may be converted at will into the alternative form, $M + Ah$, by taking M equal to the difference in the numerical values of H and Am and changing Am to Ah. The form $H + Am$ ($= Amh$), is commonly used when $H < \frac{1}{2}Am$; the alternative form $M + Ah$ ($= Ahm$) is used when $H > \frac{1}{2}Am$.

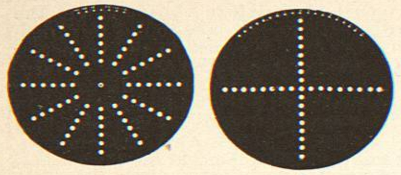

FIG. 370.

Test objects made up of arrangements of points or dots are best made by punching holes in a sheet of cardboard, to be hung in a window against a background of ground glass or of white or colored (yellow or red) tissue paper (Fig. 370). The astigmatic eye sees each bright

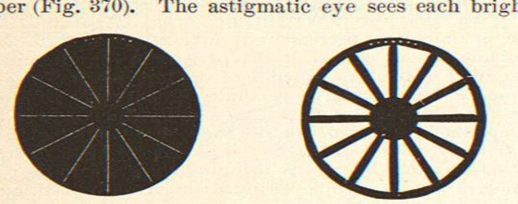

FIG. 371.

dot elongated in the direction of one of its principal meridians, and if the test object is viewed through a spherical lens, selected as in the case of examination by the aid of the diagrams with radiating lines, the elongation will be in the direction corresponding to the ocular meridian of greatest refraction (M_o). If now the attention is directed to the row of dots lying in this meridian, the several dots will appear as if fused together in a bright streak, whereas in the other principal meridian

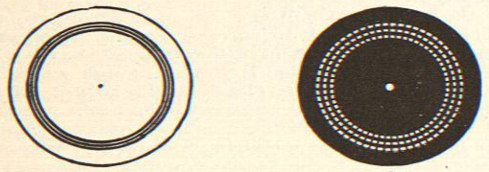

FIG. 372.

(corresponding to the ocular meridian of least refraction) they will be seen distinctly separate from one another, and can be easily counted. Transparent test objects may also be made with radiating lines, either bright lines on a dark ground or dark lines on a bright ground (Fig. 371). Owing to the strong irradiation, the contrast between the lines in the several meridians is much more conspicuous than in the case of the printed diagrams, but by using one or more thicknesses of tissue paper for the background, we may reduce the irradiation to any degree that may be found most advantageous. A useful test object may also be made with translucent red (carmine) radii on a translucent blue (ultramarine) field, separating the two colors by narrow dark lines (see *Optometry*); the radii which lie in the plane of the ametropic meridian are seen in their proper color, while the others appear of a combination (purple) tint. Test objects may also be constructed of circles instead of radii, or of combined radii and circles (Fig. 372); or lines of different degrees of inclination may be arranged in a linear series (Fig. 373), or as in the striped letters devised by Pray. Advantage may also be taken of the property of certain letters or figures to take on confusing shapes under the influence of astigmatic refraction.

A stellate arrangement of very fine lines may be used as a test for astigmatism by placing it at or near the principal focus of the convex lens of an optometer (Burow). The best apparatus for this purpose is the binocular optometer of Javal, in which the two eyes are severally directed, with their axes parallel, upon two small figures, like watch dials, corresponding to the two pictures on a stereoscopic slide (Fig. 374). Upon one of the dials are engraved the hours, and the star of fine

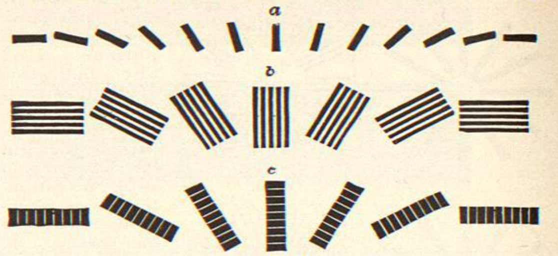

FIG. 373.

lines; besides these there are a number of circles and lines common to both dials, to facilitate binocular fusion of the two pictures. The radiating lines are thus viewed by only one of the eyes, while the other eye is fixed upon the second dial. The card with the two dials is placed in the optometer (or in a stereoscope fitted with a sliding holder), at a distance from the lenses well within their principal focus, and is then moved slowly away until all the radii except those in one meridian become indistinct; this meridian corresponds to the ocular meridian of greatest refraction (M_o), and the measure of the refraction for this meridian is the difference between the power of the convex lens (in dioptries) and that of a lens having a focal length equal to the greatest distance at which the line in question is distinctly seen. The measure of the astigmatism is obtained by successive trials with concave cylindrical lenses, brought in front of the lens of the optometer (or stereoscope), until a glass is found through which all the radii are seen clearly defined. Having measured one of the eyes in the manner described, the card is exchanged for another with transposed dials and the other eye tested in its turn.

The *stenopæic apparatus*, which is simply a thin plate of blackened metal perforated by a narrow slit, may be

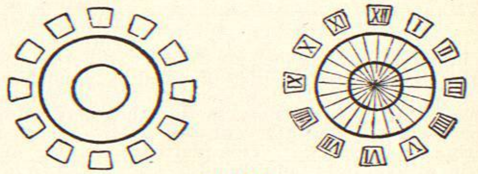

FIG. 374.

used to shut out from the eye all rays except those which lie in the plane of the meridian of the slit. In this way it is possible to measure in succession the refraction in the two principal ocular meridians by the use of spherical glasses. The stenopæic slit is often useful in the first approximate diagnosis of complicated cases of astigmatism, but the method is greatly inferior in accuracy to those in which cylindrical lenses are employed.

The optical correction of astigmatism is by wearing a spectacle lens of asymmetrical refraction, of such power and so mounted as to equalize the refraction of the eye in its two principal meridians. The simplest form of lens for this purpose is a plano-cylindrical lens, mounted so that the axis of the cylindrical surface shall lie in the plane of the ocular meridian of greatest refraction (M_o) when the cylindrical surface is convex, or in the plane of the meridian of least refraction (at right

angles to M_o) when the cylindrical surface is concave. A convex plano-cylindrical lens in the case of simple hypermetropic astigmatism (Ah), or a concave plano-cylindrical lens in the case of simple myopic astigmatism (Am), corrects the entire refractive error and so reduces the eye to the condition of emmetropia (E). In all other cases the effect of any plano-cylindrical lens which corrects the astigmatism is to reduce the eye either to simple hypermetropia (H) or to simple myopia (M). To correct this residual hypermetropia or myopia a convex or a concave spherical surface, of appropriate radius of curvature, may be ground on the back of the plano-cylindrical lens, thus making a spherico-cylindrical lens suited to the correction of the total refractive error.

In any case of astigmatism, the equalization of the refraction in the two principal meridians may be effected either by a convex cylindrical or by a concave cylindrical lens, as may be preferred. Thus, in Am, we ordinarily prescribe a plano-concave cylindrical lens; but we may, at pleasure, prescribe an alternative form of lens combining a convex cylindrical with a concave spherical surface of equal (negative) power. In $M + Am$, we ordinarily prescribe a lens combining a concave cylindrical with a concave spherical surface; but we may, at pleasure, prescribe an alternative lens in which a convex cylindrical surface is combined with a concave spherical surface of a (negative) power equal to the sum of the (negative) powers of the concave cylindrical and the concave spherical surfaces in the former combination. In mixed astigmatism (Amh or Ahm), we may, at pleasure, combine a concave cylindrical with a convex spherical surface, or a convex cylindrical with a concave spherical surface. In all these cases there may be a positive advantage in prescribing a lens with a concave spherical surface turned toward the eye, thus approximating, more or less closely, the concavo-convex form of lens. In Ah we may, at pleasure, prescribe a plano-convex cylindrical lens, or a lens in which a concave cylindrical surface is combined with a convex spherical surface of equal power. In $H + Ah$ we may similarly choose between a lens in which a convex cylindrical surface is combined with a convex spherical surface, or a lens in which a concave cylindrical surface is combined with a convex spherical surface of a power equal to the sum of the powers of the convex spherical and the convex cylindrical surface in the first combination. In these alternative combinations the meniscus form of lens is partially realized, and some advantage may be obtained by mounting the concave cylindrical surface toward the eye.

The greatest freedom of choice in the selection of the best form of lens, in any case of astigmatism, is afforded by the use of lenses in which one of the surfaces is ground to a curvature of unequal radii in its two principal meridians. Such lenses, having either a convex or a concave surface ground to the configuration of a segment of a torus,* may be made of any required radius of curvature in each of the two principal meridians. The difference in power in the two meridians represents the required correction for the astigmatism, and the power of the lens in one or the other of these meridians represents the correction for any residual hypermetropia or myopia. A concave toric combined with a convex spherical surface, or a concave spherical combined with a convex toric surface, may be prescribed for the correction of any case of simple, compound, or mixed astigmatism. Such a lens, with the concave surface (spherical or toric) turned toward the eye, may be so proportioned as to realize fully the particular advantages derivable from the periscopic (concavo-convex or meniscus) form of lens. Lenses may also be ground with two unequal cylindrical surfaces with crossed axes, but such lenses do not differ in effect from those in which a spherical and a cylindrical surface are combined.

Any lens set obliquely to the direction of a pencil of rays refracted through its centre develops an increase of power in all meridians, but most in the meridian cut by the common plane of the axis of the pencil and the axis of the lens. A convex or concave spherical spectacle lens may thus have its power so increased in its vertical meridian, by tilting it forward, as to render it equivalent to a lens of somewhat greater power combined with a cylindrical lens with its axis horizontal. This property of lenses is sometimes utilized, intentionally or unintentionally, in cases of compound myopic astigmatism ($M + Am$), when the ocular meridian of greatest refraction is vertical, and in cases of aphakia after cataract extraction, when, as is oftenest the case, the meridian of greatest refraction is horizontal (see *Spectacles*).

As the ordinary spherical glasses, convex or concave, worn in hypermetropia or myopia, have the incidental effect of increasing or diminishing the apparent size of objects, so the effect of a convex or concave cylindrical glass, worn for the correction of astigmatism, is to increase or diminish the apparent magnitude in the direction at right angles to its axis. Thus a circle is made to appear as a somewhat elongated or as a somewhat compressed ellipse, a square as an elongated or shortened parallelogram, etc. This distortion, which is in proportion to the power of the cylindrical glass required to correct the astigmatism, may cause temporary annoyance; or, in the case of unequal or unsymmetrical correction of the two eyes, it may give rise to special stereoscopic illusions. Errors of judgment from this cause are, however, speedily corrected, as the patient becomes accustomed to the new conditions (see *Spectacles*).

As a consequence of the impairment of the acuteness of vision incident to the higher grades of astigmatism, an astigmatic person may be compelled to hold his book very near to the eyes in order to distinguish the smaller sizes of print. The effort to improve the recognition of special details of the object, through rapid changes in the accommodation, may also be a cause of fatigue. Particular forms of astigmatism may, therefore, contribute materially to the development of asthenopia, either accommodative or muscular (see *Asthenopia*), of excessive accommodative tension and progressive myopia (see *Accommodation and Refraction*, *Myopia*), or of convergent or divergent strabismus (see *Strabismus*).

IRREGULAR ASTIGMATISM.—Under this title Donders has included all visual defects due to irregularity in the general form or in the surface of the cornea, and also to inequality in the refraction of the crystalline lens in its different sectors, and in different parts of the same sector.

Some degree of irregular astigmatism is present in every eye, and must, therefore, be regarded as *normal*. Under this head falls the irregularity in refraction which results from the partial scattering of the rays of light in passing through the crystalline lens. If we prick a very small hole, with the point of a fine needle, in a card, and, holding it a little within the anterior focus of the eye (14.8 mm. = 0.6 inch in front of the cornea), look through the hole at a bright light, the shadow of the pupillary opening and of the central portion of the crystalline lens will be thrown upon the retina and will be seen as delineated in Fig. 375 (Donders). If now we move the card slowly away from the eye, this picture will change gradually to the familiar figure which we call a star, and which we see when we look at a star in the heavens, or at a distant point of light. If, instead of a luminous point, we look at a minute speck of white pigment on an intensely black ground, the speck will appear multiple (*polyopia monophthalmica*), with indications of a stellate arrangement, as in Fig 376 (Helmholtz).

If we look, with a single eye, at a disk made up of concentric circles, as in Fig. 377 (after Helmholtz), the circles will appear wavy and confused in particular sectors of the disk, and also abruptly bent or broken along the radii which separate one sector from another. From this and from the preceding experiment it is evi-

* Torus is a word used in architecture to designate a moulding, of convex cross section, carried around the base of a column. In geometry, a torus, or tore, is the surface generated by the revolution of a circle about a right line in its own plane; when the right line is taken outside the circle the torus has the form of a ring—anchor ring. A strip of metal of this cross section, (, bent around a cylinder, takes the form of an equatorial zone of a torus, and may be used as a tool for grinding either a concave or a convex toric lens surface.

dent that the eye does not focus a point sharply upon its retina, but rather as a small group of points, each one of which is seen somewhat expanded and distorted, or, in

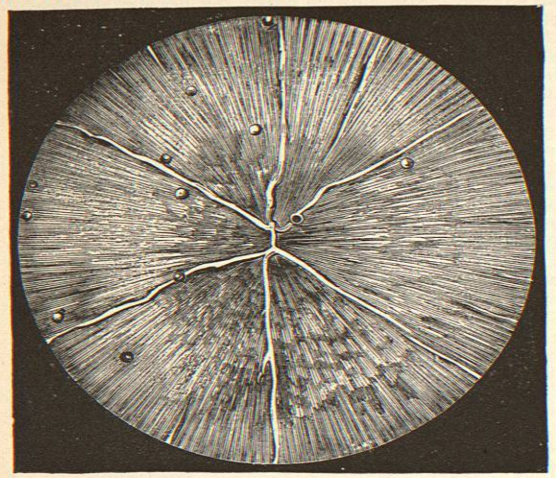

FIG. 375.

the case of a bright point, as a star-shaped figure made up of a number of points more or less completely fused together and rendered still more complex by innumerable fine radiating lines.

Thus, a brilliant fixed star or planet is seen as of very conspicuous magnitude, whereas the image of a fixed star in the most powerful telescope is but an intensely bright point of inappreciable diameter. A white dot, line, or letter on a black ground is similarly seen expanded, and is therefore visible at a greater distance than a black object of the same size upon a white ground; on the other hand, the form of the black object on a white ground may often be recognized at a greater distance than that of the bright object on a black ground. This phenomenon is called *irradiation.*

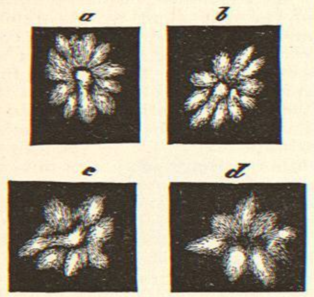

FIG. 376.

The phenomena of normal irregular astigmatism are complicated also by aberration of curvature, in so far as the configuration of the cornea and of the crystalline lens varies from the theoretically perfect curvature requisite for the refraction of incident rays to a single focus, as well as by the slight inequality of refraction in different meridians, which is demonstrable in almost every eye, and which must, therefore, be considered as *normal regular astigmatism.* Hence the retinal image of a star is actually seen a little more expanded than it would be as a result of the scattering of the rays of light in traversing the crystalline lens, and, in the presence of regular astigmatism, the star is also seen elongated.

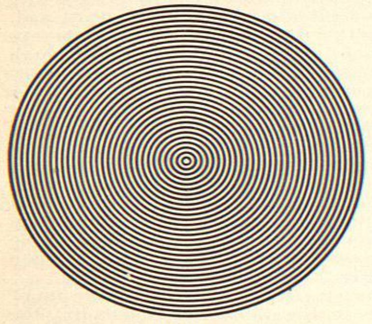

FIG. 377.

Abnormal irregular astigmatism attains perhaps its highest grade in conical cornea (*staphyloma pellucidum*), in which affection it may be a source of very great confusion of vision. Inflammatory processes in the cornea may lead to softening and consequent irregular distention of that tissue; and changes of curvature, both partial and total, may follow the cicatrization of corneal wounds, incisions made in operations, ulcers, etc. In all these cases the disturbance of vision may often be resolved in part into regular astigmatism, and sight may then be materially improved by wearing appropriate cylindrical glasses; in other cases the definition of objects is much improved by looking through a small hole or narrow slit punched in a blackened card or in a thin plate of metal; in rare instances it may be justifiable to attempt to change the position of the pupil by the operation of *iriddesis* (Critchett).

Abnormal irregular astigmatism, with multiple vision, may occur as a result of changes in the crystalline lens, incident to the incipient stages of cataract; myopic refraction also may be developed at the same time, probably through an increase in the curvature of the lens surfaces. *John Green.*

ASTRINGENTS.—Astringents—from *ad* (to) and *stringo* (I bind)—are agents which, acting locally, produce condensation and corrugation of tissues by precipitating their contained albumin and gelatin, and by diminishing the amount of fluids present in protoplasm. They also cause contraction of living muscular fibre, possibly by direct irritation. Secretion from mucous membranes and from denuded surfaces is lessened by astringents, which produce a constricting effect upon the capillary blood-vessels and also perhaps at the same time upon the glands and their ducts. All the astringents except alcohol produce some sort of chemical action which promotes destructive metamorphosis. Alcohol, on the other hand, retards these retrograde changes in the tissues. The subdivision into vegetable and mineral astringents is recognized and their action is either local or remote. Astringents are said to act locally, when they are applied directly to a part upon which it is desired to produce this particular kind of effect. On the other hand, they act remotely, when they are taken into the circulating blood and are thus brought in contact with certain internal (remote) organs. Among the astringents, which are used in this way are dilute sulphuric acid, gallic acid, lead acetate, etc. According to some authorities, this mode of action of astringents is precisely the same as that which takes place, when the remedy is applied locally in the ordinary, direct manner. Intestinal and urinary astringents are terms, which are applied to certain drugs, which exert a special astringent influence upon these organs of the body; the former contracting the walls of intestinal vessels and constringing the intestinal mucous membrane, while the latter manifest their influence mainly by diminishing the excretion of urine. Astringents are administered internally in the form of solutions, pills, or powders.

Vegetable astringents depend for their action upon the contained tannic and gallic acids. Tannic acid is said to be digallic acid anhydride. It is a crystalloidal substance, a glucoside, having the formula $HC_{14}H_9O_9$. It combines with colloids, precipitates pepsin, and coagulates albumin and gelatin. In this respect it differs from gallic acid, which does not coagulate either albumin or gelatin, and which is therefore better adapted for internal use. In fact, before tannic acid can be absorbed it must be converted, in the system, into gallic and pyrogallic acids. Arranged alphabetically, the vegetable astringents are: alnus, castanea, catechu, diospyros, galla, geranium, granatum, hamamelis, hæmatoxylon, heuchera, kino, krameria, myrica, nymphea, quercus alba,

rhus glabra, rosa glabra, rubus statica, uva ursi, and all other substances which contain tannic acid. Among the mineral astringents may be mentioned: the dilute acids (acetic, carbolic, muriatic, nitric, sulphuric), alcohol, alum, bismuth subnitrate and other bismuth salts, cadmium sulphate, chalk, cocaine, cerium oxalate, copper sulphate, creosote, ferric chloride and ferric persalts, lead acetate and subacetate, zinc preparations, especially the oxide and the sulphate, and several other metallic salts.

Astringents are valuable styptics and hæmostatics, and they also harden and restore tone to relaxed tissues. They cause capillary vessels to contract, and they constrict glands and their ducts. They exert some control over inflammation and they diminish the secretion from mucous membranes and from denuded surfaces. They excite contractions in muscular fibre, and they cause spongy granulations to wither away. When applied to an ulcerated or denuded surface they bring about (through coagulation of the protoplasmic albumin) the formation of a pellicle which covers and protects this surface from the atmosphere and from external irritants. Thus, pain is lessened at the same time that healing is promoted by astringents. When they are administered internally, their action is either local, or, like tonics, which they somewhat resemble, they impart vigor and tone to various structures of the body. Thus, upon the nervous system they may exert a decided and oftentimes a beneficial influence. They diminish peristaltic action to some extent. With three exceptions all astringents irritate more or less. They are therefore contraindicated in acute inflammation. The three sedative astringents are lead acetate or (subacetate), cerium oxalate, and bismuth subnitrate.

Synergists: Tonics, especially the bitter tonics, also those agents which increase retrograde metamorphosis.

Antagonists and Incompatibles: Vegetable astringents are incompatible with the "ic" and "ous" salts of iron, also with the salts of antimony, copper, lead, silver, and zinc; with alkalies, alkaloids, and glucosides; and with pepsin, albumin, gelatin, emulsions, and the mineral acids.

Manner of Elimination from the System: Tannic acid is excreted by the bowels as gallic or pyrogallic acid. It is also eliminated by way of the kidneys.

Uses and Therapeutic Applications: To check excessive secretion from the skin, as in hyperidrosis or in night sweats; to check secretion from mucous membranes, as in the various catarrhs (nasal, buccal, bronchial, intestinal, urethral, vesical, vaginal, etc.); to lessen secretion from denuded and ulcerated surfaces. It must always be remembered that astringents are not to be used until the inflammation reaches that stage in which the secretion from the inflamed part is beginning to be excessive. Capillary oozing or hemorrhage from some remote organ, as from the kidney or bowel, may be controlled by the astringents; gallic acid being preferable to tannic in such cases. Diabetes insipidus and albuminuria are other pathological conditions in which the use of gallic acid is indicated. Where the part can be directly reached, as in epistaxis, hæmatemesis, hemorrhage from lower bowel, hemorrhoids, rectal fissure or ulcer, prolapsus ani, subacute or chronic conjunctivitis, otorrhœa, etc., tannic acid is preferable to gallic. In bed sores or where excoriation is taking place, as in dermatitis intertrigo, alcohol, bismuth, or tannic acid will be found useful as a means of hardening the skin. Finally, since tannic acid is chemically incompatible with the alkaloids and glucosides, it may serve as a useful chemical antidote in poisoning from these active principles. It accomplishes this good effect by throwing down a very slowly soluble, or entirely insoluble, therefore inert, tannate of the alkaloid or glucoside in question. *Leon L. Solomon.*

ATAVISM. See *Reversion.*

ATELECTASIS.—(Synonyms: Apneumatosis; collapse of lung.) The term *atelectasis* (ἀτελής, imperfect, and ἔκτασις, dilatation) is used to designate all non-inflammatory conditions by which either the whole or sharply defined portions of the lungs are undistended by air. Two forms are recognized: congenital and acquired atelectasis.

In some new-born babies, more or less extensive areas of the lungs are unexpanded by the forcible extrance of air into the alveoli. This condition, which is normal in fetal life, becomes pathological when it continues after birth, and is named *congenital atelectasis.*

In other cases, although the respiratory functions have been thoroughly established, collapse is induced as a consequence of some mechanical impediment to the movement of air through the bronchi; and a tract of lung of variable extent becomes again condensed and airless, as in the fetal state. This is called *acquired atelectasis* or *collapse of the lung.* There are two varieties: collapse from obstruction and collapse from compression.

Atelectasis is comparatively rare in adults, but is quite common in infancy and childhood, especially during the first few months of life. A considerable percentage of the mortality in infants is attributable to this cause. The liability to the occurrence of pulmonary collapse adds gravity to all diseases, but especially to those of the respiratory organs at this period of life.

ETIOLOGY.—Congenital atelectasis is not commonly due to vice or disease of the pulmonary organs, but is produced by any condition which prevents the prompt and efficient establishing of the function of respiration after birth. It may be the result of causes which have been in operation during the intra-uterine life of the child, or which have originated during or immediately succeeding birth. Physical weakness, premature birth, placental separation, compression of the cord, protracted labor, and kindred conditions are common causes of atelectasis. It is also not infrequently due to plugging of the bronchioles by liquor amnii and mucus, sucked in by efforts at respiration before the head has cleared the maternal passages. Intracranial effusions pressing upon the pneumogastric, the result of severe protracted or instrumental deliveries, may be placed among the rarer causes of this affection in the new-born.

Atelectasis from obstruction is always secondary to some disease or accident which interferes mechanically with the access of air to the lung cells. The lodgment of a foreign body in a bronchus may result in alveolar collapse. In the vast majority of instances this impediment is the presence of mucus in the bronchial tubes, the effect of an acute or chronic bronchial catarrh, and collapse is therefore a frequent complication of those diseases, like pertussis and measles, in which bronchitis is a part of the natural history.

Whenever one or more terminal bronchioles are occluded by viscid mucus and swelling of the mucosa, the collapse of that portion of the lung fed by the obstructed tube inevitably takes place as soon as the imprisoned air is expelled or absorbed. This purely mechanical explanation of collapse, first advanced by Gairdner of Edinburgh and adopted by nearly all writers on the diseases of children, has been challenged by Holt and others.

Weakness of the inspiratory muscles, and the consequent inability to overcome the obstacles in the tubes, is a powerful auxiliary factor in bringing about collapse, and hence any condition which decreases the physical vigor of the child strongly predisposes to this accident. It is, therefore, a common malady among those enfeebled by a bad inheritance, by chronic and wasting diseases, or by unsanitary surroundings. Rickets also plays an important rôle in the causation, associated as it is with softening of the ribs and narrowing of the thorax.

External pressure may render a lung, or any portion of it, airless (*atelectasis from compression*). Intrathoracic growths or exudations, spinal deformities, and upward displacement of the diaphragm by abdominal tumors or effusions may cause collapse of such portions of the lung as are subjected to pressure.

MORBID ANATOMY.—The collapse may involve considerable areas of the lung (*diffuse atelectasis*), or it may be