LOCAL LIGHTNING FLASH COUNTER WITHIN 20 KM

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Summary— Last summer. direct comparisons among eleven lightning flash counters of various types concerning the receiving frequency ranges and gains were made at Maebashi.

The results obtained are discussed and compared with the data of visual and aural observations at meteorological observatories.

Sufficient data on observation to restrict the counting radius within 20 km, as recommended by C. C. I. R. have not yet been obtained, but some results suggest that instruments available for a suitable frequency range and gain, especially a wide band of frequencies in the V. L. F. range, can be used to restrict the counting radius within 20 km.

Design details of more suitable and convenient instruments for the purpose are left to future study.

I. Introduction

From 1953 to 1954 test observations to indicate thunderstorm activities by the atmospherics radiated from the local lightning flash within a specified radius have been made by our Research Institute.

Also, it is proposed by U. R. S. I. or C. C. I. R. that apparatus should be devised for automatically counting lightning flashes within a specified radius.

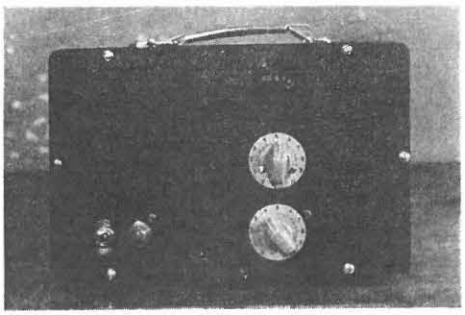
Several devices have been proposed for this purpose and their experimental results reported, but for the moment available performance data are insufficient to compare their merits.

Therefore, it would be interesting to construct an apparatus for counting the local lightning flashes occurring within about 20 km.

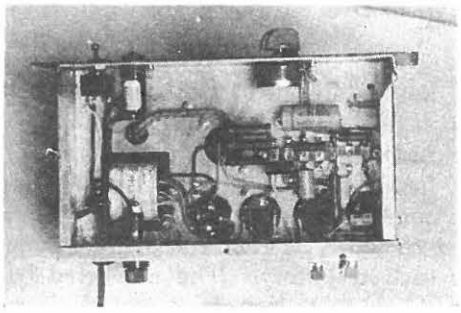
II. Devices

To determine the most appropriate device for counting local lightning flashes which occurred only within a certain distance, the following five kinds of receivers were examined:

Photograph 1. Front view of the device.



Photograph 2. Inside view of the device.



Photograph 3. Rear view of the device.

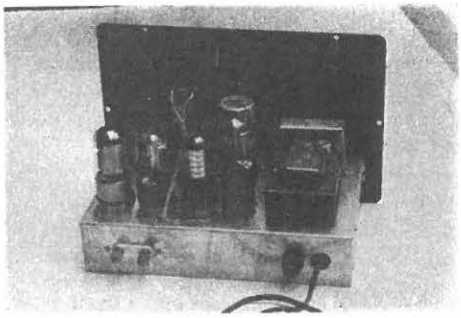
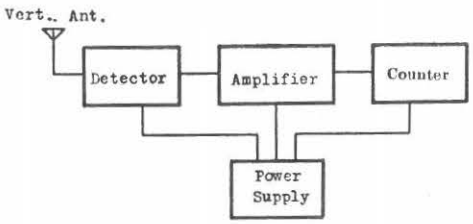


Figure 1. Circuit diagram of lightning flash Counter



1. Aperiodic type in the V. L. F. range
2. Tuning type to 10 kc/s
3. Tuning type to 100 kc/s
4. Tuning type to 1 mc/s
5. Tuning type to 5 mc/s

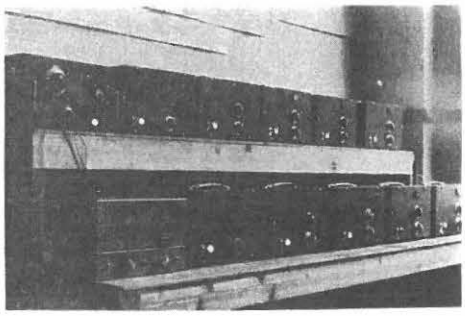
The front, inside, and rear views of this counter are shown in Photographs 1, 2, 3, respectively. A circuit diagram is shown in Figure 1.

The outline of performance is as follows. The atmospheric received by the antenna is detected and amplified, and then the output is applied to the grid of a thyratron, in the plate circuit of which is inserted an apparatus for recording the received signals.

III. Observations

The arrangement of the counters employed in observations is given in Photograph 4. Test observations were made at Maebashi for one month beginning 15 July 1954. During this period, these counters to record local lightning flashes were operated every day from 07.00 to 20.00 J. S. T. and the number of countings were recorded at certain unit time intervals.

Photograph 4. Appearance of arrangement of the devices.



Of those counters tested, only the aperiodic type accurately recorded the lightning flashes occurring within about 20 km, and therefore, only the results obtained with this device are reported in this paper.

IV. Results and Discussions

Results obtained have been examined by referring to the variation chart of distribution of thunderstorms in Gumma Prefecture, as reported by the Maebashi Meteorological Observatory (Figure 2).

In Figure 2, for convenience of reference with Figure 3, the thunderstorm trajectories are numbered 1, 2 etc. and the correlation between the distance of the thunderstorms from the observers and the counted frequency of thunderstom occurrences was examined for each trajectory. The numbered trajectories 1 and 2 in variation chart Figure 2 correspond to trajectories 1 and 2 in variation chart Figure 3.

Figure 2. Variation chart of distribution of thunderstorm

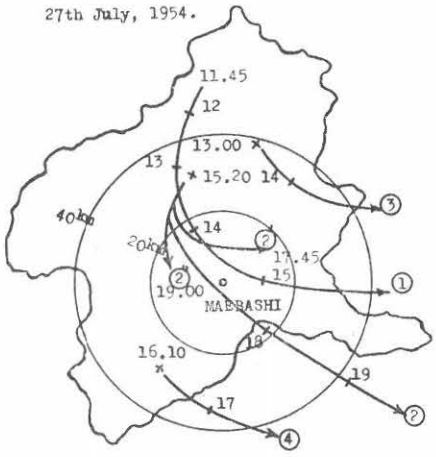
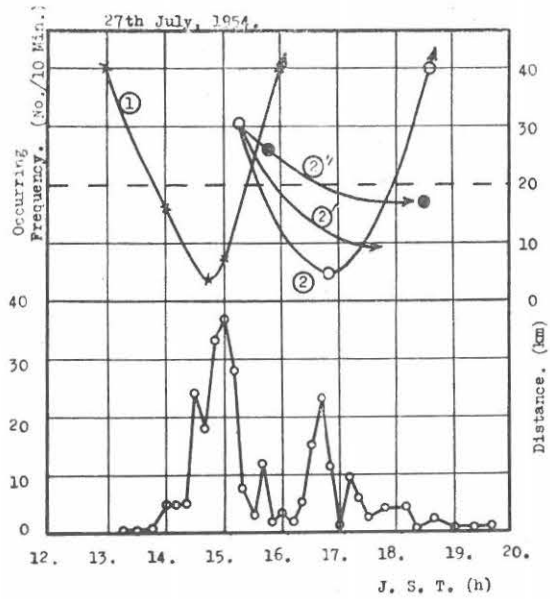


Figure 3. Variation Curve of Occurrence of Atmospherics



(1). **27 July, 1954.**

The distribution of thunderstorms in Gumma Prefecture on this day is shown in Figure 2. On that day the conditions for testing recording devices near thunderstorms were the best, i. e. the travelling thunderstorm No. 1 gradually approached the point of observation and, at the same time, there was no other thunderstorm within 20 km.

The variation curve of occurrence of atmospherics on this day is shown in Figure 3. The comparison between the performance of thunderstorm No. 1 in Figure 2 and that in Figure 3 brings out the following facts.

At 13. 50 J. S. T. when the device began to count the local lightning flahes, the position of thunderstorm No. 1 was about 20 km NNW of the observing point, 50 km and 35 km at 12. 00 and 13. 00 J. S. T., respectively. At that time, readings of the device were zero.

Therefore, this result may be taken to indicate that the device used in this observation started counting when the thunderstorm approached within about 20 km.

This is a most important fact for finding the operating distance and is a good example of the possibility of counting local lightning flashes occurring within a certain distance through the use of a suitable set designed for this purpose.

Therefore, the nearer the thunderstorm, the higher the variation curve of occurrence. At 14. 50 when the thunderstorm approached nearest to the observing point, the variation curve of occurrence of atmospherics showed maximum, and the frequency of occurrence decreases in proportion as the thunderstorm moves away from the station. It is suggested that the thunderstorm corresponding to the second maximum appearing from 16. 00 to 17. 00 is No. 2. Thunderstorm No. 2 occurred in the district at 30 km's distance at 15. 20, passed through the neighborhood of the station between 16. 00 and 17. 00, at 20 km's distance at 18. 00 and at 40 km at 19. 00. Accordingly, it is natural to assume that the second maximum appearing on the variation curve of occurrence of

atmospherics may have been caused by thunderstorm No. 2, though this is not indicated on the variation chart of distribution of thunderstorms this time. It was determined by visual observation that between 16.40 and 16.50 this thunderstorm approached nearest to the observing point, and thereafter was 20 km's distance at 18.00 and at 45 km at 19.00. It is considered that some countings between 18.00 and 19.00 on the variation curve of occurrence may be attributed to thunderstorm No. 2″ which branched out from thunderstorm No. 2, because thunderstorm No. 2′ branching from thunderstorm No. 2, is extinguished at 15.45 and thunderstorm No. 2″ at 19.00 (within 20 km from the station). The result that no thunderstorm at all was counted after 19.00 may be useful data to find the operating range of this device, because at this time there was no thunderstorm within 30 km of the station. Moreover, thunderstorm No. 3 occurred at a point between 35-40 km from 13.00 to 14.00, and yet the levels of the variation curve of occurrence at these times were zero. This fact may also be useful to find the operating range.

As mentioned above, it has been proved from the correlation of the thunderstorms with the occurrence of atmospherics that the thunderstorm occurring only within about 20 km could be counted by this device. And in checking the travelling thunderstorm, the fact was perceived that the time at which the thunderstorm approached the nearest point corresponds to the time of maximum peak of the variation curve of occurrence of atmospherics.

(2). **30 July, 1954.**

The variation chart of distribution of thunderstorms in Gumma Prefecture is shown in Figure 4 and numerals 1 to 6 indicate the principal thunderstorms of this chart. Figure 5 is the variation curve of occurrence of atmospherics recorded on that day.

Figure 4. Variation chart of distribution of thunderstorm

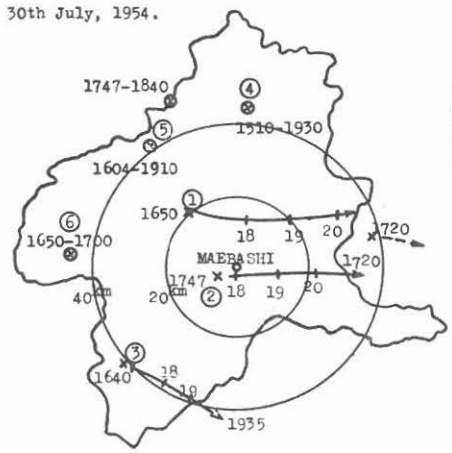
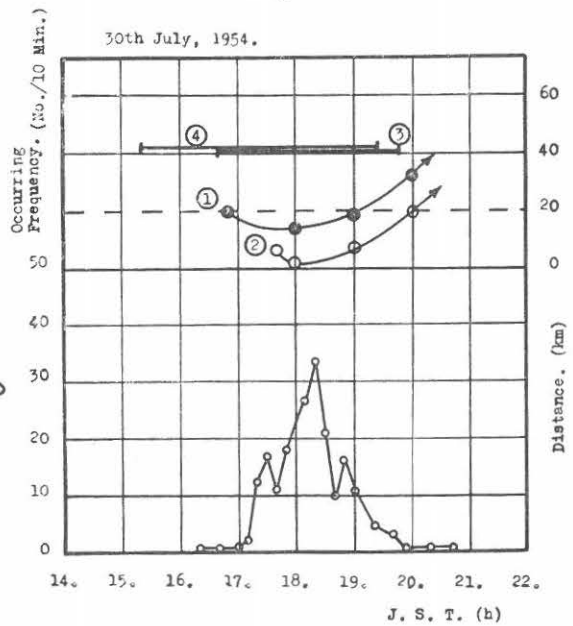


Figure 5. Variation curve of Occurrence of Atmospherics



First, let us take thunderstorm No. 4 in order to make clear the correlation between the response of this device and the thunderstorm. The position of the thunderstorm occurred at 15.10 was at about 40 km's distance from the station. Then, the reading of this device was zero until 17.00. Therefore, it may be concluded that the thunderstorm at 40 km's distance from the station could not be counted by this device.

The same explanation given above may be used for thunderstorm No. 5 which occurred at a point 40 km from the station at 16.04. This explanation may be reasonable in consideration of the data on 27 July. When the device began to operate at 17.00, the thunderstorm was at a point about 20 km from the observing point. Perhaps thunderstorms No. 3 and No. 6 at 40 km's distance were not counted by this device as made clear from the examples of thunderstorms No. 4 and No. 5.

Consequently, it may be assumed that the thunderstorm counted by the device was No. 1, and the same result as indicated on 27 July was obtained. At 18.00, thunderstorm No. 1 approached a point 15 km from the station, and thunderstorm No. 2. ocourring at 17.00, was just passing the observing point. It may be assumed that readings at this time are contributed by the resultant value of both thunderstorms, the greater part depending on No. 2, and its maximum value appearing at 18.20. But the discrepancy between the time of maximum reading and the position of the thunderstorm may be caused by the interruption of counting opration owing to the stoppage of electric supply. During 30 minutes before and after 18.20, the lightning was most violent in the neighborhood, and the electric power was stopped by thunderbolts.

At 19.00, thunderstorm No. 1 was at 20 km's distance, No. 2 at 10 km, and when the reading reached zero at 20.00, thunderstorm No. 1 was at 30 km, No. 2 at 20 km, respectively.

The result mentioned above may also be useful to find the operating distance of this device.

V. Conclusions

In the summer of 1954, as part of the observation of thunderstorm at Maebashi, we investigated the possibility of counting the lighthing flashes which occurred only within a certain distance, by using the local lightning flash counter.

The general features are clear from the two examples given above. In conclusion we may say:

(1). When the flash occurs within the predetermined distance, we can obtain with the counter a corresponding reliable record from which we can grasp the feature of the thunderstorm.

(2). The predetermined distance mentioned in (1) can be adjusted as desired by choosing gain and frequency range of the receiver

As described above, the purpose of this investigation was almost satisfied, but available perforformance data are yet insufficient to specify the local lightning flash counter within a given distance.

Further investigatigations with the observing device and extended observations are expected in future study.

VI. Acknowledgements

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VII. References

1) T. Kamada : Bulletin of the Research Institute of Atmospherics, Nagoya University, Vol. 4, No. 2, Dec. 1953.
2) A. W. Sullivan : Electronics, Vol. 27, No. 12, 1954.