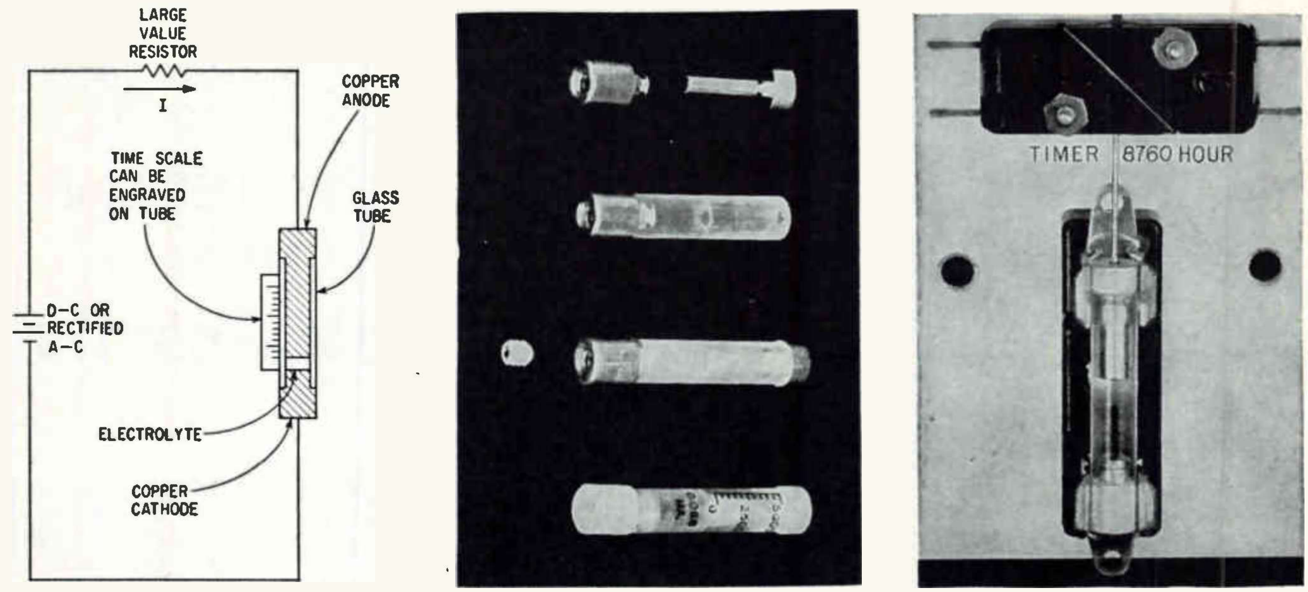

Miniature electroplating bath in cell, (left), is a trade secret. Simple, inexpensive device measures length of time electronic equipment has been in operation. Details of cell are shown, (center). One of many uses includes a long-time-delay relay, (right). Here a loaded micro type switch is tripped at a designated time, with no need for auxiliary relays or switches. Marketable timers for the full range of temperatures from —55 C to 85 C should be available soon

Electrochemical Elapsed-Time Indicator

DETERMINES TIME-TO-FAILURE OF COMPONENTS

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CONVENTIONAL METHODS of time measurements generally use a mechanical device such as a clock or an electrical motor in the form of an ordinary electric clock. These devices have considerable limitations in size and cost.

The need for a simple, small timer, so cheap that it could be used in virtually every piece of electrical equipment and take up no more than, say, a cartridge fuse, led to the development of an elapsed-time indicator which operates on the electroplating principle. This device, called a Chronistor, can be used for indicating the total number of hours during which any electrical instrument, appliance or component has been in operation. Current required by the device is provided by the unit being timed. No auxiliary relays or switches are needed. Elapsed time is given as a direct-scale reading.

The device is in effect, a miniature electro-plating bath containing anode and cathode electrodes of copper and an electrolyte. The unit is connected in parallel with the device to be timed so that when the d-c voltage is applied, electro-plating proceeds, tending to make the anode shorter and the cathode longer. Where d-c is not available, rectified a-c serves adequately.

By making the dimensions of the electroplating cell small, the current required to transfer copper from one electrode to the other can be made as small as necessary (in fact, proper choice of electrode dimensions is an important consideration in design).

A large value series resistor limits current (and incidentally, serves to maintain a constant current) so that the small variations in the resistance of the electroplating cell are negligible compared to the value of the external resistance.

The cell is a current operating device in that the speed of plating is directly proportional (within limits) to the amount of current passed through the cell. A simple way for maintaining the current constant is to use a series resistor connected to a voltage in the equipment. This resistor will be large compared to the resistance of the time cell and thus maintain a substantially constant current through the cell independent of changes within the cell due to temperature, resistance, time, etc. It is important to keep the voltage applied to the cell substantially constant to achieve the maximum accuracy. Variations of this applied voltage within moderate limits (say ± 10%) have little effect on the overall accuracy of the time measuring cell since they usually tend to average out; that is, higher voltage causes plating to speed up and lower voltage to slow down, with the overall result that accuracies of ±5% can readily be achieved in the timer although the voltage applied to the circuit may vary as much as ± 10% or ± 15%.

Chronistor electroplating cells are usually used by connecting the cell and its associated resistor in parallel with the electrical device whose operating time is to be measured. Thus if it is desired to know how long a battery has been in operation, the cell would be mounted across the power input terminals of the battery load (after the power ON-OFF switch). This way, whenever the switch is turned ON, voltage is applied to the cell and its resistor, and time begins to be clocked.

It is also possible to utilize the elapsed-time indicator within an equipment to measure the operating time of a component that is used only intermittently. For example, in a transmitter tube while the power applied to entire transmitter may be on almost continuously, the plate voltage applied to the power tubes may be on only intermittently when the transmitter is keyed or modulated.

If it is needed to know the operating time of the transmitter tube alone, the device can be connected through a large series resistor directly to the plate of the transmitter tube.

In this way, whenever plate voltage is applied, the elapsed time indicator would record operating time. It is only necessary to select the proper size series resistor to keep the current within the rated value for that cell.

The actual time indication is given by a fixed scale marked or engraved on the electrochemical cell. As the anode becomes shorter due to metal being plated from it, the time indication is given directly in hours by this change in length by reading against the fixed time scale.

The rate of plating is controlled by selecting the proper value of resistor in series with the unit for any given voltage.

A single unit can therefore be used for measuring a wide range of operating times, merely by changing the scale and adjusting the current which flows through the cell.

Data taken on one variety of elapsed time indicator shows that the rate of plating as a function of the current passing through the cell is linear, permitting cells ranging from 100 hours full scale to 10,000 hours full scale to be based on the identical construction. This permits a simple relationship which can be tabulated giving the standard value series resistors for several popularly used d-c voltages.