twenty-four hours, correspond inversely with the variations in the amount of vapor.

The experiments we have thus far described are intended to establish the inductive character of the atmosphere in its condition of dryness and serenity, particularly during clear and cold weather.

We have employed movable conductors terminated by balls, which have been of the most favorable form and relative dimensions to exhibit the effects of induction. The apparatus, however, usually employed before the experiments of Peltier, were principally stationary insulated conductors, terminated by points above, which, as we have seen, act powerfully in discharging electricity from a body, or in absorbing it from the surrounding medium.

If in the experiments with the apparatus, Fig. 16, the rod be terminated by a point instead of a ball, but feeble excitation will be observed during clear cold weather, because the point exhibits so exceedingly small a surface that but very little electricity can be drawn down into the lower end, before the intensity of attraction of unsaturated matter upwards comes into an equilibrium with the attraction of the earth downwards. With this instrument the observer would probably make a record to the effect that the electricity of the atmosphere was very feeble, whereas if the experiment were made with the apparatus previously described, an opposite condition would be noted. The result, however, would be entirely different if the air were damp and the insulated rod elevated to a considerable height, the negative intensity of the upper end would be sufficient to attract a portion of the natural electricity from the surrounding medium, even although this had become slightly negative by the previous induction of the earth. In this case the pointed conductor would indicate a large amount of electricity.

The intensity of the induction may even become so great as to absorb a portion of the natural electricity of the dry atmosphere, as in the case of a very long wire, the upper end of which is furnished with a series of points, and raised to a great height by means of a kite. The points may attract a portion of the natural electricity of the air, and thus produce at the lower end of the wire a series of sparks, following each other, after the lapse of a certain time, at regular intervals.

From the foregoing, it will be evident that in interpreting the indications of the two classes of instruments we have described, which may be denominated those of induction and those of absorption, we must keep constantly in view the principles which have been explained; and it is for want of a clear appreciation of these principles that so much complexity has been introduced in the otherwise comparatively simple effects of induction.

ELECTRICITY OF THE CLOUDS.

The explanation of the thunder-storm and the tornado given by Peltier does not appear to us as satisfactory as could be desired. In common with most of the meteorologists of Europe, he does not take into consideration the real character of the storm, which, as we think, has been fully established by theory and observation in this country.

We have stated in a previous report that this consists in the rushing up of the lighter air to restore the normal equilibrium of the atmosphere, which had been disturbed or rendered unstable by the gradual introduction, next to the ground, of a stratum of warm and moist air. As an illustration of this disturbance, we may mention the fact pointed out to Arago, by Captain Hessard, which he had observed in the Alps, namely, that during great heats there takes place suddenly at the lowest stratum of clouds, upward rushings, extending vertically like rockets.

We shall endeavor to supply the deficiency, in the exposition of Peltier, we have mentioned, and to present, on the principles of the induction of the earth in connection with the upward motion of the air, a logical explanation of the origin and continued supply of the great quantity of electricity developed in the meteors under consideration.

It follows, from the principles of induction, that the upper end of all perpendicular insulated conductors must be electrified negatively, and the lower end positively, since the attraction of the unsaturated matter of the earth below will draw down the natural electricity of the conductor into its lower extremity, leaving a deficiency in the upper part. Now, if we admit, agreeably to the theory of Mr. Espy, that a cloud consists in the upward motion of a mass of moist and heated air, the vapor of which is condensed as it ascends into the colder regions, thus forming a high perpendicular column of partially conducting material, it will be evident that by induction, the upper part of this cloud will become negatively electrified, and the lower part positively, as in the case of the conductor, Figure 15. The intensity of this excitement will depend upon the length of the vertical dimensions of the cloud, which, in many cases, is exceedingly great, and also upon the density, and consequently the conducting power of the vapor. The induction of the earth being very intense, a partial excitement of the atoms of vapor may take place even before the condensation of the whole mass has reached its maximum. If this be the case, a transparent mass of vapor, or that which is merely beginning to condense into cloud, will be electrified throughout its entire mass; and when the condensation of the vapor has gone so far as to render the interior a tolerably good conductor, the electricity of each atom will be repelled to the surface, as in the case of a globular conductor; the intensity

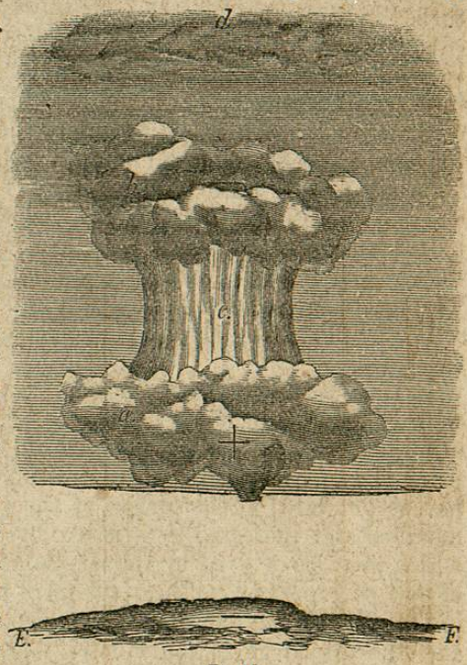

Fig. 19.

will thu be highly increased; and while the rushing upward of moist air is going on, a series of discharges will take place between the upper and lower portions of the cloud.

It is asserted by Mr. Wise that the thunder cloud, when viewed on one side from a sufficient elevation, presents the appearance of an hour-glass, the upper and the lower ends spreading out almost into two distinct clouds, as seen in Figure 19.

We find that the same form of the thunder cloud has been described by other ærial voyagers, also by Volta; and we are inclined to consider it the usual one presented by this meteor, since it is precisely that which would be produced by the self-repulsion of the upper and lower parts of the cloud, each charged, as it is throughout its mass, with the same kind of electricity. The middle of the perpendicular dimensions of the cloud, as illustrated by the perpendicular conductor Figure 15, will be neutral, and hence no tendency to bulge out at this point will exist. Mr. Wise also states that flashes of sheet lightning are constantly seen at *c*, in the middle space; and sometimes intense discharges from the upper to the lower part of the cloud—appearances in exact conformity with the views here presented.

The immense number of discharges of lightning from a single thunder cloud in its passage over the earth, through a distance in some cases of more than 500 miles, indicates a constant supply of electricity; and this is found in the continued rushing up of new portions of moist air, and, as it were, in the successive renewals of the perpendicular column with fresh materials, the electrical equilibrium of which is disturbed by induction.

In the case of a tornado or water-spout, the ascending current of air is confined to a very slender column, in which the action is exceedingly intense; and since it is scarcely possible that the rushing in from all directions of the air below to supply the upward spout can be directed to precisely the same central point, a whirling motion must be produced. This will tend to limit the diameter of the spout, and to create a partial vacuum at the axis of the column, in which the moist air, by the cold of the sudden expansion, will have its vapor condensed, and a conductor will thus be formed extending from the cloud to the earth. Through this conductor a constant convective discharge of electricity will take place, and all the phenomena described by Dr. Hare will be exhibited.

In this view of the nature of the tornado or spout, although we adopt with Franklin and Espy, as the characteristic of the commotion of the atmosphere, the rushing upwards in the form of a column, on the principles of hydrostatics, of a stratum of heated and moist air, which had accumulated at the surface of the ground, yet the phenomena are modified and increased in number by the great amount of electricity which must be evolved by the simple action of the continued elevation of new portions of a constant stream of moist air. Since the conductor, in the case of the tornado or water-spout, extends to near the earth, and the discharge is continually taking place, the cloud, which is spread out immediately above, will be negatively electrified, and the upper portion of the cloud, as exhibited in Figure 19, will be wanting.

The greater or less degree of conduction of the depending spout will vary the phenomena and give rise to the different appearances which have been seen at the surface of the water. When the conductor does not quite reach to the earth, visible discharges of electricity will be exhibited, and the surface of the water will be attracted upwards. When the conducting material of the spout touches the surface of the water, the liquid will be depressed.

That the rushing up of the air with intense violence does take place in the column of a land or water spout is abundantly proved by direct observation, and that electricity cannot be the cause of this action, but is itself an effect, is proved by the fact, that since the column of moist air extends to the earth, through it discharges of the fluid must be made, which would soon exhaust the cloud, were it not constantly renewed. In some instances the meteor has been known to continue its destructive violence along a narrow line of more than two hundred miles in length. To merely refer this prolonged action to a whirling motion of the air, without attempting to explain on known principles of science, the renewed energy of the rotation, is to rest satisfied with a very partial analysis of the phenomenon.

If, by the action of an elevated horizontal current of air, the upper part of a thunder-cloud be separated from the lower, we shall have a mass of vapor charged entirely with negative electricity, and from such a mass floating high in the atmosphere, a new evaporation may take place by the heat absorbed directly from the sun. The column of invisible vapor thus produced being a partial conductor elongated upward, the attraction of the earth will draw down a new portion of its natural electricity into the cloud from which the vapor was produced, and thus diminish its negative intensity. If, now, the upper end of this transparent column be condensed by the cold of the greater altitude into visible vapor, it will form a cloud of the second order of negative intensity. We shall thus have, according to Peltier, lower clouds intensely excited with positive electricity, clouds of medium elevation either neutral or slightly negative, and the highest cirrus clouds, which are formed by the secondary evaporation we have mentioned, excited intensely with a negative electricity.

Since particles of ponderable matter similarly electrified repel each other, it is evident that the electrical state of the cloud must in some degree counteract the tendency to condensation which would result from the cold of the upper regions; and also, the same action in the lower clouds will tend to prevent precipitation in the form of rain, even though the atoms of vapor are in a condition to coalesce into drops of water.

It is evident, also, since the earth is negatively electrified, that the particles of vapor in the same state will be repelled further from the surface, and those which are positively electrified will be drawn down. Hence, the negative clouds will tend to retain their elevated position, although they may be pressed downwards by descending currents.

Negative clouds may also be formed near the surface of the earth by a detached portion of cloudy matter under a cloud more highly charged with positive electricity, which will cause the former, by induction, to

discharge its positive electricity into the earth, as well as a portion of its natural electricity; and if the upper cloud be afterwards driven away by the wind, the lower will be left highly negative.

Peltier states that he can determine from the appearance of a cloud whether it be positively or negatively charged. Clouds negatively electrified, according to him, are of a bluish grey color, while those which are positively charged are white, and exhibit at the setting sun, a red appearance.

From the foregoing considerations it must be evident that, in addition to the disturbance which is produced in the atmosphere by the variations of heat and moisture, which we have so fully discussed in the last report, we must take into account those that result from the changes in the electrical condition of the atoms of moisture. Though they may not be as important as the former, still they must modify the conditions of the general phenomena, and no theory of storms can be complete which does not include the effect of this agent.

On the principles we have developed, the discharges of lightning which are exhibited in volcanic eruptions are readily understood. The column of vapor of water, heated air, and other conducting materials, which sometimes rise to a great elevation from Vesuvius, must be subjected to the inductive action of the earth, and, consequently, the electricity of the upper end of the column, as soon as its elevation is sufficient to produce a condensation of the vapor, by the cold of the higher regions, must send down to the lower part of the column a large amount of electricity which, when the length is great, and the ascending stream rapid, will manifest itself in discharges of lightning. In accordance with the same principles, thunder storms have been produced in a peculiar state of the atmosphere, as it were, artificially. About thirty years ago a farmer at Greenbush, near Albany, collected on a knoll in the middle of a field, a large amount of brushwood, which was set on fire simultaneously at different points, and, burning, gave rise to an ascending column of heated air, extending to a great altitude. The air rushing in to supply the upward current assumed a rapid rotary motion, accompanied by a loud roaring and discharges of lightning of sufficient magnitude to frighten the laborers from the field. The explanation in this case is too obvious to require a formal statement.

In the equatorial regions, under a vertical sun, masses of moist air are constantly rising during the day time, and producing electrical discharges to the earth. The vapor, therefore, which accompanies the reverse trade winds in the upper region, must be negatively electrified, while the earth in the torrid zone must constantly be receiving electricity from the clouds. From this, we may infer, that there is a current of electricity through the earth, from the equator towards the poles, and a neutralization by means of the air above, which may give rise to the aurora polaris.

Arago has described the different forms of lightning under three classes. The first class comprises the lightning which consists of a vivid luminous line or furrow, very narrow, and sharply defined, the course of which is not a direct line, but is that denominated

zig-zag. This peculiar form of lightning, according to Moncel, is referable to the effect of partial, interrupted conduction, and may be imitated by sprinkling iron filings on a plate of glass; the bifurcations of the discharge may also be referred to the same cause. The drops of rain distributed through the air perform the office of the particles of iron filings in the experiment, and the repulsion of the electricity tending to separate it into different streams. The next class consists of what is called "sheet lightning," which, instead of being narrowed to bright sinuous lines, appears on the contrary to extend over immense surfaces. It not unfrequently has an intensely red tinge, and sometimes a blue or violet color predominates. The color, probably, belongs to the flashes of lightning which take place at a great elevation, and seems to illuminate lower clouds, and thus to present the appearance of a broad flash.

We may also mention that flashes of lightning are sometimes observed in a summer evening, without thunder, and known as "heat lightning." They are, however, merely the light from discharges of electricity from an ordinary thunder-cloud beneath the horizon of the observer, reflected from clouds, or perhaps from the air itself, as in the case of twilight. Mr. Brooks, one of the directors of the telegraph line between Pittsburg and Philadelphia, informs us that, on one occasion, to satisfy himself on this point, he asked for information from a distant operator during the appearance of flashes of this kind in the distant horizon, and learned that they proceeded from a thunder storm then raging two hundred and fifty miles eastward of his place of observation.

The third class is called "globular lightning," which is remarkable, besides its peculiar form, for the slowness of its motion. The occurrence of this form of lightning is very rare, and were not the phenomenon well authenticated, we should be inclined to regard it as a delusion. But it does not comport with the cautious procedure of true science to deny the existence of all appearances which may not come within the prevision of what are considered as established principles; although when facts of an extraordinary nature are related to us they should not be received with that easy credence which might be due to less remarkable phenomena, yet, after having fully satisfied ourselves of their reality, we must endeavor to collect all the facts connected with them, and to ascertain with accuracy the essential conditions on which they depend. Arago has given a number of instances of this remarkable form of the electrical discharge, the general appearance of which is that of a ball moving slowly through the air, and sometimes, when coming near a body, exploding with tremendous violence.

The only explanation which has been suggested for this remarkable meteor, and which, at first sight, appears to belong entirely to some other class of phenomena than those denominated electrical, is that which was in part suggested, I think, by Sir W. Snow Harris. According to his hypothesis, the ball of light is the result of what is analogous to that which is known as a glow discharge, a phenomenon familiar to all who are in the habit of making electrical experiments. When a conductor connected with the earth is brought near a charged

body, particularly when the air is damp, a partial silent discharge will take place, during which, although there may be no light perceptible in the space between the two, yet on the end of the conductor connected with the earth a glow of light will appear, attended with a hissing noise. Now, if we suppose that in the atmosphere between the cloud and the earth there exists a stratum or current of very dry air, while the remaining portions are in a very moist condition, and that the silent discharge from the cloud is taking place, for example, nearly perpendicularly to the earth, and passing through the dry stratum, then the partial interruption of conduction as the current of electricity passes through the dry stratum will give rise to the exhibition of light. Again, if we suppose the cloud to be in motion, this appearance will travel with it, and the patch or glow of light will thus exhibit in mid-air a comparatively slow progressive motion, and disappear as if with an explosion, when a disruptive discharge takes place. This hypothesis can only be considered as an antecedent possibility, and is not presented as a full or satisfactory explanation; the phenomenon itself must be more frequently observed, and the associated condition of its appearance more minutely noted before a definite hypothesis can be formed as to its cause.

Records of observations, therefore, with regard to this meteor are exceedingly desirable; they should, however, be made with scrupulous accuracy, and by persons accustomed to scientific investigations. We have found, from experience, great difficulty in obtaining an accurate account of all the circumstances attending a peculiar occurrence of nature, from those who were present at the time and witnessed the phenomenon. It is astonishing how much the products of the imagination are mingled with the actual impressions made upon the senses, and how difficult it is to separate from the testimony of a witness, what he actually saw; and what he unconsciously infers from the previous crude conceptions of his mind, awakened at the instant by a powerful association of ideas. In the transit of the meteor which passed over a considerable portion of the United States, in November last, a large number of persons declared that it fell in an adjoining field, or in the water near by, although it must have been at the time many miles in altitude above the surface of the earth.

INDUCTIVE ACTION OF THE CLOUD.

A cloud formed as we have described must produce a great inductive effect on the earth beneath, and as it is borne along from the west in this latitude over the surface of the ground, the intensity of the electricity of the lower part must constantly vary, on account of the conducting condition of the materials at or below the surface. For example, since water is a better conductor than dry earth, if the cloud is moving in a line which, if produced, would cross a river, its course will frequently be changed, and in a similar way we can explain the fact that discharges of lightning more frequently fall on some places than others. Although the cloud may be impelled in the same direction by the wind, yet the attraction of the surface of the water, rendered more than naturally negative by induction, will tend to draw it from its course. And since the induction acts at a distance through all substances, if a quantity of water or good conducting material exist below the surface of the earth, the cloud will be similarly affected. It frequently happens that when a heavy discharge of lightning passes near a house or descends along a rod, inductive effects are exhibited which are more startling than dangerous.

We have seen in the experiment described in page 477 that an induced spark was exhibited at the edge of a large disk covered with tinfoil, in the lower story, by suddenly drawing the electricity from a similar disk in the upper part of a house. A precisely similar arrangement, but on a much more gigantic scale, is presented when a highly charged thunder-cloud is in the zenith of a building. Now, if the intensity of this be suddenly diminished by a discharge to the earth, flashes of electricity and sparks from different objects within the house will be observed. The explanation of this is very easy. The free electricity of the cloud, which we may suppose to be positive, repels all the positive electricity of conductors and partial conductors into the ground, and renders them negative. They will be brought, however, into this state very gradually, either by the comparatively slow approach of the cloud, or by its increase in intensity. The fluid, therefore, will escape into the ground without being perceptible in the form of sparks, but when the repulsion is suddenly relieved, at least in part, by a discharge of the cloud, the natural electricity rushes back and exhibits itself in flashes and sparks, and even may give shocks to persons in the vicinity. Although this sudden return of the electricity from the earth into which it has been driven, in ordinary cases of conductors in a house supported by bad conducting materials, is usually attended with but slight effects; yet it may, under certain circumstances, produce serious accidents, particularly when a person is in good conducting connection with the earth. A remarkable instance of this kind was given by Mr. Brydone, in a letter to the president of the Royal Society, in 1787.

Two laborers, each driving a cart loaded with coal, and sitting upon the front part, ascending a slight eminence, the one following the other at a distance of about twenty-four yards, as represented at *M* and *L*, Fig. 20, were conversing about the thunder which was heard at a distance, when in an instant the man in the hinder cart was astounded by a loud report, and saw his companion and the two horses which he was driving fall to the ground. He immediately ran to his assistance, but found him quite dead. The horses were also killed, and appeared to have died without a struggle. The hinder cartman had the horses and driver of the forward cart full in view when they fell to the ground, but he saw no flash nor appearance of fire, and was sensible of no shock nor uncommon sensation. Each wheel was marked with a bluish spot on the tire, as if the iron had been subjected at that place to an intense heat, and directly under these spots were two holes in the ground, from which the earth was removed as if by an upward explosion. Flashes of lightning had been seen and thunder heard by

Mr. Brydone also, who was in the vicinity at the time, but these were at the distance of five or six miles, as shown by the time elapsed between seeing the flash and hearing the thunder. There were no marks, however, of the exit of the discharge upwards from the body of the man or of the horses, or any effect which could be attributed to a discharge immediately from the cloud. The accident was seen by another person, from a greater distance, who was also astounded by the loud report, saw the horses and man fall to the ground, but observed no lightning nor fire at the time, but perceived the dust arise at the place. A shepherd in a neighboring field, during the same storm, observed a lamb drop down dead, and felt at the same time as if fire had passed over his face, although the lightning and clap of thunder a were at great distance from him. This happened a quarter of an hour before the accident to the cartman, and not over three hundred yards from the same spot. A woman making hay near the bank of the river near by, fell suddenly to the ground, and exclaimed to her companions that she had received a violent blow on her foot, and could not imagine whence it came.

A scientific analysis of these phenomena is given by Earl Stanhope, on principles similar to those of induction, which we shall translate as it were into the precise language of that theory. Let us suppose a cloud eight or ten miles in length to be extended over the earth in the situation represented by A B C in Fig. 20, and let another cloud D E F

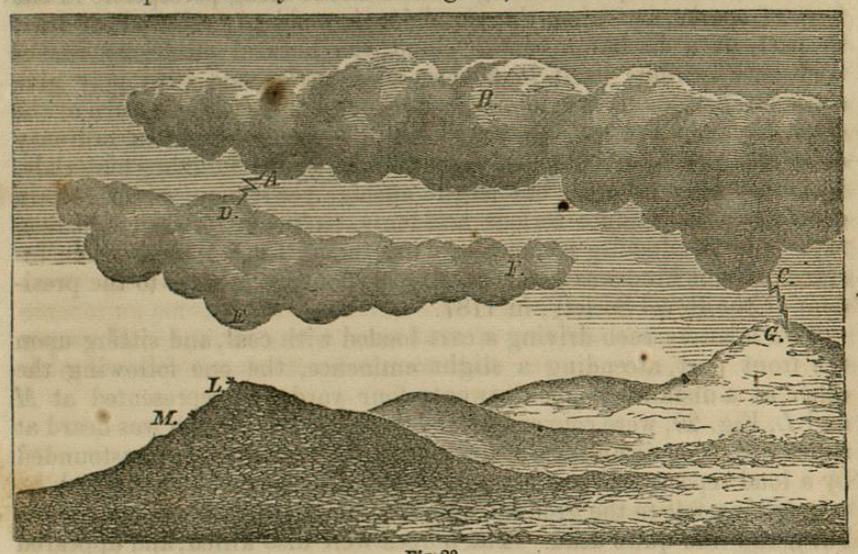

Fig. 20.

be situated between the above-mentioned cloud and the earth. Let the two clouds be supposed to be charged with the same kind of electricity, and both positive. Let us further suppose that the lower cloud D E F be only so far from the earth as to be just beyond the striking distance, and the man, cart, and horses to be at L, under the part E of the cloud which is nearest the earth. Now, let the remote end C of the upper cloud approach the earth within striking distance, and suddenly discharge itself at G. The effect which would be produced by this

arrangement, at the moment of the discharge C G, will be understood by considering the condition of the electricity in the two clouds, and in the earth a moment previous to the discharge. Both clouds being positive, the two will act upon each other by repulsion, the free electricity of the lower cloud will be driven down into its lower surface, and will be accumulated particularly in the point E nearest to the earth. The ground underneath the lower cloud, and more especially at L, where the distance is least, will become highly negative. The natural electricity will be driven down into the ground by repulsion, and will be retained there as long as this condition remains, but when a discharge takes place at the point C G, if the cloud B be a good conductor, the repulsion at A and D will be suddenly removed, and the natural electricity of the earth will return with a rush to the surface, and pass beyond its point of natural equilibrium, as in this case into the man and horses. The loud report was caused by the discharge from D to A, which was invisible to the eye of the spectator on account of the density of the lower cloud.

An experimental illustration of the effects produced in this case may be readily furnished by charging two conductors, arranged in the relative position of the two clouds. At the moment a spark is drawn from the end C, a discharge is observed at D A. The death of the lamb, and the shock felt in the foot of the woman were both produced according to this view, by the sudden rushing up of the natural electricity of the ground, when the repulsion in the upper cloud was in part diminished by the distant discharge.

The inductive action at a distance which we have described, affords a rational exposition of the effects which are perceived by persons of nervous sensibility on the approach of a thunder-storm, and may also be connected with the change which is said to take place suddenly in liquids in an unstable condition, such as the souring of milk and other substances, near the point of fermentation. But whether the latter effects are due to the inductive action of the electricity or the tremor produced by the thunder, has not, to our knowledge, been definitely settled. If the effects are due to induction, it is probable that they would be greater in the case of milk in a metallic pan resting on the earth, than in one of glass, supported on glass legs or a thick cake of beeswax.

PRECAUTIONS WITH REGARD TO LIGHTNING.

Men have often been struck by lightning in open plains, and since the human body is a good conductor of electricity, from the principles we have given it must be evident that when standing it would be more likely to be struck than any point on the earth in the vicinity. There is less danger in a horizontal position, particularly if the person be resting on some non-conducting substance which would prevent the natural electricity from descending into the earth. Near the foot of a tall isolated tree is always considered a dangerous position, and this is in accordance not only with facts but well-established principles. The upper part of the tree being a partial conductor, particularly if covered with foliage, will become electrified by induction, will attract the dis-

charge to itself, and in the passage of the lightning toward the earth it will act with energetic induction on all surrounding objects, and since the body of the man is a better conductor than the wood, the instantaneous inductive effect of the descending bolt will be greater on the head of the man than on the remaining part of the tree in its descending course, and hence it will diverge from the line it was pursuing, break through the air, and pass through the body of the man. To attempt to explain this phenomenon, by merely saying that the electricity leaves the tree because the human body is a better conductor than the wood, is to attribute to this agent prescience and forethought, but by an application of the principles of induction, the whole is referred to the simple action of attraction and repulsion. In the interior of a house, the safest position we can well imagine is that of being horizontally suspended in a hammock by silk cords in the middle of a room, and perhaps the next, that of lying on a mattress or feather bed on a wooden bedstead, the materials of which are very imperfect conductors. It is scarcely necessary to say that if the bedstead be in the middle of the room, at a distance from the wall, the danger will be less.

It may, perhaps, be well to dwell for a moment on the explanation of the foregoing statement. Let us suppose a man to be standing on a large piece of beeswax, which is almost a perfect non-conductor, and exposed to a cloud highly charged with positive electricity A portion of the natural electricity of his head would be drawn down into his feet; the former would become negatively electrified and attract the lightning of the cloud, while the latter would repel it; the tendency to be struck would be on account of the difference of these two actions. If the man stepped off the non-conducting wax on to the earth, the redundant electricity which had collected in his feet would be discharged, his head would become still more negatively electrified, the repulsion which existed in the other case would disappear, while the attraction would be increased, and hence the tendency to be struck would be much greater.

Let us next consider what would take place if a man should be extended horizontally on a large disk of beeswax. In this case the upper part of the body, or that toward the sky, would become negative, and the lower part, or that in contact with the beeswax, would become positive, and the attractions and repulsions would be exhibited as in the first instance, but with less energy, because their foci would be much nearer each other, and consequently they would act with almost equal effect; while the repelled electricity not having space into which to descend, a less quantity of it would be repelled from each point of the upper surface. If the disk of wax were placed above the man's head while in a standing position, it would not screen the repulsive energy of the cloud, which, like gravitation, acts through all bodies; the induction would take place as before, the head would become highly negative, while the natural electricity which had been driven down would escape into the earth. The effect would, therefore, be the same as if the individual were standing on the earth without the intervention of the non-conducting material. A descending bolt would be attracted towards his head, and if the tenacity of the beeswax were not sufficient to withstand a disruptive discharge, the body would be injured. It is

from a misapprehension of these principles that it has been supposed that the protection is increased by a slight covering over the body, of silk or feathers, or by interposing a plate of glass between the sky and body; but it is well known that fowls and other large birds are struck, the slight covering of feathers affording no protection while the feet are in connection with the earth.

From the conducting capacity of the lining of the soot of a chimney, and of the smoke and heated air which ascends from the flue, it will be clear that the vicinity of the fire-place during a thunder storm is not the safest position which may be chosen in a house. A person leaning out of an open window may also not be in a very safe position, because the outside of the house, wetted with rain, will be rendered a partial conductor, and a descending charge along the wall may reach the body projecting beyond the surface. The induction is always greater where there is a large amount of conducting material; hence barns filled with damp hay will be more liable to be struck than when empty. Besides the action of induction in this case, it is generally supposed that the danger is increased by the ascent of moist vapor from the barn at the season mentioned; and this supposition, which is in accordance with scientific principles, is apparently borne out by observation.

On the principle of the increase of induction in the collection of a large number of conducting bodies in a given space, the assemblage of persons in churches, or other places of public meetings, increases the tendency of lightning to fall on the edifice. The inductive action will be slightly increased when the audience assumes a standing position. For a similar reason, sheep which are crowded together during a storm are frequently killed by lightning. The fact has several times been noticed, that when a discharge passes through a number of animals arranged in a straight line, those which are at the extremities of the row suffer most; and this has been observed even when the animals were not in immediate contact with each other, as, for example, a number of horses in a series of stalls. It is probable that the heated air between the horses may have served as a conducting medium, and that the effect can be referred to the increase of intensity which always takes place in the electrical discharge at the points where the air is ruptured, or where the electricity enters and passes out.

The probability of injury from lightning, even in this country, where thunder-storms are comparatively frequent in the summer, is slight; and though it may be well to observe proper precaution, yet, on account of the small risk to which we are subjected, we should not deprive ourselves of the gratification of observing and studying one of the most sublime spectacles of nature; and, indeed, we know of no better way of overcoming the natural dread which many persons have of this meteorological phenomenon than by becoming interested in its scientific principles, and in studying, in connection with these, its appearance and effects.