course becomes less and less complete, and is extinguished long before the time usual in the normal condition of things. When the inflammation reaches its highest point the pain is great, and any attempt to move the organs causes exquisite suffering. When the inflammation reaches the highest point, it remains nearly stationary for several days. The gonorrhœal discharge, or the gleet, usually ceases when the inflammation begins, and to its disappearance the patient attributes the development of the trouble in the testes. Professional opinion formerly acquiesced in this view, and to a limited extent this may be admitted; but it is to the migration of the gonococcus and the development of colonies of micrococci that the extension of disease is due.

DISEASES OF THE NERVOUS SYSTEM.

CLINICAL EXAMINATION — MODES OF ASCERTAINING THE STATE OF THE NERVOUS APPARATUS.

Cerebrum.—The examination into the functions of the cerebrum includes the study of the mental condition, of the organs of special sense, and of the state of common sensibility in the area of distribution of the sensory nerves supplying the head and face.

The *intra-cranial circulation* is investigated through the facial vein, and the appearance of the membranum tympani and the retina. When an obstacle to the intra-cranial circulation exists sufficient to compress the cavernous sinus, the conjunctiva is injected, the eyelids swollen, and the nasal mucous membrane is congested and bleeds readily. These results come from the anatomical connection between the facial vein and the pterygoid plexus of veins. When there is cerebral congestion, or anæmia, the membranum tympani exhibits a more or less vivid redness, or an appearance of pallor.

Ophthalmoscopy.—The retinal circulation being a diverticulum of the cerebral, valuable information is gained by ophthalmoscopic examination. The ophthalmoscope used for this purpose should be a metal concave mirror, of ten or twelve inches focus, with a revolving disk behind it provided with ocular glasses. Loring's or Knapp's are well suited to this purpose. The observer should be provided also with two convex object glasses, having two to four inches focus, and a concave lens—the latter for the direct method of examination.

Both the *direct* and *indirect* methods of examination are to be employed, as a rule. In the former the eye-ground is illuminated by

the mirror, and the observer, seated close to the patient, looks through the pupil down on the retina, as one would look into a closed room through the key-hole of the door (upright image). In the indirect method (inverted image) the light is thrown into the eye as before, but a double-convex lens, held between the thumb and index-finger, is interposed in front of the eye under examination, the hand being supported by the little finger resting on the patient's forehead. In this way the focus can be readily adjusted.

The simplest appliances suffice for such ophthalmoscopic examination as may be required in ordinary clinical work. A small kerosene-oil lamp will furnish the light, or, in the absence of this, a candle even may be utilized for the purpose. Although such an examination will not be sufficient for any important scientific purpose, it will afford more or less valuable insight into the condition of the intracranial organs, and suggest the course for future and more accurate investigation.

The changes occurring in the retina or the "eye-ground" will be mentioned hereafter in connection with the maladies of the brain.

Impairment of vision, amblyopia, amaurosis, hemiopia, diplopia, etc., alterations of the accommodation, deviations of the ocular globe from paralysis or spasm of the eye-muscles, the size and sensitiveness of the pupil, may be symptomatic of intracranial disease, and will be discussed in their proper relations.

Otological examinations are necessary in all cases of cerebral disease, whether or not the ear appears to be directly affected. It has already been stated that the condition of the intracranial circulation may be ascertained by an inspection of the *membranum tympani*.

The hearing power can be measured by the ticking of a watch, by the tuning-fork, and by the voice. The distance from the ear the tick of a watch can be heard by the normal individual, is the standard with which the hearing power is to be compared. For example, if the watch-tick is audible by the normal ear at a distance of six feet, and by the diseased ear at one foot, the hearing power would be stated as $= \frac{1}{6}$. The voice is a more accurate measure, and the hearing should be tested by distinct tones, and by whispering at a specified distance. The tuning-fork (of the note C) is used more especially to determine the condition of the auditory nerve, and is placed in contact with the incisor teeth or forehead. If the patient is deaf to the watch-tick and voice, he may still hear the tuning-fork, showing that the difficulty is in the sound-conducting apparatus, and not in the nerve, which yet transmits the sound vibrations.

The apparatus required for the investigation of the auditory complications in cerebral diseases is, besides those mentioned above, a suitable ear speculum, and a concave mirror with a central hole, and attached to a convenient handle with a universal joint.

The condition of the hearing power comes into relation to various intracranial diseases, such as tumor, abscess, meningitis, etc. Lesions of certain parts of the ear cause symptoms of cerebral disease—for examples, Menière's disease or labyrinthine vertigo, etc.

The electrical reactions of the auditory nerve as determined by the polar method have some diagnostic value.

The *sense of taste* may be studied by placing sapid substances on the tongue, and noting the time when their character is appreciated, or the diminution in acuteness or the entire absence of the sense. The tongue should be well protruded, and the eyes closed. Then, by means of a small spatula, or brush, the substance to be tested is placed on that part of the tongue supposed to be affected, and is allowed to remain until contact with the nerves is assured. Salt, sugar, quinine, and vinegar may be used to determine the appreciation of the saline, sweet, bitter, and acid sensations respectively.

For the electrical reactions, see *post.*

Spinal Cord and Nerves.—The examination of this part of the nervous system includes *sensibility*, *motility*, and the *reflexes.*

Sensibility.—In the absence of special contrivances, sensibility may be tested by the simplest means. With a needle-prick, pinching the

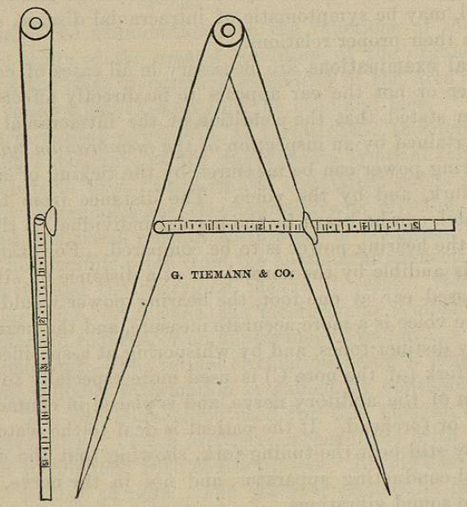

Fig. 47.—Æsthesiometer.

skin, pulling on hairs, the presence or absence of common sensation can be ascertained, and differences noted by comparing symmetrical parts. The faradic current is the best mode of ascertaining the absence of the sense of pain (*analgesia*). In testing in this way, the skin is carefully dried, and some drying powder (infant powder will answer) is dusted over the surface to remove all moisture, so that the current may be limited to the skin. A metallic electrode of small size is then passed over the affected area and the neighboring normal integument. The limits of lessened or absent sensibility to pain are, in this way, exactly indicated, and can be marked out.

The tactile sense is best studied by means of the *æsthesiometer*, an instrument originally devised by Sieveking.* The most convenient form of this instrument is that suggested by Hammond, and shown in Fig. 45. It consists of a pair of dividers, to one arm of which a scale is attached for indicating the distance of the points apart.

Works on physiology contain tables exhibiting the relative acuteness of the tactile sense of various areas. A few of these may be mentioned as a guide. The points of the æsthesiometer can be distinguished as two, at a distance apart—

On the tip of the tongue of	·5	line.
Palmar surface of index-finger	1	"
End of the nose	3	lines.
Palm of the hand	5	"
Back of the hand	8	"
Forehead	10	"
Back of the foot	18	"
Front of the thigh	30	"

Several circumstances affect the results: attention and practice on the part of the patient increase the acuteness. When the points are separated transversely to the direction of the limb, they are more readily perceived than when placed longitudinally; also, when put on one after the other, and when the instrument is moved along the surface.

It is necessary, to secure accuracy, that the patient do not guess; that the points of the instrument be blunted, so that pain may not interfere, and that the temperature of the compass be that of the body, so that the impression of heat or cold may not increase the readiness of perception.

The *sense of temperature* may be ascertained by the application of hot and cold bodies. Test-tubes containing cold and hot water at a known temperature can be put on the affected regions, and the acuteness of perception compared with that of normal parts.

Allochiria is a peculiar state in which the patient is unable to say on which side he has been touched, or refers the sensation to the wrong side.

The *sense of pressure and of weight* is determined by placing

* "The British and Foreign Medico-Chirurgical Review," January, 1858, p. 251.

weights on the part to be tested, superimposed, so that the least difference can be noted. Eulenburg* has invented for this purpose an instrument called the *baræsthesiometer*, which is a spring having a graduated scale attached, on which are registered varying degrees of pressure. Ordinary brass weights, or bits of metal of definite weight, can be used for this purpose. They must be sufficiently varied to permit a nice discrimination between the sense of the normal and of the diseased part.

Rate of Conduction of Sensory Impressions.—In diseases characterized by impaired sensibility, the rate at which impressions move to affect the sensorism is below the normal, and when hyperæsthesia exists it may be above. In some cases the retardation may be sufficient to be recognized by ordinary means, but usually very delicate apparatus is necessary to determine the time. The various modes of sensibility may be interrogated in turn—touch, pain, taste, vision, and hearing.

Motility.—The motor mechanism to be studied embraces the voluntary and the automatic.

The gait of the patient should be carefully observed—in walking, running, standing on leg, etc. The movements of the hands in writing, in touching the tip of the nose with the eyes closed, in buttoning clothing, etc., should be watched, and deviations from the normal noted. Weakness of the hands can be measured by means of the dynamometer (Fig. 46); and by the dynamograph (Fig. 47), tremors, unsteadiness, early fatigue of the muscles, may be represented graphically. In using the dynamometer the spring is grasped in the hand, and the whole strength that can be put forth is measured on the graduated scale of the instrument.

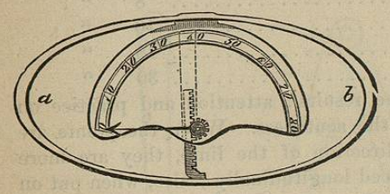

Fig. 48.—Dynamometer.

The automatic movements to be observed are those of the iris, of the respiration, and of walking. The mechanism of locomotion is governed by a voluntary and automatic regulator. The effect of disease in this locomotive apparatus is seen in the character of the gait. For example, the gait of ataxia, the reeling movement in disease of the cerebellum, and the ataxia and reeling combined in affections of the peduncles of the cerebrum.

Electric Excitability.—In determining the state of the voluntary muscles, both faradic and galvanic excitation must be employed. In electrical stimulation we possess the best means of ascertaining the

* "Lehrbuch der functionellen Nervenkrankheiten," etc., Berlin, p. 17.

state of the muscles. The applications of the electrodes are *labile* and *stabile*, *direct* and *indirect*—labile, when the electrode is moved over the surface under examination; stabile, when kept in one position; direct,

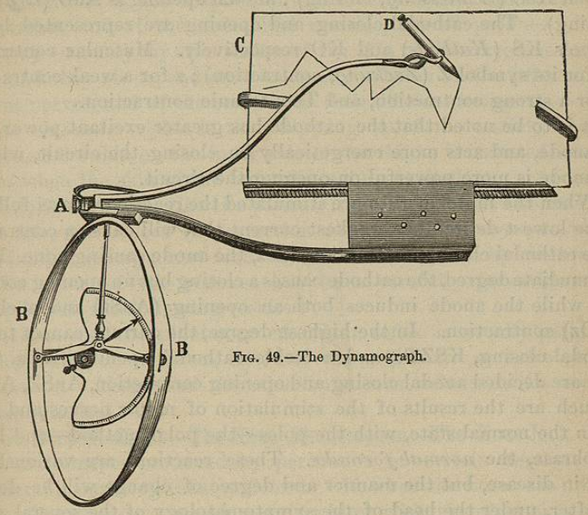

Fig. 49.—The Dynamograph.

when the electrodes are applied to the muscle to be tested; indirect, when the muscle is stimulated through the motor nerve supplying it.

When the muscles are healthy, the weakest current that can induce a muscular contraction will have an equal effect whether the motor nerve or the muscle be stimulated. In using the faradic current for determining the state of the voluntary muscles, only the weakest current that will cause contraction should be used. An increase in the readiness of response may be noted; more frequently there ensues a quantitive decline, and it is found that not only are stronger currents required to bring about a contraction, but that with a current of definite strength the contraction produced is feebler than in health.

The excitability to the faradic current may entirely disappear, and no strength of current cause any contraction.

In using the galvanic current, it must be remembered that muscular contractions ensue on opening and closing the circuit. There is a well-defined law of muscular action under the stimulus of the galvanic current; it is called the *normal formula*, and the method by which it has been ascertained is designated the *polar method.* Certain symbols in imitation of the chemical have been agreed on as a means of giving ready and precise expression to the data. The polar method consists in the application of the pole, the reactions to which are to be

determined, to the nerve or muscle, while the other rests on any indifferent point, as the sternum, thigh, etc. Closing the current by the application of the anode is anodal closing, and is represented by the symbol AnS (*Schliessung*, closing) ; anodal opening is AnO (*Oeffnung*, opening). The cathodal closing and opening are represented by the symbols KS (*Kathode*) and KO respectively. Muscular contraction has for its symbol Z (*Zuckung*, contraction) ; z for a weak contraction, Z′ for a strong contraction, and Te a tetanic contraction.

It is to be noted that the cathode has greater excitant power than the anode, and acts more energetically on closing the circuit, whereas the anode is more powerful on opening the circuit.

When the motor nerves are stimulated the reactions are as follows : In the lowest degree, the weakest current that will cause a contraction is the cathodal closing contraction, KSz, the anode causing none. In the intermediate degree, the cathode causes a closing but no opening contraction, while the anode induces both an opening (AnSz) and a closing (AnOz) contraction. In the highest degree, the current causes tetanic cathodal closing, KSZTe, and a feeble cathodal opening, KOz, while there are decided anodal closing and opening contraction, AnSZ, AnOZ.

Such are the results of the stimulation of motor nerves and muscles in the normal state, with the poles—the polar method—and hence the phrase, the *normal formulæ*. These reactions are variously altered in disease, but the manner and degree of change will be defined hereafter, under the head of the symptomatology of the several affections concerned.

The Reflexes.—To every reflex action the following mechanism is necessary : A point of perception of the impression or irritation ; afferent fibers of communication ; the center ; efferent fibers for transmitting the reaction outwardly. The reflexes may be deranged in two ways : they may be heightened or exaggerated—*reflex hyperkinesis ;* they may be wanting—*reflex akinesis.* The cutaneous reflexes are those due to irritation of certain parts of the integument, followed by muscular contractions in areas anatomically associated therewith. They have, consequently, a high degree of significance, and are of great importance as a means of ascertaining the condition of the spinal centers. The deep reflexes consist of muscular contractions, caused by percussion of the muscles or of their tendons. They have even higher significance than the cutaneous reflexes.

The *eye reflexes* to be observed are the closure of the lids on irritation of the conjunctiva, and contraction of the pupil on exposure to the light. The movements of the iris may be studied as follows: Closing one eye, the outspread hand is passed in front of the other eye. The shadow thus caused sensibly affects the healthy iris. The rate and degree of movement, or the absence of movement, should be noted.

The *palmar reflex* consists in contraction of the fingers on tickling

the palm, but this can be seen only in infants, or in adults during sleep or unconsciousness, since the brain in activity exerts a controlling inhibitive influence on the spinal reflexes.

The *reflexes* of the scapula, of the erector spinal muscles, of the epigastrium, and of the abdominal muscles, are all produced in the same way—namely, by stimulation of the skin of these regions respectively, and they all depend on a normal condition of the afferent and efferent nerves, and of the center, for their efficient action.

The *cremaster reflex* is that drawing up of the testicle which is seen when the skin on the inner side of the thighs is irritated, and the *gluteal* when the skin of the buttocks is duly excited.

The *plantar reflex*, like the palmar, is produced by tickling the skin of the sole, and is seen in perfection when disease above cuts off the dorso-lumbar enlargement from the inhibition exerted by the brain.

The value of the reflexes has been carefully investigated by Knapp,* with the following results :

" Absence of the plantar or cremaster reflex is usually pathological, depending on a direct lesion of the reflex arc or some cerebral disturbance. Absence of the other cutaneous reflexes is not necessarily pathological."

The Deep Reflexes—The Knee Phenomenon—The Knee-Jerk.—The clonic movements produced by percussion of certain tendons have considerable pathological significance. If, when the knees are crossed, the patellar tendon is struck a smart blow with the ulnar side of the extended hand, or with the percussion hammer, a sudden extension of the foot takes place, caused by contraction of the thigh extensor muscles. This is called the " knee-jerk," and in health is very rarely absent. The explanation of this phenomenon is not yet agreed on, but by most observers it is regarded as a reflex. Although opinions may differ as to its nature, there can be no question of the value of this sign. In certain states of disease the knee-jerk is present in an exaggerated degree ; for example, when the cerebral inhibitory influence is withdrawn by disease of the pyramidal tract ; when an irritative state of the gray matter or of the efferent and afferent nerve fibers exists. The knee-jerk is absent whenever there are destructive lesions in any part of the reflex arc, as in posterior spinal sclerosis, in disease of the anterior cornua, and of the efferent fibers of the anterior roots, and when the inhibitory action of the cerebrum is increased.

The *ankle clonus* is another significant pathological sign, the presence of which can be made manifest in healthy persons only after preparation which has aptly been termed *sensitizing*. To induce this " sensitized " condition in healthy individuals, the leg is flexed on the thigh at an acute angle, the weight of the leg resting on the ball of

* " Observations on the Cutaneous and Deep Reflexes." By Philip Coombs Knapp, A. M., M. D. (Harvard). " The American Journal of the Medical Sciences," April, 1885.

the great toe, the heel raised from the floor. If now the top of the knee be struck a smart blow with the edge of the hand, and some voluntary motion be given to the limb in this position, a rhythmical movement, clonic spasm—the ankle clonus—will then go on independently. This movement is due to clonic contractions of the gastrocnemius, resulting in alternate elevation and depression of the knee and heel. In certain diseases, as lateral sclerosis, the ankle clonus is produced without preparation. If the heel is held in the operator's left hand, while the right puts the foot into the position of dorsal flexion by pressure on the ball of the great toe, the ankle clonus will then appear on tapping smartly the top of the knee. The clonus consists in rhythmical contractions and relaxation of the muscle, and consequent elevation and depression of the toes.

ACUTE AND CHRONIC NERVOUS DISEASES.

CEREBRAL HYPERÆMIA.

Definition.—*Cerebral hyperæmia*, or cerebral congestion, is a malady characterized by an increase in the amount of blood in the brain. The hyperæmia may be arterial, or *active;* venous, or *passive.*

Causes.—Any condition diminishing the amount of arterial blood in other parts will divert a larger quantity to the cranial cavity: compression of the abdominal aorta, ligation of an important artery, are examples. The suppression of an habitual discharge of blood—as that of hæmorrhoids, for illustration—is alleged to produce the same effect. Cerebral congestion occurs in the cold stage of an ague, and is also produced by the application of cold to the surface of the body. Prolonged intellectual effort, insolation, or sunstroke, protracted wakefulness, over-indulgence in alcoholic beverages, and the use of such narcotics as belladonna, are supposed to induce congestion of the brain. Hypertrophy of the heart, fullness of the general vascular system, and general plethora, are also alleged to have this effect, but grave doubts may well exist on this point. Passive congestion is produced when there is an obstacle to the return of blood from the cranial cavity, as when the superior *vena cava* and the jugular are compressed by intra-thoracic or cervical tumors, or when the venous system is overfilled by mitral or tricuspid disease. Venous stasis is also caused by atheromatous degeneration of the arterial tunics, feebleness of the cardiac contractions, and lowered vascular tonus.

Pathological Anatomy.—There are no structural changes beyond

an increase in the amount of blood, the displacement of a corresponding amount of cerebro-spinal fluid, and mechanical compression of the cerebral matter. The veins of the dura mater are distended, but still more those of the pia mater and choroid plexus. The sinuses are also overfilled. The convolutions are somewhat flattened, and the perivascular lymph-spaces are closed by the approximation of their walls. On section, more blood than normal flows out of the divided vessels, and the *puncta vasculosa* are more numerous. If the hyperæmia is of long standing, or if repeated attacks have occurred, the changes are more pronounced. The veins enlarge and become varicose, and small arteries previously invisible come into permanent view, and aneurismal dilatations form on the arterioles. There may be minute extravasations and capillary hæmorrhages, the evidence of which is afforded in old cases by pigment deposits and blood-crystals in the lymph-spaces. Transudations of serum may occur in the subarachnoid spaces and in the ventricles, and also in the perivascular sheaths, whence it follows, in old cases, that permanent dilatation of these spaces may have occurred, producing the *état criblé.*

Symptoms.—There are three well-marked forms of cerebral hyperæmia—the *light*, the *severe*, and the *apoplectic* (Jaccoud). In the light form the onset is gradual, and among the first symptoms is headache, which is soon followed by characteristic signs: the headache is dull and heavy, with occasional sharp, lancinating pains, increased by motion or sudden shocks, or by light and sound; there is inaptitude for any mental effort, and the attempt to exercise the mind causes a sense of cerebral exhaustion; there is singing in the ears, with other subjective noises; the conjunctivæ are injected, the retina is sensitive to light, and there are flashes of light and moving objects before the eyes; the sleep is fitful and unrefreshing, and disturbed by dreams of a terrifying kind; vertigo occurs, and the muscular movements are uncertain and fatiguing; the sensations are disordered, and numbness and tingling are felt in the extremities; the stomach is uncertain, and nausea is often experienced; and the heart is exceedingly irritable, the pulse rising considerably with the least mental or physical effort or emotional excitement.* The *severe form* may develop out of the light, or it may come on without any prodromic symptoms. As compared with the light form, we find the headache is more intense; the special senses are more irritable and intolerant of light and sound; the mind more disturbed, ideation more confused, illusions and hallucinations occurring; the wakefulness more obstinate and complete; the motor functions more excited, the movements more irregular and uncertain, jactitations appearing; the sensory functions are more perverted; besides the headache, are neuralgic pains, especially in the

* Hammond, "Cerebral Hyperæmia," p. 48.