3060 W / 28/9/88
1968 W / 2/7/88
845 W / 14/3/88
1946 W / 8/8/81

Lr 3816 W d/ 4 Dec/88
B

A sum of ~~Rs~~ 2355
A sum of Rs 2355
is allotted from the
is allotted from the
Provincial reserve
Provincial reserve
to complete ~~the~~ work
to complete the work
of providing lightning
of providing lightning
conductors for the Govt
conductors for the Govt
Central Museum Madras.
Central Museum

WCB
3.12.88

3/12/88

B 5/12

S.E. V Circle
S.E. V Circle
Examr. P.W.A.
Examr. P.W.A.

5/12

8/12 8/12.

8/12 10/12.

From

THE SUPERINTENDING ENGINEER,

V Circle,

To

THE Chief Engineer
P.W. Department.

Dated 29th } November 1888.
Recd.

SECRETARY TO GOVERNMENT
-1 DEC 88
P.W. DEPARTMENT, MADRAS.

ENCLOSURES.

B. Lr 3816 W d/ 4-12-88

No. 3944.

Government Central Museum.

Recommends that 2355 may be appropriated for providing Lightning Conductor to the — in the current official year.

SUPERINTENDING ENGINEER'S OFFICE,
V Circle, Madras,
Chepâk, 29th November 188 .

No 3944.

From

Colo W H. Burton RE

SUPERINTENDING ENGINEER, V CIRCLE,

To

THE Chief Engineer
P W Department

SIR,

Enclosures.

With reference to G.O.
No 3060 W dated 28th September
1888, I have the honor to state
that the revised estimate of
Rs 2375 for providing Light-
-ning Conductor to the Govt.
Central Museum at Madras
has been sanctioned but
there are no funds under
Provincial Civil Buildings
Minor new works at the
disposal of the Executive Engi-
neer Presidency Divisions to
complete

complete the work. This is an
incomplete work of 1887-88
and I recommend that Rs 2355
may be appropriated for
expenditure on the work in
the current official year.

I have the honor to be
Sir
Your Most Obedt Servant

W H Burton Coll. R.E.
Supty: Engineer
5th Circle

3060 W 7 28/9/88
1968 W 7 2/7/88
845 W 7 14/3/88
1946 W 7 8/8/81

From

THE SUPERINTENDING ENGINEER.

[illegible] 12368

[illegible] 8/12 D 10/12.

[illegible]

G. 6. 1968 W. 2. 7. 88

available now is Rs 3,672 & the work is an incomplete work of last year. The sum of Rs 2,388 required for completion, can be allotted — Please obtain orders —

[illegible]
3/12.

[illegible]
3.12.88

G. 24. 9. 88. [illegible] 26(9) R 28. X. 88.

From

THE SUPERINTENDING ENGINEER,

P.W.C. No 9461

With Order

3060 W 28/9/88
1968 W 2/7/88
845 W 14/3/88

C No 12368

C Aw

With reference to W's pencil remark within, you will find from item 57 of the Statement printed with G O No 1968 W dy 2d July/88 that the work in question was brought forward by the C.E; but no funds were allotted pending receipt of a revised estimate as the amount applied for was much in excess of the sanctioned estimate.

The resume balance

withdrawn

3/10/12 8/10/12

G. O. 1968 W. 2.7.88
" 1357 W 8.5.88
" 845 W. 14.3.88

From P.W.C No 9461

THE SUPERINTENDING ENGINEER,

3610

G. 24.9.88. 1883

28.X.88

With Order

3060 W / 28/9/88
1968 W / 2/7/88
845 W / 14/3/88
1946 W / 8/8/81

G. O. 1968 W. 2. 7. 88
" 1351 W. 8. 5. 88
" 845 W. 14. 3. 88

No. 3060 W d/28th Septr. 1888

3 (9)

The estimate is returned
The estimate is returned

to the Supdg Engineer V
to the Supdg Engineer V Circle
Circle for sanction under
for sanction under G. O. No 1351 W
G. O. No 1351 W d/8th May 1888
d/8th May 1888.

WCB
24.9.88

26/9/88

To S. E. V Circle with 3 enclos.
The S. E. V Circle with 3 ..

D
2/10/88

3/10 6/10

O. 24. 9. 88. 26(9) R 28. IX. 88.

P. W. C. No 9467

From

THE SUPERINTENDING ENGINEER,

V Circle,

To (9)

THE Chief Engineer
P. W. Department

Dated 17th } September 1888.
Recd. 20 }

ENCLOSURES. 3

No. 3060 W d/28th Septr. 1888

No. 2533.

Lightning Conductor to
Govt. Central Museum.

—

Submits for Sanction a
revised Estimate of Rs. 2375
for providing — at Madras

20/9/88

With Order

3060 W 28/9/88
1968 W 2/7/88
845 W 14/3/88
1946 W 8/8/81

Public Works Department.

B/

Current No. 9461

Letter No. 2533

Dated 17th September 1888

From the Supg: Engr: II Circle

Tourtin [illegible] 22.9.88

NOTE OF REMARKS.

The Estimate under review amounting to Rs 2375 for providing lightning Conductors to the Govt: Central Museum is submitted for sanction in supersession of the Est for Rs 2850 sanctioned in G.O. No 1946W of 8th August 1881.

The necessity for a revised Estimate was due to the arrangements originally proposed being at variance with the arrangements laid down in Appendix 4 of the Standard Specification and the instructions

8/12 D/10/12.

balance

3060 W 28/9/88
1968 W 2/7/88

conveyed in G. O. No. 8454 d/ the 14th March 1888 for the construction of lightning conductors

In the Statement of requirement on account of Provincial incomplete works of 1887-88 it is stated that "the question of providing funds for the work will be considered on receipt of the revised Estimate" the revised Estimate is accordingly submitted and is lower by Rs 475 than the original Estimate.

The Estimate has been countersigned by the Superintendent of the Govt: Central Museum -

C.M.P.
21/9/88

No. 2533.

SUPERINTENDING ENGINEER'S OFFICE,
V Circle, ~~Madras~~,
Bangalore ~~Chepak~~, 17th September 1888.

From
Colonel H. M. Vibart R. E.
SUPERINTENDING ENGINEER, V CIRCLE,

To
THE Chief Engineer
P. W. Department.

SIR,

Enclosures.
1. Revised Estimate
1. Comparative statement
1. Plan.

With reference to remarks against Item No. 57 in the statement of Demands printed with G. O. No. 1968 W. dated 2nd July 1888, I have the honor to submit for sanction a revised Estimate of Rs 2375 for Providing lightning Conductors to Government Central Museum at Madras in lieu of the Estimate of Rs 2850 sanctioned in G. O. No. 1946 W. dated 8th August 1881.

The revision has been necessary, as the arrangements provided for in the original Estimate are not in accordance with the rules laid down in Appendix A to the Standard specification & the further

instructions circulated with
G.O. No. 845 W. dated 16th March/88.
in regard to the Construction
of Lightning Conductors.

The revised estimate is less
by Rs 475 than the original
Estimate, and as the reduced
Estimate comes under the head
of Minor Nen works I request
that an appropriation of Rs
2325 may be made to the
Presidency Division for the
work.

I have the honor to be
Sir
your most obedient servant.

H. Hutchinson
Col. R.E.

Supdg Engineer
& Circle

G. O. 1968 W. 2.7.88
" 1357 W. 8.5.88
" 845 W. 14.3.88

From

P.W.C. No 9461

3260

G. 24.9.88

With Order

GENERAL.
ACCOUNT.

Govt. of {1888} Madras.

PUBLIC WORKS.

Dated July, 2nd.

Recd. *Encl.*

G.O., 2nd July 1888, No. 1968 W.

JULY.

Funds

Orders on statements of demands under Provincial for incomplete works of 1887-88 and for minor new works, repairs and tools and plant for 1888-89.

G. O. 1968 W. 2.7.88
" 1357 W. 8.5.88
" 845 W. 14.3.88

From

P.W.C. No 9461

2nd July 1888, No. 1968 W., Public Works.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

General.
Account.

Read—the following papers :—

From the Superintending Engineer,	I Circle,	dated	11th May	1888,	No.	95 G.L.
" " "	I "	"	22nd "	"	"	95 V.Z.
" " "	II "	"	26th "	"	"	—
" " "	III "	"	30th April	"		(Six statements).
" " "	IV "	"	9th May	"	No.	173 E.W.
" " "	V "	"	6th June	"	"	951.
" " "	V "	"	6th "	"	"	956.
" " "	V "	"	6th "	"	"	960.
" " "	VI "	"	6th May	"	"	130 T.C.
" Consulting Architect to Government		"	10th "	"	"	212.

3/10

28/9

With Order

G. 24.9.88.

R. 28.IX.88.

ENCLOSURES.

A.—STATEMENT showing the amounts applied for, and those granted under Provincial Civil Works.

Divisions.	AMOUNTS APPLIED FOR							AMOUNTS ALLOTTED.						
	Minor Works.			Repairs.			Tools and Plant.	Minor Works.			Repairs.			Tools and Plant.
	Civil Buildings.	Communications.	Miscellaneous Public Improvements.	Civil Buildings.	Communications.	Miscellaneous Public Improvements.		Civil Buildings.	Communications.	Miscellaneous Public Improvements.	Civil Buildings.	Communications.	Miscellaneous Public Improvements.	
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.
Ganjam	..	..	..	4,000	..	..	200	..	..	..	4,000	..	..	200
Rushikulya	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Vizagapatam	680	..	..	3,000	14,880	..	3,000	680	..	..	3,000	14,870	..	1,500
Godâvari, Eastern	300	..	..	6,000	12,000	200	..	300	..	..	6,000	12,000	200	..
Do. Central	..	..	..	300	..	..	..	..	..	..	300	..	..	..
Do. Western	280	..	..	200	..	..	..	280	..	..	200	..	..	..
Kistna, Eastern	..	..	..	3,000	..	500	500	..	..	..	3,000	..	500	500
Do. Western	115	..	..	1,134	..	..	50	115	..	..	1,100	..	..	50
Nellore	710	..	..	3,000	..	..	3,500	710	..	..	3,000	..	..	2,000
Buckingham Canal	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bellary	1,700	..	..	2,000	7,000	..	1,000	1,700	..	..	2,000	7,000	..	1,000
Cuddapah	700	..	..	5,000	..	..	1,000	700	..	..	5,000	..	..	1,000
Kurnool	200	..	..	1,000	..	..	1,000	200	..	..	1,000	..	..	1,000
Nilgiri	3,535	3,000	1,410	20,000	51,000	2,000	17,750	3,535	3,000	1,410	20,000	50,000	2,000	12,042
Coimbatore	1,500	..	..	7,000	..	..	1,000	1,500	..	..	7,000	..	..	1,000
West Coast	9,654	..	..	10,000	..	..	1,500	9,654	..	..	10,000	..	..	1,000
North Arcot	3,750	..	..	1,000	..	..	500	3,750	..	..	1,000	..	..	500
South do.	1,380	..	..	1,200	1,000	..	500	1,380	..	..	1,200	1,000	..	500
Chingleput	3,000	..	..	10,400	..	..	..	3,000	..	..	10,400	..	..	..
Presidency	10,000	..	1,000	70,000	13,500	3,000	3,500	10,000	..	1,000	60,000	13,500	3,000	3,500†
Public Works Workshops ..	..	..	..	5,000	..	..	4,000	..	..	..	5,000	..	..	3,000
Do. Stores	480	..	..	450	..	..	11,000	480	..	..	450	..	..	11,000‡
Tanjore	200	..	..	3,000	..	..	1,000	200	..	..	3,000	..	..	1,000
Negapatam	200	..	..	2,500	..	..	100	200	..	..	2,500	..	..	100
Trichinopoly	500	..	..	4,000	..	..	300	500	..	..	4,000	..	..	300
Madura	300	..	..	1,700	..	..	700	300	..	..	1,700	..	..	700
Tinnevelly	500	..	..	600	..	..	1,000	500	..	..	600	..	..	1,000
Ramnad	..	..	..	980	..	..	450	..	..	..	980	..	..	450
Architect	6,000	..	2,000	20,000	..	12,000	400	6,000	..	2,000	20,000	..	12,000	400
Reserve with the Government ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Do. do. for Archæological Works ..	..	..	..	..	..	..	..	..	..	..	7,500*	..	..	..
Total ..	45,684	3,000	4,410	1,86,464	99,380	17,700	53,950	45,684	3,000	4,410	1,83,930	98,370	17,700	43,742

* Includes Rs. 637 appropriated in G.O., No. 1519 W., dated 23rd May 1888 and Rs. 30 in G.O., No. 1956 W., dated 29th June 1888.
† Includes Rs. 2,226 referred to in G.O., No. 1635 W., dated 5th June 1888.
‡ Represents the amount promised in G.O., No. 486 W., dated 11th February 1888.

B.—Statement of requirements on account of Provincial incomplete works of 1887-88, and of new works sanctioned but not commenced.

Division.	Item No.	Name of work.	Amount of estimate.	Number and date of sanction.	Past expenditure.	Balance of estimate.	AMOUNT APPLIED FOR FOR 1888-89.		AMOUNT ALLOTTED		Item No.	Remarks.
							For incomplete works.	For new works.	For incomplete works.	For new works.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Minor Works.	RS.		RS.	RS.	RS.	RS.	RS.	RS.		
Ganjam. ..	1	Constructing a dead-house in lieu of the existing one at Chicacole.	515	G.O., No. 3156 W., dated 29th November 1886.	..	515	..	515	..	..	1	
Vizagapatam ..	2	Alterations to the quarters of the medical subordinate attached to the Lunatic Asylum, Waltair.	1,270	G.O., No. 1796 W., dated 6th July 1887.	..	1,270	..	1,270	..	..	2	
	3	Two iron safes for Koraput treasury.	..	....	..	..	..	1,100	..	..	3	No funds are available.
Nellore ..	4	Quarters for a sub-divisional officer, Gúdúr.	2,450	G.O., No. 705 W., dated 1st March 1888	..	2,450	..	2,450	..	..	4	
	5	Improving the workshops at Nellore.	800	G.O., No. 923 W., dated 21st March 1888.	..	800	..	800	..	..	5	
	6	Improvements to the out-offices of the Sub-Collector's bungalow, Ongole.	1,185	G.O., No. 2488 W., dated 21st September 1887.	59	1,126	1,100	..	1,100	..	6	From the reserve.
Bellary ..	7	Covering with corrugated iron sheeting the roof of the combined office for the Superintending and Executive Engineers at Bellary.	1,380	G.O., No. 530 W., dated 16th February 1888.	..	1,380	..	1,380	..	1,380	7	From the reserve—*vide* G.O., No. 1737 W., dated 12th June 1888.
Cuddapah ..	8	Constructing a store-shed at Cuddapah.	1,667	G.O., No. 279 W., dated 4th February 1887.	..	1,667	..	1,667	..	..	8	
	9	Purchase of a private building at Nandalore for use as Public Works stores and inspection bungalow.	650	G.O., No. 453 W., dated 8th February 1888.	..	650	..	650	..	..	9	No funds are available.
	10	Renewing the roof of clerks' offices on Stonehouse Hill.	2,250	G.O., No. 2872 W., dated 25th October 1887.	1,456	794	794	..	794	..	10	From the reserve.
	11	Tiling the roof of All Saints' Church, Coonoor.	1,350	G.O., No. 962 W., dated 23rd March 1888.	..	1,350	..	1,350	..	..	11	No funds are available.
	12	Erecting verandahs to the peons' quarters on Stonehouse Hill.	2,360	G.O., No. 1194 W., dated 23rd April 1888.	..	2,360	..	2,360	..	2,360	12	From the reserve—*vide* G.O., No. 1194 W., dated 23rd April 1888.
Nílgiri ..	13	Constructing rough stone revetments on Coonoor-Kullar road.	1,380	G.O., No. 684 W., dated 27th February 1888.	819	561	561	..	561	..	13	From the reserve.
	14	Improving the approaches and widening the roadway of the Pykara bridge on the Kullar-Gúdalúr road.	1,000	G.O., No. 265 W., dated 23rd January 1888.	..	1,000	..	1,000	..	1,000	14	From the reserve—*vide* G.O., No. 265 W., dated 23rd January 1888.
	15	Alterations to the road near the Adam Memorial Fountain, Ootacamund.	940	G.O., No. 532 W., dated 16th February 1888	119	821	821	..	..	..	15	Rs. 940 were provided in G.O., No. 1283 W., dated 2nd May 1888. The excess provision, Rs. 119, is resumed and credited to the reserve.

B.—Statement of requirements on account of Provincial incomplete works of 1887-88, &c.—*cont.*

Division.	Item No.	Name of work.	Amount of estimate.	Number and date of sanction.	Past expenditure.	Balance of estimate.	Amount applied for for 1888-89.		Amount allotted		Item No.	Remarks.
							For incomplete works.	For new works.	For incomplete works.	For new works.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Minor Works—cont.	RS.		RS.	RS.	RS.	RS.	RS.	RS.		
Presidency ..	16	Improvements to the chancel of St. Andrew's Church, Bangalore.	1,440	G.O., No. 1305 W., dated 3rd May 1888.	2	1,438	1,438	..	1,438	..	16	From the reserve.
Trichinopoly ..	17	Constructing a compound wall and latrine for the District Munsif's Court at Ariyalúr.	1,230	G.O , No. 3100 W., dated 23rd November 1886.	388	842	842	..	842	..	17	From the reserve.
Tinnevelly ..	18	Constructing a solitary cell and latrine in the District Jail, Tinnevelly.	1,128	G.O., No 3089 W., dated 16th November 1887.	..	1,128	..	1,128	..	..	18	No funds are available.
	19	Making experiments in producing decorative porcelain.	500	,, ,,	422	78	78	..	..	..	19	
	20	Reconstructing the parapet wall on the north side of the Revenue Board Office with stone.	1,190	G.O., No 2143 W , dated 12th August 1887.	1,135	55	55	..	..	..	20	Appropriation is not necessary under Code para. 1908, Part III.
	21	Providing four new wooden weather boards to the office of the Examiner of Public Works Accounts.	469	,, ,,	356	113	113	..	..	..	21	
Architect ..	22	Providing a new screen to the Consulting Architect's office.	53	,, ,,	23	30	30	..	..	..	22	
	23	Providing a small room by partitioning off the east end of the wing on the upper floor of the Chepák buildings occupied by the Settlement Department.	356	,, ,,	..	356	..	356	..	..	23	No funds are available.
	24	Clearing the site of the old fishing village and sewage farm.	1,566	G.O., No. 2851 W., dated 29th October 1886.	1,378	188	188	..	..	..	24	Appropriation is not necessary under Code para. 1908, Part III.
	25	Laying pipes for the supply of water to St. Andrew's Church at Madras.	662	G.O., No. 1170 W., dated 18th April 1888.	..	662	..	662	..	662	25	From the reserve—*vide* G.O., No. 1170 W., dated 18th April 1888.
		Total ..	..		..	..	6,020	16,688	4,735	5,402		
		Major Works.										
Vizagapatam ..	26	Additional accommodation for the Huzur treasury at Vizagapatam.	9,890	G.O., No. 1180 W., dated 20th April 1888.	9,196	694	530	..	530	..	26	From the reserve.
	27	Constructing an hospital at Ganapuram.	4,020	G.O., No. 421 W., dated 6th February 1888.	2,040	1,980	1,980	..	1,980	..	27	From the reserve.

	28	Completing the taluk office at Potinghi with a police station and sub-jail.	..	....	3,316	..	4,000	..	..	..	28	The question of providing funds for the work will be considered on receipt of the estimate.
	29	Constructing an office for the General Deputy Collector at Vizianagrum.	5,000	G.O., No. 491 W., dated 11th February 1888.	..	5,000	..	5,000	..	..	29	No funds are available.
Godávari, Eastern.	30	Constructing a church at Cocanada.	18,380	G.O., No. 586 W., dated 5th March 1886.	12,867	5,513	801	..	801	..	30	From the reserve. Rs. 801 represent balance of contribution by Government.
	31	Constructing a dispensary at Bhádrachalam.	4,246	G.O., No. 1804 W., dated 3rd August 1885.	3,309	937	937	..	937	..	31	From the reserve.
	32	Constructing a residence for the Executive Engineer at Dowlaishweram.	16,300	G.O., No. 1869 W., dated 23rd June 1888.	14,929	1,371	1,371	..	1,371	..	32	Do.
Godávari, Central	33	Converting the store-shed at Ralli into an office for the Central division.	3,040	G O., No. 302 W., dated 25th January 1888.	2,586	454	3,256	..	..	..	33	Rs. 3,040 were provided in the budget—*vide* item No. 61. The Superintending Engineer will explain fully the circumstances in which Rs. 3,256 are required when part outlay is said to be Rs. 2,586.
Do. Western.	34	Constructing a first-class taluk office at Bhimavaram.	22,650	G.O., No. 3563, dated 20th December 1875.	24,307	..	1,363	..	..	..	34	The question of providing funds for the work will be considered on receipt of revised estimate.
Bellary ..	35	Collector's office at Anantapur ..	64,290	G.O., No. 2571 W., dated 28th September 1887.	63,427	863	863	..	863	..	35	From the reserve.
Cuddapah ..	36	Additions and alterations to the District Jail at Cuddapah.	31,900	G.O., No. 2883 W., dated 3rd December 1885.	23,903	7,997	7,997	..	7,997	..	36	From the reserve.
	37	Improving Christ Church at Cuddapah.	3,176	G.O., No. 1019 W., dated 29th March 1888.	..	3,176	..	3,176	..	..	37	No funds are available.
	38	Repairs to Mount Stuart property, Ootacamuud.	19,945	G.O., No. 1615 W., dated 13th July 1885.	16,646	3,299	3,299	..	3,299	..	38	From the reserve.
	39	Constructing a Roman Catholic Church at Wellington.	33,576	G.O., No. 2791 W., dated 19th October 1887.	23,864	9,712	2,260	..	2,260	..	39	From the reserve.
	40	Providing accommodation for the court of the Subordinate Judge, Ootacamund.	59,030	G.O., No. 1540 W., dated 25th May 1888.	50,026	9,004	3,004	..	..	..	40	Rs. 6,000 are provided in the budget. Additional funds required should be applied for later in the year.
Nílgiri ..	41	Improvements to the District Jail buildings, Ootacamund.	2,950	G.O., No 1450 W., dated 17th May 1888.	2,205	745	745	..	745	..	41	From the reserve—*vide* G.O., No. 1639 W., dated 5th June 1888.
	42	Constructing eight cart stands on the road from Kullar to Ootacamund.	6,100	G.O., No. 58 W., dated 7th January 1886.	4,722	1,378	1,378	..	..	..	42	No further expenditure to be incurred.
	43	Improving the water-supply of that portion of Ootacamund lying north of the lake.	1,70,000	G.O., No. 1545 A/W., dated 18th June 1886.	1,42,995	27,005	27,005	..	20,000	..	43	From the reserve. The balance may be applied for later in the year.
	44	Constructing a road from Calicut to Vayitri.	4,11,965	G.O , No. 913 W., dated 20th March 1888.	3,10,925	1,01,040	11,050	..	..	..	44	Rs. 90,000 are provided in the budget. The balance of the estimate may be applied for later in the year.
Coimbatore ..	45	Repairs and improvements to the Government taluk school at Námakal.	4,300	G.O., No. 471 W., dated 9th February 1888.	..	4,300	..	4,300	..	3,148	45	From the reserve, being the portion of the Government grant—*vide* G.O., No. 471 W., dated 9th February 1888.

B—Statement of requirements on account of Provincial incomplete works of 1887-88, &c.—*cont.*

Division.	Item No.	Name of work.	Amount of estimate.	Number and date of sanction.	Past expenditure.	Balance of estimate.	Amount applied for for 1888-89.		Amount allotted		Item No.	Remarks.
							For incomplete works.	For new works.	For incomplete works.	For new works.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Major Works—cont.	RS.		RS.	RS.	RS.	RS.	RS.	RS.		
West Coast ..	46	Constructing public offices at Ponâni.	74,521	G.O., No. 2597 W., dated 23rd October 1884.	65,384	9,137	9,137	..	9,137	..	46	From the reserve.
	47	Law Courts at Calicut	1,23,656	G.O., No. 1454 W., dated 17th May 1888.	1,07,106	13,094	13,094	..	..	..	47	Rs. 13,500 were provided in the budget and Rs. 3,456 in G.O., No. 1454 W., dated 17th May 1888. The excess provision, Rs. 406, is resumed and credited to the reserve.
	48	Constructing Sea Custom House and store-shed at Cochin.	17,940	G.O., No. 2427 W., dated 2nd October 1884.	5,491	12,449	7,000	..	..	..	48	Rs. 5,000 are provided in the budget. If additional funds are required, application may be made later in the year.
	49	Collector's office at Calicut ..	1,89,970	G.O., No. 1186 W., dated 21st April 1888.	10,119	1,79,851	20,000	..	5,200	..	49	From the reserve. In addition to Rs. 14,800 allotted for land compensation in G.O., No. 1231 W., dated 26th April 1888.
	50	Constructing a residence for the Assistant Superintendent of Police, Malapuram.	13,660	G.O., No. 3034 W., dated 16th December 1885.	12,600	1,060	1,060	..	..	..	50	Rs. 3,200 are provided in the budget. The excess provision, Rs 2,140, is resumed and credited to the reserve.
South Arcot ..	51	District Munsif's Court at Chidambaram.	11,155	G.O., No. 239 W., dated 20th January 1888.	..	11,155	..	5,000	..	..	51	No funds are available.
	52	Taluk office, Tirukoilúr ..	20,680	G.O., No. 770 W., dated 7th March 1888.	..	20,680	..	5,000	..	..	52	
	53	Do. Tindivanam ..	22,640	Do. do.	..	22,640	..	7,000	..	..	53	
	54	Constructing an embankment to the Gadilam river to protect the town of Tirupápuliyúr.	10,630	G.O., No. 1809 W., dated 18th June 1888.	6,812	3,818	3,818	..	3,818	..	54	From the reserve.
Chingleput ..	55	Completing the Agricultural College at Saidápet.	24,520	G.O., No. 1792 W., dated 15th July 1886.	21,331	3,189	3,189	..	3,189	..	55	
	56	Artesian boring in the Kortalayár Valley.	8,745	G.O., No. 3147 W., dated 21st November 1887.	6,027	2,718	2,718	..	2,718	..	56	
Presidency ..	57	Providing lightning conductor to the Government Central Museum, Madras.	2,850	G.O., No. 1946 W., dated 8th August 1881.	20	2,830	3,458	..	..	..	57	The question of providing funds for the work will be considered on receipt of the revised estimate.
	58	Putting new roof over the close prison cells in the Madras Penitentiary.	11,200	G.O., No. 2724 W., dated 16th October 1886.	9,176	2,024	2,024	..	2,024	..	58	From the reserve.
Presidency ..	59	Widening the Elephant Gate Bridge, Madras.	20,200	G.O., No. 3303 W., dated 3rd December 1887.	9,506	10,694	10,694	..	..	..	59	The Financial Department will be requested to provide the necessary funds.
	60	Raising the walls and renewing the roof of the stables and tiffin rooms of the Public Works Workshops, Madras.	3,450	G.O., No. 1268 W., dated 1st May 1888.	..	3,450	..	3,450	..	3,450	60	From the reserve—*vide* G.O., No. 1268 W., dated 1st May 1888.
	61	Self-acting shutters at 3 bridges on the Kuam river.	36,856	G.O., No. 1730 W., dated 11th June 1888.	..	36,856	..	5,000	..	5,000	61	From the reserve—*vide* G.O., No. 1730 W., dated 11th June 1888.
North Arcot ..	62	Improvements to the Sub-Magistrate's office at Punganúr.	4,480	G.O., No. 1306 W., dated 25th May 1886.	3,799	681	681	..	681	..	62	From the reserve.
Trichinopoly ..	63	District Jail at Trichinopoly ..	85,244	G.O., No. 3275 W., dated 1st December 1887.	70,405	14,839	4,839	..	..	..	63	Rs. 10,000 are provided in the budget. Application should be made later in the year for additional grant required.
	64	Converting the Artillery barracks at Trichinopoly into an office for the Collector.	5,300	G.O., No. 668 W., dated 27th February 1888.	..	5,300	..	5,300	..	5,300	64	From the reserve—*vide* G.O., No. 1864 W., dated 22nd June 1888.
Tanjore ..	65	Tahsildar's office at Máyavaram ..	11,680	G.O., No. 342 W., dated 7th February 1887.	4,907	6,773	2,093	..	..	..	65	Rs. 4,680 are provided in the budget. The balance of the estimate will be provided late in the year on application by the Superintending Engineer.
Negapatam ..	66	Improving the District Munsif's Court at Mannárgudi.	5,010	G.O., No. 1841 W., dated 8th August 1885.	4,059	951	951	..	951	..	66	From the reserve.
	67	District Munsif's Court at Tiruválúr.	12,970	G.O., No. 481 W., dated 10th February 1888.	5,133	7,837	940	..	940	..	67	From the reserve. In addition to Rs. 6,897 provided in the budget.
	68	Alterations and improvements to St. Joseph's College buildings at Negapatam to fit them for use as public offices.	52,490	G.O., No. 531 W., dated 16th February 1888.	37,819	14,611	3,121	..	..	..	68	Rs. 12,360 are provided in the budget. The balance of the estimate may be applied for later in the year.
Madura ..	69	Preservation of Tirumal Naik's palace at Madura and adaptation for public offices.	3,35,109	G.O., No. 3095 W., dated 14th November 1887.	3,33,660	1,449	3,868	..	864	..	69	From the reserve. In addition to Rs. 585 provided in the budget. Further allotment will be made on receipt of the revised estimate
Tinnevelly ..	70	Constructing a first-class taluk office at Srivaikuntham.	25,940	G.O., No. 533 W., dated 16th February 1888.	..	25,940	..	10,000	..	10,000	70	From the reserve—*vide* G.O., No. 1337 W., dated 7th May 1888.
	71	Re-constructing the printing office at Kokarakulam.	8,960	G.O., No. 666 W., dated 27th February 1888.	..	8,960	..	5,000	..	5,000	71	From the reserve—*vide* G.O., No 666 W., dated 27th February 1888.
Architect ..	72	Additions to the College of Engineering, Chepák.	90,066	G.O., No. 2547 W., dated 29th September 1886.	67,019	23,047	23,047	..	23,047	..	72	From the reserve.
		Total ..	..	....	..	..	1,87,571	58,226	93,352	31,898		

B.—Statement of requirements on account of Provincial Incomplete works of 1887-88, &c.—*cont.*

Division.	Item No.	Name of work.	Amount of estimate.	Number and date of sanction.	Past expenditure.	Balance of estimate.	Amount applied for for 1888-89		Amount allotted		Item No.	Remarks.
							For incomplete works.	For new works.	For incomplete works.	For new works.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Registration.	RS.		RS.	RS.	RS.	RS.	RS.	RS.		
Vizagapatam ..	73	Sub-registrar's office, Chodavaram.	2,450	G.O., No. 751 W., dated 22nd March 1886.	..	2,450	..	2,450	..	..	73	No funds are available.
	74	Converting into a Registrar's office the building known as canteen in Vizagapatam.	897	G.O., No. 805 W., dated 31st March 1885.	..	897	..	897	..	..	74	
Godávari, Eastern.	75	Sub-registrar's office, Prattipad ..	3,400	G.O., No. 796 W., dated 10th March 1888.	..	3,400	..	3,400	..	..	75	
Godávari, Western.	76	Do. do. Ellore ..	3,380	G.O., No. 1241 W., dated 27th April 1888.	1,858	1,522	1,522	..	1,522	..	76	From the reserve.
Ganjam ..	77	Do. do. Tekkali ..	2,380	G.O., No. 191 W., dated 17th January 1888.	..	2,380	..	1,000	..	..	77	No funds are available.
Nellore ..	78	Do. do. Atmakúr ..	3,185	G.O., No. 176 W., dated 21st January 1886.	..	3,185	..	1,500	..	..	78	
Kistna, Western	79	Do. do. Bápatla ..	2,860	G.O., No. 1622 W., dated 27th June 1884.	1,009	1,851	1,851	..	1,851	..	79	From the reserve.
Cuddapah ..	80	Registrar's office at Cuddapah ..	5,192	G.O., No. 1493 W., dated 12th June 1886.	3,899	1,293	1,293	..	1,293	..	80	
	81	Sub-registrar's office at Váyalpád.	2,435	G.O., No. 719 W., dated 23rd March 1885.	2,119	316	316	..	..	..	81	Appropriation is not necessary under Code para. 1908, Part III.
	82	Do. do. at Chitvél ..	2,040	G.O., No. 1232 W., dated 14th May 1884.	1,001	1,039	1,039	..	1,039	..	82	From the reserve.
Coimbatore ..	83	Do. do. at Sálúr ..	2,750	G.O., No. 1587 W., dated 13th June 1887.	..	2,750	..	2,750	..	..	83	No funds are available.
	84	Do. do. at Gobichettypalayam.	2,680	G.O., No. 278 W., dated 4th February 1887.	..	2,680	..	2,680	..	..	84	
	85	Sub-registrar's office at Kollegal.	2,630	G.O., No. 1790 W., dated 14th July 1882.	900	1,730	1,730	..	1,730	..	85	From the reserve.
	86	Additions to the taluk office for a Sub-registrar's office at Salem.	2,365	G.O., No. 418 W., dated 6th February 1888.	..	2,365	..	2,365	..	..	86	No funds are available.
	87	Adding a record room to the Sub-registrar's office at Avanáshi.	880	G.O., No. 2867 W., dated 2nd November 1886.	..	880	..	880	..	..	87	
West Coast ..	88	Sub-registrar's office at Koduvayur	2,940	G.O., No. 525 W., dated 26th February 1886.	1,471	1,469	1,469	..	1,469	..	88	From the reserve.
	89	Improvements and additions to the Sub-registrar's office at Quilandi.	1,010	G.O., No. 816 W., dated 12th March 1888.	..	1,010	..	1,010	..	1,010	89	From the reserve. *Vide* G.O., No. 816 W., dated 12th March 1888.
	90	Providing additional accommodation to the Sub-registrar's office at Vetatapudiyangádi.	1,350	G.O., No. 2926 W., dated 26th November 1884.	..	1,350	..	1,350	..	1,350	90	From the reserve. *Vide* G.O., No. 831 W., dated 13th March 1888.
North Arcot ..	91	Sub-registrar's office at Tirutani ..	2,230	G.O., No. 3046 W., dated 26th October 1883.	709	1,521	1,521	..	1,521	..	91	From the reserve.
	92	Do. do. at Kuppam.	2,850	G.O., No. 2944 W., dated 5th November 1887.	..	2,850	..	2,850	..	..	92	No funds are available.
	93	Do. do. at Arkónam.	2,575	G.O., No. 655 W., dated 24th February 1888.	..	2,575	..	2,575	..	..	93	
South Arcot ..	94	Do. do. at Merkanam	3,196	G.O., No. 827 W., dated 13th March 1888.	..	3,196	..	1,500	..	..	94	
	95	Do. do. at Vanur ..	3,080	G.O., No. 827 W., dated 13th March 1888.	..	3,080	..	1,500	..	..	95	
Madura ..	96	Do. do. at Tirumangalam.	2,864	G.O., No. 2502 W., dated 23rd October 1885.	2,405	459	602	..	602	..	96	From the reserve.
		Total ..	..		..	..	11,343	28,707	11,027	2,360		
		Police.										
Ganjam ..	97	Rebuilding the police hospital at Chicacole.	1,480	G.O., No. 2342 W., dated 31st August 1887.	..	1,480	..	1,480	..	..	97	No funds are available.
	98	Twenty-six police huts for the reserve police at Parlákimedi.	7,150	G.O., No. 490 W., dated 11th February 1888.	..	7,150	..	7,150	..	..	98	
Nellore ..	99	Police huts at Moolapett ..	3,300	G.O., No. 1834 W., dated 19th July 1886.	..	3,300	..	3,300	..	..	99	
	100	Converting the old sub-jail at Nellore into a town police station.	..	....	..	..	..	2,500	..	..	100	
	101	Police huts at Thettu	1,350	G.O., No. 1834 W., dated 19th July 1886.	..	1,350	..	1,350	..	..	101	
	102	Police huts at Naidupett ..	2,490	G.O., No. 419 W., dated 6th February 1888.	..	2,490	..	2,490	..	..	102	
	103	Police station house at Podili ..	2,100	G.O., No. 419 W., dated 6th February 1888.	..	2,100	..	2,100	..	..	103	
Bellary ..	104	Police huts at Vanavole ..	2,928	G.O., No. 88 W., dated 11th January 1887.	600	2,328	2,328	..	2,328	..	104	From the reserve.
Kurnool ..	105	Nine constables' huts at Pattikonda.	2,903	G.O., No. 923 W., dated 26th March 1887.	1,298	1,605	1,605	..	1,605	..	105	
Nílgiri ..	106	Constructing two additional police huts and providing court-yards to the existing huts at Kotagiri.	2,155	G.O., No. 826 W., dated 13th March 1888.	..	2,155	..	2,155	..	..	106	No funds are available.
	107	Repairs to the police station huts and inspector's quarters at Wellington.	1,200	G.O., No. 3084 W., dated 16th November 1887.	400	800	800	..	800	..	107	From the reserve.
	108	Constructing out-houses for the police inspector at Nellakóta.	..	....	..	..	..	665	..	..	108	No funds are available.
	109	Repairs to the police station and huts at Coonoor.	1,845	G.O., No. 3084 W., dated 16th November 1887.	500	1,345	1,345	..	1,345	..	109	From the reserve.
Coimbatore ..	110	Constructing a first-class police station at Salem.	2,556	G.O., No. 289 W., dated 24th January 1888.	..	2,556	..	2,556	..	..	110	No funds are available.
West Coast ..	111	Additions and improvements to the office of the Superintendent of police, Mangalore.	10,383	G.O., No. 616 W., dated 21st February 1888.	8,850	1,533	1,533	..	1,533	..	111	From the reserve.
	112	Constructing ten police huts at Putur.	3,067	G.O., No. 85 W., dated 10th January 1888.	..	3,067	..	3,067	..	..	112	No funds are available.
	113	Constructing six police huts at Sultan's Battery in Wynaad.	1,920	G.O., No. 894 W., dated 19th March 1888.	..	1,920	..	1,920	..	..	113	

B.—Statement of requirements on account of Provincial Incomplete works of 1887-88, &c.—*cont.*

Division.	Item No.	Name of work.	Amount of estimate.	Number and date of sanction.	Past expenditure.	Balance of estimate.	Amount applied for 1888-89		Amount allotted		Item No.	Remarks.
							For incomplete works.	For new works.	For incomplete works.	For new works.		
1	2	3	4	5	6	7	8	9	10	11	12	13
		Police—cont.	Rs.		Rs.	Rs.	Rs.	Rs.	Rs.	Rs.		
South Arcot ..	114	Constructing a third-class police station-house at Kanagaryut.	1,460	G.O., No. 2274 W., dated 30th September 1885.	930	530	530	..	530	..	114	From the reserve.
Presidency ..	115	Additions and alterations to the office of the Inspector-General of Police, Madras.	1,874	G.O., No. 2833 W., dated 22nd October 1887.	500	1,374	1,374	..	1,374	..	115	From the reserve.
Madura ..	116	Constructing a third-class police station-house and one head and five constables' huts at Samayanallur.	2,690	G.O., No. 1206 W., dated 22nd May 1885.	2,041	649	783	..	783	..	116	From the reserve.
		Total ..	..	....	..	..	10,298	30,733	10,298	..	..	

ORDER—dated 2nd July 1888, No. 1968 W., Public Works.

With the papers above recorded, Superintending Engineers and the Consulting Architect to Government submit statements of demands under Provincial for incomplete works of 1887-88 and for minor new works, repairs, and tools and plant for 1888-89.

2. The provision in the budget under "Reserve" was Rs. 2,27,213, and it has been since reduced to Rs. 2,20,957 with reference to modifications of grants subsequently sanctioned. Adding to this Rs. 2,665, the total of the amounts resumed from the grants already provided for items 15, 47 and 50 of statement B printed with these Proceedings, the sum available for distribution is Rs. 2,23,622.

3. The demands under original works amount to—

	Rs.
Incomplete major works	1,87,571
Do. minor works	6,020
Do. Registration works	11,343
Do. Police works	10,298
Lump sum for minor works	53,094
Total ...	2,68,326
... ...	58,226
New major works	16,688
Do. minor works	28,707
Do. Registration works	30,733
Do. Police works	
Total demands ...	4,02,680

4. The allotments sanctioned under original works are detailed in statements A and B, and they amount to—

	Rs.
Incomplete major works	93,352
Do. minor works	4,735
Do. Registration works	11,027
Do. Police works	10,298
Lump sum for minor works	53,094
Total ...	1,72,506
... ...	31,898
New major works	5,402
Do. minor works	2,360
Do. Registration works	...
Do. Police works	
Total allotments ...	2,12,166

5. The demands under incomplete major works include additions to allotments already provided in the budget, but these demands have not been complied with, with the exception of items 49, 67 and 69, as it is now too soon to consider the question of supplementing budget grants. Funds have been provided for all other incomplete works brought forward by Superintending Engineers and the Consulting Architect to Government. The sum of Rs. 1,378 required for completing the cart stands on the road from Kullar to Ootacamund has not been provided as the Government decline to allow any more money to be spent on the work.

6. In the case of new works, grants have been provided only for those the urgency of which has already been brought to the notice of Government, and for which provision of funds was promised to be considered when disposing of the demands on account of incomplete works.

7. The marginally noted works should have been included in the Superintending Engineers' budget-estimates for 1888-89. Funds have now been allotted to them with much inconvenience, as the small reserve with the Government is intended chiefly for such incomplete works as were expected to be completed before 31st March 1888, but were delayed owing to unforeseen causes.

* Item 30. Additions and alterations to the District Jail, Cuddapah.
Item 43. Water-supply of northern section, Ootacamund.
Item 46. Public offices, Ponáni.

8. The Superintending Engineer, V Circle, applies for a sum of Rs. 10,694 for expenditure during the current official year on "widening the Elephant Gate Bridge, Madras." With reference to G.O., No. 1090 M. (Local and Municipal), dated 22nd October 1887, the Financial Department will be requested to place the amount at the disposal of this department.

9. The demands under "Repairs" and "Tools and Plant" and the allotments sanctioned against them are shown in statement A. The demands under Communications and Miscellaneous Public Improvements being in excess of the budget provision under those heads, a sum of Rs. 8,570 has been transferred from the budget provision under "Civil Buildings," viz., Rs. 6,370 to "Communications" and Rs. 2,200 to "Miscellaneous Public Improvements," and the demands under Tools and Plant have been reduced to bring the total sum within the budget provision, Rs. 43,742.

10. A sum of Rs. 5,200 is appropriated from the "Reserve" to meet the increased provision under Tools and Plant, London supplies, with reference to the indents alluded to in G.Os., Nos. 1467 W., dated 18th May 1888, and 1965 W., dated 2nd July 1888.

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

To Superintending Engineers.
To the Consulting Architect to Government.
" Examiner, Public Works Accounts.
" Financial Department.
" Judicial Department.
" Educational Department.
" Public Department.
" Ecclesiastical Department.
" Revenue Department.

Exd. L. Passaigne.
Spare Copies

Public Works Department

Proceedings of the Madras Government

No . 1351 W dated 8th May 1888.

In accordance with the authorisation of the Government of India, communicated with endorsement No 92 B dated 22nd February 1888, His Excellency the Governor in Council resolves to invest Colonel H.M. Vibart R. E. Superintending Engineer with the following powers of sanction :-

Under Public Works Code para 267

Original Works

(a) Buildings & Roads.

44 . Military Works, and — Rs 2500

45 Civil Works

(2) Irrigation.

42. Minor Works (Working Expenses)

43. Minor Works & Navigation — Rs 2500

(c) Subsidiary works for projects for which Capital & Revenue Accounts are kept — Rs 2500

2. The conditions under which these enlarged powers of sanction will be exercised will be the same as those hitherto in force, as laid down in para 267 of the Code.

(True Extract)

(Signed) J. O. Hasted Colonel R.E.

Secretary to Government P. W. D.

To

The Supte. Engineer V Circle.
Examiner P. W. Accounts.
Chief Engineer for Irrigation.

BUILDINGS AND ROADS.
CIVIL WORKS.

Govt. of [1881] Madras.

PUBLIC WORKS.

To

THE SUPERINTENDENT OF WORKS,
PRESIDENCY,

&c., &c., &c.

Dated August, 8th.

Issued

Recd. *Encl.*

G. O., 8th August 1881, *No.* 1,946 W.

AUGUST.

Nos. 28-29.

Government Central Museum, Madras.—Sanctions for execution when funds are available the estimate for providing lightning conductors to the —.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

8th August 1881, No. 1,946 W.

Buildings and Roads.
Civil Works.

Read the following paper :—

No. 28. From the Superintendent of Works, Presidency, dated 28th July 1881, No. 1,569.

No. 29. ORDER THEREON, 8th August 1881, No. 1,946 W.

THE estimate amounting to Rs. 2,850, for providing lightning conductors to the Government Central Museum, Madras, is sanctioned for execution when funds are available.

2. This sanction has been entered as Provincial No. 53 W. of 1881-82 in the register of this office and classified as Civil Buildings, Original Works.

(True Extract.)

(Signed) R. H. SANKEY, Colonel, R.E.,
Secretary to Govt., P.W.D.

To Superintendent of Works, Presidency, with three enclosures.
To the Examiner of Public Works Accounts, with duplicate Abstract Estimate.
„ Public Department.

Exd. S. T. Austin.
Spare Copies

BUILDINGS AND ROADS.
MILITARY WORKS.

Govt. of {1888} Madras.

PUBLIC WORKS.

Dated March, 14th.

Read. *Encl.*

G.O., 14th March 1888, No. 845 W.

MARCH.

Lightning Conductors

Letter from the Government of India forwarding copies of the "Instructions as to the application of — for the protection of Powder Magazines and other Buildings," communicated to officers of the Public Works Department.

[*Issued with Army Circulars, dated 1st November* 1887.]

REGULATIONS FOR THE ROYAL ENGINEER DEPARTMENT.

APPENDIX II.

APPENDIX TO PARAGRAPH 280.

Instructions as to the Application of Lightning Conductors for the Protection of Powder Magazines and other buildings.

General Principles.

Thunder-clouds.

(*a*) A thunder-cloud is a mass of vapour charged with electricity at extremely high pressure or potential. The origin of this charge has been variously ascribed to evaporation, to friction of air currents, as well as to all the changes in the physical condition of the earth's surface which are incessantly occurring.

Induced charge.

(*b*) A thunder-cloud acts by induction on the land or water beneath, or on clouds near it, and draws a charge of electricity of opposite kind to the surface. This induced charge re-acts upon the cloud in a similar manner, thereby forming a huge electrical condenser.

Disruptive discharge.

(*c*) When the difference of electrical pressure between the oppositely electrified cloud and earth, or cloud and cloud, is sufficiently strong to break across the air space which separates them, an electric discharge of a disruptive nature, with consequent disengagement of heat, takes place.

Clouds imperfect conductors.

(*d*) Clouds are imperfect conductors, and therefore do not part with all their charge at once. Hence a single discharge does not necessarily deprive a cloud of the whole of its charge; there may be several successive discharges.

Sites least liable to lightning.

(*e*) The surface of the earth is formed of fairly good conducting media, but there are some portions, such as sandy deserts and chalk downs, which, after long droughts, form non-conducting areas. Lightning is least to be feared in such situations, the induced charge not being so easily drawn to the surface.

Path of lightning.

(*f*) The lightning discharge between cloud and earth follows the line of least resistance, or, in other words, selects the easiest path. Objects which project above the general level are, therefore, *cæteris paribus*, most frequently struck. Dry air is practically a non-conductor of electricity, but moist or hot air possesses a certain conducting capacity. Hence rain or hail, and columns of rising smoke or steam, sometimes determine the direction of the discharge, which does not therefore always strike the highest points. Metals, which are the best conductors of all, generally determine the path of the electrical discharge.

(*g*) The lightning discharge does not always follow a single track; it frequently divides into several lines. When alternative routes are offered for its passage, the electric discharge will divide itself among them in direct proportion to their several conducting capacities, *i.e.*, inversely as their respective resistances. In its passage to earth, however, the discharge will not leave a line of good conductors for an inferior one, with which it is unconnected, except when the latter offers a much more direct path to earth, in which case a portion of the discharge may leave it. Again, when a conductor is bent abruptly through a considerable angle, the discharge may seek a shorter path to earth by bridging the air space connecting the nearest portions of the conductor, and a portion of the discharge is then very liable to be diverted to any alternative route which may present itself. This action is due to the attractive effect of induction.

Path of lightning.

(*h*) Atmospheric electricity is only destructive when it is overcoming high resistances. If the conductivity of its path to earth be sufficient, the discharge passes off harmlessly.

When the electric discharge bridges a gap or sharp bend in a conductor, or jumps from one conductor to another, a considerable mechanical effect is produced. The conductor may be broken, bent, or melted, both at the point where the discharge leaves and at that on which it jumps, and the effect is greater in proportion to the distance across which the discharge jumps. Hence the importance of ensuring perfect metallic continuity in the joints of all lightning conductors, of leading them to earth by the most direct route, of avoiding sharp bends, and of connecting all masses of metal in the line of probable discharge with the lightning conductor, so as to avoid the danger of lateral discharges across the air, or it may be through the building.

Effects of discharge.

(*i*) A lightning rod is a pointed conductor, in intimate connection with the earth, fixed on the salient feature of a building with the object of protecting it from the destructive action of lightning. It fulfils two functions:—

Double function of lightning rod.

1*st*. A lightning rod tends to *prevent* a disruptive discharge occurring by silently* neutralizing the conditions which determine the formation of an induced charge in its neighbourhood.

2*nd*. It *protects* the building to which it is attached by offering a path of high conductivity by which the discharge may be carried off harmlessly to earth.

(*j*) The *preventive* action of a lightning rod depends on the power of its pointed end. A thunder-cloud in the vicinity of a building draws a charge of electricity to the lightning rod, and this charge will escape from the point as fast as it can be induced, provided there be a sufficient number of sharp points all well connected with the earth. This power of points to dissipate a charge is due to the self-repulsive action of electricity of the same kind and to the law of distribution of electricity on a surface that the density is greatest at points or on portions of the surface of greatest curvature. It is essential, therefore, to foster this gradual or brush discharge by providing a sufficient number of sharp lightning rods in intimate connection with the earth by means of continuous metallic conductors, so as to collect or tap the induced charge, and to oppose the least possible resistance to its escape from the points.

Preventive action.

Further, the flow of electricity from the points being directed towards the charged cloud, some of the inducing charge may thereby become neutralized. Hence not only does a lightning rod tend to prevent the accumulation of electricity on the surface of the earth within its sphere of action, but it also tends to restore the clouds to their natural state, both of which concur in preventing lightning discharges.

(*k*) Should, however, this brush discharge of electricity from the points of the lightning rods be insufficient to prevent the accumulation of a charge and a lightning discharge take place, it would pass to the points, because the density and consequent attraction are greater there than anywhere in the neighbourhood, and also because the flow of electricity from the points reduces the mechanical resistance of the intervening air. The discharge in this case would, in all probability, be greatly modified by the previous escape of electricity from the points, and being conveyed to earth by a continuous conductor of ample capacity, would leave no trace of its passage. This may be termed the *protective* function of a lightning rod.

Protective action.

(*l*) A lightning rod in imperfect connection with the earth, due either to insufficient surface of conductor buried in the ground, or to defective joints, although it may save a building from actual damage by determining the path of the electric discharge to earth, is generally regarded as a source of danger, inasmuch as the sudden and disruptive discharge would be liable to fuse or scatter some portion of the conductor in its passage, and so leave the building unprotected from further strokes. Again, a lightning rod in such a condition, by allowing the

Defective lightning conductor a source of danger.

*The word silent is the conventional term used to describe a continuous brush discharge which generally is not audible. The brush discharge when very rapid is, however, accompanied by considerable noise, and is frequently visible at night.

comparatively slow accumulation of an induced charge, tends to attract or invite an electric discharge, while the resistance offered at the defective portions of the conductor may cause a portion of it to seek another path disruptively through the building. A faulty lightning conductor may thus prove worse than useless.

(*m*) The lightning rod terminal should be designed so as to combine, as far as possible, both its preventive and protective action (*vide* paragraph *i*). The requirements are somewhat antagonistic, because the sharper the point the more rapid is the brush discharge, but at the same time the more liable is it to be fused should a heavy disruptive discharge fall upon it. Attempts have been made to obtain a resisting point by the use of platinum tips, and silver or other alloys, but they enormously increase the cost, and have not proved reliable. The system which has been adopted is to separate the double function of a lightning rod by prolonging the upper terminal, and bevelling it off to a blunt right-angled cone of the effective section of metal capable of safely carrying off any disruptive discharge, and with a view to facilitate as much as possible the brush discharge, to add three or four very sharp-tapered points projecting upwards from a ring fixed about a foot below the top of the lightning rod.

Design of lightning rod.

(*n*) As regards the earth connections, it is most important that the electrical resistance which they offer shall be very far less than that offered by any alternative route in the line of probable discharge, such as the rain water or gas pipes outside a building. The earth connections should be the best which the nature of the soil will admit of, and all available means which will assist in tapping a large extent of moist earth in the immediate vicinity of the building should be utilised.

Earth connections.

(*o*) Except where the permanent water level is very near the surface, both deep and shallow earth connections are required, because after a long period of dry weather the induced charge may be collected on a damp substratum, whilst after rain it may be collected on the surface. The deep earths should be carried down to water bearing strata or to permanently moist soil, and the shallow earths should be arranged so as to offer a considerable surface of connection with the soil around the building.

Deep and shallow earths required.

(*p*) Earth connections should be buried throughout in small coke, which is a fairly good conductor of electricity, readily absorbing and retaining moisture. The contact surfaces between the metal conductor and the soil in which it is laid, are thereby much increased, and the tapping of any induced charge or the transmission of any discharge to earth facilitated. A layer of coke also tends to preserve copper from corrosion.

Coke for earth connections.

(*q*) The metals employed in lightning rod construction are iron, plain or galvanised, and copper. Roughly speaking, they cost the same for equal conductivity; but conductors made of iron are stronger, less easily fused, and less liable to be stolen. Copper conductors, on the other hand, have the advantage of being far more durable, and being smaller and lighter, they interfere less with architectural features, and are much cheaper to erect. Copper tape of high conductivity, which is now manufactured in long lengths, thereby obviating the necessity of numerous joints, has been adopted for all conductors on War Department buildings.

Metals employed as conductors.

(*r*) The size of conductor required for lightning rods is based on recorded instances of metal bars and rods which have been fused. The Lightning Rod Conference of 1881 recommended the following as the minimum sizes of conductors to be employed, viz.:—

Size of conductor.

Material.	Section.	Area sq. in.	Weight per ft.
Copper tape	$\frac{3}{4}'' \times \frac{1}{8}''$	0·09	6 oz.
„ rope	$\frac{1}{2}''$ diameter.	0·10	7 „
„ rod	$\frac{3}{8}''$ „	0·11	7 „
Iron rod	$\frac{9}{16}''$ „	0·64	35 „

The recorded instances of lightning rods which have been fused or damaged can invariably be traced either to faulty earth connections, defective joints, want of continuity or adequate sectional area in the conductor, or to the propinquity of neighbouring masses of metal unconnected with the conductor which have invited a portion of the discharge to leave the main conductor by providing an alternative route. There is no authentic record of a properly-constructed lightning rod having been injured or having failed to do its work, and there is every reason to infer that a smaller size of conductor would suffice to carry off any electrical discharge, provided perfect continuity and efficient earth connections could be permanently maintained. The size of conductor required for lightning conductors is, however, practically ruled more by

considerations of strength and surface for making good connections than by that of electrical resistance. The smallest size of copper tape to be used for the main conductors on War Department buildings is $1'' \times \frac{1}{8}''$.

(*s*) It may be accepted that a lightning rod will protect a space included in a cone having the point for its apex, and a base whose radius equals the height from the ground. Buildings protected on this principle would require very lofty lightning rods. It is considered that a number of smaller rods well connected together by conductors, carried along the salient features of a building, provide a more reliable protection than an equal amount of metal in higher rods spaced at greater intervals, and this is the system which has been adopted for the protection of all War Department buildings.

System of protection.

RULES.

I. A complete system of lightning conductors should be provided for all overground magazines, and for all buildings in which the manufacture or manipulation of explosives is carried on.

Buildings requiring protection.

II. Important underground magazines, although less exposed to lightning than overground buildings, should nevertheless be provided with conductors, because magazines are now so frequently filled with gunpowder in metal cases that a line of smaller electrical resistance than through the surrounding earth might be offered to the lightning through the body of the magazine.

Underground magazines.

III. Expense small arm ammunition magazines need not be fitted with lightning conductors, except in cases where they occupy very exposed sites, or have much metal connected with them. Steps should be taken to remove forthwith defective lightning conductors on these magazines, or to make them efficient should it be decided to retain them.

Expense magazines.

IV. The salient features of barrack buildings should be provided with lightning rods when experience has shown that the locality is attractive to lightning, more especially when any considerable mass of metal enters into their construction.

Barracks.

V. It is advisable to fix a lightning rod on any flagstaff that may be near a magazine, and also on all high chimney shafts.

Flagstaffs.

VI. All lightning conductors on War Department buildings should be brought as far as possible into conformity with these rules, but existing arrangements may generally stand, provided care be taken to improve defective earth connections and to make good all joints.

Existing conductors.

VII. Whenever lightning conductors are to be erected or reconstructed on any War Department magazine or building, the Commanding Royal Engineer of the District should invariably forward a special report, accompanied by descriptive drawings, to the Inspector-General of Fortifications, in order that the details and general arrangements may be approved before any steps are taken to carry out the work. In cases where a doubt may exist as to the necessity of erecting lightning rods (*vide* paragraphs III and IV), a report should be made specifying any peculiarities of the site; its height as compared with the neighbouring ground; liability of locality to thunderstorms; nature of soil and substrata, and depth of permanent water level; and full particulars of building, and of all masses of metal entering into its construction or placed near it.

Special report to be forwarded with plans.

VIII. The angles and prominent features of a building being the most liable to be struck, lightning rods should be fixed on gable ends, chimneys, turrets, &c., and they should be connected together by continuous conductors along the ridges.

Position of conductors.

IX. Lightning rods should be about 4 feet high, and spaced at intervals not exceeding 50 feet, so that no point on the building is more than 25 feet horizontally distant from a lightning rod.

Height and spacing.

X. The material to be exclusively employed for the construction of new lightning conductors is copper tape It is manufactured in lengths of 300 feet and upwards. A conductivity of at least 95 per cent. of that of pure copper should be specified, and the tape should be soft and flexible, so as to admit of its following closely the outlines of a building. Copper tape

Specification of material.

$1'' \times \frac{1}{8}''$, weighing about $\frac{1}{3}$ lb. per foot, is the most suitable size for all ordinary conductors, and $1\frac{1}{2}'' \times \frac{1}{8}''$ may be used for very high chimney shafts.

XI. In situations where copper tape is liable to be stolen, it may be let into the walls of the building and cemented over, or otherwise concealed where it is accessible. The practice of protecting the lower portion of copper conductors on buildings by enclosing them in iron pipes at the base of a building is questionable.

Protection from theft.

XII. In order to guard against those accidental defects and disarrangements to which conductors are liable, buildings provided with lightning conductors should have, as a rule, at least two earth connections, the conductors leading to them being connected at the base of the building, either above the ground line, or by a conductor underground forming a "surface" earth (*see* paragraph XV). Each lightning rod should be connected direct to earth by the shortest path outside the building, and, where practicable, it is well to carry the conductor down that face of the building which is most exposed to prevailing wet. In the case of gabled buildings, the conductors should be taken down the barge courses in preference to the gable, so as to protect the angle of the building, and at the same time secure the advantage of the additional moisture in the ground near the rain-water down-pipes, and facilitate their connection thereto.

"Earth" connections.

XIII. When the level of water or permanently wet soil lies within a few feet of the surface, the conductors should terminate in earths offering each about 18 square feet of external surface. These may consist of copper plates, about $3' \times 3 \times \frac{1}{16}'$, rivetted to the ends of the conductors, and buried in water or wet soil from 15 to 25 feet from the building. A better plan, however, is to coil the end of the conductor spirally on a wooden frame, the external diameter of the coil being 4 feet, with 6-inch intervals between the turns. About 33 feet of tape are required for this earth connection; it obviates the necessity of any underground joint, taps a larger surface of earth, and, the tape being twice the thickness of the plate, it is more durable, besides being a cheaper arrangement.

Earth coils.

XIV. When the permanent water level is deep, it may be necessary to sink special wells for the earth plates, which should be of the same size as those specified in the previous paragraph. The wells should be carried down several feet below the water level in the driest seasons, and the lower portion of the well should be built dry.

Wells.

If coils of copper tape, however, be employed for earths, special wells are not necessary, because, there being no joints underground, the same necessity for periodical examination no longer exists. In this case the earth coils may be buried at the bottom of a pit sunk below the level of permanently wet soil.

Where the depth is considerable, two or more conductors may be connected to the same earth plate, and in the case of a coil of tape the inner, as well as the outer, end may be brought up to the surface of the ground so as to form two earth connections. In both cases the size of earths should be made proportionately larger.

XV. In addition to these deep earths it is necessary to provide surface "earths" laid in trenches, from 1 foot deep in clay soils to 2 feet deep in sand or shingle, through which the rain percolates more freely.

Surface "earths."

These surface earths may consist of that portion of the conductor which leads from the base of the building to the well or deep earth, or they may be arranged as separate conductors led in trenches away from the building. In the latter case, the deep and surface earths should be connected together by a conductor carried round the base of the building.

The length of each surface earth trench may be from 25 feet in ordinary soil to 50 feet in dry soil, and the width at bottom should be about 9 inches. A few inches of powdered coke should be spread both above and below the conductor, and the trench filled in with light soil. The rain-water down-pipes from the roofs may with advantage be led into these trenches.

XVI. In the case of forts and magazines near the sea, good earths can be obtained by laying a length of tape so that at least 5 square feet of it shall always be under water; or a coil of tape may be buried in permanently wet sand.

Sea earths.

When the distance to the sea is considerable, these earths should be supplemented by surface ones round the building, so as efficiently to tap any induced charge in its vicinity.

XVII. Iron water mains form good earth connections Soft metal pipes and gas mains should not be used, but when they run close to the conductors from a building, they should be connected to the lightning conductor system. There are many recorded instances of both water and gas pipes which have been damaged by lightning springing on to them from neighbouring conductors, which would have been obviated had they been connected thereto. (*Vide* General Principle *h*).

Water mains.

XVIII. In extremely dry or rocky situations it is often impossible to obtain good earth connections except at a great distance. In such cases the best plan to adopt is to bury several hundredweight of old iron at the foot of the earth coil or plate in a mass of coke, leading the rain-water pipes so as to discharge into it.

Dry and rocky sites.

XIX. Coke, suitable for improving the earth connections of lightning rods (*vide* General Principle *p*), is procurable as a waste product of gas works. Clean smiths' ashes may also be used. A layer of about 3 inches should be spread both below and above the conductors in the trenches, and also round the earth plates or coils.

Coke for earth connections.

XX. The earth connections of flagstaffs near magazines should be led in a direction away from the building. Should, however, the horizontal distance between the flagstaff and the nearest lightning rod on the magazine be within 50 feet, or should any portion of the building lie within the cone protected by the flagstaff rod (General Principle *s*), then the magazine and flagstaff earths may be connected, or have an "earth" common to both. This rule is also applicable to shafts of powder mills, &c.

Flagstaff earths.

XXI. The rain-water pipes and gutters should never be utilised as a portion of the system of lightning conductors, to which, however, they should be connected.

External masses of metal.

All external masses of metal, such as copper sheeting on magazine doors and ventilators, &c., should also be connected to the nearest conductors by lengths of copper tape.

In the construction of magazines and other buildings in which the manipulation of explosives is carried on, the employment of external masses of metal should be avoided as far as possible.

XXII. Lines of rail near buildings protected by lightning rods should be connected to earth direct on both sides of the building, and when the line is carried inside the building it should be connected also to the system of lightning conductors. Iron railings round magazines should be connected direct to earth at intervals of about 50 feet.

Lines rail.

XXIII. All large and long masses of metal, such as beams, girders, pipes, hot-water systems, and large ventilators fixed in the interior of buildings should be electrically connected with the earth as well as with the conductor; but the soft metal gas-pipes should never be used as conductors; and the lightning conductors should be kept as far as possible from them, and also from all internal gas-pipes.

Internal masses of metal.

XXIV. Lightning conductors should not be insulated from the buildings to which they are attached. The copper tape should be laid on the ridges and walls, and secured by suitable fastenings screwed or nailed to the building. The holdfasts should be of gun-metal fixed by nails of hard copper, and they should allow free expansion or contraction, at the same time preventing all the weight falling on any one bearing.

Fixing conductors.

XXV. Powder mills, &c., with zinc or galvanised roofs, should be protected by copper conductors laid over them, but protected from actual contact by strips of wood, paint, or tarred felt. The zinc roof itself should be treated like any other external mass of metal, and should be thoroughly well connected to the conductors in several places. The system sometimes adopted of having sheet zinc lightning rods and copper tapes from the eaves of the roof to earth is very unreliable, because the lightning rods are of ineffective section, the zinc sheets are insulated from one another by a layer of oxide, and the joint between the zinc and copper is liable to failure.

Metal roofs.

XXVI. Chimney shafts should be protected by a ring of copper tape $1\frac{1}{2}'' \times \frac{3}{16}''$, placed round the outside of the top of the cap and a few inches below it, having stout copper points, projecting 1 foot above the top of the shaft, at intervals of 3 or 4 feet all round. A copper tape should be carried down on opposite sides of the shaft to earth from the ring; and these conductors should be connected at the base, a test clamp being added to enable the continuity of the conductors and the state of the earth connections to be ascertained when necessary.

Chimney shafts.

XXVII. Metallic continuity should be ensured at the joints of all conductors. Solder should never be used where this can be done by closely-fitting rivetted or screwed joints. The solder is seldom properly sweated through the joint, and often consists of an imperfectly adhering mass of metal hiding up badly-fitting and dirty surfaces. Solder tends to set up galvanic action, which after a time will destroy the connection; and, in the case of copper conductors, its use is objectionable, because it interposes an alloy of high resistance and low melting point in the joint. Soldering conductors in the vicinity of magazines and powder factories

Joints in conductors.

is attended with so many restrictions and precautions that it is practically unsuited for War Department requirements.

For these reasons it is considered preferable to ensure a perfect metallic contact between copper tapes, by drawing the surfaces together by close rivetting or by screw clamps, and to exclude damp from the joint by paint or other means.

In rivetting copper tapes, five rivets should be used, and the holes should be bored, not punched. The "arris" being removed, and the surfaces brightened with emery, the joint should be brought together with a hollow punch before rivetting.

XXVIII. The connection between the lightning rod and the conductor is made by means of a slotted clamp similar in design to those employed for test or other joints. The lightning rod terminates at its lower extremity in a $\frac{3}{4}$-inch bolt, which is screwed into the clamp, thereby making firm contact with one or more tapes inside it. This joint admits of visual inspection.

Joint between lightning rod and conductors.

XXIX. For the repair of old lightning conductors, however, it is sometimes necessary to use solder. For copper the solder usually employed consists of equal parts of tin and lead, which has a resistance nearly ten times that of copper. The surface of the joint should, therefore, be not less than $1\frac{1}{4}$ square inches.

Repair of old conductors.

Molten zinc should be used for soldering iron conductors. Being nearly twice as conductive as iron, the surface of the joint need not necessarily exceed that of the cross section of the conductor.

In both cases the joint should be put together previously by screws or rivets, and the soldered joint, especially in underground work, should be carefully protected from galvanic action by tarred tape.

XXX. Existing iron wire rope conductors may be connected to copper tapes in the following manner. Take a piece of sheet copper $4\frac{1}{2}'' \times 3''$ $\times \frac{1}{8}''$, and cut it down at one end to the size of the tape for a length of $1\frac{1}{2}''$, and rivet the tape to the sheet at this part; then bend the remainder of the sheet round the end of the rope, which has been previously frapped with fine wire, thus forming a tube which should be previously tinned inside. Sweat up the joint with zinc solder, and protect it by tarred tape bound tightly over it.

Connecting wire rope to copper tape.

XXXI. Copper tape conductors may be connected to iron water mains by filing about a foot of the top of the pipe bright, binding the tape on to it by wire, and soldering with zinc; or a short length of iron bar, $2'' \times \frac{1}{2}''$, may be rivetted and soldered to the copper tape, and then $\frac{1}{2}''$ screws studded together both through the bar and a flange of the pipe.

Connection to mains.

It is a good plan to coil several turns of the copper tape round the main, keeping it from actual contact by battens previous to fastening the end, so as to increase the earth connection should the joint ultimately fail.

The greatest care must in all cases be taken to protect the joint from galvanic action by layers of tarred rope, or by imbedding the main at the joint in cement.

XXXII. Metal surfaces on which the rays of the sun fall are exposed to a maximum range of temperature of about 144° Fahr. This range of temperature produces an expansion and contraction in copper conductors of about 1 inch in 60 feet, which should be provided for by forming small loops near the base of the lightning rods, and by allowing the conductor free play through the holdfast employed to fix it on the building. Conductors should never be screwed or nailed down. Vertical conductors on shafts, flagstaffs, and high walls should have small loops above every second or third holdfast, to take the weight of the conductor while still allowing for expansion and contraction. The holdfasts should in this case be about 4 feet apart.

Expansion of conductors.

XXXIII. Artisans, and especially painters employed on War Department works, should be cautioned never on any pretence to disconnect, move, or tamper with any portion of a lightning conductor without first obtaining the written authority of the Royal Engineer Officer in charge.

Conductors not to be tampered with.

XXXIV. Lightning conductor records should be kept in the office of the Commanding Royal Engineer of each district. In addition to the usual small scale plan, showing the details of the conductors, the position of the buildings protected and the earth connections should be marked on the lithographed plan. Copper conductors should be shown by red, and iron by blue lines. The lightning rods numbered 1, 2, 3, &c., conductors *a*, *b*, *c*, and earths E_1, E_2, E_3, &c., to correspond with a descriptive record containing as many of the following particulars as possible:—

Record plans.

(1) Date of erection or reconstruction of lightning rods.
(2) Character of soil and substrata, and depth of permanent water level or wet soil.
(3) Full particulars of lightning rods, conductors, and earth connections, nature of joints and connections, &c.

(4) Details of all external or internal masses of metal entering into construction of building, and how connected to conductors.
(5) Position of test joints, if any. Nearest earth available for testing, &c.
(6) Quantity of powder, &c., kept in store.
(7) Date of last inspection and *précis* of former tests, suggestions, &c., of inspecting officer.
(8) To whom notice of inspection should be sent, so that ladders may be ready for getting on the roofs, &c.

XXXV. Lightning conductors should be periodically inspected, once a year, and the Inspector should forward, on the accompanying form, a report to the Inspector-General of Fortifications, through the Commanding Royal Engineer of the district.

Periodical inspection.

The Commanding Royal Engineer should take steps to have every portion of the system of lightning conductors visually examined by a competent mechanic, in order that all defects may be remedied, so far as the means at his disposal will admit, before the periodical inspection.

Annual Inspection of Lightning Conductors.

District

Name of fort, battery, magazine, &c.

State of soil when inspected.

Date of inspection.

Lightning rod.		Conductor.		Earths.			
Number.	State of points and connections.	Letter.	Condition.	Letter.	Condition.	Tests.
1						
2		*a*		E_1		
3		*b*				
&c.		*c*		E_2		
		&c.				
				E_3		
				&c.		

XXXVI. In the case of lightning rods which require repair or reconstruction, the Inspector should submit, in addition, a special report, accompanied by tracings or hand-sketches, foolscap size, of the existing system of conductors, detailing fully the various defects either in design or construction, and his suggestions and proposals for their improvement.

Report of repairs or reconstruction.

XXXVII. The object of electrical tests of lightning conductors is to determine the resistance of the earth connections, and to localize the position of any defective joints or connections in the conductors. The resistance of the conductor itself is quite inappreciable (less than $\frac{1}{4}$ ohm per 1,000 yards for copper tapes $1'' \times \frac{1}{8}''$), and could not be detected by the portable testing apparatus employed. The resistance of the earths depends on the nature of the soil, and its state of moisture at the time of the test. As a rough guide, however, it may be mentioned that the joint resistance of two earths, such as those described in paragraph XIII, 30 yards apart in damp soil, will not exceed 2 ohms.

Electrical tests.

XXXVIII. The best system of testing lightning conductors is to balance the resistance of each of the earths of the building against the remainder of the system, from which the state of the earths may be inferred with sufficient accuracy for all practical purposes. With this object test joints should be added to all magazines and shafts.

System of testing.

When the system of conductors is permanently rivetted up, the resistance of two small test earths, placed not less than 20 yards apart in water or moist soil, or of any two convenient earths unconnected with the system of lightning rods, such as a gas and a water pipe, is first ascertained. Then the sum of the resistance of each test earth in succession, and the earths of the

lightning conductor system is ascertained, and the joint resistance of the latter calculated from the resulting three equations. Thus:—

Let L = conductivity resistance of the leads, ... = $L+e_1+e_2=A$
Then the resistance of leads and test-earths ... ... = $L+e_1+E=B$
Resistance of leads, one test-earth, and the earths of lightning conductors ... ... = $L+e_2+E=C$
Resistance of leads, other test-earth and earths of lightning conductors ... ... (1)

$$\text{Then } E = \tfrac{1}{2}(B+C-A-L) \quad (2)$$
$$e_1 = \tfrac{1}{2}(A+B-C-L) \quad (3)$$
$$e_2 = \tfrac{1}{2}(A+C-B-L)$$

Very short contacts should be made in order to avoid polarisation of the test plates. If the resistances be very unequal, the results obtained from these equations may not be very accurate.

XXXIX. The resistance of the conductors from each lightning rod point to that part of the conductor from which the resistance of the earth connections was ascertained, is then found. As the resistance of the conductor should be practically *nil*, any resistance in excess of that of the leads must be due to defective joints, and the faults should be localized and marked for repair.

Defective joints localized.

XL. Conductors made in short lengths and connected by joints, the metallic continuity of which has not been ensured by soldering, or by a good system of rivetting, if tested electrically, give results of little value.

Underground joints and earths, the nature of which are not known, should be dug up and examined when practicable.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads
Military Works.

Read—the following papers :—

From Major J. E. BROADBENT, R.E., Assistant Secretary to the Government of India, Military Department, to the Secretary to the Government of Madras, Public Works Department, dated Fort William, 13th February 1888, No. 318 M.W.

In continuation of Military Department No. 2496 M.W., dated the 14th December 1887, I am directed to forward ten additional copies of "Instructions as to the application of Lightning Conductors for the protection of Powder Magazines and other Buildings."

From the Secretary to the Government of India, Military Department, to the Secretary to the Government of Madras, Public Works Department, dated Fort William, 7th March 1888, No. 513 M.W.

In reply to your letter, No. 766 C., dated the 22nd February 1888, I am directed to state, for the information of the Governor in Council, that Military Department No. 2496 M.W., dated 14th December 1887, a copy of which is asked for, is merely a docket forwarding two copies of the "Instructions for the application of Lightning Conductors."

Order—dated 14th March 1888, No. 845 W., Public Works.

Communicated to officers of the Public Works Department for information and guidance, in continuation of G.O., No. 3187 W., dated 12th November 1883.

(True Extract.)

(Signed) H. R. MEAD, Colonel, R.E.,
Joint Secretary to Govt., P.W.D.

To Superintending Engineers.
To the Consulting Architect to Government,
" Chief Engineer for Irrigation,
} with copies of the Instructions.

Exd. J. Moses.
Spare Copies