In two of the instances the lightning was seen to strike the rod on one of the towers; in a third, a bright spark due to induction and attended with an explosion as loud as that of a pistol was perceived; and in the fourth instance, although the platinum top of the rod, which was one hundred and fifty feet from the surface of the ground, was melted, the discharge was transmitted to the earth without any other effort than a slight inductive shock given to a number of persons standing at the foot of the tower. In three of the cases, the peculiar sound we have mentioned was observed; first, a slight hissing noise, and afterwards the loud explosion, as if the former were produced by the effect of the discharge on the air in the immediate vicinity of the rod, and the loud noise from that on the air at a more distant point of its path.

The writer of this article was led to reflect upon this effect of the rod, by a remarkable exhibition he witnessed during a thunder storm at night in 1856. He was in his office, which is in the second story of the main tower of the Smithsonian edifice, when a noise above, as if one of the windows of the tower had been blown in, attracted his attention; an assistant, who was present, was requested to take his lantern and ascertain what had happened. After an absence of some time he returned, saying he could discover nothing to account for the noise, but that he had heard a remarkable hissing sound. The writer then ascended to the top of the tower, and stood in the open trap-door with his head projecting above the flat roof within about twelve feet of the point of the lightning-rod. No rain was falling, though an intensely black cloud was immediately overhead and apparently at a small elevation; from different parts of this lightning was continually flashing, indeed the air around the top of the tower itself appeared to be luminous. But the most remarkable appearance was a stream of light three or four feet long issuing with a loud hissing noise from the top of the lightning-rod. It varied in intensity with each flash, and was almost continuous during the observation. Although the whole appearance was highly interesting, and produced a considerable degree of excitement, yet the writer did not deem it prudent to expose himself to the direct or even inductive effect of a discharge under such conditions, thinking, as he did, with Arago, that however our vanity might prompt us to boast of the acquaintance of some great lords of creation, it is not always desirable to seek their presence or court much familiarity with them. The effect in this case of the rod on the surrounding air and on the cloud itself by invisible induction must have been considerable.

ACTION OF LIGHTNING-RODS.

The question as to whether the lightning-rod actually attracts the electricity from a distance has been frequently discussed. It will be found, says Sir W. Snow Harris, "that the action of a pointed conductor is purely passive. It is rather the patient than the agent; and such conductors can no more be said to attract or invite a discharge of lightning than a water-course can be said to attract the water which flows through it at the time of heavy rain." This statement does not, as it appears to us present a proper view of the case. From the

established principles of induction, it must be evident that all things being equal, a pointed rod, though elevated but a few feet above the ground, would be struck in preference to any point on the surface, and the propositions as to the space which can be protected from a discharge of lightning is founded on the supposition that the direction of the discharge can be changed by the action of the rod at a distance, and the bolt drawn to itself. The true state of the case appears to us to be as follows:

1st. An elevated pointed rod, erected for example on a high steeple, by its powerful induction diminishes the intensity of the lower part of the cloud, and therefore may lessen the number of explosive discharges to the earth.

2d. If an explosive discharge takes place from the cloud due to any cause whatever, it will be attracted from a given distance around to the rod, and transmitted innoxiously to the earth.

A too exclusive attention to either one or other of these actions has led to imperfect views as regards the office of the lightning-rod. On the one hand, some have considered the whole effect of the rod is to lessen the number of discharges in the way we have described, and have considered it impossible that an explosive discharge could take place on a pointed conductor. But this is not the case, as was shown by Mr. Wilson many years ago by his experiments in London. It is true, that when a needle is presented to a charged conductor, the electricity is drawn off silently without an explosion, and this is always the case if sufficient time be allowed for the electricity to escape in this way. But if the point be suddenly brought within striking distance of the conductor by a rapid motion, such as would be produced by the movement of a horizontal arm carrying the point immediately under the conductor in an instant, an explosive discharge will take place. In this case, sufficient time is not given for the slower transmission of the electricity by what has been denominated the glowing discharge, and a rupture of the air is produced as in the action of a conductor terminated by a ball.

It would follow from this, that, in case of a rapidly-moving cloud across the zenith of a rod, there would be a greater tendency to an explosive discharge on the point than when the cloud was nearly stationary. For a similar reason, if a point, connected by a wire with the earth, be directed toward an insulated conductor, and the latter be suddenly electrified by a discharge from a second conductor, an explosion will take place between the first conductor and the point. A similar effect would be produced if a lower cloud received a sudden discharge from one above it, a case which probably frequently occurs in nature. Mr. Wise informs us that, when a discharge takes place beneath a cloud to the earth, a discharge is seen to pass between the upper and lower part of the cloud, represented by Fig. 19. We are warranted from the foregoing facts, as well as from the numerous examples in which lightning has actually beeen seen to fall upon pointed rods explosively, and the number of points which have been melted, to conclude that the rod, under certain conditions, does actually attract the lightning; though when properly constructed it transmits it without accident to the earth.

It has been denied by some that the point has any perceptible influence in lessening the number of strokes from a cloud, but this proposition can scarcely be doubted when we reflect upon the fact that it is not necessary entirely to discharge a cloud in order to prevent a rupture of the air, it being only necessary to draw off a quantity of the fluid sufficient to reduce it just below that which is required to produce the explosion; and for this effect there may be required but a very slight diminution in the intensity of a cloud which is just at the striking distance to prevent an explosion, particularly when we consider the prodigious number of sparks which, during thunder storms, were silently withdrawn from the cloud by the pointed rod erected by Beccaria.

Arago has collected a large number of instances, from which it appears that the erection of a rod lessened the number of explosive discharges.

The campanile of St. Marks, at Venice, which from the multitude of the pieces of iron in its construction, was in a high degree obnoxious to danger from lightning, and had been in fact prior to 1776, known to be struck nine times. In the beginning of that year a conductor was placed upon it, and since that time the edifice has been uninjured by lightning.

Previous to 1777, the tower of Sienna was frequently struck, and on every occasion much injured. In that year, it was provided with a conductor, and has since received one discharge, but with no damage.

In the case of a church at Corinthia, on an average four or five strokes of lightning annually were discharged upon the steeple until a conductor was erected, after which one stroke was received in five years. At the Valentino palace the lightning conductors established by Beccaria, caused the entire disappearance of strokes of lightning which were previously of frequent occurrence.

The monument in London, although only accidentally provided with a virtual conductor, appears to have been exempt from damage by lightning for nearly one hundred and eighty years.

The action of the rod, however, in diminishing the intensity of the cloud, can only be of a very temporary character, and cannot, as some have supposed, affect its subsequent state, or disarm it of its fulminating power, since its electricity is constantly renewed; a fact sufficiently demonstrated by the observation that a thunder storm, through its whole course of several hundred miles in extent, continually gives discharges to the earth. Notwithstanding the instances given by Arago of the diminution of discharges of lightning after the erection of the rod, the fact is established by observation, experiment, and theory, that the rod does attract the lightning, and receives the discharge not alone silently, but explosively. The points of the conductors are frequently melted, and although in cases in which this occurs, the discharge passes harmlessly to the earth, yet in some instance the explosion might not have taken place had the rod not been present.

In a house properly provided with lightning-rods, however many discharges may fall upon it, we are well assured from full experience and established principles, no damage can ensue to the occupants within.

There is, perhaps, no edifice in the country more exposed to explosive discharges of lightning than the Smithsonian building. It is situated on a plain, at a considerable distance from any other building, at present without trees near it, except those of a few years growth, and surmounted with nine towers, of heights varying from 60 to 150 feet. Five of these are provided with lightning-rods; and, although we should have advised the furnishing a rod to each tower, yet thus far the building has escaped unscathed, although several explosive discharges have passed down the rods.

The following instructive illustration of the action of a very elevated conductor in transmitting a discharge from a thunder cloud, is furnished us by Mr. Henry J. Rogers, telegraph engineer, who was himself an eye witness of what he relates:

"In accordance with my promise, I will endeavor to give you a brief description of the effect produced by atmospheric electricity at the House Telegraph Mast, erected at the palisades on the west side of the Hudson river, in the vicinity of Fort Lee, New Jersey, and distant about ten miles from the city hall, New York, during a terrific thunder storm which occurred on Friday, June 17, 1853, between three and four o'clock, p. m., while I was on an official visit.

"Before I proceed with the description, it will be necessary to explain that the wires of the House and Morse telegraph lines cross the Hudson river between Fort Washington and the palisades, inasmuch as this is the narrowest part of the river in the vicinity of New York; and the elevation of the land at the palisades, renders it a desirable place for suspending the wires from one shore to the other, so as to allow vessels of large size to pass under them free from interruption.

"The mast to support the wire was 266 feet in length, and was erected on the top of the columnar wall of the palisades, which at this place is 298 feet above the river, as determined by trigonometrical measurement. The top of the mast was therefore 564 feet above the water, and was sufficiently elevated to allow for the unavoidable swag of the telegraph wire, and to leave sufficient distance for vessels to pass beneath.

"It was composed of three pieces of heavy timber placed one above the other and fastened together by iron bands, to which were attached long iron braces or guys, secured at the lower ends to the rock, for the purpose of sustaining the mast in its perpendicular position. The braces or guys were formed of iron rods three fourths of an inch in diameter, and painted black. The longer or outer ones, those which were attached to the top of the mast along which the electricity descended to the earth, terminated about 32 paces from the lower end of the mast, and was composed of pieces of iron rod of thirteen feet in length, and each piece terminated in a bolt and shackle, thereby forming a series of links 30 in number.

"A lightning-rod six feet long, three quarters of an inch diameter, painted white, sharpened to a point, but not tipped with platinum, and secured at its lower end to the iron band to which were attached the upper set of guys, projected about two or three feet above the truck of the mast. The point of the rod was at the time in the center of a cedar bush in

full foliage which had been placed there by the riggers when they completed the mast.

"At 3 p. m., when the storm commenced, I placed myself in the rail way house at Fort Washington, a point distant about three quarters of a mile from the mast at Fort Lee, on the opposite side of the river. From my position I could distinctly observe the gust as it advanced from the southwest; and from the heat of the weather and appearance of the clouds I expected to witness heavy discharges of atmospheric electricity, and prepared my mind to observe the effects of the storm on the mast at Fort Lee, having frequently expressed a desire to witness a thunder storm in the vicinity of the mast, as I felt assured the iron rod and guys would protect it from injury.

"As the gale increased, the clouds advanced with a heavy atmosphere, and accompanied with frequent discharges of lightning and loud thunder. When it approached the mast the foremost cloud assumed the shape of an inverted cone similar to those I have witnessed in the gulf, forming a water-spout; and I soon observed a terrific flash of lightning descend by the southern iron guy clearly defining its form and every link of the guy as though it were a rod of red-hot iron; and this appearance continued for a least four seconds, followed by three or four heavy peals of thunder in rapid succession, during which time the lightning appeared to flow in a continued stream of fire along the iron guy, and giving off during its progress apparently as many snaps of electricity as there were links in the guy, and which I supposed to be caused by the resistance offered by each link to the free passage of the electricity.

"These discharges were succeeded by a heavy gush of rain, which obstructed my view of the palisades, but other discharges of atmospheric electrity followed as the cloud rushed on its course of the North river. The storm lasted about half an hour.

"Within 50 paces north of the mast described stood the Morse-line mast, which is about 40 feet less in height than the House mast; and during the storm there was no indication of any part of it being struck by lightning, although there is attached to it a conductor of atmospheric electricity. From this, I infer that the discharge of lightning passed to the earth along the iron guys of the House mast, owing to its greater elevation, and its being nearer south in the direction of the storm.

"Such was the vividness and intensity of the light which was emitted along the guy at the time of the discharge that I received the impression that the iron was melted, and expected every moment to see the mast prostrated by the wind, but was much surprised, on examining the premises next day, not to find the least evidence of fusion on the rod, or marks of any kind along its surface, to indicate the passage of the electrical discharge.

"The palisades in the vicinity of the mast are heavily timbered, and although the limbs of several trees are in contact with the iron guys running from the mast, not the slightest damage was done to any of these trees; but about one fourth of a mile south of the mast a large tree was shattered by lightning during the same storm.

"The mast stood about five years, and during that time, as reported by those having charge of it, was struck at almost every violent thunder storm that passed over the place. It was considered by persons living in the neighborhood as a protection against lightning.

"Indeed such was the confidence in it, that the telegraph workmen did not hesitate to take shelter during a storm in a house 15 feet square, which was built around the mast, and in which implements, windlasses, &c., were kept.

"HENRY J. ROGERS.

"BALTIMORE, *November* 30, 1853."

The facts presented in the foregoing narative are highly instructive. The descent of the visible vapor in the form of an inverted cone is a phenomenon which will be considered of special interest, particularly by those who ascribe the motive power of a tornado entirely to electricity.

The continuance of the discharge during four seconds is in accordance with other instances which have been frequently observed, and is to be attributed to a series of discharges in rapid succession through the same path.

The appearance of light along the whole course of the rods forming the guy may be attributed to the circumstance that the metal at the time of the discharge was covered with a thin stratum of water into which the electricity was projected by its self-propulsion, and on account of the imperfect conductibility of the liquid, gave rise to the phenomena observed.

This may be illustrated experimentally by discharging an electrical battery through a slip of tin foil wetted with a thin stratum of water. The discharge which would be insensible along the dry metal becomes luminous through its whole course.

While this account of Mr. Rogers clearly shows the attractive power of an elevated conductor under particular circumstances, it also proves the fact that an edifice may be protected from harm, provided it be furnished with a sufficient number of properly constructed rods.

CONSTRUCTION OF LIGHTNING-RODS.

Electricity as we have seen page 483, tends to pass at the surface of a conductor of a sufficient size, but it does not follow from this that every increase of surface, the quantity of metal being the same, will tend to diminish the resistance of the conductor to the passage of a discharge. From an imperfect view of the subject, many persons have supposed that merely flattening the lightning-rod, and thus increasing the surface would tend to increase the conducting power, but it must be evident from the principle of repulsion, that in diminishing the distance between the two flat surfaces, we tend to increase the repulsion between the atoms, which would pass parallel to the axis along the middle of each flat side, and thus, though the surface is increased by flattening a round bar, the conduction is diminished, and a greater intensity is given to the electricity at the edges, tending to increase the lateral escape of the fluid. The only proper way of diminishing the resistance to conduction in a cylinder of metal of a given capacity, is

to mold it into the form of a hollow cylinder; a gas-pipe, for example, will offer less resistance to conduction than the same weight of metal in the form of a solid cylinder; but we must not infer from this that a gas-pipe an inch in diameter will conduct better than a solid rod of iron of the same diameter. There is no known law of electricity which would lead us to suppose that by removing the metal from the interior of a rod, we increase its conducting capacity. On the contrary, when the charge is very great in proportion to the size of the conductor, it is probable that the discharge penetrates through the entire mass. The rod should be of sufficicent size to transmit freely the largest discharge which experience has shown to fall on a building. A rod of three fourths of an inch of round iron is generally considered sufficient for this purpose, since a conductor of this capacity has in no case been found to have been fused by a discharge from the clouds. There is no objection on the score of electrical action to using a larger bar, or to the same weight of metal in the form of a hollow cylinder; indeed every increase of diameter lessens the resistance to conduction, and the tendency to give off lateral sparks.

Lightning-conductors are frequently constructed in this country with points projecting at intervals of two or three feet through their whole length; this plan has been adopted from some erroneous idea in regard to the action of the conductor, and of the proper application of points. The essential office of the conductor is to receive the discharge from the cloud, and to transmit it with the least resistance possible, silently and innoxiously to the great body of the earth below, and anything which militates against these requisites must be prejudicial. Now, in the passage of the electricity through a conductor, it retains its repulsive energy, and hence each point along the rod in succession becomes highly charged, and tends to give off a spark to bodies in the neighborhood. Besides this, the irregularity in the motion of the electricity which is thus produced, must on mechanical principles interfere with its free transmission. The points along the course of the rod should, therefore, be omitted, since they can do no possible good, and may produce injury.

We may conclude what we have said in regard to lightning-rods by the following summary of directions for constructing and erecting them:

1st. The rod should consist of round iron, of not less than three fourths of an inch in diameter. A larger size is preferable to a smaller one. Iron is preferred because it can be readily procured, is cheap, a sufficiently good conductor, and when of the size mentioned cannot be melted by a discharge from the clouds.

2d. It should be, through its whole length, in perfect metallic continuity; as many pieces should be joined together by welding, as practicable, and when other joinings are unavoidable, they should be made by screwing the parts firmly together by a coupling ferule, care being taken to make the upper connection of the latter with the rod water-tight, by cement, solder, or paint.

3d. To secure it from rust, the rod should be covered with a coating of black paint.

4th. It should be terminated above, with a single point, the cone of which should not be too acute, and to preserve it from the weather as well as to prevent melting, it should be encased with platinum, formed by soldering a plate of this metal, not less than a twentieth of an inch in thickness, into the form of a hollow cone. Usually the cone of platinum, for convenience, is first attached to a brass socket, which is secured on the top of the rod, and to this plan there is no objection. The platinum casing, however, is frequently made so thin and the cone so slender, in order to save metal, that the point is melted by a powerful discharge.

5th. The shorter and more direct the rod is in its course to the earth the better. Acute angles made by bending in the rod and projecting points from it along its course should be avoided.

6th. It should be fastened to the house by iron eyes, and may be insulated by cylinders of glass. We do not think the latter, however, of much importance, since they soon become wet by water, and in case of a heavy discharge are burst asunder.

7th. The rod should be connected with the earth in the most perfect manner possible, and in cities nothing is better for this purpose than to unite it in good metallic contact with the gas mains or large water pipes in the streets; and such a connection is absolutely necessary if the gas or water pipes are in use within the house. This connection can be made by soldering to the end of the rod a strip of copper, which, after being wrapped several times around the pipe, is permanently attached to it. Where a connection with the ground cannot be formed in this way, the rod should terminate, if possible, in a well always containing water, and where this arrangement is not practicable, it should terminate in a plate of iron or some other metal buried in the moist ground. It should, before it descends to the earth, be bent so as to pass off nearly perpendicular to the side of the house, and be buried in a trench surrounded with powdered charcoal.

8th. The rod should be placed, in preference, on the west side of the house, in this latitude, and especially on the chimney from which a current of heated air ascends during the summer season.

9th. In case of a small house, a single rod may suffice, provided its point be sufficiently high above the roof, the rule being observed, that its elevation should be at least half of the distance to which its protection is expected to extend. It is safer, however, particularly in modern houses in which a large amount of iron enters into the construction, to make the distance between two rods less than this rule would indicate rather than more. Indeed we see no objection to an indefinite multiplication of rods to a house, provided they are all properly connected with the ground and with each other. A building entirely inclosed, as it were, in a case of iron rods so connected with the earth, would be safe from the direct action of the lightning.

10. When a house is covered by a metallic roof, the latter should be united, in good metallic connection, with the lightning-rods; and in this case the perpendicular pipes conveying the water from the gutters at the eaves may be made to act the part of rods by soldering strips of copper to the metal roof and pipes above, and connecting them with the earth by plates of metal united by similar strips of copper to their lower ends, or better with the gas or water-pipes of the city. In this

case, however, the chimneys would be unprotected, and copper lightning-rods soldered to the roof, and rising a few feet above the chimneys, would suffice to receive the discharge. We say soldered to the roof, because if the contact was not very perfect, a greater intensity of action would take place at this point, and the metal might be burnt through by the discharge, particularly if it were thin.

11. As a general rule, large masses of metal within the building, particularly those which have a perpendicular elevation, ought to be connected with the rod. The main portion of the great building erected for the world's exhibition at Paris is entirely surrounded by a rod of iron, from which rises at intervals a series of lightning conductors, the whole system being connected with the earth by means of four wells, one at each corner of the edifice.

The foregoing rules may serve as general guides for the erection of lightning-rods on ordinary buildings, but for the protection of a large complex structure, consisting of several parts, a special survey should be made, and the best form of protection devised which the peculiar circumstances of the case will admit.

Various patents have been obtained in this country for improved lightning-conductors, but as a general rule such improvements are of minor importance.

An improvement in the form of the lightning-rod, which was recommended by the French Academy in 1823, would presuppose some important discoveries in electricity having a bearing on the subject; but after the lapse of thirty years, the same Academy being called upon to consider the protection of the new additions to the Louvre, finds nothing material to change in the principles of the instructions at first given.

TOBACCO.

From CHARLES A. LEAS, *United States Consul.*

REVEL, RUSSIA, *August* 25, 1859.

Tobacco is cultivated in the Russian governments of Paltowa, Tschernegow, Saratof, Bessarabia, Charkow, Orel, Riazen, Koursh, Kiew, &c,, portions of the Crimea, Siberia, and the Trans-Caucasian provinces. I understand, however, that in consequence of the failure to produce a good and profitable article, its cultivation has been abandoned in some of the above governments. It is all of very inferior quality. The only place that an article sufficiently good for the manufacture of cigars is produced, is in Bessarabia.

The government of Russia, with the view of encouraging and improving the cultivation and quality of tobacco, had seed brought from Turkey, Germany, Cuba, and the United States, and distributed it free; but still the experiments were not satisfactory. She then instructed her agents in those countries to observe carefully the cultivation and all the important facts connected therewith, and transmit the result for the benefit of the cultivator. An experienced tobacco grower was also brought from Germany to impart instruction. After all this, as above stated, an article sufficiently good for cigars could not be produced, except in Bessarabia, and that was from seed brought from the United States. Its cultivation has been proved to exhaust, to an enormous extent, the strength of the soil, to renew which the strongest manures must be used; namely, the ordinary barn-yard manures. It is not here as profitable a crop as the ordinary grains; that is to say, in some of the governments alluded to the cost of transporting the surplus grain product to the exterior is so great, that the cultivation of tobacco takes its place from necessity, because the tobacco can be consumed at home. But there is little doubt that when Russia shall have completed her great net-work of railroads, thus giving to her people a cheap and speedy outlet for the surplus grain product, tobacco will cease to be cultivated to any considerable extent, and the demand from foreign countries will be increased. There is none so popular in Russia as the American tobaccco, and that of Maryland is preferred.

At present about one hundred and eight millions of pounds is produced per annum. None, I believe, is exported.

In 1857, 60,000,000 of pounds was imported, namely:

	Poods.
From America, direct	422
From Prussia	14,601
From Denmark	384
From Hanse Towns	51,141
From Holland	44,544
From Belgium	16
From England, direct	3,148
From France, direct	636
From Sardinia, direct	1
From Austria, direct	154
From Turkey	56,458
From West Indies and South America	376
From all other countries	576
	172,457

or 30,000 English tons.

The duty on tobacco brought into this country, is, on raw or unmanufactured, six rubles and thirty kopecks per pood, or $308 57 cents per ton, being fifteen and nearly a half cents on the pound, or, as will be seen by the United States census returns, over 100 per cent. on the cost of production in America.

On smoking tobacco the duty is the same. On cigars it is about $1 50 per pound.

There is no tobacco made or used for the purpose of chewing in this country. Each inhabitant in the empire consumes an average of two pounds per annum.