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THE DEVELOPMENT OF ANESTHESIA*

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"I esteem it the office of the physician not only to restore health, but to mitigate pain and dolors."

—*Sir Francis Bacon*

THE history of the development of anesthesia is, like the history of many other useful contributions to civilization, filled with hopes and disappointments, comedies and tragedies, successes and failures. The bitterness of the controversy concerning the introduction of anesthesia with ether as well as nitrous oxide still raging after almost a century is disappointing in that it has about it the suggestion of a lack of historical perspective, as quarrels concerning priority usually have.

It has been suggested by Archer (1) that ancient man sensed relief from pain caused by bruises and sprains when the injured part was exposed to cold water in a lake or stream. Other wounds were said to have been favorably influenced by the sun's heat, and later, by heat from fires or hot stoves.

Perhaps, as Fülöp-Miller (2) (p. 12) has recently observed, the first method used to eradicate pain by primitive peoples was to treat pain as a demon and to try to frighten the demon away. To do this there were many methods. The skin was tattooed to keep the demon of pain outside the body; rings were worn in the ears and noses; talismans, amulets, tigers' claws and similar charms were worn to ward off evil spirits.

The first anesthetist probably was a woman, for the head of the primitive family was the Great Mother under the matriarchal system, which has been said by some to have been the status of society in primitive times. The Great Mother was priestess and sorceress, and consequently was the founder of the healing art. When a primitive sick man could not relieve his own suffering he called on the priestess. Conjurations and spells were resorted to, magic was applied, and pain was thought to be banished thereby.

Even under the patriarchal state, which some anthropologists have said subsequently developed, woman remained as a healer. Indeed, the classic example was the blonde Agamede of the Greeks, who was considered to wield exclusive power over the demons of illness and thus was

* *Editor's Note.* This is the first of a series of articles on the history of anesthesia by Mr. Keys. Additional ones will appear in subsequent issues of ANESTHESIOLOGY.

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able to banish pain. Gradually, however, the medicine man, conjurer or *shaman* took her place. Using different technics, he achieved the same results in the banishment of pain. He muttered magic incantations. He wrestled and fought the invisible demon. If the soul had been drawn from the body, thus causing pain, he searched for the hiding place of the soul and triumphantly returned the soul to the sufferer's body, thus relieving the patient of his pain.

Later in the development of society the medicine man was replaced by the priest, the servant of the gods. Priests have ever ministered to the sick and they relied on prayer for the alleviation of pain. Thus, the fate of the patient was entrusted to a higher power.

With the birth of Christianity came a concept for the relief of pain, based on divine healing through touch and prayer. One of the tasks of the Son of God and his followers was the banishment of suffering of all mankind. This was accomplished through the power of touch as well as prayer, which was willed down through the ages from Christ through the disciples to the Church fathers and ultimately to all those who had ministerial duties. In this manner the church of the early Middle Ages became a healing institution. Priests, monks and nuns, who to a great extent represented the church, practiced the healing art and were thought to be able to relieve pain. As some historians have shown, the early monks and their helpers not only used empirical methods for the relief of pain but also developed practical aids. Indeed, as early as 1530 monks used alcoholic fumes to alleviate pain prior to and during surgical intervention (Fig. 1).

The early Christian kings tried to cure the sufferings of their subjects from many diseases by the laying on of hands. This, as has been suggested, formerly was the province of the ministers of the church. But the kings usurped this privilege for their own protection. They formulated the theory of the "divine right of kings," which was convenient for many other purposes in addition to cure of the sick. Later, "touching" by monarchs was reserved for special diseases such as scrofula or the "King's evil."

Long known to man has been the use of drugs to bring about artificial sleep. Drugs which brought about loss of consciousness were compounded from many roots, barks, herbs, berries, seeds and blossoms of flowers. The most mentioned in the literature which were taken to relieve the pain of surgery were henbane, poppy, mandragora and hemp.

A Babylonian clay tablet of about 2250 B.C. reveals a remedy for the pain of dental caries, according to Prinz (3). Cement consisting of henbane seeds in powdered form was mixed with gum mastic and applied to the cavity.

In the *Odyssey* (4) of Homer it is recorded that Helen, the daughter of Zeus, prepared a drug, possibly opium, dissolved in wine to sleep off grief and anger and to forget pain: "Now elsewhere Helen turned her thoughts, the child of Zeus. Straightway she cast into the wine of which

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FIG. 1. Early use of alcoholic fumes for anesthetic purposes in a monastic hospital. From Deboiet Schilling's *Swiss Chronicle*, 1530.

they drank a drug which quenches pain and strife and brings forgetfulness of every ill." According to Archer (1), Aesculapius, the god of medicine, was supposed to have used a potion, nepenthe, to produce insensibility in his surgical patients, and Hippocrates, according to the same authority, produced narcosis by having a patient inhale the vapor of bang.

The Greeks and later the Romans also resorted to a sort of local anesthesia. They placed on the region they desired to anesthetize the "stone of Memphis" treated with vinegar. According to Kleiman (5) it is possible that the anesthetic effect was obtained by dulling, for the Memphis stone was composed of carbonates which, in coming into con-

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tact with the vinegar, were said to have liberated carbon dioxide which numbed the affected part.

It is well known that the Semites compressed the veins before circumcision, thus producing, in effect, regional anesthesia. Egyptian, as well as Assyrian, physicians obtained an artificial sleep for their patients by quickly compressing the carotid vessels of the neck, possibly by producing a temporary aneuria or, more likely, simple suffocation.

Dioscorides, the famous Greek physician of the first century A.D., administered the root of the mandragora plant boiled in wine to his patients before submitting them to surgery (5). Galen used this plant experimentally to paralyze sensation and movement. Curiously enough, mandragora was employed for centuries in Asia by the Chinese and the Hebrews in cases of criminologic investigation. Criminals were compelled to drink a concoction in a form of infusion with other drugs. This produced a confused mental status which often led to a confession of crime. Mandragora also was administered, paradoxically, to aid in the relief of the sufferings and tortures endured by accused persons. In such an event it was known as the "potion of the condemned." Kleiman (5) said that Pliny observed that the "potion of the condemned" was often given to diminish the agonies of crucifixion.

The ancient Scythians breathed fumes produced by a certain form of hemp (*Cannabis indica*). From this they obtained a state of mental excitation followed by sleep (5). The Egyptians as well as the Arabians, similarly, inhaled the fumes of this plant which they called *hashish* (that is, hemp) from which they also obtained an exalted mental state. In the third century, Hoa Tho, the Chinese physician, utilized Indian hemp to render his patients unconscious. This practice was also used in many other countries.

In the thirteenth century Hugues de Lucca prepared a soporific agent with opium as the base. It also included hemlock, henbane, leaves of mandragora, wild ivy, and the seed of some salad plant. This mixture was administered to patients and apparently was successful in producing anesthesia for minor surgical procedures. To revive the patients, sponges filled with vinegar were held under their noses.

Theodoric de Lucca, his son, was one of the first to attempt to produce general anesthesia by inhalation. He used a sponge, which can be thought to have been the earliest crude gas machine. Having previously steeped the sponge in a soporific mélange, he allowed it to dry. When this sponge was ready for use after soaking in hot water, he applied it under the nose of the patient, who was instructed to breathe deeply. The uncertain action of the medicated sponge, because of lack of standardization of the drugs employed in the mélange, was the cause for abandonment of its use. Probably one of the reasons why anesthesia in general was so slow in developing was the fact that no drugs were standardized. No attempt was made to purify them or to regulate dosage. Often a drugged sleep resulted in death through asphyxia or

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congestion. This in itself discouraged the more staid physicians in the conquest of pain. Then, too, pain was considered in a holy light; which is to say, something that God deemed good for mankind. This was especially true in obstetrics. Babcock (6) has reported the case of Eufame MacAlyane of Edinburgh, who in 1591 was buried alive on Castle Hill for seeking the assistance of Agnes Sampson for the relief of pain at the birth of her two sons. The time was not ripe for the acceptance of anesthesia.

In the early part of the thirteenth century Raymondus Lullius, the prominent Spanish alchemist, discovered a white fluid which he called "sweet vitriol." Two centuries later Paracelsus, the great physician, searching for an agent that would relieve pain, mixed sulfuric acid with alcohol. He distilled this mixture and rediscovered "sweet vitriol" which was not called "ether," however, until 1792, when Frobenius of Germany so named it; but early as 1540 Valerius Cordus described the synthesis of what later was to be called ether.

A digression to Paracelsus reveals some very important evidence which supports a claim for him as the founder of anesthesia. In writing of his experiments with fowl he is reported by Fülöp-Miller (p. 25) to have said: "Of all the extracts of vitriol, this particular one [sulfuric ether] is the most important, being stable. Furthermore, it has an agreeable taste, so that even chickens take it gladly, and thereafter fall asleep for a long time, awakening undamaged. In view of the effect of this vitriol, I think it especially noteworthy that its use may be recommended for painful illnesses, and that it will mitigate the disagreeable complications of these."

At the beginning of the seventeenth century, Valverdi made use of a sort of regional anesthesia (5). He compressed nerves and blood vessels near the region to be operated upon; a procedure similar to that of the ancient Semites and Assyrians, as mentioned previously. Ambroise Paré also knew the anesthetic value of compression. Indeed, as late as 1784, James Moore (7) produced local anesthesia of a limb by compressing the nerves of the trunk. It is known that John Hunter used this method in a case of amputation below the knee, with some degree of success.

The Renaissance fostered a great scientific spirit which made for many remarkable advancements. Emphasis was placed on the development of chemistry and physics. Search was made in these two fields for agents to relieve pain. As will be shown later, the role of chemistry is of great importance in the history of anesthesia. In addition to genuine workers who produced valid contributions, there were many "pseudo" scientific thinkers who speculated, often chiefly to their own benefit, regarding the cause and cure of disease. One of these, as Fülöp-Miller has so vividly described, was Franz A. Mesmer, who introduced the doctrine of vitalism. Mesmer received his degree in medicine from the University of Vienna in 1766. Vitalism was based on the assumption

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that some men possess the authority of transmitting what are called "the harnessed powers of the cosmic energies." These "cosmic energies" were remarkable in that they banished pain and suffering. Mesmer first used a magnet as an instrument to transmit the cosmic energy to the body of an afflicted person. He had remarkable success with the magnet, and soon thousands of patients came to him to receive the vital energies. Mesmer soon found it impossible to treat all his patients individually, so he took a wooden rod and by making passes over it invested the rod with magnetic energy. By pointing the stick at several patients he claimed that he could cure many simultaneously.

FIG. 2. Mesmer practising animal magnetism. From Holländer, Eugen: Die Karikatur und Satire in der Medizin. Ed. 2, Stuttgart, Ferdinand Enke, 1921.

Later, Mesmer announced that the healing force emanated from his own body, and that subsequently, the same beneficial results were obtained. This old healing power of the touch was rechristened "animal magnetism" (Fig. 2). Absurd as Mesmer's ideas were, his confidence was shared by many leading dignitaries of the day, including Marie Antoinette, the Duke of Bourbon and Lafayette, who recommended Mesmer's ideas to America.

Somnambulism in Europe, a development of mesmerism, had a curious beginning. One of Mesmer's pupils, Count Maxime de Puységur of Busancy, in treating a patient who had been tied to a tree, made passes over his body to increase the magnetic influence. At the moment the treatment should have taken effect, the patient fell into a profound

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sleep. The count ordered him to awake and to untie himself. The patient complied and walked across a park with his eyes closed. He also obeyed all commands of the master.

After Puységur had experimented in other cases and had achieved similar results, the success of somnambulism spread over Europe. In the British Isles James Esdaile and John Elliotson of Edinburgh adopted it, being convinced that it would prove an infallible agency for the relief of pain during surgical operations.

Because the leading surgeons were skeptical of this "remedy," Esdaile journeyed to India to continue his experiments. According to Fülöp-Miller (p. 37) members of certain Indian castes had known for centuries of a process akin to somnambulism, calling it *Yar-Phoonk*. Esdaile is said to have removed scrotal tumors successfully from patients in this state of artificial sleep. In Europe somnambulism failed to relieve the pain of surgery, and in America John Collins Warren of the Massachusetts General Hospital had no success with this method.

Thus far, as has been intimated herein, no dependable means of relieving pain during surgical intervention that was generally acceptable had been discovered. To be sure, in isolated cases, it is apparent that many remedies had met with partial success. By far the most acceptable method was to offer the patient a strong drink of an alcoholic beverage and to operate swiftly. This by no means dispelled the imminence of pain. It remained for chemistry, plus much Yankee ingenuity and resourcefulness, to provide an answer to this problem.

The pioneer who discovered carbonic acid gas (date, unknown), oxygen * (1771) and nitrous oxide (1772) was Joseph Priestley. His fundamental research on gases was the foundation of the discovery of modern surgical anesthesia, although he was unaware of it. Priestley moved to America and died in Northumberland County, Pennsylvania, in 1804. Because Priestley suggested that the inhalation of oxygen might be of benefit for certain diseases of the lungs, some members of the medical profession as well as quacks developed "pneumatic medicine." This soon became a treatment fad and not only inhalations of oxygen but also of hydrogen and nitrogen were employed as therapy chiefly for asthma, catarrh and consumption. Later, some physicians employed inhalations of various gases for the treatment of paralysis, scurvy, hysteria and cancer.

It is of interest to note that an American chemist and physician, Lantham Mitchell, administered nitrous oxide to animals with such dire results that he came to the conclusion that this gas was very poisonous. He also believed that nitrous oxide might possibly be the contagium for the spread of epidemics. His opinions were accepted without reservation and for many years no physician cared to make use of nitrous oxide. However, in 1795, Humphry Davy, then a young

* Karl Wilhelm Scheele of Sweden is said to have discovered oxygen independently the same year (1771) and to have described it in 1777 in his *Chemical Essay on Air and Fire.*

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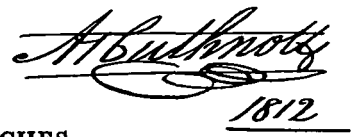

1812

RESEARCHES,

CHEMICAL AND PHILOSOPHICAL;

CHIEFLY CONCERNING

NITROUS OXIDE,

OR

DEPHLOGISTICATED NITROUS AIR,

AND ITS

RESPIRATION.

By HUMPHRY DAVY,

SUPERINTENDENT OF THE MEDICAL PNEUMATIC INSTITUTION.

LONDON:

PRINTED FOR J. JOHNSON, ST. PAUL'S CHURCH-YARD.

BY BIGGS AND COTTLE, BRISTOL.

1800.

FIG. 3. Title page to Humphry Davy's book wherein he discussed the possible use of nitrous oxide as an anesthetic agent.

man of seventeen years, was bold enough to inhale this gas. Instead of dying, he experienced many pleasurable sensations; he felt an agreeable sense of giddiness, a relaxation of the muscles, noticed his hearing to be more acute, and in general felt so cheerful that he was compelled to laugh.

In 1800, Davy, who in early life had been a surgeon's assistant, published the results of his studies on nitrous oxide in that now much sought-after volume (8) entitled: *Researches, Chemical and Philosophical; Chiefly concerning Nitrous Oxide* . . . (Fig. 3). This important

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book not only outlined his basic researches but also suggested the possible anesthetic qualities of nitrous oxide. In one section of the book (p. 465) Davy described his use of the gas in the temporary alleviation of the pain of inflammation of the gums induced by eruption of a wisdom tooth:

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

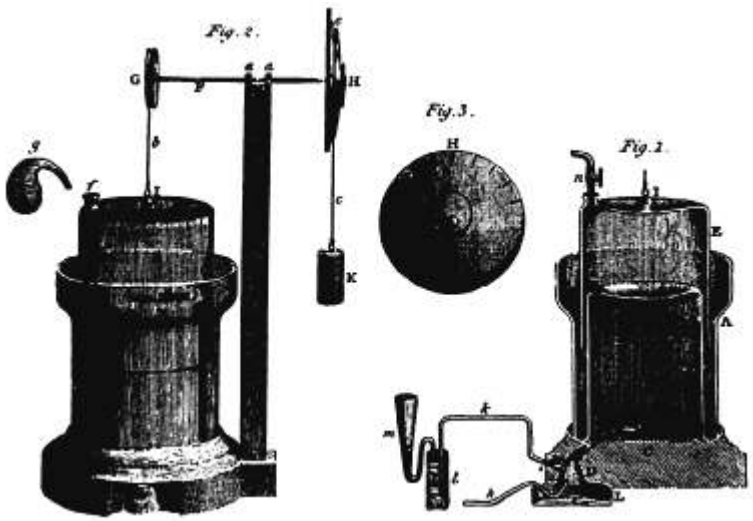

FIG. 4. Humphry Davy's "gas machine." From the frontispiece to his book. (See Fig. 3.)

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

Later in his book (p. 556) Davy again mentioned the possibility of the use of nitrous oxide as an anesthetic agent.

"As nitrous oxide in its extensive operation appears capable of destroying physical pain, it may probably be used with advantage during surgical operations in which no great effusion of blood takes place."

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Humphry Davy constructed what was perhaps one of the first modern gas machines, for in 1799 he is known to have used a gas tank for the storage of pure nitrous oxide (Fig. 4). To this he attached an almost impermeable silken bag from which he inhaled the gas.*

There were others, of course, besides Davy who soon developed an interest in nitrous oxide. According to Wilks and Bettany (9), William Allen, lecturer on chemistry at Guy's Hospital wrote in his diary in March, 1800:

"Present, Astley Cooper, Bradley, Fox, and others. We all breathed the gaseous oxide of azote. It took a surprising effect upon me, abolishing completely at first all sensation; then I had the idea of being carried violently upward in a dark cavern with only a few glimmering lights. The company said that my eyes were fixed, face purple, veins in the head very large, apoplectic stertor. They were all much alarmed, but I suffered no pain and in a short time came to myself."

Interestingly enough, Dr. John C. Warren, who often enters into the story of anesthesia, used the inhalation of ether in 1805 as a means of relieving the last stages of pulmonary inflammation (10).

Michael Faraday, a student of Humphry Davy, was the next investigator to make a contribution to the modern application of anesthesia. He did much original work on the isomerism of butylene with ethylene, and on the chlorides of carbon. He also liquefied many gases. While thus experimenting he noticed the soporific nature of ether vapor. In 1818 he wrote in the *Quarterly Journal of Science and the Arts,* according to Fülöp-Miller (2) (p. 71): "When the vapour of ether is mixed with common air and inhaled, it produces effects very similar to those occasioned by nitrous oxide. By the incautious breathing of ether vapour, a man was thrown into a lethargic condition which, with a few interruptions, lasted for thirty hours."

Davy had suggested the anesthetic possibilities of nitrous oxide and Faraday had noticed the similar effects of ether. But the evaluation of any process is necessarily slow, and it was some time before physicians were to apply these and similar gases to the relief of pain during surgical operation.

Undoubtedly, one of the heroic figures in the development of surgical anesthesia was Henry Hill Hickman (11). This scholarly Englishman was admitted in 1820 as a member of the Royal College of Surgeons of London, at the early age of 20 years. He was also a member of the Royal College of Surgeons of Edinburgh. In 1824 he carried out a series of experiments by operating, without causing pain, on animals after the administration of carbon dioxide gas (Fig. 5). Because of the many prejudices of the era, he did not persuade surgeons either at

* In 1795 James Walls constructed a gas inhaler for Thomas Beddoes. See Beddoes, Thomas and Walls, James: Considerations on the Medicinal Use, and on the Production of Factitious Aires. Bristol, J. Johnson, 1795.

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FIG. 5. Hickman experimenting with anesthesia on animals. From an oil painting in the Wellcome Historical Medical Museum. Courtesy of Wellcome Foundation, Ltd.

home or abroad to allow him to try this gas as an anesthetic on their patients. Nevertheless, he deserves the credit of having been the first of the modern investigators to prove by experimentation on animals that the pain of surgical operation could be abolished by the inhalation of a gas.

Hickman recognized that certain vapors introduced into the lungs and thence into the circulation of the blood should provide a means of bringing on an artificial sleep prior to surgical intervention. He had mice, puppies, and a mature dog inhale carbonic acid gas, and he thus obtained anesthesia for them during surgical procedures. According to Buxton (12), Hickman further recognized the importance of maintenance of "the constant flow of the blood and of the surgeon's being prepared to meet and deal with circulatory collapse.

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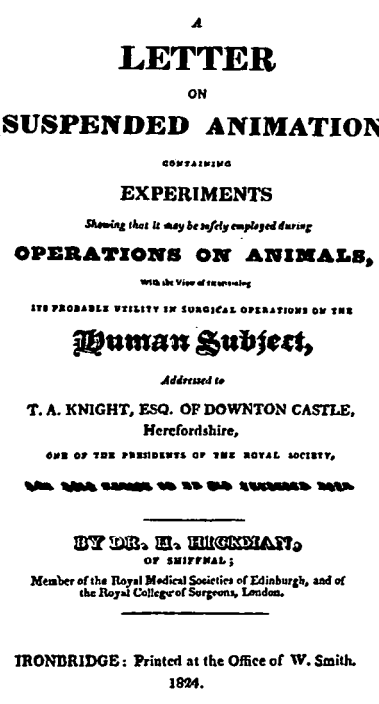
On February 21, 1824, Hickman wrote a letter to Mr. T. A. Knight of Downton Castle, near Ludlow, giving full account of his investigations. Knight was a fellow of the Royal Society and Hickman, a personal friend, hoped to obtain recognition from this much respected body so that his work might be checked by others. In the same year Hickman published his famous pamphlet "A letter on suspended ani-



A

LETTER

ON

SUSPENDED ANIMATION,

CONTAINING

EXPERIMENTS

Shewing that it may be safely employed during

OPERATIONS ON ANIMALS,

With the View of ascertaining

ITS PROBABLE UTILITY IN SURGICAL OPERATIONS ON THE

Human Subject,

Addressed to

T. A. KNIGHT, ESQ. OF DOWNTON CASTLE,
Herefordshire,

ONE OF THE PRESIDENTS OF THE ROYAL SOCIETY,

BY DR. H. HICKMAN,
OF SHIFFNAL;

Member of the Royal Medical Societies of Edinburgh, and of the Royal College of Surgeons, London.

IRONBRIDGE: Printed at the Office of W. Smith.
1824.

FIG. 6. Title page to Hickman's pamphlet. Courtesy of Wellcome Foundation, Ltd.

mation" (Fig. 6). In this pamphlet he suggested the possibilities of the production of anesthesia prior to surgical operations on human patients. Failing to impress his own countrymen with the importance of his investigations, he turned to the French capital. In April, 1828, he presented a memorial to King Charles X of France, in which he explained the importance of his discovery. In August of 1828 he asked the French Academy of Medicine to investigate his claims. The academy named a committee to do this, but nothing came of it.

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It is hard to believe that the leading scientists of both England and France failed to recognize the contribution of Hickman or to investigate his claims scientifically. Even Sir Humphry Davy, who had been president of the Royal Society, failed to be impressed. In France, the brilliant Baron Larrey alone supported Hickman. He had been army surgeon under Napoleon and knew the horrors of pain caused by surgical operations. He had found that wounded soldiers suffered little

FIG. 7. Crawford W. Long. Reproduced from frontispiece to Taylor, F. L.: Crawford W. Long and the discovery of ether anesthesia. Courtesy of Paul B. Hoeber, Inc., 1928.

pain when they were operated on in a half-frozen condition. But his colleagues outvoted him and declined to push the matter. Hickman, of course, was most disappointed. He returned to England and died prematurely on April 5, 1830.

Meanwhile, in the United States, the use of ether and nitrous oxide was developing. Stockman of New York demonstrated the exhilarating effects of nitrous oxide as early as 1819. Following the advice of men like Beddoes, American physicians employed ether in the treatment of pulmonary tuberculosis and suggested it for other conditions. But it

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was the employment of nitrous oxide and ether for pleasurable purposes that largely contributed to the use of these gases in anesthesia. There were many itinerant "professors *" of chemistry who traveled through the towns and villages of the country, lecturing on gases and demonstrating the exhilarating effects of nitrous oxide, especially. Many times part of the demonstration consisted of having young members of the audience inhale ether vapor or nitrous oxide. These young participants became pleasantly drunk. They lost their sense of equilibrium, talked foolishly and sometimes laughed with complete abandon.

Soon some of these young persons were amusing themselves without lectures. "Laughing-gas parties" and "ether frolics" became the vogue. Sometime during the year 1839, according to Lyman (13), William E. Clarke, a young student of chemistry in Rochester, New York, was in the habit of entertaining his companions with inhalations of ether. While a student at Berkshire Medical College in 1841 and 1842 Clarke continued his "ether entertainments." Presumably because of these experiences, in January, 1842, having returned to Rochester, he administered ether from a towel to a young woman named Miss Hobbie, and one of her teeth was then extracted without pain by a dentist, Dr. Elijah Pope. This would appear to be the first use of ether anesthesia on record; it antedates what is presently known of the work of Long by at least two months.†

It was after a public demonstration, which he had not attended, of the effects of nitrous oxide, that the young physician, Crawford W. Long (Fig. 7) of Jefferson, Georgia, was moved to consider the possibility of administering ether to a patient so that he could operate without causing pain. He knew little about nitrous oxide, but had witnessed "ether frolics" while he was a medical student in the University of Pennsylvania. One of his friends, James M. Venable, who had participated in "ether frolics," had for some time been discomforted by two small tumors on his neck. Here was an opportunity to demonstrate the effectiveness of ether. After some persuasion, Venable agreed to be operated on while he was under the influence of ether, and on the afternoon of March 30, 1842, Long removed one of the small tumors from Venable's neck. The operation was performed successfully and the patient did not feel the surgeon's knife nor did he suffer any pain. Crawford Long was the first man to use ether for the purpose of producing surgical anesthesia for other than dental operations. Dr. Long continued for some time to use ether for anesthesia in his operations. He hoped to encounter patients who needed to undergo major surgical procedures so that he might make a more convincing report, but in such a small community none came his way. Dr. Long published in the issue

* Samuel Colt, inventor of the revolver, in his early years was one of these.

† Apparently Clarke did not consider his contribution of importance for it is not mentioned in an account of his life in Stone, R. F.: Biography of Eminent American Physicians and Surgeons, Indianapolis, Carlon and Hollenbeck, 1894, p. 89.

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for December, 1849, of the *Southern Medical and Surgical Journal* an account of his discovery, but Morton's work had been reported by Bigelow (14) and Warren (15) in the *Boston Medical and Surgical Journal* in 1846, as will be shown herein.

It is of interest to note in passing that Dr. Long, at about the same time as Sir James Simpson (1847) began the administration of ether in obstetrical work (16).

FIG. 8. Horace Wells. Reproduced from Camac, C. N. B. (Compiler): Epoch-making contributions to medicine, surgery and the allied sciences. Courtesy of W. B. Saunders Company, 1909.

It was at an exhibition of the exhilarating effects of nitrous oxide gas that the next important development in the history of anesthesia took place. On the evening of December 10, 1844, Dr. Gardner Q. Colton was demonstrating the effects of "laughing gas" before an enthusiastic audience at Union Hall in Hartford, Connecticut. According to Colton's own story (17), one of the young men who volunteered to try the gas was Samuel A. Cooley, a drug clerk. He immediately became under the influence of the gas and while jumping about, struck his leg on a wooden settee. He bruised it badly. After taking his seat he was astonished to find his leg bloody. He felt no pain until the effects of the gas had worn off. Dr. Horace Wells (Fig. 8), the

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town's leading dentist, who had sat next to Cooley and had himself sniffed the gas at Colton's urging, noticed this circumstance. When the audience was retiring Dr. Wells asked Dr. Colton why a man could not have a tooth extracted without pain while he was under the influence of this gas. Dr. Colton replied that he did not know, because the idea had never occurred to him. Dr. Wells believed that it could be done and persuaded Colton to bring a bag of the gas to his office

FIG. 9. William T. G. Morton. Reproduced from Camac, C. N. B. (Compiler): Epoch-making contributions to medicine, surgery and the allied sciences. Courtesy of W. B. Saunders Company, 1909.

the next morning, December 11, 1844. Dr. John M. Riggs, a colleague (for whom Riggs' disease, or alveolar pyorrhea, is named), was called in to extract one of Wells' own teeth. Dr. Colton administered the nitrous oxide and Riggs extracted a molar. Dr. Wells on recovery was said to have exclaimed: "It is the greatest discovery ever made! I didn't feel it so much as the prick of a pin!"

At Dr. Wells' request, Dr. Colton taught him how to prepare the gas and then left Wells and continued his lectures on the exhilarating

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powers of nitrous oxide. Dr. Wells made and tested the effects of the gas and then journeyed to Boston to make known the discovery. He called on Dr. William Thomas Green Morton (Fig. 9), a former student and partner as well as other dentists and physicians, stating his discovery. According to Colton, they treated him as a visionary enthusiast.

FIG. 10. John C. Warren. Reproduced from Camac, C. N. B. (Compiler): Epoch-making contributions to medicine, surgery and the allied sciences. Courtesy of W. B. Saunders Company, 1909.

Wells obtained permission from Dr. John C. Warren (Fig. 10) to address the class in surgery at Harvard Medical School. At the close of his remarks, Wells administered the gas to a boy and extracted a tooth. Most unfortunately, the boy screamed out, for anesthesia had not been complete. Later, the patient admitted that he had suffered no pain and did not know when the tooth had been drawn. At the time,

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however, the students hissed and pronounced the so-called discovery a hoax. Had Dr. Wells' demonstration proved successful to all parties concerned, nitrous oxide probably would have been adopted for surgical anesthesia. But even though Wells returned to Hartford and used nitrous oxide successfully in his dental practice in 1845, as the deposition of some forty respectable citizens of Hartford indicates, the use of this gas was abandoned until June, 1863, when Dr. Colton revived it in New Haven, Connecticut, administering it for Dr. J. H. Smith, a distinguished dentist of that city. Although Wells had failed to convince the world of the value of nitrous oxide as an anesthetic agent, he is credited with conceiving the idea of anesthesia and publicizing the possibility of its use.

Wells, according to Garrison (18), was further discouraged in his work on anesthesia when a patient to whom he administered too much nitrous oxide expired. Wells then changed his occupation, becoming a bird fancier. According to Fülöp-Miller (p. 109) he traveled through Connecticut with a troupe of singing canaries. He also attempted the sale of shower baths and coal sifters. Not prospering in such endeavors he made a trip to France for the purpose of procuring paintings and engravings to sell to rich American customers. Apparently he did not prosper in this field. While in France he presented his claims as the discoverer of anesthesia and received some recognition. He returned to America in 1848, rather discouraged, however, not feeling that he had received rightful recognition for his share in the development of anesthesia. While in a state of mental confusion Wells one night threw vitriol on a street walker on Broadway in New York City. Shortly thereafter he took his own life in a prison cell.

As has been mentioned, William Morton had witnessed the unsatisfactory demonstration of his former partner and teacher, Horace Wells, under whom he studied dentistry. At that time Morton had been a student at the Harvard Medical School, where he had for his preceptor Dr. Charles A. Jackson. Dr. Jackson was not only a qualified physician but was a chemist of note and among other accomplishments was well known for his researches in geology.

In the practice of dentistry, Morton, according to Miller (19), had invented an improved process for making artificial teeth. This required that his patients submit to the painful process of having the roots of their teeth extracted before Morton's artificial teeth could be fitted. The pain of extraction of such roots was tremendous, and the procedure was unsatisfactory. Morton was constantly thinking of a means of alleviating this pain.

One day in July, 1844, a patient, Miss Parrot, asked to have a tooth filled, a process which ordinarily caused excessive pain. Many times Jackson had mentioned that ether sprinkled on the skin could relieve pain. Morton's patient could not endure the pain caused by the necessary preparation for filling. To deaden the pain locally, Dr. Morton

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applied sulfuric ether to the adjacent tissue as recommended by Jackson. He was able to continue his work without hurting the patient. Because the action of ether as he administered it was slow, it was necessary for the patient to return on several subsequent days. One day, in using the ether a bit freely, Morton noticed its numbing effects on the surrounding parts of the face. The idea occurred to Morton that if the whole system could be brought under the influence of this drug, a valuable means of relief might be afforded for more difficult dental surgery.

Morton thought of the inhalation of ether, being influenced by Wells' use of nitrous oxide. But he thought it would endanger life. He had learned on reading Pereira's *Materia Medica* that a small amount of ether inhaled was not dangerous, but that inhalation of large amounts was dangerous. He began to experiment. First he submitted a puppy to the inhalation of ether. This was successful. Next he tried to anesthetize goldfish. Fülöp-Miller (p. 120) said that he also experimented on insects, caterpillars and worms. One day the puppy sprang against a glass jar containing ether and broke it. The contents fell to the floor and Morton soaked his handkerchief in the portion that remained and applied it to his own mouth and nostrils. He felt the effects of the vapor and thought he might have had a tooth pulled without feeling pain.

Morton next tried to experiment on his two dental assistants, Thomas Spear and William Leavitt. But when they inhaled ether both students became greatly excited, not subdued. Something was wrong. He consulted Dr. Jackson. Jackson recommended that he try pure sulfuric ether. Morton professed ignorance of the use of sulfuric ether and Jackson later based his claim to the discovery on his suggestion to Morton that ether would anesthetize the patient. Morton did find out from Jackson, however, that pure sulfuric ether would serve his purpose better than the commercial product. After experimenting on himself, he was ready for the proper patient.

On September 30, 1846, an opportunity presented itself for Morton to test his theoretic discovery. On the evening of that day a patient, Eben H. Frost, came to Dr. Morton's office. An ulcerated tooth was causing him considerable pain and he wished to have it extracted. Dreading the operation, Frost asked to be mesmerized. Morton said that he had something better and induced his patient to inhale sulfuric ether. The success of his first dental operation under anesthesia produced by ether is best told by the *Boston Journal* which Miller (19) said printed an account of the operation the following day:

"Last evening, as we were informed by a gentleman who witnessed the operation, an ulcerated tooth was extracted from the mouth of an individual, without giving him the slightest pain. He was put into a kind of sleep, by inhaling a preparation, the effects of which lasted about three quarters of a minute, just long enough to extract the tooth."

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FIG. 11. The first public demonstration of anesthesia with ether. Engraving by H. B. Hall. From Rice, N. P.: Trials of a public benefactor. New York, Pudney & Russell, 1858.

Shortly after the painless extraction of Eben Frost's tooth, Morton called on Dr. John C. Warren, explained his discovery and asked permission to try it at some operation. In reply to his visit he received the following historic note from Dr. C. F. Heywood, house surgeon to the Massachusetts General Hospital (19):

"*Dear Sir:* I write at the request of Dr. J. C. Warren, to invite you to be present on Friday morning at 10 o'clock, at the hospital, to administer to a patient who is then to be operated upon the preparation which you have invented to diminish the sensibility to pain.

"Yours respectfully, C. F. Heywood,
"*House Surgeon to the General Hospital,*

"Dr. Morton, Tremont Row, October 14, 1846."

* * * * * *

On that famous Friday morning, October 16, 1846, members of the staff of the hospital filled the operating room. Because Morton had to wait for the completion of his inhaling apparatus, which was being constructed for him by an instrument maker, he arrived a few minutes late at the hospital. Meanwhile, Dr. Warren, believing that Morton had not intended to fulfill his mission, prepared to proceed with the operation in the usual manner. Then Morton appeared on the scene and after apologizing for his slowness, induced the patient to inhale the vapor from his new apparatus, the principle of which, according to Miller (19), has been but slightly improved in all the succeeding years (Fig. 11).

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As to the actual operation, the removal of a tumor of the jaw, the report (15) of the surgeon, John C. Warren, may be consulted:

"On October 17th, the patient being prepared for the operation, the apparatus was applied to his mouth by Dr. Morton for about three minutes, at the end of which time he sank into a state of insensibility. I immediately made an incision about 3 inches long through the skin of the neck, and began a dissection among important nerves and blood vessels without any expression of pain on the part of the patient. Soon after he began to speak incoherently, and appeared to be in an agitated state during the remainder of the operation. Being asked immediately afterwards whether he had suffered much, he said that he had felt as if his neck had been scratched; but subsequently, when inquired of by me, his statement was, that he did not experience pain at the time, although aware that the operation was proceeding."

On the next day Dr. Hayward performed an operation on a patient anesthetized with ether. He removed a large fatty tumor of the arm. Morton was the anesthetist. The operation was a success and there was no evidence of pain, excepting some occasional groans during the last stage. The patient subsequently stated that these were the result of a disagreeable dream.

According to Garrison (18), it was largely due to the high character of such men as Warren and Bigelow that anesthesia produced by ether was instituted all over the world. Warren conceived it to be his duty to introduce the use of anesthesia into the practice of hospitals, but learned that Morton intended to obtain an exclusive patent for its use.* On consultation with Hayward, Warren came to the conclusion that since the ethics of medicine forbade physicians to conceal any useful discovery, further use of this new invention could not be encouraged, since it was not known of what it was made and since by patent it was prohibited from being used freely. Morton became much alarmed at this turn of events, and declared his willingness to make known the agent employed and to supply assistance in administration of it whenever called on to do so.

On October 30, 1846, Morton requested a list from Dr. Warren of all hospitals and charitable institutions in the country, so that he might present them with the use of his new alleviator of pain. Apparently this was done, and operations conducted on patients anesthetized with

* It would appear that, in spite of Morton's jealous guarding of his secret, some physicians strongly suspected the true nature of his anesthetic agent. Dr. J. D. Mansfield of South Reading, Massachusetts (*Boston M. & S. J.* 35: 424–425 [Dec. 23] 1846) in a letter dated November 10, 1846, said that he himself had had experience "in a social party" with a mixture composed of "sulph. ether, water and morphine, with a few drops of diluted sulphuric acid. This mixture was inhaled through a common retort, with a ground stopper at the apex of the globe. The effects which it had on those who inhaled it were similar, if not identical, with those produced by the *vapor* now so much in vogue." Dr. Mansfield was sharply critical of Morton's decision to patent his anesthetic agent.

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ether became established at the Massachusetts General Hospital, and subsequently, in other hospitals throughout the country.

The first thorough account of the use of sulfuric etherization was read by Henry Jacob Bigelow, one of the surgeons of the Massachusetts General Hospital on November 9, 1846, before the Boston Society of Medical Improvement (14). It was subsequently published in the *Boston Medical and Surgical Journal* for November 18, 1846, and at once provoked from the Philadelphia *Medical Examiner* the much-quoted attack on Boston physicians on the score that they were giving succor to quackery and that if such actions continued, "Physicians and quacks will soon constitute one fraternity (20)."

Stimulated by the appearance of this paper by Dr. Bigelow, Dr. F. Dana, Jr. (21), of Boston, sent to the *Boston Medical and Surgical Journal* a spirited defense of mesmerism, in which he said that mesmerism had been tested much longer than anesthesia produced by sulfuric ether. He referred to the work of Elliotson in England (previously mentioned in this paper), said that the Section on Medicine of the Royal Academy of France had approved mesmerism in 1831, and claimed that Baron Cuvier, Gabriel Andral, François Broussais and Matthew Baillie all had strongly approved mesmerism. The *Boston Medical and Surgical Journal*, however, always had been contemptuous of mesmerism.

The use of anesthesia developed very rapidly in Europe. Ether was administered in Paris on December 15, and in London on December 18, 1846 (19). On December 21 anesthesia was assured a prominent place in the world when Robert Liston performed his first operation in which anesthesia was produced by ether.

Oliver Wendell Holmes suggested the name "anaesthesia" for the condition and "anaesthetic" for the adjective. Miller (19) has shown that Holmes did not claim to have coined the term "anaesthesia."

Osler (22) said that Withington told him that the word was used "first in Plato (Timaeus) and is used by Dioscorides in the modern sense." It was used, according to Miller (19), in 1718 by J. B. Quistorpius in the title "De Anaesthesia." It first appeared in English in N. Bailey's dictionary of 1721 as "Anaisthesia, a loss or Defect of Sense, as in such as have the Palsy or are blasted."

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