THE LANCET

June 21, 1890

pp. 1369 - 1408

HYDERABAD CHLOROFORM COMMISSIONS REPORTS

THE REPORT OF THE SECOND HYDERABAD CHLOROFORM COMMISSION.

IN presenting to our readers this week a selection of tracings from those obtained by the Second Hyderabad Commission, we think it may be well to bring shortly again to their notice the facts about this Commission. Its object was an essentially practical one, and could not be better defined than in the words of his Highness the Nizam himself, "to save people's lives." This object Surgeon-Major Lawrie hoped to attain by showing experimentally what he, in common with his teacher Syme and many others, had found clinically, that attention to the respiration was the safeguard against death during chloroform anæsthesia. At his suggestion, the First Hyderabad Commission was appointed by the Nizam's Government, but the results were so different from those obtained by many other experimenters that we hesitated to accept them when they were forwarded to us. At Dr. Lawrie's instance a Second Commission was appointed, and the Nizam generously forwarded to us £1000, with the request that THE LANCET would nominate an expert to assist in the investigation, and Dr. Lauder Brunton kindly acceded to our request to act as our representative. To take up the whole general action of anæsthetics, although interesting, would have occupied more time than the Commission had at its disposal, and consequently it restricted its experiments to those having a direct practical bearing.

In a subject of such vital interest as the mode of action of anæsthetics it is important that no conclusion should be accepted without the most thorough criticism, and it is with the view of enabling our readers to draw their own conclusions from the experiments of the Second Hyderabad Commission that we present them with a selection from the tracings obtained. Nearly 600 experiments in all were performed by this Commission, about 150 of them being blood-pressure, and each blood-pressure, as a rule, involving three or four tracings or more. Out of the total number of tracings, amounting to 400 or 500, we now select 32 in order to illustrate some of the most important points.

The facts on which the Commission lay most stress are that when chloroform is given to animals by inhalation, in the same way as it is given to patients during operations, the respiration invariably stops before the heart, and if the administration of the anæsthetic be stopped and artificial respiration be begun as soon as natural breathing ceases, life can invariably be restored. The great slowing of the heart's action which has been observed, more especially by the Committee of the British Medical Association, and which has been regarded as due to the action of chloroform, the Hyderabad Commission regard as due to asphyxia, inasmuch as they entirely failed to obtain this tracing by giving chloroform with free admixture of air, but were able to obtain it at will by simple obstruction of the animal's respiration. Moreover, instead of looking at this slowing of the heart's action as a cause of danger, the Commission regard it rather as a means of safety, preventing the anæsthetic from being carried too rapidly from the lungs to the nerve centres. From the observations made by the Commission there seems to be little doubt that while chloroform given with a free supply of air by inhalation does not paralyse the heart directly, yet that asphyxia with chloroform is very dangerous, and generally causes the heart to stop much more quickly than asphyxia alone would do, although to this rule there may be exceptions.

The influence of shock was very fully tested by the Commission, as will be seen from Experiments 79 and 185. It was found to be very much less than what might have been expected. These experiments are no doubt open to the objection that the operations intended to produce shock were not performed at the time when sudden death from shock is said to be most likely to occur—viz., at the very beginning of the operation before any anæsthetic had been given at all, but were done after the animal had first of all been thoroughly anæsthetised, and had only partially recovered from the anæsthesia. Of this objection the Commission took full cognisance, but decided not to perform operations before anæsthetics had been given, because animals are less liable to shock than man on account of their lower mental development, and the chance of obtaining evidence of shock seemed too small to justify the infliction of the pain which would necessarily have been entailed by operating without chloroform.

In THE LANCET of Sept. 21st, 1889, we indicated that difference of temperature might have something to do with the varying results obtained at Hyderabad and elsewhere, and the Commission consequently noted the temperature of the room as well as of the animal in most of their experiments. The effect of chloroform upon animals with a fatty heart was ascertained by administering phosphorus to the animals previously, so that their organs became fatty; but, as will be seen from Experiment 79, the effect was less marked than might have been anticipated.

The lamentable case of death from the combined influence of nitrous oxide and tight-lacing which occurred in Edinburgh last autumn shortly before the Second Hyderabad Commission began their work induced them to test the effect of tight-lacing in monkeys subjected to the action of chloroform. It will be seen that death occurred rapidly. No doubt this might readily have been anticipated, and the Commission no doubt would not have tried the experiment had not the death of the unfortunate lady shortly before shown that the danger of tight-lacing when taking an anæsthetic was not sufficiently appreciated. These experiments of the Commission have caused much remark by many of our lay contemporaries, who did not seem to understand that their object had nothing to do with tight-lacing in general, but simply with tight-lacing as affecting the action of anæsthetics.

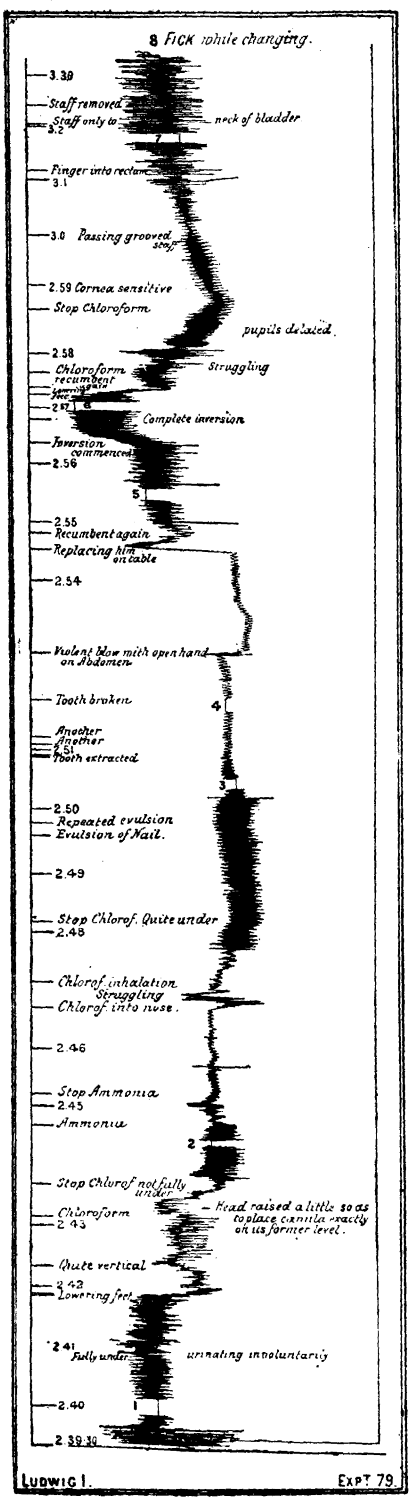
As we have already pointed out, a question of such importance is not likely to be finally settled either by clinical observation alone or experiment upon animals alone; the two must be combined.

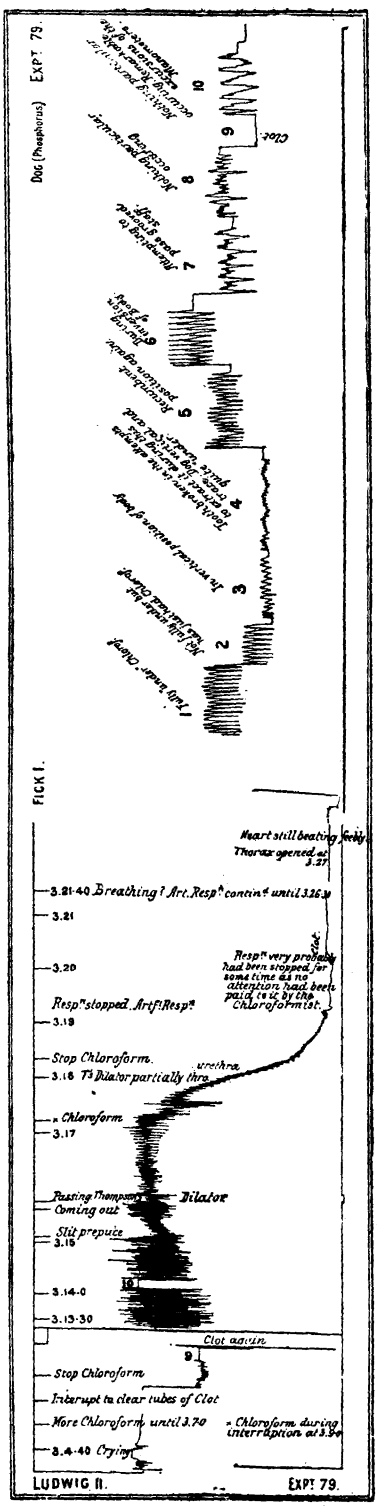
The experiments of the Second Hyderabad Commission have supplied us with a mass of experimental data such as has never been obtained before, and is not likely to be obtained again, at least for many years; but in order to have this supplemented from the clinical side, we issued with THE LANCET of March 15th a form of inquiry regarding deaths from anæsthetics, which we trust that our readers will fill up and return as soon as possible, and that they will also aid us in our work by obtaining answers from as many trustworthy persons as they can.

By combining the experimental and clinical data we trust that we shall be able to set finally at rest the vexed question of how death occurs during anæsthesia, and thus "to save people's lives," as the object of the Commission was expressed by the enlightened ruler to whose generosity, backed by the public spirit of his ministers, we owe the establishment of the Hyderabad Commissions.

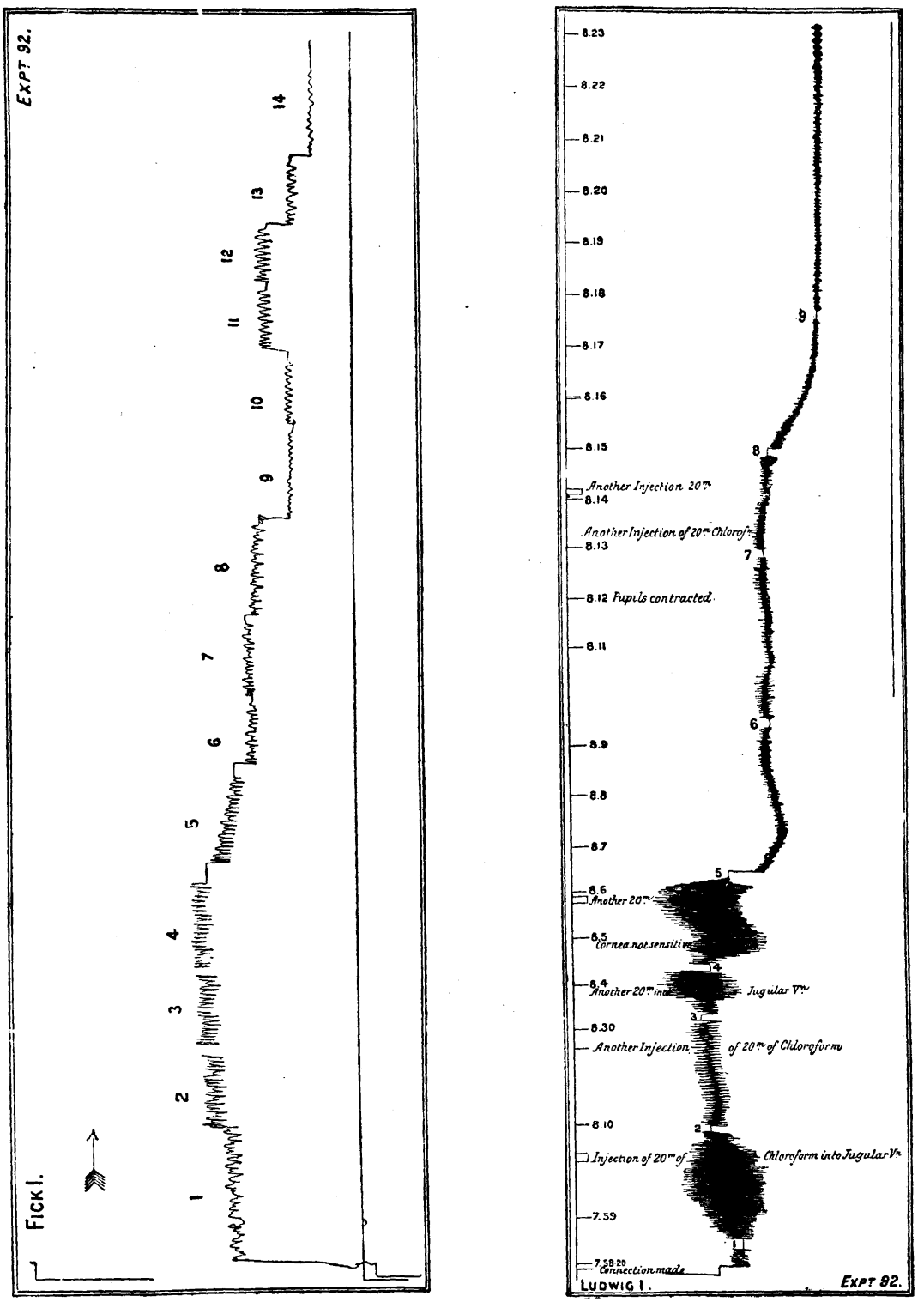
The tracings which we have reproduced were taken by connecting the carotid artery of the animal with a mercurial manometer, the float of which ascended and descended with every rise or fall in the arterial pressure, and traced upon the slowly revolving cylinder blackened with soot the variations of the pressure upon the arterial system. As the revolutions of the cylinder were too slow to allow of the individual pulse beats being seen, a second cylinder was employed which revolved at a speed nearly ten times as great as the first; by using a wide tube, either limb of which could be shut off or opened at leisure, both manometers could either be put into communication at once with the artery, or a single one could be connected at a time. Usually only one was thus connected; the general variations of the arterial pressure are shown in the tracing taken by the Ludwig's or mercurial kymograph, termed shortly "Ludwig" in the tracings, and the pulse beats were taken by a Fick's kymograph on the quickly revolving cylinder. These tracings are indicated by the word "Fick" in the corner. In the tracings taken by Ludwig's manometer a straight line will be found here and there in place of the usual curve. These lines indicate the points where the Fick's kymograph was connected with the artery in place of Ludwig's. Each is numbered, and by reference to the corresponding tracings by Fick's kymograph the character and rate of the pulse at any of these periods can be readily ascertained.

NOVEMBER 12TH. — EXPERIMENT 79.

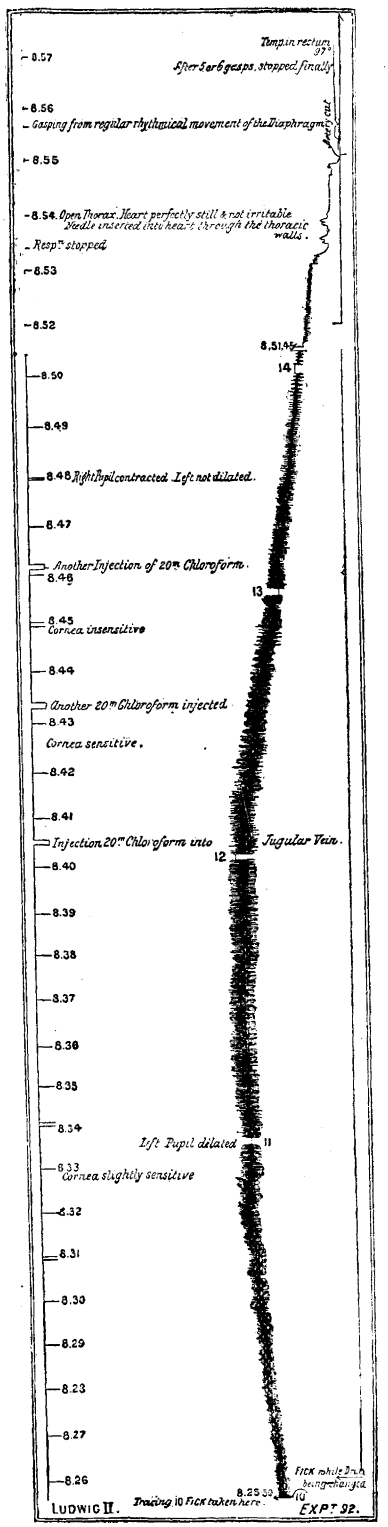




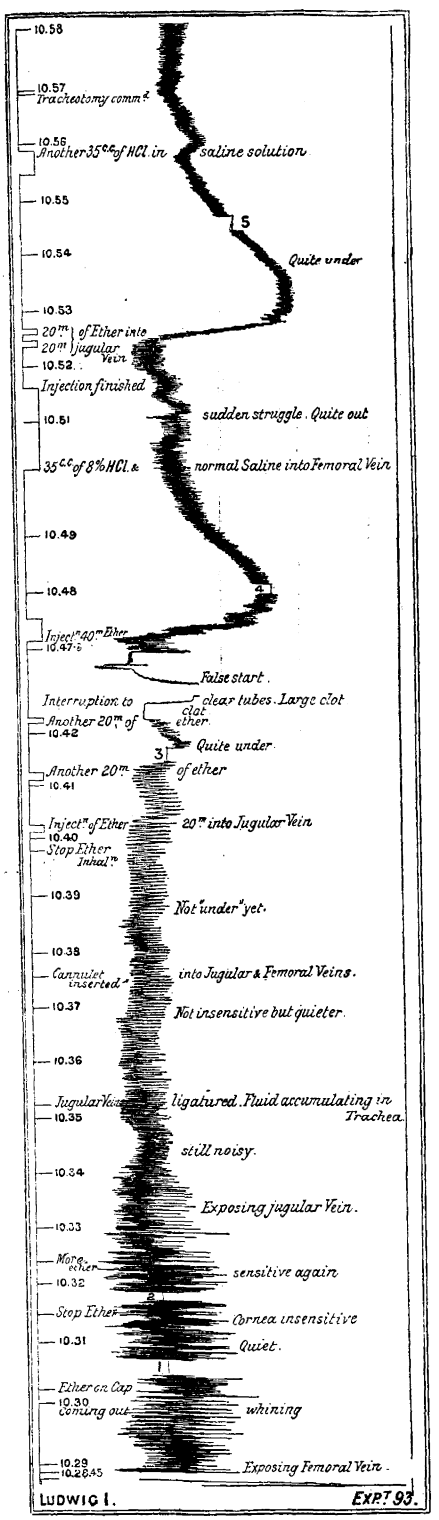
NOVEMBER 18TH.—EXPERIMENT 92.

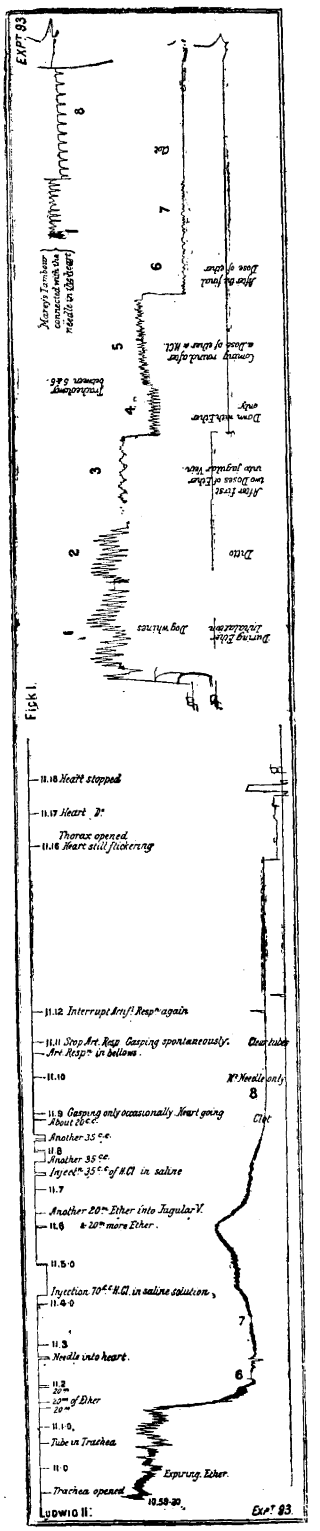


EXPERIMENT 92 (*continued*).



NOVEMBER 18TH. — EXPERIMENT 93.





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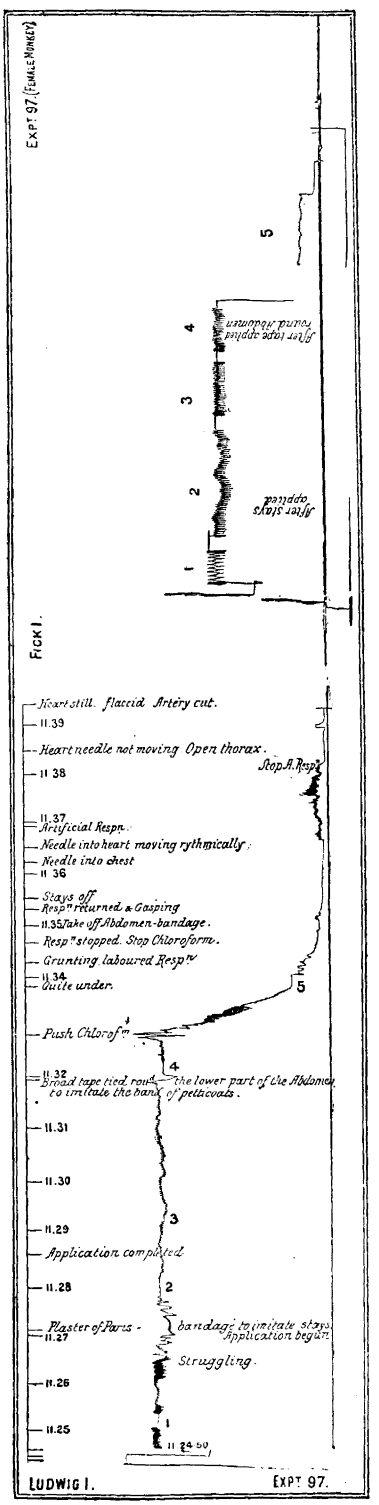
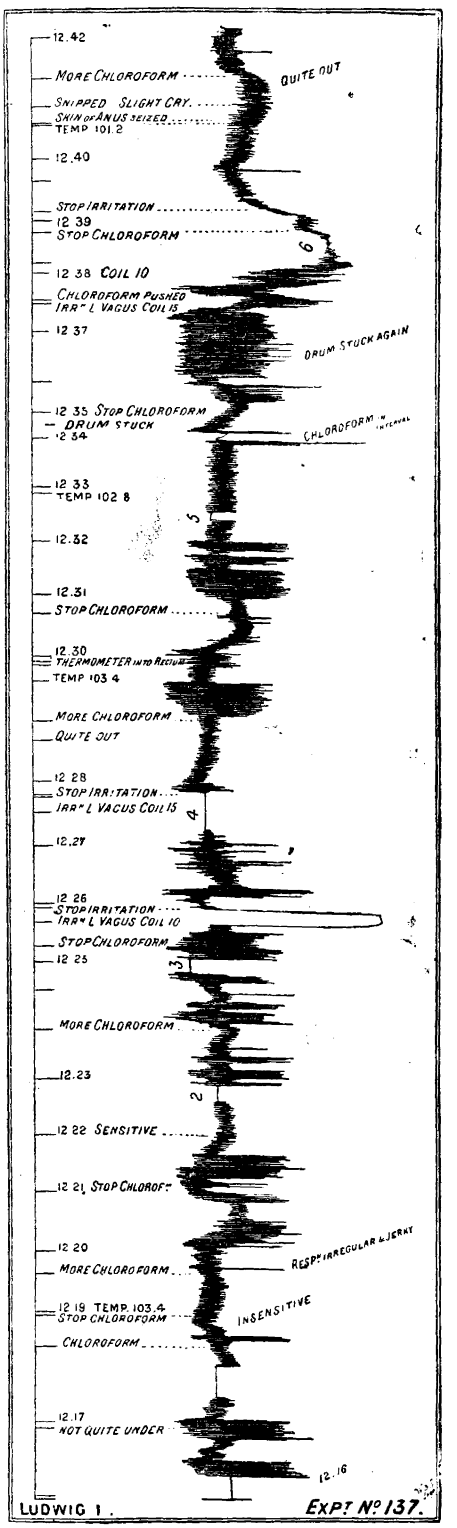
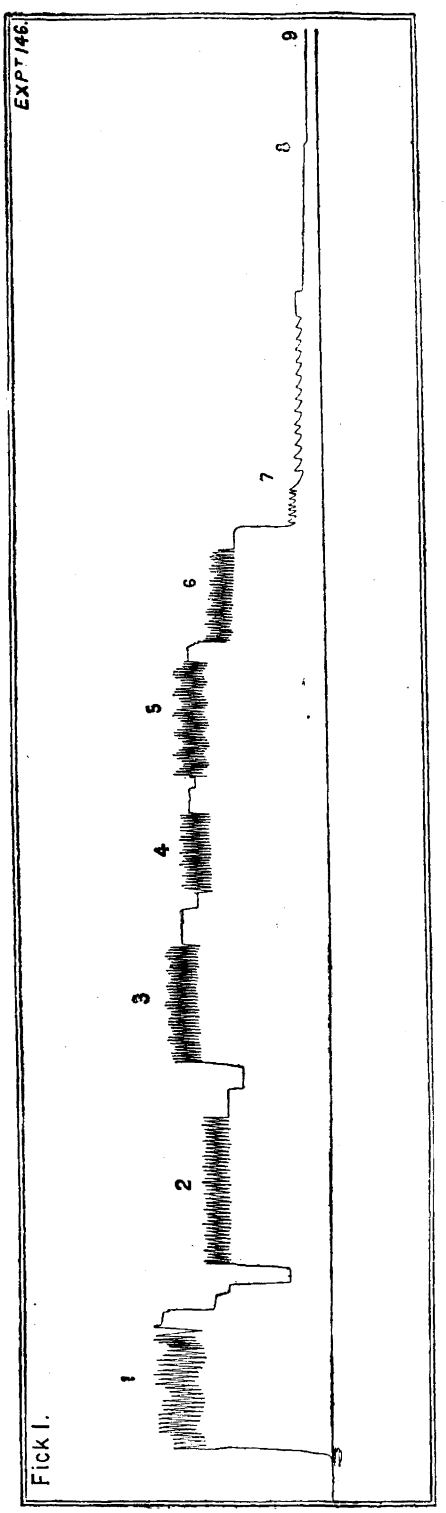
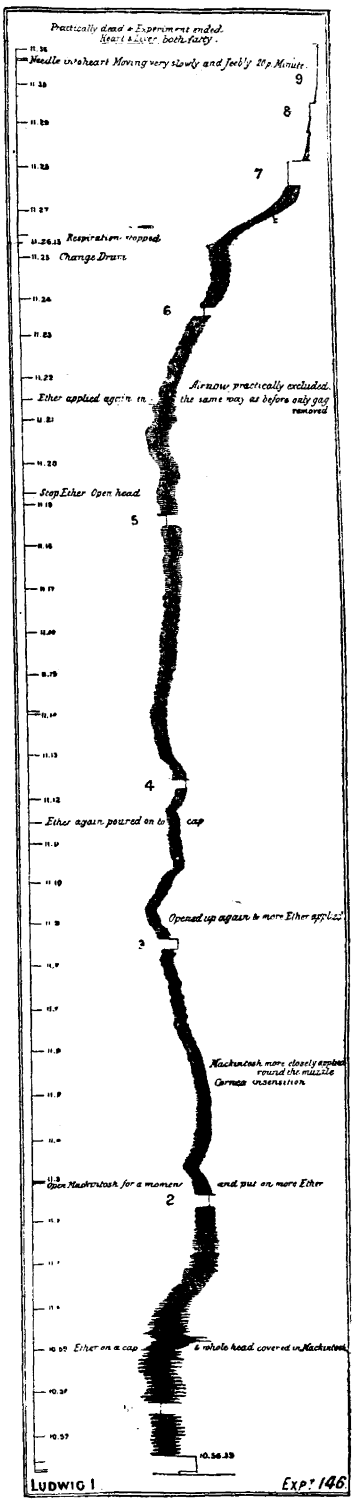


NOVEMBER 28TH. — EXPERIMENT 137.



NOVEMBER 30TH. — EXPERIMENT 146.





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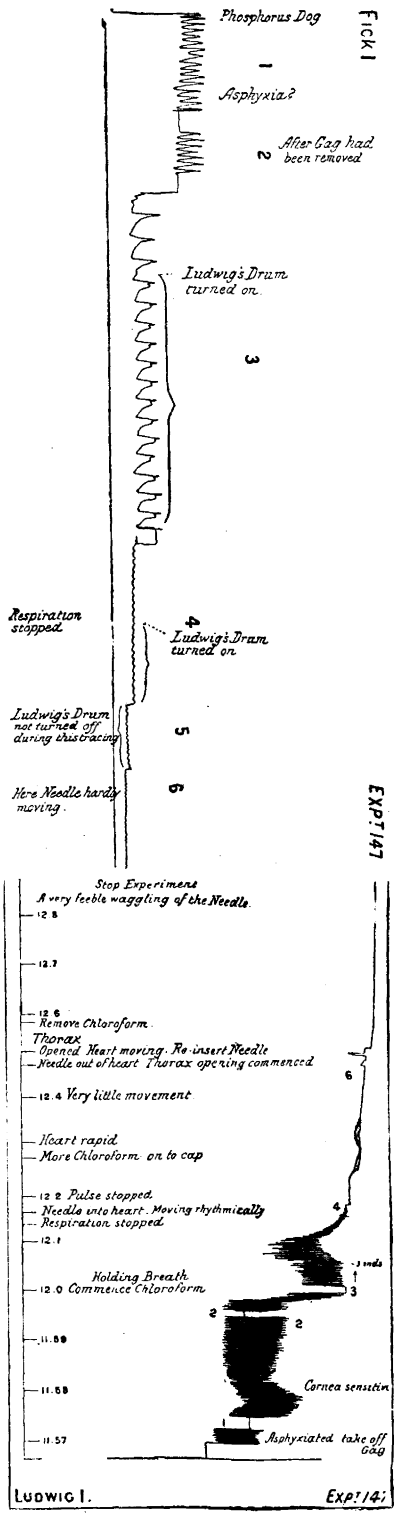
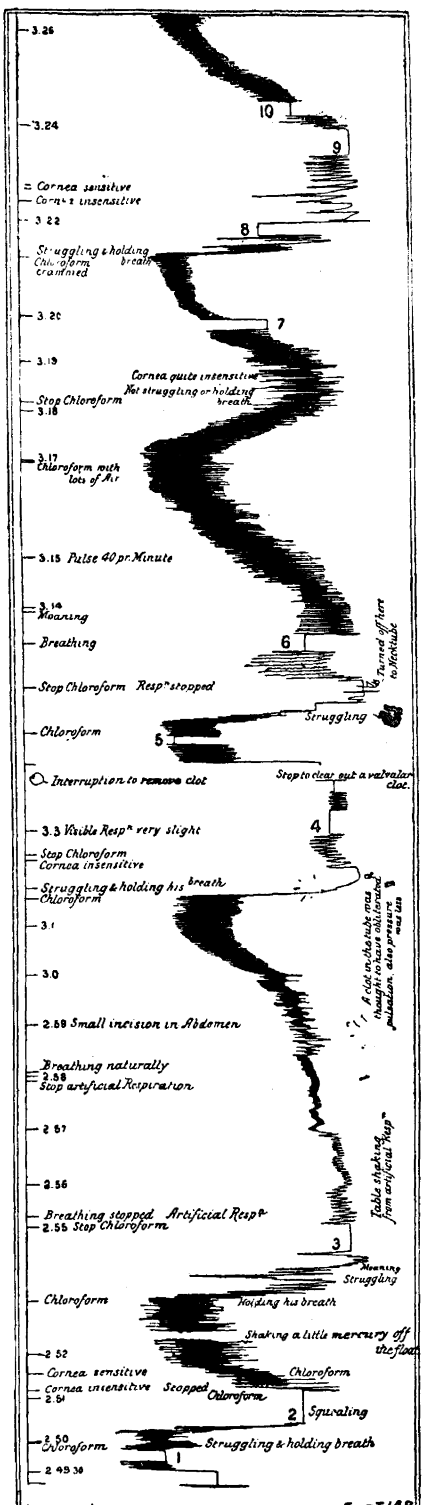
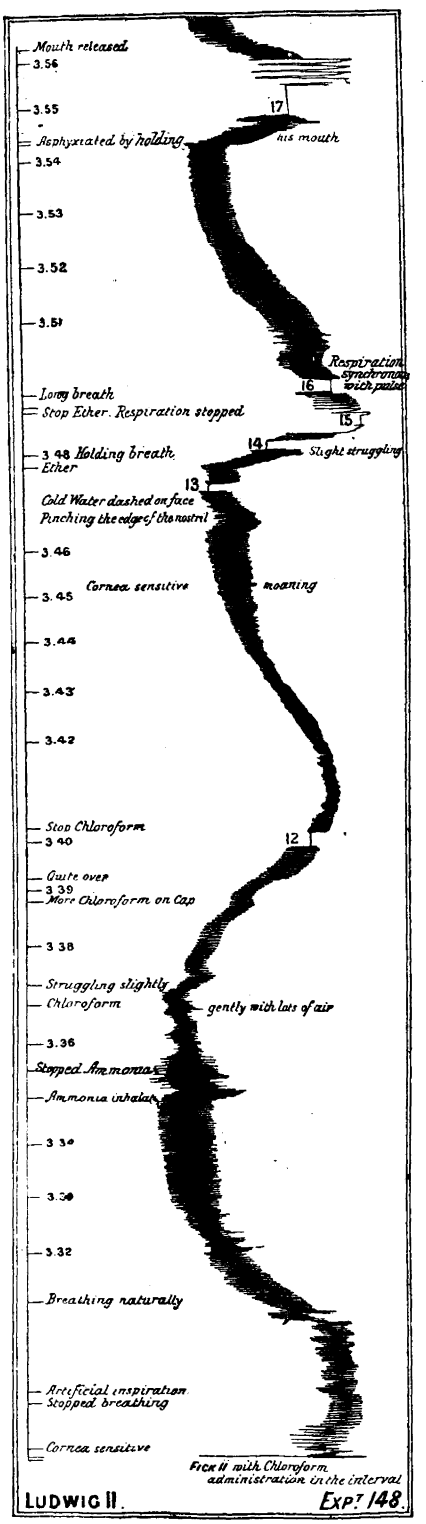


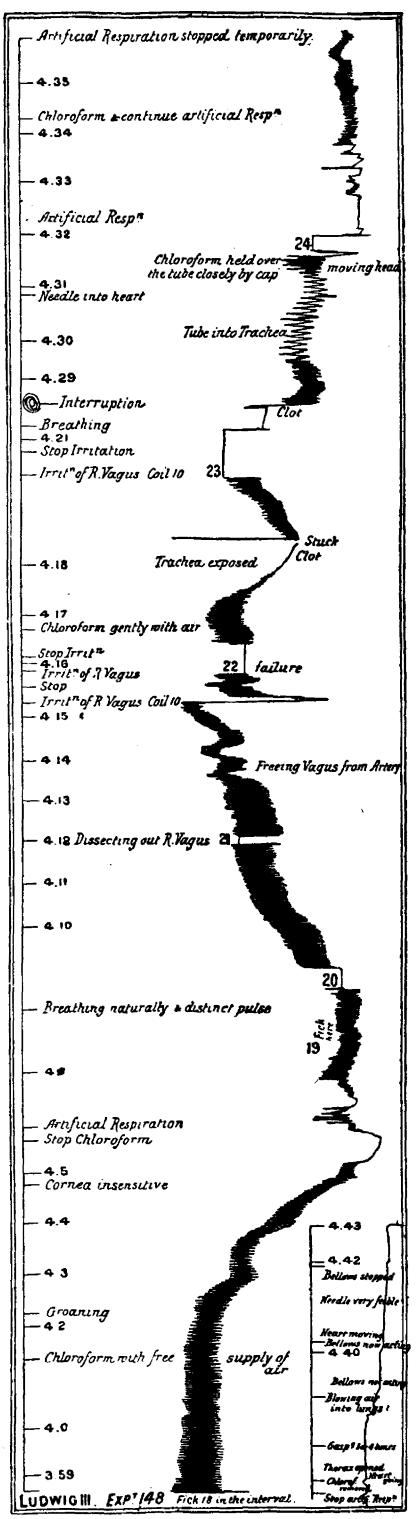
NOVEMBER 30TH. — EXPERIMENT 146.

NOV. 30TH. — EXPERIMENT 147.

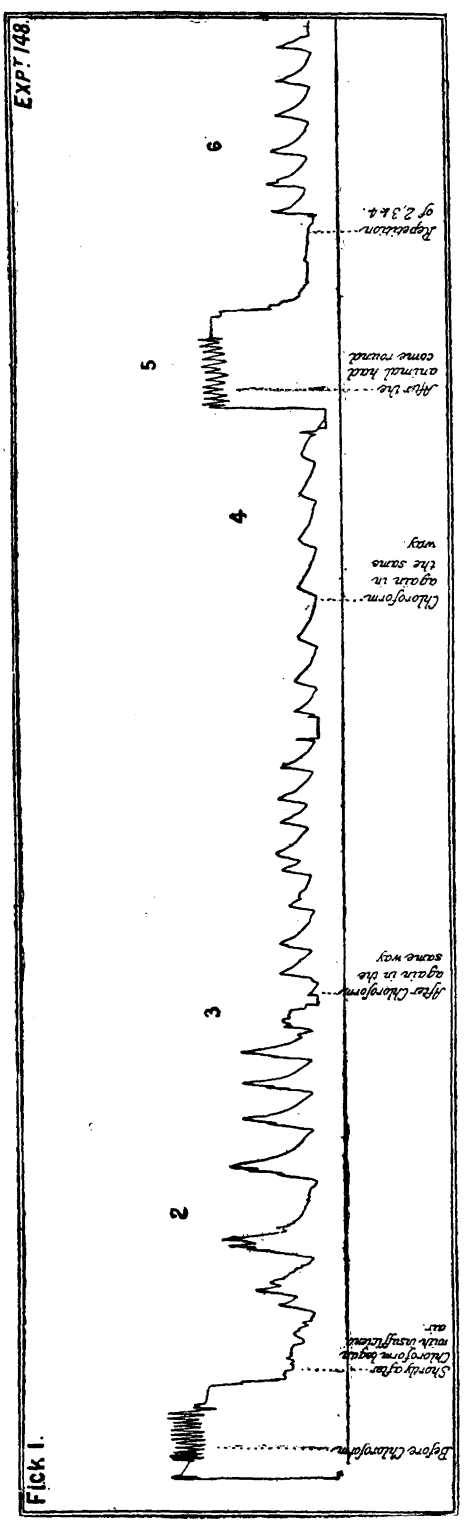
NOVEMBER 30TH. — EXPERIMENT 148.

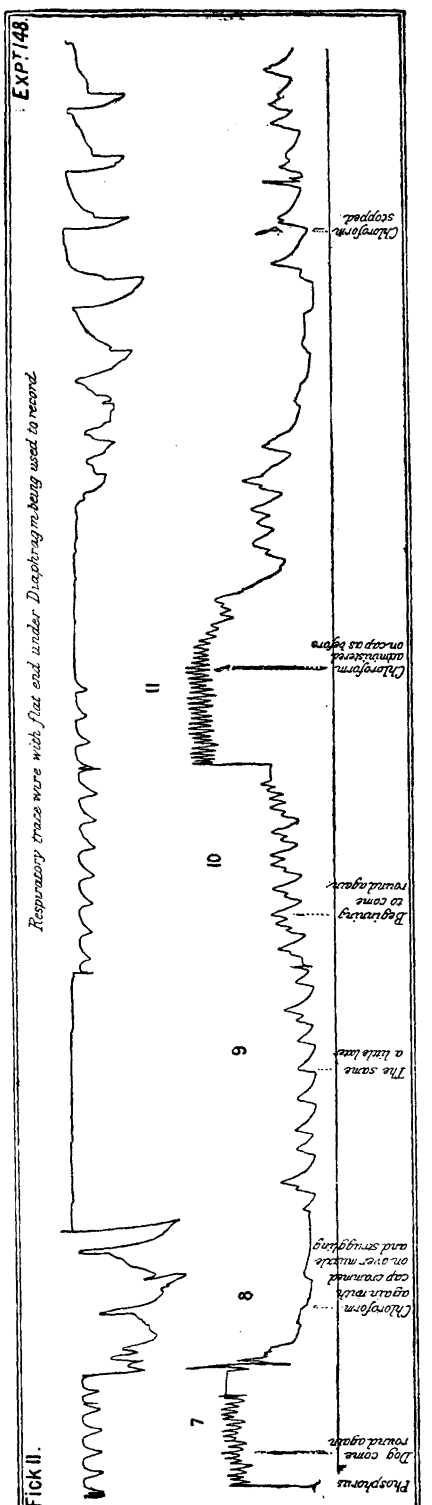






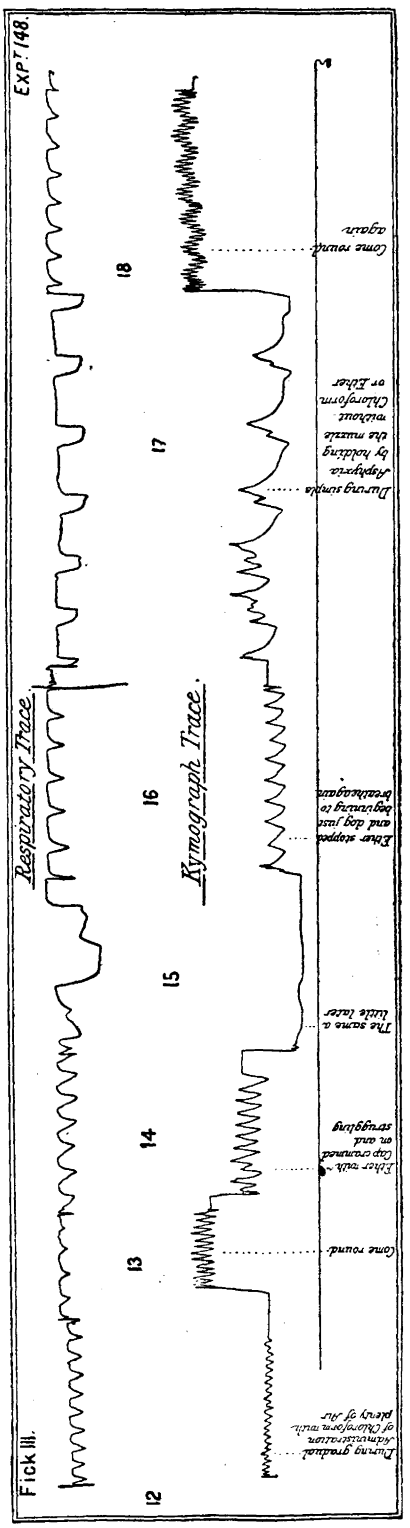
EXPERIMENT 148 (*continued*).

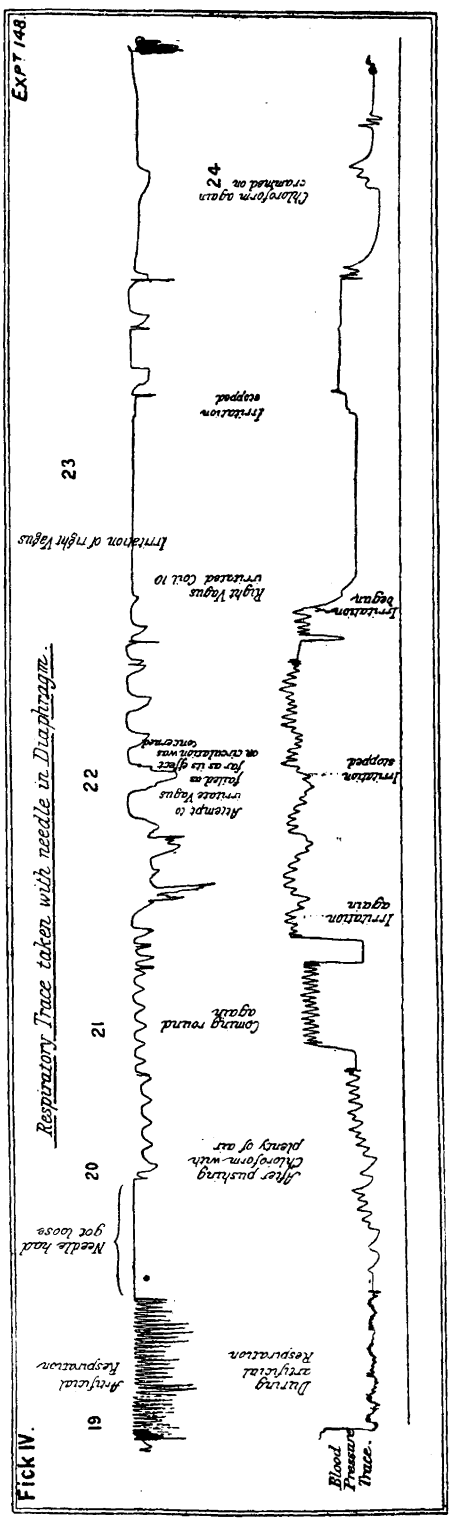


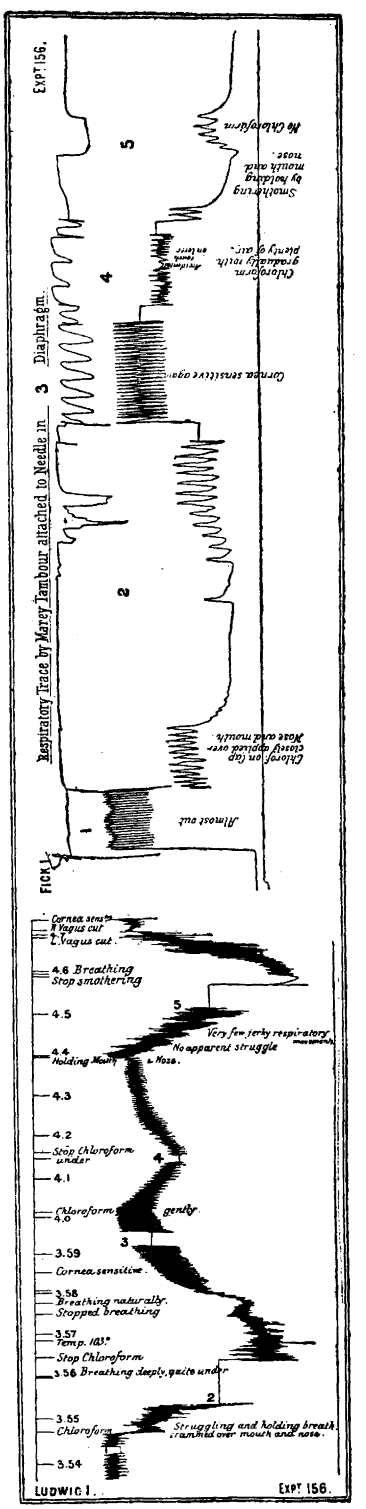


EXPERIMENT 148 (*continued*).

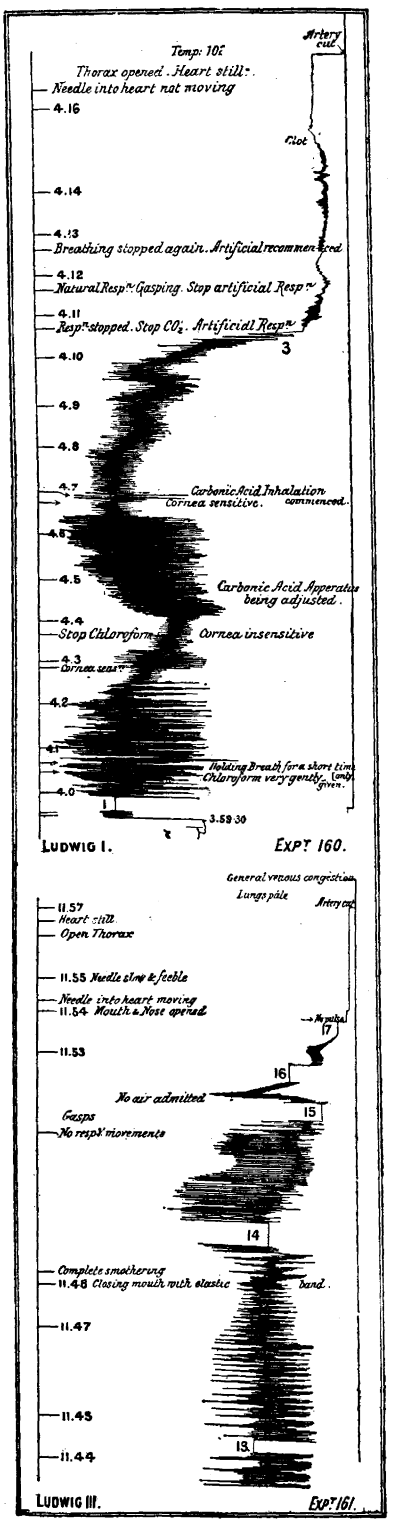
DEC. 3. — EXPERIMENT 156.



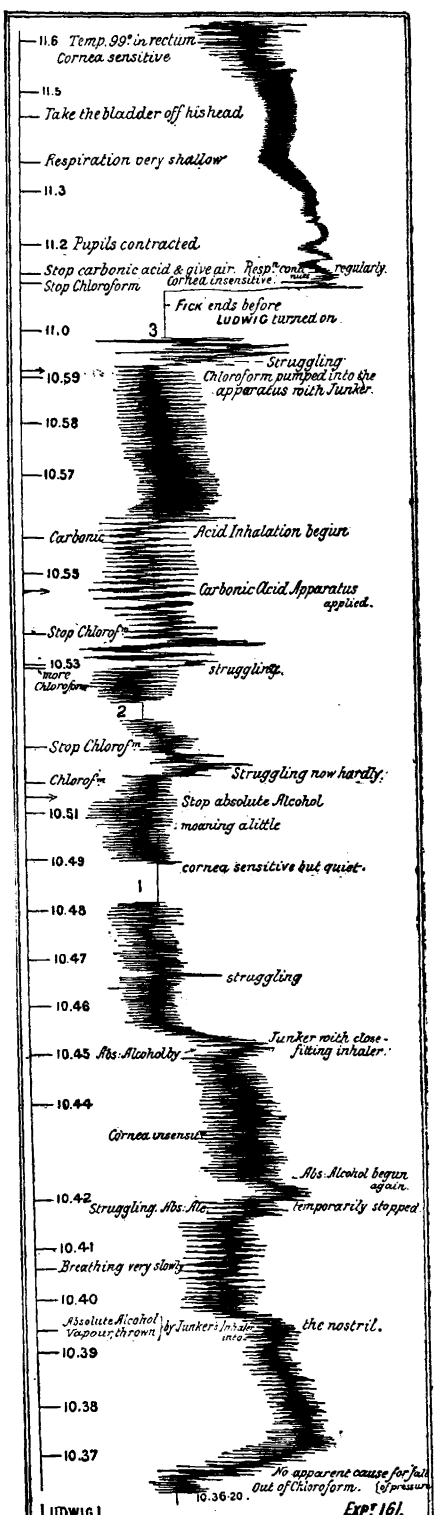




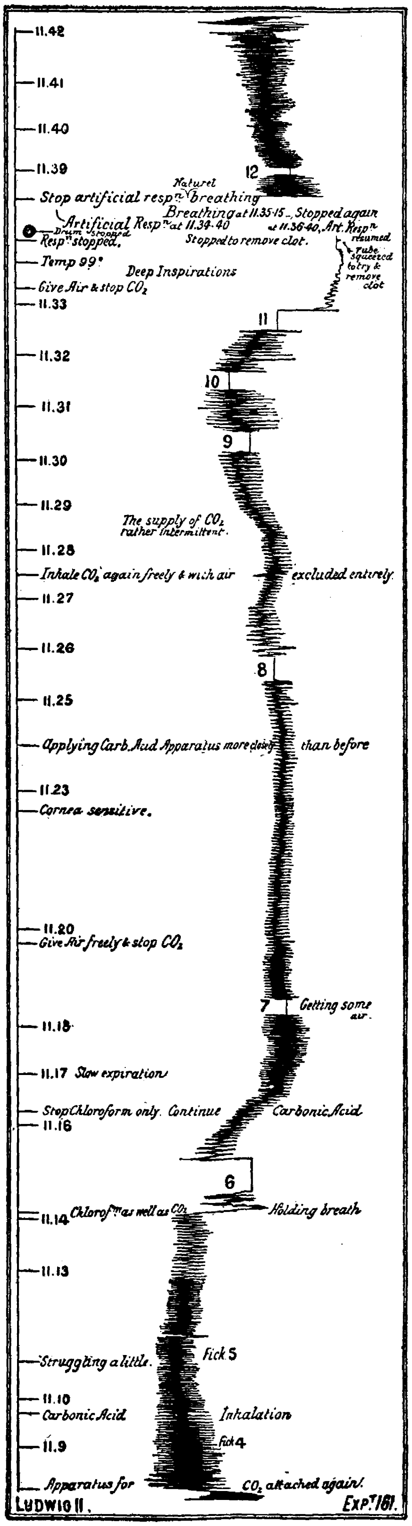
DEC. 4TH.—EXP. 160. DEC. 6TH.—EXP. 161.

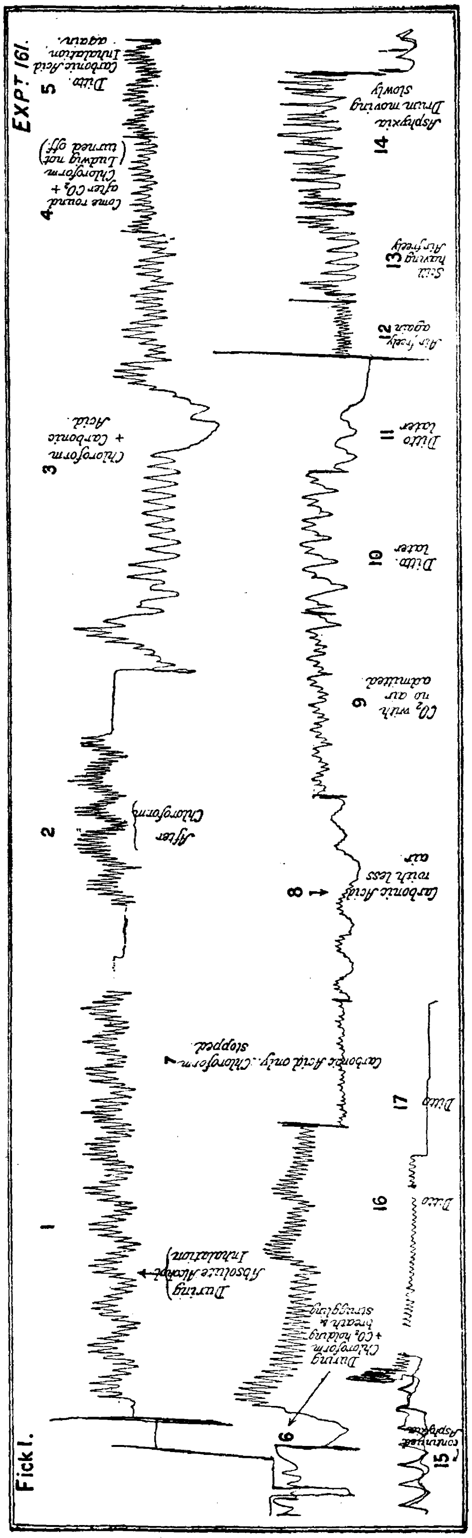


EXPERIMENT 161 (*continued*).

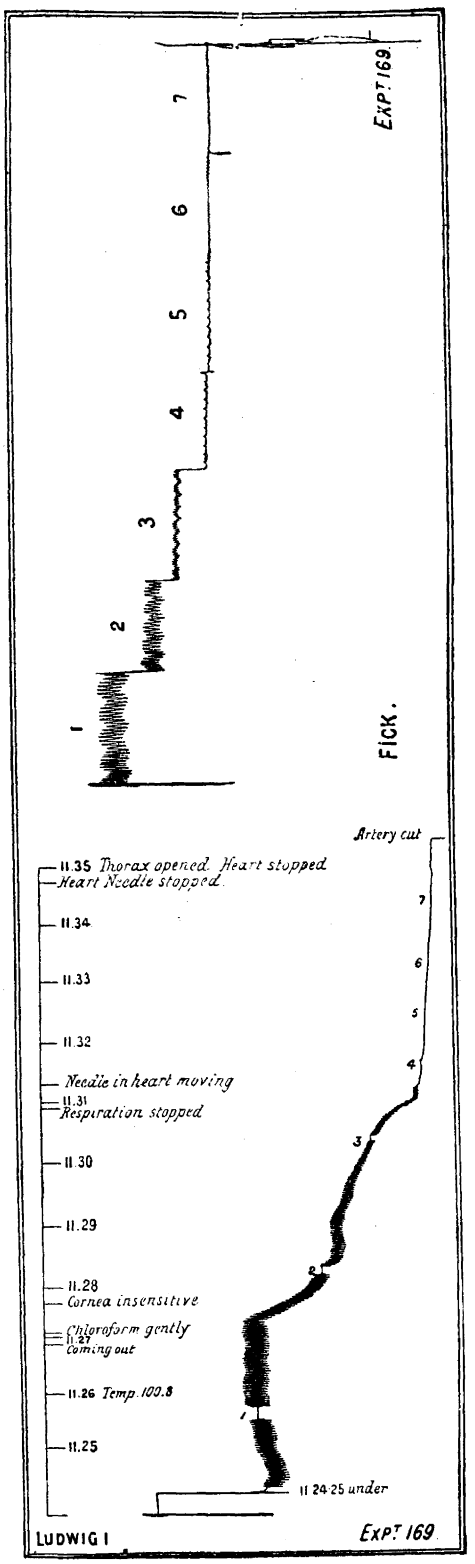


EXPERIMENT 161 (*continued*).

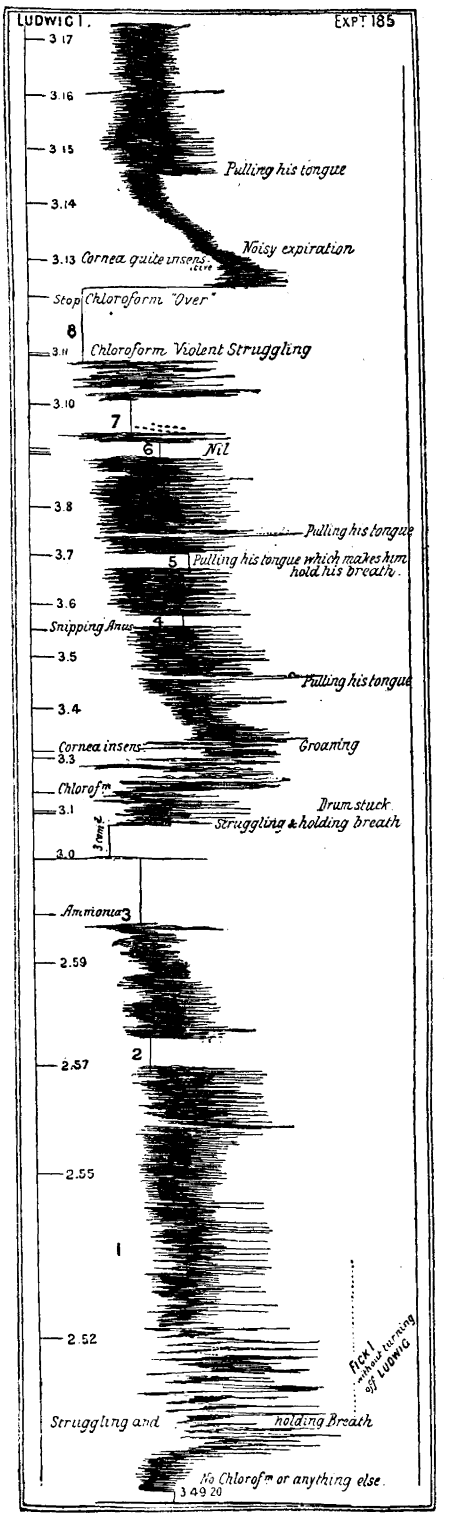




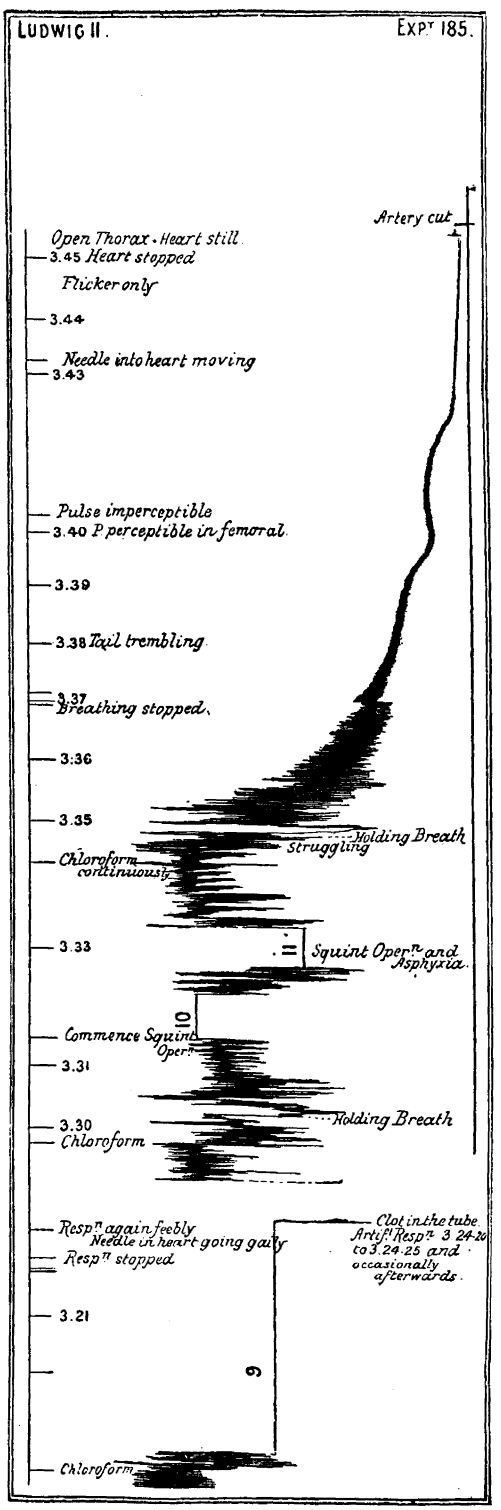
DECEMBER 9TH. — EXPERIMENT 169.

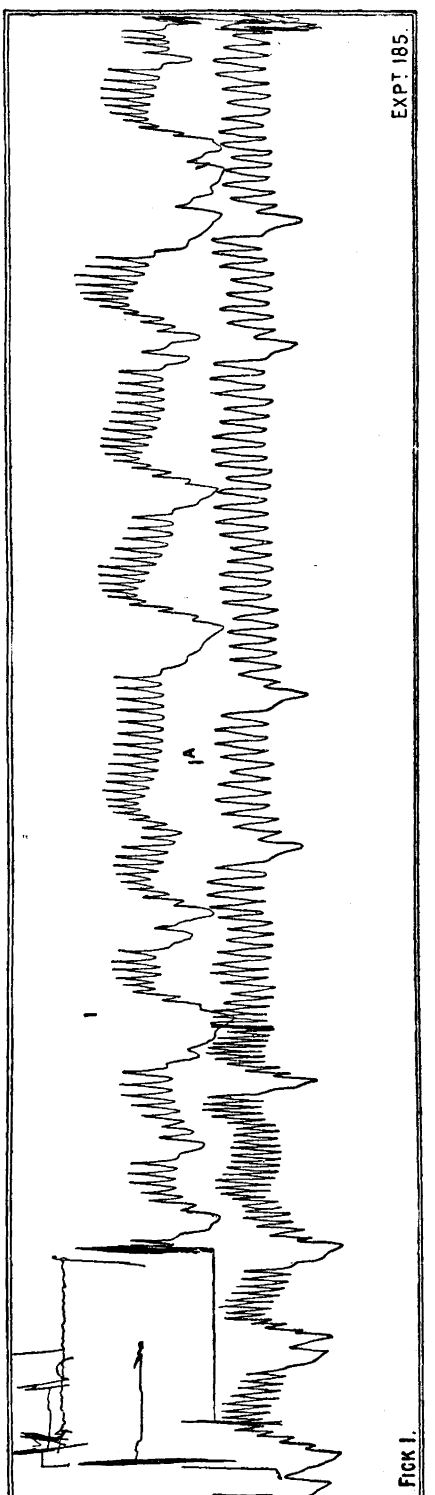


DECEMBER 16TH. — EXPERIMENT 185.

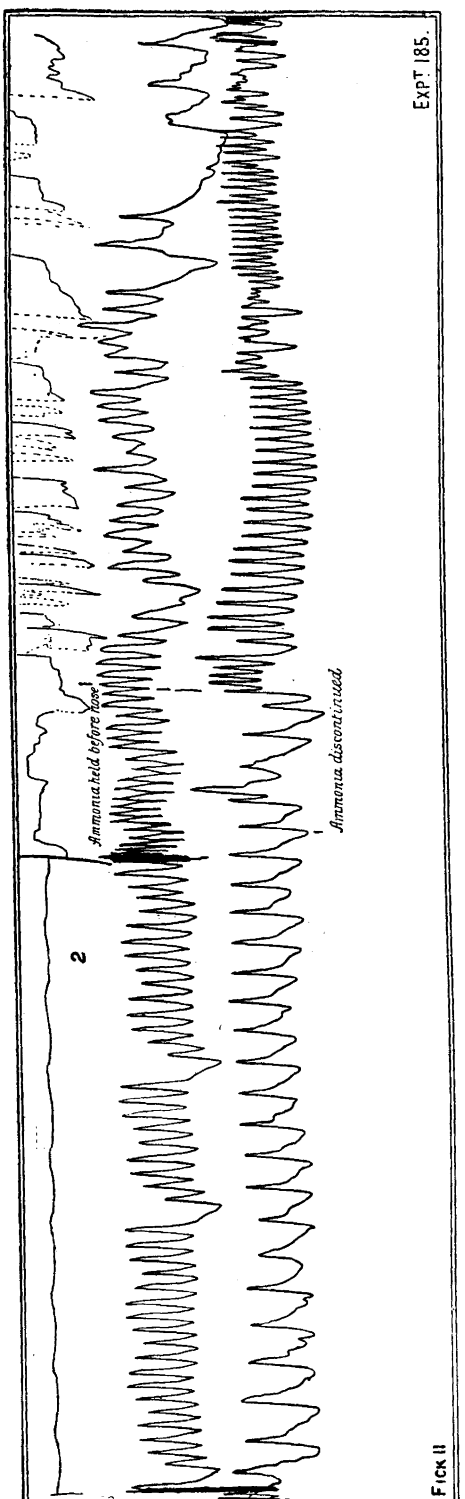


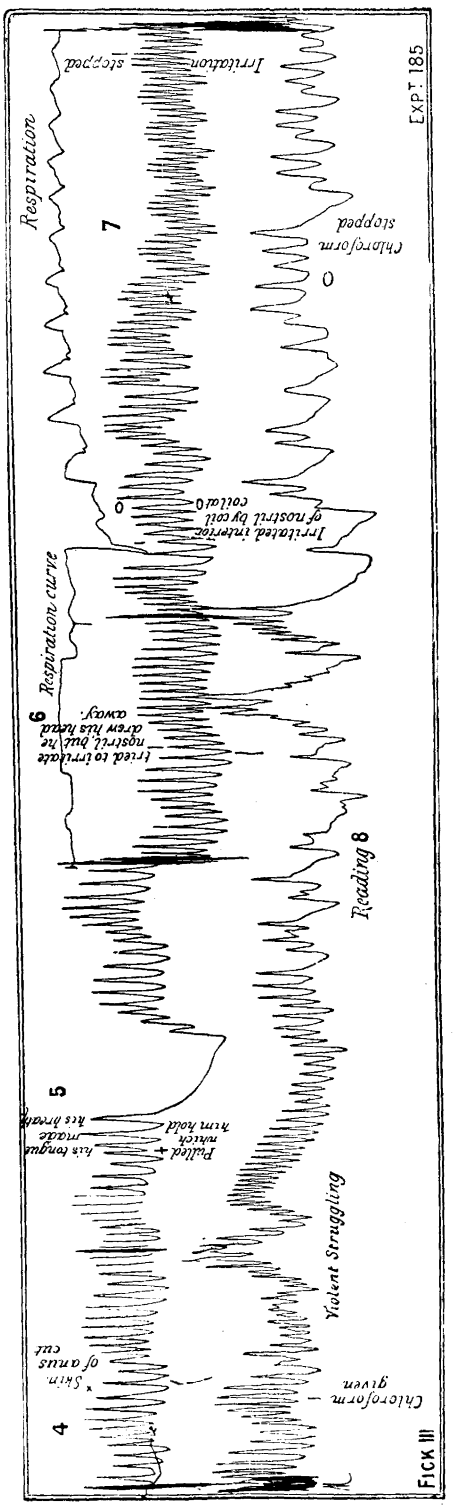
EXPERIMENT 185 (*continued*).



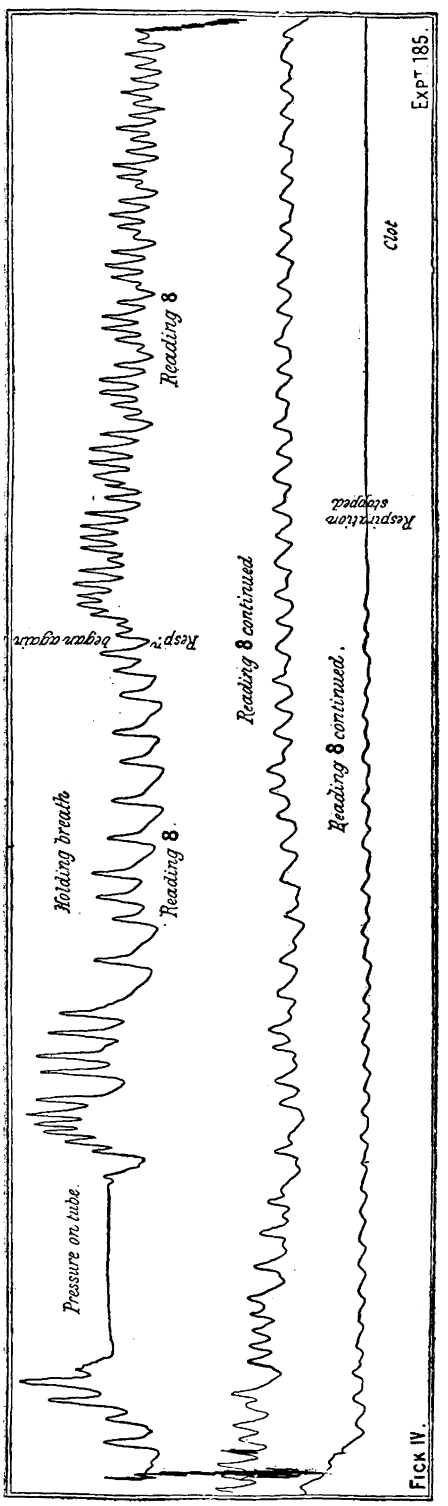


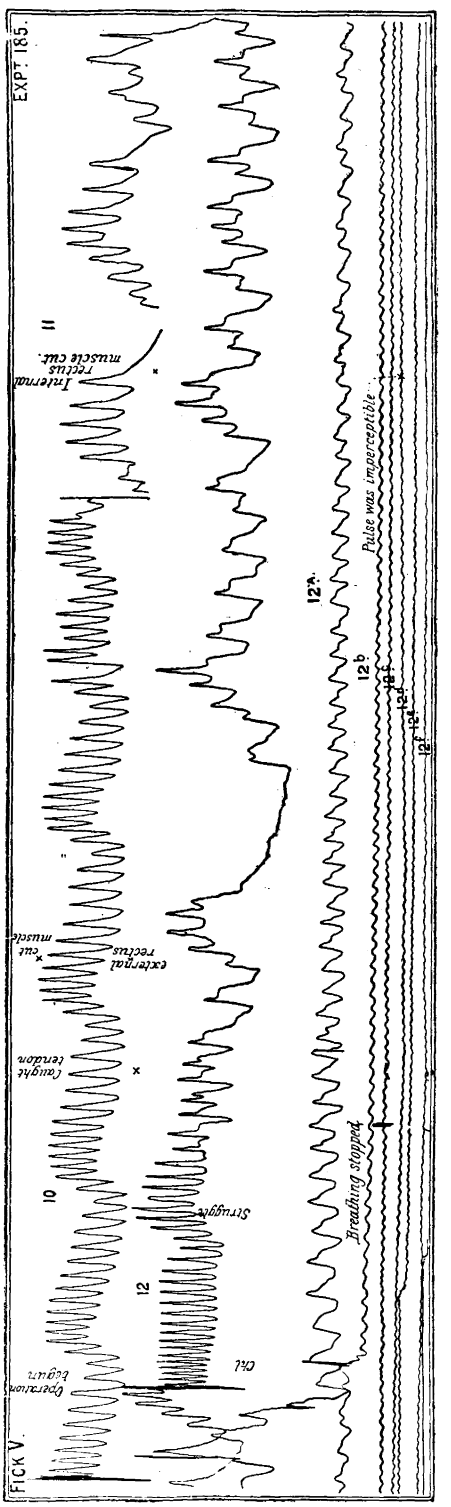
EXPERIMENT 185 (*continued*).





EXPERIMENT 185 (*continued*).





DESCRIPTION AND REMARKS.

NOVEMBER 12TH.—EXPERIMENT 79.

GOOD-SIZED pariah, weight 33lb., that has had two doses of phosphorus—one yesterday, the other to-day, each 1-16th of a box of James's beetle paste. Into chloroform box at 2h. 9m. 34s. Fallen down 2h. 23m. 39s. Placed on the table at 2h. 24m. 26s. Respiration stopped at 2h. 24m. 45s. Artificial respiration until 2h. 27m. 39s. Artery ligatured and cannula inserted at 2h. 36m. 13s. Temperature in the rectum 100° F. Connexion made with the manometer at 2h. 39m. 30s. Two Ludwig and one Fick tracings during—(*a*) Change to the vertical position of the body; (*b*) chloroform administration while in the vertical position; (*c*) ammonia inhalation while in the vertical position; (*d*) squirting chloroform into the nose while in the vertical position; (*e*) evulsion of the nails while in the vertical position; (*f*) extraction of the teeth while in the vertical position; (*g*) violent slap with the open hand on abdomen while in the vertical position; (*h*) restoration to the recumbent position on the table; (*i*) inversion of the body so that the dog was completely head downwards, and again lowering to the recumbent position; (*j*) chloroform administration in the ordinary position; (*k*) attempts to pass grooved staff and Thompson's dilators into the bladder; (*l*) slitting prepuce; (*m*) pushing chloroform carelessly until after respiration had ceased; temperature after death 99° F.; the organs did not appear to be fatty.

Remarks.—No. 79 shows the effects of different positions of the body on the blood-pressure, and of attempts to produce shock by various operations in different stages of chloroform inhalation. In this experiment the exact time of the final stoppage of the respiration was not noted, as the chloroformist was watching the operations. The respiration had stopped some time before the fact was observed, and the animal died in spite of artificial respiration. The heart continued to beat feebly for seven minutes after the commencement of artificial respiration.

NOVEMBER 18TH.—EXPERIMENT 92.

Temperature of the room 23° cent. Large-sized pariah. Weight 33¼ lb., rather thin. Into chloroform box at 7h. 24m. 43s. Fallen down at 7h. 28m. 53s. On the table at 7h. 29m. 37s. Artery ligatured at 7h. 41m. 8s., and cannula inserted. Temperature in the rectum at 7h. 42m. 30s., 100·6° F. Jugular vein tied at 7h. 51m. 47s. Connexion made with the manometers at 7h. 58m 20s. Three Ludwig and one Fick tracings during repeated injections of chloroform into jugular vein. Nine doses were given in the course of an hour, and death ensued very gradually. Temperature after death 97° F. Post-mortem: After the chest was opened five or six regular movements of opening and shutting the jaws, coincident with rhythmical contractions of the diaphragm, occurred. The heart was quite still in all its cavities. There were no clots in the heart. No sign of the needle in the heart.

Remarks.—Tracing No. 92 shows that the effect of repeated injections of chloroform into the jugular vein is to produce anæsthesia and a gradual fall of blood-pressure, exactly as if the chloroform had been inhaled, and not to paralyse the heart.

NOVEMBER 18TH.—EXPERIMENT 93.

Temperature of the room 24° cent. Large pariah dog; weight 33¾lb. Into chloroform box at 9h. 59m. Fallen down at 10h. 5m. 25s. On the table at 10h. 8m. 27s, and kept quiet with chloroform. Artery ligatured at 8h. 20m. 50s. Cannula inserted at 8h. 22m. 22s. Temperature in rectum, 99 8° F. Connexion made with manometer, 10h. 28m. 45s. Two Ludwig and one Fick tracing during injection of ether into the jugular vein, with at the same time injection of solution of hydrochloric acid (0·8 per cent.) in normal saline solution into the femoral vein. Notice also effect of thrusting needle into heart. Temperature 101·2° F. after death. Post-mortem: heart very much distended. Right ventricle full of clot; left free. Superior and inferior vena cava and pulmonary artery filled with clot.

NOVEMBER 19TH.—EXPERIMENT 97.

Medium-sized female monkey. Weight 9¾lb. Temperature of the room 23½° cent. Into chloroform box at 10h. 50m. Fallen down at 10m. 58m. 30s., and placed on the table Temperature in rectum 102·4° F. Artery ligatured at 11h. 11m. 10s. and cannula inserted. Connexion made with manometers at 11h. 24m. 50s. One Ludwig and one Fick tracings during—(*a*) Struggling; (*b*) application of a plaster-of-Paris bandage to the chest to imitate stays, and (*c*) a tight broad tape round the lower part of the abdomen to imitate the effect of petticoats; (*d*) pushing chloroform until respiration stopped. Death ensued although the bandages were quickly removed, and in spite of artificial respiration. Post-mortem: Blood arterial in left side of heart. Temperature after death 102·4° F.

Remarks.—No. 97 shows the evil effects of interference with the respiration by pressure on the chest and abdomen during chloroform inhalation.

NOVEMBER 28TH.—EXPERIMENT 137.

Goat, young male. Weight 15¾lb. Into chloroform box at 11h. 46m. 43s. Fell down at 12h. 2m. 30s., and taken out of box, but still quite sensitive. More chloroform from time to time to keep it under. Holds its breath like the other goat whenever chloroform is given. Temperature in rectum at 12h. 8m. 103·6° F. Artery ligatured at 12h. 11m. 15s. Cannula inserted at 12h. 12m. 50s. Connexion with manometer at 12h. 16m. Two Ludwig and one Fick tracings during—(*a*) Ordinary chloroform administration, with irregular respiration. (*b*) Irritation of the left vagus nerve. No pulsation for 17 seconds. (*c*) Pushing chloroform and irritating the left vagus. Pulse reduced from 80 to 20. (*d*) The same, only for a much longer time, after which the animal died in spite of artificial respiration, which, however, for some reason was never efficient, no air passing in and out of the chest. Pulse reduced from 80 to 48. On opening the chest a large quantity of blood was found in the left pleural cavity.

Remarks.—Tracing No. 137 shows the effect of irregular breathing in chloroform administration, causing a corresponding irregularity of the blood-pressure. It also shows the effect of electrical irritation of the vagus, producing complete stoppage of the heart for 17 seconds without any bad result. This tracing shows the safeguard effect of slowing the circulation by irritation of the vagus. The first time this was done during chloroform administration it reduced the pulse from 80 to 20 a minute, and the chloroform had no effect. The second time the pulse was only reduced from 80 to 48; the chloroform inhalation was kept up much longer, and gradual death ensued.

NOVEMBER 30TH.—EXPERIMENT 146.

Dog, weight 35lb, that has had three doses of phosphorus, one grain each day, on the 25th, 26th, and 27th instant respectively. Of twelve dogs similarly dosed, four have already died. Into chloroform box at 10h. 27m. 50s. Fallen down at 10h. 32m. 25s. On to the table at 10h. 33m. 15s., and given chloroform from time to time. Left carotid ligatured and cannula inserted into it. Connexion with manometers at 10h 56m. 35s. Two Ludwig and one Fick tracings during administration of ether persistently, with more or less perfect exclusion of air, until death resulted. Both sides of the heart distended with venous blood. Heart and liver both fatty.

Remarks.—Experiment 146 shows the effects of ether administered, so as to more or less completely exclude the air.

NOVEMBER 30TH —EXPEERIMENT 147.

Another pariah to whom phosphorus has been given, as in the case of 146. Is, however, more sickly. Into chloroform box at 11h. 32m. 57s. Fallen down at 11h. 40m. 41s. Placed on the table and kept quiet with chloroform. Cannula inserted into artery at 11h. 51m. 7s. One Ludwig and one Fick tracings during the administration of chloroform persistently until death resulted. At the commencement there was a sudden fall of pressure, the result of holding the breath.

Remarks.—No. 147 shows the effects of ordinary chloroform administration and poisoning.

NOVEMBER 30TH —EXPERIMENT 148.

A thin phosporus dog of the same batch as 146 and 147. (Has had chloroform this morning, but was revived by artificial respiration.) Into chloroform box at 2h. 30m. 37s. Fallen down at 2h. 40m, and taken out of box. Placed on the table and kept under with chloroform. Artificial respiration at 2h. 42m. 20s. until 2h. 42m. 50s. Artery ligatured and cannula inserted. Connexion with manometers at 2h. 49m. 50s. Three Ludwig and four Fick tracings showing the effect of (*a*) giving chloroform on a cap crammed on closely over the face so as to partially asphyxiate the animal compared with the gradual fall of pressure that occurs when chloroform is properly administered with air,

(*b*) giving ether in the same way, (*c*) giving ammonia in the same way, and (*d*) holding the dog's mouth and nose so as to produce asphyxia without chloroform or ether, (*e*) irritation of the right vagus. The dog was eventually killed by making him inhale concentrated chloroform vapour through a tube tied into the inhaler.

Remarks.—Experiment 148, Ludwig I., II., III., and Fick I., II., III., IV., shows the difference between chloroform administration (*a*) when the respiration is embarrassed by struggling and holding the breath consequent on the attempt to make the animal inhale unduly strong vapour, and (*b*) when chloroform vapour is diluted and the respiration is natural and free. If Ludwig I. and Fick I. and II. are carefully examined, it will be found that every time chloroform is given with insufficient air so as to cause the animal to hold its breath and struggle from asphyxia, irregularity of the blood-pressure was produced, which recurred when the animal was recovering. This corresponds exactly with the irregularity in the Glasgow traces A, B, &c. on the one hand, and on the other in the irregularity caused by artificial stimulation of the vagus. With reference to this point, compare traces 137, Ludwig I., between 12.25 and 12.26, with trace 148 Ludwig I, between 3 1 and 3 3. It was in experiment 148 that the Commission first became fully aware of the vital importance of natural respiration in chloroform administration. The tracings show that even the slightest struggling (*vide* Ludwig II., 3.36 to 3.39), or interference with respiration (*vide* Ludwig III., 4 2 to 4 5) caused a corresponding irregularity in the blood-pressure. But whenever the chloroform was given so that the respiration was natural the blood-pressure was perfectly regular, as is seen in Ludwig I. at 3 17 and Fick III., reading 12. The tracings of Experiment 148 also show the effects of simple asphyxia and of electrical irritation of the vagus for 20 seconds (*vide* Fick IV., reading 23).

DECEMBER 3RD.—EXPERIMENT 156.

Weight 27¾lb. A large pariah that had two grains of phosphorus this morning. Into chloroform box at 3h. 26m. 30s. Fallen down at 3h. 39m. 35s., and placed on the board at 3h. 40m. 10s. Artery ligatured at 3h. 46m. 50s., and cannula inserted at 3h. 48m. Loop under both vagi. Connexion made with manometer at 3h. 51m. 7s. One Ludwig and two Fick tracings during (*a*) administration of chloroform with a cap closely applied to the muzzle (Fick 2 shows the extreme depression of the heart's action); (*b*) gradual administration of chloroform with plenty of air; (*c*) simple smothering without chloroform by holding the mouth and nose (compare Fick reading 5 with 2); (*d*) division of both vagi; (*e*) simple smothering again (compare the extremely rapid pulse in Fick 7 with that of Fick 5); (*f*) chloroform again, with the cap closely applied, and while the pulse was still extremely rapid (compare No. 151); the pressure fell rapidly, and after the chloroform was stopped the animal gave two or three convulsive gasps in rapid succession, which had no effect on the pressure; (*g*) artificial respiration failed to restore the animal, and the heart stopped beating about six minunes after the last gasp. Temperature 101 4° F. Thorax opened at 4h. 23m. Heart quite still, but irritable.

DECEMBER 4TH.—EXPERIMENT 160.

Pariah dog, weight 24lb.; has had two grains of phosphorus, as in 159. Into chloroform box at 3h. 38m. 24s. Fallen down at 3h. 49m. 20s. Placed on the table at once. Cannula inserted into the left carotid at 3h. 55m. 45s. Connexion with manometer at 3h. 59m. 30s. One Ludwig tracing only. Chloroform was given at first very gently, with plenty of air until the animal was fully under. The animal's head was then placed in a bladder which communicated with an apparatus (described in Appendix) for generating carbonic acid as soon as the cornea became sensitive. Carbonic acid was generated, and the inhalation of this gas commenced. Blood-pressure fell slowly at first, but afterwards more rapidly. After three minutes and three-quarters the respiration stopped, and the bladder was at once taken off the dog's head and air freely admitted while artificial respiration was commenced. Gasping respiratory movements occurred after about a minute, but had little or no effect upon the blood-pressure, and ceased finally after another minute. Artificial respiration was resumed, but without avail. The liver was not apparently fatty.

DECEMBER 6TH.—EXPERIMENT 161.

Temperature of the room 20° cent. Large pariah, weight 26lb., that has had three grains of phosphorus in one-grain daily doses, but is not particularly sick, though out of a batch of seven, of which he is one, that were dosed with phosphorus in the same way three died in the course of the day. Into chloroform box at 10h. 11m. 20s. More chloroform into the box at 10h. 17m. 40s. Fallen down at 10h. 22m. 40s. Placed on the table at 10h. 23m. 25s. Slight convulsions at 10h. 25m., after which the breath was held for about half a minute, and artificial respiration was employed for a few seconds. More chloroform at 10h. 25m. 55s., as the animal was sensitive and groaning. Temperature in the rectum 100·4° F. Chloroform stopped again at 10h. 27m. 50s. More chloroform at 10h. 29m. 25s. Artery ligatured at 10h. 30m. Stop chloroform again at 10h. 30m. 10s. Cannula inserted at 10h. 31m. 52s. More chloroform at 10h. 33m. 50s. until 10h. 34m. 30s. More chloroform again at 10h. 34m. 40s. Stop chloroform at 10h. 35m. 20s. Connexion made with manometer at 10h. 36m. 30s. Three Ludwig and two Fick tracings during: (*a*) administration of absolute alcohol by Junker's inhaler, the tube introduced into the nostril (the pressure in this animal fell in a marked way whenever he struggled); (*b*) absolute alcohol continued, but close-fitting inhaler used in place of the tube in the nostril; (*c*) chloroform administration with struggling; (*d*) inhalation of carbonic acid, and; (*e*) chloroform at the same time (*vide* especially Fick reading 3); (*f*) carbonic acid inhalation again (after giving fresh air) and for short time chloroform as well (Fick 6); (*g*) carbonic acid inhalation again, with more careful exclusion of air; (*h*) after the carbonic acid was stopped he breathed spontaneously for a short time, but then artificial respiration became necessary at intervals; (*i*) lastly, smothering, by bandaging mouth and nose with an elastic band until he died.

DECEMBER 9TH.—EXPERIMENT 169.

Dog, 37¾lb. Given chloroform at 11h. 12m. 30s. Fallen down at 11h. 15m. 55s. Placed on the table at 11h. 16m. 10s. More chloroform given 11h. 17m. 47s. Stopped at 11h. 18m. 25s. More chloroform at 11h. 19m. 5s. Artery ligatured at 11h. 19m. 55s. Stopped chloroform at 11h. 21m. 5s. Cannula inserted at 11h. 21m. 21s. More chloroform at 11h. 22m. 35s. Stopped chloroform at 11h. 23m. 10s. Connexion with manometer at 11h. 24m. 25s. One Ludwig and part of a Fick tracing during continued gentle administration of chloroform until death.

Remarks.—No. 169 is a good example of the most important point brought out by the experiments of the Commission. Whenever chloroform is properly administered the blood-pressure invariably falls gradually and regularly, as is shown in the Ludwig and Fick tracings of Experiment 169; and the fall of pressure is in no sense dangerous if the inhalation is stopped when the subject is fully under the influence of the anæsthetic.

DECEMBER 16TH.—EXPERIMENT 185.

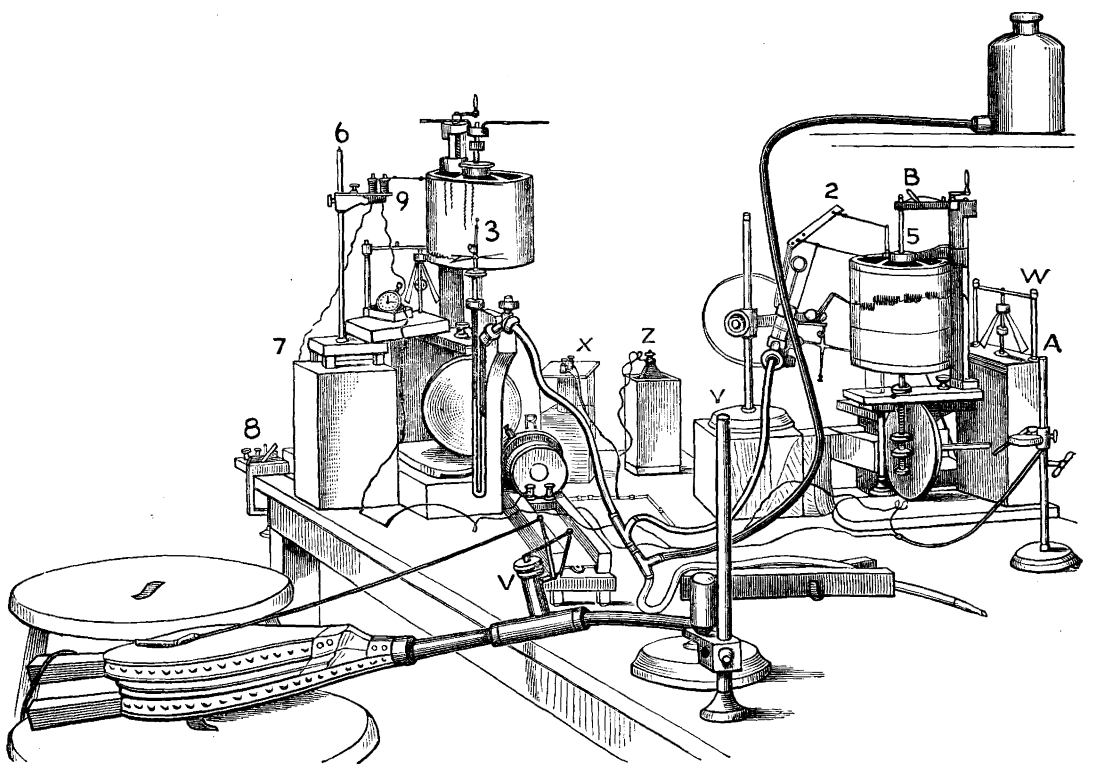
Dog, weight 36lb,, unpoisoned and healthy. Into the chloroform box at 2h. 30m. 35s. Fallen down at 2h. 36m. Placed on the table at 2h. 36m. 15s. Foaming at the mouth, and kept quiet with chloroform. Artery ligatured at 2h. 42m. 30s. Cannula inserted at 2h. 43m. 25s. Connexion with manometer at 2h. 49m. 20s. Two Ludwig and five Fick tracings during—(*a*) Struggling and repeated holding of the breath when he was quite out of chloroform; (*b*) holding an ordinary cap with ammonia on it before the nose; (*c*) chloroform administration during struggling and holding of the breath; (*d*) snipping the anus; (*e*) pulling out the tongue forcibly, which had the effect of making him hold his breath; (*f*) chloroform during violent struggling; (*g*) pushing chloroform until respiration stopped; (*h*) squint operation; (*i*) chloroform pushed until death resulted.

N.B.—The Fick drum revolved once in 1m. 9s. in this and the previous experiment. In all experiments previously to 183 the Fick revolution occupied 3m. 9s.

Remarks.—Experiment 185 shows the irregularity of the blood-pressure which is produced by struggling and holding the breath when the subject is or is not under the influence of chloroform. It also shows the fall of pressure and slowing of the circulation produced by forcibly pulling forward the tongue (*vide* Ludwig I. at 3.4 and 3 7, and Fick III., reading 5). This is constantly done when patients are in danger from an over-dose of chloroform, and was the only operative procedure in the Commission's experiments which caused the same effect as electrical irritation of the vagus. During the 185th Experiment many operations were performed, with a view to induce shock without any effect upon the heart, the pulse, or the blood-pressure.

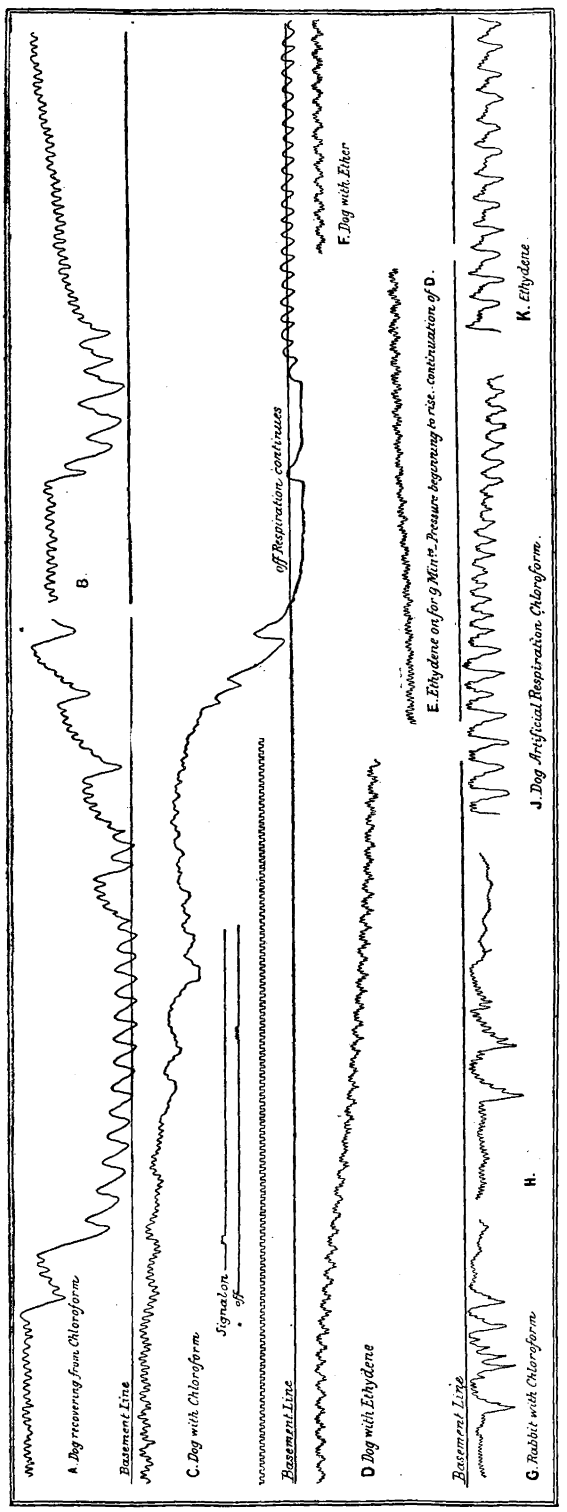
GENERAL VIEW OF THE APPARATUS EMPLOYED.

THE apparatus stands on a solid teak table. In front is seen a strong upright for supporting a Bernard's dog-holder. Close behind the upright is a wooden burette-holder, bent almost to a horizontal position. This was used to support the elongated glass bulb connected with the arterial cannula, and to prevent any drag being exerted upon it. Y is almost hidden by the upright, and is supported by a long needle above the Y-tube, which it indicates. From the Y-tube go two white tubes to the two manometers; 2 indicates Fick's manometer; 3 is fastened above the mercurial manometer, against the tracing on Ludwig's kymograph, above the clockwork of which 9 is fastened; 6 indicates the magnetic time-marker, and is raised on a large block of wood to a proper height; on a small block of wood at the bottom of the instrument is seen the watch of the observer; 7 is the Du Bois-Reymond key, by which the time-marker is worked;



R is a Du Bois-Reymond's coil for irritating nerves; 8, the key by which contact is made and broken; X is a Leclanché battery for the time-marker, and Z a bichromate cell for the coil; 5 indicates the tracing on Fick's kymograph, and W the clockwork of the instrument; A and B are two of Marey's tambours connected together. The lever of A was connected occasionally by a thread with a needle fixed in the heart or diaphragm of the animal, and the movement being transmitted to A was recorded by it on the cylinder of Fick's kymograph. V indicates the valve used with the bellows for artificial respiration. It is fixed to the nozzle of the bellows by a kind of splint made of wood and cork. Across the top of the photograph and down its centre extends the indiarubber tube conveying soda solution to the apparatus from the vessel fixed against the wall.

THE GLASGOW COMMITTEE'S TRACING, 1879.



The chloroform tracings of the Glasgow experiments should be compared with the Fick tracings of the Commission's Experiments 148, 156, and 185, in which there are irregularities due to asphyxia, or to some interference with or irregularity of the respiration. The Commission has shown that regularity of the respiration ensures regularity of the fall of the blood-pressure in chloroform inhalation, and the fact that the blood-pressure was irregular in the Glasgow Committee's tracings is proof positive that there was irregularity of the respiration in their experiments.

EXPERIMENTS WITH CHLOROFORM MADE BY SURGEON-MAJOR LAWRIE, SURGEON ARTHUR CHAMARETTE, MR. WILLIAM MAYBERRY, AND MR. KNIGHTLEY OWEN BURNE.

Temperature of room 28° C. Chloroform given in box 1 h. 58 m. 30 s. Dog fallen down 2h. 4m. Dog on table 2h. 5m. Artery ligatured 2h. 10m. 30s. Cannula inserted 2h. 12m. 30s. Connexion with manometer made 2h. 16m. 30s.

Ludwig III. shows the effects of—

(*a*) Recovery from chloroform.

(*b*) Ordinary chloroform inhalation at 2h. 53 m. 32s.

1. Cornea insensitive; dog fully under at 2h. 54m. 30s. 2. Breathing stopped at 2h. 56m. 3. Electrical irritation of right vagus coil 5 from 2h. 56m. 3s. to 2h. 57m. 25s. 4. Breathing restored spontaneously; chloroform continued for 30 seconds longer.

(*c*) Spontaneous recovery without artificial respiration.

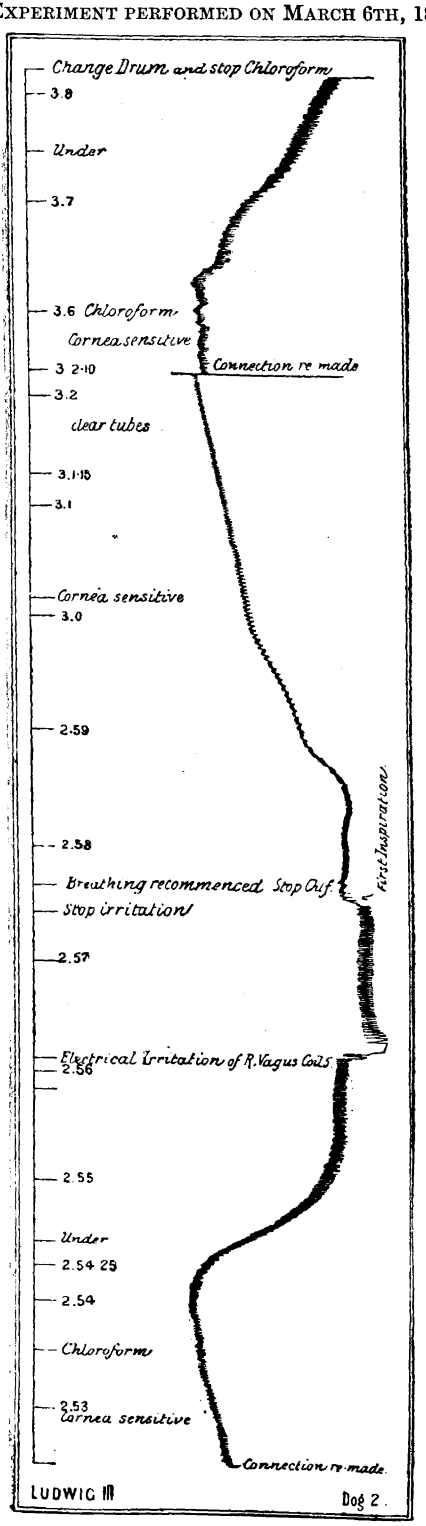
(*d*) Ordinary chloroform inhalation.

Ludwig IV. shows the effects of—

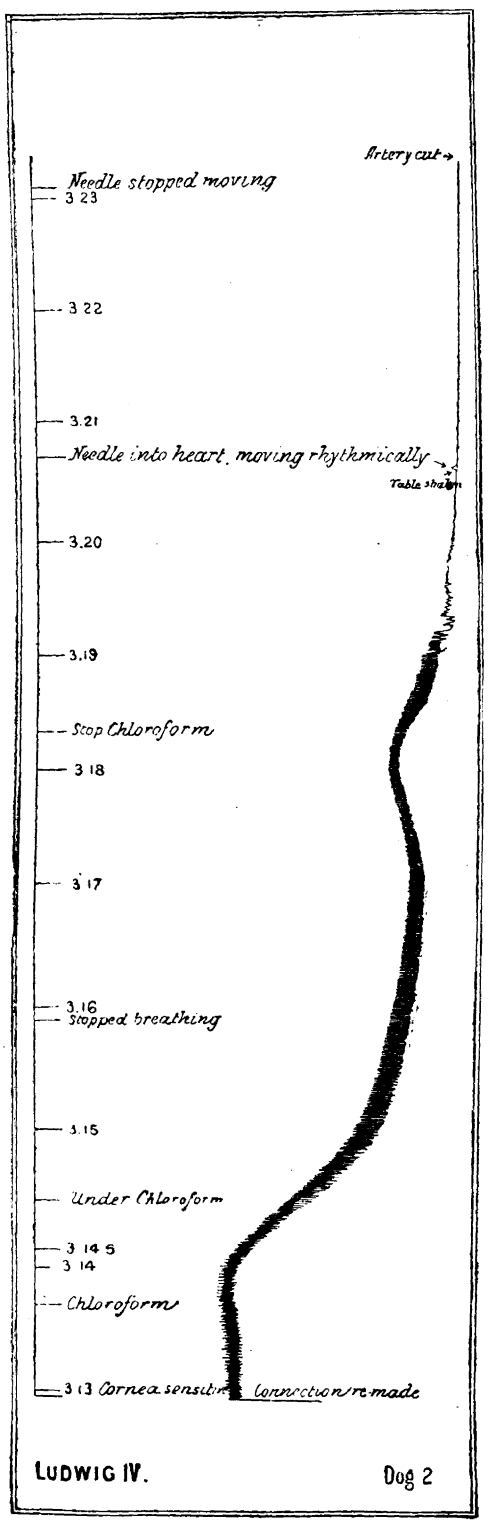
(*a*) Ordinary chloroform inhalation at 3h. 13m. 40s.

1. Cornea insensitive; dog fully under at 3h. 13m. 30s. 2. Stopped breathing 3h. 15m. 50s. 3. Chloroform cap removed 3h. 18m. 15s. 4. Needle into heart at 3h. 20m. 45s., moving rhythmically until— 5. Heart needle gradually ceased to move at 3h. 23m. 5s. Death

I. EXPERIMENT PERFORMED ON MARCH 6TH, 1890.



II. EXPERIMENT PERFORMED ON MARCH 6TH, 1890.



THE HYDERABAD CHLOROFORM COMMISSION.

By SURGEON-MAJOR LAWRIE.

WHATEVER may be the result of the labours of the Second Hyderabad Chloroform Commission, the gratitude of our profession is due to his Highness the Nizam of Hyderabad for the opportunity of scientific progress which his unbounded liberality has afforded. At the time the Commission was appointed, the *Pioneer*, the leading journal of India, wrote: "Nothing could show better the beneficent nature of the solid and friendly tie which binds together the British and the Nizam's Governments than the remarkable and cosmopolitan interest which his Highness the Nizam and his officials, one and all, have taken in bringing the question of the safety of chloroform to the proof. It redounds to the honour of the Government of India no less than to that of the administration of Sir Asman Jah, that the leading Indian State should take a principal share in the settlement of a question which concerns the welfare and happiness of the whole of mankind." Since we are in a position to show that the researches of the Commission have finally proved the safety of chloroform, it is right to ask that the Nizam and his Minister, Sir Asman Jah, together with the Minister's responsible adviser, the Nawab Mushtak Hussain, should receive public recognition as benefactors not only of the human race, but also of the animal kingdom, which, no less than mankind, will derive benefit from the advantages chloroform confers in the abolition of pain and in the relief of suffering.

In considering the work of the Second Hyderabad Chloroform Commission, a very brief recapitulation is necessary. Four hundred and thirty animals were killed with chloroform by the Commission's subcommittee, or were subjected to experiments as to the effects of artificial respiration, with the object of confirming, elaborating, or disproving the work of the First Commission. In addition to this, 168 animals were killed by the Commission with chloroform and ether, and the effects were recorded by Drs. Lauder Brunton and Bomford with Ludwig's and Fick's manometers. The subcommittee's experiments confirmed the results obtained by the First Commission presided over by Dr. Hehir; and in their turn the results of the subcommittee were confirmed by the experiments undertaken with the self-recording apparatus. In every case of death from chloroform the respiration stopped before the heart. The three series of experiments showed that simple chloroform poisoning causes paralysis of the respiratory centre and then gradual death, the heart being the last organ in the body to die. The exceptions to the rule that the heart retains its vitality longer than any other part of the body were found in four cases, in which more or less energetic contractions of the diaphragm occurred after the cessation of the heart's action. In one case the contractions took place after the thorax had been laid open, and when the lungs were collapsed. The Commission called these movements gasps, but solely for convenience and the want of a better term. They were no more respiratory movements than the wagging of the tail and the snapping of the jaws, which went on for ten minutes after death in two other cases, were movements of joy or of mastication. The respiratory is a coördinating centre, but there is no reason why any of the muscles should not contract spasmodically from stimuli applied to their own proper centres after the respiratory centre is paralysed. The diaphragmatic contractions in vomiting and hiccough are not generally considered respiratory movements.

With reference to the manometer experiments of the Commission, it must be borne in mind that the inhalation of chloroform necessarily causes a fall of the blood-pressure. When this was first imperfectly demonstrated by the English Commission in 1864 it was erroneously thought to be a source of danger; and the idea was confirmed by the Glasgow Committee in 1879, which went further and attempted to prove, by means of more accurate apparatus, that not only does chloroform cause a fall of the blood-pressure, but that the fall is sometimes capricious, and that this constitutes the grave danger in chloroform administration. The Commission have shown that the capricious effects which the Glasgow Committee attributed to chloroform were produced by accidental asphyxia; and the fact that the fall of the blood-pressure, as indicated in the Glasgow Committee's tracings, was irregular is now known to prove that there must have been irregularity of, or interference with, the respiration in their experiments. How the fall of the blood-pressure is produced by chloroform may be left for physiologists to determine, but it must be clearly understood that it is in no sense a danger, in any case which is fit for an operation, unless it is excessive—that is to say, unless an over-dose of chloroform is inhaled.

The facts brought out by the manometer experiments of the Commission, which can be proved from the tracings, are:

1. "Chloroform, when given continuously by any means which ensures its free dilution with air, causes a gradual fall in the mean blood-pressure, provided the animal's respiration is not impeded in any way, and it continues to breathe quietly without struggling or involuntary holding of the breath. As this fall continues, the animal first becomes insensible, then the respiration gradually ceases, and lastly the heart stops beating (*vide* Experiment 169: Ludwig and Fick tracings). If the chloroform is less diluted the fall is more rapid, but it is always gradual so long as the other conditions are maintained; and, however concentrated the chloroform may be, it never causes sudden death from stoppage of the heart."

2. Chloroform has no power of increasing the tendency to either shock or syncope during operations. Every operation that ingenuity could suggest, or that has ever been supposed to be dangerous under chloroform, was performed by the Commission in every stage of chloroformisation, without any effect upon the heart, the pulse, or the blood-pressure.

3. The Commission found, however, that struggling during chloroform inhalation, or anything which interfered with the breathing in any way, such as holding the breath or asphyxia, produced irregularities in the circulation and in the action of the heart (*vide* tracings of Experiment 148). Even such slight interference as is brought about by forcibly pulling the tongue forward had this effect (*vide* Tracing 185). In fact, pulling the tongue, which is constantly done when patients are supposed to be in danger from chloroform, was the only proceeding short of direct irritation of the vagus that appeared to produce shock. This would have been thought very paradoxical had it not been that previously, when Experiment 65 was reached, Dr. Bomford had proposed that the heart should be inhibited by electrical irritation of the vagus during chloroform poisoning, as he believed it would prove beneficial by postponing or preventing the fatal effects. If Tracings 65 and 117 are examined, it will be seen that inhibition of the heart's action and slowing of the circulation, with rapid fall of pressure, caused by irritation of the vagus, proved to be a safeguard, exactly as Dr. Bomford had anticipated, rather than a danger.

4. Following up the discovery regarding the vagus, the Commission found that an effect precisely similar to that caused by electrical stimulation of the vagus is produced through the same nerve: (*a*) in the holding of the breath, which occurs in the early stages of chloroform administration (*vide* Experiment 148: Fick I. and II., readings 2, 3, 4, 6, 8, 9, and 11); (*b*) in asphyxia (*vide* Experiment 161: Fick I, readings 14, 15, 16, and 17; and Experiment 156: Fick I., reading 5); and (*c*) sometimes after the respiratory centre is paralysed in the later stages of chloroform poisoning (*vide* Experiment 148: Ludwig III., from 4·5 to 4·7; and Experiment 178, all tracings). The same effect is produced in man by identically the same causes, and is what THE LANCET of March 2nd, 1889, wrote of as "primary and secondary syncope." It is evidenced by pallor of the face and other symptoms, to which Mr. Battle and Mr. Hewett referred in their letters to THE LANCET of Feb. 22nd and March 1st, 1890.

5. The Commission discovered gradually (*vide* Experiment 148) that it is possible to give chloroform in such a way that full anæsthesia is produced, with a gradual fall of blood-pressure, unaccompanied by any irregularity of the heart or circulation. The Commission found that the way to do this was to ensure natural and regular respiration, without struggling, holding the breath, or asphyxia, or any interference with the breathing. It became evident in the course of the experiments that it was difficult, if not impossible, to make any animal inhale unduly strong chloroform vapour without previously making it hold its breath, asphyxiating it, or making it insensible. When an inhaler saturated with chloroform is held too close to the mouth and nose an animal holds its breath; and in many animals,

especially the rabbit or the goat, holding the breath stimulates the vagus and at once slows the heart and retards the circulation.

6. The experiments of the Commission proved that death from chloroform is invariably due to an over-dose; and the question which next arose was, Are there any circumstances which make chloroform inhalation dangerous, and, as it were, open the door to an over-dose, or make the action of the drug appear capricious?

7. It is fully demonstrated by the experiments of the Commission that struggling, holding the breath, any form of asphyxia, or any kind of interference with the breathing are dangerous in chloroform administration. Obviously either complete asphyxia or continuous holding of the breath, if this were possible, would be sure preventives of poisoning by chloroform; but the danger in such conditions is due to the fact that they must alternate with extra vigorous and deep respiration. Struggling makes the inhalation of chloroform dangerous, because it either partially asphyxiates the patient, or alternately does this and accelerates the respiration and circulation, so increasing the amount of chloroform inhaled and hastening the rapidity with which the chloroform is conveyed to the brain and nerve-centres. Holding the breath causes asphyxia, and asphyxia produced in this or in any other manner poisons and stimulates the respiratory centre, and, on the one hand, makes it extremely obnoxious to paralysis by chloroform; while, on the other, it leads to gasping and deep inspirations, by which an over-dose is very soon taken in. The rapidity of chloroform poisoning when asphyxia is produced is much the same as it would be if you threw a man into a pond, and held a chloroform inhaler over his head every time he came to the surface to take a breath. This is exactly what a timid or badly taught operator often does. He measures his chloroform and pours it into a patent inhaler, which he then applies to the patient's face. The patient holds his breath and becomes deadly pale, while his vagus slows the heart and circulation. Presently the patient takes a deep gasp, and as soon as the chest begins to move, the chloroformist thinks there is no danger and replaces the inhaler on his face, too probably adding another dose of chloroform as he does so. The patient's natural protective means being exhausted, he very quickly absorbs a fatal dose of chloroform, and we are subsequently told that his heart failed, that he afterwards gasped two or three times and then died. No care in measuring the chloroform or diluting it in a mechanical inhaler is any guide whatever to the amount of the anæsthetic a patient inhales or absorbs. Moreover, breathing through an inhaler is not natural breathing.

8. The Commission has shown that the key to the safe administration of chloroform is that the breathing be natural, so as to avoid struggling and any form of respiratory embarrassment; and that it may be so the anæsthetic must be administered in an open cone or cap, which is held far enough from the patient's face to avoid causing him to hold his breath or struggle, and into which he is at first made to blow after each inspiration, the cap being brought nearer to the face, and eventually quite close to it, as the chloroform begins to take effect and he breathes regularly.

The two tracings dated March 6th, 1890, Nos. 3 and 4, Ludwig, show very conveniently all the points claimed by the Commission. They demonstrate:—(*a*) The gradual fall of blood-pressure caused by chloroform inhalation, when the chloroform is properly given, so as to entirely avoid struggling or holding the breath, &c. (*b*) The value of reflex winking when the eye is touched, as a guide to the state of anæsthesia. When this point is reached, the subject may as a rule be said to be ready for operation, and this, it will be seen from the tracings, occurs long before the fall of pressure, if this be regular, reaches a dangerous stage. (*c*) The effects of pushing chloroform till the stoppage of the respiration, the heart being unaffected till long after this stage is passed. (*d*) The slowing of the circulation and fall of blood-pressure caused by irritation of the vagus. No one doubts that the vagus has the same action in man as it has in animals. (*e*) The effect of electrical irritation of the vagus when the respiration has ceased; and the slowing of the circulation, which retards the conveyance of chloroform to the nerve centres. It is not difficult to understand how slowing of the circulation necessarily retards the conveyance of chloroform to the medulla. For example, if the pulse is sixty, and sixty atoms of chloroform are conveyed to the brain in a minute, only thirty atoms a minute will reach the brain (other things being equal) if the pulse is reduced to thirty by stimulation of the vagus. Tracings 3 and 4 of the effects of ordinary chloroform inhalation are identical up to he point where the respiration ceased. Tracing 3 then shows that the breathing having entirely ceased, stimulation of the vagus slowed the circulation from eighty-six to forty-two a minute and saved the dog's life. Tracing 4 shows how, after the stoppage of the respiration, when artificial respiration was not employed and the vagus was not irritated, the heart's action gradually ceased. Both tracings show how useless it would have been to have taken the action of the pulse as a guide. When the pulse failed, as it did at the end of Tracing 4, it was a sign of impending death. The two tracings demonstrate that by taking the respiration alone as a guide, danger could have been averted, as it always can be in the human subject under chloroform, if the breathing is carefully kept free. It is remarkable that in these two experiments the chloroform was given undesignedly for precisely the same length of time—viz., 4·42 minutes. Considered by the light of the work of the Commission, these tracings prove incontestably that the slowing of the heart and circulation through the stimulation of the vagus is a safeguard in chloroform poisoning. The symptoms—pallor and loss of pulse—produced in a similar manner in man are none the less signs of the greatest danger, as they signify that the patient has not been breathing properly, or that he has been asphyxiated, or that the respiratory centre has been paralysed. They do not indicate, as has hitherto been supposed, that chloroform has any direct effect upon the heart; but whenever they occur, at whatever stage of chloroform administration, they show most unmistakably that it has been given in such a way as to interfere with the breathing.

The most important point of all in the tracings is to be found in the invariably gradual and regular fall of blood-pressure when chloroform is properly administered. This is shown in many of the Commission's experiments, especially from No. 164 to the end (*vide* 169), and in the tracings of March 6th, 1890. In Tracings 3 and 4 of March 6th the fall of blood-pressure is gradual and perfectly regular, and they demonstrate the only method of chloroform administration compatible with absolute safety. Though fall of pressure is inseparable from chloroform administration, there is never the least danger if it falls regularly, and if the inhalation is stopped directly the state of the cornea shows that the patient is "under." Regularity of the blood-pressure depends entirely upon regularity of the respiration. Any irregularity, therefore, in the fall of blood-pressure during chloroform inhalation indicates irregularity of or interference with the respiration; and, *per contra*, any irregularity of or interference with the respiration at once causes irregularity in the fall of blood-pressure; but as long as the respiration is regular and not interfered with, the fall of the blood-pressure will exactly correspond with it, and will cease long before a dangerous point is reached *if the inhalation is stopped when the cornea becomes insensitive*, or other signs show that the patient is "under." If the respiration is kept up without struggling, holding the breath, or asphyxia, chloroform may be given slowly or quickly, freely and with perfect confidence, without the slightest risk to the patient.

From the standpoint of medical education it is a serious misfortune that ether has been allowed to displace chloroform in any of our large hospitals. The public has a right to demand that every medical man shall be able to administer an anæsthetic with safety in any part of the world; and there is no anæsthetic which can be thus universally employed except chloroform. If ether is used as the sole recognised anæsthetic in the hospitals attached to our medical schools, students cannot learn how to give chloroform; or if anæsthetics are only to be administered by specialists, students cannot learn anæsthesia practically; and it is notorious that the advance of ether has been accompanied by a decrease in the employment of anæsthetics by the general practitioner, and has limited their usefulness.

In conclusion, I desire to do justice to the wisdom of my old masters by comparing the principles Syme laid down for the safe administration of chloroform—principles which he always said he took from Sir James Simpson—with the physiological proof the Hyderabad Commission has succeeded in determining from their experiments. In the lecture to which I have so often referred, which was published in THE LANCET of Jan. 20th, 1855, Mr. Syme states:

"The points that we consider of the greatest importance in the administration of chloroform are: first, a free admixture of air with the vapour of chloroform; secondly, we do not stint the quantity of the chloroform; then, and this is most important, we are guided as to the effects, not by the circulation, but entirely by the respiration. We also always give chloroform in the horizontal position, taking care that there is no article of clothing constricting the neck, *and we never continue beyond the point when the patient is fully under the influence of the anæsthetic.*"

The Commission has demonstrated that the aim of the surgeon must be to give chloroform so that the blood-pressure should fall regularly throughout the whole administration, and that the blood-pressure can only be kept free from irregularities by absolute regularity of the breathing. The chloroform must therefore be inhaled in such a way that the breathing is natural and regular throughout. Feeling the pulse during chloroform inhalation is no guide whatever either to the blood-pressure or to the one thing necessary for safety, which is to keep it regular; and it has been shown above that the pulse is of no value as a sign of approaching danger, since it is only affected dangerously (*a*) when the respiration has been interfered with or (*b*) by an overdose. Lastly, in order to keep the breathing regular, the whole of the administrator's attention must be concentrated upon this point alone; and it is therefore clear that if, as is now recommended in most of the text-books, part of the chloroformist's attention is to be given to the pulse, an important element of danger comes into the administration.

We can no longer contend, with regard to chloroform, that the results of clinical experience and of experimental research do not agree. The investigations of the Hyderabad Commission have brought to light a strikingly precise and complete agreement between both. I have stated in THE LANCET of April 5th, 1890, that the late Mr. Syme's and my own form a continuous series amounting to more than 45,000 cases of almost daily (and often several times a day) chloroform administration, extending from 1847 to 1890, in which the respiration alone was taken as a guide, without one death resulting. Mr. Roger Williams has proved in THE LANCET of February 8th, 1890, from the statistics of one of the largest hospitals in London (which, he says, may be accepted as reliable averages of all the London hospitals), in which the pulse is taken as a guide, and is carefully watched as well as the respiration, that the deaths amount to one in every 1236 administrations. We thus see that in a long series of 45,000 cases, extending over forty years, in which the chloroformist's attention was concentrated on the respiration alone, and in which the chloroformists were students, there were no deaths at all; while in another series of 12,368 cases, in which a part of the chloroformist's attention was devoted to the pulse, and in which the chloroformists were specialists (anæsthetists), there were no less than 10 deaths—a fraction over one in every 1250 administrations. These clinical results correspond with the conclusions arrived at by the Hyderabad Commission, and are sufficient to show what a tremendous difference to the patient the mere method of administration may make. One of the London journals, the *St. James's Gazette*, recently published an article on the question "Is Chloroform Safe?" and answered it by saying, "It depends upon who gives it." We now know that it does indeed depend upon who gives it, but we also know that any intelligent third or fourth year's medical student may be trained to give it safely, so as to do good without the risk of evil.

I think I have shown that the Hyderabad Commission has proved Syme's principles to be true. The *rationale* of the proof and the keystone to the work of the Second Commission is to be found in the discovery of the safeguard action of the vagus nerve, and in the thorough comprehension of the significance of this fact. As soon as this was demonstrated, it became clear that chloroform and shock were not associates but incompatibles, and that the supposed capricious action of chloroform upon the heart was due either to the stimulating effect of concentrated vapour upon the nervous system, or to the effect of asphyxial blood upon the nerve centres, resulting in the exclusion of the poison from the system, and not the direct effect of the absorbed poison upon the heart or its nerves.

APPENDIX.

THE above paper was written before the Glasgow Committee's criticism appeared in the *British Medical Journal* of the 14th inst. I lose no time in exposing the Committee's fallacies, as I am obliged shortly to return to India.

The first point to notice in the Glasgow Committee's remarks is their reference to the paralysing effect of chloroform vapour on the muscular tissue of the heart. "Chloroform vapour has a paralysing effect upon the muscular tissue of the heart, and indeed upon all kinds of protoplasm when directly applied. When the heart of a frog is exposed to the direct action of chloroform vapour 'it became rapidly weaker till it ceased beating.'" The accuracy of this point may be conceded as far as it goes. It is only necessary to supplement it by stating that this paralysing effect is never sudden, but always gradual. "As regards the action on the mammalian heart," the Glasgow Committee performed artificial respiration by pumping air saturated with chloroform into the lungs of rabbits and dogs through an opening in the trachea. "It soon became apparent that when chloroform is given in this way there is at once a most serious effect upon the heart; *the right ventricle almost immediately begins to distend;* the heart presently stops, with the right ventricle engorged with blood." It is evident from this description that the serious effect upon the heart is not caused in the heart itself. The distension of the right ventricle must mean damage to the circulation through the lungs. It is the first effect of stasis in the lungs. Sir Joseph Lister has shown (*vide* Professor Roy's paper in the *Journal of Physiology*, 1879, vol. ii., p. 323) that when chloroform is applied directly to the web of a frog's foot stasis immediately takes place; and the same effect is undoubtedly produced in the same manner in the lungs, and is sufficient to account for the ventricular engorgement which the committee observed when they pumped air saturated with chloroform into the lungs of the rabbit. It is incorrect to imply that driving chloroform into the lungs brings it into direct contact with the heart, or that the process of pumping in the chloroformed air eliminates respiration from the inquiry. If respiration is not to be taken into consideration in this way of giving chloroform, we should first require to have it proved that the air driven into the lungs is sufficient, or sufficiently free from poison, to keep up the respiratory function independently of the action of the chloroform. Air saturated with chloroform cannot do this. In any case, the fact stated by the Committee—that the right ventricle was first affected by distension in their experiment—is proof that it was due to something outside the heart, and not to any direct action upon the heart itself.

The Glasgow Committee ask us to believe that, when air saturated with ether was pumped into a rabbit's lungs, "*twenty minutes were occupied in producing anæsthesia,*" and that it "may be given for an indefinite period without interfering with the heart." At the end of an hour's pumping "the heart was beating as vigorously as at first." It is contrary to all experience that twenty minutes should be occupied in anæsthetising a rabbit by means of air saturated with ether pumped into the lungs. The Hyderabad Commission made many experiments with ether, from among which I have selected two as examples of its effect. In the first, manometer No. 106, a pariah dog weighing 25lb., the tracing of which will be published as soon as possible, the administration of ether on a saturated sponge in a fairly close-fitting cap was commenced at 9h. 46m. 10s. on Nov. 21st, 1889. The blood-pressure rose immediately. It began to fall again at 9h. 46m. 30s., and continued to do so till death. At 9h. 47m. the cornea was insensitive. At 9h. 48m. 40s. there was rattling in the trachea. At 9h. 50m. 30s. the respiration was slow and shallow, and it stopped at 9h. 51m. At 9h. 52m. 30s. the pulse became imperceptible; artificial respiration was kept up, and the dog's body was inverted until 9h. 57m. The thorax was then opened, and the dog was found to be dead. The artery was cut and the pressure fell to zero. The whole experiment lasted ten minutes and fifty seconds, and anyone who chooses to examine the tracing can verify this description of what occurred. The second experiment took place on Nov. 26th, 1889, on two monkeys weighing 4 lb. each, Nos. 129 and 130. In the first monkey, a measured quantity of chloroform was pumped into the lungs through an opening in the trachea by artificial respiration, much in the manner described by the Glasgow Committee. The inhalation was begun at 4h. 2m. 37s., 10cc. of chloroform were used in divided doses, and the heart stopped at 4h. 10m. 55s. The other monkey had ether in the same way. The inhalation was commenced at 4h. 2m. 24s., 15cc. of ether in divided doses were employed, and the heart stopped at 4h. 12m. 20s. In the chloroform experiment 10cc. of chloro-

form freely diluted with air killed a monkey in eight minutes and eighteen seconds. In the ether experiment 15cc. of ether freely diluted with air killed a similar monkey in nine minutes and fifty-six seconds. The difference corresponds with the recognised difference in the strength of the two anæsthetics in the ordinary practice of surgery. With reference to the committee's statement that the heart was beating as vigorously at the end of an hour as at first, we are not told whether there was any natural respiration when the ether administration was stopped, or even whether the animal was alive; and in the absence of reliable information on these points we cannot consider this experiment trustworthy. Either the ether which the committee employed had lost its strength, or else the committee fell into the error of supposing that because the heart was still beating the ether had not interfered with its action.

The same vigorous action of the heart after prolonged anæsthesia, brought forward by the committee in favour of ether, recently came under my notice with chloroform. On May 28th, 1890, air saturated with chloroform was administered to a rabbit in my presence, in precisely the same way as that described by the Glasgow Committee. The administration was begun at 12h. 59m. 40s. At 1h. 0m. 20s. the inhalation was stopped. There was no return of natural breathing, and the blood-pressure had fallen nearly to zero. Artificial respiration was commenced at 1h. 0m. 30s., and continued till 1h. 5m. 5s., when the artery was cut and the rabbit was thrown aside dead. The thorax was opened at 1h. 5m. 50s., and the heart was seen by several competent observers "beating vigorously and rhythmically." At 1h. 15m., it is noted, "heart still beating rhythmically; auricles and ventricles both contracting strongly, but the action of the ventricle is intermittent." At 2h. 5m., one hour after death, the auricles were rhythmically beating; the ventricles were still. This continued till 3 o'clock, two hours after death, after which no more notes were taken. In the face of these facts we cannot accept the vague statements of experiments which the Glasgow Committee first brought forward in 1879, and have repeated without confirmation in 1890.

The next part of the Glasgow Committee's paper deals with the manometer experiments of the Commission. I may observe that in all the manometer experiments of the Commission every event which is marked in the Ludwig tracings was written on the tracings, as the drum revolved, at the time it actually occurred. The committee says:—"In the first place, in Experiments 103, 119, and 157 we have sudden falls of pressure, and opposite some of these, not all, there is the note, 'holding breath.' But these sudden falls of pressure are not confined to occasions when the animal held its breath."

This must mean, if it has any meaning at all, that some of the sudden falls of pressure in tracings 103, 119, and 157 (which will shortly be published) are not accounted for, and are due to some effect on the heart which the Commission overlooked. As a matter of fact, all the sudden falls of pressure in the three tracings were due (1) to holding the breath; (2) to struggling, which interferes with respiration; (3) to asphyxia; or (4) to electrical stimulation of the vagus. This is clearly stated on the tracings, and the Glasgow Committee ought not to have endeavoured to make a point by omitting to say so, in describing the inferences which they think may be drawn from any of these sudden falls.

The committee proceed: "Turning to experiments referred to in section 12[1], where the breathing was artificially interrupted, we have been astonished to find that the traces do not bear out the statements of that paragraph." It is impossible in this short abstract to follow the Glasgow Committee through the quotations which are put forward as "facts" to substantiate the assertion that the tracings do not bear out the statements in section 12. The complete report—with the whole of the tracings taken by the Commission—will shortly be published, and an examination of those tracings which the Glasgow Committee refer to will show that their assertion is inaccurate. One example of their inaccuracy must suffice. The Committee states "at Fick 7 (Experiment 150) we have 'mouth closed,' but there is scarcely any effect on the blood-pressure, and very little on the pulsation." It is distinctly shown on the Ludwig tracing that Fick 7 began at 12h. 17m. 12s. and ended at 12h. 17m. 40s. The mouth and nose were not closed till 12h. 17m. 35s.—just five seconds before the end of, and therefore too late to produce any marked effect in, the Fick reading. But the effect is well shown in the continuation of the observation on the Ludwig manometer. The Glasgow Committee have had every possible opportunity of examining the original tracings, and an inaccurate quotation such as that which I have called attention to is no less misleading than it is, from a scientific point of view, indefensible.

I make no comment on the comparison of the Commission's Experiment 148 with the Glasgow trace. All the tracings of Experiment 148 are published above, and anybody can form his own opinion about them, and about the committee's observations on them.

The committee next confuse the fall of pressure due to ordinary chloroform inhalation with the fall due to interference with the respiration. The Hyderabad Commission have stated that the fall of pressure and slowing of the pulse, from either involuntary holding of the breath or from asphyxia in chloroform inhalation, are due to vagus stimulation, reflex or direct. The Commission has given no opinion as to the cause of the fall produced by diluted chloroform alone. It is obvious, from all their experiments, that the effects of chloroform are first exerted upon the nervous tissues, the vaso-motor centre is very soon involved, the respiratory centre becomes paralysed, then the muscular tissues become affected, and last of all the heart. The fall of blood-pressure becomes dangerous if pushed to the point of paralysis of the respiratory centre. After this point is passed, if the poisoning with chloroform still continues, the fall becomes much more rapidly dangerous; the nutrition of the heart is profoundly interfered with, and the deprivation of oxygen produced by the paralysis of the respiratory centre causes it to gradually cease to act. The Glasgow Committee contend that "when chloroform is pushed, whether the mouth and nose be held or not, the blood-pressure falls, and there is the additional fact that this seems to depend very little on the action of the vagi." In support of this contention—which the Hyderabad Commission do not dispute—the committee quote from Fick, readings 3 and 6 of Experiment 151. But Fick 3 of No. 151 is a reading during simple smothering, the vagi being intact. The effect of the smothering is to almost immediately lower the pressure about 25 millimetres, and to slow the pulse from 72 to 31 per minute at the same time. After the vagi are cut, when asphyxia is again produced by smothering (*vide* Fick 6), the effect is to accelerate the pulse to 105 per minute, while the pressure only falls about 5 millimetres. This difference is most assuredly due to the division of the vagi, and yet the committee assert that the slight fall with rapid pulse in Fick 6 is "*the true asphyxia curve*," and depends "very little on the action of the vagi." In this connexion, it may be well to notice what the Glasgow Committee have to say with regard to atropine. The committee refer to the Hyderabad Commission's discovery of the safeguard action of the vagus in chloroform poisoning, and remark that when the inhibitory action of the vagus is brought into play less chloroform is conveyed to the nerve centres; and, further, if vagus irritation ceases, or the nerve becomes exhausted, the heart "bounds on again, and the blood then becomes very quickly saturated with chloroform, and an overdose is at once conveyed to the nerve centres." The committee continue: "This ingenious view has much to support it," and "it undoubtedly explains the beneficial action of atropine as an adjunct to chloroform administration." The action of atropine is to paralyse the vagus and produce the same dangerous condition as when the nerve is exhausted. If the committee regard the effect of atropine as beneficial they must intend to convey that the inhibitory action of the vagus is a danger in chloroform administration when atropine is not used—i.e., that the normal action of a healthy nerve is dangerous to life. The greatest living physiologists are agreed that the inhibitory action of a nerve like the vagus is not a danger to the organ inhibited, and the Hyderabad Commission goes a step further and shows

[1] Complete, or almost complete, asphyxia, as by forcibly closing the nose and mouth, or closing the tracheal tube after tracheotomy, has an effect similar to, but more marked than, that produced by holding the breath, and the character of the trace corresponds precisely to that produced by irritation of the peripheral end of the cut vagus. The pressure falls extremely rapidly, sometimes almost to zero, and the heart's action becomes excessively slow, or even stops for a few seconds. If the Fick trace of Experiment 148 be compared with the photographic reproduction of trace A of the Glasgow Committee, it will be seen that they are identical, and that the slow action of the heart with great fall of pressure, which the Glasgow Committee attributed to some capricious action of chloroform upon the heart, was undoubtedly due to asphyxia.

that it may be a safeguard to the organism in poisoning by an anæsthetic. If the views of the Glasgow Committee are right, then a patient is in much less danger with the pulse at 105, carrying 105 atoms of chloroform to the medulla in a minute, than he is when the pulse is 31 and only 31 atoms of chloroform are being conveyed to the medulla in a minute. This is manifestly an absurdity. In actual practice the amount of atropine employed as an adjunct to chloroform administration would probably be so small as to be immaterial; but, if it produces any effect at all, it must be to do more harm than good.

The Glasgow Committee's tracings have been reproduced in the *British Medical Journal*. They are given above for the sake of comparison with tracings 148 and others of the Hyderabad Commission. The committee state that in the experiment which furnished tracing C the chloroform was administered "by a cloth *saturated* with the agent being held over the mouth and nose. This exactly bears out the conclusion of the Commission. The animal got chloroform with insufficient air, and the 'Glasgow trace,' which the Hyderabad Commission produced over and over again in their experiments, was due to the stimulation of the nerve centres with asphyxial blood." It only remains to add that the Glasgow Committee's remarks on the condition of an animal whose pressure is "minus" require explanation. As they stand, it looks as if the committee were describing the existence of pulse and respiration curves, as, indeed, they are represented in trace C, below the basement or true zero line, the line of no pressure, which is, of course, an impossibility. The animal in trace C was never in any danger except from the improper manner in which the chloroform was administered to it. It did not die; and the committee's argument about the danger of chloroform to the heart, which is based upon the faulty tracing, has its foundation, not in physiology, but solely in imagination.

In their practical conclusions the Glasgow Committee say: "We think the Hyderabad Commission attach too much importance to one common mode of death—failure of the respiratory centres; and while we agree generally with their conclusions, which in many respects are similar to our own, we consider it unwise and unsafe in practice to pay no attention to the state of the circulation, and to observe respiration alone. We also consider it unwise to convey to the public, even through the profession, the notion that the administration of chloroform is a proceeding in which there is practically no danger." The statistics I have given elsewhere prove the great danger in chloroform administration of dividing the attention between the respiration and the circulation. For this danger the report of the Glasgow Committee in 1879 must be held to be very largely responsible. The committee now argue as if it were wise to keep up the unfounded dread of chloroform the public have acquired, so that whenever an operation is about to be performed under chloroform the patient is nearly frightened to death beforehand, not by the operation itself, but by terror of the effect of the anæsthetic. The committee state finally: "As a matter of common prudence, and especially seeing that when respiration fails we can employ artificial means for its restoration, while if the heart fails, little or nothing can be done to avert a fatal issue, it is incumbent on every one giving chloroform to watch both the pulse and the breathing." If this statement is to be acted upon, it is incumbent on everyone giving chloroform to watch the pulse for heart failure, in spite of the fact recorded by the committee themselves, that "if the heart fails, little or nothing can be done to avert a fatal issue." No teaching could possibly be more dangerous. Without denying that there may be conditions of the heart in which failure and death may occur in some of the processes connected with chloroform administration, just as a man with a certain condition of heart may die of heart failure from running to catch a railway train, the Hyderabad Commission has shown that sudden death from stoppage of the heart is not a risk of chloroform itself. If the surgeon is to have constantly before his mind the fear of the sudden death of his patient by stoppage of the heart from the mere action of chloroform, and is to carefully watch the pulse for signs which can only have a fatal issue, it is a physical impossibility for him to concentrate his attention on the warnings given by the respiration, by which alone danger can invariably be averted. The teaching of the Glasgow Committee is wrong, and if it is followed deaths with chloroform will be as inevitable in the future as they have been under the same circumstances in the past.

ASSOCIATION OF FELLOWS OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

A GENERAL MEETING of this Association was held at the rooms of the Medical and Chirurgical Society, Hanover-square, on Saturday, June 14th. Among those present were: Mr. George Pollock (chairman); Messrs. T. Holmes, Macnamara, Willett, R. Barnes, Richard Davy, Rivington, Lawson Tait, Victor Horsley, Gant, Purnell, Aikin, Collins, Adams, Haward, Allingham, Paterson, Tweedy, E. Willett, Morgan, Alban Doran, Dale, Jessett, Percy Dunn, Watson, Hinckes Bird, and Herbert Allingham (hon. secretary). After the confirmation of the minutes of the last general meeting the accounts of the past year were presented, and Mr. John Morgan was re-elected as an auditor. The list of officers nominated by the committee for the year 1890[1] was read. On the proposal of Mr. WILLETT, seconded by Mr. GANT, these gentlemen were unanimously elected, Mr. Gant's name being added.

The PRESIDENT read his annual report, emphasising the objects of the Association of Fellows. An account of the work of the Association had been sent to every Fellow in the United Kingdom. From 300 to 350 favourable answers were returned to the honorary secretary. It would be remembered that on March 24th, 1884, the following resolutions were carried at an annual meeting of Fellows and Members at the College of Surgeons: "1. That it would materially conduce to the welfare of the College if the Fellows and Members were invested with a larger share of its management. 2. That it is desirable that no alteration in the constitution or relations of the College be effected without the consent of the Fellows and Members convened to discuss such alteration. 3. That there shall be an annual meeting of Fellows and Members, at which the annual report of the Council shall be presented, received, and (if approved) adopted. 4. That at such meeting the President for the ensuing year be elected by the majority of the Fellows present." The Council of the College rejected the 1st, 2nd, and 4th resolutions, but agreed to the 3rd, with the omission of the words, "received, and [if approved] adopted." The principles contained in these resolutions were approved of by over 250 Fellows of the College. On the initiation of Mr. Paul Swain, of Plymouth, this led to a meeting of the Fellows in June, 1884, when the following resolution was moved by Mr. Tweedy, and carried—viz.: "That a Society be formed to promote the general interests of the Fellows of the Royal College of Surgeons of England, and to consider all matters relating to the constitution, government, and administration of the College, whether in its corporate, examining, academical, or political capacity; and that the Society be called the Association of the Fellows of the Royal College of Surgeons of England." In January, 1885, a scheme drawn up by a committee appointed for that purpose contained the following recommendations:—"1. Any Fellow who has been a Fellow for ten years, or a Member for twenty years, shall be eligible to be a member of the Council. 2. Any member of the Council, other than the President, who may be absent from more than four successive meetings without leave shall, *ipso facto*, cease to be a member of the Council, unless a satisfactory reason for such absence be assigned. 3. The appointment of scrutineers to take the ballot at the election of the Council. 4 and 5. The discontinuance of the payment of a fee on election by members of the Council and members of the Court of Examiners. 6. The appointment of a treasurer and the auditing of the accounts by a professional auditor. 7. That Members of the College shall be eligible, as well as Fellows, for the examinerships in anatomy and physiology, except for the primary Fellowship. 8. That an annual general meeting of Fellows and Members shall be convened, at which a report of the Council shall be presented, and that other meetings may be held, either by the direction of the President, or on a requisition signed by thirty Fellows or Members. 9. That the confirmed minutes of each meeting of the Council be suspended in the hall of the College for the inspection of Fellows and Members. 10. Reduction of the number of signa-

[1] Vide THE LANCET, p. 1281.