tion of the exact functions of this gland. Schäfer says that as early as 1855 Addison showed the great importance of these glands in relation to nutrition, since their pathological alterations were thought to be connected with asthenia and the bronzing in patches of the skin and mucous membranes. In 1856, and subsequently, Brown-Séquard showed that their removal was always rapidly followed by death in all animals. It is interesting to note that removal of one gland has apparently no untoward effect. But when the second is taken away, even though the interval between the two operations may be a long one, the fatal symptoms quickly supervene. They are practically those of Addison's disease, though more acute than the latter—asthenia, loss of vascular tone, anorexia, and general prostration. The peculiar pigment characteristics of this disease are not always noticed, probably due to the fact, as Brown-Séquard suggested, that there is no time for its development between the ablation of the capsules and the death of the animal. Tizzoni has experimented on animals which have lived a certain time after either complete or partial removal of the glands, and has in these cases observed the pigmentary changes. The cause of death seems due generally to paralysis of the respiratory muscles. Experiments by Brown-Séquard, Abelous and Langlois tend to show that blood taken from an animal which is dying from the effects of "decapsulation" has no effect on normal animals, although it is toxic for animals more recently deprived of their adrenal glands. On the other hand, normal blood transfused into animals deprived of their capsules seems to prolong life. Since muscular weakness is the most prominent symptom after removal of the glands, the conclusions of Abelous and Langlois are that the capsules when *in situ* remove or destroy some toxic substance which is the result of muscular metabolism. Observations of these experiments has suggested the "auto-intoxication" theory of the adrenal glands. This theory, like all others of its kind, is weak in that the blood of any dying animal would probably be toxic to a certain extent, and also in that the animal on which its effect is observed is, on account of its recent operation, in a state of lessened resistance to any toxin. Nevertheless, it must be admitted that the adrenal glands elaborate some material which is very different from any found in the blood of animals deprived of their capsules. The intravenous injection of the adrenal extract is most active in its physiological working. Schäfer sums up these effects as follows: First, as to its action on skeletal muscle. After one excitation of its nerve, the muscle contracts as quickly as the normal, but this contraction is extremely prolonged. The effect is like that of a small dose of veratrine, but not of curare, for the muscles continue to be as capable of excitation as they were previous to the injection. It can thus be clearly seen that these phenomena are very different from the "so-called auto-intoxication paralysis which is stated to result after removal of the suprarenal capsules in animals." Consequently the material which has been extracted from the adrenals by water is not the same which is said to collect in the blood after ablation of these glands. The effect on the circulatory system is shown in two ways—on the arteries and on the heart. As to the latter, the effect depends upon the condition of the vagi. When these nerve trunks are uncut and the connection, therefore, between the heart and the cardio-inhibitory centre in the medulla is still intact, the contractions of the auricle are slowed, or they entirely cease after the injection of the extract. The ventricle continues to beat slowly. The pulse is necessarily very slow. But if the vagi are cut or their cardiac ends paralyzed by atropine, the effect of the extract is exactly the reverse. The auricle is more energetic in its contractions, both their strength and frequency being much increased, while the functions of the ventricle are likewise augmented. All of these phenomena cause a great increase in blood pressure by sending a much larger quantity of blood into the arteries. But besides this, the extract has a direct effect on the arteries themselves, for if the blood pressure be taken in a dog and then a small injection of the extract be made, the vagi being uncut and therefore the heart action being slowed, the blood pressure increases to quite an extent; but if the vagi are cut or paralyzed by atropine, the rise is extreme. If a certain member of the body be enclosed in a plethysmograph, the effect of the extract is clearly shown in the decrease of the member in size, due to the contraction of the arterioles. This effect is exerted directly on the musculature of the vessels, since it appears as markedly when the spinal cord is cut or the bulb extirpated. Schäfer does not believe in the view of Cybulski and Szymonowicz, that the rise in blood pressure and the contraction of the arteries are due to the excitation of the vasomotor centre; for, as his experiments show, this effect is peripheral. In the bulb he states that especially the cardio-inhibitory and respiratory centres are affected. In certain experiments on dogs the first effect of the extract has been excitement, this being followed by paralysis, while great thirst was experienced by these animals. In cats, rapidity of the respiratory movements was noticed, as well as thirst and loss of appetite. Recently strong astringent properties have been observed. As a local styptic it has given potent effects. Meyers, in experiments with various organs, discovered that the adrenal body is alone found capable of neutralizing cobra poison. Guinea-pigs and sheep give the same results. The medulla is found inactive, the cortex and the entire gland active. Oliver has demonstrated that the extract when applied directly to the mesenteric vessels, either in the living or in the "surviving" animals, causes rise of blood pressure. Von Cyon, in reviewing the different theories of various workers, states that they all agree as to the increase of blood pressure caused by the intravenous injection of the adrenal extract, but not as to the influence which it exerts on the heart action. Oliver and Schäfer think this latter due to the excitation of the musculature of the small arteries, as well as of the heart vagi. Cybulski and Szymonowicz think that the extract has a special influence on the vasomotor centre of the vessels. Gottlieb believes the motor heart ganglia to be chiefly affected. Von Cyon himself believes that the extract of the adrenal gland acts in a high degree as a stimulant to the sympathetic nervous system of the heart and the vessels (accelerantes and vaso-constrictors) and also as a paralyzer to the regulatory (motor) nerves of these organs (vagus and depressors). So this extract is a powerful antagonist of iodothyrin and hypophysin. Schäfer describes the effect of the injection of the extract as quite transitory, even if the dose be large. This fact presents the interesting problem of the disposal of this extract—where is it eliminated? The kidneys are not its route of exit, for when the renal arteries are clamped, the effects are just as fleeting. Just so with the suprarenals. If the circulation in the abdominal organs is entirely stopped by tying the aorta and vena cava in the upper abdomen, the effects are nearly as short in duration. The blood does not oxidize or destroy the active principle of the extract, for after twenty-four hours' contact with this fluid the power of the extract is as great as normal. It seems logical to conclude that the active principle is stored away somewhere in the body and there rendered harmless, and, since the effects endure much longer in the skeletal muscles than in the heart and arteries, that the muscles are the great storage house.

Now as to the effect of the extract when administered hypodermically or by mouth, results by the former method vary exceedingly, depending on the animal experimented on and the dose injected. Oliver says that in man the extract, when given by the mouth, has the effect of reducing the calibre of the arteries, as measured by the arteriometer.

As in every other line of research in relation to these organs, so have there been varied and contradictory results concerning the chemical nature of their active principle. Abel has shown that the "specific blood-pressure-raising constituent" exists in the embryonic gland. At just what stage it first appears has not been determined. Oliver believes that the peculiar properties of this principle are due to an alkaloidal body and not to

the proteid elements. The substance is not dialyzable, consequently its molecule is probably very large. Cybulski, Oliver, Schäfer, and Swale Vincent believe from their work that the active principle is found only in the medulla, and that the cortex yields no appreciable amount. Schäfer and Oliver believe in the internal secretion theory which promulgates the idea that a certain substance is formed by these glands and passed out into the blood, which has a beneficial effect on the muscular contraction and tone of the cardiac and vascular walls and on the skeletal muscles.

Allbutt calls these two theories that we have mentioned, one as the auto-intoxication theory, the other as the internal secretion theory: (1) The excretory or katabolic, which supposes that the adrenals dispose of waste materials in the blood; (2) the secretory or anabolic, which supposes that they elaborate some substance necessary to the animal economy and pass it into the circulation. Other authors, Byrom Bramwell and Boinet, have recently combined the nervous and the "adrenal inadequacy" theories by suggesting that in Addison's disease the symptoms are caused by irritation and neuritis of the sympathetic as well as by the pathological suppression of the extract.

Dreyer, in his work in 1899, has shown again what Cybulski first proved, that the active principle of the adrenal extract can be obtained from the blood of the adrenal vein; consequently it is a true internal secretion. He has further proved the influence of nervous control over the secretion, for if the splanchnic nerve below the diaphragm be stimulated by an electrical current, the amount of this active principle in the secretion is augmented, judging from the increase in the physiological effects caused by the extract. This increase has no connection with the blood vascular changes which take place at the same time. The objection was formerly raised that the active principle was found only in the dead gland, but the proof that blood collected from the adrenal vein, and from no other, has the same effect as the extract itself, establishes the significance of the reactions of the gland. Dreyer has also demonstrated that intravenous injection of the extract in a normal animal causes slowing of the heart and an increase of blood pressure, while after the vagi are cut or atropinized the heart beat is quickened and the blood pressure increases to a still greater degree. From the experiments of Oliver and Schäfer, Swale Vincent, and Dreyer, it would seem that the adrenal secretion is under nervous control. As to the relative importance of the two parts of the gland, Swale Vincent says that "the cortex from a morphological standpoint would seem to be the more important or essential element of the suprarenal gland, for it is always more abundant in amount than the medulla, and is universally present in all animals above the very lowest vertebrates, whereas the medulla appears to be absent in some orders of fishes. In the present state of our knowledge the medulla must undoubtedly be considered as the more important from a physiological standpoint."

The writer wishes to express grateful acknowledgment for the invaluable assistance derived from the perusal of the manuscript of Mr. Flint's very scholarly contribution to this subject. *Emma E. Walker.*

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ADRENALS (PATH.). See *Addison's Disease*

ADRUE. See *Cyperus.*

ÆGLE MARMELOS. See *Bael Fruit.*

AEROTHERAPEUTICS, or PNEUMATOTHERAPEUTICS.—These terms refer to the employment of air as a therapeutic agent. They are generally restricted to the use of air that has been altered in density, by which it is possible to simulate the advantages derived from residence at high or low levels, and increase the functional power of the lungs. The term is sometimes broadened to include medicated air and air that has been altered chemically by increasing the proportion of oxygen, nitrogen, or carbonic acid gas. These latter, however, will be treated in separate articles and under *Inhalations.*

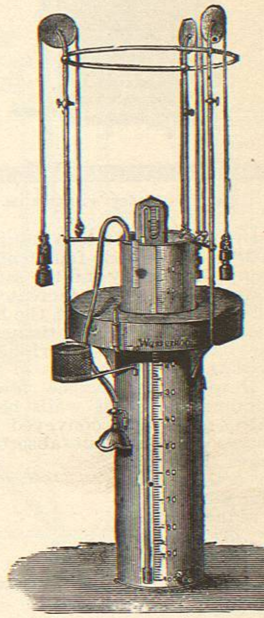

FIG. 50.—Waldenburg's Apparatus for Compressing Air. Natural height is one metre.

Two methods of adapting the air for use are in vogue. In one the patient is placed in a specially prepared chamber in which the density of the air may be increased or diminished; in the other the patient remains under ordinary atmospheric conditions, and inhales through a tube air that has been altered in density.

The pneumatic chamber, as used in the European sanitaria, is an elaborate and costly apparatus. It consists of a large metal, air-tight chamber, capable of seating three or four persons, in which the patient remains for a definite time. The arrangements are such that the air may be slowly or rapidly increased or lessened in density. There are provisions for heating and ventilating, windows through which the patient may be observed during treatment, and electric bells for the convenience of the patient. These chambers are numerous in Europe, and one has been erected at the Brompton Hospital for Consumptives, in London, England.

When the patient is placed in the pneumatic cabinet, the effect of the altered density is directed externally to the surface of the body and internally upon the lungs. The result is much the same as when the patient ascends to a high elevation or descends into a deep mine or in a diving-bell. To prevent the ill effects of a sudden change in pressure, the treatment is commenced under ordinary atmospheric conditions, then the alteration in density is made gradually, and the return to a normal pressure is equally slow. The importance of this has been noted by those in charge of men working in caissons during the construction of large bridges, where all the most distressing symptoms were traced to the workmen who too hastily emerged from the compressed air.

Air in which the density is increased is the form generally employed for therapeutic purposes. The increase is never very great, ranging from one-fifth to one-half of an atmosphere. This degree of compression is free from any danger. In the construction of the St. Louis bridge workmen continued their employment for hours under a pressure of fifty pounds, and others during the construction of the Brooklyn bridge were exposed to thirty-eight pounds, equal to about two and a half atmospheres.

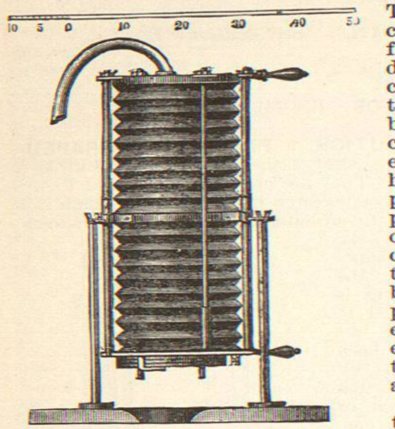

FIG. 51.—Biedert's Apparatus.

The duration of the compressed air bath varies from half an hour to two hours, the first exposures always being of short duration. About one-fourth of the time is occupied in increasing the density and the same period in its reduction. The first effect of the increased pressure is to drive the blood from the surface of the body, and from the lungs, to the deeper organs and tissues. Later, the equilibrium is re-established, the peripheral circulation being increased and the congestion of the deep organs reduced. The respirations become fewer, but are increased in depth, and the chest walls become more mobile. The quantity of oxygen conveyed to the lungs is increased, as is also the amount absorbed by the blood; tissue change becomes more active, and at the same time the kidneys and other organs increase in activity. Although the patient exposed to compressed air derives a certain benefit from the dilatation of the lung tissue and other mechanical effects, its chief value depends upon the increased functional activity of the lungs and the improved tissue change that follows. All forms of congestion are improved, and exudates and other products of inflammation are removed. It is said to be of benefit in early lung congestion, bronchitis, pleuritic effusion, liver disease, and disturbances of other organs accompanied by hyperæmia. In anæmia and chlorosis it is of equal benefit.

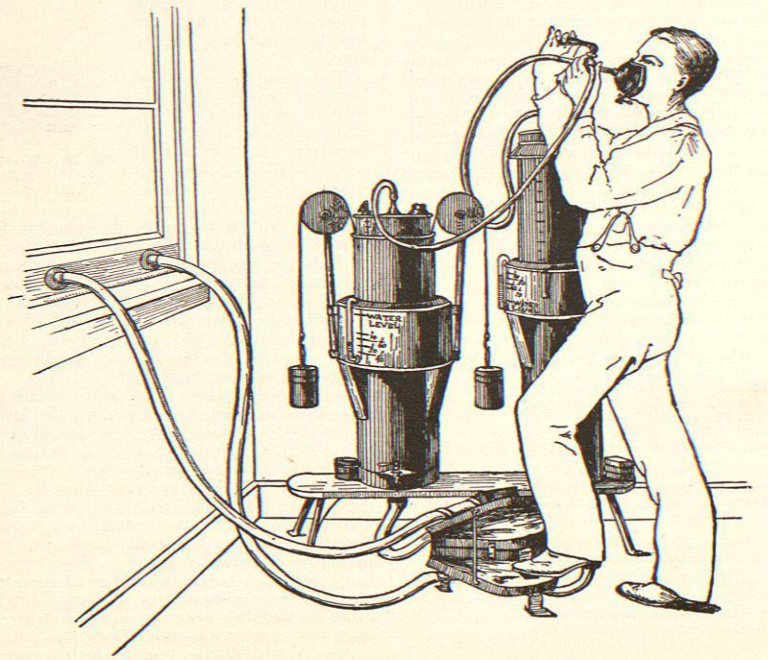

FIG. 53.—Solis-Cohen's Apparatus for Inhaling Compressed Air and Exhaling into Rarefied Air.

Rarefied air in the pneumatic cabinet is employed to a much more limited extent as a therapeutic agent. It does not in any way supply the benefits of residence in high situations. Muscular action of the respiratory muscles, it is true, is increased during respiration, and the patient derives whatever benefit is to be gained from this form of exercise, but the air respired has not the purity or the chemical properties of mountain air, nor does the patient gain the general beneficial effect of living in mountainous regions.

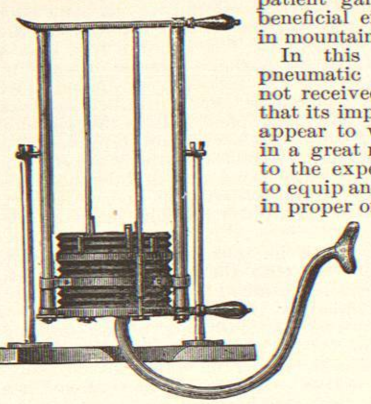

FIG. 52.—The Same, Reversed.

In this country the pneumatic chamber has not received the attention that its importance would appear to warrant. This in a great measure is due to the expense necessary to equip and maintain one in proper order, but what will always hinder its adoption is the success which has attended the employment of the smaller apparatus for inhaling compressed or rarefied air.

This method, which has been termed "pneumatic differentiation," is now adopted very extensively and possesses many advantages over the large chamber. The chief of these is the much greater expansive power of compressed air taken into the lung when the external pressure is that of the ordinary atmosphere. Equally advantageous are the numerous changes that may be made with the compressed air and the rarefied air. The patient may inspire compressed air and expire into the compressed air, or into ordinary atmosphere, or into a second vessel in which the air is rarefied. He may also reverse the order and inspire rarefied air and expire into any media.

A great number of appliances for carrying out this method of inhalation have been made, some of them being extremely complicated. Two principles prevail in their construction. In one the ordinary gasometer is the guide, in the other it is a bellows or an accordion. The best

examples of these two systems are the instruments known as Waldenburg's and Biedert's.

In Waldenburg's apparatus the alteration in the density of the air is controlled by a system of weights and pulleys. There is also attached a gauge to indicate the degree of compression. Biedert's apparatus is constructed like an accordion and is suspended by a bar at its centre upon which it may be rotated. The tube for inhalation is attached at one end and the weights at the other. When the weight is uppermost the air in the apparatus is compressed; when the instrument is reversed and the weights are below, the chamber is expanded and the air becomes rarefied.

Prof. Solomon Solis-Cohen, who has done much to make known in this country the value of compressed air, has devised an instrument that is much superior in every respect ("Hare's Therapeutics," 1891, vol. i., 796). It is a modified Waldenburg gasometer, with a bellows attached, which is worked by the foot of the physician. The bellows maintains a constant supply of fresh air, and the combination of the two systems allows a reduction to be made in the size of the cylinder. The instrument is small and compact, and may be conveyed to the house of the patient without any inconvenience. He has also arranged twin cylinders (Fig. 54), in one of which the air is compressed and in the other rarefied; to this is attached an ingenious inhaler by means of which the patient may inspire from one cylinder and expire into the other without removing the mask from the face. For hospitals and large institutions a system of cylinders may be arranged for a number of patients to receive treatment at the same time, the pressure being derived from the ordinary water-supply pipe.

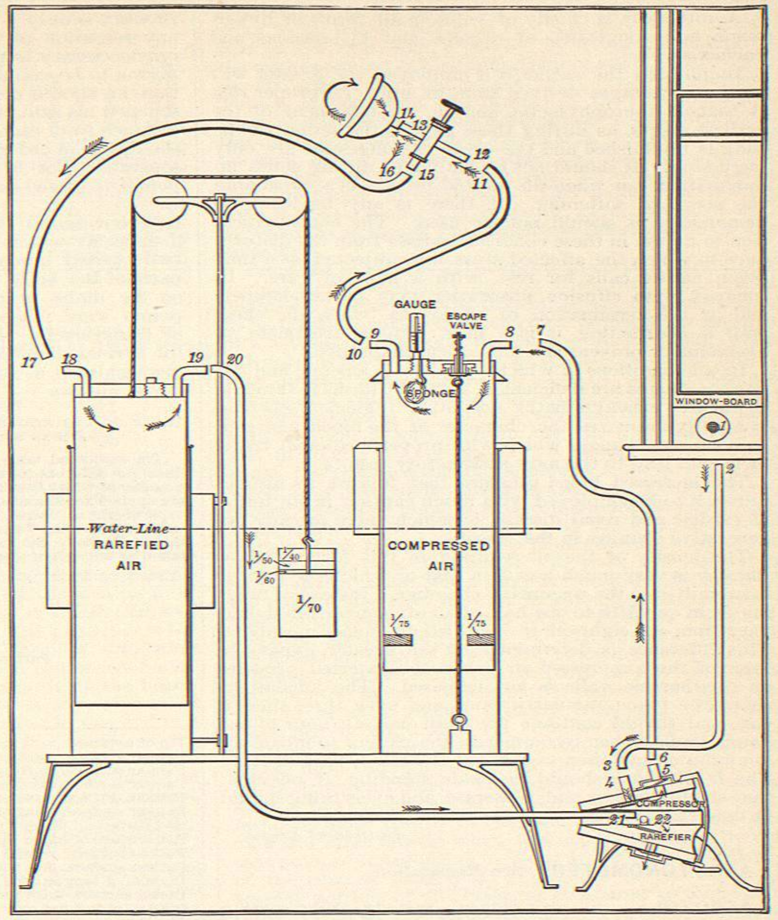

FIG. 54.—Section of the Same. Figures and arrows indicate the course of the current of air.

A small-sized pneumatic cabinet has been used by Drs. Martin and Johnson (New York *Medical Journal*, May 15, 1886). In this the patient is placed, and while the pressure in the cabinet is changed, he inhales, through a tube, air of a different density. The pressure in the cabinet is very easily controlled, and by means of a lever it may be increased or diminished with the respirations of the patient, aiding the expansion of the chest walls during inspiration, and compressing them during expiration.

The inspiration of compressed air is performed with ease, and the chest walls are expanded in a marked degree. The quantity of air in the lungs is greatly increased, and during expansion of the chest the alveoli and air cells are distended. The expiration is equally free, the rebound of the elastic structures forcing out a large proportion of air. If the expiration is into rarefied air, that remaining in the lungs is much less than the normal; and if the breathing is continued, it increases the flow of tidal and complemental air, and lessens the proportion of residual air. The distention of lung tissue extends to cells that have been rendered weak by disuse and to others that have been disabled by disease. On the former the effect is always beneficial, but upon the latter the advantage is not so certain. In many cases it restores to functional activity cells that have been blocked by secretions, but in others it may render active disease that is quiescent and improving. Upon the circulation, the effect is to increase the blood pressure and to render the flow of blood through the organs more rapid. The increased supply of oxygen also improves the quality of the blood. The physical effects are more or less modified by the media into which the patient expires. If the air is returned against the compressed air, an expiratory effort is required, during which many muscles are brought into action, and the elasticity of the lung tissue is exercised. If the medium into which the lungs empty themselves is other than the compressed air, the muscular effort is less, but the contraction of the lung tissue is much greater than under ordinary conditions. The value of these changes as a gymnastic exercise is very evident, as it adds to the vital capacity and increases the functional activity of the lung.

In pneumatic differentiation as in the pneumatic cabinet, compressed air is the form generally employed, the object being to increase the amount of air carried to the lungs. Rarefied air is of greater service as a gymnastic agent. During its use the lungs are filled only by a muscular effort; if the patient has sufficient muscular power to secure the larger amount of air required, the effect is beneficial; if not, the supply of oxygen is deficient and the evil results that follow are quickly manifest.

Aerotherapy is chiefly of value in all forms of hyperæmia and congestion of organs, and in anæmias and cachexias.

In phthisis the earlier it is employed the greater will be the advantages derived from its use. Its proper rôle is that of a prophylactic, and in the treatment of the earliest stages, as during these periods the action of the lung is diminished and the areas of congestion are only beginning. It should not be employed during acute inflammation, nor when the morbid process is approaching the stage of softening. If there is any tendency to hemorrhage it should not be used. The contraindication to its use in these conditions arises from the disturbance to which the affected areas are subjected, at a time when nature calls for rest, with a hope of cure. In pleurisy with effusion, absorption may be accelerated; and at the termination of empyema, when the chest wall is contracting, it is a most rational treatment to overcome or prevent the consequent deformity.

In all conditions in which the blood is anæmic and the various organs are deficient in action, it forms a valuable adjunct to massage, baths, and other hygienic measures. It rapidly improves the character of the blood and promotes tissue change, which with proper medicinal treatment will lead to the most satisfactory results.

The increased blood pressure that follows its use requires it to be employed with much caution in all forms of cardiac and renal disease, in which there are any degenerative changes in the vessels.

The density of the air required in this form of aerotherapy is very much less than that to which the patient is submitted in the pneumatic chamber. Instead of ranging from one-fifth to one-half of an atmosphere, it should vary from one-eightieth to one-thirtieth of an atmosphere. This difference is determined by the greater expansive force of the compressed air, when the external pressure on the thoracic walls is not increased. The inhalations should be taken regularly twice and even three times a day, and should continue for from half an hour to one hour. Solis-Cohen recommends the patient to inhale for ten minutes and then to rest for the same space of time. The inspirations should be made standing, if possible; they should be slow and deliberate, and everything should be done to facilitate the expansion of the lung.

Beaumont Small.

AEROTONOMETER. See *Respiration*.

AEROZOL. — A proprietary remedy representing twenty-five volumes of ozone dissolved in certain volatile oils.

W. A. Bastedo.

ÆSTHESIOMETER.—The word æsthesiometer is derived from the Greek *αἰσθάνομαι*, I perceive, *αἴσθησις*, perception, sensation, and *μέτρον*, a measure; thus meaning literally a measure of sensation; and it is used to denote an instrument which measures that form of sensation known as tactile sensibility (*Tastsinn* in German).

Tactile sensibility or the sensations of tactile impressions may be considered as comprising the sensations of touch, of locality or position (*Raumsinn*, *Ortsinn*, in German), and of temperature. The sense of touch is in this sense nothing more than a sense of pressure applied to the skin. These sensations differ in certain important respects from the *general* or *common sensations*, which include pain, sensual pleasure, and perhaps hunger and thirst.

Æsthesiometers, properly so called, are instruments for testing the sense of locality. The first one used, one which under slight modifications still retains its place, is that of E. H. Weber, who, in 1829, appears to have published his first account of his investigations in regard to the sense of locality. The instrument had probably, however, been for some time in use at that date, for in 1846 he refers to its use twenty years ago. It consisted simply of a pair of compasses with cylindrical arms, the points of which were so ground down that their ends had a diameter of one-third line, so that they should produce simply a sensation of touch and should avoid any sensation of pain. To use this instrument it was only necessary to place the two points upon the skin of the person to be examined, care being taken at the same time that he should not see whether both points or only one touched his skin, and by examination to find out at what distance from each other it was necessary that the points should be in order that they should be distinctly felt as separate. For in any portion of the skin two distinct points, if placed near enough together, will be felt as only one.

Weber found that the sense of locality, that is, the distance at which the points could be distinguished as two, varied much in healthy individuals in different parts of the body, and varied also somewhat, especially on the limbs, according to the direction in which the points were placed, whether longitudinally, obliquely, or transversely. His figures and those of Valentin for the normal distance between two points, which can be distinguished as such in the various parts of the body, are as follows:

Table of Variations of the Sense of Locality in Different Portions of the Skin (Weber and Valentin).

[The subjoined table gives the mean minimum distances (in Paris lines) for different parts of the body between the points of the æsthesiometer at which two impressions can be distinguished when the points are applied simultaneously. The first column gives the results of the experiments of Weber, the second of those of Valentin, while the third column (also from Valentin) gives the relative obtuseness of each portion of the body, the most delicate part, the tip of the tongue, being taken as the unit of measurement.]

Part of Surface.	Weber.	Valentin.	
		Mean.	Relative obtuseness.
Tip of tongue	0.50	0.483	1.000
Palmar surface, third phalanx of forefinger	1.00	0.603	1.248
Palmar surface, third phalanx of middle finger	1.00	0.706	1.462
Palmar surface, third phalanx of ring finger	1.00	0.723	1.497
Palmar surface, third phalanx of thumb	1.00	0.725	1.501
Palmar surface, third phalanx of little finger	1.00	0.733	1.518
Red surface of under lip	2.00	1.500	3.106
Red surface of upper lip	2.00	1.520	3.147
Palmar surface, second phalanges of fingers	2.00	1.558	3.226
Palmar surface, first phalanges of fingers	....	1.650	3.416
Dorsum of tongue (one inch from tip, Weber)	4.00	1.916	3.967
Dorsal surface, third phalanges of fingers	3.00	2.125	4.400
Portion of lips not red	4.00	2.208	4.572
Tip of nose	3.00	2.250	4.658
Edge of tongue, one inch from tip	....	2.478	5.130
Palmar surface of the metacarpus (capitula ossium)	3.00	2.625	5.434
Lateral surface of dorsum of tongue	....	2.500	5.176
End of great toe (plantar side of last joint, Weber)	5.00	3.250	6.729
Metacarpal joint of thumb	4.00	3.333	6.901
External surface of eyelids	5.00	3.833	7.936
Palm of hand	5.00	3.833	7.936
Dorsal surface of second phalanx of thumb	5.00	3.893	8.660
Dorsal surface of second phalanx of forefinger	5.00	3.893	8.060
Dorsal surface of second phalanx of middle finger	5.00	3.900	8.075
Dorsal surface of second phalanx of little finger	5.00	3.943	8.163
Dorsal surface of second phalanx of ring finger	5.00	3.971	8.221
Centre of hard palate	6.00	4.042	8.369
Mucous membrane of lips near gums	9.00	4.125	8.540
Skin of cheek over buccinator	5.00	4.541	9.402
Skin of cheek over anterior part of malar bone	7.00	4.620	9.565
Dorsal surface, first phalanges of fingers	7.00	4.917	10.180
Prepuce	....	5.100	10.559
Dorsal surface of heads of metacarpal bones	8.00	5.250	10.869
Cheek, over posterior part of malar bone	10.00	5.286	10.944
Plantar surface of first metatarsal	7.00	5.875	12.164
Lower part of forehead	10.00	6.000	12.422
Back of hand	14.00	6.966	14.423
Lower part of hairy scalp in occipital region	12.00	8.292	17.168
Surface of throat beneath lower jaw	15.00	8.292	17.168
Back of heel	10.00	9.000	18.634
Pubes	....	9.200	19.048
Crown of head	15.00	9.583	19.840
Patella and surrounding parts	16.00	10.208	21.135
Areola around nipple	....	12.066	24.982
Dorsum of foot, near toes	18.00	12.525	25.932
Axilla	....	13.000	26.915
Skin of forearm (upper and lower extremities of forearm, Weber)	18.00	13.292	27.520
Back of neck (over spinal column, Weber)	24.00	13.292	27.520
Upper and lower extremities of lower leg	18.00	13.708	28.381
Penis	18.00	13.850	28.675
Acromion and upper part of arm	18.00	13.886	28.708
Sacral region	18.00	14.958	30.969
Sternum	20.00	15.875	32.867
Gluteal region	18.00	16.625	34.420
Middle of arm	30.00	17.083	35.368
Middle of thigh	30.00	17.633	36.507
Spine near middle of cervical vertebræ	30.00	18.542	38.389
Spine near fifth dorsal vertebra	24.00	19.000	39.337
Lower part of thorax, and over lumbar vertebræ	24.00	19.912	41.225
Middle of dorsal vertebræ	30.00	24.208	50.120

Foster gives the following figures in millimetres obtained by the use of a pair of compasses (a Paris line equals 2.256 mm.):

Tip of tongue	1.1	mm.
Palmar surface of terminal phalanx of finger	2.2	"
Palmar surface of second phalanx of finger	4.4	"
Tip of nose	6.6	"
White part of lips	8.8	"
Back of second phalanx of finger	11.1	"
Skin over malar bone	15.4	"
Back of hand	29.8	"
Forearm	39.6	"
Sternum	44.0	"
Back	66.0	"

Weber's æsthesiometer is still in constant use, and serves its purpose well, but certain other forms or modifications have been introduced. In 1858 Sieveking published the account of his æsthesiometer in the *British and Foreign Medico-Chirurgical Review*. The principle is the same as that of Weber's, but the form is somewhat altered. Instead of using the common compasses Sieveking has made his instrument in the form of the beam-compass used by mechanics; that is to say, of a solid graduated bar of metal, which terminates at one end in a point running at right angles to the bar, while on the bar slides another point of horn or ivory, which can be fixed at any desired distance from the first by means of a screw on top. A modification of Sieveking's æsthesiometer has been made by Brown-Séquard, who has apparently made both the bar itself and the points lighter, and has done away with the screw at the top of the movable point. In his instrument the points are of steel, and there is a roughened prominence on the side of the second point to enable it to be readily moved by the finger or thumb (see Fig. 55). Nearly all the æsthesiometers at

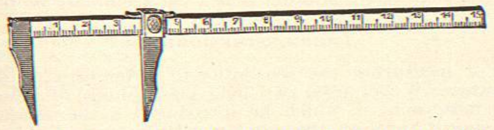

Fig. 55.—Brown-Séquard's Æsthesiometer (reduced in size).

present used are modifications of these two forms. Hammond's convenient little instrument is a modification of Weber's, consisting essentially in allowing the index bar to swing on a rivet fastened to one arm of the compass, the bar, while in use, being held by a catch on the other arm, in which it slides freely. When not in use, it can be lifted from the catch and swings into approximation with the arm to which it is fastened, so that the whole instrument, when closed, occupies but little space and can readily be carried in the pocket. Carroll's instrument is simply a compass, each arm of which ends in two points, one blunt and one sharp, either of which can be used as desired; while Vance's is an arrangement of compass with flattened arms, which shuts up in a case like a penknife.

The delicacy of the sensation of space in various parts of the skin may be tested by the æsthesiometer in two ways. In the first place, as mentioned above, by determining how far apart the points must be placed in order to be felt distinctly as two separate points in any part of the skin; and, secondly, by fixing the points of the æsthesiometer at a certain distance apart and moving the instrument from one portion of the body to another. Thus it is found that the distance of the two points appears to increase when the æsthesiometer is drawn from the cheek horizontally over the mouth, one point resting on each lip, to the median line, and that if continued across that line to the other cheek, the distance appears proportionately to diminish. This method of testing with the æsthesiometer is, however, of no practical use, as we have no means of measuring the strength of our sensations.

From the numerous experiments made in regard to the normal tactile sensibility the following results have been deduced: 1. The points of the æsthesiometer always seem to be farther apart when one point is placed on one side of a natural opening and one on the other. Thus, when one point is placed on the upper lip and one on the lower, they appear farther separated than if both points are placed in a corresponding position on either lip. This in part accounts for the increase apparent when the æsthesiometer is moved from the cheek to the median line in Weber's experiment. 2. Other things being equal, the points of the æsthesiometer seem farther apart when they rest upon different tissues. Thus, for example, when one point is placed upon the mucous membrane of the lip and one point upon the skin, they seem farther apart than when both points are upon either the skin or the mucous membrane. 3. As a rule the points seem farther apart when they are on different sides of the median line than they do in corresponding positions when both are on the same side. This law does not, however, always hold good. 4. The direction in which the points are placed in relation to each other is of considerable importance in certain parts of the body, especially on the limbs. When placed transversely they appear to be at a greater distance from each other than when placed longitudinally. On the body proper there seems to be but little difference, while it is more marked on the face, and more so still on the limbs, especially the lower arms and legs. The cause of this is as yet unknown, but it may be that the skin over different muscles responds more readily to two stimulations than the skin over the same muscle when touched at two equally distant points. (According to Vierordt the relative delicacy of the sense of locality at any point on the skin of a special portion of the body, as compared to that of the other points of the same portion, is a function of its mobility, and increases proportionately to its distance from the axis on which that part moves, since it depends on the relative greatness of the excursions which it effects about its axis through the movements of the part concerned.)

In applying the æsthesiometer certain precautions should always be observed. In the first place, the operator should take especial care that both points are applied as nearly as possible *simultaneously*, as the element of time enters distinctly into our tactile impressions, and the greater the time which elapses between any two impressions of a similar kind, the more readily are such impressions recognized as distinct. For this reason, also, the points, when once applied, should not be moved, for if they be moved, a new sensation, or a series of sensations, will be produced, which will enable us to interpret the impressions more easily. It is a curious fact that, if two points be placed so near together that they are felt as only one, and a third point be drawn across the skin between the two, the sensation of a moving object can be felt, although its position cannot be localized. The impression produced by the points, moreover, becomes clearer the longer they remain in contact with the skin. Hence, in making comparative observations, the points should be held on each place for the same amount of time. In addition to the simultaneousness of the touch the pressure at the two points should be as nearly equal