

The History of Anesthesiology

Reprint Series: Part Eleven



Clockwise from lower center: Sir Humphry
Davy, Gardner Q. Colton, Horace
Wells, Paul Bert, Edmund
Andrews

NITROUS OXIDE

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NITROUS OXIDE

Little controversy exists over who should be given the credit for the first public demonstration of nitrous oxide, for the honor belongs to Horace Wells, dentist of Hartford, Connecticut. However, as in the ether demonstration, where multiple introductions occurred almost simultaneously, nitrous oxide had been "in the air" for some time. This small collection of classical articles reveals how Davy (and Priestley beforehand) had imagined nitrous oxide, and how Colton, Andrews and Bert enriched its status in anesthesia. Thus, Wells may have been mollified for not having been awarded the laurels as discoverer, for his gas has outlived Morton's ether vapor.

Nitrous oxide, not besmirched so far as we know by the conversion to toxic metabolites, is remarkable for its historic endurance. However, this longevity is the result of many an observation by others: Cyril B. Courville, for example, who in 1936 wrote on, "Asphyxia as a Consequence of Nitrous Oxide"; or the initial measurements of uptake and distribution in the body, by John W. Severinghaus, after the predictions of S. S. Kety; and, a galaxy of recent discoveries on the so-called nonpharmacologic properties of this inorganic gas. Among the latter are the inhibitory effects on bone

marrow elements, the possibility of a mutagenic influence on primitive cells and the phenomenon of diffusion of nitrous oxide into air-containing body cavities. Venerable nitrous oxide is even caught up in the excitement aroused over the demonstration of opioid receptors in the central nervous system and the presence of endogenous ligands. The whole story is so historically typical of humanly inspired innovation!

Leroy D. Vandam, M.D.

SELECTED PAPERS ON NITROUS OXIDE

1. Davy, Sir Humphry. Research IV. Relating to the Effects Produced by the Respiration of Nitrous Oxide. Division I. History of the Discovery—Effects Produced by the Respiration of Different Gases
In Davy H: Researches, Chemical and Philosophical; Chiefly Concerning Nitrous Oxide or Dephlogisticated Nitrous Air and Its Respiration. London, J. Johnson, 1800. pp. 451-465.
2. [Beddoes, Thomas] III. Observations on the Effects of Nitrous Oxide by Dr. Beddoes—Conclusion Ibid. pp. 541-559.
3. Wells, Horace. A History of the Discovery of the Application of Nitrous Oxide Gas, Ether and Other Vapors, to Surgical Operations. Hartford, Connecticut, J Gaylord Wells, 1847
4. Colton, Gardner Quincy. Anaesthesia. Who made and developed this great discovery? A Statement "Delivered upon the mellowing of occasion." New York, A. G. Sherwood & Co., Publishers, 1886
5. Andrews, Edmund. The Oxygen Mixture, a New Anaesthetic Combination. Chicago Medical Examiner, 9:656-661, November 1868
6. Andrews, Edmund. Liquid Nitrous Oxide as an Anaesthetic. Medical Examiner, 13: 34-36, 1872

RESEARCHES,
CHEMICAL AND PHILOSOPHICAL;
CHIEFLY CONCERNING
NITROUS OXIDE,
OR
DEPHLOGISTICATED NITROUS AIR,
AND ITS
RESPIRATION.

By HUMPHRY DAVY,
SUPERINTENDENT OF THE MEDICAL PNEUMATIC
INSTITUTION.

LONDON:
PRINTED FOR J. JOHNSON, ST. PAUL'S CHURCH-YARD.
BY BIGGS AND COTTE, BRISTOL.
1800.

MERCURIAL AIR-HOLDER and BREATHING MACHINE.

Fig. 2.

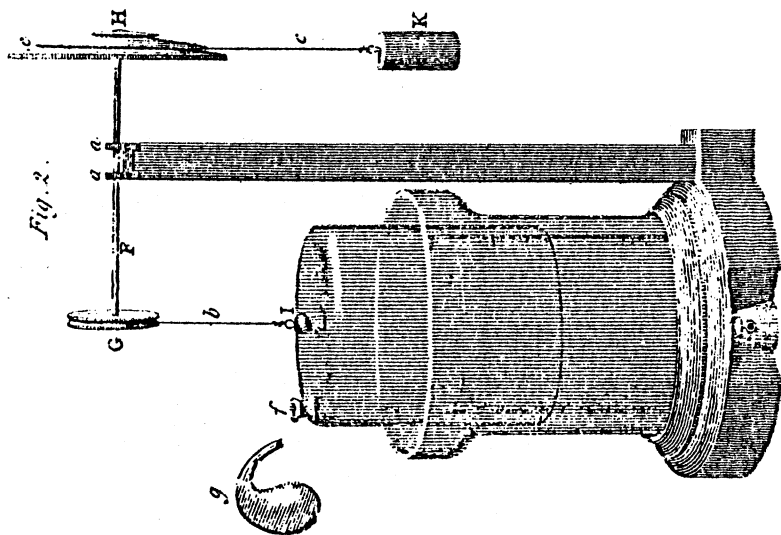


Fig. 3.

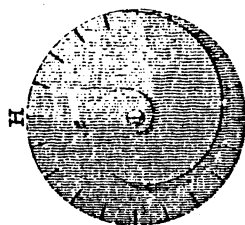
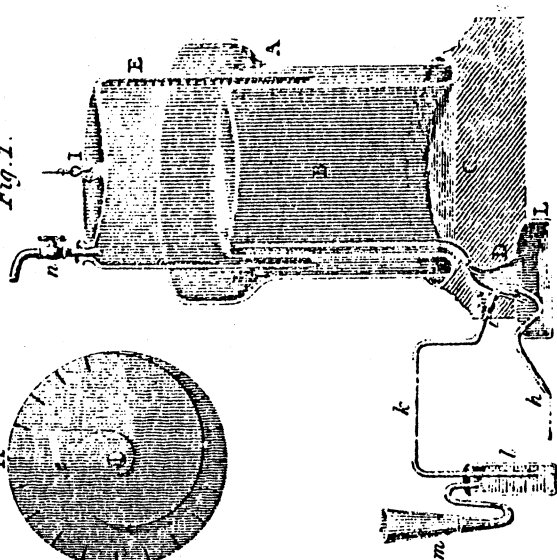


Fig. 1.



RESEARCH IV.

RELATING TO THE

EFFECTS PRODUCED BY THE RESPIRATION

OF

NITROUS OXIDE

UPON DIFFERENT

INDIVIDUALS.

RESEARCH IV.
RELATING TO
THE EFFECTS
PRODUCED BY THE
RESPIRATION OF NITROUS OXIDE.

DIVISION I.

*HISTORY of the DISCOVERY.—Effects produced by
the RESPIRATION of different GASES.*

A SHORT time after I began the study of Chemistry, in March 1798, my attention was directed to the dephlogisticated nitrous gas of Priestley, by Dr. Mitchill's Theory of Contagion.*

The fallacy of this Theory was soon demonstrated, by a few coarse experiments made on small quantities of the gas procured from zinc

* Dr. Mitchill attempted to prove from some phænomena connected with contagious diseases, that dephlogisticated nitrous gas which he called oxide of septon, was the principle of contagion, and capable of producing the most terrible effects when respired by animals in the minutest quantities or even when applied to the skin or muscular fibre.

and diluted nitrous acid. Wounds were exposed to its action, the bodies of animals were immersed in it without injury ; and I breathed it mingled in small quantities with common air, without remarkable effects. An inability to procure it in sufficient quantities, prevented me at this time, from pursuing the experiments to any greater extent. I communicated an account of them to Dr. Beddoes.

In 1799, my situation in the Medical Pneumatic Institution, made it my duty to investigate the physiological effects of the aëriform fluids, the properties of which presented a chance of useful agency. At this period I recommenced the investigation,

A considerable time elapsed before I was able to procure the gas in a state of purity, and my first experiments were made on the mixtures of nitrous oxide, nitrogene and nitrous gas; which are produced during metallic solutions.

In the beginning of March, I prepared a large quantity of impure nitrous oxide from the nitrous solution of zinc. Of this I often breathed

the quantities of a quart and two quarts generally mingled with more than equal parts of oxygene or common air. In the most decisive of those trials, its effects appeared to be depressing, and I imagined that it produced a tendency to fainting: the pulse was certainly rendered slower under its operation.

At this time, Mr. Southey respired it in an highly diluted state; it occasioned a slight degree of giddiness, and considerably diminished the quickness of his pulse.

Mr. C. Coates likewise respired it highly diluted, with similar effects.

In April, I obtained nitrous oxide in a state of purity, and ascertained many of its chemical properties. Reflections upon these properties and upon the former trials, made me resolve to endeavour to inspire it in its pure form, for I saw no other way in which its respirability, or powers could be determined.*

* I did not attempt to experiment upon animals, because they die nearly in equal times in non-respirable gases, and gases incapable of supporting life and possessed of no action on the venous blood.

I was aware of the danger of this experiment. It certainly would never have been made if the hypothesis of Dr. Mitchill had in the least influenced my mind. I thought that the effects might be possibly depressing and painful, but there were many reasons which induced me to believe that a single inspiration of a gas apparently possessing no immediate action on the irritable fibre, could neither destroy or materially injure the powers of life.

On April 11th, I made the first inspiration of pure nitrous oxide; it passed through the bronchia without stimulating the glottis, and produced no uneasy feeling in the lungs.

The result of this experiment, proved that the gas was respirable, and induced me to believe that a farther trial of its effects might be made without danger.

On April 16th, Dr. Kinglake being accidentally present, I breathed three quarts of nitrous oxide from and into a silk bag for more than half a minute, without previously closing my nose or exhausting my lungs.

The first inspirations occasioned a slight degree of giddiness. This was succeeded by an uncommon sense of fulness of the head, accompanied with loss of distinct sensation and voluntary power, a feeling analogous to that produced in the first stage of intoxication ; but unattended by pleasurable sensation. Dr. Kinglake, who felt my pulse, informed me that it was rendered quicker and fuller.

This trial did not satisfy me with regard to its powers ; comparing it with the former ones I was unable to determine whether the operation was stimulant or depressing.

I communicated the result to Dr. Beddoes, and on April the 17th, he was present, when the following experiment was made.

Having previously closed my nostrils and exhausted my lungs, I breathed four quarts of nitrous oxide from and into a silk bag. The first feelings were similar to those produced in the last experiment ; but in less than half a minute, the respiration being continued, they diminished gradually, and were succeeded by a

sensation analogous to gentle pressure on all the muscles, attended by an highly pleasurable thrilling, particularly in the chest and the extremities. The objects around me became dazzling and my hearing more acute. Towards the last inspirations, the thrilling increased, the sense of muscular power became greater, and at last an irresistible propensity to action was indulged in; I recollected but indistinctly what followed; I know that my motions were various and violent.

These effects very soon ceased after respiration. In ten minutes, I had recovered my natural state of mind. The thrilling in the extremities, continued longer than the other sensations.*

This experiment was made in the morning; no languor or exhaustion was consequent, my feelings throughout the day were as usual, and I passed the night in undisturbed repose.

* Dr. Beddoes has given some account of this experiment, in his Notice of some observations made at the Medical Pneumatic Institution. It was noticed in Mr. Nicholson's Phil. Journal for May 1799.

The next morning the recollections of the effects of the gas were very indistinct, and had not remarks written immediately after the experiment recalled them to my mind, I should have even doubted of their reality. I was willing indeed to attribute some of the strong emotion to the enthusiasm, which I supposed must have been necessarily connected with the perception of agreeable feelings, when I was prepared to experience painful sensations. Two experiments however, made in the course of this day, with scepticism, convinced me that the effects were solely owing to the specific operation of the gas.

In each of them I breathed five quarts of nitrous oxide for rather a longer time than before. The sensations produced were similar, perhaps not quite so pleasurable ; the muscular motions were much less violent.

Having thus ascertained the powers of the gas, I made many experiments to ascertain the length of time for which it might be breathed with safety, its effects on the pulse, and its

general effects on the health when often respired.

I found that I could breathe nine quarts of nitrous oxide for three minutes, and twelve quarts for rather more than four. I could never breathe it in any quantity, so long as five minutes. Whenever its operation was carried to the highest extent, the pleasurable thrilling at its height about the middle of the experiment, gradually diminished, the sense of pressure on the muscles was lost; impressions ceased to be perceived; vivid ideas passed rapidly through the mind, and voluntary power was altogether destroyed, so that the mouth-piece generally dropt from my unclosed lips.

Whenever the gas was in a high state of purity, it tasted distinctly sweet to the tongue and palate, and had an agreeable odor. I often thought that it produced a feeling somewhat analogous to taste, in its application to my lungs. In one or two experiments, I perceived a distinct sense of warmth in my chest.

I never felt from it any thing like oppressive

respiration : my inspirations became deep in proportion as I breathed it longer ; but this phænomenon arose from increased energy of the muscles of respiration, and from a desire of increasing the pleasurable feelings.

Generally when I breathed from six to seven quarts, muscular motions were produced to a certain extent ; sometimes I manifested my pleasure by stamping or laughing only ; at other times, by dancing round the room and vociferating.

After the respiration of small doses, the exhilaration generally lasted for five or six minutes only. In one or two experiments when ten quarts had been breathed for near four minutes, an exhilaration and a sense of slight intoxication lasted for two or three hours.

On May 3d. To ascertain whether the gas would accelerate or retard the progress of sleep, I breathed at about 8 o'clock in the evening, 25 quarts of nitrous oxide, in quantities of six at a time, allowing but short intervals between each dose. The feelings were much less pleasu-

rable than usual, and during the consumption of the two last doses, almost indifferent ; indeed the gas was breathed rather too soon after its production and contained some suspended acid vapour which stimulated the lungs so as to induce coughing.

After the experiments, for the first time I was somewhat depressed and debilitated ; my propensity to sleep however, came on at the usual hour, and as usual was indulged in, my repose was sound and unbroken.

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 only.

The doses were generally from six to nine quarts ; their effects appeared undiminished by habit, and were hardly ever exactly similar. Sometimes I had the feelings of intense intoxication, attended with but little pleasure ; at other times, sublime emotions connected with highly vivid ideas ; my pulse was generally increased in fulness, but rarely in velocity.

The general effects of its operation upon my health and state of mind, are extremely difficult of description ; nor can I well discriminate between its agency and that of other physical and moral causes.

I slept much less than usual, and previous to sleep, my mind was long occupied by visible imagery. I had a constant desire of action, a restlessness, and an uneasy feeling about the præcordia analogous to the sickness of hope.

But perhaps these phenomena in some measure depended on the interest and labour connected with the experimental investigation relating to the production of nitrous oxide, by which I was at this time incessantly occupied.

My appetite was as usual, and my pulse not materially altered. Sometimes for an hour after the inspiration of the gas, I experienced a species of mental indolence* pleasing rather than

* Mild physical pleasure is perhaps always destructive to action. Almost all our powerful voluntary actions, arise either from hope, fear, or desire ; and the most powerful from desire, which is an emotion produced by the coalescence of hope or ideal pleasure with physical pain.

otherwise, and never ending in listlessness.

During the last week in which I breathed it uniformly, I imagined that I had increased sensibility of touch : my fingers were pained by any thing rough, and the tooth edge produced from slighter causes than usual. I was certainly more irritable, and felt more acutely from trifling circumstances. My bodily strength was rather diminished than increased.

At the latter end of July, I left off my habitual course of respiration ; but I continued occasionally to breathe the gas, either for the sake of enjoyment, or with a view of ascertaining its operation under particular circumstances.

In one instance, when I had head-ache from indigestion, it was immediately removed by the effects of a large dose of gas ; though it afterwards returned, but with much less violence. In a second instance, a slighter degree of head-ache was wholly removed by two doses of gas.

The power of the immediate operation of the gas in removing intense physical pain, I had a very good opportunity of ascertaining.

In cutting one of the unlucky teeth called *dentes sapientiæ*, I experienced an extensive inflammation of the gum, accompanied with great pain, which equally destroyed the power of repose, and of consistent action.

On the day when the inflammation was most troublesome, I breathed three large doses of nitrous oxide. The pain always diminished after the first four or five inspirations ; the thrilling came on as usual, and uneasiness was for a few minutes, swallowed up in pleasure. As the former state of mind however returned, the state of organ returned with it ; and I once imagined that the pain was more severe after the experiment than before.

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RESEARCH IV.

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DIVISION III.

*ABSTRACTS from ADDITIONAL DETAILS.—
OBSERVATIONS on the EFFECTS of NITROUS
OXIDE, by Dr. REDDOES.—CONCLUSION.*

I. Abstracts from additional Details.

THE trials related in the following abstracts, have been chiefly made since the publication of Dr. Beddoes's Notice. Many of the individuals breathed the gas from pure curiosity. Others with a disbelief of its powers.

MR. WYNNE, M. P. breathed five quarts of diluted nitrous oxide, without any sensation. Six quarts produced fulness in the chest, heat in the hands and feet, and sense of tension in the fingers, slight but pleasant sensations. Seven quarts produced no new or different effects.

Miss B. Y—— and Miss S. Y—— both delicate but healthy young ladies, were affected very pleasantly ; each by three quarts of nitrous oxide, the first time of respiring it. Miss B Y—— continued exhilarated and in high spirits for some hours after the dose. Miss S. Y—— had a slight head-ache, which did not go off for some hours.

Mrs. F. inclined to be hysterical, breathed four quarts of nitrous oxide mingled with common air. She was giddy and described her feelings as odd ; but had not the slightest languor after the experiment.

III. *Observations on the effects of Nitrous Oxide, by DR. BEDDOES.*

Neither my notes nor my recollection supply much in addition to what I formerly stated in the *Notice of Observations at the Pneumatic Institution. Longman.* The gas maintains its first character as well in its effects on me, as in

the benefit it confers on some of the paralytic, and the injury it does or threatens to the hysterical and the exquisitely sensible. I find that five or six quarts operate as powerfully as ever. I seem to make a given quantity go farther by holding my breath so that the gas may be absorbed in a great degree without returning into the bag, and therefore, be as little heated before inspiration as possible.—This may be fancy.

After innumerable trials, I have never once felt lassitude or depression.* Most commonly

* Of the facts on which Brown founded his law of indirect debility, no prudent man will lose sight either in practising or studying medicine. They are incontrovertible.—And our new facts may doubtless be conciliated to the Brunonian doctrine.

But to suppose that the expenditure of a quality or a substance, or a spirit and its renewal are the general principle of animal phænomena, seems to me a grievous and baneful error. I believe it often happens that excitement and excitability increase, and that they oftener decrease together ;—In short, without generalizing in a manner of which Brown and similar theorists had no conception, our notions of the organic world will in my opinion, continue to be as confused as the elements are said to have been in chaos. On some future occasion, I may presume to point

I am sensible of a grateful glow *circum præcordia*. This has continued for hours.—In two or three instances only has exhalation failed to be followed by pleasurable feeling, it has never been followed by the contrary. On a few occasions before the gas was exhausted, I have found it impossible to continue breathing.

The pulse at first becomes fuller and stronger. Whenever, after exposure to a cold wind, the warmth of the room has created a glow in the cheeks, the gas has increased this to strong flushing—which common air breathed in the same way, failed to do.

Several times I have found that a cut which had ceased to be painful has smarted afresh, and on taking two doses in succession, the smarting ceased in the interval and returned during the second respiration. I had no previous expectation of the first smarting.

out the region through which I imagine the path to wind, that will lead the observers of some distant generation to a point, whence they may enjoy a view of the subtle, busy and intricate movements of the organic creation as clear as Newton obtained of the movements of the heavenly masses.

The only time I was near rendering myself insensible to present objects by very carefully breathing several doses in quick succession, I forcibly exclaimed, TONES !—In fact, besides a general thrilling, there seemed to be quick and strong alterations in the degree of illumination of all surrounding objects ; and I felt as if composed of finely vibrating strings. On this occasion, the skin seemed in a state of constriction and the lips glued to the mouth-piece, and the mucous membrane of the lungs contracted, but not painfully. However, no constriction or corrugation of the skin could be seen. I am conscious of having made a great number of observations while breathing, which I could never recover.

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.

Mr. John Cave, Junr. and his three friends, as well as others, compared the effects to Cham-

pagne. Most persons have had the idea of the effect of fermented liquors excited by the gas. It were to be wished that we had, for a standard of comparison, observations on the effect of these liquors as diversified and as accurate as we have obtained concerning the gas; nor would more uniformity in the action of these substances be observed if the enquiry were strictly pursued. Opium and spirits seem, in particular states to sicken and distress in the first instance; how differently does wine at an early hour and fasting act upon those who are accustomed to take it only after dinner!

I thought it might be an amusing spectacle to see the different tints of blood flowing from a wound by a leech in consequence of breathing different airs. The purple from the nitrous oxide was very evident. Oxygene, we thought, occasioned a quicker flow and brighter color in the blood. In another experiment, an inflamed area round the puncture from a leech applied the day before, was judged by several spectators to become much more crimson on the respiration of

about 20 quarts of oxygene gas, which possibly acts more powerfully on inflamed parts.* These and many similar experiments, require to be repeated on the blood of single arteries opened in warm and cold animals.

It has appeared to me that I could hold my breath uncommonly long when respiring oxygene gas mixed with nitrous oxide. While trying this to-day, (17th June), I thought the sense of smell much more acute after the nitrous oxide than before I began to respire at all ; and then I felt conscious that this increased acuteness had before repeatedly occurred—a

* After writing this, I was present when an invalid, in whose foot the gout, after much wandering, had at last fixed, breathed 12 quarts of oxygene gas. While breathing, he eagerly pointed to the inflamed leg ; and afterwards said he had felt in it a new sensation, somewhat like tension.—I never had seen oxygene respired where there was so much local inflammation.

June 18. After four quarts of oxygene with 6 of nitrous oxide and then 6 of nitrous oxide alone, violent itching of the wounds made by the leech ; and redness and tumour.—Both had healed, and I did not expect to feel any thing more from them.—I tried this again with two doses of nitrous oxide—The yellow halo round one wound changed to crimson, and there was so much stinging and swelling that I feared suppuration.—Absorption here was rapid.

fact very capable, I apprehend, of a pneumatological interpretation.

Time by my feelings has always appeared longer than by a watch.

I thought of trying to observe whether while I alternately breathed quantities of nitrous oxide and oxygen gas and common air, I could observe any difference in the operation of a blister beginning to bite the skin. It would be of consequence to ascertain the effect of regulating by compression the flow of blood, while stimulants of various kinds (and heated bodies among the rest) were applied to or near the extremities—because in *crispelas* and various inflammatory affections, a ready and pleasant cure might be effected by partial compression of the arteries going to the diseased part ; and a great improvement in practice thus obtained.

But I should run into an endless digression, were I to enumerate possible physiological experiments with artificial airs, or to speculate on the mechanical improvement of medicine, which at present as far as mechanical means of affect-

ing the living system are concerned, is with us in a state that would almost disgrace a nation of savages.

IV. CONCLUSION.

From the facts detailed in the preceding pages, it appears that the immediate effects of nitrous oxide upon the living system, are analogous to those of diffusible stimuli. Both increase the force of circulation, produce pleasurable feeling, alter the condition of the organs of sensation, and in their most extensive action destroy life.

In the mode of operation of nitrous oxide and diffusible stimuli, considerable differences however, exist.

Diffusible stimuli act immediately on the muscular and nervous fibre. Nitrous oxide operates upon them only by producing peculiar changes in the composition of the blood.

Diffusible stimuli affect that part of the system

most powerfully to which they are applied, and act on the whole only by means of its sympathy with that part. Nitrous oxide in combination with the blood, is universal in its application and action.

We know very little of the nature of excitement ; as however, life depends immediately on certain changes effected in the blood in respiration, and ultimately on the supply of certain nutritive matter by the lymphatics ; it is reasonable to conclude, that during the action of stimulating substances, from the increased force of circulation, not only more oxygene and perhaps nitrogene must be combined with the blood in respiration,* but likewise more fluid nutritive matter supplied to it in circulation.

* See Dr. Beddoes's *Considerations*, part 1. page 26. His observations in the note in the last section, will likewise apply here.—Is not healthy living action dependant upon a certain equilibrium between the principles supplied to the blood by the pulmonary veins from respiration and by the lymphatics from absorption ? Does not sensibility more immediately depend upon respiration ? Deprive an animal under stimulation, of air, and it instantly dies ; probably

By this oxygene and nutritive matter excitability may be kept up : and exhaustion consequent to excitement only produced, in consequence of a deficiency of some of the nutritive principles, which are supplied by absorption.

When nitrous oxide is breathed, nitrogen (a principle under common circumstances chiefly carried into the blood by the absorbents in fluid compounds) is supplied in respiration ; a greater quantity of oxygene is combined with the blood than in common respiration, whilst less carbonic acid and probably less water are evolved.

Hence a smaller quantity of nutritive matter is probably required from the absorbents during the excitement from nitrous oxide, than during the operation of stimulants ; and in consequence, exhaustion from the expenditure of nutritive matter more seldom occasioned.

if absorption could be prevented, it would likewise speedily die. It would be curious to try whether intoxication from fermented liquors cannot be prevented by breathing during their operation, an atmosphere deprived of part of its oxygene.

Since Research III. has been printed, I have endeavoured to ascertain the quantities of nitrogene produced when nitrous oxide is respired for a considerable time. In one experiment, when I breathed about four quarts of gas in a glass bell over impregnated water for near a minute, it was diminished to about two quarts; and the residuum extinguished flame.

Now the experiments in Research II. prove that when nitrous oxide is decomposed by combustible bodies, the quantity of nitrogene evolved is rather greater in volume than the pre-existing nitrous oxide. Hence much of the nitrogene taken into the system during the respiration of nitrous oxide, must be either carried into new combinations, or given out by the capillary vessels through the skin.

It would be curious to ascertain whether the quantity of ammoniac in the saline matters held in solution by the secreted fluids is increased after the respiration of nitrous oxide. Experiments made upon the consumption of nitrous oxide mingled with atmospheric air

by the smaller animals, would go far to determine whether any nitrogene is given out through the skin.

The various effects of nitrous oxide upon different individuals and upon the same individuals at different times, prove that its powers are capable of being modified both by the peculiar condition of organs, and by the state of general feeling.

Reasoning from common phænomena of sensation, particularly those relating to heat, it is probable that pleasurable feeling is uniformly connected with a moderate increase of nervous action ; and that this increase when carried to certain limits, produces mixed emotion or sublime pleasure ; and beyond those limits occasions absolute pain.

Comparing the facts in the last division, it is likely that individuals possessed of high health and little sensibility, will generally be less pleasurable affected by nitrous oxide than such as have more sensibility, in whom the emotions will sometimes so far enter the limits

of pain as to become sublime;* whilst the nervous action in such as have exquisite sensibility, will be so much increased as often to produce disagreeable feeling.

Modification of the powers of nitrous oxide by mixture of the gas with oxygen or common air, will probably enable the most delicately sensible to respire it without danger, and even with pleasurable effects: heretofore it has been administered to such only in its pure form or mingled with small quantities of atmospheric air, and in its pure form even the most robust are unable to respire it with safety for more than five minutes.

The muscular actions† sometimes connected

* Sublime emotion with regard to natural objects, is generally produced by the connection of the pleasure of beauty with the passion of fear.

† The immortal HARTLEY has demonstrated that all our motions are originally automatic, and generally produced by the action of tangible things on the muscular fibre.

The common actions of adults may be distinguished into two kinds; voluntary actions, and mixed automatic actions. The first are produced by ideas, or by ideas connected with passions. The second by impression, or by pleasure and pain.

with the feelings produced by nitrous oxide, seem to depend in a great measure upon the particular habits of the individual ; they will usually be of that kind which is produced either by common pleasurable feelings or strong emotions.

Hysterical affection is occasioned by nitrous oxide, probably only in consequence of the strong emotion produced, which destroys the power of the will, and calls up series of automatic motions formerly connected with a variety of less powerful but similar feelings.

The quickness of the operation of nitrous oxide, will probably render it useful in cases of extreme debility produced by deficiency of

In voluntary action, regular associations of ideas and muscular motions exist : as when a chemist performs a pre-conceived experiment.

In mixed automatic actions, the simple motions produced by impression are connected with series of motions formerly voluntary, but now produced without the intervention of ideas : as when a person accustomed to play on the harpsichord, from accidentally striking a key, is induced to perform the series of motions which produce a well-remembered tune.

Evidently the muscular actions produced by nitrous oxide are mixed automatic motions.

common exciting powers. Perhaps it may be advantageously applied mingled with oxygene or common air, to the recovery of persons apparently dead from suffocation by drowning or hanging.

The only diseases in which nitrous oxide has been hitherto employed, are those of deficient sensibility.—An account of its agency in paralytic affections, will be speedily published by Dr. Beddoes.

As by its immediate operation the tone of the irritable fibre is increased, and as exhaustion rarely follows the violent muscular motions sometimes produced by it, it is not unreasonable to expect advantages from it in cases of simple muscular debility.

The apparent general transiency of its operation in the pure form in single doses has been considered as offering arguments against its power of producing lasting changes in the constitution. It will, however, be easy to keep up excitement of different degrees of intensity for a great length of time, either by administering

the unmingled gas in rapid successive doses, or by preserving a permanent atmosphere, containing different proportions of nitrous oxide and common air, by means of a breathing chamber.* That single doses nevertheless, are capable of producing permanent effects in some constitutions, is evident, as well from the hysterical cases as from some of the details—particularly that of Mr. M. M. Coates.

As nitrous 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.

From the strong inclination of those who have been pleasantly affected by the gas to respire it again, it is evident, that the pleasure produced, is not lost, but that it mingles with the mass of feelings, and becomes intellectual pleasure, or hope. 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

* See R. IV. Div. I. page 478.

breathe with eagerness, the air remaining in the bags after the respiration of others.

As hydrocarbonate acts as a sedative,† and diminishes living action as rapidly as nitrous oxide increases it, on the common theory of excitability‡ it would follow, that by differently modifying the atmosphere by means of this gas and nitrous oxide, we should be in possession of a regular series of exciting and depressing* powers applicable to every deviation of the constitution from health : but the common theory

† R. IV. Div. I. page 467.

‡ That of Brown modified by his disciples.

* Supposing the increase or diminution of living action when produced by different agents, uniform, similar and differing only in degree ; it would follow, that certain mixtures of hydrocarbonate and nitrous oxide, or hydrogen and nitrous oxide, ought to be capable of supporting the life of animals for a much longer time than pure nitrous oxide. From the experiments in Ref. III. Div. I. it appears however, that this is not the case.

It would seem, that in life, a variety of different corpuscular changes are capable of producing phenomena apparently similar ; so that in the science of living action, we are incapable of reasoning concerning causes from effects.

of excitability is most probably founded on a false generalisation. The modifications of diseased action may be infinite and specific in different organs ; and hence out of the power of agents operating on the whole of the system.

Whenever we attempt to combine our scattered physiological facts, we are stopped by the want of numerous intermediate analogies ; and so loosely connected or so independant of each other, are the different series of phænomena, that we are rarely able to make probable conjectures, much less certain predictions concerning the results of new experiments.

An immense mass of pneumatological, chemical, and medical information must be collected, before we shall be able to operate with certainty, on the human constitution.

Pneumatic chemistry in its application to medicine, is an art in infancy, weak, almost useless, but apparently possessed of capabilities of improvement. To be rendered strong and mature, she must be nourished by facts,

strengthened by exercise, and cautiously directed
in the application of her powers by rational
scepticism.

A

HISTORY OF THE DISCOVERY

OF THE APPLICATION OF

NITROUS OXIDE GAS,

ETHER, AND OTHER VAPORS,

TO

SURGICAL OPERATIONS

BY HORACE WELLS.

HARTFORD:
J. GAYLORD WELLS,
CORNER MAIN AND ASYLUM STS.
1847.

PREFACE.

IN answer to a request, made by several scientific and medical societies of Europe, who have desired me to furnish them with the evidence of my priority of discovery of the application of gas, or vapor, for the performance of surgical operations, I have obtained testimonials and affidavits sufficiently numerous and satisfactory, as I believe, to establish the fact beyond a doubt.

I have forwarded the original papers to Dr. C. S. Brewster, of Paris, (No. 11 Rue de la Paix,) who will have charge of them until this question is settled.

The following pages contain a correct copy of those papers, which prove, conclusively, that I made known this discovery in November, 1844, which date is nearly two years prior to that given by Drs. Jackson and Morton.

HORACE WELLS.

Hartford, March 30, 1847.

HISTORY, &c.

TO THE EUROPEAN AND AMERICAN PUBLIC:

I propose, in the briefest manner possible, to give, in the following pages, a true and faithful history of the discovery which is at present causing an unparalleled excitement throughout the whole medical world. I refer to the administering of exhilarating gas, or vapor, to prevent pain in surgical operations. It is very unfortunate that there should be more than one claimant for the honor of the discovery; but so it is: and the only alternative now is, for the man who considers himself entitled to this honor to present his proofs, that a discriminating and impartial public may "give credit to whom credit is due."

Reasoning from analogy, I was led to believe that surgical operations might be performed without pain, by the fact, that an individual, when much excited from ordinary causes, may receive severe wounds without manifesting the least pain; as, for instance, the man who is engaged in combat may have a limb severed from his body, after which he testifies, that it was attended with no pain at the time: and so the man who is intoxicated with spirituous liquor may be severely beaten without his manifesting pain, and his frame, in this state, seems to be more tenacious of life than under ordinary circumstances. By these facts I was led to enquire if the same result would not

follow by the inhalation of exhilarating gas, the effects of which would pass off immediately, leaving the system none the worse for its use. I accordingly procured some nitrous oxide gas, resolving to make the first experiment on myself, by having a tooth extracted, which was done without any painful sensations. I then performed the same operation for twelve or fifteen others, with the like results.

This was in the fall of 1844. Being a resident of Hartford, Connecticut, I proceeded to Boston, in December of the same year, in order, to present my discovery to the medical faculty; first making it known to Drs. Warren, Hayward, Jackson, and Morton: the last two of whom expressed themselves in the disbelief that surgical operations could be performed without pain,—both admitting that this *modus operandi* was entirely new to them; and these are the individuals who now claim to be the discoverers!

By invitation of Dr. Warren, I addressed his medical class upon the subject. I embraced the opportunity, and endeavored to establish the principle that the system, when wrought up to a certain degree of nervous excitement, by any means whatever, would thus be rendered insensible to pain, and would admit of surgical operations being performed without any disagreeable sensations. In proof of this theory, I related my experience in extracting teeth under the influence of nitrous oxide gas, stating that, with one or two exceptions, all on whom I had operated (numbering twelve or fifteen) assured me that they experienced no pain whatever; and, in further proof of the truth of this principle, I cited analogous cases, as, the man

who is excited by passion, or he who is much intoxicated by liquor; stating, that individuals under these circumstances uniformly testify, when wounded, that such injuries were inflicted without pain. I stated, also, that I was making use of nitrous oxide gas simply because I considered it more harmless than any thing else which could be used for this purpose; assuring them that the same result would follow, let the nervous system be excited sufficiently in any manner whatever. I remained several days in Boston in order to have an opportunity of administering the gas to a man who was expecting to have a limb amputated, but the operation was postponed. I was then invited to extract a tooth for a patient in presence of the medical class, which operation was performed, but not with entire success, as the gas-bag was removed too soon; and as the man said he experienced some pain, the whole was denounced as an imposition, and no one was inclined to assist me in further experiments.

The excitement of this adventure immediately brought on an illness, from which I did not recover for many months; being thus obliged to relinquish, entirely, my professional business. I will now, in a few words, state how the names of Jackson and Morton came into notice, as being connected, with this discovery.

Dr. Morton, who is a dentist in Boston, was instructed in his profession by myself, about five years since, and I subsequently assisted in establishing him in the city of Boston, and after I had made the above discovery, I had frequent interviews with him; and he, being aware that I had relinquished my professional business in consequence of a protracted indisposition, requested me to instruct him

how to prepare the gas which I had been giving so successfully in Hartford, stating that he wished to make a trial of it in Boston. As this interview was in Hartford, I told him to request Dr. Charles T. Jackson (with whom we were both acquainted) to prepare him some of it, as he was a chemist. Accordingly, Dr. Morton went to Dr. Jackson for the gas, who gave him the ether, as being attended with the least trouble. After one or two teeth were extracted, it was then introduced into the Massachusetts General Hospital, where a capital operation was performed under its influence with perfect success; which fact was immediately published in the principal newspapers of the day, with the names of Jackson and Morton (who had, by a written contract, entered into a sort of co-partnership business in this matter) as the discoverers; and Dr. Jackson, as I have since been informed, immediately sent letters to London and Paris, to be read to the several Academies, where he takes all the credit to himself, not even mentioning the name of Morton, his partner by written contract, which contract was signed and executed on the 27th of October, 1846. In this agreement, Dr. Jackson acknowledges that Dr. Morton made the discovery "*in conjunction*" with himself, as the following extract from the paper signed by Jackson fully proves :

"To all persons to whom these presents shall come: Whereas, I, Charles T. Jackson, of Boston, in the State of Massachusetts, chemist, have, *in conjunction* with William T. G. Morton, of said city, dentist, invented, or discovered, a new and useful improvement in surgical operations on animals, whereby *we are enabled* to accomplish many, if not all operations, such as are usually attended with more or less pain and suffering, without any, or with very little, pain or muscular action, to persons who undergo the same," &c., &c.

After the fact came to the knowledge of Morton that Jackson had sent privately to Paris, he, as a natural consequence, became very indignant ; and each of these individuals now deny that the other has had anything to do with the discovery which was at first claimed by both, "acting in conjunction." I will here make a quotation from the Boston Advertiser, of March 6th, 1847, which contains Dr. Morton's reply to Dr. Jackson. Dr. Morton proceeds as follows :

"In the letter to M. Beaumont, of Paris, from which I have already made extracts, Dr. Jackson says :

" 'Five or six years ago, I remarked the peculiar state of insensibility into which the nervous system was plunged by the inhalation of the vapor of pure sulphuric ether,' &c.

"Previously to this, he had already stated, under oath, in the preamble to the specifications, which bear date the 27th of October, 1846, that the same hath not, to the best of his knowledge and belief, *been previously known*. Now, Dr. Jackson either did know, previous to this time, that sulphuric ether would produce insensibility to pain; or he did not. If he did, as stated in his letter to M. Beaumont, then I have to remind him of his oath, under the solemnity of which he statès that, according to the best of his knowledge and belief, '*the fact had not been before known*.' But if he did not, then I remind him of his statement to M. Beaumont, in which he says that he *had known it for 'five or six years.'* And the learned Doctor may take either horn of the dilemma he may prefer.

"It is not known that Dr. Jackson ever made more than one experiment in inhaling ether; and then he used it as an antidote to the vapor of chlorine, which he had accidentally breathed, but from his own statement, in the Advertiser, it did not answer the purpose—the deleterious effects returning with the return of consciousness. But, supposing he had known of it six years or six months before Dr. Morton applied it in practice, is it not inexcusable in him to

have withheld from suffering humanity this inestimable boon so long—a boon by the gift of which such an incalculable amount of misery might have been saved? Or is it within the limits of probability, that if he had been so long in possession of a discovery which, if made known, would in four months call down blessings on his head from ten thousand hearts, and from all civilized lands, and which, from present prospects, would make him to be remembered and cherished by the side of Jenner by all coming generations, and to all coming time—I say, is it probable, had he known of this noble gift, that he would not have been more zealous in publishing it to the world? If he did make this discovery, is it not a remarkable coincidence that Dr. Morton should have made it at the same time, and still more remarkable, that Dr. J. should leave to another the honor to make his discovery known? But to settle this whole matter, and it might have been done in the outset, to the satisfaction of any candid mind:—After Dr. Morton began to use the ether in his practice, and for some weeks, it is well known to a large number of our most respectable citizens, that Dr. Jackson clearly and distinctly repudiated and washed his hands of the whole thing. He, on many occasions, as it is well known to his friends, disclaimed all connection with the discovery or use of ether in surgery. A gentleman of high standing, asked Dr. J., in presence of several others, if he ‘knew that, by the inhalation of ether, such a state of insensibility could be produced as that the knife could be applied, and the patient feel no pain?’ Dr. J. replied:

“‘No; nor Morton either, nor any one else. *It is a humbug*, and it is reckless in Morton to use it as he does.’

“In speaking to two other persons, at different times, on this subject, he said:

“‘I don’t care what he [Morton] does with it, [the discovery,] if he does not drag my name in with it.’

“At another time, he said, he ‘did not know how it would work in pulling teeth, but he knew its effects at college upon the students, when the faculty had to get a certificate from a physician that it was injurious, to prevent them

from using it.' Many other statements, on this point, can be given, but it is deemed wholly unnecessary. The above, and other statements even stronger, can be verified by affidavits."

When it was announced in the Boston papers that Drs. Jackson and Morton claimed this discovery, the citizens of Hartford were taken by surprise, for it was well known here that I had put in practice the same more than two years before, and not only this, but it was generally known that I had long since made a journey to Boston exclusively on this business, in order to present it to the medical faculty. Dr. P. W. Ellsworth, a son of the Hon. W. W. Ellsworth, Ex-Governor of Connecticut, who was acquainted with the circumstances above mentioned, immediately published an article in the Boston Medical and Surgical Journal, stating those facts that came under his personal observation—which accord perfectly with what I have already stated. Dr. E. E. Marcy, of this city, also published an article in the Journal of Commerce about the same time, stating that he was knowing to my making the discovery, and going to Boston in 1844, when I had an interview with Dr. Jackson, who said that he did not believe that surgical operations could be performed without pain, when I informed him of the discovery I had made. Dr. Marcy quoted Dr. Jackson's language to me, and in his (Jackson's) reply, he does not deny that I had this interview with him, but simply says that he did not use the *words* which are credited to him in the quotation marks. He does not deny but that the substance of those words were said by him; and, furthermore, he cannot deny this.

This letter of Dr. Jackson, in reply to Dr. Marcy, requires still further notice. He says that he had merely

heard that I had tried some experiments with nitrous oxide gas, but had never heard that they were successful. Now I am fully persuaded that Dr. Jackson does not remember the circumstance of his being informed and assured in November, 1844, that my operations were uniformly successful, with but one or two exceptions; but such was the case, and the individual who informed him of this fact will make the statement under oath, if necessary. Dr. Jackson was then informed that I had operated on twelve or fifteen patients by the use of nitrous oxide gas, without causing the least pain, in but two instances.

Dr. Jackson claims that the nitrous oxide gas and the vapor of ether are essentially different in their effects when inhaled. He asserts, in this letter, that sulphuric ether, as it is used in Boston, does not act as a stimulant, but has the reverse effect. In reply to this statement, Dr. Marcy quotes an article from the Boston Medical and Surgical Journal, where Dr. J. C. Warren, of the Hospital, in his report, proves that ether, as given in Boston, acts as a stimulant; but in order to prove, even to the satisfaction of Dr. Jackson himself, that he was mistaken, I will quote his own language, from an article published in the Boston Advertiser, of March 3, 1847. He says:

"We are aware that ether ranks in the pharmaceutic books and dispensatories, as a diffusible stimulant, and that its fumes or vapor produce intoxication of short duration."

The fact is, that nitrous oxide gas and the vapor of ether, are identical in their effects; first exhilarating, then, when continued to excess, the reverse effect follows, acting as a sedative, throwing the person into a deep sleep or stupor.

This discovery does not consist in the use of any one specific gas or vapor, for anything which will cause a certain degree of nervous excitement, is all that is required to render the system insensible to pain; consequently, the only question to be settled is, which exhilarating agent is least likely to do harm? I have confined myself to the use of nitrous oxide gas, because I became fully satisfied, from the first, that it is less injurious to the system than ether. In the fall of 1844, after I had tried several experiments with nitrous oxide gas with perfect success,—then wishing to use a substitute which would be attended with less trouble in its preparation,—I advised with Dr. E. E. Marcy, of this city, at which time we discussed the comparative merits of nitrous oxide gas and rectified sulphuric ether. Knowing that both had the same effects upon the system, so far as causing insensibility to pain was concerned, the object of the discussion was to ascertain which would do least harm. I had, previous to this, inhaled ether, as well as nitrous oxide gas, and found their effects upon the nervous system to be precisely the same; but I found it very difficult to inhale the vapor of ether in consequence of the choking sensation. For this reason, and for the reason that Dr. Marcy and myself came to the conclusion that nitrous oxide gas was not so liable to do injury, I resolved to adhere to this alone. Let it be observed, however, that at this time, (November, 1844,) while we had the subject under consideration, a surgical operation was performed at Dr. Marcy's office, under the influence of sulphuric ether, as is proved by affidavit. The Doctor then advised me, by all means, to continue the use of nitrous oxide gas.

If the question is asked, why so much time has elapsed since its first discovery, without its coming into more

general use, I can only say, that I have used my utmost endeavors, from the first, to influence physicians and surgeons to make a trial of it, assuring them that my operations were numerous, and perfectly successful. But all were fearful of doing some serious injury with it; and not wishing to incur the responsibility of administering this powerful agent without the co-operation of the medical faculty, and also for the reason that I was obliged to relinquish my professional business in consequence of ill health, my operations have been somewhat limited.

On making the discovery, I was so much elated respecting it, that I expended my money freely, and devoted my whole time for several weeks, in order to present it to those who were best qualified to investigate and decide upon its merits, not asking or expecting any thing for my services, well assured that it was a valuable discovery. I was desirous that it should be as free as the air we breathe; but judge of my surprise, after the lapse of many months, when I was informed that two individuals (Drs. Jackson and Morton) had claimed the discovery, and had made application for a patent in their own names.

After making the above statement, and submitting the following testimonials and affidavits, I leave it for the public to decide to whom belongs the credit of this discovery.

Respectfully,

HORACE WELLS.

ANÆSTHESIA.

Who Made and Developed this Great Discovery?

A STATEMENT

“Delivered upon the mellowing of Occasion.”

BY

G. Q. COLTON.

“Fear not to touch the best,
The truth shall be thy warrant.”
Sir Waller Raleigh.

NEW YORK:
A. G. SHERWOOD & CO., PUBLISHERS,
47 LAFAYETTE PLACE.
1886.

ANÆSTHESIA.

WHO FIRST DISCOVERED AND DEVELOPED IT ?

Some of my friends have claimed for me a greater share of credit in the discovery and development of anæsthesia than I deserve, or have ever claimed for myself.

I propose, in this brief treatise, to give a plain and simple statement of the facts concerning this discovery, and leave the public to judge of the degree of merit which each of the actors may justly claim.

It is an established principle that the mere conception of a discovery, without any practical application and development of it, does not constitute a discovery. The real discoverer is the man who not only conceives, but practically applies and develops his discovery—puts it into actual use.

By this rule, the claims of Sir Humphry Davy and of Dr. Crawford W. Long, of Georgia, must be set aside. In a work entitled, "Researches on Nitrous Oxide," published by Sir Humphry Davy in 1800, he uses these words: "Inasmuch as Nitrous Oxide, when inhaled in large doses, seems capable of rendering one insensible to pain, it is not improbable that it may be used in surgical operations where no great flow of

blood is caused." There is no evidence that Sir Humphry Davy or any one else ever acted on his suggestion.

Dr. Crawford W. Long performed a surgical operation while the patient was under the influence of Sulphuric Ether in 1842. But there is no evidence that he ever performed any other operation with it, or that he made any publication of it. Evidently he did not consider or claim that he had made a discovery.

Without any knowledge of the suggestion of Sir Humphry Davy, or the experiment of Dr. Long, the great discovery of modern anæsthesia was made by the late Dr. Horace Wells, of Hartford, Conn., on the evening of the 10th of December, 1844; and on the following day he put it to a practical test on his own person.

The circumstances were as follows: On the evening of the 10th of December, 1844, I gave an exhibition of the effects of laughing gas in the city of Hartford, Conn. Among those who inhaled it was a young man by the name of Cooley, who while under its influence, in jumping about, ran against some wooden benches or settees on the stage, bruising his legs badly. After taking his seat, he was astonished to find his legs bloody; and said he did not know he had run against a bench, and felt no pain until after the effects of the gas had passed off. Dr. Wells—who sat next to him—noticed the circumstance, and as the audience were retiring, asked me why a man could not have a tooth extracted without pain while under the influence

of the gas. I replied that I did not know, as the idea had never occurred to me. Dr. Wells then said he believed it could be done, and would try it on himself, if I would bring a bag of gas to his dental office the next day. The next morning—11th of December, 1844—I took a bag of gas to his office—Dr. Riggs having been called in—and administered it to Wells, and Dr. Riggs extracted a molar tooth for him. Dr. Wells, on recovering, exclaimed, “ *It is the greatest discovery ever made! I didn't feel it so much as the prick of a pin!* ” This was the first operation performed in modern anaesthesia, and was the forerunner of all the other anaesthetics. Beyond all question, this discovery had its birth in the brain of Dr. Horace Wells! I can only claim for myself that I was the *occasion* of the discovery, and of having given the gas for the *first* operation with an anaesthetic.

At the request of Dr. Wells, I instructed him how to make the gas, and then went off on my exhibition business. Dr. Wells got up the apparatus, made and tested the effects of the gas, and then went to Boston to make the discovery known. He called upon Dr. Morton, his former pupil in dentistry, also on many other dentists and physicians, stating what he had discovered and done. They all treated him as a visionary enthusiast. He obtained permission of the elder Dr. Warren to address the class in surgery at Cambridge College. At the close of his remarks, he administered the gas to a boy and extracted a tooth.

The boy screamed out, though he said he didn't know when the tooth was drawn. The students, however, hissed, and pronounced the pretended discovery a humbug. After laboring in and around Boston for about three weeks without any success, Wells returned to Hartford and resumed his dental practice, using the gas as an anæsthetic. He used the gas during all of the year 1845, as the depositions of some forty respectable citizens of Hartford on whom he had operated, bear testimony. During this year of 1845, no one claims that any dentist or surgeon used the gas, or any other anæsthetic, save Wells alone.

At the close of 1845, Dr. Wells went to Europe on account of ill health, where he remained several years. When in Paris he presented his claims before the Academy of Sciences, and the Academy conferred upon him the honor of an "M.D."

During the month of September, 1846, Dr. Morton (Dr. Wells's former pupil) went to Dr. Jackson, a chemist of Boston, to learn how to make the Nitrous Oxide or laughing gas, as he wished to test the truth of Wells's pretended discovery. Dr. Jackson advised him to try Sulphuric Ether, and said, "That gas exhilarates, makes people laugh, dance, etc. If that will destroy pain, Sulphuric Ether will do the same," but advised him not to incur the expense of the apparatus to make the gas. Upon this suggestion, Dr. Morton purchased some Ether and tried it on a boy named Eben Frost. This first experiment with Ether took place

on the 30th of September, 1846—almost two years after Wells had used the gas—and was suggested by Wells's experiments! Dr. Morton reported the success of his operation to Dr. Jackson, which they followed up by a series of experiments between them, with Ether. Finding it successful, they applied, jointly, for a patent for the discovery of the anæsthetic effects of Ether. Before the patent was issued, Jackson assigned all his interest in it to Morton, taking an agreement from the latter that he—Morton—should give him 10 per cent. of all he made out of it. Dr. Jackson then wrote to the Commissioner in Washington, requesting that the patent should be issued to Morton, which was done, while Morton, in order to mystify the public, called it "Letheon," and began to sell "rights." At this early period, it was too much to believe that *any* vapor inhaled into the lungs could destroy pain in a surgical operation, and, as a result, the discovery was scouted by the profession. Dr. Morton deserves great credit for his perseverance in pushing it into use and demonstration in the Massachusetts General Hospital. Any one, on discovering that Nitrous Oxide would destroy pain, would naturally infer that Ether might do the same; and at the suggestion of Dr. Marcy (who was then practising medicine in Hartford), Dr. Wells tried Ether on one occasion, *before he went to Europe*. But he did not like the symptoms, the odor was bad, and this was the only experiment he ever tried with it.

In the latter part of 1847 Wells returned from Europe, and was astonished to learn that Dr. Morton had obtained a patent for Ether, and claimed the honor of the discovery of anæsthesia! An exciting discussion followed between them on the subject in the *Boston Medical Journal*. This discussion so worked on the sensitive nature of Wells, that he became deranged and committed suicide. This took place on the 24th of January, 1848. *Up to this period no one had attempted to use the gas save Wells.*

After the death of Wells, Dr. Morton claimed that Nitrous Oxide was *not an anæsthetic*, and that insensibility to pain could not be produced by it; therefore he, Morton, was the discoverer of anæsthesia! And Dr. Jackson endorsed this view, stating in his work on Chemistry, that he had tried the gas with "large orifices and small orifices" and could not produce insensibility with it. Subsequently, when Jackson learns that some man's name is going down to posterity as a great discoverer, he claims the discovery of anæsthesia, inasmuch as he suggested the trial of Ether to Morton. A violent discussion followed between them on the subject.

Dr. Morton, in his claim that Nitrous Oxide was not an anæsthetic, virtually admits that Dr. Wells was the discoverer of anæsthesia, *provided* that Nitrous Oxide *was* an anæsthetic, and that pain could be destroyed by it.

Dr. Morton's claim to be the discoverer of anæ-

thesia was almost universally recognized, from the time of the death of Wells, January 24th, 1848, till the month of June, 1863, when I *revived* the use of the gas in the city of New Haven, Conn. During this period of fifteen years, when the gas was mentioned, the profession said, "O that was tried by Wells and proved a failure." When in New Haven in June, 1863, I was preparing to give an exhibition of the amusing effects of the gas, and invited a number of gentlemen to attend a private preliminary entertainment at which I gave a history of the discovery of anæsthesia, and detailed the experiments of Wells; stating also that I had never been able to induce a dentist to try the gas. Dr. J. H. Smith, a distinguished dentist of New Haven, who was present, said to me that he would try the gas, provided I would administer it. I replied that I would be very glad to do it, as I wished to demonstrate what could be done with it. We commenced at his office. The first patient who came in was a wealthy old lady, for whom we extracted seven teeth with the gas. On recovering she was so pleased with the result, that she said I might mention her name to my audience, and state that she had had seven teeth extracted without pain, and without any ill or unpleasant effects from the gas. I did so. In three weeks and two days, we extracted a little over three thousand teeth! This success induced me to abandon the "Exhibition" business, and to establish an Institution in New York, devoted exclusively to the extrac-

tion of teeth with the gas. I called it the Colton Dental Association, because my name had been so long identified with the gas.

Whatever credit I deserve in connection with this matter is derived from the fact that I *revived* the use of the gas after it had been condemned, dead and forgotten as an anæsthetic from 1848 to 1863. In this revival and demonstration of the value of the gas as an anæsthetic, is not the world *practically* indebted to me for its use? If I had not revived it, when, and by whom would it have been done? That poor Wells failed to convince the world of its value does not militate in the slightest degree against the honor he deserves as the discoverer of anæsthesia. He did all that a man could do under the circumstances.

Chloroform was discovered and brought into practical use by Professor Simpson, of Edinburgh, in the latter part of 1847, or about a year after the first experiments made with Ether; but Chloroform is a dangerous agent to use, especially in unskilful hands, as thousands of deaths have occurred while under its influence. Ether is a much safer agent, yet both these agents often cause nausea, and the ill effects frequently last for days. The Nitrous Oxide is beyond all comparison the safest of all anæsthetics; as it is pleasant to inhale, and the patient is quickly under its influence and quickly over it. I have given it to over 150,000 patients without a single death. I have the autograph signatures, and numbered, of every patient in my office.

Nearly ten years ago the following TESTIMONIAL was given to me, signed by many of the most eminent Physicians, Surgeons and Dentists of New York :

NEW YORK, *November, 1876.*

The undersigned hereby certify that they are more or less familiar with the anæsthetic effects of Nitrous Oxide Gas, having *experienced or witnessed* its operation at the COLTON DENTAL ASSOCIATION in the Cooper Institute. When the gas is pure and properly administered, it suspends all consciousness of pain, and, so far as we know, has never been attended with any injurious effects. We regard it as the safest of all anæsthetics.

Signed by

WILLARD PARKER, M.D.,
GURDON BUCK, M.D.,
C. F. CHANDLER, M.D.,
FORDYCE BARKER, M.D.,
J. MARION SIMS, M.D.,
STEPHEN SMITH, M.D.,
C. R. AGNEW, M.D.,
ALEX. B. MOTT, M.D.,
T. A. EMMETT, M.D.,
A. B. CROSBY, M.D.,
JOHN ALLEN, D.D.S.,
A. L. NORTHRUP, D.D.S.,
GEO. E. HAWES, M.D.,
WILLIAM H. DWINELL, M.D.,
J. SMITH DODGE, Jr., M.D.,
NORMAN W. KINGSLEY, D.D.S.,
CHAUNCEY P. FITCH, M.D.,
CHARLES MERRITT,
S. L. CLOSE, D.D.S.,

FRANK H. HAMILTON, M.D., LL.D.,
WILLIAM A. HAMMOND, M.D.,
LEWIS A. SAYRE, M.D.,
H. B. SANDS, M.D.,
AUSTIN PLINT, M.D.,
T. M. MARKOE, M.D.,
JAMES R. WOOD, M.D.,
ISAAC E. TAYLOR, M.D.,
JAS. KNIGHT, M.D.,
ANDREW H. SMITH, M.D.,
R. OGDEN DOREMUS, M.D., LL.D.,
ALFRED C. POST, M.D.,
ELISHA HARRIS, M.D.,
JEROME C. SMITH, M.D.,
W. A. BRONSON, M.D.,
ALBERT LEPLER,
WILLIAM H. ALLEN,
J. S. LATIMER, D.D.S.,
ENRICK PARMLEY,
E. A. BOGUE, M.D.

When the gas is breathed freely, as it should be, its effects are admirably described by the Rev. Dr. Prime in one of his "IRENÆUS" letters published in

the *New York Observer*, March 3d, 1870, from which the following extract is taken :

"He received me kindly in his spacious parlors, and concurred in the justice of the sentence pronounced. He seated me comfortably in the old arm-chair, and offered me the mouth-piece which the Empress once, for a moment, held. I put it to my lips, and inhaled three, four, perhaps five times, and then, instantly, as it seemed to me, I heard the Doctor say, 'There, it's all right.' I was awake, but the five teeth were gone, as if by magic, without a sense of feeling, with no knowledge of any operation having been performed. There was no more sense of having been asleep, or of having taken anything, than if it had been a glass of water, or a draught of fresh air. It was about two minutes from the time of inhalation to the waking, but the unconsciousness was so complete that it seemed no time at all. Not the slightest inconvenience supervened, and that intense benumbing effect which follows the wrenching of a tooth from its socket, was entirely unknown. In a few days the gums healed and became solid, and all sense of having undergone any operation was past.

"The Doctor has a big roll of manuscript, on which he requests each one who has been operated upon in this room to subscribe his name. They are numbered regularly, and my name was opposite 40,509. This is not the noble army of martyrs exactly, but of living witnesses to the safety and efficacy of the

process, for in the whole number, some of whom have had fifteen teeth removed at a single sitting, not an accident has occurred."

There are, no doubt, many dentists who manufacture impure gas; or administer pure gas after it becomes stale. There is this important fact to be considered. There is no injury produced by the inhalation of stale gas, only it fails to produce the effect desired. And if the gas is so impure that its inhalation would prove fatal, *it cannot be breathed at all*—it would be coughed up at once. When the gas is pure, it has no more taste or odor than the common air, and is perfectly agreeable to the lungs. I suppose that, in showing patients how I wish them to commence to breathe the gas, I inhale, in the aggregate, twenty gallons myself every day. *There is no reaction following the inhalation of the gas.* In this respect it is unlike all other stimulants. And this, simply because it acts on the blood, and not on the substance of the lungs or other organs. Consumptive patients will often feel stronger for days after inhaling it, because it supplies to the blood that element—oxygen—for the lack of which they are growing weaker and weaker. The good effects however, are only temporary.

Where *Neuralgic* pains arise from a low vital or unoxygenized condition of the blood, the gas affords instantaneous relief. This fact—and it is a fact—has not as yet engaged the attention of the Medical Profession.

Of what is Nitrous Oxide, or laughing gas, composed? It is composed of precisely the same elements—oxygen and nitrogen—as the common air, only the proportions are different. In the air we have (in round numbers) one-fifth oxygen and four-fifths nitrogen. In this gas there is half oxygen and half nitrogen, or by volume, one of oxygen to two of nitrogen. Oxygen is the life-giving principle of the air, and in this gas *we have more of it*; a person *lives a little faster* while under its influence.

Chloroform and Ether act as sedatives, and depress the action of the heart, running the pulse down from 70 to 20 or 25 beats to the minute; and this, because they cut off the necessary supply of oxygen. The laughing gas, on the contrary, acts as an *exhilarant*, as by supplying an extra supply of oxygen to the lungs, the pulse is increased 15 to 20 beats to the minute. The former agents carry the patient down towards the point of death; the latter up into increased life.

I suppose I am safe in saying that, in the use of Chloroform, one death has occurred in every 1,000 times it has been administered. I have given the gas 150,000 times without such an accident. And I doubt if there has *ever* been a well authenticated case of death caused by the gas; or a death in which there was not some other cause sufficient to produce the result.

Although my connection with this great discovery was incidental, yet I think it will be admitted that I

was the *occasion* of the discovery, and that but for me it would not have been made; certainly not at that time. And is it too much to claim that the world is practically indebted to me for the anæsthetic use of the Nitrous Oxide gas, having revived and demonstrated its value after it had been abandoned and forgotten for the space of fifteen years?

I leave the subject to the impartial judgment of the profession and the public.

G. Q. COLTON.

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A MONTHLY JOURNAL DEVOTED TO THE
EDUCATIONAL, SCIENTIFIC, AND PRACTICAL INTERESTS
OF THE
MEDICAL PROFESSION.

EDITED BY
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CHICAGO MEDICAL COLLEGE, ETC., ETC.

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ARTICLE XLVI.

THE OXYGEN MIXTURE, A NEW ANÆSTHETIC COMBINATION.

By E. ANDREWS, M.D., Prof. of Principles and Practice of Surgery,
Chicago Medical College.

Every surgeon who has seen the prompt and pleasant anæsthetic action of the nitrous oxide gas, so much used by dentists, has wished that in some way it might be made available in general surgery. The patient usually goes under the influence in 30 or 40 seconds, and wakes with equal promptness, without vomiting or other unpleasant symptoms, all of which is in striking contrast with the slowness, the nausea, and the discomforts of chloroform and ether. There have been, however, great obstacles to the use of the gas, owing to its evanescent action. The oxygen contained in it is in a state of chemical combination, so that it is not available for oxygenation of the blood; hence if any attempt is made to continue its action, the patient becomes purple in the face, showing all the signs of asphyxia; subsultus tendinum then supervenes, and shortly after he almost ceases to breathe, and, if allowed nothing but pure nitrous oxide, would doubtless die in a few minutes.

I have for some time been experimenting, to see whether by the addition of free oxygen to the nitrous oxide, a mixture would not be obtained, by which a patient might be anæsthetized for an indefinite period without danger of asphyxia, and thus render gas available for the most prolonged operations of surgery. These experiments are not yet finished, but they have advanced far enough to show that the preparation, which I have named the Oxygen Mixture, is certainly available for a large part of our operations, and that for pleasantness, and probable safety, it is infinitely superior to chloroform, ether, or unmixed nitrous oxide. The following facts and experiments show the present state of our knowledge on the subject:—

In the first place, pure nitrous oxide, when given for brief operations, appears to be the safest anæsthetic known. Chlo-

roform, in American and European hospitals, kills one out of about every 3600 patients who take it; but the Colton Dental Association, a company with branches in all our principal cities, established for the sole purpose of extracting teeth, has on its books over sixty thousand cases of anæsthesia by nitrous oxide, without a single death caused by the anæsthetic.

Now, it cannot be supposed that the addition of a moderate amount of free oxygen, in mechanical mixture, to nitrous oxide can produce any new danger; on the contrary, by removing all possibility of asphyxia, it must be eminently an element of safety.

To test this question, the following experiments were performed:—

EXP. 1. A large rat was placed in a glass jar on a perforated floor, beneath which was a stratum of lime-water to absorb the carbonic acid produced by its breathing. To make more sure of this result, a jet of lime-water spray was thrown into the jar at frequent intervals during the experiment. I then turned on a small stream of pure nitrous oxide gas, which, being fifty per cent. heavier than atmospheric air, settled to the bottom, and expelled the atmospheric air by displacement. In two minutes the animal fell over upon its side, breathing slowly with deep-labored inspirations. The respirations continued to become slower, until, at the end of ten minutes, they ceased entirely, and life was found to be extinct. The death was doubtless from asphyxia.

EXP. 2. Another rat was placed in the jar under the same conditions, and exposed to an oxygen mixture consisting of about one-fourth of free oxygen to three-fourths of nitrous oxide. In two and a half minutes he was so completely anæsthetized that he could not be made to respond to pinching or pushing. There was no panting, or laboring for breath, as when pure nitrous oxide was used, but the respiration was rather slow, and very gentle. He was kept in the mixture half an hour, and then removed, still perfectly anæsthetized. In five minutes he began efforts at walking, and in ten seemed to be perfectly restored to his natural condition.

EXP. 3. A rat was placed in the jar and given the oxygen mixture, containing 25 per cent. pure oxygen. This being more than is contained in the atmosphere, diluted the nitrous oxide too much, which, together with the fact that the animal was less susceptible than the former, prevented full anæsthesia. He fell into a sort of intoxicated condition, without appearing to be fully unconscious, and continued thus throughout the experiment. At the end of 30 minutes the gas was shut off, and the animal shortly recovered his sobriety.

EXP. 4. The same animal was again exposed to the oxygen mixture for half an hour, with precisely the same results as before.

EXP. 5. To test the relative safety of the oxygen mixture as compared with ether, my friend Dr. Sherman took the same rat, after his recovery from experiment No. 4, and dropped into the jar a little sulphuric ether. In a short time he was unconscious, and in two minutes was dead.

EXP. 6. A lady had an anchylosed knee, to which I wished to restore motion by forcible flexion. Having a dread of ether and chloroform, she inhaled the oxygen mixture in the proportion of one-third free oxygen to two-thirds nitrous oxide. In forty seconds she was perfectly anæsthetized, without any blueness of the countenance, or laboring for breath. There was a little pallor about the lips. I broke up the adhesions of the joint by flexing and extending it forcibly. She probably inhaled the gas about two minutes, felt no pain, and awaked without nausea.

EXP. 7. A young woman took in my presence the mixture as prepared by Dr. Rogers, dentist, for the extraction of a tooth. There was, as before, a slight pallor of the prolabia, but no asphyxiated purpling of the face. The tooth was extracted without pain, and the patient awoke without nausea.

EXP. 8. A woman, aged 42, had ankylosis of the right hip, with contraction of the flexors of both knees, fixing those joints at a right angle. I desired to cut all the hamstring tendons of both limbs, and to break up by force the adhesions of the anchylosed hip. The gas was given from a 30-gallon elastic bag,

with an imperfect inhaler. The mixture contained one-third free oxygen. Owing to the imperfection of the inhaler, it was found impossible to prevent the patient getting considerable atmospheric air with the gas, so that the anæsthesia was less perfect, and slower than in the former instance. After inhaling it for nine minutes, she became unconscious, and I severed all the hamstrings. I then endeavored to break the adhesions of the head of the femur, but found they were too firm, and I desisted. The operations lasted about three minutes, when she was allowed to recover, which she did without nausea, though she had a meal in the stomach. Twice during the inhalation there was a sort of pallor of the face, with very faint duskiness, which induced me to suspend the administration of the gas a few respirations.

EXP. 9. Mrs. R. had ingrowing, painful nails on both feet. Ten months ago she took ether for the extraction of one of them. She was of a very nervous temperament, was slow in coming under the influence of the ether, and after partially awaking remained delirious, and distressed a considerable time. Three months afterwards she took pure nitrous oxide for the extraction of a tooth. She was anæsthetized in about one minute, and felt no pain, but the countenance was blue with asphyxia, and she was delirious a good while after waking. She felt uncomfortable for several days. Six months afterwards she was again anæsthetized by Dr. Reber, a dentist, who had prepared the oxygen mixture at the suggestion of Dr. Sherman. The gas contained one-third free oxygen. She was anæsthetized in one and three-quarter minutes, and in that condition Dr. Sherman split the offending toe-nail and tore out the proper half of it without causing any pain. She inhaled the gas for three minutes in all. On awaking, she was as usual delirious, which state, however, continued only fifteen minutes, a much shorter time than after ether or pure nitrous oxide. There was no blueness nor pallor of the lips during inhalation, and on her waking she was much more comfortable than after anæsthesia with the other articles.

Dr. Reber has given the oxygen mixture to several patients

for the extraction of teeth, and states that it uniformly acts more agreeably than unmixed nitrous oxide.

Dr. Rogers, a dentist of this city, states that he has used a mixture containing one-third free oxygen for several years, and that in his opinion it is far pleasanter than unmixed nitrous oxide.

Some months ago some such mixture was proposed in England, but was overthrown, I think, by the influence of Dr. Richardson, who argued, on theoretical grounds merely, that it would not be successful, nor safe. I cannot learn that it was ever actually tried in Europe.

Prof. Watt, of the Dental College in Cincinnati, has been experimenting, I understand, on what involves partly the same principle. I am informed that he gives alternately inspirations of nitrous oxide and atmospheric air, and thus both avoids the asphyxia, and is able to continue the inhalation a long time. I have written to him inquiring about his results, but have received no answer.

The above experiments are by no means sufficient to settle the value of the oxygen mixture, but they give strong reason to think that it will prove the safest, and by far the pleasantest, anæsthetic known. As to its safety, it is highly significant, that a rat which had been twice immersed in the mixture for half an hour without injury, was killed in two minutes by ether; and yet ether is far safer than chloroform.

It is my impression that the best proportion of oxygen will be found to be one-fifth by volume, which is the same as in the atmospheric air. There are some points requiring care in the management, in order to insure success. As the oxygen dilutes the nitrous oxide, it is necessary to be very careful to exclude all atmospheric air, or else the anæsthesia will be imperfect. The inhaler must be taken into the mouth, the lips very carefully closed around it, and the nares compressed by the person administering the anæsthetic. For the same reason, great care should be taken to secure purity of the gases, otherwise the mixture will be too weak to control some patients. I have found, by introducing phosphorus into a bell glass of what was

supposed to be very pure nitrous oxide, that it contained considerable free oxygen, which doubtless was from included atmospheric air; and therefore four times the bulk of free, inert nitrogen must have been present also, to weaken the power of the article.

The oxygen is best prepared by taking pure chlorate of potash mixed with a little black oxide of manganese, and placing them in a copper retort and applying heat. The gas should pass through four washing-bottles, just as the nitrous oxide does. The same bottles will answer. As the nitrous oxide is fifty per cent. heavier than oxygen, it is better to pass it into the gasometer first. The oxygen coming afterwards, passes up through it, and hastens the mixing. It is better to let them stand a day or two, if possible, before using, to complete the mixture, but this is not essential.

Dr. Evans, the well-known American dentist in Paris, asserts that the ordinary nitrous oxide is very far from pure, even when well made. He states that he has been in the habit of purifying his gas by mechanically condensing it to a liquid under high pressure. This liquid, being absolutely pure nitrous oxide, is then allowed to reassume the gaseous form in a bag, or a gasometer. He finds that gas thus purified, only requires about half the usual quantity to anæsthetize a patient.

It seems probable, therefore, that the oxygen mixture will enable us to anæsthetize a patient for the longest as well as for the shortest surgical operations, and that it is safer and pleasanter than any anæsthetic known. There are, however, some inconveniences about it, on account of its great bulk. For office use, and also in hospitals, this is no objection, as it can be kept in a gasometer; but for outside patients it can only be carried in a large rubber bag. In city practice, among the higher classes, however, this is no obstacle, as the bag can always be taken in a carriage, without attracting observation.

I shall continue my experiments, and report the results at a future time.

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sisted in dilating the urethra by injections of tepid water, and smearing the point of the syringe at every attempt with the cerat. simplex, to prevent cohesion. After continuing this course for two or three days he called again to say he had no further difficulty.

Observations.—This is the second case of this character occurring in old subjects, which has come under my notice lately. From the history of the above case, there would appear to be a hereditary tendency in the family to lesions of nutrition in the mucous membrane of the urethra, in consequence, I suppose, of some modification of the capillary circulation of the part. I have seen various degrees of narrowing in the urethra of boys, and the same cause which produces it in the boy will undoubtedly produce it in the adult. Cases present themselves of chronic inflammation, from gonorrhea, of the corpus spongiosum urethra, but in such cases the spongiosum may be felt indurated with more or less discharge from the urethra, but in the above instance nothing of the kind has ever been the case with my patient. That there must have been chronic inflammation there can be no doubt, but from what source?

CASE III.—HYDRATE OF CHLORAL IN ASTHMA.

Asthma is often so obstinate and unmanageable, and so difficult to treat successfully, that any remedial agent that promises to be of value, is important, and deserves a trial at the hands of the profession; and it may therefore be not altogether unprofitable on my part to report the following case: A lady of about thirty-six years of age, of rather delicate constitution, subject to asthma, was seized with a violent paroxysm of spasmodic asthma, and sent for her physician, who was not at home, when I was called in, at six o'clock in the evening, to attend her. She had then been suffering twelve hours. I found her, on my arrival, laboring hard from want of breath, almost suffocating, and a loud, wheezing noise, and rattling, from effusion of mucus in the pulmonary tissues. I administered a mixture of Hoff's anodyne, compound syrup of squills, and fluid extract valerian, in large teaspoonful doses from time to time, when the squills caused

her to throw up a quantity of mucus, which gave great relief at the moment, and induced a sleep of half an hour. On waking up, the paroxysm returned, with an aggravation of all the symptoms, and with great oppression and dyspnoea; she desired the doors to be thrown open—more air was the cry. At this moment her pulse was small and weak, her skin cold, her countenance indicative of great suffering. I now added some hyosciamus to my prescription, but nothing I had done, or could suggest, did any good. She seemed to be getting worse, and I knew of no practice which experience has proved generally successful, or of no pathological light to direct me to the radical cure or relief of this most distressing disease. Antispasmodics, anodynes, expectorants, and the datura stramonium, which was repeatedly smoked during the intervals of the paroxysms, all failing, which had given great relief in her previous attacks.

Entertaining, among the various pathological views of this disease, the impression that the disease was one of spasmodic action of the excito-motory nerves, and most probably consequent on visceral derangement, I resolved to change my treatment, my first indication being to relieve the pain and dyspnoea, and induce sleep. For this purpose I used the following prescription: \mathcal{R} Hydrate of chloral $\mathfrak{D}\text{ij}$, acet. scillæ, tinct. opii camph. aa $\mathfrak{z}\text{ss}$, one-fourth of which was given every hour. After the second dose, the pains and dyspnoea subsided, and she fell into a sound uninterrupted sleep, which continued for some hours, and awoke comparatively well, expectorates freely, and has been improving without any further treatment.

LIQUID NITROUS OXIDE AS AN ANÆSTHETIC.

BY EDMUND ANDREWS, M. D.

Professor of Surgery in Chicago Medical College.

Many months ago I made experiments on the use of nitrous oxide pure, and nitrous oxide mixed with oxygen, with the view of adapting them to the purposes of anæsthesia in general surgery. These experiments, which

were published in THE EXAMINER, showed that there were several difficulties in the way of using, for prolonged operations, the ordinary gas of the dentists—one of which was that the gas never makes the least approach to purity, containing always from 10 to 25 per cent. of free nitrogen and oxygen. As it is almost impossible to separate the free nitrogen without an apparatus for reducing the gas to a liquid form, I suspended the experiments until this deficiency could be supplied.

Three weeks ago I received from Johnston Brothers' Dental Depot, 812 Broadway, New York, an apparatus and a supply of liquid nitrous oxide equal to 100 gallons of gas. It is well-known that under a pressure of about 750 pounds to the square inch nitrous oxide condenses to a liquid, while the free nitrogen and oxygen, contained as impurities in it, remain in the gaseous form in the top of the receiver, hence the condensation serves as a means of separating the oxide from the other gases. The liquid was contained in a strong iron flask about four inches wide and twelve inches long. When it is desired to use the anæsthetic a faucet is turned slightly, allowing the gas to escape into a rubber tube leading to a small sack, and thence to an ordinary inhaler, so contrived, with valves, that the inspirations are drawn from the sack and the expirations pass into the open air. When not in use the whole is packed in a neat case about five inches square and fourteen inches long, with a handle on one side for carrying it, and weighs, perhaps, twelve pounds. The contents of one flask will last long enough for about three surgical operations of moderate length. The intention is to have the flasks kept ready filled at drug stores and dental depots, where the surgeon can return his empty flasks and procure filled ones.

The apparatus being new to myself and assistants, it is probable that we did not obtain the best possible results from it, but the following cases illustrate the effects:

Case 1. Five fingers to be amputated for frost bite, followed by mortification. The patient came under the influence slowly and with difficulty. At length his consciousness seemed to be gone, and his countenance pre-

sented the blue asphyxiated look characteristic of full anæsthesia by nitrous oxide, nevertheless he writhed and struggled during a large part of the operation, and afterwards complained that he felt every cut. The result was decidedly unsatisfactory.

Case 2. This was mortification of a single finger requiring amputation. The patient was given the gas more freely, by turning on a more copious stream from the flask. He was anæsthetized in about forty seconds, and went through the operation without any consciousness of pain.

Case 3. This was an operation upon varicose veins in the leg. The patient went under the influence of the anæsthetic in 35 seconds, obtaining a complete insensibility. In this state I injected the veins of the leg in about ten places with tincture of iron, without causing any pain.

Case 4. The inhalation commenced, but the supply of gas gave out, and the anæsthesia was completed with ether.

It is stated that the operation of ovariectomy has been performed under the successful influence of this anæsthetic in New York.

The present state of knowledge on the subject, derived largely from my own investigations, may be summed up in the following propositions:

1. Nitrous oxide is the safest anæsthetic known. In a laborious collection of statistics which I made, embracing over 200,000 cases, I showed that the mortality of these articles was nearly as follows:

Chloroform, one death in 2,723 cases; sulphuric ether, one death in 23,204 cases; mixed chloroform and ether, one death in 5,588; bichloride of methylene, one death in about 7,000; nitrous oxide, no death in 75,000. (Chicago Medical Examiner, 1870.)

2. Nitrous oxide anæsthetizes the patient in about forty seconds, while the other articles require from five to twenty minutes. The patient also awakes quickly, and does not suffer from nausea afterwards.

3. The liquefaction of the gas renders it portable, so that it can now be easily carried to patients' houses.

4. The expense, after the manufacture and

sale are well established, will probably be less than that of ether.

5. Nitrous oxide always produces a purplish flush of the face, indicating partial asphyxia, though without any sense of dyspnoea, hence it cannot, in prolonged operations, be given continuously, but must be alternated with short intervals of breathing atmospheric air, renewing the inhalation of the gas as often as the duskiness of the countenance subsides.

6. It is not certain yet that all patients can be kept steadily asleep in this manner. Some of them seem to arouse after the first short sleep, and cannot be again fully quieted, even if the gas be pushed to the production of a decided flush of asphyxia in the countenance. Perhaps further experiments will remove this difficulty.

7. Nitrous oxide, in the gaseous form, may be mixed with one-fourth its bulk of free oxygen, and then does not asphyxiate. In my experiments on this subject I kept one patient nine minutes breathing the mixture, but the anæsthesia was less profound than was desirable.

8. If the patient be kept absolutely on pure nitrous oxide alone, he will die by asphyxia in spite of the general safety of the article, as it is incapable of oxidating the blood. The assistant administering it must pay attention to this matter, and give atmospheric air as required. I placed a rat in nitrous oxide gas from a dentist's gasometer, and the animal died in ten minutes, while another rat placed in a jar of the gas mixed with pure oxygen, remained in it half an hour and was taken out alive.

9. Although it is not yet certain that the nitrous oxide can be made generally available for long operations, it is already for all short ones the most convenient, safe and pleasant anæsthetic known.

No. 6 Sixteenth St., CHICAGO, Jan. 10, 1872.

THE REMOVAL OF AN INVERTED WOMB.—Dr. Thomas Hay, of York, Pa. (*Med. and Surg. Reporter*), lately removed an inverted uterus with an intramural fibrous tumor of the fundus. Four weeks afterward the patient was up and about her room, and the operation bade fair to be a perfect success.—*Ibid.*

EXTENSIVE FRACTURE OF THE SKULL AND EFFUSION OF BRAIN, WITH RECOVERY.

BY W. W. MCMANN, M.D., OF GARDNER, ILL.

I was summoned in great haste, on the 10th of April, 1859, to see the son of Wm. H——, of this village, a boy some eight years of age, who unfortunately had his head crushed between the box of a wagon and a building. The injury was so severe that one ounce of brain was pressed from the wound, which was situated about half an inch above the left supraorbital ridge; this I carefully gathered up and weighed. Upon examination I discovered that it would be necessary to trephine and elevate the depressed portion of bone over the left temple. For this purpose I made a V shaped incision, raised the flaps, and sawed off an angle of bone. In the process of elevating the fractured os frontis that was driven into the brain, I scooped out one half ounce more of brain, by weight, making in all one and a half ounces. Although the fractured portion of the skull was pushed into the brain at least half to three quarters of an inch, and the boy was perfectly unconscious from the time the injury was received until the operation was performed, so much so as to be in perfect coma, with total paralysis of all the senses, still, as soon as the depression was relieved, consciousness began to return, and in two hours time he had so far recovered as to recognize his mother. From this the little patient rapidly convalesced, and in three weeks was playing about the house.

REMARKS.—The above unique case was one of considerable interest to me, from the fact of the great loss of brain, and the quick recovery that followed. Also from the fact that he perfectly recovered all his mental faculties. Although nearly three years have past since the injury was received, yet we find him well and hearty, and he is considered the sharpest child in the family of six children.

A NEW MEDICAL BARONET.—The honor of baronetcy has been conferred on the celebrated English pathologist and surgeon, Jas. Paget.

