Practical suggestions for making and inhaling nitrous oxide / by A.W. Sprague.

PRACTICAL SUGGESTIONS

FOR

MAKING AND INHALING

NITROUS OXIDE.

BY

A. W. SPRAGUE, A.M.,

AUTHOR OF "ELEMENTS OF NATURAL PHILOSOPHY," "CHEMICAL MANIPULATIONS," &c.

138 LINCOLN ST., BOSTON.

BOSTON:

WRIGHT & POTTER, PRINTERS, No. 4 SPRING LANE.

The following testimonials, unsolicited, we extract from letters received from those using our Patents:—

The Gas from Sprague's Ammonia, which we are now using, works to a charm. We have long dealt with Mr. S., and know him to be reliable.

January, 1868. FLAGG & OSGOOD, 25 Tremont St., Boston.

The apparatus you sent me works admirably—I have had no trouble whatever with it, and consider it a very ingenious and complete generator. I also notice a difference in the effect of the gas generated by your apparatus and that before used—the advantage being decidedly in favor of that by your machines.

F. J. S. GORGAS, M.D., D.D.S.,
Prof. Dental Surgery, Baltimore College of Dental Surgery.

DEC. 7, 1867.

My apparatus has given entire satisfaction.

J. H. CRAWFORD.

RALEIGH, N.C., Nov. 5, 1867.

The Gas by your machine works admirably, and I am very much pleased with the whole thing.

W. E. BROWN.

NORTH ADAMS, Mass., June 3, 1867.

I have used your self-watching (kerosene) apparatus some two months with the greatest satisfaction. I would not be without it for four times the price it cost me. No Dentist should make Nitrous Oxide without one.

C. A. BRENNER.

ROCKPORT, Ind., Dec. 9, 1867.

In regard to your machine, it worked off like a charm the first time I heated up.

W. R. LILLY.

CIRCLEVILLE, Ohio.

I have been using the Nitrous Oxide Gas generated by your apparatus for nearly two years, and have had unprecedented success, not having, to my recollection, failed in one single instance in extracting a tooth without pain.

CHAS. CHIDSEY.

MOBILE, Ala., Dec. 5, 1867.

I like my Nitrous Oxide apparatus very much. It is far superior to the old method of making and administering the Gas. I could not be induced to return to the old gas bag and watching process.

J. B. PRESCOTT.

MANCHESTER, N.H., Dec. 6, 1867.

Your Regulator and Lamp work beautifully. I am delighted with the whole arrangement.

J. A. CUMMINS.

WARSAW, Ind., Nov. 3, 1867.

The apparatus we had from you works finely in every particular.

DOW & ELLIS.

FREDERICTON, N.B., June 8, 1867.

The apparatus works well.

WRIGHT & SHEARER

COLUMBUS, Ohio.

PRACTICAL SUGGESTIONS UPON NITROUS OXIDE.

The amount of available knowledge in any department of art or science cannot be determined by the number of books and essays issued. The fact that a chemical compound has been long known and familiarly dealt with in popular lectures is no sure proof that it is generally understood. The mania for lecturing and authorship, coupled with the love of gain, has given birth to vast quantities of crude instruction, whenever a new principal of science has been developed or an old one applied.

Nitrous Oxide, although written about and lectured upon for nearly a century, is still new in all that is of use to man. Dr. G. Q. Colton, following the suggestions of the late Dr. Wells, first introduced it successfully, as an anesthetic agent, in 1863. No agent in surgery or hygiene ever had a more rapid introduction: none ever more miraculously escaped death at the hands of ignorant but admiring friends.

At the request of our patrons we have been induced to make the following suggestions, dictated by our experience in this department of chemical surgery.

Is Nitrous Oxide Safe? This is a question so often asked that we will here give our answer in print. We reply, in general terms, that, in our judgment, *Nitrous Oxide is a safe inhalant.* Like beverages sold under the names of coffee, beer, and brandy, it may injure health and destroy life even, — safety in all these cases depending on the *purity of the articles* and the manner of their use. Artificial brandy, "Edgey" beer, and even adulterated coffee, not only injure health, but have been known to prove fatal; and yet we

do not say that *pure* brandy, beer, or coffee are productive of immediate danger. Again, taken too freely, without discretion, in wrong states of the body, all these, and even cold water, have in numerous cases caused sudden death,—but who, on such facts condemns their use?

Every valuable agent is entitled to a fair trial. This, Nitrous Oxide has scarcely had. Hampered by crude salts, unsuitable apparatus, ignorance and blundering, its success has exceeded reasonable expectation even. Of the more than 300,000 instances where it has been administered for anesthesia during the brief period since its introduction, to our knowledge, but three cases of death from this have been reported, and two of these even were under circumstances which left much doubt as to the real cause.

Numerous faults and blunders must necessarily attend the *introduction* and trial of any agent in surgery so extensively employed as Nitrous Oxide. When the "Laughing Gas" furor prevailed in 1863, ignorance seemed to vie with avarice, in furnishing the materials for producing "Anesthesia" by its use. Whiskey casks, small filthy inhaling bags, and cheap nitrate of ammonia were rampant. "Teeth extracted without pain by Pure Nitrous Oxide," hung promisingly from almost every Dentist's office door.

At this time, a lady acquaintance in delicate health applied to one of those "Pure Gas" offices, to have an offending molar removed by gas. While she waited, a furious heat was applied to a pint retort charged with a crude salt, and the gas forced rapidly through a single small washing bottle into a four-gallon bag. Soon the bloated bag was brought out, the lady gagged with a cork, the mouth-piece forced between her jaws, and she left, *nolens volens*, to breathe this compound of corruption. Insensibilty *from some cause* soon followed, and the tooth was drawn. Upon recovering consciousness she experienced a violent headache, nausia, and a sore mouth. The irritation of her lungs was also increased, and for weeks she was a severe sufferer. Her experience assured her, and the whole community, that Nitrous Oxide was not safe. Friends and neighbors, and "all the doctors" of the village, joined in condemning the use of such a dangerous agent as Nitrous Oxide, while not a suspicion rested upon the knowledge and skill of the "excellent dentist."

We have more than once tested gas in offices where they "did'nt have any complaint," that "sent us whirling."

A popular lecturer once assured us that in one of his best exhibitions of "laughing gas," the delirium was effected by inhaling and exhaling from a small rubber bag *filled only with air.*

At another exhibition by a strolling "professor," all who inhaled the "laughing gas" were made sick. The same "professor" pronounced us altogether too fussy when we cautioned him against gas made from cheap nitrate ammonia, at a high heat, and only partially washed through a single rude washer.

We might multiply cases where these "chain lightning" compounds have been administered for pure Nitrous Oxide. But we have said enough to show the causes for complaint which have been preferred against Nitrous Oxide. Pure Nitrous Oxide, administered with discretion, comports itself with all systems. We have inhaled to insensibility, that prepared by ourselves, nearly 200 times during the past three years, with beneficial rather than injurious results.* Messrs. Flagg & Osgood, of this city, have given the gas for extracting teeth more than eleven thousand times without a single serious result.

On this point, Professor Geo. Watt, well-known as authority on all matters pertaining to the chemistry of dentistry, thus remarks:

"Never before did I feel so strongly the importance of using only *pure nitrous oxide.*

"In our schoolboy days, when bad results followed the administration of 'laughing gas,' the explanation was that some temperaments could not bear it. Now let it be remembered, that *pure* nitrous oxide agrees with all temperaments, and, probably, with all conditions of the constitution. But this must not be misunderstood. A patient may be afraid of the gas, or may dread the operation, or from various causes may be unduly excited at the time. Such patients

*A little more than a year ago an interested and unscrupulous "Doctor," well known under sundry aliases, attempted to convince the public of Boston that Nitrous Oxide was dangerous. He employed, as we have reason to believe, an accomplice to aid him in his purpose.

Entering a certain office in the city where Nitrous Oxide tested by ourselves, and known to be pure, was given, this accomplice requested to inhale the gas for an alleged bronchial difficulty. After inhaling, as we were informed, "about a quart," he quite unceremoniously took a recumbent posture, and performed successfully the part of a fit. After rolling about the floor a sufficient time, he was removed, and soon after commenced against the proprietors an action for damages from the effects of Nitrous Oxide. No damages were however allowed — none paid. Facts which have recently come to light leave little doubt that the whole was a farce, paid for by one whose reckless career promises to be seriously embarrassed by the stern retributions of the law.

are not apt to breathe freely, and, therefore, the blood is not decarbonized, and the system suffers. Then the apparatus may be so arranged as to make breathing difficult. The delivery tube may be too long, or the valves of the inhaler too contracted. Of course, the blood will not be duly oxygenated, and the patient is the worse for the inhalation. But when *pure* nitrous oxide is inhaled as tranquilly and as easily as atmospheric air usually is, *it can disagree seriously with no one.*"

How should Nitrous Oxide be Inhaled? Many in every profession seem to practice upon the maxim that "whatever is, is right." Many dentists still cling to the semi asphyxiating process of breathing in and out from a small rubber bag. Those of this class, who think it impossible to advance on Humphrey Davy and the "old college professors," will think us too fast when we call such a loathsome practice an insult to refinement, and a positive injury to health. Think of being rendered insensible by gas inhaled from a small bag reeking with filth, and into which the effete matter from one's own lungs is to be repeatedly emptied. Some very caustic criticisms have been justly made upon this practice by certain medical journals; and, unfortunately, the use of Nitrous Oxide has been condemned because of this.

Experience long ago convinced us that pure gas, skillfully administered by a proper valve-inhaler, requires little, if any, more for effectual anesthesia than where the bag is used.* To be sure, giving gas by the valve arrangement requires some skill and experience; but what operation in surgery does not require more skill when safely and rightly, than when recklessly, performed. In most cases, the quantity of pure gas for effecting anesthesia varies with the skill and judgment of the operator. The action of the lungs, and nervous condition of the patient, have also much to do with the amount inhaled. We once saw a "raw hand" administer to a lady *fifteen* gallons of gas with scarcely any anesthetic results. The same lady was afterwards unconsciously and successfully deprived of five teeth from breathing only *four* gallons by means of the valve-inhaler. Dr. H. F. Russell, of this city, who has always given Nitrous Oxide pure from a zinc gas-holder, by the use of a valve-inhaler, recently

* We first used the valve-inhaler in lectures upon the gas, given during the winter of 1854, and have ever advocated the use of such only.

showed us a table of the quantity inhaled by each patient during several successive weeks, the average being only $3\frac{7}{10}$ gallons.

Economy of the gas, and successful anesthesia, require the observance of certain conditions in inhaling. The lungs should be expanded to their *full* capacity by several inspirations of air before any gas is given, as the amount of oxidation of the blood has to do with anesthesia, and as air and Nitrous Oxide both act the same, but in different degrees, a few such breathings will serve to calm the patient and greatly aid the effects of the gas. This air may be given through the inhaler.

Avoid inhaling the gas too rapidly at first. Breathe in full breaths *slowly*, and exhale the same. The object is, to retain the gas as long as possible in the lungs, and allow it to be absorbed in the blood. Should the patient seem distressed, give a single breath of air through the nose; this will usually afford relief, and retard but little the anesthetic effect. Or, should the patient stop breathing, and act balky, giving the nose to *exhale* will often right the breathing. Until the blood is decarbonized, the eliminating of carbonic acid in the lungs is often so rapid as to produce temporary suffocation. This may be relieved as we have directed.

Patients who pass too rapidly into the anesthetic state generally pass out of it the same. For this reason we prefer giving some air in a few cases to moderate the action of pure gas.

No specific directions can be given which shall exactly meet every case — much about inhaling must be left to the judgment of the dentist.

When Nitrous Oxide is inhaled in its purity, the head is affected far less unpleasantly than when mixed with carbonic acid in a bag. We have never experienced with pure gas, "the fearful hum," the wild delirium, and the spectral visions so often described.

On the subject of inhaling Nitrous Oxide, Dr. Watt remarks as follows: —

"I will not, in this paper, discuss its *modus operandi*, in producing anesthesia. But it appears to be on principles totally different from those of chloroform and ether.

"An important practical point in using absolutely pure gas, is to avoid carrying the patient beyond the stage of complete anesthesia. I do not recollect of having seen anything in the books or journals to lead us to suspect that this is even possible. The general impres-

sion appears to be, that the longer a patient breathes the gas, unmixed with air, the more profound the unconsciousness; and I can account for this only on the theory of not experimenting with pure gas. Even when pure gas has been obtained, till very recently, the experimenters only inhaled *one* pure breath of it before commingling with it the carbonic acid and other deleterious agents contained in their expirations. Each breath, diminishing the quantity of oxygen, and increasing the carbonic acid, tended to bring on a state of asphyxia in connection with anesthesia. Patients thus smothered may remain unconscious in proportion to the time spent in the process of suffocating them; suffocation, rather than anesthesia, being the proper term to designate the process.

"But when pure gas is freely breathed, the patient soon becomes unconscious; but by the time the superoxydized blood has become commingled with the general circulation, the breathing becomes less frequent and less full, the patient feeling no inclination to breathe more than enough to decarbonize the blood. Such a patient soon returns to consciousness, and may breathe the gas for an indefinite period, without mental or muscular disturbance. I have said for an indefinite period, simply meaning that I know not how long it may be thus breathed. I have breathed it so myself for ten minutes, being fully self-possessed, reading, making mathematical calculations, etc., requiring not only consciousness, but concentration of thought; and at the close of the experiment the muscles were as obedient to the will as usual. I have had similar experience with others.

"Then, to produce perfect anesthesia, the gas should be breathed freely at the start, and all admission of atmospheric air should be prevented. Many patients fail to breathe freely and fully through dread of the operation, — fearing that it will be painful, or, if not, that they will never return to consciousness. Some patients cannot control themselves so as to aid the respiratory function by voluntary effort. Their breathing, at best, may be feeble. With such it is often difficult to produce full anesthesia. They should be induced to practice full inspirations for a little while before trying to inhale the gas; as by the effort the air cells are expanded, the respiratory muscles are brought freely into play, and the patient usually begins the gas with correspondingly full inspirations. A patient once breathed twenty-one gallons of the gas, and at another sitting thirty, without being at all unconscious. By adopting the

measures just recommended, he was brought to a state of complete unconsciousness by inhaling two and a half gallons.

"But it is fortunate that those patients who breathe slowly and feebly are not usually excitable. Hence they are generally calm enough to sit still for an operation, even though conscious that it is about to be performed. The fact of consciousness is not proof of pain; for it has been long recognized, that a severe operation may be performed while the patient does not suffer, though conscious of all that is going on. Any one familiar with the use of chloroform must have seen cases that prove this position.

"This return to consciousness while breathing the pure gas, indicates that nitrous oxide is not likely to supersede ether and chloroform for tedious operations, though I have known it highly successful in those requiring from five to fifteen minutes; but in the latter part of the operation, in each case, the patient was quite conscious, though quite indifferent, to all that was in progress."

How can Nitrous Oxide be Prepared in its Purity? This question should be seriously considered by every Dentist who uses the gas. To prepare a really pure gas is just as easy as to prepare that of doubtful quality. Ignorance or parsimony, however, often jeopardizes the health of patients,—and the reputation of Nitrous Oxide, by attempts to economize too much in its preparation. One "bad case" will, however, more than balance a hundred successes.

To prepare pure Nitrous Oxide three conditions must be regarded: a pure salt of the nitrate of ammonia, a moderate and uniform heat applied to this, and an effectual and thorough washing of the gas. To effect these requires a proper apparatus. Many have been led into serious mistakes by the rude and childish devices figured in many of our text-books of chemistry. One exhibits an-oil flask for holding the ammonia, a single pint Woulf's bottle for washing the gas, and a *bladder* for receiving and inhaling it.

The retort for holding the salt should have sufficient capacity (one to three quarts), so as to expose a broad surface to the action of the heat. The heat of the melted nitrate should be kept under 410°, and so controlled as to maintain this nearly uniform.* We employ

*Few seem to realize how a few moments of excessive heat will deteriorate and render unfit for respiration a whole gas-holder of gas. We are convinced from actual experiment, that a too great and fluctuating heat is as often fatal to good gas as bad nitrate of ammonia, and both should be carefully avoided.

for this a water-gauge, or *self-watching regulator*. When properly arranged, we have ever found this regulator reliable, and the gas quite different in its physiological effects from that prepared by the ordinary apparatus where the heat is watched and determined by the eye.

The washers (from three to five) should be of suitable capacity (one to two gallons), and provided with some device for washing the gas, by *dividing* or *straining* it in its passage through the purifying liquid. A simple forcing through a single opening in this does not effectually wash the gas.

The Gas-holder should be of metal (thick, well-rolled German Zinc), and so arranged that the gas may be collected and inhaled from this over water.

For holding Nitrous Oxide, rubber bags or wood holders are unsuitable. Besides giving an unpleasant taste to the gas, these allow the mysterious attraction which Nitrous Oxide and air have for each other to go on rapidly through them, so that soon (one to four days) the contents of the bag or cask are found to be largely adulterated by air. In a suitable metallic holder, we have often administered Nitrous Oxide successfully from six weeks to two months after its preparation.

Excessive and Irregular Heat of the Melted Ammonia to be Guarded Against. Of this we have already spoken. Disregard of the heat applied is the cause of very much of the impurity found in Nitrous Oxide.

Nitrate of ammonia, from which the gas is usually prepared, melts at a heat of about 230°. At 395° it begins to decompose into Nitrous Oxide and water. Between 395° and 410° the pure *fused* and *dry* salt yields only pure Nitrous Oxide and water. 80 parts by weight of the salt yielding 36 parts of water and 44 of the gas.* When the heat is allowed to rise much higher than this point, deleterious compounds form with the Nitrous Oxide, which, if allowed to any considerable extent, may prove fatal to health and even life.

Of the changes effected by heat, Prof. Watt remarks as follows: —

"Unfortunately, it has been the general belief, that when pure

*One pound of fused salt yields about 37½ gallons of gas. Cold water will in time absorb its own volume of this, and give it out when warmed. Hence the appearance of leakage of the gas-holder at first making. When the water becomes saturated (from 3 to 6 days) this apparent leakage ceases, if the holder be tight.

nitrate of ammonia is used pure nitrous oxide will be obtained. This is a very serious mistake. At least three violent poisons may be generated from the pure nitrate. But the one most likely to be formed, the hardest to separate from the nitrous oxide, and the most deleterious in its effects when inhaled, is the binoxide of nitrogen, or *nitric* oxide. This gas is colorless, and therefore invisible; is much lighter than nitrous oxide, and far less soluble in water. If any of it is formed, it is likely to pass into the gasometer. Unfortunately, some of our authors tell us that it and all other impurities are removed by passing the gas through water. To wash this out of nitrous oxide would be equivalent to washing sand out of sugar. If equal quantities of the two gases were commingled, and the mixture passed through water, by the time the water had absorbed all the *nitrous* oxide eighty-nine per cent. of the *nitric* oxide would still remain.

"To separate nitric from nitrous oxide, some writers tell us to put sulphate of iron in the washers. But this is not satisfactory. When it is not the intention to form any nitric oxide, and when we have no means of knowing, at the time, how much is made, how are we to know how much sulphate to use? Again, we are told to leave some atmospheric air in the gasometer. If nitric oxide is formed, it will be changed to nitrous acid by the oxygen of the air, and this will be dissolved in the water. But how much air shall we leave in? If too much, our gas is *diluted*, and not reliable. If too little, we still have the poison.

"But if nitric oxide is formed, why is its presence so objectionable? Think, for a moment, of its nature and properties. It is composed of one equivalent of nitrogen united with two of oxygen. When exposed to atmospheric air, it takes two more equivalents of oxygen, and is changed to nitrous acid. This, in contact with water, is changed to nitric acid, by taking an equivalent of oxygen from the water. And who would not shrink from the thought of cauterizing the entire pulmonary mucous membrane with the vapors of nitric acid? But the nitric acid formed as above described is brought in contact with this membrane in its nascent state, being then as much more caustic than ordinary nitric acid, as ozone is more corrosive than oxygen. That nitric oxide goes through these changes rapidly, may be demonstrated by a simple experiment in the hands of any one. Nitric oxide is colorless. When dilute nitric acid is

poured on copper, or a similar metal, this gas rises in small bubbles. These have scarcely escaped into the air till orange-colored or red fumes are seen, showing that the change to nitrous acid has already taken place.

"The only proper and safe way, then, is not to generate the nitric oxide. And this involves the control of the temperature at which the nitrate is decomposed. I am constantly becoming more careful on this point. The heat regulator of Sprague's apparatus very nearly accomplishes the desired result in this direction: that is, when illuminating gas is used in heating. I am not familiar with the action of his regulator for Kerosene heaters. It is altogether impracticable to regulate the heat by the eye. No inexperienced person would believe how small the flame must be toward the close of the process.

"For the various reactions that may take place in decomposing nitrate of ammonia by heat, I refer you to a brief article in the December number of the REGISTER, which was republished in the *Cosmos*. Since writing that, I have received many letters of inquiry, many of which I have not had time to answer. Some of them tell me they have no heat regulator, but they 'have a boy to watch it'; that their heater is small, and they don't have a large flame, — they had to get their apparatus because their competitors used gas, — and they had 'a real good gasometer,' and did n't I think they were safe in using it? — and so on, *ad infinitum*. One day I got a number of these letters. I went to sleep at night while my imagination was carrying me back to the days of James Watt. I thought a young engineer wrote to him that he had put up a first-rate steam-engine, but could not afford a patent steam-gauge. So to make it safe he put a small fireplace under the boiler, and got wet shavings for kindling, used only green wood, and hired a very lazy fireman, and told him he need n't fire-up very vigorously, and now, did n't he think it was safe for the hands to work above it in the factory?"

NITRATE OF AMMONIA SHOULD BE PURE. The quality of no article sold varies more than this. As every dentist claims to administer pure gas, so every chemist claims to make only pure nitrate of ammonia.

A safe gas can never be made from a bad salt; especially is this true where the heat is not controlled by a self-watching regulator.

Vast quantities of the nitrate of ammonia sold have been prepared from the cheap commercial nitric acid and crude ammonia. Both of these are almost invariably charged with impurities which enter into the composition of the resulting salt.* The *color* of nitrate of ammonia does not necessarily determine its purity. Many suppose the purity of this to depend on its *whiteness*. An excess of acid, or undue heat, will give a snowy whiteness to many a spurious article. In the fused lump ammonia, a slightly yellow or blueish tinge is a favorable indication.

Nitrate of ammonia not being a very stable compound, easily parts with a portion of its alkali, and suffers deleterious change when exposed to air and moisture; hence it should be kept tightly closed from the air, and in a cool place.†

The following excellent advice under this head, we quote from the well-known writer already mentioned: —

"Having insisted on the purity of nitrous oxide as a condition of success, it is well to inquire what agents are most likely to contaminate it, why these are objectionable, and how we may avoid their presence.

"The contaminating agents most likely to annoy us in practice are atmospheric air, vapor of water, chlorine, and nitric oxide or binoxide of nitrogen.

"The first of these annoys by the patient inhaling it along with the gas, the result being a failure to secure complete anesthesia, the patient reaching that state referred to above in which he will not breathe even the pure gas with sufficient rapidity to render him unsconscious. An improved mouth-piece will remedy this difficulty.

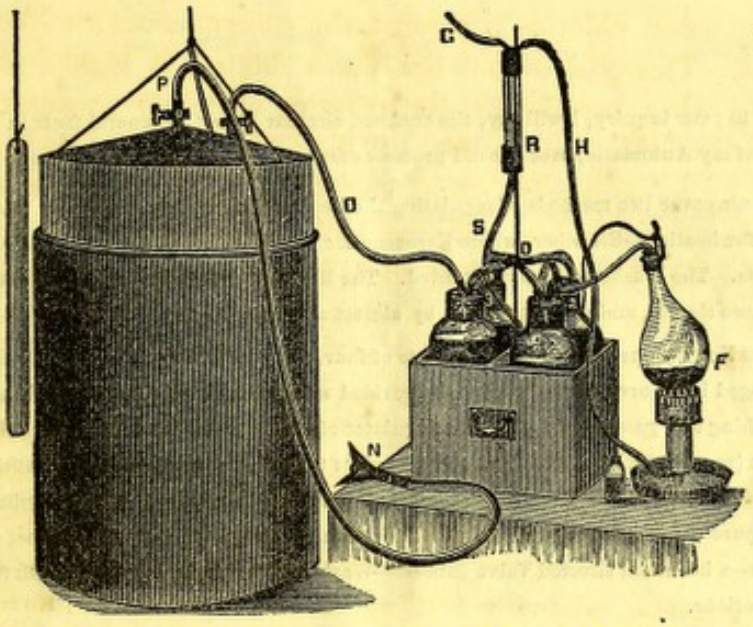
"Nitrous oxide, as ordinarily observed, becomes diluted by mixture with the vapor of water. This does not interfere with its purity in a therapeutic sense, nor does it ordinarily result in any inconvenience. When I find a patient is hard to influence, if a second operation is necessary, I endeavor to have gas very recently prepared, to meet the case. Thus far, the difficulty is *dilution* rather than adulteration.

* Gas prepared from the cheap and impure salt is very apt to "blacken" the patient. We have known instances from this cause, where life seemed to hang for awhile in a balance. In such cases of suspension, a battery may be used, or artificial breathing, created by efforts to compress and expand the lungs of the patient. The safest and the cheapest in the end, is to purchase only pure nitrate of ammonia.

† We prefer for convenience the *fused granulated*. This we are now furnishing in tightly sealed packages of 5, 10, 20, and 50 pounds.

"But when chlorine is present, the consequences are likely to be serious. This gas, even when much diluted, is highly poisonous, causing, when breathed, great irritation of the air passages, as well as constitutional disturbance. If the nitrate of ammonia is contaminated by *sal ammoniac*, called sometimes muriate of ammonia, and chloride of ammonium, chlorine will be liberated when the salt is decomposed by heat. When there is any doubt, the salt should be tested. In the absence of test tubes, small vials will answer. What are called 'homœopathic vials' will be convenient. A portion of the nitrate is to be dissolved in pure water. Dissolve also a small quantity of nitrate of silver in pure water. Pour the solution of the nitrate of ammonia gradually into that of the nitrate of silver. If any soluble chloride is present, a grayish-white precipitate will be formed, which will render the solution milky in appearance at first, the precipitate gradually settling to the bottom. Chlorine being twice as soluble in water as nitrous oxide, a moderate proportion of it may be washed out; but the only judicious and safe way is not to make it."

Difficulty of Bringing Patients into a Complete Anesthetic State. The mingling of air with the Nitrous Oxide is a principal cause of failure in this respect. The lips of many patients do not close around the mouth-piece, or the cup does not fit to the face, or the outer valve of the inhaler may leak badly. From such causes, air often enters with the gas sufficient to allow this to produce only intoxication and delirium — not anesthesia. Again, patients who have just recovered from anesthesia are usually excited and often fatigued. In such cases, it is sometimes quite difficult to effect a second anesthesia. The better course, especially with persons of weak nerves, is to wait until the next day before inhaling again. *A calm resignation, and full and slow breathing*, are great economizers of the gas. Do not let the head of the patient tip back too far, or the tongue fall down, so as to cause the breathing to be difficult.



SPRAGUE'S SELF-WATCHING

Nitrous Oxide and Oxygen Apparatus.

Patented Nov. 1st, 1864.—June 12th, 1866.—Improved July 6, 1867.

By this arrangement, an absolutely pure Gas, ready at once, for inhaling, may be easily prepared, at *half the usual cost*. More than 100 Dentists and Physicians now attest to the economy, purity and safety of this over all other processes. We make four sizes—each *complete* for preparing and inhaling gases. Prices $50, $75, $85, and $100.

Dr. G. Q. Colton has recently ordered six No. 1 Machines for his Dental association—a seventh for the Paris Exposition, and an eighth for the Dentiste Royal of Belgium.

We have made by Sprague's patent some 150 gallons of Nitrous Oxide daily, for more than three years. We could not afford now to return to the old principle. FLAGG & OSGOOD, Boston.

I could not think of giving the Gas unless I had your Regulator in preparing it.

C. G. DAVIS, New Bedford.

I should not want to be without your Regulator for the price of the whole apparatus. No Dentist after once using it will be without it. A. F. DAVENPORT, North Adams, Mass.

F.—Flask for holding the salt. This is connected by a free bent glass tube with Washer No. 1.

D.—Distributor of the Oxygen or Nitrous Oxide through the perforated Washers.

R.—Regulator for governing the flow of the burning gas, supplying the heater, by means of a water valve.

G.—Hose leading from the gas pipe to R.

H.—Hose leading from R. to the heater.

Water supplying R. is conveyed from a washer beneath, through a siphon and hose S. By this simple arrangement, a uniform heat of the melted salt is accurately maintained during the entire operation, and at a point below that at which white fumes, or any noxious gases form—thus effecting a great saving of time and ammonia, and insuring a pure gas.

O.—Hose for delivering the gas after washing, into the gas-holder.

N.—Valved Inhaler, attached to the large inhaling hose P.

Boston, 186

Dear Sir:

In reply to your inquiry, I will say, the enclosed circular gives the general facts in reference to the advantages of my Automatic, over the old processes for preparing Oxygen and Nitrous-Oxide Gases.

My patents cover two methods of regulating the heat of the decomposing salt. One where lighting Gas is used for heating—the other, where Kerosene &c., are the heating agents. Please state which you must use. The Washers are also patented. The Regulator, for lighting Gas, is decidedly preferable, being more simple, and easily operated by almost any one.

Apparatus No. 1 (figured in the cut) consists of four, one and a half gallons Washers, (a fifth extra) neatly arranged in an ornamented case, and provided with a Distributor and Glass Strainers for dividing and washing the gases—an Automatic Regulator of the heat—a Gas or Kerosene Heater—two half gallon flasks (provided with rubber stoppers and glass tubes)—a seventy-gallon, beautifully japanned zinc Gas-holder, with water packing—weight and pulley for balancing the inner cylinder—ten feet of large thick pure Rubber Inhaling Hose, with ⅝ inch hole, and seven feet of the same, delivering hose, ¾ inch hole—a beautiful silvered Valve Inhaler—Washing Chemicals, &c. &c.; with full and accurate printed directions.

Apparatus No. 2,—Same as No. 1,—with the following exceptions. No extra washer—plainly painted case—a fifty-two gallon, plain zinc Gas holder, and wood or hard rubber valved Inhaler.

Apparatus No. 3.—Same as No. 1, with the following exceptions:—Four Washers without case, (see cut No. 2—One flask, stopper and tube.—Seven feet of inhaling and five feet of delivery hose.—Hard rubber or wood valved Inhaler, and a fifty-two gallon, plain zinc Gas-holder, without weight.

Apparatus No. 4.—Same as No. 3, but without the Self-watching arrangement or Heat-Regulator.

These apparatuses, are all thoroughly made of the best material, and are neat, attractive and *durable*. The Gas-holders are made of the best German zinc. No trashy sheet tin or galvanized iron. No Machines are sent from our place until tested and known to be perfectly operative.

The Generating Apparatus, all packs safely inside the Gas-holder, and the whole, in a strong box. We have very rarely had any breakage in transporting.

PRICES.—No. 1; $100.00. No. 2; $85.00. No. 3; $75.00. No. 4; $50.00—No. 4 with bag for Gas-holder; $45.00. An apparatus of the common form, without our patent Washers, we will furnish for $35.00. Our charges for Nos. 1, 2 and 3 Machines, are not for a good Apparatus merely, but for a safe and economical patented principle. Packing extra. With Gas-holder, $2.50—without Gas-holder, $1.00. We take no risks after the goods are safely delivered to the carriers. Deductions for Apparatus without Zinc Gas-holders $18.00 and $23.00. Larger Gas-holders made to order.

All Machines worked by a Heat Regulator, are sent direct from our place in Boston. Duplicate pieces furnished at cost.

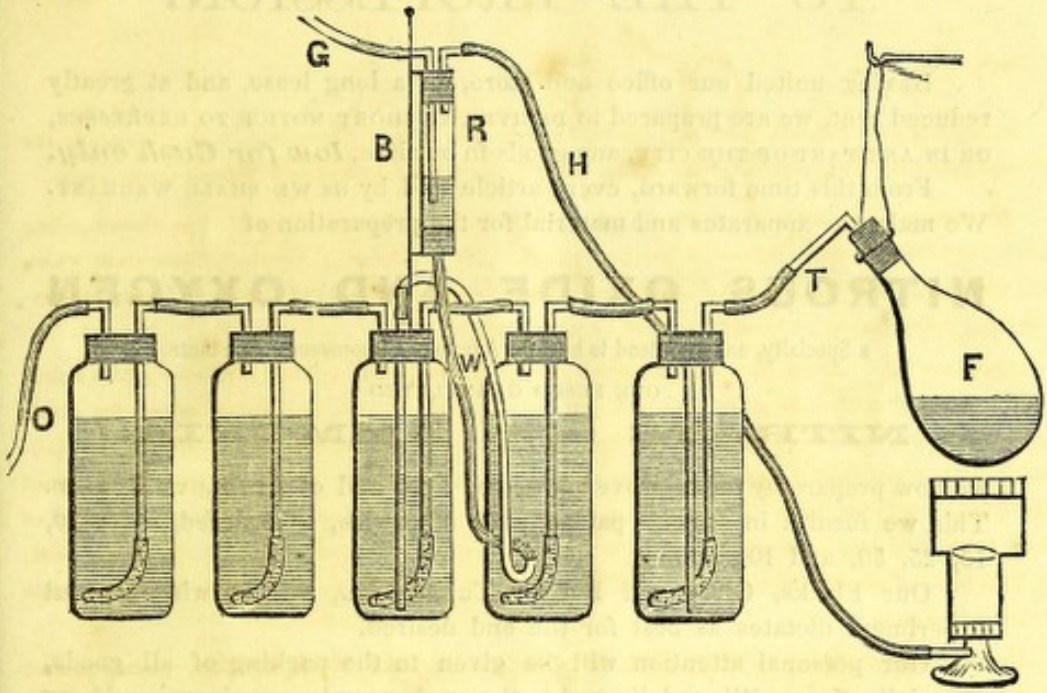
Exclusive Medical or Anesthetic rights for territory sold and guaranteed.

More than one hundred Machines of our patent are in operation in America and Europe. To them we refer the inquirer as to the merits of our process.

We shall not attempt to effect sales by the degrading policy of "running down" other apparatuses, or by taking advantage of the ignorance of the purchaser.

A. W. SPRAGUE, 138 Lincoln Street.

GENERATING AND WASHING ARRANGEMENT OF SET NO. 3.



Sprague's Self-Regulating Nitrous-Oxide Apparatus,

FOR PREPARING

CHEMICALLY-PURE ANESTHETIC GAS,

For Dentists, Hospital Surgeons, and others.

Patented Nov. 1*st*, 1864.

F.—Quart or half-gallon glass flask, for holding the nitrate ammonia.

T.—Long bent glass tube, connecting, by means of the rubber hose, the flask with the longer side tube of the first wash jar.

R.—Regulator of the flow of gas or air supplying the heater beneath F. The gas passes through the hose G, down the longer tube, into the water of R; and out, through the shorter side tube and H, to the heater.

Advantages of Automatic Regulation of the Heat.

First. — Purity of gas, not attainable by the common methods of heating.

Second. — Saves nearly the whole time usually required in watching the heat.

Third. — Does not allow the ammonia to waste by distilling it over at an undue heat. By the old process, two ounces in a pound are sometimes so wasted.

Fourth. — Does not break flasks and retorts. We have used the same flask three months. Our washers as now made we can warrant to be tight and durable.

Any Infringement on these Patents will be prosecuted to the full extent of the law.

TO THE PROFESSION.

Having united our office and store, on a long lease, and at greatly reduced rent, we are prepared to DELIVER AT SHORT NOTICE TO EXPRESSES, OR IN ANY PART OF THE CITY, any goods in our line, ***low for Cash only.***

From this time forward, every article sold by us WE SHALL WARRANT. We make the apparatus and material for the preparation of

NITROUS OXIDE AND OXYGEN

a Specialty, and we intend to hold the Advance in Improvements on these.

OUR FUSED GRANULATED

NITRATE OF AMMONIA,

we now prepare by an improved process, DRY and of ABSOLUTE PURITY. This we furnish in SEALED packages or otherwise, as ordered, of 5, 10, 15, 25, 50, and 100 pounds.

Our Flasks, Glass and Rubber Tubing, &c., will be what careful experiment dictates as best for the end desired.

Our personal attention will be given to the packing of all goods, especially glass. When delivered to the express, unless we insure, and are paid therefor, our liability ceases.

☞ ***The cost of collection by express will in every case*** be added to the bill, when the amount does not exceed $20. Goods paid for by mail will receive special care, and any overplus will be returned. Confidence reposed in us will not be violated. Goods, when prepaid, may be forwarded by fast freight at about one-quarter the cost of expressing.

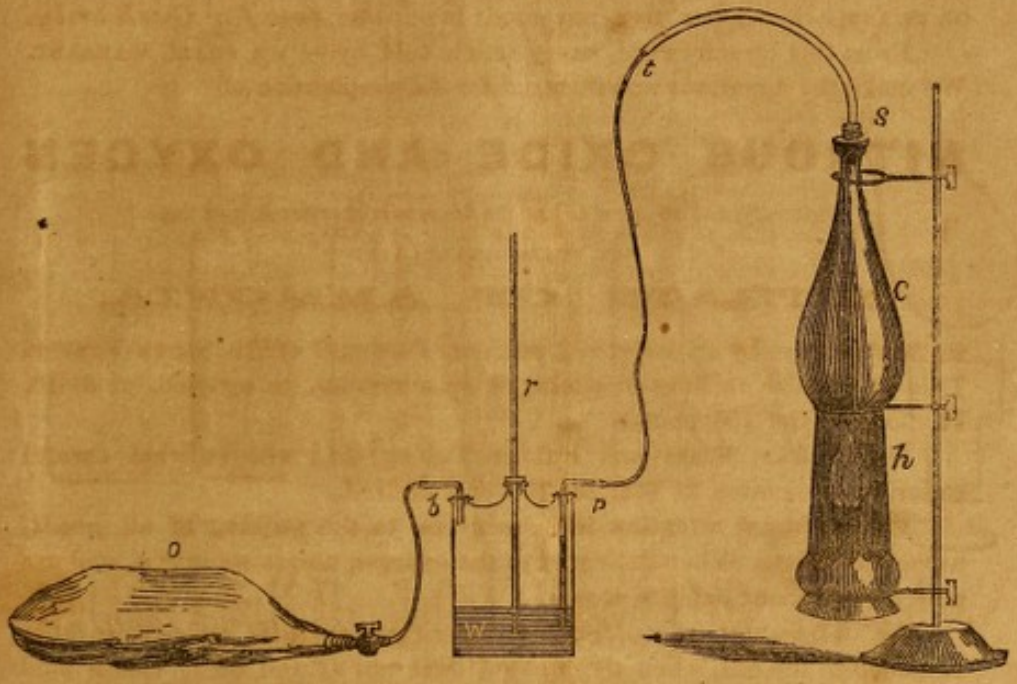
PRICES.

Nitrate Ammonia, fused & granulated, single packages of 5 or 10 lbs., per lb.,	$0.65
" " " " " " of 15 or 20 " "	.58
" " " " " " of 50 or 100 " "	.55 & .50
Packing extra of each,	.25, .50, & .70
Chlorate of Potash for Oxygen, per lb.,	.75
Per Oxide Manganese, "	.20
Half-gallon Glass Flasks, best quality, 1 to 6 each,	.75
" Iron " porcelain lined,	8.00
" Glass " best quality, 6 to 12, each,	.65
" " " " " by the cask (3 to 4 doz),	.55
Packing extra of each,	.30, .50, & 1.00
Rubber Stoppers for Flasks, each,	.25
Very thick pure Rubber Tube, 3-16 inch hole, per foot,	.20
" " " " ⅜ " "	.30
" " " " ½ " "	.35
" " " " ⅝ " "	.40
Glass Tubing, per pound,	.75
Sprague's Silver-plated Valve Inhaler,	8.00
Hard Rubber " "	4.00
Shaw's Gas Heaters,	.75
Jet for "	.75
In ordering flasks, give the size of your stoppers.	
"Practical Suggestions for Making and Inhaling Nitrous Oxide" (Sprague),	.20

A. W. SPRAGUE,

138 Lincoln, cor. Kneeland St., Boston.

(Opposite Albany R.R. Depot.)



SPRAGUE'S OXYGEN APPARATUS,

FOR

SCHOOLS, AND CHEMICAL EXPERIMENTS.

Price, $15 and $20.

Binden