Ether and chloroform : a compendium of their history, surgical use, dangers, and discovery / By Henry J. Bigelow.

Contributors

Bigelow, Henry Jacob, 1818-1890.
Harvey Cushing/John Hay Whitney Medical Library

Publication/Creation

Boston : D. Clapp, 1848.

Persistent URL

https://wellcomecollection.org/works/qecve494

License and attribution

Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
https://wellcomecollection.org

aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa

BIGELOW, Henry J.
Ether and chloroform: a compendium of their history, surgical use, dangers, and discovery. Boston, 1848.

aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa

ETHER AND CHLOROFORM:

A COMPENDIUM

OF THEIR

HISTORY, SURGICAL USE, DANGERS,

AND DISCOVERY.

BY HENRY J. BIGELOW, M.D.

ONE OF THE SURGEONS OF THE MASS. GEN. HOSPITAL.

BOSTON:

DAVID CLAPP, PRINTER....184 WASHINGTON STREET.

1848.

ETHER AND CHLOROFORM.

The astronomer Leverrier calculated the direction and rate of travel of a star, and pointed to its place in the heavens. A star appeared; yet astronomers tell us that this was not his star, that its rate of travel was other than had been predicted by Leverrier. No other appeared exactly to fulfil the astronomer's calculations. Yet Leverrier is great, and his name is familiar.

Professor Schönbein converted cotton into a new vehicle of sudden force. The belief that gun cotton might be cheaply used for purposes of offence or of defence, gave to the name of Schönbein a currency in all parts of the civilized world, and to gun cotton the position of one of the discoveries of the age.

The French experimenter has attached his name to the Daguerreotype, and this, too, is great, although a mere luxury when tested by its applicability to the necessities of man.

Few will deny to these inventions and discoveries the epithet *great*, when compared with others of the day; and yet their greatness is of very different kind. What, then, shall be considered a test of greatness in discovery?

A writer upon patents has said that an invention is entitled to protection from the law, when it materially modifies the result produced, or the means by which it is produced; that a patent right is due to novelty in a machine producing an old fabric in a new way, or to the manufacture of a new and very different fabric, resulting from a slight change in the machine; in other words, to novelty in the combined result of means and end. This distinction, if not legal, is apparently just; and I should, in like manner, call an invention great, in proportion to the combined amount of mind invested in its production, and of its intrinsic ability to minister to the supposed or real comfort and well-being of the race.

What, then, is the character of the discovery of etherization? And it is not idle nor superfluous to examine definitively the claims of this invention. I shall presently show that there are regions where the use of

ether is still unknown, or its efficacy doubted ; and that there have been those who maintained that a certain good fortune attended its discovery, which in a measure abated its claim to greatness.

The following position is, I believe, quite tenable.

Ether is capable of producing, with very rare exceptions if there be any, complete insensibility to pain ; with discomfort to the patient in only a part of the cases ; this discomfort being trifling compared with the pain of an incision an inch in length.

What is pain, which the race has ceased to know in its more formidable phase, and which in another age will be remembered as a calamity of rude and early science? Pain is the unhappy lot of animal vitality. It respects neither condition nor external circumstances. In the countless generations which lead us step by step into the remote ages of antiquity, each individual has bowed before this mighty inquisitor. It has borne down the strongest intellect, and sapped and withered the affections. The metaphysician finds in it the secret spring of one half of human action ; the moralist proclaims it as the impending retribution of terrestrial sin ; the strongest figure of the Bible condemns man to eternal flames ; and yet this "dreaded misery, the worst of evils," now lies prostrate at the feet of science. Pain is encountered at man's option, and the nerves fulfil their functions only with the connivance of the intellect.

One hundred years ago, a lecturer proved that the discoverer who had subdued the lightning was not an impious man. The modern lecturer may proclaim that the greatest of discoveries has deprived terrestrial fire of its terrors ; that man was not born to pain ; and he may reply to those who argue that pain is immediately administered by a divine agency, that physical suffering grows out of the imperfection of physical existence, and that it is not the mundane retribution of transgression.

The practical employment of etherization ensued upon the conference of two individuals. One of these, retreating to the privacy of his own apartment, placed his watch upon the table, and applied ether to his mouth. Eight minutes of complete obliviousness now elapsed, and he awoke excited with the purpose of testing the degree and quality of this new somnolency, with reference to his peculiar art. For some hours the confirmation of certainty was delayed, and the future discovery hung upon a slender thread. Public wayfarers inclined no sympathetic ear to the necessities of a discoverer, and several diplomatists, sent out to bribe some chance foot-passenger to lose a tooth for an equivalent of five dollars, returned without being able to negotiate. Towards nine o'clock, the inmates of the establishment were aroused by the arrival of a patient. Yet he, recognizing in the dental art only the substitution of one pain for another, des-

pairingly inquired if mesmerism was not available in such ordeals. Here, then, was the long-wished-for opportunity, and complete unconsciousness crowned the experiment with success. It is quite probable that the world will not remember who this individual was, and yet it is true that the whole discovery of which we are now speaking, exhibited its first authentic effort when it annulled the pain accompanying the lesion of the little nerve that animated his defective molar.

It is worth while here to ask, What was the position of the discovery at this time? A tooth had been painlessly drawn, and, at a previous time, an irritation of the pulmonary air-tubes had been alleviated, with alleged insensibility, by the inhalation of a subtile vapor. Here were two facts, insufficient for the most hasty generalization, circumscribed in their bearing, and showing, not that every person could be affected in a similar manner, bearing not upon vitality at large, but upon two specimens of it as modified in these two individuals; and proving, at the most, that animal vitality could be thus affected in two instances; and not that it could be so in all instances. Besides this, the wholly different question of danger was not yet touched by evidence. If these two cases showed that insensibility could be thus effected without danger, two or three previous cases showed, with equal clearness, that insensibility produced death. Knowledge, at this point, rested upon a few hypothetical facts. I confess, had I been then asked what inference I considered safe, I should have replied, "You have succeeded in two instances only; and, in view of the previous evidence upon this subject, it is quite likely, that, in two more instances, either you will fail to produce insensibility, or, having produced it, your patients will die." This seems to me the necessary logical conclusion upon previous evidence; and that this was the first conclusion of those who had knowledge in such matters, will be well remembered by many. I cite only the opinion of a distinguished chemist in a neighboring city, who, after one or two facts o insensibility, counselled his son not to risk his health upon it. Also a letter from Sir Benjamin Brodie, one of the distinguished experimenters in physiology of twenty years ago, who, in full view of all the facts that were borne across the Atlantic, at the first announcement of the discovery, and after reflection, still wrote to Dr. Chambers—"I had heard of this before. The narcotic properties of inhaled ether have been long known, and I have tried it on Guinea pigs, whom it first set asleep and then killed. One question is, whether it can be used with safety."

This was indeed the one great question now to be decided. Another question was, Can insensibility be produced in all cases? Let these questions be answered affirmatively, and the surgeon would be justified in

multiplying experiment, while the value of the discovery would be infinitely enhanced.

To settle these important questions, many instances of insensibility were needed, which were not long in offering themselves to the tenant of a largely frequented dental establishment. Each new trial added evidence in geometrical proportion, while the absence of serious mishap encouraged hope.

Here is a second point in the discovery, and I consider a second proposition to have been now pretty well demonstrated. This was, not that ether *might* produce insensibility during the extraction of a tooth, and that the state of somnolence might be unattended with danger, but that it could always produce insensibility, and that the danger was comparatively slight.

Brief inhalation may be considered as fairly tested, and the discovery fairly demonstrated, in this rapid and multiplied experience.

Analogy, the degree of insensibility, and its superficial extent, rendered it quite probable that such insensibility would prove complete and universal. An *experimentum crucis* could alone determine such a point, nor was it long delayed.

The gentleman who had conducted these experiments determined upon submitting the new phenomena to the test of a surgical operation; and there was a certain liberality of spirit which was instrumental in introducing the discovery into the Massachusetts General Hospital. Many such pretended discoveries had failed. To be a party to such public failure, was to invite an imputation of lack of judgment; and although this novelty presented peculiar and unequivocal evidence, and possessed an intrinsic worth which need have regarded no opposition, yet a spirit of liberality and of discernment is to be recognized in the attitude of Dr. Warren, who assumed the responsibility of failure, and of the danger that might well seem possible to one who had not witnessed the previous experiments. Ether has not always met with equal consideration.

The operation of that day was incomplete in its results, for reasons to be hereafter indicated. A young man offered signs of sensibility, during and after a dissection which was not particularly painful. Some powerful drug already known, or even the imagination, might well have been suspected of agency in the phenomena.

On the ensuing day, a woman offered herself with a tumor of considerable magnitude in the right shoulder. A few minutes of the most complete and passive insensibility served for its extirpation. No imagination was here to be accused. The drooping lid, the head fallen on the

shoulder, the stolid relaxation of the mouth, suggested no overworking of the intellect, no rapt unconsciousness, nor inspired ecstasy. The phenomena were real, familiar to daily experience; they belonged to the profoundest sleep. This operation of Dr. Hayward, first showed conclusively the power of the new agent in averting the terrors of the surgical art. The casual spectator would have remarked no expression of wonder nor unusual excitement in the by-standers at the working of this miracle. Nothing to awe or startle, marred the tranquillity of the operating-room. Yet I think those present will not soon forget the conviction of those few moments, associated at this remote day with the breathless silence of the crowd, and the unwonted fumes of aromatics burned to mask the emanations from the yet mysterious agent. Cognizant of these facts, and having studied the phenomena of etherization in a number of successive experiments at the dental establishment before alluded to, I felt that there was no longer any hazard in vouching for the efficacy of ether; and on the 3d of November, I read a memoir upon the subject before the American Academy of Arts and Sciences. The case of Alice Mohan, whose limb was successfully amputated by Dr. Hayward under the new influence, occurring soon after, I incorporated this confirmatory evidence into a second paper read before the Medical Improvement Society of this city. This paper, afterwards published in this Journal, was the first upon the subject, and was that, I believe, which carried the news to the South and across the Atlantic.

It has been well said that the first attitude of the world towards a great discovery is incredulity, and then hostility; and this was well exemplified in the reception of this announcement at the South. Three weeks elapsed before any notice of the subject appeared. Then came the doubts of those sagacious and experienced philosophers who were not easily to be deceived.

In January, 1847, a New York Medical Journal announced that "the last special wonder has already arrived at the natural term of its existence. It has descended to the bottom of that great abyss which has already engulphed so many of its predecessor novelties, but which continues, alas, to gape until a humbug yet more prime shall be thrown into it."

The New Orleans Medical Journal says, in the same month, "That the leading surgeons of Boston could be captivated by such an invention as this, excites our amazement." "Why, *mesmerism*, which is repudiated by the *savans* of Boston, has done a thousand times greater wonders."

A leading medical periodical in Philadelphia, says—"We should

not consider it entitled to the least notice, but that we perceive, by a Boston Journal, that prominent members of the profession have been caught in its meshes." It was "fully persuaded that the surgeons of Philadelphia would not be seduced from the high professional path of duty, into the quagmire of quackery, by this Will o' the wisp." What the surgeons of Philadelphia have considered the "high professional path of duty," up to a very recent date, I shall soon show.

It is fair to state, that at the West, in Chicago, Buffalo, and St. Louis, the discovery received candid consideration.

The great show of dissatisfaction, emanating from those who were not contented to receive tranquilly this great discovery, and to recognize it as such, was directed against the patent right connected with its early history; but, so soon as the discovery received the confirmation of European testimony, it was providentially discovered that the patent was probably invalid, and hesitation and opposition rapidly subsided, although for some weeks the enthusiasm of periodical medical literature was tempered by the character of the reports which reached us from the other side of the Atlantic.

The article before alluded to was, I believe, the first published in the European Journals. The discovery, then, rested in Europe upon the identical evidence which introduced it to the medical community on this side of the water, and it is interesting to observe what was the attitude there assumed towards it.

Upon the arrival of the steamer of December 1st, private notices were at once forwarded to many of the eminent surgeons in London, who zealously investigated the subject. Mr. Liston, who amputated a leg, was, on the whole, successful. Yet there, as elsewhere, doubtful cases occurred. A signal failure happened at Guy's Hospital. Other cases of incomplete success contributed to place the subject upon doubtful ground. Notwithstanding these failures, the mere chance of producing insensibility to pain once demonstrated, aroused an inconceivable enthusiasm in the surgical world. The English Journal which announced the discovery, remarked, in an editorial article, "The discovery seems to have *a remarkable perfection about it*, even in its first promulgation." "We suppose we shall hear no more of mesmerism and its absurdities as preparations for surgical operations." And of the paper alluded to and of Liston's case, it says, "it is almost impossible to discredit the statements conained in the communication referred to." A similar tone was held by other leading Journals, experiments were instituted in all the leading hospitals, and new evidence daily arrived from the provincial towns.

Information was conveyed to Paris, by a private letter, in the month

of November, 1846. The incredulity of surgeons prevented its early adoption. Velpeau " politely declined " to experiment upon it. When, however, in January, the accumulation of evidence arrived from England and America, a new interest was at once excited. Experiments, the majority of which had previously been failures, were now instituted with a Boston inhaling apparatus, which soon arrived, and before the first of February, the two great surgeons, Velpeau and Roux, averred, in the presence of the two Academies, that the discovery " was a glorious conquest for humanity." The news rapidly spread through the European cities, and over the civilized world.

Once, and only once, out of the country of its birth, did a government discountenance the discovery.

In this country, where no legal form hinders any individual from purchasing a bottle of prussic acid for his own private consumption, such interference excites comment; but, when we remember that a court adviser is quite likely to be some single philosopher who has become too wise for innovation, an error of judgment emanating from such a source is less remarkable.

In thus detailing the early narrative of the discovery I have endeavored to present the contemporaneous and accumulaing evidence of experiment, in order to show how far, at each stage of its advancement, new experiments were justified, and also to exhibit in this relation, the various attitudes of those who were to be the instruments of its progress. And this is important. At various points in its history those who stood between this agent of mercy and the world, those whose duty it was to deal out to mankind this inestimable blessing, have seen fit to refuse it to the unhappy victims of surgical art, and have condemned them to severe suffering which might easily have been avoided.

It would be illiberal to impugn the motives of those who occupy this position; nor do I conceive it would be attempted by those who know the variety and complication of the secret agencies of human action. Yet a wide influence is diffused by many such, and it is impossible to calculate how far the mass of human misery may be augmented by such opinions joined to authority.

However easy it may be for an individual, or body of individuals, to promulgate what they conceive to be their convictions, yet if there is a chance of error in these convictions, and if that error tends considerably to increase the aggregate of human suffering, it will be readily conceded that the world has a right to question how far such convictions may be reasonable. Fortunately for this purpose, human reason is identical in all.

To establish how far etherization ought to be adopted by the world, let us re-examine the evidence in relation to its more obvious conclusions.

Ether was said, in one instance, to have produced insensibility. In another experiment, it made an individual unconscious of the drawing of a tooth. Twenty or more experiments were immediately instituted, with nearly the same effects and no accidents.

These were certainly novel and striking circumstances. They were calculated to arrest attention. They presented credentials which had a right to be examined. Ether had a right to be tried, candidly and fairly, unless it could be shown that its previous bad character forfeited all claim to further consideration. What, then, was its previous character? What is the *a priori* evidence respecting the danger of ether on the one hand, or its narcotic power on the other? And, first, the danger rests mainly upon the evidence of a few cases; the gentleman in Brande's Journal, the druggist's maid servant, and the young man of the Midland Medical and Surgical Journal; to which may be added the experiments of Orfila upon dogs, and Brodie upon Guinea pigs.

I put against these cases the hundreds of young men who had been for years harmlessly exhilarated by ether; I add to these well-known facts, the half hundred cases which occurred in a few weeks after the discovery; and re-affirm that, as far as danger goes, ether, before the end of 1846, had a right to be tested anew. Analogy fortifies this ground. It points to a state of dead drunkenness effected through the air tubes, as corresponding to a similar state effected through the stomach. Patients dead drunk had lost their legs without pain; others had instantaneously revived when alcohol was pumped out of their stomachs. Why should not the lungs become the recipient of the inebriating agent, and respiration be the resuscitating stomach pump? This analogy, which still holds good, was distinctly alluded to in the original article upon the subject of ether inhalation.

Many people had died when alcohol was not thus pumped out of their stomach; and might they not well die when the atmosphere of a room was surcharged with ether, and they asleep in it? If the argument from analogy proves anything, it proves that it is no more dangerous to be narcotized by inhaling ether, than to be dead drunk with alcohol. I hold, then, that at the time alluded to, the middle of November, 1846, neither analogy nor fact forbade the use of ether.

At this date, too, certain doubters shook their heads and talked of *mesmerism*. Now there was something in the previous knowledge of ether which widely separated it from such pretended agencies, whose

phenomena are opposed to our experience of the order of nature. Ether is very different from mesmerism; and I think it must have occurred to any one who fairly investigated the subject, that it was quite possible, and even probable, that what was now affirmed of twenty cases, was, unlike mesmerism, likely to be true from all previous evidence. A gentleman well known in the professional and scientific world, hearing, on the day of the first experiments, that inhalation had produced insensibility to pain, exclaimed, as conviction flashed upon him, "I believe it! It can be done! Ether will do it!" Such discrimination is not to be generally looked for; but such a fact tends to show that previous evidence led towards ether, and not from it.

Mesmerism, in spite of the bad odor of repeated failure and deception, has not unfrequently obtained a candid hearing; and this circumstance singularly contrasts with the philosophy that refused to give ether an impartial hearing, even after it was invested with the accumulated evidence of experience.

A hundred promiscuous cases rapidly occurred; often in the face of hundreds of spectators, not one of whom attributed the results to deception or imagination. Many of these cases were detailed in papers published by Drs. Warren, Hayward, Peirson, Townsend, J. M. Warren, Parkman, and many others, of equal credibility. The mass of evidence swelled as it rolled onward, month after month, to every part of this country and of the civilized world; and yet in November, 1847, more than a year after the discovery, we find it stated, that, in one of the largest hospitals in North America, ether "had not been tried at all."

For the sake of humanity, if not of science, it is to be hoped that no hospital gates are barred against ether, at this late day.

How different was the attitude of the London surgeons, who, only eight weeks after the first discovery, and with far less evidence than lay at the disposal of any one on this side of the water, hailed the American discovery with generous enthusiasm. The gentleman to whom the communication above alluded to was sent, was kind enough to return to me the replies received from some of the leading medical men. Thomas Bell writes, "I fully intend to try it the first opportunity. The cases are very satisfactory, and the whole affair most important." Liston says, December 21, "I tried the ether inhalation to-day, with perfect and satisfactory results;" and at once writes, "It is a very great matter to be able thus to destroy sensibility to such an extent without apparently a bad result. It is a fine thing for operating surgeons, and I beg to thank you most sincerely for the early information you were so kind as to

give me of it." Of Liston's case of amputation, which is usually supposed to have carried with it extraordinary conviction, Sir James Clarke says, "The man said that he felt something was doing with his leg, but it was not pain." Yet he does not hesitate to avow, that "it is really a marvellous thing." December 17, Richard Bright, in spite of information from Guy's Hospital that "they had completely failed to produce the desired state of intoxication, apologetically writes, "However, there must have been some want of skill in this first attempt, and I can scarcely doubt that future experience will lead to better success." Lastly, Dr. Forbes adds to the American communications Liston's case, and writes, "I have sent copies of the enclosed to all the newspapers, so that I hope all the world will soon have the great news."

Here was the effect of evidence upon the scientific mind of Europe. Now it is unquestionably very respectable to doubt. The world may not question the judgment of those who suspend their judgment. Yet there are times when doubt is sophistry, and indecision culpable. Richard Bright did not delay to forward the news to Guy's Hospital, "that no time might be lost in affording so great a relief to any who might be in the unfortunate condition of being obliged to undergo a serious operation."

Ought not the motive of relieving human pain to induce the appointed officers of public charities to ask what is the nature of this anodyne, in whose behalf united nations rise to testify? Is it supposed that one of these gentlemen would lose his own arm without invoking ether? Shall none remonstrate, when those who are appointed to alleviate human suffering in administering the accumulated charities of years, virtually avow, that, having tried no experiments, and comparatively ignorant of the subject, they consider that the decision of mankind is wrong; and, acting upon this avowal, they condemn, not themselves, nor yet the reasoning community who resist their influence, but their helpless hospital patients, to the horrors of the knife!

If these consequences were limited to the sphere of a few institutions, the public would have a proportionally limited interest in the subject; but the wide-spread influence which such institutions exercise upon their own section of the country, and upon the large community of which they are the scientific centre, as well as the indirect influence they may have exercised upon governments, render it imperative at least to exhibit the actual value of the influence they choose to exert.

Equally futile were the objections to the new and patent method upon the ground of quackery and professional etiquette. Such considerations should fall before a question of this magnitude; and as to the fact, professional custom does not sanction such objections.

A few words upon the patent may not be here inappropriate. Discoverers in art tax the world for a pecuniary equivalent. In the higher atmosphere of science, which deals with abstract truth, it is not easy, nor is it usual, thus to extort a value for any application growing out of discovery. It is well that a line should be drawn between discoveries in pure science, which enlarge the sphere of the intellect and the boundaries of permanent knowledge, between such discovery, and the transitory and less disinterested labors directed to the amelioration of a narrower circle and a briefer term.

It does not harmonize with our better impulses, that a great invention in the art of relieving human suffering should be in any way conditional. I believe that nations would have emulated each other in meeting any liability generously abandoned to them as a debt of honor. Yet it should be remembered that the question of patent is very insignificant compared with the discovery itself, or the gratitude due to it. Besides which, secrets are common, and perhaps justly so, in the profession with which this discovery had an intimate connection in its early history, and a patent there is not a subject of comment.

Some of the Journals seem to have been indignant at the announcement of this patent by a regular physician. I investigated and published some of the first experiments, by the permission of those concerned in making them, and announced the patent with its extenuating circumstances, at their stipulation. That the patent was an error of judgment as well as a violation of custom, I had no doubt; I vainly endeavored, as far as my very humble influence might weigh, to prevent the final measures for procuring it. I even urged an appeal to interest; the force of which has been fully verified in this case; viz., that when the burden of sustaining his position falls on the patentee, and not upon the violator of the patent, nor upon the government who grants it, an invention may be so valuable as to be worthless to the patentee in a pecuniary point of view. In other words, the encroachment of the multitude may become too formidable for the resistance of an individual.

Finding such expostulation of no avail, and as an humble instrument in the announcement of a great discovery, I did, what I should be most ready to do every week, if by so doing, I were able to accelerate, even by a few days only, the ability of the world to relieve human suffering. Those who were most indignant at the patent, seem to have been

slowest to grant ether to their patients. A fear of "quackery" was instrumental in persuading Congress to withhold the agency of ether, when it might assuage the agony of the wounded soldier. Let us hope that such nice discriminators have no more to lay to their consciences, than a violation of professional etiquette, like that of announcing and using a patent right, by which a man is lulled to slumber while his leg is amputated.

A want of ability has been displayed in confounding the questions of ether patent and ether inhalation. Those who have declaimed against the ether patent, upon this side of the Atlantic, have found it very difficult to give a candid hearing to the separate question of ether insensibility. But it was not so abroad. In England, scientific discrimination far outweighed any discreditable feeling of prejudice or jealousy. The very unimportant question of patent was soon at rest. This error of custom or of taste was forgotten; and the united scientific world abandoned themselves to a determination of the real value of the discovery. No opportunity for experiment was lost; no evidence rejected. The whole medical community gave themselves to the work, and in a short time most honorably avowed that the discovery of etherization was not second to the discovery of their own Jenner. Let us believe that in the country of its birth, prejudice against ether inhalation will now yield to a recognition of its value.

An impartial consideration of the question—"Who was the discoverer of ether insensibility to the pain of surgical operations?" will be best attained by a previous consideration of the abstract question of discovery; reserving for its conclusion, a special application of the principles illustrated by it, to this special subject.

Why was the discovery not made before? Why did no one discern the value of the exhilarating agent which had attracted the attention of so many?

Because the human mind is fettered by long custom. It runs in the channels of routine. First diverted from its course by some little obstacle, its current swells and deepens, bearing down solid opposition that it may roll tranquilly in its distorted bed. Watch the tide of human footsteps, guided by the mind of successive generations. The pathway turns here and there to avoid some little inequality, and the old man and the child follow the winding track. Mind follows where mind has been. Few turn aside to analyze the difficulties which discouraged others. That a thing has not been, is to most men, perhaps justly, a reason why it will not be; and here is the office of philosophic incredulity which doubts the track of custom.

It is quite obvious that such incredulity may emanate from widely

differing sources. It often grows out of depth and originality of intellect; of capacity which takes a wide and general view, discovering imperfection in mode or in material.

On the other hand, as he who is ignorant of a path may make the shortest route from point to point, so one who is not familiar with the erroneous conclusions of previous knowledge, may first trace a true result. In such a case, ignorance of error is an accidental vantage ground, which places its man considerably nearer truth, than that occupied by prejudice based upon error.

I hold that such incredulity, whether of knowledge or of ignorance, is likely to indicate a philosophic mind. It proposes to think for itself. Its experience of the world has shown it that the world may be wrong. Its experience of its own abilities has taught it to respect itself. For example, Whitney was said to form his decisions, not after the model of common opinion, but by his own nicely-balanced judgment. Perhaps in some details, humble though they be, such a mind has seen the defect of others' judgment, and has had cause to prefer its own results; and, thus instructed, turns to a new subject, determined to win its own experience, to make its own investigation.

Such incredulity, brought to bear upon an extended system, especially in the inexact sciences, is justly viewed with suspicion; and the reformer in politics, in the social system, or in medical science, meets no enthusiastic greeting. A little zeal, with a little error of premises or of reasoning, may then make the reformer dangerous. Here, the *experimentum crucis* cannot easily be tried, either from the number of elements in the problem, from the length of time required, or from the magnitude of the interests at stake; and the world therefore very justly maintains a degree of conservatism and immobility, in its moral, social and political relations.

In the exact physical sciences, the tenets of a reformer may be easily tested. Here the logician easily supplies himself with facts. The result of single and brief experiments made at will, can admit of little doubt. Even in the obscurer parts of medicine, where the material and immaterial influences are numerous and sometimes inappreciable, every honest and logical mind must, upon points of importance, arrive at one and the same result. No danger can result from incredulity in medical science. On the contrary, in view of the errors of fact which grow out of want of time or qualification on the part of observers, or the intrinsic difficulties of the science, a healthy and vigilant skepticism of recorded facts, whether in diagnosis or in therapeutics, is one of the essential methods of its advancement.

It is quite obvious that such incredulity—such distrust of recognized authority, occupies a merely negative position. It is a quality which adapts its possessor for the reception of new light, from which the act of invention may emanate. But that such act should in reality occur, certain active faculties are requisite. Positive inventive talent is required; the nature of which I shall attempt to show. But let it be remembered that there is a partial substitute for talent. It has been said that the difference between men lies more in their power of application, than in this quality. Great application, resulting from strong stimulus, will be readily allowed to bring about results, much like those of talent. At any rate, it is more nearly allied to the untiring zeal and stern energy which recognizes no obstruction to its march. It is well known that this unyielding perseverance has characterized a large proportion of inventors; it has animated them in failure, and nerved them through adversity. Of Whitney, whose cotton gin, even fifteen years ago, was said to be demonstrably worth 100,000,000 dollars to the United States, it was said, "of all my experience in the thorny profession of the law, I never saw a case of such perseverance, under such persecution. Even now, after thirty years, my head aches, to recollect his narratives of new trials, fresh disappointment and accumulated wrongs." Fulton's energy was marvellous. His experimental boat was completed after inconceivable difficulties in the spring of 1803, when a messenger announced that the "boat had broken in pieces and gone to the bottom." After a momentary despondency, which till then he had never felt, and without returning to his lodging, without rest or refreshment, he labored with his own hands to raise her, during twenty-four hours incessantly. To this imprudence he attributed much of his subsequent bad health. The boat was almost entirely re-built, and was again completed in July. I take Fulton, Whitney and Arkwright as types of the mechanical inventor. They possessed, in an eminent degree, the inventive talent, but this did not predominate over determination and perseverance, as not unfrequently happens when such talent is exaggerated. Of Whitney's power of invention, it was said, "it never ran wild; it accomplished, without exception, all that he ever asked of it, and no more. I emphasize this last expression, from having in mind the case of a man, whose inventive power appeared to be more fertile even than Whitney's, but he had it under no control. When he had imagined and half executed one fine thing, he darted off to another; and he perfected nothing. Whitney perfected all he attempted."

Such energy, vital to the existence of most discoveries, may grow

out of either the inventor's sense of the necessity, or his conviction of the possibility of reaching his object. And the last is another agent, mysterious to many, which is allied to the incredulity before alluded to, and which eminently characterizes the inventor's mind. It may be defined as a belief in the possibility, or certainty, of producing a result attained by the more active perception and reflection of the inventor's mind, by a series of processes which he may be, and often is, totally unable to impart. He is often, in consequence, considered as unsound or unwise; for as far as the subject in hand is concerned, the inventor is actually ahead of the world. His faculties may not be recognized as stronger, his character more forcible, his intellectual range broader, nor his knowledge of experience greater, than those of other men. Yet for the narrow point at issue, he is more competent than any other. His perceptions are stimulated and brought to a focus; and his energy is hot. He may actually become a better instrument for a special purpose, than another whose intellectual mechanism is far more complicated. Franklin, in an essay before the American Philosophical Society, gave a drawing of a water-wheel, accompanied by a demonstration, conclusive as he supposed, that such wheels could not be used to advantage in propelling steamboats. He proposed a jet from the stern. Fulton proved that among all methods proposed, the jet was the worst, and the wheel the best. Fulton was right, and not Franklin.

The power of remodelling old forms, of abbreviating method, of devising and economizing force for the passage of trodden or untrodden paths, appears to me essentially the same in most of the vocations of the human mind. Superadded to it, may be a taste or a talent for the combinations of mechanical or other force, or for the complicated details of number and of space, or for any other of the fields of science. But how often is a mind simultaneously given to various inventive fields; exhibiting its powers in various directions, and intuitively recognized and stigmatized by the world as having a genius which incapacitates it for the daily routine of life. And how many, like Newton or Franklin, who added the element of perseverance to this genius, have been distinguished for a versatility of talent, manifesting itself each year in a new field, and exhibiting in each its peculiar trait. Franklin was a reformer; Fulton a warm advocate of the principles of free trade; while Whitney, in his college compositions and in the words of his biographer, "with a spirit somewhat prophetical, anticipated the decline and overthrow of all arbitrary governments, and the substitution in their place of a purely representative system like our own."

The inventor invents or devises the means to attain his ends. He is, therefore, most likely, other things being equal, to be a discoverer, because he will best devise the instruments, material or abstract, to cross-examine nature, and discover abstract truth. Yet it often happens that an inventive talent confines itself to the exposition of mechanical truths of limited application; not demonstrating large and suggestive laws in science, but settling limited questions of expediency in art; or making combinations, as Newton did his watch, for the intellectual pleasure of it.

Such mechanical talent as that of Fulton and Whitney, and hosts of others, whose names are or are not attached to great inventions and discoveries, is not the less because it remained circumscribed by the field of mechanical force, to which it first addressed itself. The modifications of mechanical force do in fact afford an ample field to such intellect. But give opportunity to such men as Fulton, or to a thousand nameless artizans, whose talent is valued at more than gold by those who convert such knowledge into money; find some way of detecting this humble genius and give to it the opportunity for education in science and unmerchantable truth, which may take the place of natural strong taste for it, and the combination of the inventive talent with the scientific knowledge, would yield the true philosopher. Newton built a watch, and, having a rare genius for arithmetic computation, discovered the law of gravitation.

It is difficult to over-estimate this talent for expedients and resources. What is American ingenuity? It is this great talent seeking a field in mechanical combinations in a country where opportunities for scientific knowledge have been hitherto comparatively rare. The elements of American ingenuity constitute the perception, the discrimination, and the resources of the American people.

The true power of originating, wherever manifested, is the combined result of a power of analysis and a power of combination; the former enabling the inventor to discover the differences between the elements of existing combinations, to detect the influence of each, and to reject the useless, while the latter perceives the relations of new elements to the problem, and invokes their agency in the new combinations. The intellectual philosopher may justly recognize in these faculties, the agency both of powerful judgment and of the imaginative quality; both brought to bear upon a range of subjects with which their possessor is familiar.

It has been conceded that this talent is peculiar; often an uncultivated gift, brought to bear upon some narrow range of material, by those whose general knowledge does not testify to their industry or opportunities, or

whose intellectual calibre and general range, does not at all comport with this local development of talent in the direction to which taste has guided it.

On the other hand, many discoveries, important to the world, owe little to this peculiar talent. They depend upon a fortunate or accidental succession of events, encircling a comparatively moderate ability; and then the magnitude of the invention may be much out of proportion to the degree of the inventive faculty. The invention of printing, perhaps the greatest in the scale of social importance, was but a division of the Roman printing block. Gun-powder, which happens to abbreviate warfare, was an unpremeditated invention. The discovery of Jenner has been attributed—1, to his talents; 2, to his education under Hunter; 3, to his situation in the vale of Gloucestershire.

I would not abate a leaf of the laurel to which the discoverer has an undisputed right; and I shall presently indicate another quality, different from the inventive talent, which ranks high in intellect, and often compensates a discoverer for this talent. I wish here to show that a discovery of great practical importance may result in part from good fortune; from the first occupation of a ground; from perseverance in a particular direction, or from some other adventitious circumstance; that its magnitude and importance may be out of proportion to the character of the intellectual processes invested in it; and that it has happened that a discovery of immense practical importance to the human race, with good fortune to aid it, has involved but an inconsiderable intellectual pang in its creation; and in consequence, that any *a priori* reasoning upon the mode of its creation, has very little connection with what may well be a question of pure fact.

Having thus considered the intellectual qualities concerned in the invention, I pass to the progress of the invention itself, and to a consideration of its successive steps. These consist, first, of the suggestion; and, second, of the generalization.

Perhaps the most fertile source of error in the history of invention, grows out of a misappreciation of these two stages of discovery. Yet they can be shown to differ widely, both in their character, and in the credit they deserve.

There can be no doubt that unless invention be a result of pure accident, suggestion always precedes it. It has been often distinctly recorded, in connection with the greater inventions and discoveries. Thus the vertical spindles of an overturned spinning wheel, suggested the jenney to Hargreaves. Iron rolling suggested the drawing of cotton by rollers to

Arkwright, who thus re-invented the machine (ignorant of Wyatt's previous invention); the valves of Fabricius, the circulation of the blood; and so on.

In such cases the inventor or discoverer abstracted from the individual instance, some inherent element, the applicability of which to other instances, he alone saw. Hargreaves saw the value of a vertical position to spindles; Newton, of the force which attracted the apple; Harvey, of the idea that venous blood could run in only one direction; and they generalized this element in re-applying it.

It does not modify the truth of this proposition, that the first suggestion or experiment should yield a new result; that instead of a falling apple, it should be the contraction of a frog's leg, or an unpremeditated pustule on the hand of a Gloucestershire milkmaid. Such facts were still suggestions and not discoveries; and were new only in the aspect they received from the mind whose key-note they struck; new because attention was then first drawn to them in a new relation, and not new in their actual occurrence.

And the suggestion varies in its suggestive power, both from its own character and from that of the mind it works upon. The apple fell, and Newton alone abstracted a principle in behalf of the moon. Horace Wells says, and I believe first—"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 treated severely without his manifesting pain. * * * By these facts I was led to inquire if the same result would not follow, by the inhalation of some exhilarating gas." And it is well known that he tried the experiment, with various results, upon himself and others, in November, 1844. And yet the philosopher Seneca makes the remarkable observation—"That which presses hard upon you, and is very urgent, if you begin to withdraw yourself, will certainly pursue you and fall heavier. If, on the contrary, you stand your ground and seem resolved upon opposition, you will drive it from you. How many strokes do boxers receive on the face and whole body! Yet a thirst of glory makes them regardless of pain."

To Seneca it suggested nothing; but to Wells, a principle.

A suggestion derived from one or two instances, becomes an invention

only when its important element is abstracted and actually re-applied; and it will be soon seen that the abstraction itself, the supposition, the theory, without this actual re-application, amounts to nothing; and that for every actual and successful re-application of a newly-appreciated phenomenon, there have been innumerable claims from those who suspected that such re-application might be made, but did not actually make it; who mistook a single truth for a universal truth; suspicion for certainty; theory for fact.

It will be found, by reference to the histories of discoveries, that the suggestion and generalization have occurred almost invariably in the experience of one and the same individual. Though it is quite possible to conceive that while the suggestion occurred to one individual, he might transfer it for generalization to another individual, yet I am unable to find any instance in which this has occurred. On the contrary, the suspicion, the groundwork of the hypothesis, has generally stimulated and goaded the possessor, until he was able to convert it into fact. The suspicion has been then established; or, much more frequently, has not been established. It has proved erroneous; hope has not been realized, and the discovery has turned out to be no discovery. Watt, whose name is identified with the history of steam, and the soundness of whose practical views no one will dispute, speaks of "the cast of a die. For," says he, "in that light I look upon every project that has not received the sanction of repeated success."

This transfer of a suggestion, a theory, unconfirmed by fact, or relying upon one or two facts alone, is, as I have said, quite possible. It would then have the character of a ticket in a lottery which should be thus transferred, with which the recipient may draw a prize, but which is far more likely to turn up a blank.

But especially in great discoveries, the theory has not been thus made over to a second party. The perceptions of the inventor, keen upon this point, have enabled him to discern its value, and he has allowed himself no rest, no interval, in the steady prosecution of his task.

I have alluded to a second quality which contributes to discovery. The inventive talent lies at one end of the intellectual vibrations. At the other extreme is a high quality which elaborates another element; while the invention itself is the electric flash which results from the contact of the two.

Here let me do ample justice to the mind of Jenner, which I do not find to have been especially characterized, in his biography, by the inventive genius. It did possess, as an equivalent, the power of appreciat-

ing the importance of a discovery; and it was in this power and in the perseverance that resulted from it, and indicated it, that I recognize his chief merit. Jenner comprehended that vaccination would considerably prolong the average of human existence. A breadth of view, a simultaneous consideration of many circumstances, with ability to reason justly upon them; in short, a very clear conception of the whole subject, could alone afford the notion of importance or necessity which was to become the stimulus and proximate cause of the discovery. Few minds are capable of becoming so imbued with the importance of a merely possible result, as to permit it to divert the current of daily life. Such men are pointed at as having one idea; their wisdom is questioned; they are the butt of ridicule. And when the result demonstrates the accuracy of their convictions, we may fairly bow at once to their discernment and understanding, whether it detected a possibility, or comprehended a necessity which others overlooked.

At this point let us pause to make a distinction of cardinal importance. We have hitherto considered the qualities of the inventor's mind, and the successive steps of the process by which it accomplishes its end. Another element now complicates the problem. The invention is to go forth to the world; and to establish certain relations between the world and the discoverer.

Up to this point it is quite obvious that an invention may be made, that it may grow from an original hint into a theory, which again may be confirmed beyond a doubt, by the test of repeated experiment, and yet that the whole process may be confined to the inventor's mind; to his own cognizance. So long as he thus retains it for his own benefit or for that of a few friends, does the world stand in his debt? Clearly not. The demonstration of the world to an inventor is a demonstration of gratitude and honor—gratitude for the donation of a great invention, honor to intellectual ability. To the latter it is conceded in the case of certain astronomical discoveries, for example, not immediately concerned in the direct welfare of mankind; but the product of vast and recognized intellectual power.

But when a discovery becomes great, not from the character of the intellect invested in it, but from its immediate applicability to the amelioration of the condition of humanity, then the gratitude and honor conceded by the world is a mere equivalent for value received. The world will not concede this gratitude until they have received the value. They will only concede it to the source through which they receive it, and they will examine very closely the claims of those who may claim to have acted as agents in the matter.

To investigate this last position further—The world is to bestow a large reward in honor and in gratitude, but requires indisputable evidence of merit on the part of the recipient. It is prejudiced against *ex post facto* claims; because it naturally argues, first, that one who had made the invention and appreciated it, would in anticipation of this honor, grateful to all men, have published his invention when he made it; and secondly, that although such *ex post facto* claimant be a real inventor, yet he is so only in relation to himself or those with whom he has communicated; and as he either could not, or did not, make the world at large feel the full value of it, so they owe him nothing. Such is ample reason for the world's prejudice against such claims.

This suspicion of inventors who do not appear until after the world has been made to recognize a discovery, is also justified by the remarkable fact that hardly an invention of importance was ever made known, that it was not at once claimed; often simultaneously from a variety of sources. It is perfectly natural that it should be thus claimed. The world, whether in science or in art, is built up to a certain point, by the easy and wide transmission of knowledge, and upon this elevation stand a multitude of philosophers, engaged, often, in identical researches, and who will be possessed of much information upon the subject to which a discoverer first gives utterance. The world is then liable for a short time to confound their claims, to confuse the perfect with the imperfect knowledge; the incomplete result of few facts with the complete demonstration from many; the unproved with the indisputable; theory with fact. But the law of the land has left no doubt upon this point. Before ceding a patent, it first identifies a discoverer. Here is an opinion from the clear head of Judge Story. "He is the first inventor in the sense of the act, and entitled to a patent for his invention, who has first perfected and adapted the same to use; and until it is so perfected and adapted to use, it is not patentable. An imperfect and incomplete invention, resting in mere theory or in intellectual notion, or in uncertain experiments, and not actually reduced to practice, is not and cannot be patentable under our patent acts. In a race of diligence between two independent inventors, he who first reduces his invention to a fixed, positive and practical form, would seem to be entitled to a priority of right to a patent therefor."

And the actual history of discovery and invention is conclusive upon these points. The world, if it has doubted awhile, has always been right in the end. *The man who has first generalized the proposition, and first made the world allow that it was thus generalized, has been the inventor.*

About 1750 one Sultzer published an account of the peculiar taste,

arising from the contact of bits of silver and of lead with the tongue. Forty years after, Galvani brought metals in contact with a frog's leg. In each case a hint was received; Sultzer published it, but the world were not impressed with its importance. Galvani pursued the hint with numerous experiments; demonstrated that the phenomena resulted from a new modification of abstract force; compelled the world to recognize it, and was the discoverer.

The young countrywoman at Sodbury said of smallpox, I cannot take that disease, for I have had cowpox!—The Duchess of Cleveland said she had no fear about her beauty, for she had had a disorder which would prevent her from ever catching the small-pox. Were these discoverers? No. They furnished the isolated hint, and made no farther experiments. Jenner, with infinite energy and perseverance, through many successive years, in spite of ridicule, at last proved, not that cowpox might protect the system, but that it always would thus protect it, and that it was safe. He generalized the single fact, and was a discoverer.

Many experimenters raised their voice to say that they, too, had wiped up acids with a towel which had then burned like powder. Schonbein was the first to make the world allow that cotton, treated by a certain process, always would thus burn.

The Abbe Nollet suspected the identity of the electric fluid and of lightning, and experiments were made in France. Franklin, braving the ridicule of failure, flew his kite, and by this and subsequent experiments with a lightning rod, he proved that the electric fluid was thus identical.

Adams made a calculation with regard to the existence of a new planet, and could not or did not compel the world, through the astronomer royal, to listen to him. Leverrier calculated a result, compelled the world to recognize its intrinsic greatness, and the magnitude of his own mathematical power, and was the discoverer.

Jonathan Hull, the Abbe Arnal, the Earl of Stanhope, Franklin, and others, proposed to propel boats by steam. They tried it, and failed to persuade the world of the expediency or value of the method. Long after, Fulton, impressed with the immense importance of the subject, made a series of experiments and calculations, discerned the cause of previous failures, persevered through inconceivable difficulties, and in the face of ridicule he felt but did not yield to, demonstrated a proposition; not that steam, a long recognized power, might be made to move a boat, but that it could do so efficiently and profitably. He first compelled the world to recognize this great fact, and was the discoverer of this abstract truth, and the inventor of a profitable steamboat.

A hundred other instances might be cited to show that the man, to

whom the original hint occurs, is not the inventor; nor yet he who forms a theory upon this hint; nor even he who publishes this theory, if he does not convince other people of its truth. This last may readily occur. A man may happen upon a fortunate theory, and yet not appreciate its value; so he gives himself no trouble to proclaim it; or perhaps his proofs are not conclusive, and the world will not believe. Goethe knew this when he said, "many things may be discovered and made known for a long time without producing any effect on the world, or the effect may be wrought without its being observed; wrought and yet not take hold of the multitude. This is the reason why the history of inventions is so surrounded with strange riddles."

He is the inventor who generalizes the single instance, and who makes the world concede that it is thus generalized.

Now, if there is any one point which has identified the true inventor's mind, it has been an invincible determination to compel the world to recognize the reality and value of its invention. The inventor saw it himself when other men could not, and he determined that other men should see it, and he accomplished his determination. "He," Sidney Smith says, in the Edinburgh Review, "is not the inventor who first *says* the thing, but he who says it so long, loud and clearly, that he compels mankind to hear him."

Recognize this point, and the question of invention is comparatively simple. Yet it is not recognized. There is no abatement of claims to previous invention. The writer of a Life of Fulton well says—"Those who question Mr. Fulton's claim are precisely those who have been utterly unsuccessful in their own attempts; and it would seem that exactly in proportion as their efforts were abortive, and as they had thrown away money in fruitless experiments, their claims rose in their own estimation, and that of their partizans." And the witness, I believe before the House of Commons, probably did not overstate the matter when he gave it as his opinion, that if a man were to show that he had found a road to the moon, his neighbors would testify, that, if they had not been there themselves, they knew several individuals who were familiar with the road in question.

The above considerations have been presented with the intention and desire of exposing the authority of precedent with impartiality. I have wished that the reader should not lean to one or the other side of the ether controversy, until all these considerations were presented. It remains to show their bearing upon the gist of the evidence contained in the state-

ments which have been made in behalf of Dr. Jackson and of Dr. Morton. The considerations alluded to bear upon four principal points.

1. The character of the mind and education required for discovery.
2. The suggestion of the discovery.
3. The generalization of this suggestion.
4. Its presentation to the world.

1.—This community is familiar with the great scientific talent and attainment of Dr. Jackson. Dr. Morton has acuteness, ingenuity, zeal, and perseverance. The discovery is not of a character to have demanded extensive scientific acquirement, and it is probable that either Dr. Jackson or Dr. Morton might have made it.

2.—The suggestion occurred to Davy, Jackson, Wells, Morton, and many others. Horace Wells seems to have conceived this hypothesis more distinctly than any other individual. So persuaded was he of its probability, that he made several experiments; and even made a journey to the Medical Class at Boston, before whom, however, he entirely failed to verify his theory. He then abandoned it, until it was confirmed by Dr. Morton. Dr. Jackson fails to prove that Dr. Morton was ignorant of the hypothesis, until he suggested it to him, because Dr. Morton shows by the evidence, that he was considering the properties of ether, at the intervals both of three months, and of three days, before his interview with Dr. Jackson.

3.—*I have shown that he who verifies the suggestion is the real discoverer. Dr. Morton, according to the evidence, did generalize this discovery. He verified the suggestion, from whatever source it emanated. He made and modified the experiments at his own discretion. He assumed the responsibility of danger. He first conclusively demonstrated of ether*—1, *that it would always produce insensibility to pain*—2, *that it was safe. These two points constitute the discovery. Dr. Morton demonstrated these points, and no one else did.*

To show that Dr. Morton was only a "nurse"—an instrument of pre-established knowledge—such knowledge must be proved to be pre-established. It is impossible for human reason to infer, upon the experiments put in evidence by Dr. Jackson, either that ether was—1, universal in its effects, or—2, that it was safe. It must, therefore, be argued that this knowledge was not pre-established—that Dr. Morton was not a mere administrator, but that he was an originator.

4. Lastly—Many may have been the real discoverers of ether insensibility to pain, and at a remote period. But if so, they have kept it to themselves; and they will be known as discoverers only to themselves.

The world has always honored that individual among such discoverers, who presented his discovery to them. Dr. Morton was, according to the evidence in print, both the prime mover and the immediate agent in the introduction of this discovery to the world.