Public Works (1895) Department.

J.

G.O., No. 602 W.

DATED 13 March 1895

[Despatch Abstract.]

Bellary Jail – Orders on explanation from Messrs Midleton and Ward, Executive Engineers, on their share of the delay in the preparation of an estimate for converting the dry well in the — into a draw well.

of
e
l
s well

[P.W. 25. 5,000—30-11-96.]

Indexed. 25-3-95.

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

C/No 122
331
490

Letter from J. H. Medlicott Esqre, Executive Engineer Madura Division No. 615 S.E. d/7 January 1895.

Letter from C.W. Wood Esqre, Executive Engineer, Immediate D.O. No. 28 dated 10 January 1895.

Letter from the S.E. III Circle No. 2472 d/21 January 1895.

Note by the Chief Engineer P.W. Dept:—

Submitted for the consideration of Government.

2. I have gone very carefully through the whole of the correspondence, from a perusal of which it is clear that Mr. Medlicott is in no way to blame, nor is any delay to be laid to his charge; he dealt with the matter within sixteen days of taking charge of the Division, and all subsequent delay as well

as a great part of that which had already occurred was due to the obstinate refusal of the Superintendent to attend to the orders which require the sanction of Government to the preparation of estimates for works likely to cost more than Rs 500. Mr Medhiatts' proceedings require no defence, and he may in my opinion be left out of the discussion.

3. The original request for the preparation of an estimate for the improvement of the well appears to have been received by Mr. Peters, in August 1892, passed on to the Sub Divisional officer and then forgotten, a proceeding I am sorry to say, entirely characteristic of Mr. Peters, [illegible] usual practice; he has however left the service, and it is useless to consider his proceedings any further.

4. Mr Wood took charge of the Division on the 31st March 1893 and his attention appears to have been drawn to the matter by a reminder dated 9th April, to which he replied on the 29th July that the estimate was under preparation; a few days later (5th August), he told the Superintendent that an estimate had been made but that as the cost was over Rs 500 the sanction of Government was necessary to its submission. Mr

sanction the Superintendent was requested to obtain. The latter officer replied to this on the 24th October (a delay of two months) that fresh sanction did not seem necessary as Government had already called for a plan and estimate.

5. It should be observed here that the estimate called for by Government was for converting a dip well into a draw well, that asked for by the Superintendent, apparently on his own authority, was for the provision of a pump and pipes, which appears to have been later on expanded into a complete system of piped water supply. Mr Wood was therefore perfectly right in declining to submit the estimate without fresh sanction and was supported in so doing by the Supty Engineer. For all delay subsequent to the 8th August the Superintendent is solely and entirely responsible, and I think it advisable to draw the attention of Government to the fact that in the precis of correspondence submitted by the Superintendent he entirely omits all reference to Mr Wood's letter No. 1918 of the 8th August 1893.

6. The Inspector General's remark that "the decision communicated in Mr. Medlicott's letter No. 627 of 17th May 1894 might have been arrived at at any time during the last 18 months" is strictly true, but the Inspector General was unaware that so far as nine out of the eighteen months were concerned the decision actually had been communicated.

7. There remains for consideration the delay of four months from the 9th April to the 8th August for which Mr. Wood is apparently responsible. It certainly appears at first sight that even this is longer than so small a matter ought to have occupied, but it must be considered first that the Division, to which Mr. Wood was entirely new, is a very large and troublesome one including the two civil districts of Bellary and Anantapur, that Mr. Wood's predecessor was notorious for his want of business capacity, and probably left a considerable mass of arrears to be cleared off, and that the preparation of even an approximate estimate for the work asked for by the Superintendent required a certain

amount of enquiry as to the cost of pump and pipes, an examination of the grounds, and probably the execution of a certain amount of levelling and surveying.

8. Allowing for these considerations the avoidable delay is reduced to an amount for which I cannot consider that any serious blame rests upon Mr. Wood.

S

6-2 Ex.

Copy 6/55

No. 61518

Executive Engineer's office
Madura Division
7th January 1895.

From. J. H. Medlicott Esquire,
Executive Engineer,
Madura Division.

To. The Secretary to Government
Public Works Department
Madras.
(through the Supt. Engineer
VI Circle)

No 1109 m2.
Forwarded
W. Hyde
S. E. Circle.
9.1.95.

Sir.

With reference to G. O. No. 3167-W. dated 10th December 1894, I have the honour to report that I took over charge on the 25th January 1894. On the 10th February I submitted the estimate for the pumping to the Superintending Engineer.

2. This estimate was returned on the 30th March 1894. for resubmission with a general abstract. (Vide Supt. Engineer's No. 3301).

3. A few days after this, I had a conversation with the gaol Superintendent with reference to the quantity of the water required for a days consumption.

It

It was then found that the provision made was insufficient. (Vide Sub-division Officer's No. 32 dated 25 April 1894) It was also proposed by the gaol Superintendent to provide a regular water supply system with pipes, cistern & tap &c., for supplying water under pressure. As this would have cost over Rs 500/-, I requested the Superintendent to obtain the sanction of Government (See my No. 627 dated 15 May 1894 and previous Correspondence). Before receiving a reply to this letter I was transferred to the Madura District.

4. The only reason for not re-submitting the original estimate for the drainage, was the proposal of Dr. O'Hara, to have a system of pipes with a cistern and force pump.

I have the honorable,
Sir,
Your most obedient Servant.

J. A. Hendrick.
Executive Engineer

Ellis/1.

P. W. CURRENT No. 122

SUPDT. ENGR. 6TH CIRCLE
No. 1029/W&B
9 JAN. 95
P.W.D.

(72)

From.

J. H. Abbiecatt Esqre.

Executive Engineer

Madura Division

To.

The Secretary to Government.

Public Works Department.

Madras.

"Thro' the Supg. Engineer 6th Circle".

Dated 7th
Dcpd 8th } January 1895
Rec'd 10th

No 615 SE

Levelo. rib.

Estimate for converting the disused well in the Bellary Jail into a draw well. Submits explanation for the delay in the submission of same —

Await explanation
Mr Wood —

CWW 10/1/95

Dw 10/1/95

No. 28.

Tinnevelly Division Office,
10th January 1895
Dft 11th

FROM

C. W. Wood Esqr.

EXECUTIVE ENGINEER

TINNEVELLY DIVISION.

To,

THE SUPERINTENDING ENGINEER

6th CIRCLE.

Enclosures.

Sir,

With reference to your No 768 S. A. of 12th December 94, I have the honor to state that I have a distinct recollection of making an estimate for providing the well near the Bellary Jail with a pump and pipe to convey water into the Jail, and of Conversing with the Superintending Engineer Colonel Fraser on the subject.

2- As far as I can remember the Superintending Engineer advised me to pursue the Course which I adopted, viz, reporting the amount of the estimate to the Superintendent of the District Jail and asking him to obtain the sanction of Government for the

preparation of the estimate. This was asked for in No 1918 of 8th August 1893.

3. After this the orders of Government were awaited calling for the formal submission of the estimate.

I have the honor to be,
Sir,
your most obedient servt

C. A. Wood
Executive Engineer

Compd
C R

No 940 TN.

Submitted to the Chief Engineer P.W.D. with reference to G.O No 3167 N dated 16th December 1894.

Supt. Engs office Trichinopoly. 16th January 1895.

W. Hughes.
Supt. Engr Madura.

P. M. CURRENT No. 331

SUPG. ENGINEER'S OFFICE
No. 770
14 JAN. 95
P.W.D.
6TH CIRCLE.

P. W. D.

From

THE EXECUTIVE ENGINEER

TINNEVELLY DIVISION.

To

THE SUPERINTENDING ENGINEER

6th CIRCLE.

No. 28

Dated 10th
Despatched 11th } January 1895.
Received 18th

Enclosures — 4 "

SUBJECT.

Well near the District Jail Bellary — stating that orders of Government were awaited calling for the formal submission of Estimate for providing the — with a pump and pipe to convey water into the Jail.

w 210 c 19.1.95
" 2762 w 31.10.94 " 2611 w 17.10.94
" 3167 w 10.12.94
" 3181 c 25.11.54
" 1663 w 4.7.54
" 1586 w 18.6.50
" 2806 w 7.10.52
" 2253 w 16.8.52

2 within No. D 140 TN 16-1-95 + E.N.

W 1812

No. 2472

Superintending Engineer's Office,
3RD CIRCLE.
Bellary 21 January 1895.

From Lt. Col. C. C. Rawson R.E.
SUPERINTENDING ENGINEER,
IIIRD CIRCLE,

To THE Chief Engineer
P. W. D.
Madras

Sir,

Enclosures. 33

With reference to para 3. of G. O. No. 3167 W dated 10th December 1894, I have the honour to forward the file (to be kindly returned when done with) containing 31 papers in connection with the Well in the District Jail Bellary.

2 A precis of the case is also put up for information.

I have the honour to be
Sir
Your most obedt Servt.
C. C. Rawson
18/1/95 Lt. Col. R.E.
Superintending Engineer
III Circle

P. W. CURRENT No. 490

From Lieut. Col. C. C. Rawson R.E.
The Superintending Engineer,
IIIrd Circle,
Bellary.

To
The Chief Engineer
& Sec. to Govt.
Madras

Dated 2nd January 1895.
Received 23rd

Enclosures. 33 38

No. 2472

Subject.

District Jail Bellary

Forwarding a file of papers regarding the delay in the (completion) of

No. 1586 way 15-6-93
" 2253 W - 16-8-92
" 2806 W - 7-10-92
" 1663 W - 4-7-94
" 2611 W - 17-10-94
" 2762 W - 31-10-94
" 3817 C - 28-11-94
" 3167 W - 10-12-94
" 210 C - 19-1-95

P. W. DEPARTMENT.

Read the following :—

Note by the Chief Engineer P.W.D.

FOR ORDERS.

Mr. Peters & Mr. Medlicott may be left out of account. Mr. Wood seems to have kept this matter up for 4 months - and the Supt. of the Jail then refused or omitted to take up the matter as it sh^d have been taken up - & to caused the further delay. The hon. Mr. Peters will deal with this.
As to Mr. Wood though of course it is to be regretted that he allowed as much as 4 months to elapse without attending to such an important matter as the water supply in a Jail - yet I hardly think it is a case wh. calls for suspension of his promotion. I have no doubt that to follow such an officer as Mr. Peters would be to enter on an unpleasant liable. W 11 Feb

43—200—23-3-93.

It will be seen from the Chief Engineer's note that no blame whatever attaches to Mr. Medlicott in connection with the matter of the well at the Bellary Jail, and very little, if any, to Mr. Wood.

2. Under these circumstances it is hoped that His Excellency will permit Mr. Wood's promotion the papers connected with which are submitted for reference) to be

notified.

3. It is thought that notice ought to be taken of the Superintendents disingenuous action in suppressing the fact that in August 1893 Mr. Wood requested him to obtain the sanction of Government to the preparation of the estimates asked for by him.

S

6/2 W.

copy 6/4/95

(1) The Hon. Mr. H. D. Black 95
(2) The Hon. Mr. C.

FOR ORDERS.

Delay in the preparation of an estimate connected with the water supply of the Bellary Jail

I agree with H.E. It is satisfactory to me that the thorough inquiry now made has resulted as it has. Mr. Wood deserves a reprimand, I do not, however, entrust any retardation of this promotion.

The Jail Supt. should be called upon explanation as suggested by the Sec. P.W.D., but in making the call there will be no need to use the word "disingenuous"

BS
18/2/95

I doubt whether Mr. Wood was to blame considering how recently he had taken charge. This promotion should certainly be allowed.

JG
13/2

[G 73] No. 1781
500—17-11-93.

CHIEF SECRETARIAT,
Fort St. George, 6th March 1895

OFFICE NOTE. No. 486

Recd: 7.3.95

From

THE CHIEF SECRETARY,

To The Secretary to Govt. in the P.W.D.

CHIEF SECRETARIAT
8 MAR 1895
GOVERNMENT OF MADRAS

Has the honour to return the accompanying draft order with the suggestion that para. 4 be altered by the substitution of "not reporting" for "suppressing the fact" The use of the word "suppressing" implies wilful misconduct on the part of the Jail Supdt and until his explanation has been received it is deemed inadvisable to use so strong an expression

JG
5/3/95

for Chief Secretary

4.3.95 No. 895 C. dated 4th March 1895

I quite agree; it is certainly premature to say that the fact was suppressed but "mentions" seems better than "reports"—

DJ.
7/3

copy
7.3.95

PUBLIC WORKS DEPARTMENT.

3rd March 1895

THE MADRAS GOVERNMENT.

READ the following

a. } A.E. No. 615 S.E. dated 17th January 1895

b. } " No. 28, dated 10th — do —

c. " No. 2472, dated 21st — do —

d. W.D. dated 6th February 1895.

In G.O. 3167 W. dated 10th December 1894, Mr. Wood and Mr. Medlicott were called on to submit such explanation as they had to offer for their share of the delay in the preparation of an estimate for converting the dip well in the Bellary Jail into a draw well.

2. The explanations have now been submitted and are reviewed by the Chief Engineer

Engineer in his note recorded above.

3. His Excellency the Governor in Council agrees with the Chief Engineer that no blame whatever attaches to Mr: Medlicott in connection with the matter; and very little to Mr: Wood who succeeded to a charge which must have presented considerable difficulties at starting.

4. Such course as may be necessary will be taken in the Judicial Department of the Superintendent's action in ~~not reporting~~ suppressing the fact that in August 1893 Mr: Wood requested him to obtain the sanction of Govt: to the preparation of the estimates called for by him.

Dr 602 b dy 13 Mar 1895

E 98

(The Hon: the Chief Secretary for favor of countersignature)

HOME SECRETARY'S DEPARTMENT
RECEIVED
25 FEB 1895
DEPARTMENT OF PUBLIC WORKS

DESPATCHED
1 MAR 95
INDEXED

S.E. III Circle.
S.E. VI Circle.
Judl: Dept:, with C. No. 9219
encls:- to be returned -

Description of Walker's Magneto-Induction Bridge for testing Lightning Conductors.

1. The efficiency of any lightning conductor depends on two conditions: the one structural, and the other electrical. The former depends mainly on the shape of the object to be protected; for, whilst a simple linear conductor is considered sufficient for any chimney or for the column of a light-house, a series of such conductors, laterally connected together, is necessary for large buildings and powder magazines. The structural condition, once carefully selected, undergoes no change whatever so long as the shape of the protected object remains unchanged. The electrical condition, however, which depends on the nature and efficiency of the joints made between different parts of the conductor, the condition of the soil, etc., undergoes constant changes which are due to a variety of causes (mechanical, meteorological, chemical and electrical), and therefore requires to be carefully watched in order that the limit of safety (which has been generally fixed at 10 ohms, from the apex to the earth connection inclusive) is not exceeded; for it is acknowledged that a defective lightning conductor becomes a positive source of danger to a building, owing to the fact that discharges of atmospheric electricity may, under such conditions, find a path to earth through some part of the building itself.

2. The testing of lightning conductors from time to time is therefore of paramount importance, as it is only by this means that any increase in their electrical resistance can be ascertained. When the tests show that the resistance has increased, we know that there is a fault in some part of the conductor circuit, and this fault should be at once found and removed. The testing apparatus herein described has been specially designed to admit of its being used by operators of ordinary intelligence. In fact the instrument itself, and the connections to be made with the conductor, are of such a simple nature that no special knowledge is required to carry out the tests.

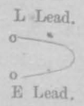
3. The apparatus consists of a Magneto-Inductor M, a telephone, and a bridge-board C (Figures 1 and 2). On the latter are fixed a ring of German-silver wire (forming the branches A and B of a Wheatstone's bridge), a contact lever P, which can be moved horizontally over the ring and used as a battery key, six terminals marked B, B^1, L, E, T and T^1, and under the bridge-board the comparison resistance R (the third arm of the Wheatstone's bridge) and an induction coil, the primary coil S^1 of which taking the place usually taken by a galvanoscope, and the secondary coil S^2 being connected to the terminals T and T^1. A leather bag A, at the side of the wooden case holds the double conductor leading wires used for connecting the terminals of the inductor and of the telephone with the bridge.

4. The procedure for testing a lightning conductor is as follows:—

Connect B, B^1 to the terminals of the inductor, E to auxiliary earth E^2, L to the apex of the lightning conductor, by means of an insulated wire not much longer than is actually required, and T, T^1 to the listening telephone. (Care must be taken that a clean and good metallic connection is made with the apex of the lightning conductor.) Place the inductor as far away from the bridge as the leading wires will permit, so that the articulation of the telephone may not be disturbed by the noise of the revolving armature. The handle of the inductor is then turned at a uniform rate by one operator (who may be a coolie), whilst

another holds the telephone to his ear with one hand, and with the other depresses the pointer P and slides it over the branch resistance ring until a point is found at which the sound produced by the induced electrical currents in the telephone is reduced to a minimum or is altogether eliminated. The figure then indicated by the pointer gives the actual resistance in ohms of the leading wire from L to the apex of the lightning conductor, *plus* that of the lightning conductor from its apex through the earth plates E^1 and E^2, *plus* the resistance of the second leading wire from E^2 to the terminal E. If this resistance R^1 be less than 10 ohms we know that the resistance of the lightning conductor and earth E^1 under test must be less than 10 ohms, and that they are therefore in good condition. Should the resistance R^1, however, exceed 10 ohms, the following more elaborate procedure described in paragraph 5 will be necessary.

5. First measure the resistance r of the leading wires, in the manner described in paragraph 4, by connecting one end of each to the binding screws L and E respectively, and the other two ends together to form a loop thus



Then disconnect the two outer ends and connect one to the apex of the lightning rod and the other to its base just above ground level (having first cleaned the points of connection with a knife to ensure good contact being made) and again read the resistance $r + r^1$*. Deducting the resistance r of the leads previously obtained, we get r^1, the actual resistance of the lightning rod itself which should be a very small fraction of an ohm.

Disconnect L from the apex of the lightning rod and connect it to a second auxiliary earth E^3, read off this resistance R^2 in the same way as before (*vide* paragraph 4).

Then disconnect E from the base of the rod, and connect it to the first auxiliary earth E^2, and read off the resistance R^3.

Calling the resistances of the three earths respectively E^1, E^2, and E^3 we obtain the following equations:—

$$E^1 + E^2 = R^1 - (r + r^1), = \text{say } 12 \text{ ohms.}$$
$$E^1 + E^3 = R^2 - r, \quad = \text{say } 26 \text{ ohms.}$$
$$E^2 + E^3 = R^3 - r, \quad = \text{say } 30 \text{ ohms.}$$

working these equations out we get

$$(E^2 + E^3) - (E^1 + E^3) = (30 - 26) \text{ ohms.}$$
$$E^1 + E^3 - E^1 - E^2 = 4 \text{ ohms.}$$
$$\text{or } E^2 - E^1 = 4 \text{ ohms.}$$
$$\text{but } E^1 + E^2 = 12 \text{ ohms.}$$
$$\text{therefore } E^2 - E^1 + E^1 + E^2 = (4 + 12) \text{ ohms.}$$
$$\text{or } 2\,E^2 = 16 \text{ ohms.}$$
$$\text{and } E^2 = 8 \text{ ohms.}$$

whence $E^1 = 4$ ohms, and $E^3 = 22$ ohms.

6. Auxiliary earth E^2 should be of the same metal as the one to be tested and should be sunk in moist earth at a depth of several feet, or in a well or tank if handy in order to ensure a good earth. Auxiliary earth E^3 should be of the

* To avoid the trouble and expense of attaching a fresh leading wire for every test of a lightning conductor, and also to ensure a good electrical connection it is advisable to have a copper wire attached and firmly soldered to the apex and to a point near the base line of all important conductors, thus supplying a permanent and reliable connection to which the testing wires can be readily attached by a binding screw.

same kind as E^2 but should not be in metallic connection with it. Water pipes can be used as auxiliary earths, but not gas pipes.

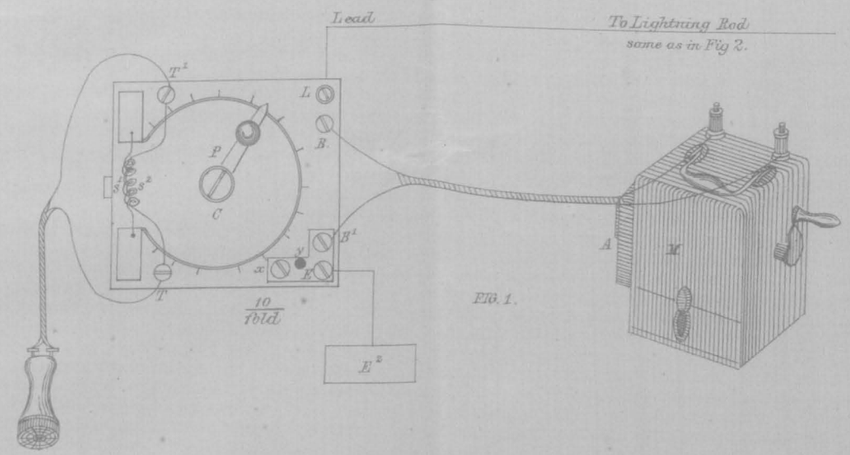
7. The polarization of the earth-plates is neutralized by the alternate currents generated by the inductor, thus rendering the tests more accurate than if currents in one direction only were employed.

8. For testing short telegraph or telephone lines or any other resistance not partaking of the nature of an electro-magnet, *i.e.*, not containing an iron core, but having a resistance greater than 50 ohms, the brass screw marked $\frac{10}{\text{fold}}$ (Figure 1), which connects E and x, must be removed and placed in the dummy hole y, provided for it, to prevent its being lost. The readings then obtained by means of the pointer P must be multiplied by 10 in order to give the true resistance under measurement. The range of the instrument, with the $\frac{10}{\text{fold}}$ screw in, is between 0·1 and 50 ohms, and when out between 1 and 500 ohms.

J. W. HENSLEY,
Electrician,
Government Telegraph Department.

CALCUTTA,
The 8th December 1894.

S. I. C. P. O.—No. 111 D. G. T. D.—24-1-95.—100.



10
1bld.

FIG. 1.

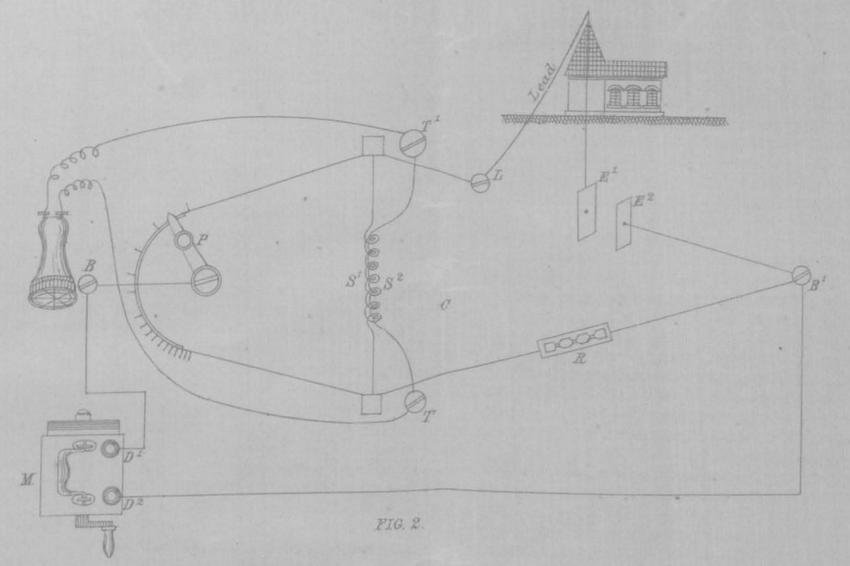


FIG. 2.

Regd. No. 686 D. G., Tel.—Jan. 35.—100.

Litho., S. I. O., Calcutta.

Description of Walker's Magneto-Induction Bridge for testing Lightning Conductors.

1. The efficiency of any lightning conductor depends on two conditions: the one structural, and the other electrical. The former depends mainly on the shape of the object to be protected; for, whilst a simple linear conductor is considered sufficient for any chimney or for the column of a light-house, a series of such conductors, laterally connected together, is necessary for large buildings and powder magazines. The structural condition, once carefully selected, undergoes no change whatever so long as the shape of the protected object remains unchanged. The electrical condition, however, which depends on the nature and efficiency of the joints made between different parts of the conductor, the condition of the soil, etc., undergoes constant changes which are due to a variety of causes (mechanical, meteorological, chemical and electrical), and therefore requires to be carefully watched in order that the limit of safety (which has been generally fixed at 10 ohms, from the apex to the earth connection inclusive) is not exceeded; for it is acknowledged that a defective lightning conductor becomes a positive source of danger to a building, owing to the fact that discharges of atmospheric electricity may, under such conditions, find a path to earth through some part of the building itself.

2. The testing of lightning conductors from time to time is therefore of paramount importance, as it is only by this means that any increase in their electrical resistance can be ascertained. When the tests show that the resistance has increased, we know that there is a fault in some part of the conductor circuit, and this fault should be at once found and removed. The testing apparatus herein described has been specially designed to admit of its being used by operators of ordinary intelligence. In fact the instrument itself, and the connections to be made with the conductor, are of such a simple nature that no special knowledge is required to carry out the tests.

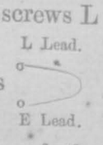
3. The apparatus consists of a Magneto-Inductor M, a telephone, and a bridge-board C (Figures 1 and 2). On the latter are fixed a ring of German-silver wire (forming the branches A and B of a Wheatstone's bridge), a contact lever P, which can be moved horizontally over the ring and used as a battery key, six terminals marked B, B^1, L, E, T and T^1, and under the bridge-board the comparison resistance R (the third arm of the Wheatstone's bridge) and an induction coil, the primary coil S^1 of which taking the place usually taken by a galvanoscope, and the secondary coil S^2 being connected to the terminals T and T^1. A leather bag A, at the side of the wooden case holds the double conductor leading wires used for connecting the terminals of the inductor and of the telephone with the bridge.

4. The procedure for testing a lightning conductor is as follows:—

Connect B, B^1 to the terminals of the inductor, E to auxiliary earth E^2, L to the apex of the lightning conductor, by means of an insulated wire not much longer than is actually required, and T, T^1 to the listening telephone. (Care must be taken that a clean and good metallic connection is made with the apex of the lightning conductor.) Place the inductor as far away from the bridge as the leading wires will permit, so that the articulation of the telephone may not be disturbed by the noise of the revolving armature. The handle of the inductor is then turned at a uniform rate by one operator (who may be a coolie), whilst

another holds the telephone to his ear with one hand, and with the other depresses the pointer P and slides it over the branch resistance ring until a point is found at which the sound produced by the induced electrical currents in the telephone is reduced to a minimum or is altogether eliminated. The figure then indicated by the pointer gives the actual resistance in ohms of the leading wire from L to the apex of the lightning conductor, *plus* that of the lightning conductor from its apex through the earth plates E^1 and E^2, *plus* the resistance of the second leading wire from E^2 to the terminal E. If this resistance R^1 be less than 10 ohms we know that the resistance of the lightning conductor and earth E^1 under test must be less than 10 ohms, and that they are therefore in good condition. Should the resistance R^1, however, exceed 10 ohms, the following more elaborate procedure described in paragraph 5 will be necessary.

5. First measure the resistance r of the leading wires, in the manner described in paragraph 4, by connecting one end of each to the binding screws L and E respectively, and the other two ends together to form a loop thus



Then disconnect the two outer ends and connect one to the apex of the lightning rod and the other to its base just above ground level (having first cleaned the points of connection with a knife to ensure good contact being made) and again read the resistance $r + r^1$*. Deducting the resistance r of the leads previously obtained, we get r^1, the actual resistance of the lightning rod itself which should be a very small fraction of an ohm.

Disconnect L from the apex of the lightning rod and connect it to a second auxiliary earth E^3, read off this resistance R^2 in the same way as before (*vide* paragraph 4).

Then disconnect E from the base of the rod, and connect it to the first auxiliary earth E^2, and read off the resistance R^3.

Calling the resistances of the three earths respectively E^1, E^2, and E^3 we obtain the following equations:—

$$E^1 + E^2 = R^1 - (r + r^1), = \text{say } 12 \text{ ohms.}$$
$$E^1 + E^3 = R^2 - r, \quad = \text{say } 26 \text{ ohms.}$$
$$E^2 + E^3 = R^3 - r, \quad = \text{say } 30 \text{ ohms.}$$

working these equations out we get

$$(E^2 + E^3) - (E^1 + E^3) = (30 - 26) \text{ ohms.}$$
$$E^1 + E^3 - E^1 - E^3 = 4 \text{ ohms.}$$
$$\text{or } E^2 - E^1 = 4 \text{ ohms.}$$
$$\text{but } E^1 + E^2 = 12 \text{ ohms.}$$
$$\text{therefore } E^2 - E^1 + E^1 + E^2 = (4 + 12) \text{ ohms.}$$
$$\text{or } 2E^2 = 16 \text{ ohms.}$$
$$\text{and } E^2 = 8 \text{ ohms.}$$

whence $E^1 = 4$ ohms, and $E^3 = 22$ ohms.

6. Auxiliary earth E^2 should be of the same metal as the one to be tested and should be sunk in moist earth at a depth of several feet, or in a well or tank if handy in order to ensure a good earth. Auxiliary earth E^3 should be of the

* To avoid the trouble and expense of attaching a fresh leading wire for every test of a lightning conductor, and also to ensure a good electrical connection it is advisable to have a copper wire attached and firmly soldered to the apex and to a point near the base line of all important conductors, thus supplying a permanent and reliable connection to which the testing wires can be readily attached by a binding screw.

same kind as E^2 but should not be in metallic connection with it. Water pipes can be used as auxiliary earths, but not gas pipes.

7. The polarization of the earth-plates is neutralized by the alternate currents generated by the inductor, thus rendering the tests more accurate than if currents in one direction only were employed.

8. For testing short telegraph or telephone lines or any other resistance not partaking of the nature of an electro-magnet, *i.e.*, not containing an iron core, but having a resistance greater than 50 ohms, the brass screw marked $\frac{10}{\text{fold}}$ (Figure 1), which connects E and x, must be removed and placed in the dummy hole y, provided for it, to prevent its being lost. The readings then obtained by means of the pointer P must be multiplied by 10 in order to give the true resistance under measurement. The range of the instrument, with the $\frac{10}{\text{fold}}$ screw in, is between 0·1 and 50 ohms, and when out between 1 and 500 ohms.

J. W. HENSLEY,
Electrician,
Government Telegraph Department.

CALCUTTA,
The 8th December 1894.

G. I. C. P. O.—No. 111 D. G. T. D.—24-1-95.—100.

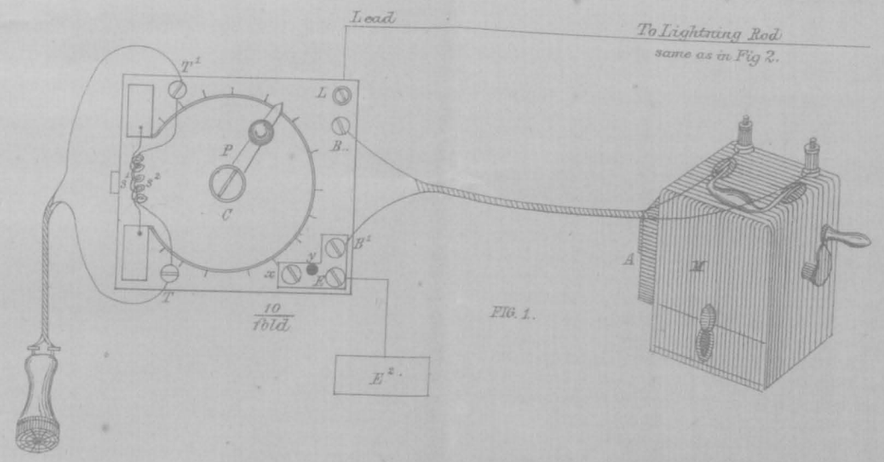


FIG. 1.

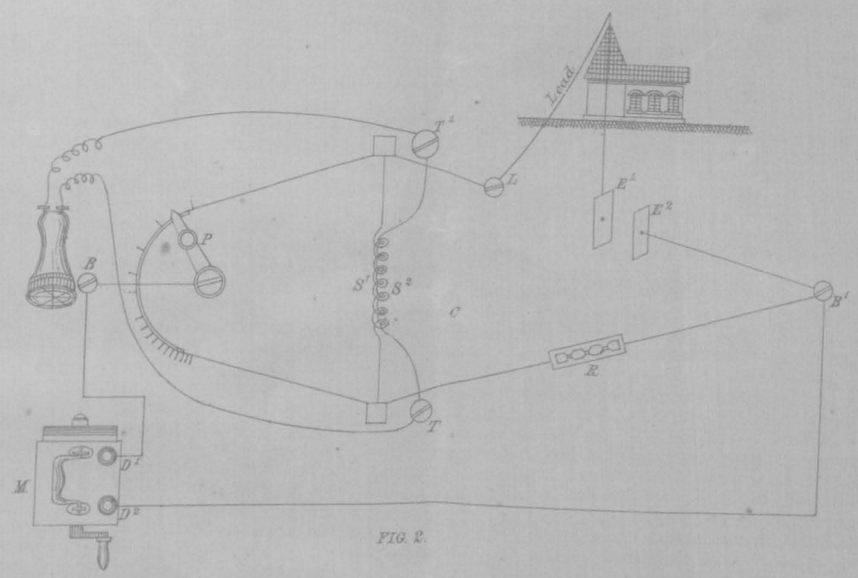


FIG. 2.

Reg. No. 686 D. G., Tel.—Jan. 35.—100.

Litho., S. I. O., Calcutta.

Description of Walker's Magneto-Induction Bridge for testing Lightning Conductors.

1. The efficiency of any lightning conductor depends on two conditions: the one structural, and the other electrical. The former depends mainly on the shape of the object to be protected; for, whilst a simple linear conductor is considered sufficient for any chimney or for the column of a light-house, a series of such conductors, laterally connected together, is necessary for large buildings and powder magazines. The structural condition, once carefully selected, undergoes no change whatever so long as the shape of the protected object remains unchanged. The electrical condition, however, which depends on the nature and efficiency of the joints made between different parts of the conductor, the condition of the soil, etc., undergoes constant changes which are due to a variety of causes (mechanical, meteorological, chemical and electrical), and therefore requires to be carefully watched in order that the limit of safety (which has been generally fixed at 10 ohms, from the apex to the earth connection inclusive) is not exceeded; for it is acknowledged that a defective lightning conductor becomes a positive source of danger to a building, owing to the fact that discharges of atmospheric electricity may, under such conditions, find a path to earth through some part of the building itself.

2. The testing of lightning conductors from time to time is therefore of paramount importance, as it is only by this means that any increase in their electrical resistance can be ascertained. When the tests show that the resistance has increased, we know that there is a fault in some part of the conductor circuit, and this fault should be at once found and removed. The testing apparatus herein described has been specially designed to admit of its being used by operators of ordinary intelligence. In fact the instrument itself, and the connections to be made with the conductor, are of such a simple nature that no special knowledge is required to carry out the tests.

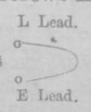
3. The apparatus consists of a Magneto-Inductor M, a telephone, and a bridge-board C (Figures 1 and 2). On the latter are fixed a ring of German-silver wire (forming the branches A and B of a Wheatstone's bridge), a contact lever P, which can be moved horizontally over the ring and used as a battery key, six terminals marked B, B^1, L, E, T and T^1, and under the bridge-board the comparison resistance R (the third arm of the Wheatstone's bridge) and an induction coil, the primary coil S^1 of which taking the place usually taken by a galvanoscope, and the secondary coil S^2 being connected to the terminals T and T^1. A leather bag A, at the side of the wooden case holds the double conductor leading wires used for connecting the terminals of the inductor and of the telephone with the bridge.

4. The procedure for testing a lightning conductor is as follows:—

Connect B, B^1 to the terminals of the inductor, E to auxiliary earth E^2, L to the apex of the lightning conductor, by means of an insulated wire not much longer than is actually required, and T, T^1 to the listening telephone. (Care must be taken that a clean and good metallic connection is made with the apex of the lightning conductor.) Place the inductor as far away from the bridge as the leading wires will permit, so that the articulation of the telephone may not be disturbed by the noise of the revolving armature. The handle of the inductor is then turned at a uniform rate by one operator (who may be a coolie), whilst

another holds the telephone to his ear with one hand, and with the other depresses the pointer P and slides it over the branch resistance ring until a point is found at which the sound produced by the induced electrical currents in the telephone is reduced to a minimum or is altogether eliminated. The figure then indicated by the pointer gives the actual resistance in ohms of the leading wire from L to the apex of the lightning conductor, *plus* that of the lightning conductor from its apex through the earth plates E^1 and E^2, *plus* the resistance of the second leading wire from E^2 to the terminal E. If this resistance R^1 be less than 10 ohms we know that the resistance of the lightning conductor and earth E^1 under test must be less than 10 ohms, and that they are therefore in good condition. Should the resistance R^1, however, exceed 10 ohms, the following more elaborate procedure described in paragraph 5 will be necessary.

5. First measure the resistance r of the leading wires, in the manner described in paragraph 4, by connecting one end of each to the binding screws L and E respectively, and the other two ends together to form a loop thus



Then disconnect the two outer ends and connect one to the apex of the lightning rod and the other to its base just above ground level (having first cleaned the points of connection with a knife to ensure good contact being made) and again read the resistance $r+r^1$*. Deducting the resistance r of the leads previously obtained, we get r^1, the actual resistance of the lightning rod itself which should be a very small fraction of an ohm.

Disconnect L from the apex of the lightning rod and connect it to a second auxiliary earth E^3, read off this resistance R^2 in the same way as before (*vide* paragraph 4).

Then disconnect E from the base of the rod, and connect it to the first auxiliary earth E^2, and read off the resistance R^3.

Calling the resistances of the three earths respectively E^1, E^2, and E^3 we obtain the following equations:—

$$E^1+E^2 = R^1 - (r+r^1), = \text{say 12 ohms.}$$
$$E^1+E^3 = R^2 - r, \quad = \text{say 26 ohms.}$$
$$E^2+E^3 = R^3 - r, \quad = \text{say 30 ohms.}$$

working these equations out we get

$$(E^2+E^3) - (E^1+E^3) = (30 - 26) \text{ ohms.}$$
$$E^1+E^3 - E^1 - E^3 = 4 \text{ ohms.}$$
$$\text{or } E^2-E^1 = 4 \text{ ohms.}$$
$$\text{but } E^1 + E^2 = 12 \text{ ohms.}$$
$$\text{therefore } E^2 - E^1 + E^1 + E^2 = (4 + 12) \text{ ohms.}$$
$$\text{or } 2\,E^2 = 16 \text{ ohms.}$$
$$\text{and } E^2 = 8 \text{ ohms.}$$

whence $E^1 = 4$ ohms, and $E^3 = 22$ ohms.

6. Auxiliary earth E^2 should be of the same metal as the one to be tested and should be sunk in moist earth at a depth of several feet, or in a well or tank if handy in order to ensure a good earth. Auxiliary earth E^3 should be of the

* To avoid the trouble and expense of attaching a fresh leading wire for every test of a lightning conductor, and also to ensure a good electrical connection it is advisable to have a copper wire attached and firmly soldered to the apex and to a point near the base line of all important conductors, thus supplying a permanent and reliable connection to which the testing wires can be readily attached by a binding screw.

same kind as E^2 but should not be in metallic connection with it. Water pipes can be used as auxiliary earths, but not gas pipes.

7. The polarization of the earth-plates is neutralized by the alternate currents generated by the inductor, thus rendering the tests more accurate than if currents in one direction only were employed.

8. For testing short telegraph or telephone lines or any other resistance not partaking of the nature of an electro-magnet, *i.e.*, not containing an iron core, but having a resistance greater than 50 ohms, the brass screw marked $\frac{10}{fold}$ (Figure 1), which connects E and x, must be removed and placed in the dummy hole y, provided for it, to prevent its being lost. The readings then obtained by means of the pointer P must be multiplied by 10 in order to give the true resistance under measurement. The range of the instrument, with the $\frac{10}{fold}$ screw in, is between 0·1 and 50 ohms, and when out between 1 and 500 ohms.

J. W. HENSLEY,
Electrician,
Government Telegraph Department.

CALCUTTA,
The 8th December 1894.

S. I. C. P. O.—No. 111 D. G. T. D.—24-1-95.—100.

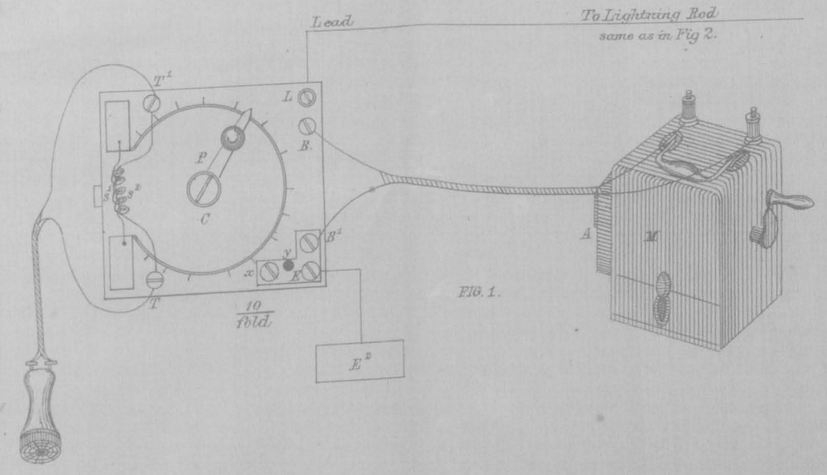


FIG. 1.

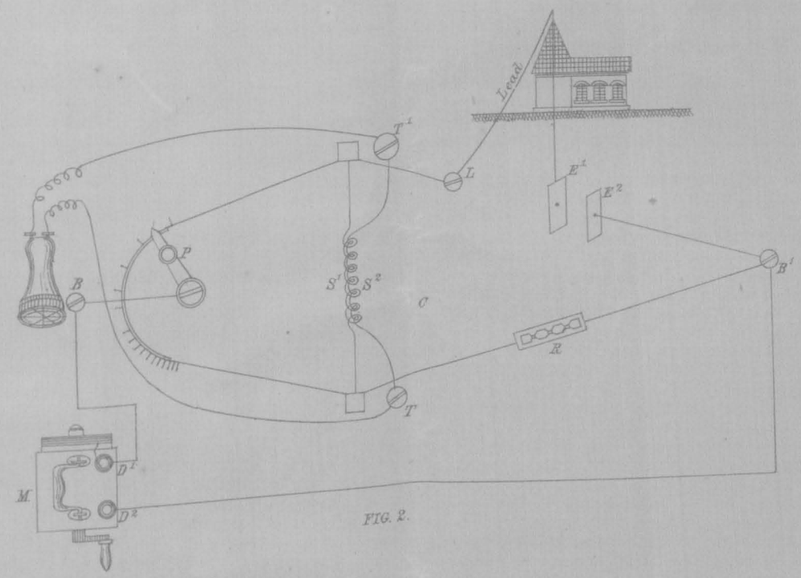


FIG. 2.

Litho., S. I. O., Calcutta.

Reg. No. 662 D, G., Tel.—Jan. 35.—190.

Description of Walker's Magneto-Induction Bridge for testing Lightning Conductors.

1. The efficiency of any lightning conductor depends on two conditions: the one structural, and the other electrical. The former depends mainly on the shape of the object to be protected; for, whilst a simple linear conductor is considered sufficient for any chimney or for the column of a light-house, a series of such conductors, laterally connected together, is necessary for large buildings and powder magazines. The structural condition, once carefully selected, undergoes no change whatever so long as the shape of the protected object remains unchanged. The electrical condition, however, which depends on the nature and efficiency of the joints made between different parts of the conductor, the condition of the soil, etc., undergoes constant changes which are due to a variety of causes (mechanical, meteorological, chemical and electrical), and therefore requires to be carefully watched in order that the limit of safety (which has been generally fixed at 10 ohms, from the apex to the earth connection inclusive) is not exceeded; for it is acknowledged that a defective lightning conductor becomes a positive source of danger to a building, owing to the fact that discharges of atmospheric electricity may, under such conditions, find a path to earth through some part of the building itself.

2. The testing of lightning conductors from time to time is therefore of paramount importance, as it is only by this means that any increase in their electrical resistance can be ascertained. When the tests show that the resistance has increased, we know that there is a fault in some part of the conductor circuit, and this fault should be at once found and removed. The testing apparatus herein described has been specially designed to admit of its being used by operators of ordinary intelligence. In fact the instrument itself, and the connections to be made with the conductor, are of such a simple nature that no special knowledge is required to carry out the tests.

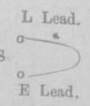
3. The apparatus consists of a Magneto-Inductor M, a telephone, and a bridge-board C (Figures 1 and 2). On the latter are fixed a ring of German-silver wire (forming the branches A and B of a Wheatstone's bridge), a contact lever P, which can be moved horizontally over the ring and used as a battery key, six terminals marked B, B^1, L, E, T and T^1, and under the bridge-board the comparison resistance R (the third arm of the Wheatstone's bridge), and an induction coil, the primary coil S^1 of which taking the place usually taken by a galvanoscope, and the secondary coil S^2 being connected to the terminals T and T^1. A leather bag A, at the side of the wooden case holds the double conductor leading wires used for connecting the terminals of the inductor and of the telephone with the bridge.

4. The procedure for testing a lightning conductor is as follows:—

Connect B, B^1 to the terminals of the inductor, E to auxiliary earth E^2, L to the apex of the lightning conductor, by means of an insulated wire not much longer than is actually required, and T, T^1 to the listening telephone. (Care must be taken that a clean and good metallic connection is made with the apex of the lightning conductor.) Place the inductor as far away from the bridge as the leading wires will permit, so that the articulation of the telephone may not be disturbed by the noise of the revolving armature. The handle of the inductor is then turned at a uniform rate by one operator (who may be a coolie), whilst

another holds the telephone to his ear with one hand, and with the other depresses the pointer P and slides it over the branch resistance ring until a point is found at which the sound produced by the induced electrical currents in the telephone is reduced to a minimum or is altogether eliminated. The figure then indicated by the pointer gives the actual resistance in ohms of the leading wire from L to the apex of the lightning conductor, *plus* that of the lightning conductor from its apex through the earth plates E^1 and E^2, *plus* the resistance of the second leading wire from E^2 to the terminal E. If this resistance R^1 be less than 10 ohms we know that the resistance of the lightning conductor and earth E^1 under test must be less than 10 ohms, and that they are therefore in good condition. Should the resistance R^1, however, exceed 10 ohms, the following more elaborate procedure described in paragraph 5 will be necessary.

5. First measure the resistance r of the leading wires, in the manner described in paragraph 4, by connecting one end of each to the binding screws L and E respectively, and the other two ends together to form a loop thus



Then disconnect the two outer ends and connect one to the apex of the lightning rod and the other to its base just above ground level (having first cleaned the points of connection with a knife to ensure good contact being made) and again read the resistance $r + r^1$*. Deducting the resistance r of the leads previously obtained, we get r^1, the actual resistance of the lightning rod itself which should be a very small fraction of an ohm.

Disconnect L from the apex of the lightning rod and connect it to a second auxiliary earth E^3, read off this resistance R^2 in the same way as before (*vide* paragraph 4).

Then disconnect E from the base of the rod, and connect it to the first auxiliary earth E^2, and read off the resistance R^3.

Calling the resistances of the three earths respectively E^1, E^2, and E^3 we obtain the following equations:—

$$E^1 + E^2 = R^1 - (r + r^1), = \text{say } 12 \text{ ohms.}$$
$$E^1 + E^3 = R^2 - r, \quad = \text{say } 26 \text{ ohms.}$$
$$E^2 + E^3 = R^3 - r, \quad = \text{say } 30 \text{ ohms.}$$

working these equations out we get

$$(E^2 + E^3) - (E^1 + E^3) = (30 - 26) \text{ ohms.}$$
$$E^1 + E^3 - E^1 - E^3 = 4 \text{ ohms.}$$
$$\text{or } E^2 - E^1 = 4 \text{ ohms.}$$
$$\text{but } E^1 + E^2 = 12 \text{ ohms.}$$
$$\text{therefore } E^2 - E^1 + E^1 + E^2 = (4 + 12) \text{ ohms.}$$
$$\text{or } 2\,E^2 = 16 \text{ ohms.}$$
$$\text{and } E^2 = 8 \text{ ohms.}$$

whence $E^1 = 4$ ohms, and $E^3 = 22$ ohms.

6. Auxiliary earth E^2 should be of the same metal as the one to be tested and should be sunk in moist earth at a depth of several feet, or in a well or tank if handy in order to ensure a good earth. Auxiliary earth E^3 should be of the

* To avoid the trouble and expense of attaching a fresh leading wire for every test of a lightning conductor, and also to ensure a good electrical connection it is advisable to have a copper wire attached and firmly soldered to the apex and to a point near the base line of all important conductors, thus supplying a permanent and reliable connection to which the testing wires can be readily attached by a binding screw.

same kind as E^2 but should not be in metallic connection with it. Water pipes can be used as auxiliary earths, but not gas pipes.

7. The polarization of the earth-plates is neutralized by the alternate currents generated by the inductor, thus rendering the tests more accurate than if currents in one direction only were employed.

8. For testing short telegraph or telephone lines or any other resistance not partaking of the nature of an electro-magnet, *i.e.*, not containing an iron core, but having a resistance greater than 50 ohms, the brass screw marked $\frac{10}{\text{fold}}$ (Figure 1), which connects E and x, must be removed and placed in the dummy hole y, provided for it, to prevent its being lost. The readings then obtained by means of the pointer P must be multiplied by 10 in order to give the true resistance under measurement. The range of the instrument, with the $\frac{10}{\text{fold}}$ screw in, is between 0·1 and 50 ohms, and when out between 1 and 500 ohms.

J. W. HENSLEY,
Electrician,
Government Telegraph Department.

CALCUTTA,
The 8th December 1894.

E. I. C. P. O.—No. 111, D. G. T. D.—24-1-95.—100.

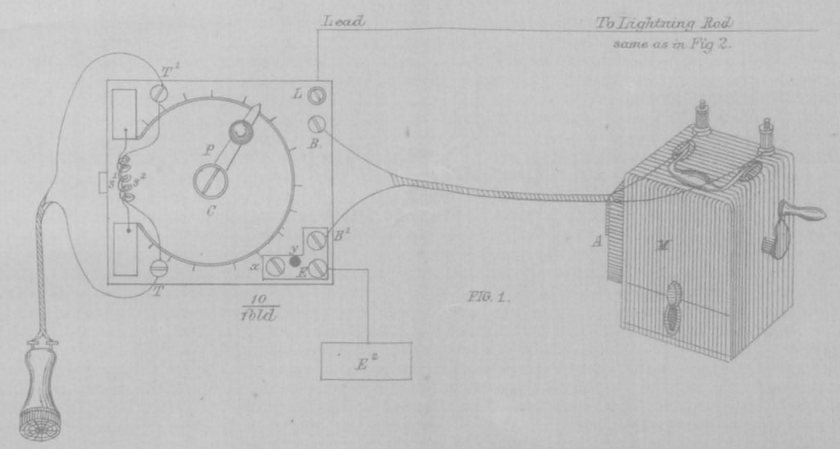


FIG. 1.

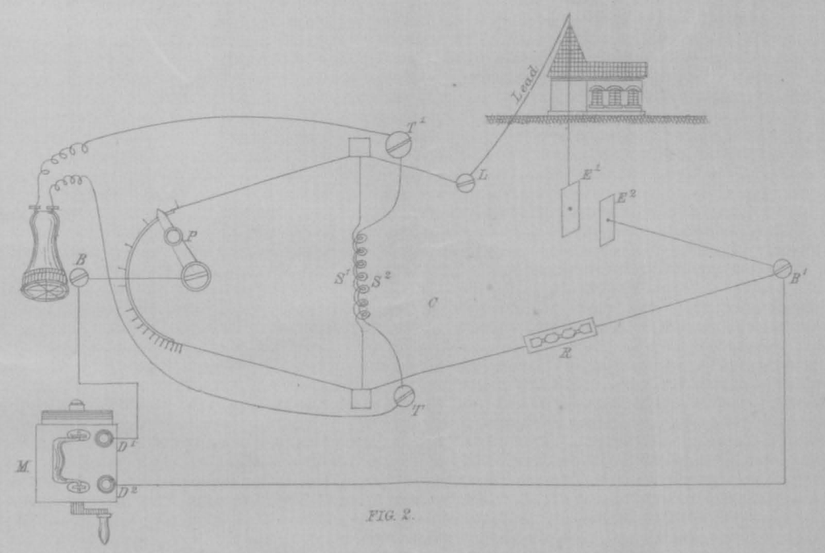


FIG. 2.

Reg. No. 628 D. G. Tel.—Jan. 35.—193.

Litho., S. I. C., Calcutta.