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A distant reading raingauge

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ABSTRACT A remote indicating rainfall counter has been designed, constructed and field tested in the Instruments Division, Meteorogological Office, Pune. The sensor used is a conventional tipping bucket raingauge. The sensor can be connected to the counter kept inside the observatory room or office. The instrument can be very useful in flood forecasting offices, hydrometeorological stations and airport meteorological offices. The total rainfall can be read off easily on the counter and the rate of rainfall easily determined using a stop-watch during heavy downpours.

1. Introduction

Flood forecasting offices and hydrometeorological stations are actively engaged in flood warning and control. Immediate information on the rainfall at and around certain sites is a must for their work.

The current weather instruments systems installed in major airports give instantaneous information on temperature, dew point, wind speed and wind direction. But the need for a simple rainfall indicating instrument remains unfulfilled.

Scientists working in various fields, *viz*., agriculture, geology, mining, fisheries etc, will find an instantaneous rainfall indicating instrument useful.

The article describes a counter type distant reading raingauge designed, constructed and field tested in the Instruments Division, Meteorological Office, Pune.

2. Principle of operation

The sensor used is a conventional tipping bucket raingauge. The area of the collector is 100 sq. cm. A balanced twin tipping bucket assembly mounted on a horizontal shaft, tilts once for every one mm of rainfall, or 10 cc of water collected. A magnet attached to the tipping bucket moves past a reed switch making a momentary electrical contact for each tilt. The number of these momentary electrical contacts are conveyed by cables into an electronic counter made up of COSMOS integrated circuits. Light Emitting Diodes (LED) driven by TTL IC decoders are used to display the rainfall registered on the counter.

3. Special design considerations

The flip-flop memory used in counters is not capable of maintaining its states after a momentary break in power. So working this counter on a power supply is meaningless. Naturally the solution is to have battery as the power source. The conservation of power is an important factor to be considered to avoid very frequent replacement of batteries. Power consumption of COSMOS integrated circuits is negligible and so the counter has been constructed using such IC's. Display tubes which need about 200 volts as their anode power supply are very inconvenient to use with battery. The display chosen for this instrument is made up of seven segment light emitting diodes which can work on 5 volts power supply. Also LED displays are more pleasing to the eye as the figures are seen at the same level. TTL IC's are used as decoders/display drivers. TTL IC's and LED displays need a power supply of 5 volts within close tolerances. As the current drain by the decoders, display and even the power supply is rather high to be continuously operated from a battery, they are enabled only by a press button switch. The forward drop in voltage of about 7 volts is to be allowed for the proper functioning of the power supply. So the counter is powered by a 12 volt battery and the output levels of the counter changed from 0 and 12 volts to 0 and 5 volts using level changers before driving the decoders. A reset switch is provided which when pressed momentarily changes the counter reading to zero. This can be approached only after unscrewing the metal cap to prevent accidental resetting. The counter and level changers are continuously on drawing a negligible current of 10μ A from the 12 volt battery. The 5 volt power supply, decoders and display gets on when the 'read' push button switch is kept pressed increasing the current drain to 250 mA. A set of eight 6-G telephone

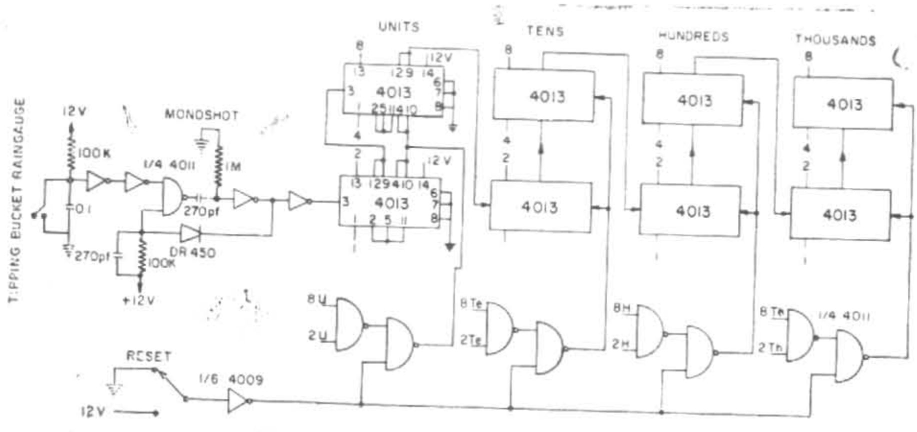

Fig. 1. Four digit rainfall counter

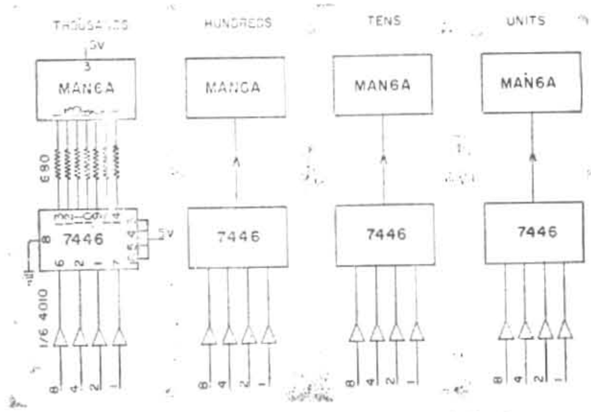

Fig. 2. Level converters, decoders and display

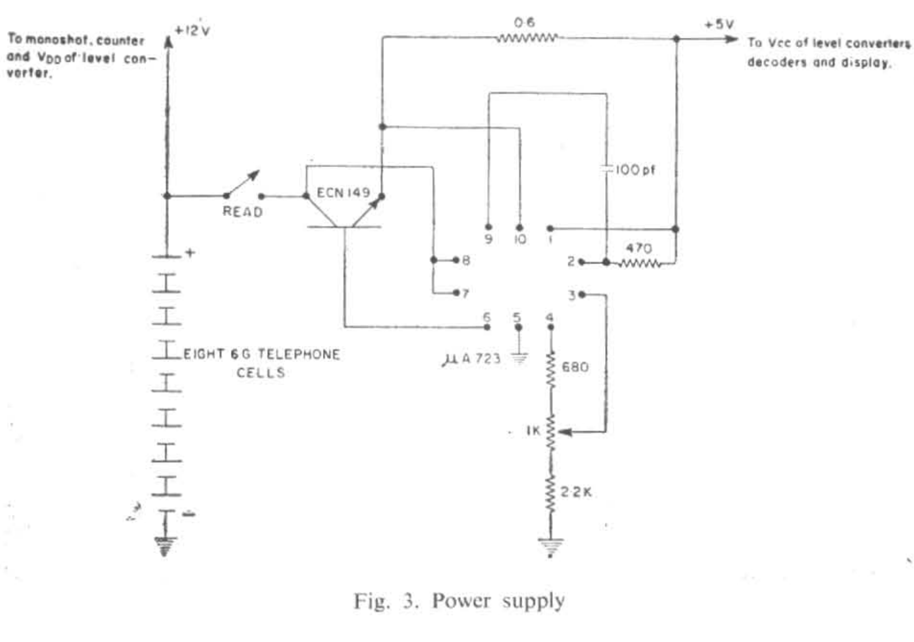

Fig. 3. Power supply

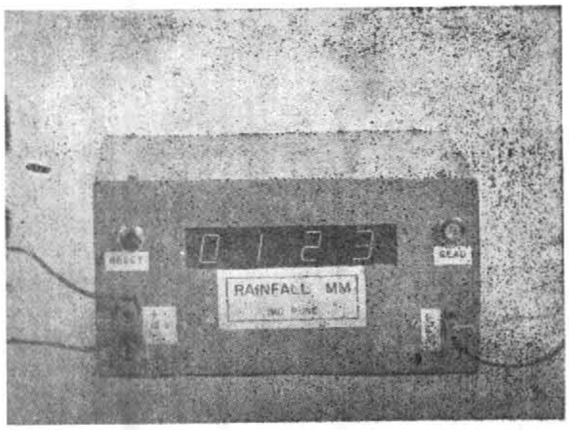

Fig. 4. The rainfall counter

cells can power the counter for one year, the display being read a few times day. More frequent replacement of the battery may be called for if the display is made on very frequently. A four digit counter and display has been chosen which can enable a cumulative total of 9999 mm of rainfall which can accommodate a whole season's rainfall for most of the places in India.

4. Circuit description

The circuit diagram of the four digit rainfall counter is given in Fig. 1. A charged condenser is discharged by the momentary contacts in the tipping bucket raingauge. The monoshot converts the pulses into very sharp and narrow ones. The pick up in long leads used do not affect the monoshot in spite of slightly varying the voltage across the condenser. The ouput of the monoshot drives the 4 digit BCD counter made up of CD 4013's reset at tenth count using CD 4011's. The reset switch which when pressed momentarily changes the counter reading to 0000. Fig. 2 gives the circuit details of the level converters, decoders and display. The level converters *cum* buffers are made using COSMOS IC's 4010. The V_{DD} of these devices are at 12 volts whereas V_{cc} is at 5 volts, assuming that the device is continuously displaying. The 8-4-2-1 outputs of the four digit BCD counter is converted to 5 volt levels—TTL compatible—and are available at the outputs of the buffers. SN 7446 are TTL IC's, BCD to 7 segment decoders. These light up the proper segments of the 7 segment LED displays MAN 6A displaying the state of the 4 digit counter. The specially designed power supply is given in Fig. 3. A photograph of the instrument is given in Fig. 4.

5. Performance

A tipping bucket raingauge was installed on the roof of the Instruments Division, Pune and connected to the counter instrument kept inside the laboratory using 100 metres of shielded cable. The performance has been studied during the monsoon period of 1977. There has been no failure.

TABLE 1

Date (1977)	Daily rainfall (mm)		Error
	Ordinary raingauge	Distant reading raingauge	
9 Jun	9·2	8	− 1·2
10 ,,	0·0	0	0·0
16 ,,	8·4	6	−2·4
17 ,,	8·1	8	—0·1
20 ,,	11·6	13	+1·4
24 ,,	0·5	1	+0·5
27 ,,	19·2	18	—1·2
1 Jul	1·3	0	—1·3
7 ,,	62·3	57	—5·3
12 ,,	8·4	8	—0·4
18 ,,	1·8	2	+0·2
27 ,,	10·7	11	+0·3
29 ,,	2·5	2	—0·5
2 Aug	0·7	0	—0·7
4 ,,	0·7	1	+0·3
8 ,,	20·0	20	0·0
19 ,,	0·0	0	0·0
23 ,,	3·3	3	—0·3
24 ,,	1·4	1	—0·4
27 ,,	4·5	4	—0·5
30 ,,	3·5	3	—0·5
1 Sep	19·7	19	—0·7
14 ,,	1·9	0	—1·9
26 ,,	0·2	0	—0·2
30 ,,	3·0	2	—1·0
1 Oct	1·7	1	+0·7
6 ,,	73·6	87	+13·4

Location of the distant reading raingauge sensor : Pune I. S. roof.

Location of ordinary raingauge : Agrimet. Observatory, Pune

Distance between the two sensors : About 2 km

Table 1 gives typical data compared with the rainfall recorded at Agrimet. Observatory, Pune.

While assessing the results due consideration has to be given to the following sources of errors :

(1) The spatial variation of rainfall as the distance between the two sensors was about 2 km.

(2) Time of readings: 0830 hr at Agrimet and 1000 hr in laboratory.

(3) Least count of the instrument is 1 mm.

(4) 0·4 mm of rainfall or 4 cc of water in the constant level arrangement in the funnel of the tipping bucket raingauge is not recorded after a dry spell.

(5) Time lost during tipping and friction.

The large error noticed on 6 October should be due to the spatial variation as the rainfall was caused by a thunderstorm. Considering the limiting factors, the performance of the instrument has been very good.

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