

Specification of James Darsie Morrison : production of anaesthesia.

Contributors

Morrison, James Darsie.

Publication/Creation

London : Great Seal Patent Office, 1858 (London : George E. Eyre and William Spottiswoode)

Persistent URL

<https://wellcomecollection.org/works/jyyvvhq4>

License and attribution

This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



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



A.D. 1857, 30th DECEMBER. N^o 3189.

SPECIFICATION

OF

JAMES DARSIE MORRISON.

—
PRODUCTION OF ANÆSTHESIA.
—

LONDON:

PRINTED BY GEORGE E. EYRE AND WILLIAM SPOTTISWOODE,
PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY :

PUBLISHED AT THE GREAT SEAL PATENT OFFICE,
25, SOUTHAMPTON BUILDINGS, HOLBORN.

Price 8d.

1858.





A.D. 1857, 30th DECEMBER. N° 3189.

Production of Anæsthesia.

LETTERS PATENT to James Darsie Morrison, of Edinburgh, in the County of Mid Lothian, North Britain, Dentist, for the Invention of "IMPROVEMENTS IN EFFECTING SURGICAL AND MEDICAL OPERATIONS BY THE AGENCY OF ARTIFICIALLY-INDUCED ANÆSTHESIA."

Sealed the 25th June 1258, and dated the 30th December 1857.

PROVISIONAL SPECIFICATION left by the said James Darsie Morrison at the Office of the Commissioners of Patents, with his Petition, on the 30th December 1857.

I, JAMES DARSIE MORRISON, of Edinburgh, in the County of Mid Lothian,
5 North Britain, Dentist, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN EFFECTING SURGICAL AND MEDICAL OPERATIONS BY THE AGENCY OF ARTIFICIALLY-INDUCED ANÆSTHESIA," to be as follows, that is to say:—

This Invention relates to the artificial production and application of
10 anæsthesia, or the anæsthetical condition, involving a diminution or deprivation of the sense of feeling in the parts of animal bodies, for the purpose of effecting various surgical and medical operations, as well on man as on the lower animals. Under one special form of application, the "improvements are peculiarly suited for the purposes of the dentist in the extraction of teeth,
15 and in the treatment of the gums and nerves.

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

In carrying out this application in dental practice the operator produces a supply of a cooled liquid in any convenient and well-known way, such as has been hitherto used in effecting similar operations, by the agency of the power of congelation; the cold action thus induced is directed immediately upon the tooth of the patient by applying thereto a bag, cushion, or other vehicle which 5 is in communication with the source of the cold liquid; whilst this is being done the parts immediately surrounding the tooth are subjected to the action of a current of cold air, the low temperature of which is produced by the removal of the latent heat in the air by the well-known system or principle of alternated compression, artificial cooling, and expansion. The cold action 10 thus induced, both upon and surrounding the tooth, nearly or completely removes the sense of feeling, and enables the operator to extract the tooth with little or no pain to the patient. The cold from the two sources referred to may be applied either by two separate and mechanically distinct channels, or the aerial flow may be brought through a tube surrounding the tube which 15 conveys the cold from the centrally applied cooled surface. And in order still further to secure the proper anæsthesical condition, an electric current is or may be brought from a suitable battery and applied by a wire to the parts under treatment, and this application may either be made alone or in conjunction with the artificially-produced anæsthesia due to congelation. In all these 20 three applications constant and graduated currents are used; for instance, in the case of the centrally applied cold, resulting from the action of the surface cooled by the cold liquid, the current is made to pass continuously over or in contact with the surface conveying the congelating effect to the parts under treatment. The graduation of the temperature of all the currents is effected 25 by the interposition of such bodies as will enable the operator to vary the conducting power.

This Invention, or modifications of it, is applicable in various surgical operations for the reduction of pain, such as where the knife or saw is used, and it is also suited as a remedial agent in various purely medical processes. 30

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said James Darsie Morrison in the Great Seal Patent Office on the 29th June 1858.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, JAMES DARSIE MORRISON, of Edinburgh, in the County of Mid Lothian, North 35 Britain, Dentist, send greeting.

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Thirtieth day of December, in the year of our Lord One thousand eight hundred and fifty-seven, in the twenty-first year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the
5 said James Darsie Morrison, Her special license, that I, the said James Darsie Morrison, my executors, administrators, and assigns, or such others as I, the said James Darsie Morrison, my executors, administrators, or assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might
10 make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "**IMPROVEMENTS IN EFFECTING SURGICAL AND MEDICAL OPERATIONS BY THE AGENCY OF ARTIFICIALLY-INDUCED ANÆSTHESIA,**" upon the condition (amongst others) that I, the said James Darsie Morrison, by an instrument in writing under my
15 hand and seal, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said James Darsie Morrison, do hereby
20 declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being had to the accompanying Drawings, and to the letters and figures marked thereon, that is to say :—

My said Invention relates to the artificial production and application of
25 anæsthesia or the anæsthetical condition involving a diminution or deprivation of the sense of feeling in the parts of animal bodies, for the purpose of effecting various surgical and medical operations, as well on man as on the lower animals. Under one special form of application the improvements are peculiarly suited for the purposes of the dentist in the extraction of teeth, and
30 in the treatment of the gums and nerves. In carrying out this application in dental practice, the operator produces a supply of a cooled liquid in any convenient and well-known way, such as has been hitherto used in effecting similar operations by the agency of the power of congelation. The cold action thus induced is directed immediately upon the tooth of the patient by applying
35 thereto a bag, cushion, or other vehicle which is in communication with the source of the cold liquid ; whilst this is being done the parts immediately surrounding the tooth are subjected to the action of a current of cold air, the low temperature of which is produced by the removal of the latent heat in the air by the well-known system or principle of alternated compression, artificial

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

cooling and expansion. The cold action thus induced, both upon and surrounding the tooth, nearly or completely removes the sense of feeling, and enables the operator to extract the tooth with little or no pain to the patient. The cold from the two sources referred to may be applied either by two separate and mechanically distinct channels, or the aerial flow may be brought through a tube surrounding the tube which conveys the cold from the centrally applied cooled surface. And in order still further to secure the proper anæsthetical condition, an electric current is or may be brought from a suitable battery and applied by a wire to the parts under treatment; and this application may either be made alone or in conjunction with the artificially produced anæsthesia due to congelation. In all these three applications constant and graduated currents are used; for instance, in the case of the centrally applied cold, resulting from the action of the surface cooled by the cold liquid, the current is made to pass continuously over or in contact with the surface conveying the congealing effect to the parts under treatment. The graduation of the temperature of all the currents is effected by the interposition of such bodies as will enable the operator to vary the conducting power.

This Invention, or modifications of it, is applicable in various surgical operations for the reduction of pain, such as where the knife or saw is used; and it is also suited as a remedial agent in various purely medical processes.

And in order that my said Invention may be properly understood, I shall now proceed to describe the several illustrative Figures upon the explanatory Sheet of Drawings which I have hereunto appended, for the purpose of showing certain modifications under which my improvements may be judiciously carried out in practice.

The modifications shown in the accompanying Drawing represent the instruments adapted for producing anæsthesia, or insensibility to pain, during operations connected with dental surgery.

Figure 1 is a longitudinal elevation or side view of an instrument for depriving the gum and other parts of the human mouth of sensibility by means of congelation or exposure to a low temperature, whereby the animal heat is abstracted and a numbness or insensibility to pain is induced; Figure 2 is an end view, Figure 3, a plan, and Figure 4 is a longitudinal sectional view, of the instrument inverted, or in a position contrary to that shown in Figure 1; Figure 5 is a longitudinal elevation, and Figure 6 is a plan, of an improved surgical instrument for inducing or maintaining the anæsthetic condition of the gums or other parts where the surface operated upon is of comparatively small area.

The instrument shown in Figures 1 to 4 of my illustrative Drawing is in-

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

tended to cover the surface of the gum at the parts surrounding the root of the affected tooth. This portion, or the anterior part of the instrument, consists of a pair of oval cheek plates A, which are arranged parallel to each other, and connected by the end ribs B to the main tubular stem C of the instrument. The cheek plates A are recessed or formed with a vertical rim, as shown in Figures 2 and 3; to this rim is soldered or otherwise attached an inner plate of metal D, which is pierced with a series of fine holes; it is these inner plates which are brought into contact with or in close proximity to the gum. The hollow cheek plates A of the instrument communicate with the tubular stem C by means of the laterally diverging tubes E, which enter the enlarged part F, formed at the anterior end of the tubular stem C. To the free extremity of the tube C is fastened one end of a flexible tube G, by means of which aeriform, gaseous, or vaporous fluids may be passed along the tubular stem C, the force or velocity of the current being controlled by the stop-cock H. The main portion of the tubular stem C in front of the stop-cock H and extending to the enlarged part F, is made with a duplex channel, which enables the operator to cause a stream of liquid or gas of any required temperature to circulate through it. The arrangement of the duplex channel I is shown in the sectional view, Figure 4, on my Drawing. The tube C passes through the duplex channel I and enters the enlarged part F, which forms the anterior part of the tubular portion of the instrument. The liquid or gaseous fluid flows into the channel I through the lateral tube J, the passage of which is controlled by the stop-cock K. To the open extremity of the tube J is adapted a piece of flexible tubing L, the other end of which is connected with the reservoir or vessel in which the requisite supply of liquid or gaseous fluid is contained. The liquid or gaseous fluid flows off through the tube M, to which a flexible tube is fitted to carry it away to a suitable receptacle. To enable the operator to estimate the temperature of the aeriform current as it flows through the tube C, a thermometer N is adapted to the instrument. The mercurial bulb of the thermometer is fitted inside the enlarged part F, the metal of this part of the instrument being curved to receive the bulb, and at the same time leave a channel for the egress of the air into the air chambers A. The stem of the thermometer N is bent in a plane parallel with the longer axis of the bulb, so that it lies close to the surface of the tubular stem C. The end of the thermometer stem is entered into a socket which forms the extremity of a tube that serves to protect the thermometer from injury, the main portion of this tube is cut away, to enable the mercurial column to be seen by the operator. In using this instrument for dental operations, the flexible tube G is attached to a reservoir containing air in a

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

highly compressed state, the latent heat of this air having been abstracted by, during, or subsequent to the operation of compression. The tube L is in like manner connected to a vessel or reservoir containing water, a saline, acid, alkaline solution or spirit, or, if preferred, a gaseous fluid, the temperature of which has been reduced by compression or other means. If a liquid is used, 5 to ensure its circulation through the channel I, the reservoir should be placed above the instrument, in order to obtain a certain amount of columnar pressure. The cheek plates or air chambers A are passed over the tooth that is to be extracted, so that the perforations in the plates D are in close contiguity to the gum. The stream of liquid or the gaseous fluid is now allowed to flow 10 through the channel I, and the current of air through the tubular stem C. As the current of cold air flows through the tube C it impinges directly upon the metal surrounding the bulb of the thermometer, and the change of the temperature is at once made evident to the operator by the movement of the mercurial column. The stream of air as it rushes through the apertures in 15 the plates D comes into contact with the patient's gum, and in expanding abstracts the animal heat therefrom. This deprivation of heat, or the life condition of the part, produces a numbness and insensibility to pain in the organic tissues, so that the tooth may then be extracted with little or no inconvenience to the patient. Where, however, the operation is prolonged, and in 20 cases where it is necessary to retard the too sudden return of the natural life condition of the part, the instrument shown in Figures 5 and 6 of my Drawing may be advantageously made use of. This instrument consists of a pair of concentric tubes O and Q, which are connected by a joint, as shown at P; the front extremities of the inner tubes Q are curved, and have their ends 25 closed. On the inner side of each of the tubes Q are small holes, through which the stream of air or vapour for effecting the congelation flows, the current of air or vapour passes through the parallel tubes R, which form a continuation of the tubes Q. The tubes are furnished with stop-cocks S, for controlling the passage of the air, aeriform or vaporious current, which is 30 admitted thereto by means of the flexible pipes T, the free ends of these pipes being connected to the holder or reservoir in which the supply of air, aeriform or vaporious fluid is stored up. In this instrument the tubes O are made with duplex channels or passages for conveying a stream of liquid through the tube as well as the aeriform current. The stream of liquid flows into the tubes O 35 by the lateral passages U, which are governed by the stop-cocks V, the supplying streams of liquid being conveyed to the tubes U by the flexible pipes W. In this arrangement the tubular channel around the air ducts are each divided by a partition or diaphragm, which extends from the posterior

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

end of each of the tubes O nearly to the part where the terminal tubes Q emerge. The effect of this is, that each tube O is divided into two channels, excepting at the part near the anterior portion of the tubes O, where the diaphragm terminates, as shown by the dotted lines in the plan of the instrument, Figure 6. As the stream of liquid flows into each of the tubes O by the lateral tube U, it passes along one side of the diaphragm, round its anterior extremity, thence backward along the opposite side of the diaphragm, and out by the descending tube X. In this manner a constantly circulating current of fluid or gas is kept up during the time the instrument is in use. In applying this instrument to operations connected with dental surgery, it is intended to be used after the instrument herein-before described has been removed from the patient's gum. The free extremities of the tubes Q are to be placed in contact or nearly so with the gum, and the stream of air allowed to flow through the holes in the same, the current of liquid being meanwhile circulated through the duplex channels of the tubes O. The current of air passing through the apertures in the tubes Q is sufficient to prevent the return of sensibility in the gum without interfering with the free use of the dental instrument; and when the dental operation is completed, the animal heat may, by means of the instrument, be gradually restored by artificial heat, in order to avoid injury to the organic tissues. It is preferred to make these instruments of gold, platinum, silver, or other metal having a limited affinity for oxygen, and advantage may be taken of this to convey by means of the instrument a stream of electricity to the affected part where such a course of treatment is deemed beneficial. In such cases the instruments may be readily made to form a portion of the electric circuit, by securing the terminal wires or chains thereto; and in this manner either positive or negative electricity may be conveyed to or abstracted from the part of the body under operation.

Figures 7 and 8 represent respectively an elevation and plan of a modified arrangement of apparatus for effecting the congelation of parts of the human body. In this modification there are two tubes *a* and *b*, arranged one above the other, as shown in the elevation, Figure 7; these tubes are soldered into the larger tubes *c* and *d*, the two being held together by the jointed clip *e*. This clip *e* is made so that the tubes held therein are readily altered as regards their relative position, that is to say, the curved extremity of one tube *a* or *b* may be advanced beyond or drawn behind the other, or turned aside from each other, as the operator requires. The joint of the clip *e* is furnished with a pin, which the operator can easily withdraw, so as to disconnect the one tube from the other at pleasure. The curved extremities of the tubes *a* and *b* have

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

lateral holes made therein to direct the aeriform current to the affected part, the other extremities of these tubes being fitted with stop-cocks and flexible tubes in manner similar to the arrangement shown in Figures 5 and 6 of my illustrative Drawing. The aeriform or vaporous fluid by means of which the
5
congelation is effected is passed through the tubes *a* and *b* from a suitable reservoir, as herein-before described. The fluid current flows into the tubes
c and *d* by the lateral apertures *f*, and away by the corresponding tubes *g*, or vice versa. Parallel to, but placed somewhat by the side of the upper
10
tube *a*, is a third tube *h*, which serves to convey a current of fluid that tempers or regulates the temperature of the other parts of the apparatus as desired. The tube *h* is made duplex at the front portion, this double
part extending about half the length of the tube in a backward direction. The front extremity of the tube is open, and is serrated so that the
fluid may flow up to the mouth of the tube without having its circulation
15
impeded; the extremity of the tube has in some cases fitted to it a metallic chamber or elastic cushion, through which the tempering current is allowed to flow. In order, however, to protect the neighbouring parts from
the influence of the anæsthetic agent, I prefer the arrangement shown in
Figures 7 and 8 of my Drawings; this consists of a covering or guard *i*, which
20
fits over the tubes *b* and *h*, and extends downwards so as to cover the outer sides of the tubes. The instruments are intended to be used in pairs, as shown in the plan, Figure 8 of my Drawing. The protective covering *i*
extends from side to side, and the lower pair of tubes *b* are in like manner
fitted with a guard *j*. The instruments are connected to each other by a
25
telescopic joint *k*, shown in the end view, Figure 9. The short pieces of tubing of which this joint is made up admits of the operator adjusting the space between the tubes *a* and *b* according to the requirements of the
operation. The material used for the protective guards *i* and *j* may be vul-
canized india-rubber or other convenient nonconducting material. The
30
elasticity and nonconducting properties of vulcanised india-rubber render it a very convenient medium for the purpose, as it admits of the instruments
being separated a sufficient distance apart, and effectually protects the cheek and tongue of the patient from the influence of the cold. When required for
the purposes of philosophical research a registering thermometer is fitted to
35
the instrument above the tube *h*, the stem of the thermometer is partly surrounded and protected by the tube *l*, the bulb of the thermometer is carried
within the guard *i*, so as to be in immediate proximity to the part that is
being operated upon. The several tubes may be held together by means of
elastic rings or other means, so as to be readily disengaged from each other.

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

By this means all the changes of temperature or electric condition may be accurately indicated and recorded during the progress of a physiological investigation. A portion of the tube *l* may be arranged to form an induction coil, and have attached to it a delicate galvanometer or electrometer, so as to
5 transmit and indicate visibly the electric condition of the part under operation or investigation. In the foregoing description of my Invention I have spoken of compressed air or gaseous fluid as a convenient agent for effecting the congelation, the reduced temperature of the air or gas being due to the amount of its compression and the means employed for conducting the elec-
10 tricity therefrom, or for abstracting the heat evolved during the operation. I do not confine myself to any particular mode of cooling and compressing air or gas, as this may be done in various ways, and by means of mechanical arrangements, which form no part of my Invention. I may, however, instance one mode which may be conveniently made use of. The air chamber or
15 reservoir consists of a strong metallic tube fitted at the extremities with induction and eduction pipes. The air cylinder is surrounded by a casing or jacket through which a stream of water is constantly flowing upwards, the overflow being carried away by a suitable pipe. The air or gas is pumped into the cylinder by a single, duplex, or triple arrangement of force pumps,
20 and as the heat of the compressed air is evolved it is absorbed and carried away by the surrounding current of water. In this manner the operator has at his command an abundant supply of an excessively cold medium of congelation for effecting anæsthetic operations. When so large a supply of the agent of congelation is not required, a sufficient quantity of air or gas may be
25 compressed by means of a hand pump, and cooled to the requisite temperature by means of frigorific mixtures, such as are ordinarily used for reducing the temperature of liquids. A highly important feature of my improved anæsthetic apparatus consists in the perfect controul which the operator has over the temperature of this agent of congelation; for by regulating the flow of the
30 aeriform current through the stop-cocks, the degree of cold imparted to the surface under operation may be adjusted with the utmost nicety. Thus the full and unchecked flow produces the most intense cold, and by checking or moderating this flow a corresponding rise in the temperature is instantly obtained. The command which the operator thus has over the agent he is
35 operating with enables him to use the instruments with a degree of confidence otherwise inadmissible. I have herein-before used the term heat in its popular and generally accepted sense, but maintain and moreover claim the discovery that electricity is a measureable substance filling all space, aeriform in its nature, compressible and elastic without limit, and that heat and light are the

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

properties of electricity; that electricity itself is a substance, and not as hitherto considered a mere property of matter; that heat and light are respectively compressed and expanded electricity; that the terms positive and negative are synonymously explained by condensation and rarefaction.

I may instance the fact that electricity and cold increase exactly in the 5 same ratio as the distance from the earth, that is to say, in ascending through the air we find that as the sensible heat diminishes the electricity increases. My system may furthermore be exemplified by the functions of the flexor and extensor muscles of the wings of birds. One class of muscles contract under electrical pressure, and while contracting set free the power to the opposite 10 class, which in their turn contracting in like manner, keep up a constant alternation of transferred force between the two sets of muscles; this transference of motive power being continually renewed by the nutrition of the animal economy. Thus by constituting one or more of the senses the greater by excitement over the rest, would lessen the electrical pressure upon the 15 sense of feeling or touch, first rendering the sense naturally negative or weak, then overcoming the weakness by artificial means, as before described.

Having now described and particularly ascertained the nature of my said Invention, and the manner in which the same is or may be used or carried 20 into effect, I may observe, in conclusion, that I do not confine or restrict myself to the precise details or arrangements which I have had occasion to describe or refer to, as many variations may be made therefrom without deviating from the principles or main features of my Invention; but what I consider to be novel and original, and therefore claim as the Invention secured to me by the herein-before in part recited Letters Patent, is,— 25

First, the general arrangement and construction of instruments or apparatus for producing anæsthesia or the reduction of any part or parts of any living animal structure to the state of local insensibility, as herein-before described.

Second, the system or mode of treating or preparing air for anæsthetic purposes by compression in connection with any arrangement suitable for 30 conducting therefrom the electricity and heat which the air contains, thereby giving it a capacity or affinity for either or both, as herein-before described.

Third, the system or mode of applying chloroform or its vapour, ether or its vapour, or any compressible fluid, (which by the mechanical compression of its particles can be deprived of its electricity or heat,) thereby adapting the 35 effects produced by alternated compression and expansion to enable them to take either electricity or heat, and furthermore the using of metallic chambers in my mouthpieces or general apparatus in any way, either with or without the perforations allowing the escape or causing the retention of fluids, vapours,

Morrison's Improvements in Producing Artificial Anæsthesia, &c.

or gases, or the effects of either, singly or combined, or for the application of any substance, air, or aeriform vapour, or vapourous gas, or gaseous fluid or solid, whether singly or combined in any proportion, which under any circumstance or condition, or by any process of chemical or mechanical arrangement, or by
5 any combination of either, they can have imparted to them any capacity or power to take from the animal tissues the electricity or heat they contain, as herein-before described.

Fourth, the system or mode of acting upon the senses so as to change the electric condition of the parts under treatment, thereby assisting in the pro-
10 duction of anæsthesia, as herein-before described.

Fifth, the system or mode of locally, gradually, and temporarily depriving the animal tissues of their conditions of life, as regards the function and feeling, by the application of air at any density or temperture, in any shape or form, under any condition or circumstance, or condition of circumstance, or
15 circumstance of condition.

Sixth, the treatment by double action or double currents by which the opposite sides of the teeth, gum, or other parts may be simultaneously or separately affected at the will of the operator, and the using of any fluid in this manner for anæsthetic purposes, as herein-before described.

20 Seventh, the system or mode of performing surgical, medical, and mechanical operations during the time the apparatus producing the local anæsthesia is applied, and of protecting the neighbouring parts from being affected by the anæsthesia, anæsthetic agents or apparatus, as herein-before described.

Eighth, the system or mode of locally, gradually, and permanently restoring
25 the animal tissues to their original condition of life, function, and feeling, as herein-before described.

In witness whereof, I, the said James Darsie Morrison, have hereunto set my hand and seal, this Twenty-eighth day of June, One thousand eight hundred and fifty-eight.

30

JAMES DARSIE MORRISON. (L.S.)

LONDON :Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1858.

331

FIG. 1.

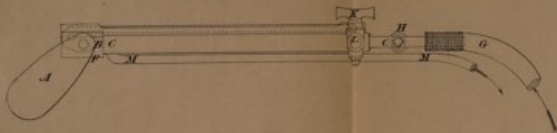


FIG. 2.

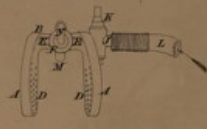


FIG. 5.

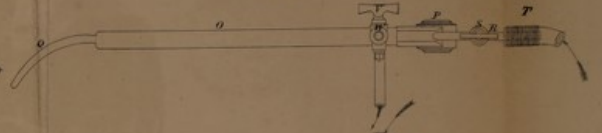


FIG. 3.

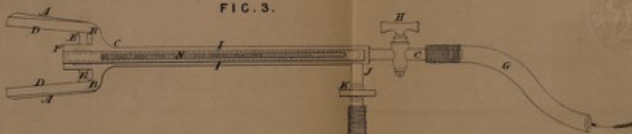


FIG. 6.

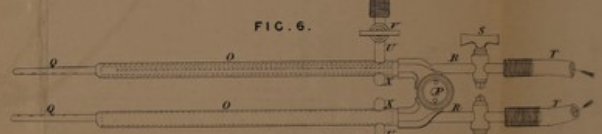


FIG. 4.

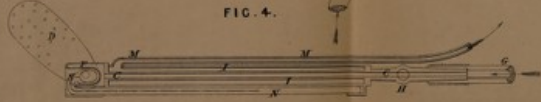


FIG. 7.

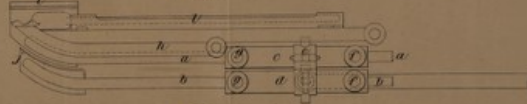


FIG. 8.

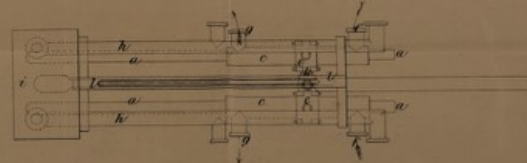


FIG. 9.



Drawn full size.

The steel drawing is colored.

