XIV.

Reſearches, Chemical and Philoſophical, chiefly concerning the Nitrous Oxide, or Dephlogiſticated Nitrous Air, and its Reſpiration. By Humphry Davy, *Superintendent of the Medical Pneumatic Inſtitution.* 8vo. *London.* 1800.

OF the many ſingular and highly intereſting particulars contained in the volume now before us, no proper analyſis could be given within the limits of our periodical publication. For moſt of theſe, therefore, we muſt refer the chemical reader to the original work, which demonſtrates, in a remarkable degree, the induſtry and genius of the author, whoſe enthuſiaſm for the diſcovery of truth, has led him, with a perſeverance almoſt without example, to undergo very great ſufferings, and even to run the riſk, on many occaſions, of

immediate death. And we have no doubt that the intelligent reader, after a careful perusal of his experiments, will give him due credit for his meritorious exertions.

We shall here content ourselves with merely mentioning, in a general way, the subjects considered in his three first researches; and we shall give a particular account of the fourth, as being more immediately connected with the practice of medicine.

The first research is into the analysis of nitrous acid and nitrous gas, and the production of nitrous oxide. After a great variety of experiments and observations on the composition of nitric acid, on its combination with water and nitrous gas, on the composition of ammoniac, and on its combination with water and nitric acid, he treats of the decomposition of nitrate of ammoniac, and the preparation of respirable nitrous oxide.

Of the preparation of nitrous oxide for experiments on respiration, he gives the following account. When compact nitrate of ammoniac is slowly dissolved, the nitrous oxide produced is almost immediately fit for respira-

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tion. But, as one part of the ſalt begins to decompoſe before the other is rendered fluid, a conſiderable loſs is produced by ſublimation. For the production of large quantities of nitrous oxide, fibrous nitrate of ammoniac ſhould be employed. This ſalt undergoes no decompoſition till the greater part of its water be evaporated, and, in conſequence, at the commencement of that proceſs, is uniformly heated.

The gas produced from fibrous nitrate muſt be ſuffered to reſt at leaſt for an hour after its generation. At the end of this time it is generally fit for reſpiration. If examined before, it will be found to contain more or leſs of white vapour, which has a diſagreeable acidulous taſte, and ſtrongly irritates the fauces and lungs. This vapour moſt probably conſiſts of acid nitrate of ammoniac and water, which were diſſolved by the gas, at the temperature of its production, and afterwards ſlowly precipitated.

It is found in leſs quantity when compact nitrate is employed, becauſe more ſalt is ſublimed in this proceſs, which being rapidly precipitated, carries with it the acid and water.

Whatever ſalt be employed, the laſt portions of gas produced generally contain leſs vapour, and may conſequently be reſpired ſooner than the firſt. The nitrate of ammoniac ſhould never be decompoſed in a metallic veſſel, nor the gas produced ſuffered to come in contact with any metallic ſurface; for in this caſe, the free nitric acid will be decompoſed, and conſequently a certain quantity of nitrous gas produced.

The apparatus which has generally been employed in the Medical Pneumatic Inſtitution, for the production of nitrous oxide, conſiſts,

1. Of a glaſs retort, of the capacity of two or three quarts, orificed at the top, and furniſhed with a ground ſtopper.

2. Of a glaſs tube, conical, for the purpoſe of receiving the neck of the retort, about four inches wide in the narroweſt part, four feet long, curved at the extremity, ſo as to be capable of introduction into an air-holder, and encloſed by tin plate, to preſerve it from injury.

3. Of air-holders, of Mr Watt's invention, filled with water, ſaturated with nitrous oxide.

4. Of a common air-furnace, provided with dampers, for the regulation of the heat.

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The retort, after the inſertion of the ſalt, is connected with the tube, carefully luted, and expoſed to the heat of the furnace on a convenient ſtand. The temperature is never ſuffered to be above 500°. After the decompoſition has proceeded for about a minute, ſo that the gas, evolved from the tube, enlarges the flame of a taper, the curved end is inſerted into the air-holder, and the nitrous oxide preſerved.

The water thrown out of the air-holders, in conſequence of the introduction of the gas, is preſerved in a veſſel adapted for the purpoſe, and employed to fill them again. For, if common water were to be employed in every experiment, a great loſs of gas would be produced from abſorption.

A pound of fibrous nitrate of ammoniac decompoſed at a heat not above 500° produces nearly five cubic feet of gas, while, from a pound of compact nitrate of ammoniac, rarely more than four cubic feet and a quarter can be collected.

For the production of nitrous oxide in quantities not exceeding twenty quarts, a mode ſtill more ſimple than that which has

been deſcribed may be employed. The ſalt may be decompoſed by the heat of an Argand's lamp, or a common fire in a tubulated glaſs-retort of twenty or thirty cubic inches in capacity, furniſhed with a long neck, curved at the extremity, and the gas received in air-holders.

Thus, if the pleaſurable effects, or medical properties of the nitrous oxide, ſhould ever make it an article of general requeſt, it may be procured with much leſs time, labour and expence, than moſt of the luxuries of life. A pound of nitrate of ammoniac coſts about 5 s. 10 d. This pound, properly decompoſed, will produce rather more than thirty-four moderate doſes of air; ſo that the expence of a doſe is about 2 d. What exhilarating ſtimulus can be procured at ſo eaſy a rate?

Mr Davy, after relating a great variety of intereſting experiments reſpecting nitrous gas and nitrous oxide, concludes his firſt reſearch by obſerving, that there are no reaſons for ſuppoſing, that nitrous oxide is formed in any of the proceſſes of nature; and that the nice equilibrium of affinity by which it is conſtituted, forbids us to hope for the power of

of compoſing it from its ſimple principles. We muſt be content, therefore, to produce it either directly or indirectly from the nitric acid. And as in the compoſition of nitrate of ammoniac, not only all the nitrogene of the nitric acid enters into the compoſition of the nitrous oxide produced, but likewiſe that of the ammoniac; this proceſs is by far the cheapeſt, as well as the moſt expeditious.

A mode of producing ammoniac at little expence, has been propoſed by Mr Watt. Condenſed in the ſulphuric acid, it can be eaſily made to combine with nitric acid from the decompoſition of nitre by double affinity. And thus, if the hopes which experiments induce us to indulge, do not prove fallacious, a ſubſtance which has been hitherto almoſt excluſively appropriated to the deſtruction of mankind, may become, in the hands of philoſophy, a means of producing health and pleaſurable ſenſation.

After treating, in the ſecond and third reſearch, of the combinations of nitrous oxide and its compoſition, and of the reſpiration of nitrous oxide and other gaſſes, Mr Davy proceeds in the fourth, to relate the effects produced by

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the reſpiration of nitrous oxide upon different individuals.

In 1799, Mr Davy's ſituation in the Medical Pneumatic Inſtitution led him to inveſtigate the phyſiological effects of the aëriform fluids, the properties of which preſented a chance of uſeful agency. In the beginning of March, he prepared a large quantity of impure nitrous oxide from the nitrous ſolution of zinc. Of this he often breathed the quantities of a quart or two quarts, generally mingled with more than equal parts of oxygene or common air. In the moſt deciſive of theſe trials, its effects appeared to be depreſſing, and he imagined that it produced a tendency to fainting. The pulſe was rendered ſlower under its operation. Mr Southey and Mr Coates alſo at the ſame time reſpired it in a highly diluted ſtate. It occaſioned a ſlight degree of giddineſs, and conſiderably diminiſhed the quickneſs of pulſe.

In April he obtained nitrous oxide in a ſtate of purity, and in this ſtate he reſolved to try to inſpire it; accordingly, on the 11th of April, he made the firſt inſpiration of pure nitrous oxide. It paſſed through the bronchia

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 him to believe, that a farther trial of its effects might be made without danger. Accordingly, on the 16th of April, Dr Kinglake being accidentally preſent, he breathed three quarts of nitrous oxide from and into a ſilk-bag for more than half a minute, without previouſly cloſing his noſe or exhauſting his lungs. The firſt inſpirations occaſioned a ſlight degree of giddineſs. This was ſucceeded by an uncommon ſenſe of fulneſs of the head, accompanied with a loſs of diſtinct ſenſation and voluntary power, a feeling analogous to that produced by the firſt ſtage of intoxication, but unattended with pleaſurable ſenſation. Dr Kinglake, who felt his pulſe, informed him that it was rendered quicker and fuller.

On the 17th of April, in preſence of Dr Beddoes, to whom the reſult of the preceding trial was communicated, he made the following experiment: Having previouſly cloſed his noſtrils, and exhauſted his lungs, he breathed four quarts of nitrous oxide from

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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 the muſcles, attended by a highly pleaſurable thrilling, particularly in the cheſt and extremities. The objects around him became dazzling, and his hearing more acute. Towards the laſt inſpiration, the thrilling increaſed, the ſenſe of muſcular power became greater, and at laſt an irreſiſtible propenſity to action was indulged in. He could recollect, but indiſtinctly, what followed, but he knew that his motions were various and violent.

Theſe effects very ſoon ceaſed after reſpiration. In ten minutes, he had recovered his natural ſtate of mind. But the thrilling of the extremities continued longer than the other ſenſations. This experiment was made in the morning. No languor or exhauſtion was conſequent. His feelings throughout the day were as uſual, and he paſſed the night in undiſturbed repoſe.

Having, from the repetition of this experiment oftener than once, determined the powers

powers of the gas, he made many experiments to aſcertain the length of time for which it might be breathed with ſafety, and to aſcertain alſo its effects on the pulſe, and its effects on the health when often reſpired.

He found that he could breathe nine quarts of nitrous oxide for three minutes, and twelve quarts for rather more than four. But he could never breathe it in any quantity ſo long as five minutes. Whenever the 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, and voluntary power was altogether deſtroyed, ſo that the mouth-piece generally dropt from his unclоſed lips.

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

He never felt any thing like oppreſſive reſpiration. His inſpirations became deep, in proportion

proportion as he breathed longer. But this aroſe from an increaſed energy of the muſcles of reſpiration, and from a deſire of increaſing the pleaſurable feelings. When he breathed from ſix to ſeven quarts, muſcular motions were commonly produced to a certain extent. Sometimes he manifeſted pleaſure by ſtamping and laughing only; at other times, by dancing round the room, and vociferating. After the reſpiration of ſmall doſes, the exhilaration generally laſted 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.

Between May and July, Mr Davy 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 he had the feelings of intenſe intoxication, attended with but little pleaſure; at other times, he had ſublime emotions, connected with highly vivid ideas. His pulſe

was generally increaſed in fulneſs, but rarely in velocity.

He found it very difficult to deſcribe the general effects of its operation upon his health and ſtate of mind. Nor could he diſcriminate between its agency and that of other phyſical and moral cauſes. He ſlept much leſs than uſual; and previous to ſleep, his mind was long occupied by viſible imagery. He had a conſtant deſire of action, a reſtleſneſs, and an uneaſy feeling about the præcordia, analogous to the ſickneſs of hope. But he thought it probable, that theſe phenomena, in ſome meaſure, depended on the intereſt and labour connected with the experimental inveſtigation relating to the production of nitrous oxide, with which he was at that time inceſſantly occupied.

His appetite continued as uſual, and his pulſe was not materially altered. Sometimes, for an hour after the inſpiration of gas, he experienced a ſpecies of mental indolence, pleaſing rather than otherwiſe, and never ending in liſtleſneſs. During the laſt week in which he breathed it uniformly, he imagined that he had increaſed ſenſibility of touch.

touch. His fingers were pained by any thing rough, and the tooth-edge was produced from ſlighter cauſes than uſual. He thought himſelf more irritable; and he felt more acutely from trifling circumſtances. His bodily ſtrength was rather diminiſhed than increaſed.

At the latter end of July, he left off his habitual courſe of reſpiration; but he 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 he had headach 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 headach was wholly removed by two doſes of gas. On a third occaſion, when he experienced an extenſive inflammation of the gum, accompanied with great pain, which occaſionally deſtroyed the power of repoſe, and of conſiſtent action, he breathed three large doſes of nitrous oxide. The pain was always diminiſhed after the firſt four or five inſpirations; the

the thrillings 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 the organ returned with it, and he once imagined that the pain was more ſevere after the experiment than before.

After giving an account of a variety of trials with the nitrous oxide, Mr Davy next relates ſome experiments which he made with other gaſſes. He reſpired four quarts of hydrogene nearly pure, produced from zinc and muriatic acid, for near a minute, his lungs being previouſly exhauſted, and his noſtrils carefully cloſed. The firſt ſix or ſeven inſpirations produced no ſenſation whatever. In half a minute, he perceived a diſagreeable oppreſſion of the cheſt, which obliged him to reſpire very quickly. This oppreſſion gradually increaſed, till at laſt the pain of ſuffocation compelled him to leave off. He felt no giddineſs during or after the experiment. His pulſe was rendered feebler and quicker; and a by-ſtander informed him, that towards the laſt his cheeks became purple. In a ſecond experiment, when hydrogene was pro-

cured from iron and diluted ſulphuric acid, he was unable to reſpire it for ſo long as three quarters of a minute. A tranſient giddineſs, and muſcular debility, were produced; the pulſe was rendered very feeble, and the pain of ſuffocation was greater than before.

He breathed three quarts of nitrogene, mingled with a very ſmall portion of carbonic acid, for near a minute. It produced no alteration in his ſenſations for the firſt twenty ſeconds. Then the painful ſenſe of ſuffocation gradually came on, and increaſed rapidly in the laſt quarter of the minute, ſo as to oblige him to deſiſt from the experiment. His pulſe was rendered feebler and quicker, but he felt no affection whatever in the head.

He next relates ſome trials made with hydro-carbonate. Mr Watt's obſervations on the reſpiration of diluted hydro-carbonate by men, and Dr Beddoes' experiments on the deſtruction of animals by pure hydro-carbonate, had demonſtrated that its effects were highly deleterious. As it apparently deſtroyed life, by rendering the muſcular fibre inirritable, without producing any previous excitement, he was anxious to compare its ſenſible

ſible effects with thoſe of nitrous oxide, which he believed to deſtroy life, by producing the higheſt poſſible excitement, ending in leſion of organiſation.

In the firſt experiment, he breathed, for near a minute, three quarts of hydro-carbonate, mingled with nearly two quarts of atmoſpheric air. It produced a ſlight giddineſs and pain in the head, and a momentary loſs of voluntary power. His pulſe was rendered much quicker and feebler. Theſe effects, however, went off in five minutes, and he had no return of giddineſs.

Encouraged by this trial, in which the feelings were not unlike thoſe which he experienced in the firſt experiments on nitrous oxide, he reſolved to breathe pure hydro-carbonate. For this purpoſe, he introduced into a ſilk-bag four quarts of this gas, nearly pure, which was carefully produced from the decompoſition of water by charcoal an hour before, and which had a very ſtrong and diſagreeable ſmell. After a forced exhauſtion of the lungs, his noſe being accurately cloſed, he made three inſpirations and expirations of the hydro-carbonate. The firſt inſpiration

produced a ſort of numbneſs and loſs of feeling in the cheſt, and about the pectoral muſcles. After the ſecond inſpiration, he loſt all power of perceiving external things, and had no diſtinct ſenſation, except a terrible oppreſſion on the cheſt. During the third inſpiration, this feeling diſappeared. He ſeemed ſinking into annihilation, and had juſt power enough to drop the mouth-piece from his uncloſed lips. For a ſhort interval he reſpired common air, before he could diſtinguiſh objects around him. On recollecting himſelf, he faintly articulated, *I do not think I ſhall die;* and putting his finger on his wriſt, he found his pulſe thread-like, and beating with exceſſive quickneſs. In leſs than a minute, he was able to walk, and the painful oppreſſion on the cheſt directed him to the open air. Even after this, however, he ſuffered great uneaſineſs; and, at the end of two hours, when he thought himſelf ſo much ſtronger and better, as to believe that the effects of the gas had diſappeared, his pulſe was 120, and very feeble. About an hour after this, the giddineſs returned with ſuch violence as to obliige him to lie down

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on bed. It was accompanied with nauſea, loſs of memory, and deficient ſenſation. To theſe ſucceeded excruciating pain in the forehead, with tranſient pains in the cheſt and extremities. Towards night, theſe affections gradually diminiſhed; and when he went to reſt, no diſagreeable feeling, except weakneſs, remained. He ſlept ſound, and awoke in the morning, very feeble and very hungry. No recurrence of ſymptoms afterwards took place, and he had nearly recovered his ſtrength by the evening.

From this experiment it appears, that hydro-carbonate acts as a ſedative; that it produces diminution of vital action, and debility, without previouſly exciting. Mr Davy thinks, that if he had taken four or five inſpirations inſtead of three, they would have deſtroyed life immediately, without producing any painful ſenſation. Moſt of the uneaſy feelings after the experiment were, he thinks, connected with the return of the healthy condition of organs.

Mr Davy afterwards attempted to reſpire carbonic acid gas. It taſted ſtrongly acid in the mouth and fauces, and produced a ſenſe

of burning at the top of the uvula; but it produced a ſpaſmodical affection at the glottis, which prevented a ſingle particle of it from entering the lungs. Even a mixture of three quarts of carbonic acid gas, with two of common air, ſtimulated the epiglottis nearly in the ſame manner as pure carbonic acid gas, and was perfectly non-reſpirable.

He found, that a mixture of three quarts of carbonic acid, with ſeven of common air, was reſpirable. He breathed it for near a minute. It produced a ſlight degree of giddineſs, and an inclination to ſleep. Theſe effects, however, very rapidly diſappeared after he had ceaſed to breathe it, and no other affections followed.

In ſeveral experiments, Mr Davy reſpired oxygene procured from manganeſe by heat. In reſpiring eight or ten quarts for the firſt two or three minutes, he could perceive no effects. Towards the end, even when he breathed very ſlowly, his reſpiration became oppreſſed, and he felt a ſenſation analogous to that produced by the want of freſh air, though but little of the oxygene had been conſumed. In one experiment, when he breathed

breathed from and into a bag, containing twenty quarts of oxygene, for near ſix minutes, Dr Kinglake felt his pulſe, and found it not altered in velocity, but rather harder than before. Mr Davy perceived no effects, but thoſe of oppreſſion on the cheſt.

Having obſerved that nitrous gas gave a purple tinct to blood, very like the colour generated in it by nitrous oxide, and finding no painful effects produced by the application of nitrous gas to the bare muſcular fibre, he began to imagine, that this gas might be breathed with impunity, provided it were poſſible in any way to free the lungs from common air before inſpiration, ſo as to prevent the formation of nitrous acid. On this ſuppoſition, during a fit of enthuſiaſm produced by the reſpiration of nitrous oxide, he reſolved to endeavour to breathe nitrous gas.

One hundred and fourteen inches of nitrous gas were introduced into a large mercurial air-holder. Two ſmall ſilk-bags of the capacity of ſeven quarts, were filled with nitrous oxide. After a forced exhauſtion of his lungs, his noſe being accurately cloſed, he made three inſpirations and expirations of

nitrous oxide in one of the bags, to free his lungs as much as poſſible from atmoſpheric oxygene. Then, after a full expiration of the nitrous oxide, he transferred his mouth from the mouth-piece of the bag to that of the air-holder, and turning the ſtop-cock, he attempted to inſpire the nitrous gas. In paſſing through his mouth and fauces, it taſted aſtringent, and highly diſagreeable. It occaſioned a ſenſe of burning in the throat, and produced a ſpaſm of the epiglottis, ſo painful as to oblige him to deſiſt inſtantly from attempts to inſpire it. After moving his lips from the mouth-piece, when he opened them, to inſpire common air, aëriform nitrous acid was inſtantly formed in his mouth, which burnt the tongue and palate, injured the teeth, and produced an inflammation of the mucous membrane, which laſted for ſome hours. Mr Davy concludes with obſerving, that he never again intends to attempt ſo raſh an experiment.

To aſcertain with certainty whether the moſt extenſive action of nitrous oxide, compatible with life, was capable of producing debility, he reſolved to breathe the gas for ſuch

ſuch a time, and in ſuch quantities, as to produce excitement equal in duration, and ſuperior in intenſity, to that occaſioned by high intoxication from opium or alcohol.

On the 26th of December, he was incloſed in an air-tight breathing-box, of Mr Watt's invention, of the capacity of about nine cubic feet and an half, in the preſence of Dr Kinglake. After he had taken a ſituation, in which he could, by means of a curved thermometer, inſerted under the arm, and a ſtop-watch, aſcertain the alterations in his pulſe and animal heat, twenty quarts of nitrous oxide were thrown into the box.

For three minutes he experienced no alteration in his ſenſations, though immediately after the introduction of the nitrous oxide, the ſmell and taſte of it were very evident. In four minutes, he began to feel a ſlight glow in the cheeks, and a generally diffuſed warmth over the cheſt, though the temperature of the box was not quite 50°. He had neglected to feel his pulſe before he went in, but at this time it was 104, and hard; the animal heat was 98°. In ten minutes, the animal heat was 99°; in a quarter of an hour

99.5° when the pulſe was 102, and fuller than before.

At this period, twenty quarts more of nitrous oxide were thrown into the box, and well mingled with the maſs of air, by agitation. In twenty-five minutes, the animal heat was 100°, the pulſe 124. In thirty minutes, twenty quarts more of gas were introduced. His ſenſations were now pleaſant. He had a generally diffuſed warmth, without the ſlighteſt moiſture of the ſkin, a ſenſe of exhilaration ſimilar to that produced by a ſmall doſe of wine, and a diſpoſition to muſcular motion, and to merriment. In three quarters of an hour, the pulſe was 104, and the heat of the body 99.5°. The temperature of the chamber was 64°. The pleaſurable feelings continued to increaſe, the pulſe became fuller and ſlower, till in about an hour it was 88, when the animal heat was 99°.

Twenty quarts more of air were admitted. He had now a great diſpoſition to laugh; luminous points ſeemed frequently to paſs before his eyes; his hearing was more acute, and he felt a pleaſant lightneſs and power of exertion in his muſcles. In a ſhort time the

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ſymptoms became ſtationary; breathing was rather oppreſſed, and, on account of the great deſire of action, reſt was painful. He now, therefore, came out of the box, having been in it preciſely an hour and a quarter.

Immediately after coming out, he began to reſpire twenty quarts of unmingled nitrous oxide. A thrilling, extending from the cheſt to the extremities, was almoſt immediately produced. He felt a ſenſe of tangible extenſion, highly pleaſurable, in every limb. His viſible impreſſions were dazzling, and apparently magnified. He heard diſtinctly every ſound in the room, and was perfectly aware of his ſituation. By degrees, as the pleaſureable ſenſations increaſed, he loſt all connection with external things. Trains of vivid viſible images rapidly paſſed through his mind, and were connected with words in ſuch a manner as to produce perceptions perfectly novel. He exiſted in a world of newly connected and newly modified ideas. He theoriſed. He imagined that he had made great diſcoveries.

When he was awakened from this ſemi-delirious trance by Dr Kinglake, who took

the bag from his mouth, indignation and pride were the firſt feelings produced by the ſight of the perſons about him. His emotions were enthuſiaſtic and ſublime, and for a minute he walked round the room perfectly regardleſs of what was ſaid to him. As he recovered his former ſtate of mind, he felt an inclination to communicate the diſcoveries he had made during the experiment. He endeavoured to recall the ideas: they were feeble and indiſtinct. One collection of terms, however, preſented itſelf; and, with the moſt intenſe belief, he exclaimed to Dr Kinglake, "*Nothing exiſts but thoughts! The univerſe is compoſed of impreſſions, ideas, pleaſures and pains!*"

About three minutes only had elapſed during this experiment, though the time, as meaſured by the relative vividneſs of recollected ideas, appeared to him much longer.

Not more than half of the nitrous oxide was conſumed during this time. After about a minute before the thrilling of the extremities had diſappeared, he breathed the remainder. Similar ſenſations were again produced. He was quickly thrown into the pleaſurable

trance,

trance, and continued in it longer than before. For many minutes after the experiment, he experienced the thrilling in the extremities; the exhilaration continued nearly two hours. For a much longer time he experienced the mild enjoyment before deſcribed, connected with indolence. No depreſſion or feebleneſs followed. He ate dinner with great appetite, and found himſelf lively, and diſpoſed to action immediately after. He paſſed the evening in executing experiments. At night, he found himſelf unuſually chearful and active; and the hours between eleven and two were ſpent in copying the foregoing detail from the common-place book, and in arranging the experiments. In bed he enjoyed profound repoſe. When he awoke in the morning, it was with conſciouſneſs of pleaſurable exiſtence, and this conſciouſneſs continued more or leſs through the whole day.

From this experiment, then, it is clearly demonſtrated, that the moſt extenſive action of nitrous oxide is not followed by any debility or depreſſion, though exhilarating to a very high degree.

To demonſtrate, that the effects produced by the nitrous oxide on Mr Davy, were by no means

means peculiar to himſelf, he preſents us, in a ſecond diviſion of this reſearch, with details of the effects produced by the reſpiration of nitrous oxide upon different individuals, furniſhed by themſelves. And, from the accounts given by Drs Kinglake, Roget and Blake, by Meſſrs Tobin, Clayfield, Southey, Thomſon, Coleridge, Wedgewood, and many others, the very remarkable exhilarating power of nitrous oxide without conſequent depreſſion, ſeems to be clearly eſtabliſhed.

From the numerous facts and experiments detailed in this work, Mr Davy concludes, 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 feelings, alter the condition of the organs of ſenſation, and, in their moſt extenſive action, deſtroy life.

He obſerves, however, that, in the mode of operation of diffuſible ſtimuli, and of nitrous oxide, conſiderable differences exiſt. Diffuſible ſtimuli, he tells us, act immediately on the muſcular and nervous fibres; while nitrous oxide, according to Mr Davy, operates upon

upon them only by producing peculiar changes in the compoſition of the blood. Diffuſible ſtimuli, he tells us, 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; while nitrous oxide, in combination with the blood, is univerſal in its application and action.

This conjecture is ingenious, and may perhaps be in ſome degree true, particularly with reſpect to the action of nitrous oxide. But we may with confidence venture to aſſert, that what he has ſaid with regard to the diffuſible ſtimuli is by no means proved. Indeed, when he employs the general term, *diffuſible ſtimuli*, without particularizing the ſubſtances which he includes under it, he uſes a word of a very ambiguous meaning, and comprehending ſubſtances which, in their action, differ very eſſentially from each other. Thus, under the head of diffuſible ſtimuli, many have comprehended opium, ardent ſpirit, ether, and volatile alkali. That theſe, however, differ eſſentially from each other in their mode of action, no one who has paid the leaſt attention to their effects on the human body, can poſſibly

poſſibly doubt. Thus, when opium has been exhibited to ſuch an extent as to produce alarming ſymptoms, particularly a drowſineſs, from which the patient can hardly be rouſed, if an additional quantity of opium be taken, certain death will be the conſequence; but if, in this ſituation, recourſe be had to volatile alkali, either taken into the ſtomach, or applied to the noſe, or other very ſenſible parts, it is often immediately productive of the very beſt effects, removing in a ſhort time all the alarming conſequences which the opium had induced.

In a ſimilar manner, many other ſtimulants, both of the chemical and mechanical kind, ſuch as forcing the patient to walk about, when ſtrongly diſpoſed to ſleep, pricking with needles, burning with irons, and other moſt powerful means of exciting, have often ſaved the lives of patients, who would otherwiſe have died from opium, if the ſleep induced by it had been allowed to go on uninterrupted. It cannot therefore be denied, that their effects, if not directly oppoſite, are at leaſt very different. And among the other ſtimuli mentioned alſo, there is a very

conſiderable

conſiderable variety, as will readily appear from comparing the effects reſulting from mechanical ſtimuli, volatile alkali, eſſential oils, and ardent ſpirits. Indeed, it ſeems highly probable, that though all ſtimuli have the general effect of exciting and arouſing, yet that the influence of no two of them on the human ſyſtem is preciſely the ſame.

Though opium, as well as ardent ſpirit, poſſeſſes to a high degree narcotic or intoxicating powers, yet ſuch is its immediate influence, in diminiſhing ſtrong morbid action of the muſcular fibres, in allaying pain, and inducing ſleep, that many medical practitioners think, it can only with propriety be ranked among the ſedatives. And it cannot be denied, that almoſt every practitioner daily employs it to obtain ſedative effects, to allay, to aſſuage, to quiet, while theſe effects, in by much the greateſt number of inſtances, are obtained without even the ſlighteſt mark of preceding excitement having been produced by the opium.

Although many ingenious men have beſtowed much pains in attempting to aſcertain by experiment the manner in which opium

acts upon the human ſyſtem, yet they have ſtill left us very much in the dark. For although it has been a common opinion, that opium acts immediately on the nervous energy, yet if the experiments of Fontana be accurate, this article produces its effects only in combination with the blood, as Mr Davy ſuppoſes to happen, with regard to the nitrous oxide.

If the exhilarating effects of the nitrous oxide ariſe from its producing a peculiar change in the compoſition of the blood, theſe effects ſhould ariſe alſo when it is introduced into the blood in other ways beſides by reſpiration; and this point might perhaps be determined by experiment. In ſhort, Mr Davy's experiments, in place of exhauſting the ſubject, have pointed out a new and moſt extenſive field for future inveſtigation. And while he has unqueſtionably very great merit in having paved the way for ſucceeding inquirers, we would fain hope, that he will not himſelf deſert a purſuit which he has already proſecuted with ſo much ſucceſs, and ſo much honour.

XV.