EXAMINATION OF THE ORGANS OF RESPIRATION.

Inspection of the Thorax.

Shape.

The thorax displays endless varieties of build in its outline, width, length, depth, and in the shape of the different bones which take part in its formation—the clavicles, sternum, ribs, and vertebral column. Its size is always directly proportionate to the volume of the lungs. A typical, normally-shapen chest is rare. Our conception of such a chest would include perfect symmetry of its two sides, both in circumference and in the form of its constituent parts; a slight arching forward of its anterior walls, beginning immediately below the clavicles, rising gradually to the nipples, and sloping downwards from that point to the lower ribs; the supra- and infra-clavicular regions should be on nearly the same plane as the clavicles, the sternum and vertebral column erect, and the scapulæ placed symmetrically; when the subcutaneous adipose tissue is abundant and the muscles prominent the ribs may not be perceptible in the upper two-thirds of the chest, but only in the lower third, where the muscles are thinner. In men and in virgins the nipple is situated at the level of the fifth rib, sometimes in the fourth intercostal space. Below the fifth rib in men is a deep furrow (Sibson's fold) which marks the lower border of the pectoralis major, especially when this muscle and its fatty covering are well developed. Among the *physiological deviations* from this typical shape may be reckoned the *undue prominence* of certain parts, such as the clavicles, the line of the costo-sternal articulations, and of parts of the sternum itself, especially near the junction of the manubrium with the body of the bone. To this category also belongs increase of the convexity of the ribs on one or both sides, most frequently of the second and third, and particularly towards their sternal ends; this malformation, when it involves several ribs, gives rise to a marked bulging of the middle part of the anterior chest-wall. *Depressions*, also of a physiological character, are sometimes observed in the anterior wall of the thorax, more often affecting the sternum than the ribs, and the lower portion rather than the upper; indentation of the lower end of the sternum is not uncommon among workmen, especially among shoemakers from the pressure of the last.

Pathological changes in the form of the thorax, of a persistent or transient nature, are produced by various diseases of the respiratory organs. These deviations may be arranged in the following groups:

1. *Dilatation* (enlargement, bulging), unilateral or bilateral.
2. *Contraction* (diminution in volume, depression), unilateral or bilateral.
3. *Local depressions*, unilateral or bilateral.

Dilatation of one side of the chest of greater or less extent is brought about by the presence of morbid matters in the pleural sac (fluid, gas, tumours), more rarely by actual enlargement of the lung (hepatization of one entire lung).

The most considerable degree of enlargement, involving the whole of one side, is found in cases of copious pleuritic effusion; a less abundant exudation produces only bulging in the lower part of the thorax, most distinct on the sides and back; when the fluid is but small in quantity it gravitates to the base of the pleural cavity behind, but makes no alteration in the form of the chest.

The first indication of distension of the thorax by pleuritic effusion is *flattening of the intercostal spaces;* subsequently the increase of pressure gives rise to more general and marked enlargement. The levelling of the intercostal spaces is due partly to paralysis of the intercostal muscles from serous inflammatory infiltration, partly to the limited range of movement now possessed by the lung, which is reduced in volume by the pressure and no longer in contact with the thoracic parietes. When the effusion is not so abundant as to fill the pleural sac, but leaves the upper lobes of the lung free to expand and contract, this alteration in the intercostal spaces is confined to the lower part of the chest, while the muscles above the level of the fluid remain unaffected. So long as the exudation makes room for itself at the expense of the lung the thorax is but very slightly enlarged; when the quantity increases to any great extent, however, the augmentation of pressure becomes

more evident in the greater enlargement of the chest and the displacement of neighbouring parts, the diaphragm and the organs immediately beneath it (the liver on the right, the spleen on the left) being forced downwards, the mediastinum towards the opposite side, and the heart, when the effusion is into the left pleura, towards the right side. Thus the long and transverse diameters are greatly increased, even more than is apparent from mere inspection. Should the fluid be absorbed within a short time the chest usually returns to its normal dimensions, but only when the lung recovers its natural expansibility and elasticity.

Accumulation of air in the pleural sac (pneumothorax) has the same effect on the external conformation of the chest as pleuritic effusion, but as it is, as a rule, suddenly developed, either from external injury to the pleura (by gunshot, stabbing, or fractured ribs) or from the bursting of a superficial pulmonary cavity communicating with one of the larger bronchi,* the lung collapses more quickly and completely, and the affected side soon assumes the form which it has after deep full inspiration. *Actual enlargement* occurs only when the air irritates the pleura and exudation takes place, and the pneumothorax becomes a pyo-pneumothorax. If the case progress favourably, and the offending matters pass off by absorption, which does not often happen, the chest regains nearly its normal shape; most usually, however, the original causes of the pneumothorax bring about a fatal termination.

Extensive pneumonic infiltration of the whole of one lung is occasionally accompanied by considerable enlargement of the corresponding side of the chest. Vesicular emphysema of *one* lung can scarcely ever occur to such a marked degree as to alter the form of the thorax on that side; the author, at least, has never seen such a case.

Tumours within the chest (mediastinal tumours, &c.) may also produce very perceptible prominence of the affected side, and of the sternum. Bulging of the lower part of the thorax on the right side is generally owing to tumour of the liver (hydatid, &c.), on the left to swelling of the spleen, on both sides to hypertrophy of both organs or to distension of the abdomen by ascites, gas, or ovarian tumour.

* In some rare cases Pneumothorax has occurred after an empyematous effusion had made its way into one of the bronchi, after the bursting of emphysematous air-cells (Rheder), and after rupture of the œsophagus or stomach into the pleural cavity (Heubner, &c.).

Bilateral enlargement of the thorax is often observed in marked and advanced emphysema of the lungs; in typical cases we have the *barrel-shaped chest*, all whose diameters,—its length, breadth, and depth—are increased, the parietes being more prominent both in front and behind, the ribs and sternum more convex, the intercostal spaces wider but not puffed out to the general level of the rest of the surface. This change takes place in the upper and middle parts of the chest, the lower portion usually remaining flat and of the normal form. In other cases this distinctive barrel-shape is wanting, the chest appearing to be uniformly enlarged in every part, even the lower portion being abnormally prominent; or the convexity may be limited to the front or, more frequently, to the back of the chest; and, lastly, there are also certain cases of emphysema in which the thorax undergoes no alteration whatever in size.

These differences in the configuration of the thorax in emphysema depend on the degree of intensity of the affection, the extent of lung implicated, and the exact locality of the lesion (upper or lower, anterior or posterior, parts of the lung); the duration of the disease and the more or less yielding character of the thoracic walls also play an important part in determining these changes, so that they are more common, *cæteris paribus*, among the young than in the aged.

There is only a trifling difference in the circumference of the emphysematous chest in inspiration and in expiration, on account of the very slight amount of expansion and contraction which takes place in the lung; even after full expiration the thorax is abnormally distended, for which reason the typical emphysematous shape has been named the *permanent inspiratory position of the thorax.*

The enlargement of the chest in vesicular emphysema arises from the fact that the lung becomes inelastic and does not subside naturally in expiration, the parietes of the thorax therefore, being no longer called upon to execute the usual movements of respiration, assume permanently the form in question.

The *second group of pathological alterations* in the shape of the thorax include *contraction, diminution in size,* of the whole or part of one side. It occurs most often in connection with the absorption of pleuritic exudation of old standing or when the fluid discharges itself externally. Thus if the lung be subjected to

great pressure for months by a large pleuritic effusion its elasticity is more or less completely destroyed and it does not expand on being relieved from this pressure by the disappearance of the fluid,—it is completely void of air and takes up much less room than when fully inflated; the chest-wall, therefore, sinks gradually as absorption goes on. The same explanation applies also to those cases of empyema which burst outwardly. In extreme cases of this nature all the dimensions of the affected side are reduced,—most strikingly antero-posteriorly; there is no trace of bulging at any point, the thorax is flat and sometimes shows on its anterior surface a considerable depression; its long diameter is shortened, the diaphragm being dragged upwards, the ribs made to approach more closely to each other, and the shoulder-blades drawn downwards; its transverse diameter is less, the ribs being forced together, bringing the nipple nearer to the sternum and the shoulder-blade to the vertebral column than on the sound side, while the anterior mediastinum is displaced towards the affected side. Further, there occurs in these cases a distortion of the spinal column, the convexity of which is towards the sound side, the dorsal muscles on the affected side, like the intercostals, becoming paralysed from the persistence of the exudation, so that those of the sound side have no counteracting force opposed to them; in this way also the shrunken side of the chest has its transverse diameter diminished.—The upward displacement of the diaphragm and the dragging of the anterior mediastinum towards the diseased side have an important influence in altering the position of such organs as stand in immediate relation to those parts. Thus, in contraction of the right side the liver rises and the heart encroaches on the right pleuritic cavity; in shrinking of the left side the heart is found situated further towards the left than in health, and above the level of the nipple. The heart's impulse *may*, nevertheless, in cases of sinking of the left side, be felt at a point more or less to the *right* of its normal position, when it has previously been dislocated towards that side by effusion into the left pleura and has there formed adhesions. The most marked contraction of one side of the chest, after the absorption of long-standing exudation or the escape externally of empyematous fluid, takes place in children, because in them we have the difference in growth of the two sides to add to the other differences. The diseased side has its development arrested while the sound side assumes vicarious functions and increases in size accordingly.

I have observed one case, that of a lad 18 years of age, who in childhood had suffered from empyema of the left side which had burst through the skin and discharged outwardly, in which the *left* side was at most but a third of the size of the right, while the heart pulsated below the *right* nipple; it is thus evident that in the early stages of the complaint the heart had been driven over to that position, and had there contracted adhesions.

The shrinking after the absorption of old pleuritic effusion is not always of such a striking character; sometimes certain parts of the lung become again expansible, and then it is only over those portions which remain collapsed that the chest-wall sinks.

The same form of atelectasis as that produced by pleuritic effusion, and the shrinking of the thorax associated with it, might, *a priori*, be expected to occur after the absorption of the gas of pneumothorax of old standing; as the latter disease usually ends in pyothorax, or pyo-pneumothorax, its secondary effects generally coincide with those of pleuritic exudation.

The *third group* of pathological changes in the shape of the chest consists of circumscribed *depressions* of the surface, which are to be distinguished from the foregoing forms of contraction chiefly by their being less considerable in degree and less extensive. They follow shrinking of the lung, from whatever cause it may arise, and owe their existence to the fact that collapsed portions of lung occupy a much smaller space than those which contain air; and as the spare room cannot be filled up by another organ the corresponding parts of the chest-wall yield to atmospheric pressure and form depressions. By far the most common cause of these concavities is caseous condensation of the lungs, and as this takes place most often at the anterior and upper parts, in the supra- or infra-clavicular regions, sometimes on one side, at other times on both, it is in these situations that they may be most confidently looked for. On the lower part of the posterior surface of the chest these depressions are seldom seen, even when there is considerable shrinking of the subjacent lung-tissue, as the powerful dorsal muscles prevent their appearance.

It not unfrequently happens that in chronic interstitial pneumonia and contraction of the pulmonary substance in *children* there are

depressions on the surface of the chest of greater or less extent, sometimes even as marked as those connected with pleuritic exudation. In a case attended by me, that of a boy twelve years of age, there was such extreme shrinking of the right lung that the chest showed a very marked depression on that side, reaching as high as the fourth rib; the diaphragm and liver were carried upwards to about same level, while the heart was displaced towards the right side, and pulsated in the third intercostal space close to the sternum.

The abnormities in the conformation of the thoracic parietes which have so far been under discussion are caused by diseases of the respiratory organs. There is another variety, however, which depends on imperfect development, and which itself not unfrequently gives rise to caseous degeneration and tuberculosis of the lungs. It is characterised by a long, narrow, and shallow chest, by sloping of the supra- and infra-clavicular regions, wide intercostal spaces (on account of the diminished power of the intercostal muscles), wing-like projection of the shoulder-blades (from the feeble action of the serrati), undue prominence of the acromial ends of the clavicles, and diminution of the antero-posterior diameter. The manubrium sterni takes part in the flattening, it sinks and so forms an angle (the angle of Louis) at the point where it joins the body of the bone. This is known as the *paralytic* form of thorax, the phthisical habit. Such individuals have an elongated neck, a delicate skin, long extremities, and clubbed fingers; they may, nevertheless, in spite of all these drawbacks, enjoy perfect health, but when attacked by disease of the respiratory apparatus can never feel assured of making so complete a recovery as those who are of a more powerful build.—There is another group of deformities due to diseases of the bones,—to rickets and diseases of the vertebral column. A description of these, however, does not lie within the scope of this work.

Mensuration of the Thorax.

Very slight variations in the form and dimensions of the thorax are easily recognisable even by inspection alone, especially when only one side is concerned. In cases in which such a difference has to be determined once for all a special measurement is scarcely necessary, more particularly as the slighter degrees of difference, which may escape notice on account of

the trifling inaccuracies often unavoidable in working with instruments, are distinctly appreciable to the practised eye. When, however, the form of the chest undergoes certain changes in the course of the disease,—when, for instance, one side is first enlarged by pleuritic effusion and afterwards contracts, it may be desirable to ascertain definitely the extent of these variations, in order to obtain a numerical statement of them with which to compare the state of matters at a later period. With this end in view we take the measurements of the circumference and diameters of the chest and the extent of the movements of respiration,—the circumference by means of a *tape* divided into centimeters, the diameters by means of *calipers*.

The *circumference* of the thorax at the level of the nipple in front and of the lower angles of the scapulæ behind, when the arms are raised and outstretched, amounts to about half the length of the body; in well-built men the average is 82 ctmr. (32·28 inches) at the end of an ordinary expiration, and 89 ctmr. (35·04 inches) after a deep inspiration; at the ensiform cartilage the circumference is about 6 ctmr. (2·36 inches) less. In old age it diminishes considerably, especially at the upper part, so that the lower circumference becomes the greater. Perfect symmetry of the two sides of the chest is rare, the right being usually 1—2 ctmr. (0·39—0·78 inch) larger. In measuring only one side of the thorax it is necessary to avoid those sources of error which are apt to arise from differences of attitude on the two sides.

The above numbers are those of Fröhlich, and represent the average circumference in 725 men of 20 years of age, well developed, and destined for the military service. Krug's measurements, made on 3,331 men of 30—34 years of age, agree generally with those of Fröhlich, and show that the girth of the chest varied from 80·9—83·3 cmtr. (31·85—32·79 inches) during expiration, the average being 82·2 cmtr. (32·36 inches), and from 89·4—93·3 cmtr. (35·19—36·74 inches) during inspiration, the average being 90·7 cmtr. (35·71 inches); the maximum range of the inspiratory movements was thus 8·5 cmtr. (3·35 inches). The circumference of the upper part of the chest in women is about 76 cmtr. (29·92 inches), that of the lower part 70 cmtr. (27·55 inches).

A knowledge of the circumference of the thorax throws but little light on the condition of the internal organs; we learn merely that the chest is weakly or powerfully built. It is a well-established fact that a perfectly healthy state of the lungs is quite compatible with a chest-circumference of 78 cmtr. (30·7 inches) or even less.

The *diameters* of the thorax are, 1, the *long diameter*, measured from the clavicle to the base of the chest; 2, the *transverse diameter* (*the breadth*), a line drawn from a given point on one side of the chest to a corresponding spot on the other side; 3, *the antero-posterior diameter* (*the depth*), a line passing from any part on the anterior surface to a corresponding point posteriorly, most usually taken from the sternum to the vertebral column, whence the term *sterno-vertebral* diameter. There are various other special comparative measurements which are sometimes made on the two sides of the chest, such as the depth at the apex, from the clavicle to the spine of the scapula, the distance between the sternum and the nipples, or between the nipples and vertebral column, &c. The changes in the diameters of the thorax occasioned by diseases of the respiratory organs have already been stated (p. 29 *et seq.*). The long diameter is very variable, so much so that it is scarcely possible to fix on any one number as expressing its normal length; the transverse diameter in the upper and lower parts of the chest in adult men amounts generally to about 25—26 cmtr. (9·84—10·23 inches), in women to 23—24 cmtr. (9·05—9·44 inches), and to 1 cmtr. (0·39 inches) more a little above the level of the mamma; the antero-posterior diameter is about 16 cmtr. (6·29 inches) superiorly, 19 cmtr. (7·48 inches) in the middle and inferiorly.

When the chest is very much misshapen, especially from spinal curvature, the tape, as it cannot be accurately applied to the various parts, gives no useful or reliable information. In such cases Woillez' cyrtometer should be used; this instrument follows closely all the heights and depressions on the surface of the chest, and when removed furnishes us with an exact tracing of its circumference at the part examined.

This cyrtometer consists of a number of small rods of whalebone $1\frac{1}{2}$ cmtr. in length so united by stiffly-moving joints as to form a non-resilient chain; at two points, coloured white, are hinges which are more freely movable than the others. The apparatus is to be applied closely to the chest and by pressure made to adapt itself to its form, dipping into its various depressions (intercostal spaces), &c.; it is then carefully removed, and its outline, drawn on paper, represents accurately that of the part of the chest examined. This measurement, repeated from time to time, affords valuable indications as to the progress of the disease under observation.

The Movements of Respiration.

In ordinary circumstances the dilatation of the thorax in respiration is effected simply by the action of the diaphragm and of the intercostal muscles, aided, in women, by that of the scaleni. In men the diaphragm is the most important of these agents; when relaxed it projects into the thoracic cavity in the form of a dome, but when contracted it becomes flattened and descends, pushing before it the abdominal organs, elevating the abdominal walls, and forcing outwards the cartilaginous parts of the lower ribs. This is termed, for obvious reasons, the *costo-abdominal type of respiration*. In women the enlargement of the chest takes place chiefly in the upper part (*costal type of respiration*), and is produced principally by the action of the intercostal muscles, and to but a slight extent by the contraction of the diaphragm. This type of respiration is not, as some hold, the result of embarrassment of the action of the diaphragm by tight lacing and the pressure of the various parts of a lady's attire, as it is observed in children of both sexes, who certainly are not exposed to these influences; it seems to originate rather in the greater flexibility of the ribs in both sexes during childhood, and in the female sex during the whole of life, the action of the intercostal muscles being more effective under these conditions. When respiration is very full and deep, in old age, and in certain pathological states, it occasionally takes the costo-abdominal form, even in women. All the diameters of the chest are increased in inspiration, the transverse and antero-posterior diameters by the movements of the ribs and sternum, the long diameter by the contraction of the diaphragm; it is by the latter means that the capacity of the chest is most of all increased.

The movements executed by the ribs are of two kinds, elevation and rotation. The *anterior* extremity of each rib is *raised* and *carried forward*, its fixed point being at the vertebral column; the rib is at the same time *rotated*, so that its convexity, which was before turned downwards, is now directed upwards and outwards. Further, as the ribs have a general inclination downwards and forwards from the spinal column to the sternum the effect of elevating them is to bring them more towards the horizontal position; this is clearly seen in deep in-

spiration and in attacks of dyspnœa. The sternum is raised and carried forward by the movements of the ribs. The antero-posterior diameter of the thorax is increased by the simultaneous forward and upward movement of the ribs, its transverse diameter by their rotation.

The lung follows every movement of the chest-wall. Its expansion in inspiration, as has been proved by exposing the pleura, and by carrying on artificial respiration after opening the thorax, takes place in two directions, from above downwards and from behind forwards; for the former movement the fixed point is the apex, for the latter a point on the posterior surface of the lung. If the lung at any part does not immediately expand when the thoracic cavity dilates—a common enough pathological phenomenon—this is at once indicated by the occurrence of a corresponding *depression* on the surface.

The diminution in the capacity of the chest in *expiration* is due solely to the relaxation of the inspiratory muscles and to the elasticity of the lung; the ribs and sternum return to their former position, and the distended lung contracts by virtue of its elasticity and expels the air which it contains.

The extent of the movement executed by the several parts of the thorax, which in normal and quiet respiration should be equal on both sides, is usually measured by passing an ordinary tape round the chest about the level of the nipples; in adults it amounts to 7—8·5 cmtr. (2·75—3·34 inches) when standing upright, to ½ cmtr. less when sitting. The changes in the transverse and antero-posterior diameters are indicated on the scale of the calipers. Inequality in the range of the movements on the two sides, even when slight, is usually readily detected, and points to the existence of some obstacle to the respiration on the side which lags behind, especially to such impediment as arises when a portion or the whole of one lung is completely collapsed or partially deprived of air. In the former case the corresponding side is generally motionless, or moves but little, in the latter case it expands, but not so freely as the sound side. These points may be observed even when the patient is breathing quietly; a full inspiration, however, brings them out more clearly, as the difference in extent of the respiratory movements in superficial and deep respiration is more marked on the healthy than on the affected side. Minute differences may

often be recognised by examining the chest in profile, frequently also by watching the movements of the shoulder-blades. Thus, in patients suffering from large pleuritic effusion, when standing with the arms hanging downwards, the scapula on the diseased side is almost motionless, while that of the other side is considerably raised and has its lower angle turned forwards. If respiration be embarrassed in both lungs, as in bilateral emphysema, neither side of the chest moves much, sometimes not more than 5—6 cmtr., or even less. Should the obstruction be situated in the upper lobe of one or both lungs,—which occurs most frequently in phthisis pulmonalis,—the limitation of the respiratory movements is confined to the upper part of the chest on one or both sides. In the latter case the finer degrees of divergence from the normal range of movement are recognised with some difficulty, as we have no longer the advantage of being able to compare one side with the other.

Sometimes certain parts of the surface of the thorax near the apex on one side, more rarely on both sides, are observed to *sink* markedly *in inspiration* and to bulge outwards again in expiration. On close examination it is usually found that those parts, which are, as a rule, situated on the front of the chest and between the first and third ribs, are, even in the respiratory pause, somewhat less prominent than those in their immediate neighbourhood. These depressions are generally connected with condensation and the formation of one or more cavities in the subjacent lung tissue, and arise from the inability of the dense inexpansible lung parenchyma to follow the chest-wall when it is raised in inspiration, and the consequent yielding of the corresponding parts of the surface to the external atmospheric pressure.

Inspiratory depressions are also very common in the lower *lateral* intercostal spaces on *both sides*, in the epigastrium, in the region around the ensiform process and sternal insertions of the lower ribs, in the supra-clavicular regions and the supra-sternal notch. These phenomena accompany the more severe forms of vesicular emphysema of the lungs and stenosis of the larynx (from croup, &c.). The cause in both cases is the rarefaction of the air within the lungs, and the consequent preponderance of the external over the internal atmospheric pressure. Direct proof of the accuracy of this explanation is found in the

facts that inhalation of rarefied air from a pneumatic apparatus produces sinking of the supra-clavicular regions and of the flexible parts at the base of the chest, and that those concavities, when due to emphysema or stenosis of the larynx, disappear on the inhalation of condensed air.

It is evident that the air in the lungs must become rarefied in severe emphysema and in constriction of the larynx or trachea, as, notwithstanding the dilatation of the thorax and the expansion of the lungs produced by the energetic contraction of the inspiratory muscles, very little air enters the chest; the internal pressure is therefore abnormally lowered, the external pressure becomes the greater, and the most yielding parts and those most distant from the larynx are forced inwards. The diaphragm is quite unable to overcome this pressure from without, and is rather driven upwards by it. The *rigid* parts of the chest, as they offer sufficient resistance to the weight of the atmosphere, are not subject to these inspiratory depressions. These symptoms are much intensified on taking a deep inspiration, and are more observable in those who have wide intercostal spaces and are of spare habit.

In many cases of dyspnœa of old standing, especially in aged emaciated persons suffering from emphysema, a shallow horizontal sulcus (Harrison's Sulcus) marks externally the lower border of that portion of the diaphragm which rises from the xiphoid cartilage.

An important diagnostic point is often found in the relative extent of the movements of respiration in the upper and lower segments of the chest. When the impediment to the free entrance of air into the upper lobes is considerable the lower lobes act more vigorously and exercise vicarious functions, the diaphragm contracts powerfully, the lower part of the thorax is widely distended, while the movements in the upper parts are restricted. This type of respiration is often seen in consumptives. On the other hand, if the action of the diaphragm be more limited, as is often the case when it is carried upwards by the pressure of fluid or tumour in the abdominal cavity, or is forced downwards by pleuritic effusion or pneumothorax, the lower part of the chest-wall takes a less prominent share in the movements of respiration. Besides being hampered in its action from these mechanical causes the diaphragm may be partially paralysed from the persistence of the pressure and from the spread of the inflammation to its serous covering. In acute fevers having a protracted course (such as typhus) there is usually a temporary enfeeblement of the diaphragm.

More or less complete paralysis of the diaphragm from neuropathic causes is rare, and is distinguished by the position of the diaphragm (which is pushed upwards into the thorax), and by the passive retraction of the epigastrium and of those parts of the chest-walls from which the diaphragm springs. The appearances are thus the same, though not so well marked, as those which follow section of the phrenic nerve in animals, the diaphragm being passively drawn up into the chest at each inspiration and forced downwards into the abdomen at each expiration. In one case of partial paralysis, long under my own care, occurring in a man otherwise healthy, the bulging of the surface of the abdomen was wanting in shallow inspiration; with deep inspiration there appeared in the upper part of the abdomen a series of wavy elevations following closely on each other which, on expiration, returned and disappeared in the same order. These peculiar phenomena had lasted many months.

Stethography.

(The graphic representation of the movements of respiration.)

Various instruments have been invented for the purpose of graphically registering the movements of respiration. Vierordt and Ludwig's consists of a two-armed lever, the end of the shorter limb of which rests on the abdominal surface of the diaphragm, whilst the longer limb, fitted with a pencil, records its movements on a slip of paper which is caused to pass before it. In other apparatuses (Rosenthal's, Gerhardt's, Marey's, Fick's, &c.), though they differ much in form, the principle remains the same,—an arrangement of levers gives a tracing of the extent of the movements, on a plate which glides past the body at a certain rate. It is obvious that with these instruments the movements of but one spot can be noted at one time. Riegel, however, has constructed a "*double stethograph*" which enables us to examine at the same instant any two points on the surface of the chest, no matter how far apart, and thus to compare their tracings directly with each other. It consists of a strip of paper which is carried forward horizontally by clockwork, of two pencils which are kept applied to the two sides of the paper by means of lever-work, and of two separate levers which are set in motion by the rising and falling of the walls of the chest, and which communicate their oscillations to the pens. The tracings from the two sides of the chest, being on the same piece of paper, can be easily compared with each other. The tracings may be increased in size by lengthening the arm of one of the levers; in this way the slightest action of any part of the thorax may be demonstrated. The whole instrument rests on an iron stand, on the longer beam of which it is mounted and on which it is movable; the shorter beam bears the counter-weight. A simpler instrument than Riegel's has lately been devised by Haenisch; it, however, does not indicate all the variations in the respiratory movements, but only the length of the inspiratory excursion at two corresponding points, such as the apices.