

A New Remote Rain Gauge and Its Tests on Odaigahara-San

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Abstract

There are many devices of telemetering rainfall-amount in the existing weather instruments. The authors explain on their remote rain gauge having a float as its sensitive element. This float has a function of making one contact every 0.1 mm of rainfall.

An impulsive signal is transmitted at each contact to the recorder at the base station.

This rain gauge has been tested successfully at Odaigahara-San, where rainfalls of about 1,000 mm a day are experienced several times a year.

1. Introduction

Several remote rain gauges have developed based upon various principles up to now, but at present, the tipping bucket system seems to be the last that has survived ever since for routine observations. The system is widely employed in U.S.A., Great Britain and Germany.

In Japan, however, the principle is criticized concerning its accumulative error and the influence caused by rain stream energy, and is excluded from observation equipments.

In compliance with the modernizing and mechanizing program of the instruments in the Central Meteorological Observatory, a telemetering remote rain gauge has been designed according to the following basic requirements:

- i) reasonable accuracy,
 - ii) ease of maintenance,
 - iii) least power consumption,
- and iv) ample transmitting capacity.

According to the discussion stated above, a single float system is chosen for the sensitive element. To spare the power consumption and also to increase the transmitting capacity, impulsive signal method is used instead of sliding resistance

method or similar principle. To obtain the ease of maintenance, an ordinary clock-work with a rotating vane governor which winds up the float in direct proportion to the rainfall amount is employed. An impulsive signal is generated by the rotation of the clock-work with the rainfall of every 0.1 mm. The amount of rainfall is read on a counter or registered on a number-of-contact recorder which are both accessories of standard cup anemometer and are quite familiar to the meteorological observers. The number of lead wires connecting the transmitter with the recorder are two, but in case of good earth condition one lead will be enough.

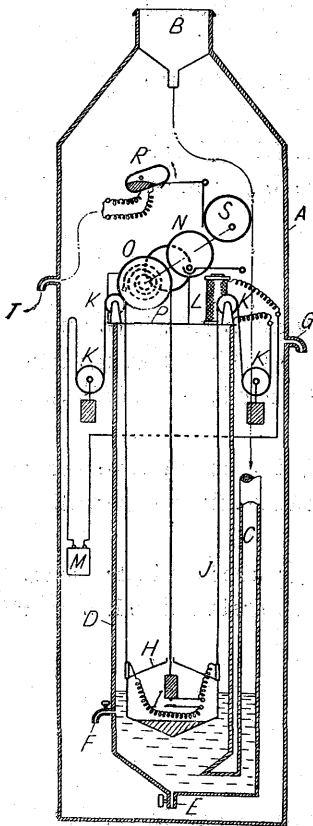
2. Description of the actual design

The principle of the actual design is illustrated schematically in Fig. 1, and the electric connection and the installation view are shown in Figs. 2 and 3.

The actual design is carried out to be accommodated to the rainfall observation and the flood warning purposes on Odaigahara-San which has the largest precipitation record of the annual mean of 4,748.9 mm, not only in Japan but throughout world's middle-latitude territories.

The transmitter consists of the following components:

- i) housing case,
- ii) rain duct tube and reservoir,
- iii) float and its suspension system,



- A: Housing Case
- B: Rain Receiver
- C: Rain Duct Tube
- D: Reservoir
- E: Drain Cock
- F: Adjusting Cock
- G: Connecting Stub Pipe at the Top Wall
- H: Float
- I: Float Contact
- J: Suspension Wire
- K: Pulley
- L: Releasing Relay
- M: Batteries
- N: Fourth Pinion
- O: Main Spring
- P: Wheel
- Q: Weight (below K)
- R: Mercury Switch
- S: Eccentric Cam
- T: Telephone Line

Fig. 1 Principle of the remote rain gauge.

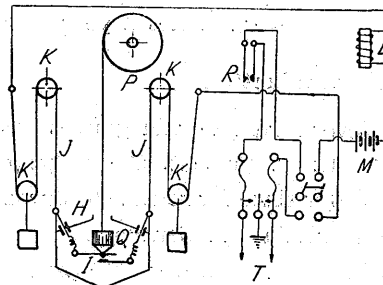


Fig. 2 Electric connection of the transmitter.

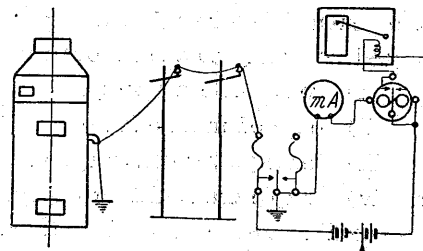


Fig. 3 Installation of the remote rain gauge system.

- iv) releasing relay including dry cell,
- v) weight winding clock-work with signal contact
- and vi) safety device against thunderbolt.

The receiver is an ordinary number-of-contact counter or a recorder for the conventional cup anemometer.

The housing case (A) of the transmitter is an upright cylinder of 440 mm diameter rolled from 1.5 mm thick steel plate, on the top of which is attached a standard rain gauge (B) of 200 mm (nearly 8 inches) diameter. The overall height amounts to 1,700 mm. The outside of the case is painted in navy blue although the white paint is most preferable to avoid excess heat absorption.

The rain duct tube (C) and the reservoir (D) are both built from soldered copper sheet of 1.5 mm thickness. The sum of sectional areas of the duct tube and the reservoir (cylindrical) equals to that of the rain gauge, viz., 314.2 cm². At the bottom of the reservoir a drain cock (E) is provided, at the bottom side wall a zero level adjusting cock (F) is incorporated and on the top side wall a connecting stub pipe (G) is attached. The last connecting pipe is only necessary in case several gauges are used in series. The capacity of the reservoir corresponds to that of 1,000 mm rainfall.

The float (H) is constructed of soldered copper sheet of 1.0 mm thickness and an electric contact (I) of platinum-rhodium is incorporated inside. The suspension system consists of two thin enameled wires (J) of 0.29 mm diameter attached to the float and hung over each pulley (K). The two wire ends are fixed on two terminals which, in turn, are connected to the releasing relay circuit.

The releasing relay (L) is of polarized type with batteries (M) of 6 V in its circuit. The armature of the relay releases and stops the fourth pinion (N) of the clock-work. The number of the stud pins on the pinion which engages the armature tongue is five and one revolution of the pinion corresponds to 0.5 mm rainfall, and therefore the rainfall of 0.1 mm can reasonably be measured.

The clock-work has a rotating vane which acts as damper and governor. The shaft of the main spring (O) has the winding-up wheel (P) of the weight (Q) and stores enough energy to lift it up 1,000 mm or two complete revolutions of the winding-up wheels. The four gear trains between the main spring barrel and the release-and-stop pinion actuated by the relay has the gear ratio of 1,000:1. The safety device (R) is a subscriber's station protector which is used on the ordinary telephone system.

3. Actuating principle

The adjusting cock is first held open and enough water is poured into the duct tube and the reservoir from the rain gauge to keep the level to the cock height, the cock is closed, and then the receiver is adjusted to indicate zero rainfall.

The rain flows into the duct tube and the reservoir through the top rain gauge, the float is lifted up, and the electric contact in it is made, being depressed by the suspended weight. The electric circuit thus closed, energizes the relay releasing the

winding-up clock-work until the weight is lifted up to just the equal height as that of the float lift.

Then the electric contact in the float is again opened and the winding-up action is checked and held at the position until further step.

The signal is generated with every push of the stud pins as impulsive current in the electric line which actuates the receiver and registers the numbers of contact, i.e., the amount of rainfall in 0.1 mm steps.

The accuracy of the equipment will therefore be considered not to exceed 0.1 mm.

4. Tests on Odaigahara-San

The projected three remote rain gauges were assembled in April 1950 and one set was decided to be installed on Odaigahara-San (1,557 m above sea level) before the following rain season.

After brief preliminary tests conducted in the authors' Laboratory the equipment was packed and shipped to the destination. According to the preliminary tests the predicted accuracy was obtained, but the extreme sensitiveness caused by the 0.1 mm accuracy seemed to be rather troublesome for routine observations, so four stud pins were taken off with the result of moderate accuracy of 0.5 mm.

In the middle of May, the installation was completed. The telephone line maintenance of about 18 km length used for connecting the equipment with the Base Office at Kawai was once abandoned for a long time since the installation and the first repairing was carried out in April. The route is led completely through a dense forest area, the insulators being attached to the live tree trunks.

The insulation resistance measured was surprisingly low giving 6,000 ohms on fair weather and 2,000~3,000 ohms on rainy days. The measured conductor resistance of the line was some 1,700 ohms which was again an enormous value for the present case of 4 mm diameter (B.S.W. No. 8) galvanized steel wire.

The cause will presumably be attributed to the rusted wire connection due to the lack of soldering and by the same reason the decreased wire cross-section. Another more dangerous cause of the line interruption is the transportation of lumber by cables along hill side. The transportation workers arbitrarily cut the telephone line and bind it again. The thunderbolts are probably less offensive.

The dry cells of 12 V to actuate the receiver were first installed at the receiving station in the Base Office, but on rainy days they energize the receiver relay owing to the leaking current along the telephone line. Therefore they were transferred later to the transmitting station on the summit, even though undesirable from the standpoint of supply.

During the installation, no rainfall could be met with and the tests were conducted by pouring water artificially into the rain gauge in various speeds and steps. The results were communicated by telephone between the base and the summit station and compared.

The routine observation was set forth on and after June 1st, 1950 and continued until the telephone line was almost completely destroyed by typhoon "Jane" passed

over the Osaka-Kobe district on September 3rd, 1950. The function of the equipment was quite satisfactory until that date except that some improvements which are described in the following article are desired. The telephone line is again repaired and improved in 1951, and the system is in operation with good results.

5. Experimental results and future improvements

The following facts were observed and improved during the experiments in the laboratory and the tests on the summit.

i) Frictional resistance in the suspension system

At the earlier stage of the preliminary experiments some notable error or a sort of "hysteresis" was observed. It is not observed if the water is continuously led into the duct and the reservoir, but only in case the pouring is carried out intermittently, the initial water corresponding to 2-3 mm or even 5 mm causes no response. If the amount of water, e.g., 10 mm is poured in, only 8-7mm reading can be obtained. There seems to be no leak in the equipment. So the cause was supposed to be due to the wetting or the sticking of water to the duct and reservoir wall. But 2-3 mm water level corresponds to 63-94 cc and the disappearance of such amount of water to somewhere inside the equipment seems to be hardly possible. The first pulley suspending the float had a frictional moment of about 12 grcm, and the pulley suspending the counter-weight had about 40 grcm. They were renewed and came to have frictional moments of 4 and 2.75 grcm respectively. The test with these new pulleys were very satisfactory.

ii) Water proof device for signal-sending contact

The signal-sending contact caused once during the observation period a short circuit owing to dew on the completely saturated condition of the top housing.

Therefore the contact was replaced by a small mercury switch. The result is quite satisfactory.

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