oscillator/timer T3 is initialized with its automatic power-on reset function. Near the end of the heating cycle T_2, the output of T3 triggers a one-shot monostable multivibrator OS1. The negative pulses of OS1 and OS3 are the commands for data logging and on their rising edges the 4040 address counter advances. The width of the OS2 is set at approximately 1 ms which is long enough for the outputs of the address counter to settle.

The data storage static RAM[5] used in the system contains a miniature lithium cell within its package and can retain the data in the absence of power for 10 years. The "nonvolatile" RAM chips are removed from the sockets of the circuit boards and mailed from the field back to the laboratory where they are read by a desktop-type microcomputer (type PC8001, NEC Corporation). Alternatively, the researchers can obtain the data at the field by a battery-driven handheld-type computer (type PC8201, NEC Corporation). Through a memory IC socket for user PROM, the data/address bus lines of the above computers are easily extended out of their body to connect to the data-storage RAM.

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Counting efficiency of systems having both paralyzable and nonparalyzable elements

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Electronics for processing random event trains may contain some elements which are paralyzable in combination with others which are nonparalyzable. An expression is derived which gives the counting efficiency or live time of such a system when its input is a Poisson random arrival process.

In nuclear pulse-height analysis and in position-sensitive photon work, the data-acquisition system throughput is often limited by two distinct elements in its chain: the pulse pile-up rejector circuit, and the analog-to-digital converter.

The purpose of a pile-up rejector is to assure that each measurement is not excessively influenced by disturbances remaining from previous stimuli. It often takes the form of a discriminator and timer which allows a measurement to begin only if the preceding time interval of fixed duration, say τ_p, was clear of all input events. It improves the accuracy of the accepted measurements by rejecting those pulses in which the base line or zero point of the measurement is likely to be disturbed. This is achieved at the expense of system throughput at higher count rates.

A paralyzable element is one that, upon being triggered into its active state, remains in that state for in interval τ_p; if subsequent events occur in that interval, its timer is reset to zero and the active interval is extended. Such an element consequently returns to its passive state only when an interval of duration τ_p has elapsed with no stimulus events occurring. Thus, a pile-up rejector is a paralyzable element whose active state vetoes the acceptance of each pulse.

A nonparalyzable element is one which goes into its active state upon being triggered, and then definitely returns to its quiescent state a time τ_n later irrespective of any possible stimuli occurring in that interval. Most types of analog-to-digital converters are nonparalyzable.

The counting efficiency or fractional live time of a system is the probability of a stimulus event succeeding in being measured; it is the ratio of its output event rate to the applied stimulus rate.

It is well known[1] that for random uncorrelated stimuli with mean rate R_{in} the efficiency of a paralyzable element is just the Poisson probability of having zero input events in its timing interval:

$$E_p = \exp(-R_{\text{in}}\,\tau_p). \tag{1}$$

For a nonparalyzable system the dead time is exactly $R_{\text{out}}\,\tau_n$. Hence, the live time, or efficiency given random uncorrelated stimuli, is

$$E_n = 1 - R_{\text{out}}\,\tau_n = \frac{1}{1 + R_{\text{in}}\,\tau_n}. \tag{2}$$

When a paralyzable pile-up rejector is combined with a nonparalyzable measurement element, the net efficiency depends on the relationship between their time constants. If $\tau_n < \tau_p$ then the combination behaves exactly like the paralyzable element alone, since each measurement cycle completes before the earliest possibility of the pile-up rejector clearing. But for systems having $\tau_n > \tau_p$ the situation is slightly more complicated. The probability that the system is ready at time zero is the probability that the pile-up rejector is in a nonveto state, times the conditional probability that the measurement element is available at time zero given that the pile-up rejector is nonveto. The first factor is just Eq. (1). The second factor is the probability that no measurement process was initiated in the interval $(-\tau_n, -\tau_n+\tau_p)$; by the same live time argument that established Eq. (2) this is $1-(\tau_n, -\tau_p)R_{\text{out}}$. The two time intervals are nonoverlapping, and the probabilities of stimuli in them are therefore uncorrelated, so we may combine the probabilities by multiplication and obtain

$$E=\frac{1}{(\tau_n-\tau_p)R_{\text{in}}+\exp(R_{\text{in}}\tau_p)}. \tag{3}$$

This expression reduces to Eq. (1) or Eq. (2) in the limit $\tau_n=\tau_p$ or $\tau_n=0$. At low count rates, this efficiency is near unity and losses are dominated by τ_n. At high count rates, the efficiency falls exponentially and is dominated by τ_p.

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Flexible tube countercurrent heat exchanger

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The countercurrent heat exchanger described here functions as a fluid heater or cooler for maintaining or modulating temperature in a liquid flowing through a glassware and plastic tube system.

In some experimental setups wherein various pieces of jacketed glassware are widely separated, or where a process in the ware adds or subtracts heat, or where a tempering fluid source is some distance from the process it is to temper, it is often difficult to maintain an unvarying and uniform temperature throughout the system.

One means to overcoming one or more of these difficulties is to have the fluid tempering media flowing through the system at a velocity sufficient to bring all parts to near the same temperature. Another marginally successful action is to provide each jacketed vessel with its own tempering fluid feed line. Both solutions have drawbacks. To move the fluid rapidly through even a simple system requires a great deal of pressure. The bore in the tubulure to the jacket of many pieces of glassware is quite small and presents a large fluid resistance. The pumps provided with many controlled temperature baths may not be able to develop enough pressure to move the required amount of fluid. If they are able to provide the pressure then often the flow is usually low. Leakage and burst tubing is often the result of a pump that can provide both pressure and flow. Feeding the jacket of each vessel with a separate flow requires a pump with a large output. The number of extra tubes required makes the system confusing. Insulated manifolds are a partial but expensive solution.

The countercurrent header for making up concentric tube heat exchangers (Fig. 1) is part of a successful solution to maintaining a required temperature. Two such headers are required for each exchanger (Fig. 2). Table I gives temperature values for perfusate entering and leaving a 6-ft countercurrent heat exchanger. The values were taken from a defined setup used for an isolated rabbit heart perfusion system. With this system it was not necessary to heat the perfusate in the reservoir. The medium reached the desired

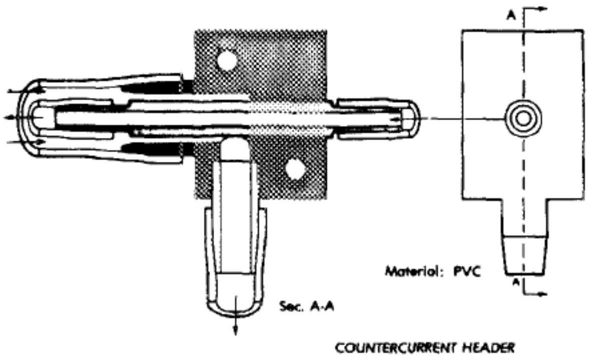

FIG. 1. Design drawing of a header for the counter-current heat exchanger.

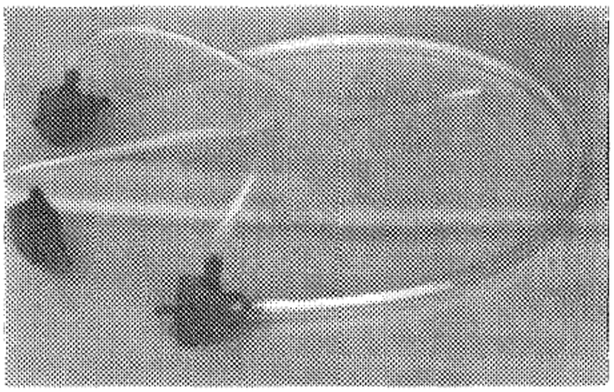

FIG. 2. Counter-current heat exchanger assembled with two heads. Another head lies free.

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