, on recovery, being generally very

[1] The largest amount of gas breathed at a single administration has been six gallons; the smallest, two and a half gallons; the average quantity of all the thirty-seven cases is three and a half gallons.

much surprised to find themselves so doing. Out of the abovementioned cases we have noted seven to have been affected in this manner in a greater or less degree, three complained of slight giddiness or faintness, and one was a little sick. One patient, a boy, urinated, his father having declined to indulge his expressed wish to do it before the operation. In several cases the removal of teeth was felt, but unattended with pain. The longest period during which we have noted a patient to be insensible is one minute. The patient is always seated in the upright position, this being found not only to be the most convenient for the operator, but the safest for the patient, as it obviates the risk of the tongue falling back on the epiglottis, and the saliva flowing into the throat, which is apt to happen if the patient lies on the back.

It is a point of great practical importance not only to keep the room perfectly quiet during the administration, but also to leave the patients undisturbed until they thoroughly awake. From a neglect of this precaution, I believe, resulted the only case of considerable excitement that I have seen. It was my second case, and the patient during recovery exhibited all the symptoms described as attending the exhibition of the nitrous oxide as laughing gas, *i. e.*, mixed with some air. In regard to the sensations experienced by patients, the majority are able only to say that they have been unconscious, some that they have been asleep and dreaming, the dreams being often pleasant, sometimes more like nightmare; and, lastly, some complain that they have had considerable annoyance from rushing or singing noises in the head. One little girl was immensely pleased with it; she said that "she felt as if she was being tickled all over." Unconscious reflex screaming is not uncommon with children during the operation; but it does not seem to be connected with any particular form of dreaming. I have not been in the habit of ordering a stimulant before the gas is taken, as is commonly done with chloroform. In the only instance in which I sanctioned such a procedure, the patient, a young, strong, but very nervous man, took one glass of undiluted brandy, and he suffered from headache for the rest of the day, which I thought might probably be due to the brandy, as I have never seen this sequent before or since in the same class of patient.

What is the physiology of the action of the gas? Sir Humphry Davy's researches led him to conclude that when breathed, and also when exposed to blood, a great part of it is absorbed, and that the residual gas is principally nitrogen. He believed, however, that the gas was not decomposed, but was absorbed only, and that the nitrogen was evolved from the blood. In regard to the residual gas being chiefly nitrogen Sir Humphry seems to have been in error, for Dr Hermann's observations, published in 1844, and quoted in the *British Medical Journal* of 18th April 1868, are as follows: It neither enters into combination with, nor suffers changes from, nor produces changes in the blood, though readily soluble in it. A hundred volumes of blood at the temperature of the body will absorb somewhat less than sixty volumes of nitrous oxide; blood saturated with it shows no sign of change, the spectrum appearances are the same, the blood-corpuscles are unaltered, and the oxygen is not driven out. In the blood, and probably in the body, laughing gas suffers no change. It does not give up its oxygen for purposes of oxidation, and therefore gives rise to no free nitrogen; it leaves the body as it went in, pure and simple laughing gas. Hence it is of no respiratory use, and when mixed with a quantity of oxygen sufficient for the needs of the economy, has no more direct effect on respiration than has nitrogen or hydrogen. Gentlemen, such are the stated facts of the action of this gas on the living body, so far as I have been able to ascertain them. We now pass for a brief space into the region of fancy, and we have a great abundance of theories attempting to explain its ultimate action in producing unconsciousness. First, for the sake of convenience of position, I will mention the opinions of the writer of the article from which the above account of Hermann's observations is taken. He says, "From these facts we may gather that the mode of action of laughing gas is that of a body having distinct effects on certain parts of the system, and does not depend, like that of some other agents, on any direct interference with the function of respiration." As it passes rapidly and unchanged out of the body, and causes no gross obvious chemical changes there, it "certainly seems peculiarly fitted as an agent for producing temporary conditions of the economy." This may be partly true, but the writer seems to forget that no free oxygen is admitted to the lungs for a period varying from forty seconds to three minutes. We have next two theories which are evidently on chemical grounds wrong, if Hermann's observations be right. Dr Johnson believes that anæsthesia is always the result of the cessation of oxidation of nervous tissue, and that in the case of nitrogen and nitrous oxide this is produced by their simply taking the place of the normal oxygen of the blood, and thus suspending oxidation. Dr Marcet's view is that the action of protoxide of nitrogen is due first to an increased supply of oxygen to the blood, causing the well-known exhilarating effects, and later, when a larger quantity of the gas is absorbed, anæsthesia is produced by the excessive formation of carbonic acid in the blood owing to this large supply of oxygen. But Hermann has shown that, in the first place, it does not take the place of the normal oxygen of the blood; and secondly, that it does not give up its oxygen to the tissues.

Dr Sansom, believing that anæsthesia is the result of cessation of oxidation, "has no doubt that nitrous oxide acts chiefly by inducing a progressive apnœa;" and he inclines to the opinion that, though it acts chiefly by mechanically inducing apnœa, it has an action on the blood-corpuscles. "Any agent which tends to render the blood-corpuscle convex, to distend it (such as carbonic acid, nitrous oxide, or ether), renders the blood black; any agent which tends to render it more concave, to empty it, if it exert any obvious effect, renders it red." The mode in which the gaseous narcotics influence the blood is to be explained by the physical effects of their endosmosis, and also probably by the preventive action on oxygenation which their presence within and around the blood-corpuscle induces.

Mr Clover observes, "Nitrous oxide acts by preventing the oxidation of the nervous centres, principally by depriving the blood of its proper supply of free oxygen in the lungs. Although there is oxygen in the nitrous oxide, it is in a state of chemical combination with nitrogen, not free, and merely mixed with nitrogen as in the air. It is probable that the presence in the blood of nitrous oxide is exciting, so long as some oxygen remains, but as soon as the oxygenating property of the blood is lost, the functions of the nervous centres fail; and if fresh air were not soon admitted, their functions would cease altogether. The functions of the brain proper cease before those of the medulla oblongata; hence we have loss of consciousness before failure of breathing, and the functions of the medulla are abolished before those of the ganglia presiding over the action of the heart, and hence the heart continues to beat after the breathing has ceased." To the practical importance of this last paragraph I would direct your attention, for it shows that after the breathing has ceased, the patient may be safe so long as the heart pulsates.

Dr Richardson believes that this agent acts simply by producing asphyxia, and is therefore a most dangerous anæsthetic.

I do not propose to indicate my adherence to any of these theories, nor do I intend to propound a new one of my own, believing as I do, that we have up to the present time been indulged with rather too many theories, and too few accurate observations or facts. And in leaving this part of the subject, I would simply quote to you the words of a wise man—Sir Humphry Davy: "It would be easy," he says, "to form theories referring the action of blood impregnated with nitrous oxide to its power of supplying the nervous and muscular fibre with such proportions of condensed nitrogen, oxygen, light or ethereal fluid, as enabled them more rapidly to pass through those changes which constitute their life; but such theories would be only collections of terms derived from known phenomena, and applied by loose analogies of language to unknown things." With some slight change of terms, would the remarks not as well suit our day as they did the beginning of the century?

Nitrous oxide has been chiefly used as an anæsthetic in dentistry, and seems eminently suited in every respect for this work. In general surgery, cases are recorded in which, by alternating it with air, insensibility has been kept up for eight minutes, twenty minutes (Dr Marion Sims), sixteen minutes (Dr Colton); and in this country, eight minutes thirty seconds (Dr Begg), twenty minutes (Mr Fox).

The advantages which I conceive it possesses as an anæsthetic are,—1*st*, Its safety. It has now been given for six years in America, and for two in this country, and a vast number of patients have been submitted to its influence, and there have been only two fatal cases recorded, both in America. In one of these the patient's lungs were found "riddled with tubercles" when a post-mortem examination was made; and in the other, the cork, which was used as a plug to keep the mouth open, was found in the pharynx. In this respect, it compares favourably with chloroform and bichloride of methylene. 2*d*, The absence of troublesome after-effects. It is only in very rare cases indeed that any complaint of sickness or faintness is made at any length of time after its use. I believe that the most prolonged inconvenience I have met with, was a headache lasting the rest of the day; and patients have been always able to leave the operating chair and walk away within ten minutes of an operation. 3*d*, The rapidity of administration. Time, often valuable time, is saved to all concerned. 4*th*, The position. This applies principally to dentistry, where the sitting is a much more convenient position than the recumbent. 5*th*, There is nothing unpleasant in the smell or taste of the gas itself, and it can be inspired and expired freely; it does not cause any choking feeling or spasm of the glottis. Its disadvantages are,—1*st*, Rapidity of recovery from a single administration; insensibility does not last over one minute or one and a half minutes. 2*d*, It is somewhat troublesome to administer; it requires close attention and a little practice to be able to give it with facility. 3*d*, The apparatus for making and administering it is costly. Until about six months ago, I should have had to state that a serious objection to its use was the trouble of making it, and its inconvenient bulk for carriage. But the gas can now be procured compressed into the liquid form, and thus reduced to small compass. This, however, costs in London twice the price of the home-manufactured gas, and, I am told, makes so much noise when escaping as seriously to discompose patients. I have no doubt that in a short time the gas and apparatus will be much less costly, and that it will come into very general use in minor surgery. I believe that it will be habitually given in cases in which we never use an anæsthetic now, save under very exceptional circumstances, as in using the potential cautery, opening small abscesses, and in applying painful dressings, and that it will supersede chloroform in all operations not lasting over one minute. As to the cases in which it would be unsafe to give this anæsthetic, evidently those in which phthisis exists deserve the first place, for one of the deaths recorded above was attributed to this cause, and other cases are mentioned in which hæmoptysis occurred. From the frequency of a laboured or panting condition of the breathing during the later stages of administration, I think its use is to be avoided in the case of all diseases of the lungs causing serious impairment of the breathing, as chronic bronchitis, emphysema, and pleural effusion. Acute chest diseases I do not mention, as there is but little likelihood of the question of gas administration occurring during their course. In heart disease, it has been knowingly given without producing death, and with only temporary aggravation of symptoms. It has been given in such cases after the patient had been prohibited from taking chloroform. I do not think that such cases are free from danger, and I believe it should only be given in them when the result to be attained is such as to justify some risk, as where an operation was a necessity, and its performance without an anæsthetic seemed likely to endanger the patient's existence. Leaving out of consideration insanity, I do not think that it would be advisable to give it where there was evidence of brain disease. But if there seemed an absolute necessity for unconsciousness to be produced, and the operation was a short one, I believe that the administrator, being thoroughly aware of the risk he was running, and on the watch for the first symptom of danger, could give nitrous oxide more safely than chloroform in any of the above-mentioned instances. I may mention, that I see it stated that the gas is to receive an extended application in the terrible plethora of surgery which the Continental war is producing: so we may look for accurate information as to its place among the agents for producing unconsciousness in general surgery.

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