ear through the chink left between the chest piece and the chest. After a little practice one learns instantly to detect this condition of things and so to shift the position of the chest piece that external noises are totally excluded; but by the beginner, the peculiar babel of external noises which is heard whenever the stethoscope fails to fit closely against the chest is not easily recognized, and hence he tends to attribute some of these external sounds to diseased conditions within the chest.

Again, it is not until we have had considerable practice that

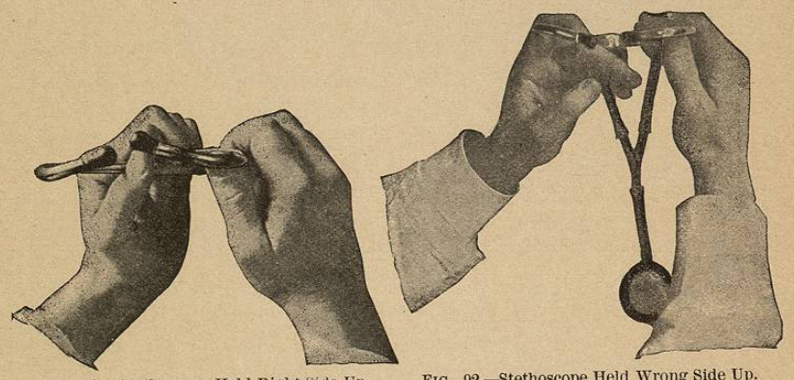

FIG. 91.—Stethoscope Held Right Side Up.

FIG. 92.—Stethoscope Held Wrong Side Up.

our sense of hearing comes instantly to tell us when something is wrong about the stethoscope itself; when, for example, one of the tubes is blocked, kinked, or disconnected, or when we are holding the stethoscope upside down, so that the ear pieces point downward instead of upward (see Figs. 91 and 92). It is only when we have learned through long practice about how much we ought to hear at a given point in the normal chest that we recognize at once the fact that we are not hearing *as much as we should*, in case some one of the above accidents has happened. Many beginners do not listen long enough in any one place, but move the chest piece of the stethoscope about rapidly from point to point, as they have seen experienced auscultators do; but it is remarkable how much more one can hear at a given point by simply persevering and

listening to beat after beat, or breath after breath. It is sometimes difficult to avoid the impression that the sounds themselves have grown louder as we continue to listen, especially if we are in any doubt as to what we hear. Therefore, if we hear indistinctly, it is important to keep on listening, and to fix the attention successively upon each of the different elements in the sounds under consideration. In difficult cases we should use every possible aid toward concentration of the attention, and where it is possible, all sources of distraction should be eliminated. Thus, in any case of doubt, I think it is important for the auscultator to get himself into as comfortable a position as he can, so that his attention is not distracted by his own physical discomforts. Many auscultators shut their eyes when listening in a difficult case so as to avoid the distraction of impressions coming through the sense of sight. It goes without saying that if quiet can be secured in the room where we are working, and outside it as well, we shall be enabled to listen much more profitably.

AUSCULTATION OF THE LUNGS.

In the majority of cases ordinary quiet breathing is not forcible enough to bring out the sounds on which we depend for the diagnosis of the condition of the lungs. Deep or forced breathing is what we need.

As a rule, the patient must be taught how to breathe deeply, which is best accomplished by personally demonstrating the act of deep breathing and then asking him to do the same. Two difficulties are encountered:

(*a*) The patient may blow out his breath forcibly and with a noise, since that is what he is used to doing whenever he takes a long breath under ordinary circumstances; or

(*b*) It may be that he cannot be made to take a deep breath at all. The first of these mistakes alters the sounds to be heard with the stethoscope in any part of the chest by disturbing both the rhythm and the pitch of the respiratory sounds In this way the breathing may be made to sound tubular or asthmatic throughout a sound chest. This difficulty can sometimes be overcome by demonstrating to the patient that what you desire is to have him take a

full breath and then simply *let it go*, but *not* blow it forcibly out. In some cases the patient cannot be taught this, and we have to get on the best we can despite his mistakes. When he cannot be made to take a full breath at all, we can often accomplish the desired result by getting him to cough. The breath just before and after a cough is often of the type we desire. The use of voluntary cough in order to bring out râles will be discussed later on. Another useful manœuvre is to make the patient count aloud as long as he can with a single breath. The deep inspiration which he is forced to take after this task is of the type which we desire.

I. Respiratory Types.

In the normal chest two types of breathing are to be heard:

(1) Tracheal, bronchial, or tubular breathing.

(2) Vesicular breathing.

Tracheal, bronchial, or tubular breathing is to be heard in normal cases if the stethoscope is pressed against the trachea, and as a rule

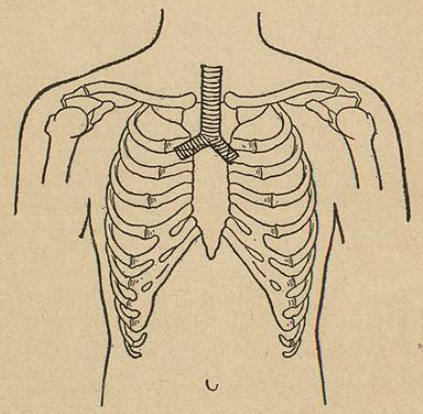

Fig. 93.—Situation of the Trachea and Primary Bronchi.

it can also be heard over the situation of the primary bronchi, in front or behind (see Figs. 93 and 94).

Vesicular breathing is to be heard over the remaining portions of

the lung—that is, in the front of the thorax except where the heart and the liver come against the chest wall, in the back except where the presence of the scapulæ obscures it, and throughout both axillæ.

(1) *Characteristics of Vesicular Breathing.*

Vesicular breathing—that heard over the air vesicles or parenchyma of the lung—has certain characteristics which I shall try to describe in terms of intensity, duration, and pitch.

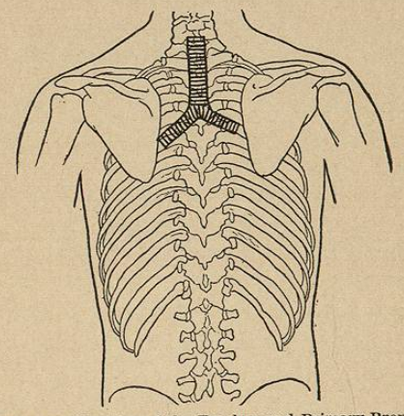

Fig. 94.—Situation of the Trachea and Primary Bronchi.

Of the *quality* of the sounds heard over this portion of the lung there is little can be said; it sounds something like the swish of the wind in a grove of trees some distance off, and hence is sometimes spoken of as "breezy."

The intensity, duration, and pitch of the inspiration as compared with that of the expiration may be represented as in Fig. 95. In this figure, as in all those to be used in description of respiratory sounds—

(1) I represent the inspiration by an up-stroke and the expiration by a down-stroke (see the direction of the arrows in Fig 63).

(2) The *length* of the up-stroke as compared with that of the down-stroke corresponds to the *length* of inspiration compared with expiration.

(3) The *thickness* of the up-stroke as compared with the down-stroke represents the *intensity* of the inspiration as compared with the expiration.

(4) The *pitch* of inspiration as compared with that of expiration is represented by the *sharpness of the angle* which the up-

FIG. 95.—Vesicular Breathing.

FIG. 96.—Distant Vesicular Breathing.

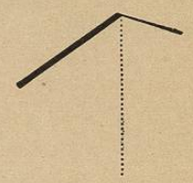

FIG. 97.—Exaggerated Vesicular Breathing.

stroke makes with the perpendicular as compared with that which the down-stroke makes with the perpendicular. The *pitch of a roof* may be thought of in this connection to remind us of the meaning of these symbols.

If now we look again at Fig. 95 we see that when compared with expiration (the down-stroke), the inspiration is—

(*a*) More intense.

(*b*) Longer.

(*c*) Higher pitched.

Our comparison is invariably made between inspiration and expiration, and not with any other sound as a standard.

Now, this type of breathing (which, as I have said, is to be heard over every portion of the lung except those portions immediately adjacent to the primary bronchi), is not heard everywhere with equal intensity. It is best heard below the clavicles in front, in the axillæ, and below the scapulæ behind, but over the thin, lower edges of the lung, whether behind or at the sides, it is feebler, though still retaining its characteristic type as revealed in the inspiration and expiration in respect to intensity, duration, and pitch. To represent distant vesicular breathing graphically we have only to draw its symbol on a smaller scale (see Fig. 96). On

the other hand, when one listens to the lungs of a person who has been exerting himself strongly, one hears the same type of respiration, but on a *larger scale*, which may then be represented as in Fig. 97. This last symbol may also be used to represent the respiration which we hear over normal but thin-walled chests; for example, in children or in emaciated persons. It is sometimes known as "exaggerated" or "puerile" respiration. When one lung is thrown out of use by disease so that increased work is brought upon the other, the breath sounds heard over the latter are increased and seem to be produced on a larger scale. Such breathing is sometimes spoken of as "rough" breathing.

It is very important to distinguish at the outset between the different *types* of breathing, one of which I have just described, and the different *degrees* of loudness with which any one type of breathing may be heard.

(2) *Bronchial or Tracheal Breathing in Health.*

Bronchial breathing may be symbolically represented as in Fig. 98, in which the increased length of the down stroke corresponds to the increased duration of expiration, and the greater thickness

FIG. 98.—Bronchial Breathing of Moderate Intensity.

FIG. 99.—Distant Bronchial Breathing.

FIG. 100.—Very Loud Bronchial Breathing.

of both lines corresponds to the greater intensity of both sounds, expiratory and inspiratory, while the sharp pitch of the "*gable*" on both sides of the perpendicular corresponds to the high pitch of both sounds. Expiration, it will be noticed, slightly exceeds inspiration both in intensity and pitch, and considerably exceeds it in duration, while as compared with vesicular breathing almost all the

relations are reversed. Bronchial breathing has also a peculiar quality which can be better appreciated than described.

In the healthy chest this type of breathing is to be heard if one listens over the trachea or primary bronchi (see above, Fig. 91), but practically one hardly ever listens over the trachea and bronchi except by mistake, and the importance of familiarizing one's self with the type of respiration heard over these portions of the chest is due to the fact that in certain diseases, especially in pneumonia and phthisis, we may hear bronchial breathing over the *parenchyma* of the lung where normally vesicular breathing should be heard.

The student should familiarize himself with each of these types of breathing, the vesicular and the bronchial, concentrating his attention as he listens first upon the inspiration and then upon the expiration, and comparing them with each other, first in duration, next in intensity, and lastly in pitch. To those who have not a musical ear, high-pitched sounds convey the general impression of being shrill, while low-pitched sounds sound hollow and empty, but the distinction between intensity and pitch is one comparatively difficult to master. Distant bronchial breathing may be represented in Fig. 99, and is to be heard over the back of the neck opposite the position of the trachea and bronchi. Fig. 100 represents very loud bronchial breathing such as is sometimes heard in pneumonia.

(3) *Broncho-Vesicular Breathing in Health.*

As indicated by its name, this type of breathing is intermediate between the two just described, hence the terms "mixed breathing," or "atypical breathing" ("unbestimmt"). Its characteristics may be symbolized as in Fig. 101. In the normal chest one can become familiar with broncho-vesicular breathing, by examining the apex of the right lung, or by listening over the trachea or one of the primary bronchi, and then moving the stethoscope half an inch at a time toward one of the nipples. In the course of this journey one passes over points at which the breathing has, in varying degrees, the characteristics intermediate between the bronchial type from which we started and the vesicular type toward which we are

moving. Expiration is a little longer, intenser, or higher pitched than in vesicular breathing, and inspiration a little shorter, feebler,

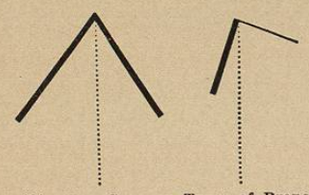

FIG. 101.—Two Common Types of Broncho-Vesicular Breathing.

FIG. 102.—Distant Broncho-Vesicular Breathing.

or lower pitched; but since these characteristics are variously combined, there are many subvarieties of broncho-vesicular breathing. Fig. 102 represents two types of distant broncho-vesicular breathing.

(4) *Emphysematous Breathing.*

A glance at Fig. 103 will call up the most important features of this type of respiration. The inspiration is short and somewhat feeble, but not otherwise remarkable. The expiration is long, feeble, and low pitched. This type of breathing is the rule in elderly persons, particularly those of the male sex.

(5) *Asthmatic Breathing.*

Fig. 104 differs from emphysematous only in the greater intensity of the inspiration. In this type of breathing, however, both sounds

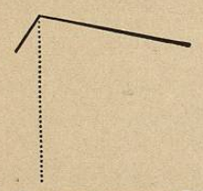

FIG. 103.—Emphysematous Breathing.

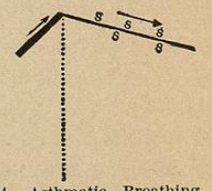

FIG. 104.—Asthmatic Breathing. s, s, s, squeaking (musical) râles.

are usually obscured to a great extent by the presence of piping and squeaking râles (see below).

(6) *Interrupted or "Cogwheel" Breathing.*

As a rule, only the inspiration is interrupted, being transformed into a series of short, jerky puffs as shown in Fig. 105. Very rarely the expiration is also divided into segments. When heard over the entire chest, cogwheel breathing is usually the result of nervousness, fatigue, or chilliness on the patient's part. With the removal of these causes this type of respiration then disappears. If, on the other hand, cogwheel respiration is confined to a relatively small portion of the chest, and remains present despite the exclusion of

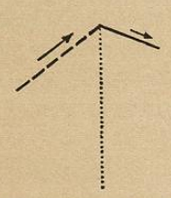

FIG. 105.—Cogwheel Breathing.

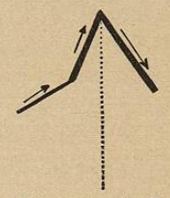

FIG. 106.—Metamorphosing Breathing.

fatigue, nervousness, or cold, it points to a local catarrh in the finer bronchi such as to render difficult the entrance of air into the alveoli. As such, it has a certain significance in the diagnosis of early phthisis, a significance similar to that of râles or other signs of localized bronchitis (see below).

(7) *Amphoric or Cavernous Breathing* (see below, p. 161).

(8) *Metamorphosing Breathing.*

Occasionally, while we are listening to an inspiration of normal pitch, intensity, and quality, a sudden metamorphosis occurs and the type of breathing changes from vesicular to bronchial or amphoric (see Fig. 106), or the intensity of the breath sounds may suddenly be increased without other change. These metamorphoses are usually owing to the fact that a plugged bronchus is suddenly opened by the force of the inspired air, so that the sounds conducted through it become audible.

II. DIFFERENCES BETWEEN THE TWO SIDES OF THE CHEST.

Over the apex of the right lung—that is, above the right clavicle in front, and above the spine of the scapula behind—one hears in the great majority of normal chests a distinctly broncho-vesicular type of breathing. In a smaller number of cases this same type of breathing may be heard just below the right clavicle. These facts cannot be too strongly insisted upon, since it is only by bearing them in mind that we can avoid the mistake of diagnosing a beginning consolidation of the right apex where none exists. *Breath sounds which are perfectly normal over the right apex would mean serious disease if heard over similar portions of the left lung.* It will be remembered that the apex of the right lung is also duller on percussion than the corresponding portion of the left, and that the voice sounds and tactile fremitus are normally more intense on the right (see Fig. 64).

Occasionally one finds at the base of the right lung posteriorly a slightly feebler or more broncho-vesicular type of breathing than in the corresponding portion of the left lung.

III. PATHOLOGICAL MODIFICATIONS OF VESICULAR BREATHING.

Having now distinguished the different types of breathing and described their distribution in the normal chest, we must return to the normal or vesicular breathing in order to enumerate certain of its modifications which are important in diagnosis.

(1) *Exaggerated Vesicular Breathing* ("*Compensatory*" *Breathing*).

(*a*) It has already been mentioned that in children or in adults with very thin and flexible chests the normal breath sounds are heard with relatively great distinctness; also that after any exertion which leads to abnormally deep and forcible breathing a similar increase in the intensity of the respiratory sounds naturally occurs.

(*b*) The term "*compensatory breathing*," or "vicarious" breathing, refers to vesicular breathing of an exaggerated type, such as is heard, for example, over the whole of one lung when the other lung

is thrown out of use by the pressure of an accumulation of air or fluid in the pleural cavity. A similar exaggeration of the breathing upon the sound side takes place when the other lung is solidified, as by tuberculosis, pneumonia, or malignant disease, or when it is compressed by the adhesions following pleuritic effusion, or by a contraction of the bones of that side of the chest such as occurs in spinal curvature.

(2) *Diminished Vesicular Breathing.*

The causes of a diminution in the intensity of the breath sounds without any change in their type are very numerous. I shall mention them in an order corresponding as nearly as possible to the relative frequency of their occurrence.

(*a*) *Fluid, Air, or Solid in the Pleural Cavity.*—Probably the commonest cause for a diminution or total abolition of normal breath sounds is an accumulation of fluid in the pleural cavity such as occurs in inflammation of the pleura or by transudation (hydrothorax). In such cases the layer of fluid intervening between the lung and the stethoscope of the auscultator causes retraction of the lung so that little or no vesicular murmur is produced in it, and hence none is transmitted to the ear of the auscultator. An accumulation of air in the pleural cavity (pneumothorax) may diminish or abolish the breath sounds precisely as a layer of fluid does; in a somewhat different way a thickening of the costal or pulmonary pleura or a malignant growth of the chest wall may render the breath sounds feeble or prevent their being heard because the vibrations of the thoracic sounding-board are thus deadened. Whichever of these causes, fluid or air or solid, intervenes between the lung and the ear of the auscultator, the breath sounds are deadened or diminished without, as a rule, any modification of their type. The amount of such diminution depends roughly on the thickness of the layer of extraneous substance, whether fluid, air, or solid.

Total absence of breath sounds may therefore be due to any one of these causes, provided the layer intervening between the lung and chest wall is of sufficient thickness to produce complete atelectasis of the lung or to deaden the vibrations of the chest wall.

(*b*) *Emphysema of the lung*, by destroying its elasticity and reducing the extent of its movements, makes the breath sounds relatively feeble, but seldom, if ever, abolishes them altogether.

(*c*) In *bronchitis* the breath sounds are usually considerably diminished owing to the filling up of the bronchi with secretion. This diminution, however, usually attracts but little attention, owing to the fact that the bubbling and squeaking sounds, which result from the passage of air through the bronchial secretions, distract our notice to such an extent that we find it difficult to concentrate attention upon the breath sounds, even if we do not forget altogether to listen to them. When, however, we succeed in listening *through the râles* to the breath sounds themselves, we usually notice that they are very feeble, especially over the lower two-thirds of the chest. *Œdema of the lung* may diminish the breath sounds in a similar way.

(*d*) *Pain in the thorax*, such as is produced by dry pleurisy or intercostal neuralgia, diminishes the breath sounds because it leads the patient to restrain, so far as possible, the movements of his chest, and so of his lungs. If, for any other reason, the full expansion of the lung does not take place, whether on account of the feebleness of the respiratory movements or because the lung is mechanically hindered by the presence of pleuritic adhesions, the breath sounds are proportionately feeble.

(*e*) *Occlusion of the upper air passages*, as by spasm or œdema of the glottis, renders the breathing very feeble on both sides of the chest. If one of the primary bronchi is occluded, as by a foreign body or by pressure of a tumor or enlarged gland from without, we get a unilateral enfeeblement of the breathing over the corresponding lung.

(*f*) Occasionally a paralysis of the muscles of respiration on one or both sides is found to result in a unilateral or bilateral enfeeblement of the breathing.

It should be remembered, when estimating the intensity of the breathing, that the sounds heard over the right lung are, as a rule, slightly more feeble than those heard over the left lung in the normal chest.

IV. Bronchial or Tubular Breathing in Disease.

(*a*) I have already described the occurrence of bronchial breathing in parts of the normal chest, namely, over the trachea and primary bronchi. In disease, bronchial breathing may be heard elsewhere in the chest, and usually points to solidification of that portion of lung from which it is conducted. It is heard most commonly in *phthisis* (see below, p. 304).

(*b*) *Croupous pneumonia* is probably the next most frequent cause of bronchial breathing, although by no means every case of croupous pneumonia shows this sign. For a more detailed account of the conditions under which it does or does not occur in croupous pneumonia, see below, p. 296. Lobular pneumonia is rarely manifested by tubular breathing.

(*c*) In about one-third of the cases of pleuritic effusion distant bronchial breathing is to be heard over the fluid. On account of the feebleness of the breath sounds in such cases they are often put down as absent, as we are so accustomed to associate intensity with the bronchial type of breathing. One should be always on the watch for any degree of intensity of bronchial breathing from the feeblest to the most distinct.

(*d*) Rarer causes of bronchial breathing are hemorrhagic infarction of the lung, syphilis, or malignant disease, any one of which may cause a solidification of a portion of the lung.

V. Broncho-Vesicular Breathing in Disease.

Respiration of this type should be carefully distinguished from puerile or exaggerated breathing, in which we hear the normal vesicular respiration upon a large scale. I have already mentioned that broncho-vesicular breathing is normally to be heard over the apex of the right lung. In disease, broncho-vesicular breathing is heard in other portions of the lung, and usually denotes a moderate degree of solidification of the lung, such as occurs in early phthisis or in the earliest and latest stages of croupous pneumonia. In cases of pleuritic effusion, one can usually hear broncho-vesicular breathing over the upper portion of the affected side, owing to the retraction of the lung at that point.

VI. Amphoric Breathing (*Amphora = A Jar*).

Respirations having a hollow, empty sound like that produced by blowing across the top of a bottle, are occasionally heard in disease over pulmonary cavities (*e.g.*, in phthisis) or in pneumothorax, *i.e.*, under conditions in which the air passes in and out of a large empty cavity within the chest. Amphoric breathing never occurs in health. The pitch of both sounds is low, *but that of expiration lower than that of inspiration.* The intensity and duration of the sounds vary, and the distinguishing mark is their quality which resembles that of a whispered "*who.*"

VII. Râles.

The term "râles" is applied to sounds produced by the passage of air through bronchi which contain mucus or pus, or which are narrowed by swelling of their walls.[1] Râles are best classified as follows:

(1) Moist or bubbling râles, including (*a*) coarse, (*b*) medium, and (*c*) fine râles.

(2) Dry or crackling râles (large, medium, or fine).

The smallest varieties of this type are known as "crepitant" or "subcrepitant" râles.

(3) Musical râles (high or low pitched).

Each of these varieties will now be described more in detail.

(1) *Moist or Bubbling Râles.*

The nature of these is sufficiently indicated by their name. The coarsest or largest bubbles are those produced in the trachea, and ordinarily known as the "*death rattle.*" Tracheal râles occur

[1] Râles are of all auscultatory phenomena the easiest to appreciate, provided we exclude various accidental sounds which may be transmitted to the ear as a result of friction of the stethoscope against the skin or against the fingers of the observer. (See above, page 145.)