

An Automatic Radio Reporting Raingauge

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ABSTRACT. The paper describes a simple automatic radio-reporting raingauge developed at the Instruments Division, Poona for automatically reporting rainfall from remote inaccessible areas. A tipping bucket raingauge measures the rainfall and operates a Morse coding unit capable of composing rainfall amounts from 000 to 999 mm. The coding unit is "read" at predetermined intervals and rainfall information is broadcast over a UHF transmitter. The signals are picked up by a semi-transistorized UHF transreceiver. The range of the instrument is about 50-100 km.

1. Introduction

With the demand for increasing numbers of rainfall reporting stations in sparsely or un-inhabited areas for flood warning and flood control purposes, the design and development of automatic reporting raingauges that would operate without attention for long periods became an urgent necessity. The problem was to design a simple automatic raingauge that would work unattended through the monsoon, signal information over radio at regular intervals, be easy to transport, install and maintain, operate under extremes of weather conditions and require no special equipment or specially trained personnel for the collection of the data. Experiments to design the various units of such an equipment were carried out in the laboratories of the Instruments Division at Poona and the first model completed and tested by the end of 1961. A second improved unit, was constructed early in 1962 and installed at Sinhagad Fort, near Poona for field trials during the 1962 monsoon season. Despite some initial troubles the station has worked satisfactorily, broadcasting rainfall data every 3 hours.

2. Principle

The principle of the equipment is simple and analogous to those of the Japanese

automatic rainfall station (Sanuki 1956 a, 1956 b and Fujiwara 1955) and the Leupold-Stevens Telemark (1956). Rainfall collected in a receiving funnel is measured by a tipping bucket raingauge. The tipping bucket every time it tips, makes a mercury switch contact, energising a coding unit and setting the position of three coding cylinders, on which the Morse code signals are engraved in parallel grooves. The cylinders can compose rainfall amounts from 000 to 999 mm. The coding unit is "read" at predetermined intervals and the rainfall information in hundreds, tens and units of mm of rainfall is broadcast over an UHF transmitter. A programming unit switches on the station every 3 hours and switches it off after about 10 cycles of operation which take about 3 minutes. At the receiving station, the signals are picked up by a radio receiver and heard in its speaker.

3. Design considerations

The main problems in the design of the radio reporting raingauge were the choice of a suitable power source and accordingly the operating frequency. Decametre frequencies require large power supply units for satisfactory long range performance. Power sources required for operation on such frequencies, which can supply

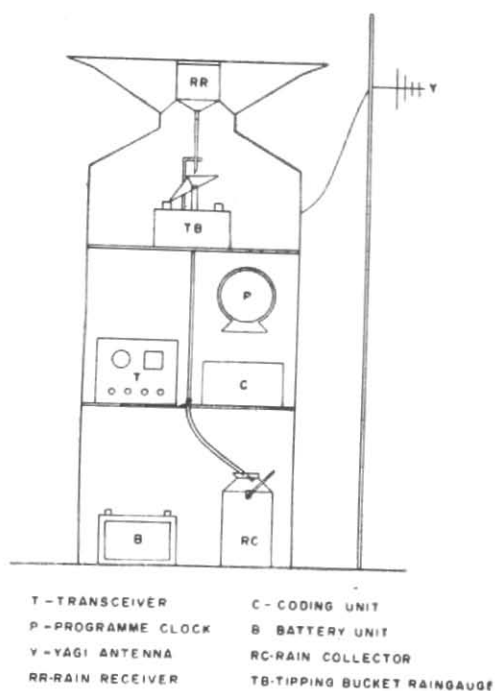


Fig. 1. Transmitting station

constant power under extreme weather conditions for periods extending up to six months are difficult to obtain. Motor or wind driven generators are expensive, large and difficult to transport and maintain. The choice of a low power UHF transmitting unit on the other hand would enable one to make use of smaller power sources, even suitable dry battery packs. Decimetre frequencies have in addition the overwhelming advantage of simplicity and compactness of the transmitting station. Objections to the relatively lower range of transmission, of the order of 50–100 km and the line of sight required between the transmitter and receiver, could be overcome by the use of relay stations. Accordingly it was considered desirable to operate the equipment on 403 mc/s and the unit designed and constructed at Poona is described below.

4. Description

The unmanned transmitting station (Fig. 1) consists of a rainfall receiver, a measuring and coding unit, a programming

unit, the transmitter and the power supply units, all of which are housed in a small hut. All the units are portable. The receiving station consists of an UHF radio receiver, operated by an observer.

4.1. *Rainfall Receiver*—The receiver funnel has a diameter of 10 cm and is provided with a Nipher wind shield. It is exposed on the roof of the station hut, about 2 m above ground level. A polythene tube connects the funnel to the tipping buckets, from where the water is led to a receiving tank (capacity 2000 mm of rainfall) below, for check measurements later.

4.2. *The measuring and coding unit*—The measuring and coding unit consists of the tipping buckets with the mercury switch and the electromagnetic counter with the coding drums. The bucket and funnel are so designed that the former tips for every mm of rainfall; this accuracy being sufficient for the heavy rainfall amounts to be measured. Every time the bucket tips, the mercury switch makes a momentary contact, energising the electromagnet and setting the position of the three coding cylinders. A drum by the side of the cylinders provides the Morse signal for the station call sign.

The setting of the three coding cylinders and therefore the amount of rainfall in code is "read" by a sliding brush contact which is moved over the coding cylinders by a drive motor. Audible dot and dash signals giving the station call sign first, followed by hundreds, tens and units of rainfall in mm are broadcast. The duration of the transmission depends on the speed of the drive motor, being generally 3 minutes for 10 cycles of broadcast. The code used is as follows :

1 —	4 . — —	7 . .
2 — —	5 . —	8 . . .
3 — — —	6 .	9 — . .
		0 — .

4.3. *The Programming Unit* which controls the sequence and timing of operations consists of a battery operated 6 volt

d.c. clock with associated cams and relays. Every 3 hours the clock makes a momentary contact which starts the drive motor. A system of "hold on" relays and cams comes into operation switching on the transmitter and broadcasting the signals. After 3 minutes of operation, a cut-off cam interrupts the circuit switching off the whole unit.

A block diagram of the transmitting unit is given in Fig. 2. A two-position switch is provided for either manual or automatic operation. With the automanual switch in the autoposition, the sequence of operation is as follows—At the predetermined time, the drive motor (9 volts d.c.) is switched on by the programme clock. The L. T. supply to the filament of the transmitter valve is switched on for warming up the transmitter and the sliding brush contact for "reading" the coding cylinders is also set into operation simultaneously. When the clock contact is broken after about 20 seconds, the relay unit continues to feed power to the motor and the transmitter continues to be "on".

The motor drives two cam A and B through a system of gears. Cam A connects jacks J_1 during the first half of its rotation so that the station call sign is broadcast for about $1\frac{1}{2}$ minutes and connects J_2 during the second half, so that the rainfall data is broadcast for the rest of the time. B is the cut-off cam which keeps the switch S_2 "on" for the duration of one rotation of the cam and then switches off the whole unit.

The system of worm and gears drives the two cams at the same speed, *viz.*, 3 minutes for one rotation. So the signals are transmitted for 3 minutes and the sliding brush contact makes 10 sweeps during these 3 minutes, giving five broadcasts of the station call sign during the first $1\frac{1}{2}$ minutes and five broadcasts of the rainfall amount during the remaining $1\frac{1}{2}$ minutes.

4.4. *Transmitter*—A modified rawin transmitter operating on 403 mc/s, using a single EC 81 valve and with a power out-

put of 500 mw, was used as the transmitter with a suitable Yagi antenna. An audio modulator was provided to make the signals audible in the receiver speaker.

A modulating tone of 1000 c/s is generated by a transistor oscillator and fed to the transmitter through an amplifier. The coding unit switches the power supply to the push-pull output stage of the audio amplifier and the modulator is thus keyed giving audible morse code signals.

The main difficulty experienced at the time of the initial field trials around Poona was the inability of the receiving station to communicate with the installation party. The transmitter unit was, therefore, modified to serve as a trans-receiver, operating on 403 mc/s with provisions for 1000 c/s tone, R/T transmission and reception.

4.5. *Power supply unit*—A 6-volt accumulator to supply power to the measuring, coding and programming units and a vibrator to provide the H. T. to the transmitter was first used, but later replaced by a set of 3 dry batteries, 90 volts for the RF unit, 9 volts for the motor and the coding unit, and 6 volts for transmitter L.T. and transistor circuits, hermetically sealed for protection against moisture.

4.6. *UHF receiver*—The block diagram of the semi-transistorized UHF receiver is shown in Fig. 3. An EC 81 valve is used as super-regenerative detector. A Yagi aerial picks up the signals which are detected by EC 81, amplified by OC 72 amplifiers and finally heard in the speaker. The receiver operates as a trans-receiver, with provision for R/T transmission and reception.

5. Installation

The radio reporting rain gauge was installed at Sinhagad Fort, 21 km from Poona, 1303 m above sea level, in August 1962 for field trials. Sinhagad Fort is continuously enveloped in low cloud throughout the monsoon season, with visibility reduced to a few metres, relative humidity near 100 per cent and rainfall over 100 mm a day. The transmitter hut was installed in the State Govt.

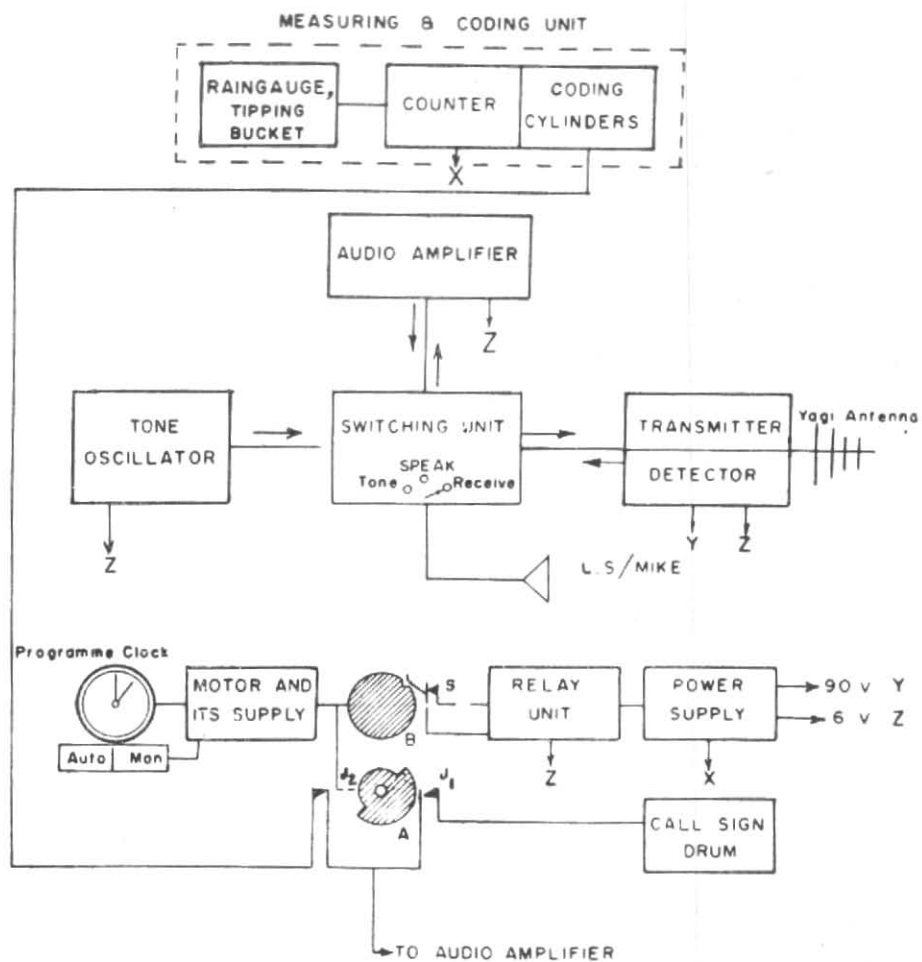


Fig. 2. Block diagram of transmitting unit

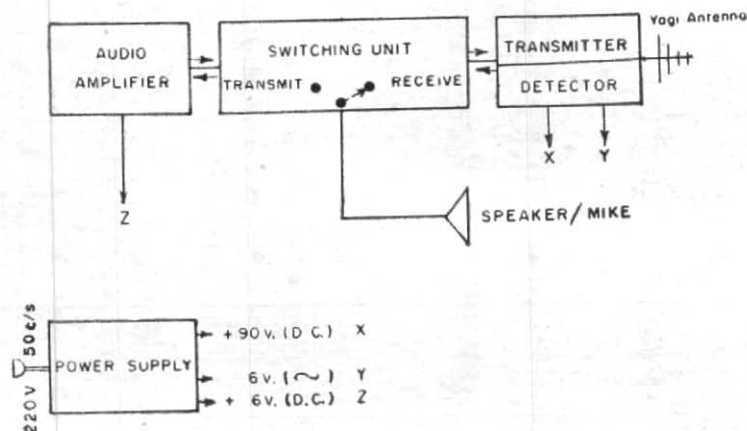


Fig. 3. Block diagram of UHF receiver

Park at a location from where line of sight to the Poona Meteorological Office was available. The aerial was installed on a mast close to the hut.

In order to check the performance of the equipment, an ordinary raingauge was installed at Sinhagad Fort. Daily readings were made by the park warden and the readings of the ordinary raingauge and the radio reporting raingauge show good agreement.

6. Difficulties experienced

The main difficulties experienced were in the working of the drive motor, coding unit and power supply. In heavy rain, water entered the Yagi aerial which was later made water-proof. The earlier coding unit had an unsatisfactory sliding brush contact. The second model is free from the trouble of the first and the resulting mutilation of the signals. The power supply units after they were replaced by dry batteries

and telephone cells have not given any trouble.

7. Relay unit

A radio relay system employing a receiver and a transmitter has been constructed on an experimental basis. The semi-transistorised unit is simple and compact, and operates on dry batteries and will be operated automatically by programme clock. When the present programme is completed, it is expected that a single relay station would pick up signals from a number of radio reporting raingauge stations within a radius of about 50 miles and monitor them to the main receiving station one by one.

8. Acknowledgement

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