A SIMPLE DIGITAL RATE-METER FOR CURRENT METERS (NOTE)

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INTRODUCTION

Current meters are frequently used in the gauging of streams and rivers; these instruments emit one or more pulses per revolution of the rotor, pulses which the operator hears in an earphone and must count over a timed period. While counting at low speeds presents no problems, errors can occur when the currents are fast or the operator is tired.

The device described below was designed to reduce counting errors and make gauging easier. It provides an accurate count, even at rates greater than 20 counts per second, automatically stopping after a preselected time period. It has proved easy to use and reliable, and is both light and compact enough to be hung around the operator's neck, thus leaving his hands free.

It was constructed from locally available components and, depending upon their source, these should cost NZ$30–40.

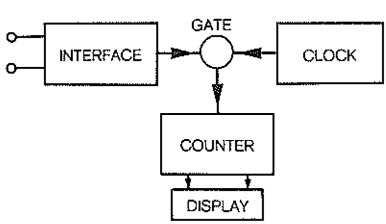

FIG. — 1 Block diagram of rate meter.

BASIC PRINCIPLES AND CIRCUIT DIAGRAM

The block diagram (Fig. 1) sets out the basic components of the rate meter. Counting is achieved using a pocket electronic calculator (Anon., 1976), the input to which is gated by the clock circuit. Because different current meters have different output modes, an interface is inserted in the input line.

The major component cost of the rate meter is that of the calculator. Not all calculators are suitable, but suitability can be easily tested by the following procedures: switch on . . clear . . press 1, +, =, =, =, etc. At each press of the = button, the calculator display should advance one count. If it remains at 1 the calculator is not suitable.

Open the selected calculator and, after tracing the keyboard circuit from the = button to the keyboard tag strip, solder a fine multicore insulated wire to each of the appropriate tags. Lead the wires out through the external battery

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socket and close the calculator again. Touching the bared ends of the wires together should now produce the same effect as pressing the = button in the suitability test procedure.

The circuit diagram (Fig. 2) used a Hanimex BCM-99 calculator and was designed for use with either a Pygmy current meter which shorts the input once per revolution or a Hydro-Products Model 460/451 remote-recording current meter which emits ten 5-volt pulses per revolution.

A short circuit at SK1 produces a voltage pulse in the secondary winding of T1 equivalent to a 5-volt pulse at SK2. R1 and C1 damp the pulse generated. This voltage pulse causes the Darlington pair Q1 and Q2 to conduct, dropping the potential on the base of the Q3 and Q4 Darlington and allowing it to conduct. With Q5 conducting, the reed relay closes once for each input pulse and advances the counter by one. Counting stops when Q5 is non-conducting.

The conduction of Q5 is controlled by the timing circuit which is built around a 555 integrated circuit. The timer is activated by closing S2 briefly. The time period over which Q5 conducts is set on VR1 or VR2. In the unit built, VR1 and VR2 were set to 30 and 60 seconds respectively, the period being selected by S1.

Power was supplied by three 4.5-volt alkaline batteries and the calculator's own battery supply. The individual battery supplies were retained because some calculators operate on 3 volts, which is below the operating voltage of the other circuitry. Similarly, a CD4066 CMOS bilateral switch (Anon., 1976) was not used as these could generate switching pulses greater than the calculator's operating voltage and thereby damage the calculator. The reed relay, although reducing the upper limit of counting speed, leaves the calculator completely isolated so that when Q5 is non-conducting the calculator can be used as originally intended.

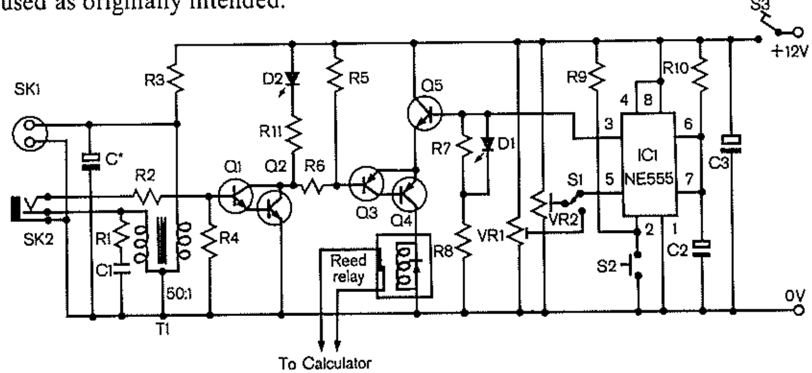

FIG. – 2 Circuit diagram of unit built. The component values were those originally used but are not critical and may be changed within a wide tolerance. C2 must be a high-quality tantalum-type capacitor. Key: R1 = 1 MΩ; R2 = 100 Ω; R3 = 2.2 kΩ; R4 = 10 MΩ; R5 = 100 kΩ; R6 = 100 kΩ; R7 = 2.7 kΩ; R8 = 4.7 kΩ; R9 = 22 kΩ; R10 = 820 kΩ; R11 = 4.7 kΩ; C* = 25 μF to 100 μF 12 V electrolytic (select for noise suppression from current meter); C1 = 0.01 μF; C2 = 64 μF tantalum electrolytic; C3 = 100 μF 16 V electrolytic; Q1, Q2 = 2N 2222 (also TIS 92 etc.); Q3, Q4 = AC128 (also TIS 93 etc.); Q5 = 40310 (also TIS 92 etc.); D1, D2 = light-emitting diodes; T1 = 25 mm square 50:1 ratio (20 kΩ:400 Ω) transformer; VR1, VR2 = 20 kΩ linear preset; reed relay = 12 V DIL (with diode) SPST-NO.

CONSTRUCTION AND OPERATION

Component layout of the rate-meter circuit is not critical. The discrete components were assembled on Vero-board and mounted in the base of a rigid plastic box. Mounting brackets to hold the circuitry and batteries were attached to the box with cyano-acrylate glue. The calculator, input sockets and switches were mounted in the box lid. The two halves of the calculator body were closed over a hole in the box lid cut to fit the groove in the edge of the calculator. A carrying strap was attached to two loops of heavy wire sealed through the box ends.

In operation, the earphone output from the current meter is plugged into the appropriate socket, the unit turned on and the calculator cleared. The time-indicator diode D1 will remain lit until the timer has completed one counting period, after which the calculator can be set by pressing 1 and then the + button. The pulse input indicator diode, D2, flashes for each closure of the current meter contacts, allowing the operator to start the timer immediately after a pulse. When the start button is pressed, the counter will record the total count received during the preset time period. This total can be processed on the calculator immediately or noted down and the calculator cleared and set for the next count. Where the number of inpout pulses from the current meter is more than one per revolution, the calculator can be set to count by the appropriate number. In the case of the Hydro-Products current meter, counting by 0.1 gives the final displayed count in revolutions per timed period. The device has worked well in most situations but has been used mainly in the gauging of small narrow streams (0.02–3m^3/s) with the Pygmy current meter or measuring slow lake currents using the Hydro-Products Model 460/451 current meter. Weed fouling of the current meter is just as apparent from the irregular display flash as it would be from the clicks in earphones.

LIMITATIONS

Weatherproofing is a problem and, although the device will float if dropped in water, the calculator keyboard is vulnerable to rain and should be covered with a thin plastic film, e.g. a clear plastic bag. This will keep the rain out but allow the keys to be manipulated unhindered.

Counting errors of two types can occur at slow speeds.

1. Because the timer is independent of the counter, unless the timer is started immediately after a pulse an error of ± 1 count will occur depending upon where the last pulse occurs in the time period.
2. Worn and dirty contacts or poor geometry of contacts can produce more than one pulse per make because the contacts scrape together. Capacitor C* was included to reduce this effect. This error is seen as a flicker of the display and a larger number being accumulated than expected. A manual count is necessary in this event.

At speeds above dead slow these errors are reduced and become insignificant compared with the natural variation in velocity of the water being gauged.

Unless a liquid crystal display is used, a sunshade should be fitted to enable the digits to be more easily read.

ADVANTAGES

Although Pygmy and Hydro-Products current meters are specifically mentioned, the device will work with any current meter or other device normally monitored by headphones or having an on/off pulse train output.

The total cost of the device is comparable with the cost of a stopwatch but is more accurate, as the human reaction time has been eliminated.

Within the above limitations, the counter is accurate and produces a reliable count when mental fatigue and stream noise would combine to make some of the clicks inaudible to an operator with earphones.

REFERENCES

Anon., 1976: A digital event counter-calculator. *N.Z. Electron* 3 (1): 12–3.