

(1) Number of pages _____
(2) Date of repair 15.7.86
(3) Initials of the Referencer long

TAMIL NADU ARCHIVES

GOVERNMENT OF TAMIL NADU

P. W. DEPARTMENT

G.O. No. <u>1806-W</u>	Press.
B.P. No.	Mis.
Dated <u>11.4.1878</u>	<u>197</u>

Not to be folded or roughly handled.

V. S. M.

GOVERNMENT OF MADRAS.
PUBLIC WORKS DEPARTMENT.

11th April 1878, No. 1,806 W.

Buildings and Roads.

Civil Works.

Read the following paper:—

No. 137. From the Deputy Secretary to the Government of India, Public Works Department, (Civil Works—Miscellaneous,) to the Secretary to the Government of Madras, Public Works Department, dated Fort William, 1st April 1878, Circular No. 35 P.W.

In continuation of Circular No. 23 PW, dated the 5th ultimo, the undersigned is directed to circulate, for general information and guidance, extract from an address delivered by Dr. Mann at the annual general meeting of the Meteorological Society, held on the 19th January 1876, regarding the protection of buildings from lightning.

(Signed) CHARLES POLLARD, Col., R.E.,
Dy. Secy. to the Govt. of India.

Extract from an Address delivered by Dr. Mann at the Annual General Meeting of the Meteorological Society held on 9th January 1876.

In the report of the Council which has afforded me the opportunity for these remarks there is one other topic touched upon which I may perhaps also be permitted very briefly to allude to, on account of the part I have personally taken, and the interest which I have found, in suggesting its consideration to my colleagues. I allude to the establishment of a permanent committee for investigating the phenomena of atmospheric electricity and the effects of lightning, and for the diffusion of sound principles in reference to provisions made for defence against the destructive meteor.

In taking up the thread of what I desire to say upon this theme, I can hardly neglect to draw your attention to the very admirable and interesting account of the accident from lightning at Roundham Head, near Torquay, with which we were favored at one of our Sessional Meetings in the past year by Mr. D. Pidgeon, who was able to give force to his instructive narrative by the argument of "Magna pars fui," which is always interesting from the mouth of one who is relating effects which he has himself experienced. I should also add that this narrative which was printed in the October number of our Quarterly Journal, has rendered us a double service, and has laid a double obligation upon us, on account of the example which it sets, in its very clear and exact description of facts, and in its very full and sagacious selection of essential characteristics of the way in which it is desirable such communications should be presented for the discussions of our Committee.

One of the most notable facts which is brought under notice in this communication from Mr. Pidgeon, is the rupture of the links of the mooring chains attached to the bottom of the stays of the flag-staff. The staff itself, which was involved in this accident, consisted of a stout mast fifty feet high, stayed with four galvanized iron guy ropes at about twenty-five feet from the ground. Each wire rope terminated about twelve inches above the ground in half-inch cable chains, which were carried down to an anchorage in a sub-soil of very dry red sand-stone conglomerate.

The entire mast above the attachment of the guys was shattered into splinters by the lightning discharge; and three of the mooring chains below were broken across, several links in each chain being severed. About twenty links altogether were fractured, and of these some were above, and some within, the ground. Several of broken links had been considerably corroded by rust, but in those the parts severed were the undiminished portions of the iron, and not the segments which had been eaten away by the corrosion. In one place a bent hook of one-tenth of an inch iron wire, which had been used as a substitute for a previously damaged link, was uninjured by the discharge, although several of the links in the same stretch of chain were severed. The broken surfaces in the damaged links were bright and crystalline, and gave no indications of the metal having been subjected to great heat. It is much to be regretted that the whole of the

broken links of these chains were not carefully preserved for a further examination of their conducting capacity. Mr. Pidgeon very kindly did what he could to recover them after his attention had been drawn to their scientific value, but unfortunately without success.

Some important practical considerations hang immediately upon the history of these damaged chains. The great increase in the molecular disturbance set up by the discharge at the lower extremity of the conducting system in consequence of the insufficiency of the earth contact is very well illustrated. The distribution of the disruptive discharge through all the several branches of the earth contact is also expressed. Three of the four mooring chains, which were directed out to four opposite points of the compass, were severed. But the most important circumstance connected with the breaking of these chains is the number of the links which were effected by the disruption, and that those which were injured were broken through the parts of largest metallic area, and not through the lines of diminished section where it might have been expected the greatest resistance to the electrical transmission would have been found. Prof. Melsens, of Brussels, one of the Foreign Members of our Committee, whose attention I have drawn to this circumstance, thinks that the highly crystalline condition of the iron of the broken links indicates that those parts of the chain had already undergone considerable molecular disintegration and change subsequently to their first attachment to the guy ropes, in consequence of the incessant vibration to which they had been subjected under the play of the wind, and he believes that they had been thereby reduced to their lowest cohesive capacity at the spots where the disruption occurred. He takes the uninjured integrity of the new piece of fibrous wire of so much smaller dimensions as furnishing a substantial proof of this view of the matter.

In further illustration of the point which is here glanced at, namely, the power of electrical discharges of high tension to produce molecular disturbance in even conducting metallic substance, I have another very curious instance to place before you. Some years ago it happened during a severe thunderstorm in Natal, that a small house of public entertainment, known as the German house, and standing upon the high road between the seaport and the capital, was struck by lightning and burned. Upon one part of the ruin, where there had been a tin box containing money, the curious object which I now present to the meeting was afterwards found, as all that remained of the tin box and the money. It consists of a fragment of a half sovereign in gold inseparably welded to a little piece of tinned sheet iron. The entire fragment weighs 75 grains, and of these about 30 grains are gold, and the rest iron. Something more than half of the gold coin has disappeared, and the remnant is eaten out into an irregular crescentic form, with one blunt horn projecting beyond the iron. The rest of the gold piece, comprising about one-third of a square inch of superficial area, is metallically connected with the iron by an actual brazing together of the particles of the iron and the gold, and the tinned surface of the iron beyond the attachment is bronzed by a thin film of gold particles that have been scattered over it at the instant of the brazing. The fragment of the iron plate is an inch long, by three-fifths of an inch broad. The "gnawed out" aspect of the gold coin, where the remnant has been left by the electric tooth which has consumed the rest, is very curious. A marginal band of lighter-colored gold, that looks as if it had been alloyed so far, either with tin or iron, is set round the sinuous edge of the erosion, and there is a central "pivot-head" like spot in the middle of the attachment of the iron and gold which is characterised by the same "amalgam-like" hue.

Professor Melsens, who is Professor of Physics and Chemistry at the School of Veterinary Medicine of the Belgian Government in Brussels, and to whom I have already made some allusion as one of the Foreign Members of our Lightning Rod Committee, has been for some time engaged with a very interesting series of experiments in regard to the capacity of copper and iron to transmit electrical force, and to the disintegrating effects that are produced by discharges of high tension. When I was recently in Brussels, the Professor did me the favor to show me many of these experiments at his laboratory, and to explain his views at some length, and it gives me great satisfaction to have this opportunity to make a somewhat public acknowledgment of the consideration and courtesy which I received at his hands upon that occasion, as well as of the readiness he has shown at other times to give me his aid and counsel.

in one of his experiments, Mons. Melsous undertakes to demonstrate that the old electrical dogma, which affirms that an electrical discharge of necessity takes the shortest and easiest path, is one that needs to be entertained with distrust and doubt. The Professor has constructed a kind of gridiron of metal, which has a straight stem of large size passing as a direct road through its centre, and also a series of roundabout lateral passages formed by small wires ranging on the right and on the left of the central stem. When energetic discharges from a Ruhmkorff coil are passed through the short, direct, and amply capacious route of the large central stem, smart shocks are simultaneously communicated to any finger that is presented to the small lateral wires. The electrical discharge here manifestly passes through the whole metallic mass, and not only through the most direct path of its straight central stem. A considerable amount of the escaping force goes out of its way to traverse the roundabout and devious route of small capacity, although the broad straight path of large capacity is open immediately before it. The equal distribution of the electrical discharge through many possible routes of conducting material is also ingeniously and pleasingly shown by offering a number of very fine wires of equal capacity to

the discharge, when the fact that they all contribute in an equal degree to the conveyance of the force is proved by the entire series of wires being "curled" and waved after the discharge in consequence of the molecular disturbance that has been set up in them during the passage. Professor Melsens also draws attention to the remarkable and interesting circumstance, that in this experiment all the several wires are curled and wave in exactly the same way, each wire having its undulations in the same place, and of the same length, like the nodal arrangements in the vibrations of a stretched string of equal tension and size, but the "facile princeps," so far as interest is concerned, of the numerous experiments of Mons. Melsens, is, I think, one in which he investigates the relative "tenacity" of copper and iron when subjected to the disintegrating dispersion of electrical discharges of high tension. The arrangement consists in placing very fine wire of copper and of iron in the path of a powerful battery discharge. The wires are carefully selected, and adjusted so as to be of precisely the same size and length, and the same discharge is passed through both the copper and the iron. The discharge employed is that of fifteen very large Leyden jars grouped together as a battery. After the discharge has been passed, it is found that the copper wire is dissipated into a trail of black dust, while the iron wire is not even broken across, but is "beaded" along its entire length by a series of successive protuberances. In this experiment it is clearly demonstrated that copper, which is almost universally accepted as the most reliable metal for powerful electrical discharges, is much more easily disintegrated by their action than iron, notwithstanding the well-known fact that it is more heated by them than copper.

copper.

I gladly availed myself, during my agreeable visit to Professor Melsens, of the opportunity to examine very carefully, under his competent guidance, the details of the arrangements which he has adopted for the protection of the fine old Hotel de Ville of Brussels from the injurious effects of lightning—a work which is now of European celebrity. In this system of defence, iron rods of adequate size are carried out to all the salient projections of the building, and are there protruded into the air in a series of pointed terminals, of which some are grouped around and above the gilded statue of St. Michael, that stands at the top of the central tower of the facade, overlooking the city from its giddy height of 298 feet. There are about 428 points, large and small, and the rods which descend from these points are collected below into a group of eighteen main stems, which are enclosed together in a wooden case, and then made into a continuous metallic mass, by pouring around them, in the interior of the case, molten zinc. On emerging from this connected block beneath, the eighteen rods are sorted out into three parcels, which thus contain six rods each. The first of the series of six is then carried down to a large iron cylinder, sunk ten feet into the moist ground, and firmly soldered to it. The second parcel is soldered in a similar way to one of the large iron pipes of the water supply of the town; and the third parcel is soldered to one of the large iron mains of the gas service of the town. By these admirable expedients a multiple earth contact is finally secured, which, to use Mons. Melsens's own words, comprises not less than twenty millions of kilogrammes, or twenty-two thousand English tons of cast iron tubes. Some of the other public buildings of Brussels have been furnished with lightning conductors upon a similar comprehensive plan, but from conversation with Mons. Melsens, I gleaned that he entertains the bold and magnificent design of getting the entire town some day connected into one continuous system of protection, which shall be to the entire city what the bristling points and multitudinous rods of the Town Hall now are to its gables and pinnacles: a purpose to which the very great compactness of the town obviously lends itself.

The great leading characteristic of this very noble work of Mons. Melsens, which most impresses itself upon the mind of the intelligent and critical observer, who looks down upon the bristling points from a near approach to St. Michael's Footstool, and then examines the subterranean earth contacts, as I did in the pleasant company of the distinguished electrician, is the boldness and uncompromising completeness with which the fundamental ideas of a very ample development of air terminals above, and of earth contacts beneath, is acted upon; an allegiance to correct theory and principle which I cannot but think it would be well for our own electrical engineers to keep more prominently in mind than is sometimes done in our own practice. Within the last few weeks a letter has been sent to me by my friend, the Secretary of the Society of Arts, suggesting that there must be a serious mistake in the printed report of a statement I was said to have made, that the French electricians employ 1,196 square yards of earth contact for lightning conductors, because 1,196 square yards are equivalent to nearly a quarter of an acre! And again, it is no uncommon thing to hear even practical electricians in England speak of a lightning rod as being sufficient for its work if its base is but placed as low in the earth as the foundations of the building that is to be protected. It will, however, be at once perceived what an important bearing upon this too confident doctrine Mons. Melsens' demonstrations of the erratic propensity of the impulsive meteor to travel by devious ways when in states of high tension, have. In the assumption that if the lightning be but furnished with a metallic conduit, so far as the vertical extension of a building is concerned, that is all that can be reasonably required, sight is entirely lost of the great practical principle that the erratic tendency of lightning—or, in other words, the high tension of its energy—is enormously increased with each fresh impediment that is offered to its free outflow from the lightning rod below; and that a lightning rod which is

entirely efficient and safe when it has a quarter of an acre of an earth contact below, becomes inefficient and eminently dangerous to all objects that are near to it when the quarter of an acre is exchanged for a single square foot of earth contact. In the one case the electrical discharge flows evenly and placidly through the conduit that is provided for its conveyance, without having much more inclination to leap aside from its proper path than the voltaic current has to leave the telegraph wire furnished for its transmission. But in the other case, it bursts through the same conduit with a fitful, disturbed, and ill-conditioned progress, and with an impetuous and fretful impulse to find lateral outlets and devious ways, and to set up, by escape through them, the various unpleasant results which are known under the general designation of the return shock. I have thought it well thus, once again, to return to this particular article of what I hold to be heretical doctrine, on account of the great practical importance which it has upon sound practice in the work of protection from lightning.

I think that, without venturing to make any further demand upon your indulgence and patience, I may hope that I have said enough in these incidental remarks to establish the argument which I have had mainly in view, namely, that there is good open ground, even in this well-worked field of research, for the useful and advantageous employment of our Committee.

No. 138.

ORDER THEREON, 11th April 1878, No. 1,806 W.

COMMUNICATED to District Engineers.

(True Extract.)

(Signed) E. A. FOORD, Colonel, R.E.,
Secretary to Government, P.W.D.

(True Copy.)

Major, R.E.,
Under Secy. to Govt., P.W.D.

To District Engineers.

To the Consulting Architect.

„ Consulting Engineer for Railways.

„ Deputy Chief Engineer, General Branch.

Exd. E. C. Shunker.

Spare Copies

BUILDINGS AND ROADS
CIVIL WORKS.

Govt. of (1878) Madras
PUBLIC WORKS.

DISTRICT ENGINEERS,

Ac. Ec. Sc.

Dated April 11th.

Issued

Recd.

U. O., 11th April 1878, No. 1305 W.

APRIL

No. 137-123

Protection of Buildings from Lightning —
Circular of the Government of India for-
warding Dr. Mann's lecture sheet — com-
municated to District Engineers.

Enclosure to Circular No. 35 Public Works of 1878.

Extract from an Address delivered by Dr. Mann at the Annual General Meeting of the
Meteorological Society held on 9th January 1876.

In the Report of the Council which has afforded me the opportunity for these remarks there is one other topic touched upon which I may perhaps also be permitted very briefly to allude to, on account of the part I have personally taken, and the interest which I have found, in suggesting its consideration to my colleagues. I allude to the establishment of a Permanent Committee for investigating the phenomena of Atmospheric Electricity and the effects of Lightning, and for the diffusion of sound principles in reference to provisions made for defence against the destructive meteor.

In taking up the thread of what I desire to say upon this theme, I can hardly neglect to draw your attention to the very admirable and interesting account of the accident from lightning at Roundham Head, near Torquay, which we were favoured at one of our Sessional Meetings in the past year by Mr. D. Pidgeon, who was able to give force to his instructive narrative by the argument of "Magna pars fui," which is always interesting from the mouth of one who is relating effects which he has himself experienced. I should also add that this narrative which was printed in the October number of our Quarterly Journal, has rendered us a double service, and has laid a double obligation upon us, on account of the example which it sets in its very clear and exact description of facts, and in its very full and sagacious selection of essential characteristics of the way in which it is desirable such communications should be presented for the discussions of our Committee.

One of the most notable facts which is brought under notice in this communication from Mr. Pidgeon, is the rupture of the links of the mooring chains attached to the bottom of the stays of the flag-staff. The staff itself, which was involved in this accident, consisted of a stout mast fifty feet high, stayed with four galvanized iron guy ropes at about twenty-five feet from the ground. Each wire rope terminated about twelve inches above the ground in half-inch cable chains, which were carried down to an anchorage in a subsoil of very dry red sandstone conglomerate.

The entire mast above the attachment of the guy ropes was shattered into splinters by the lightning discharge; and three of the mooring chains below were broken across, several links in each chain being severed. About twenty links altogether were fractured, and of these some were above, and some within, the ground. Several of broken links had been considerably corroded by rust, but in those the parts severed were the undiminished portions of the iron, and not the segments which had been eaten away by the corrosion. In one place a bent hook of one-tenth of an inch iron wire, which had been used as a substitute for a previously damaged link, was uninjured by the discharge, although several of the links in the same stretch of chain were severed. The broken surfaces in the damaged links were bright and crystalline, and gave no indications of the metal having been subjected to great heat. It is much to be regretted that the whole of the broken links of these chains were not carefully preserved for a further examination of their conducting capacity. Mr. Pidgeon very kindly did what he could to recover them after his attention had been drawn to their scientific value, but unfortunately without success.

Some important practical considerations hang immediately upon the history of these damaged chains. The great increase in the molecular disturbances set up by the discharge at the lower extremity of the conducting system in consequence of the insufficiency of the earth contact is very well illustrated. The distribution of the disruptive discharge through all the several branches of the earth contact is also expressed. Three of the four mooring chains, which were directed out to four opposite points of the compass, were severed. But the most important circumstance connected with the breaking of these chains is the number of the links which were affected by the disruption, and that those which were injured were broken through the parts of largest metallic area, and not through the lines of diminished section where it might have been expected the greatest resistance to the electrical transmission would have been found. Prof. Melsens, of Brussels, one of the Foreign Members of our Committee, whose attention I have drawn to this circumstance, thinks that the highly crystalline condition of the iron of the broken links indicates that those parts of the chain had already undergone considerable molecular disintegration and change subsequently to their first attachment to the guy ropes, in consequence of the incessant vibration to which they had been subjected under the play of the wind, and he believes that they had been thereby reduced to their lowest cohesive capacity at the spots where the disruption occurred. He takes the uninjured integrity of the new piece of fibrous wire of so much smaller dimensions as furnishing a substantial proof of this view of the matter.

1906
6

Circular No. 35 Public Works.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Miscellaneous.

To

THE GOVERNMENTS OF MADRAS, BOMBAY, BENGAL, NORTH WESTERN PROVINCES
AND OUDH, AND PUNJAB, IN THE PUBLIC WORKS DEPARTMENT.
THE CHIEF COMMISSIONERS, CENTRAL PROVINCES, BRITISH BURMAH, MYSORE AND
COORG, AND ASSAM.
THE RESIDENT AT HYDERABAD.
THE AGENTS TO THE GOVERNOR GENERAL FOR CENTRAL INDIA AND RAJPOOTANA.
THE SUPERINTENDENT OF PORT BLAIR, AND CHIEF COMMISSIONER, ANDAMAN AND
NICOBAR ISLANDS.
THE INSPECTOR GENERAL OF MILITARY WORKS.
THE PRINCIPAL, THOMSON COLLEGE, ROORKEE.

Fort William, April 1, 1878.

In continuation of Circular No. 23 P. W., dated the 6th ultimo, the
undersigned is directed to circulate, for general information and guidance,
extract from an address delivered by Dr. Mann at the annual general meeting
of the Meteorological Society, held on the 19th January 1876, regarding the
protection of buildings from lightning.

Charles Mallard

Colonel, R. E.

Deputy Secy. to the Govt. of India.

To the Secretary to the Govt. of Madras.
P. W. Department.

GOVERNMENT OF INDIA
PUBLIC WORKS DEPARTMENT
CIVIL WORKS
Miscellaneous

To

Circular No. 35 Public Works

Dated April 1, 1878.

Received

No 1806. P. 4/11 April 1878.

By R. Clarke

Amund

P. B.

set 1/4 7/10

Circulates for general information and guidance,
extract from an address delivered by Dr. Mann
regarding the protection of buildings from
lightning.

No. 543, P. W. D. Press—1-4-78—500.
Ext—J. A. B.

Dr. Mann's address
London

*1806
7*

12/10/78

Govt. of India

PUBLIC WORKS.

To

H. P. Singh

Dated

Issued

Recd.

Encl.

G. O., 11 Apr 1878, No. 1864.

Nos.

Protection of buildings from lightning

Circular of the Govt. of India
providing for the erection of lightning rods
—, communicated to the Secretary

Subd. Secy.