

## INDUSTRIAL SECTION

## Semi-Automatic Cell Testing Device for Dry Cells

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THE heavy intermittent discharge test for dry cells of the DU2 type ( $1\frac{1}{4}$ " diameter  $\times$   $2\frac{3}{16}$ " height), as laid down in British Standards Specification No. 397 of 1933, requires that each cell should be discharged through an external resistance of 5 ohms for three hours per week, with not more than thirty minutes continuous discharge per day. The discharge is to be continued until the potential difference between the terminals, measured at the end of a day's run with the test current flowing and by means of a high resistance voltmeter, has fallen to 0.75 volt per cell, when it shall be deemed to have completed its life. This testing procedure requires that a considerable period of time elapses before the electrical characteristics of the cells can be determined. During the course of the research work which has been in progress at the Government Test House in connection with problems of dry cell manufacture, it was felt that progress could be accelerated if the results of a given set of experiments were quickly made available, so that they could be used to guide further experiments. It was therefore necessary to reduce the testing period without materially changing the testing procedure or appreciably affecting the output results.

The acceleration of the testing procedure was effected by discharging the cells twice a day for half an hour each time instead of once a day as required by the B.S. Specification. In order to conduct both the discharges during the working period of the day, the intervals between successive discharges had to be fixed at 6 and 18 hours. This, however, was far from ideal, for the recuperation period of the cells was thus cut down from 24 hours to 6 hours for alternate discharges. An equal division of the 24-hour period into two 12-hour periods would have been much more desirable. This necessitated an automatic device for effecting and controlling the discharges during hours when the laboratories are normally closed. Such a device was designed and has been in operation for some time. It is briefly described in this paper in the hope that it may prove useful to other workers in this field.

## DESCRIPTION

The device comprises a wall clock controlling a set of relays which operate a solenoid fitted with a plunger connected through a mechanical tilting device to two banks of sixty mercury tube switches, the banks being disposed at right angles to each other on a triangular corner-table. Each of these switches is connected in an individual dry cell circuit. Figs. 1 and 2 show photographs of the complete device, Fig. 3 gives the circuit diagram of the test circuits, and Fig. 4 shows the circuit diagram of the control circuit.

In Fig. 1 is shown the controlling clock,



FIG. 1

on the dial of which four insulated platinum contacts are mounted. Two of these contacts make contact with the tip of the hour hand and the other two with the tip of the minute hand. The hour hand contacts are mounted at 10:00 o'clock and 10:30 o'clock positions, while the minute hand contacts are at 12:00 o'clock and 6:00 o'clock positions. Thus at 10:00 o'clock an electrical circuit is closed through the hour hand and the minute hand, while at 10:30 o'clock another circuit is closed through the same channel. Furthermore, at no other time of the day can either of the circuits possibly close. Thus at 10:00 o'clock twice a day,

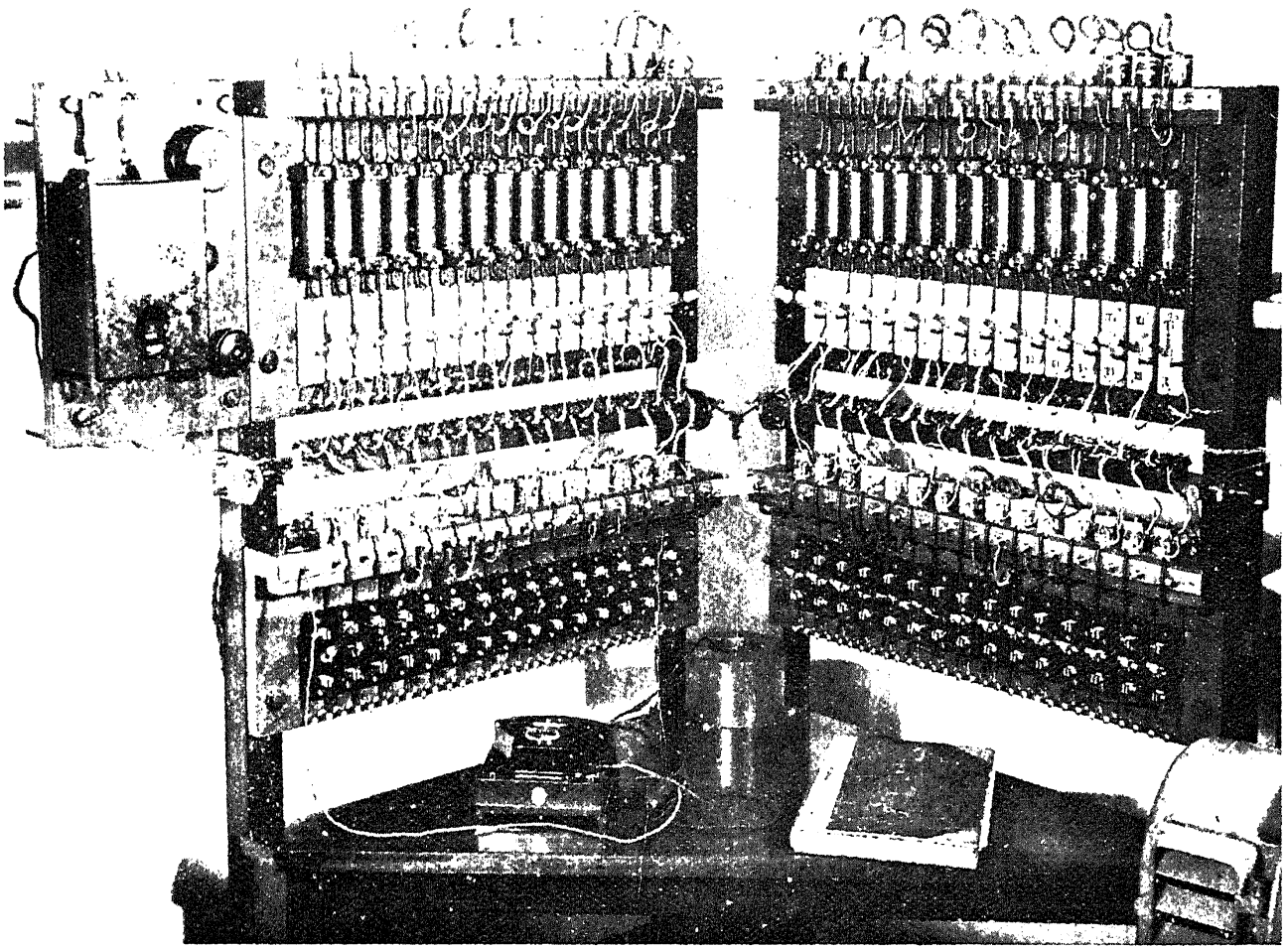


FIG. 2

the closing of the first circuit turns on the cells under test, and at 10:30 o'clock the cells circuits are opened. In order, however, to take voltage readings from day to day, the automatic device is allowed to act only

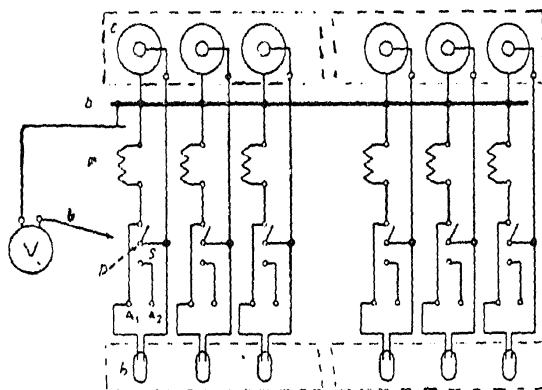


FIG. 3

Circuit Diagram of the Test Circuit

*c*-Dry cells; *L*-Busbar; *r*-5 ohm fixed resistances; *s*-S.P.D.T. knife switches; *p*-Terminals for voltage measurements; *A*<sub>1</sub> *A*<sub>2</sub>-Ammeter terminals; *h*-Mercury tube switches; *v*-Wandering voltmeter lead; *V*-High resistance voltmeter.

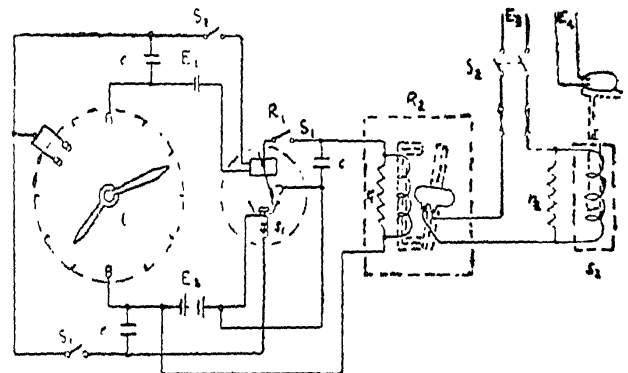


FIG. 4

Circuit Diagram of the Control Circuit

*C*-Clock; *R*<sub>1</sub>-Sensitive relay; *R*<sub>2</sub>-Power relay; *S*<sub>1</sub>-S.P.S.T. switches; *S*<sub>2</sub>-D.P.S.T. switch; *E*<sub>1</sub>-1.5 volts D.C.; *E*<sub>2</sub>-6 volts D.C.; *E*<sub>3</sub>-220 volts D.C.; *E*<sub>4</sub>-1.5 volts test cell voltage; *r*<sub>1</sub>-Discharge resistance; *r*<sub>2</sub>-Discharge resistance; *c*-1 μf Condensers; *s*<sub>1</sub>-Sensitive relay solenoid; *s*<sub>2</sub>-Tilting solenoid.

once a day in the evening, while in the morning, the device is cut out and manual discharges are carried out for which duplicate switches are provided.

The control circuit operated by the clock shown in Fig. 4 comprises a sensitive relay *R*<sub>1</sub>, power relay *R*<sub>2</sub>, and the tilting solenoid *s*<sub>2</sub>.

The closing of the sensitive relay circuit at 10:00 o'clock through the clock contacts operates the power relay, which energises the solenoid and tilts the two banks of mercury switches shown in Fig. 2. The sensitive relay contacts are held closed, because one of them is a permanent magnet, while the other one has an iron rider. At 10:30 o'clock, when the second circuit is closed by the clock contacts, a solenoid marked  $s_1$  (Fig. 4) is energised and draws the sensitive relay contacts apart and thus de-energises the tilting solenoid. The two banks of mercury switches are then tilted back to the open position by the two springs provided.

The sensitive relay and the power relay are Weston relays, model 705 (solenoid reset type) and model 630 respectively. The solenoid  $s_2$  is wound on a brass tube of  $\frac{7}{8}$ " inside diameter by  $2\frac{1}{2}$ " long with 19,000 turns of No. 30 S.W.G. double silk-covered copper wire, each layer of the winding being treated with a thick solution of shellac during the course of winding. The solenoid is enclosed in an iron body leaving an opening 3" in diameter at the top. On each bank of the tilting device thirty mercury switches are mounted, adjustment being provided for the tilting angle. Two strong springs hold the switches normally in the open position against which the solenoid pulls.

The details of the cell testing circuits are shown in Fig. 3. A double-throw single-pole knife switch is provided in each circuit, one side of which is paralleled to the mercury switch, while the other side is so connected that the discharge current may be read by connecting an ammeter to the terminals  $A_1, A_2$ . Short leads are soldered on to the terminals of the cells under test which are placed in cell receptacles. One of the leads of each cell is connected to a common bus-bar, while the other is connected to an independent terminal belonging to its own individual circuit. For manual testing, switches  $S_1$  and  $S_2$  (Fig. 4) are turned off and knife switches  $s$  (Fig. 3) are made use of, the voltage readings being taken between the common bus-bar terminal and the terminal marked  $p$  (Fig. 3) of the individual circuits.

In order to ascertain whether the device has functioned properly during the night, a strip of blotting paper is attached to the rack carrying the mercury switches and a pool of ink is placed under it just out of

contact. When the switch banks tilt, the paper dips in the ink, and the height to which the ink rises indicates approximately the time duration for which the mercury switches were turned on during the night.

#### TESTING OF CELLS

It is known that the output characteristics of cells are affected by the temperature and the humidity of the surrounding atmosphere. With a view to avoiding the effects of variation of atmospheric conditions, the testing unit is placed in an air-conditioned room, the temperature of which is maintained at 80° F. and the relative humidity at 70 per cent.

The dry cells under test are now being discharged at 10 o'clock twice a day except on Saturdays and Sundays. On Saturdays the cells are discharged only once a day in the morning and on Sundays no discharge takes place. Thus eleven discharges per week are obtained instead of six as provided by the specification mentioned above.

The watt-hour output capacity of cells obtained under double discharge conditions by means of the automatic device is naturally less than that obtained under the B.S. Specification conditions of testing, due to the smaller recuperation period permitted by the former. With a view to determining this loss in capacity a number of cells of four reputable makes were tested in parallel by the two procedures.

The cells were subjected to internal resistance and polarisation tests before putting them on life test. The polarisation tests, though not recommended by the B.S. Specification for this type of cell, was undertaken with a view to obtaining a complete record of the performance of the cells. With the automatic device, voltage readings were taken only once a day in the morning, the average values of the discharge voltages for the night discharges being taken as the average of the two successive morning discharges. The end point of the life test, if occurring during the night discharge, was similarly determined.

The watt-hour output was calculated according to the method given in the B.S. Specification. The power used during the polarisation test was added to the above figure to obtain the total watt-hour output of the cells. The watt-hour output obtained by these two methods of testing, and also the other characteristics, are given in Table I.

TABLE I

Comparative Output Figures obtained by the two methods of testing

Test No.	Laboratory designation of the make of cells	No. of cells tested	Testing method	No. of discharges per week	No. of days required to complete the test	Average characteristics				Increase in W.H. capacity obtained with the B.S. Specification method %
						Initial open circuit voltage	Internal resistance ohms	Polarisation %	Output W.H.	
1	A	3	B.S.S.	6	34	1.56	0.205	17.15	4.13	22.0
2	A	3	Automatic	11	16	1.56	0.215	17.15	3.36	
3	B	3	B.S.S.	6	25	1.56	0.225	21.50	2.57	16.3
4	B	3	Automatic	11	15	1.56	0.250	21.05	2.21	
5	C	4	B.S.S.	6	26	1.56	0.200	21.40	2.90	17.4
6	C	6	Automatic	11	16	1.56	0.215	21.85	2.47	
7	D	6	B.S.S.	6	31	1.56	0.230	17.90	3.25	20.4
8	D	6	Automatic	11	12	1.56	0.230	17.90	2.70	

Average = 19.3

In the last column of this table is given the percentage by which the output obtained by the double-discharge method, using the automatic device, has to be increased in order to calculate the output obtainable if the B.S. Specification method had been used. This correction varies between 16 and 23 per cent., giving an average of 19.3 per cent. In practice, therefore, the output of experimental cells obtained by double-discharge method, using the automatic device, requires to be increased by this factor in order to estimate the probable value which might have been obtained by the B.S. Specification method. The probable error of this estimation will be less than 3 per cent., which is very small compared with the normal

variations that occur from cell to cell. Table I also shows the saving in time effected by the use of the double-discharge method, which on the average amounts to about 50 per cent. This saving in time, besides making the results of experiments available in a shorter period, virtually doubles the capacity of the testing equipment, thereby enabling twice as many cells to be tested in a given period of time.

The device as it stands has been designed to test dry cells under certain particular conditions. It may, however, be modified at will to give any desired cycle of switching operations involving different timing for on and off intervals.

### Indian Science Congress, 1940

THE Twenty-seventh Annual Meeting of the Indian Science Congress will be held in Madras from January 2nd to 8th, 1940. His Excellency John Francis Ashley, Lord Erskine, G.C.I.E., Governor of Madras, has consented to be the Patron of the Meeting. Professor B. Sahni, M.A., Sc.D., F.N.I., F.R.S., Professor of Botany, University of Lucknow, will be President.

Intending members are requested to send their subscriptions to the Congress, to the Treasurer, Indian Science Congress Association, 92, Upper Circular Road, Calcutta.

Papers intended for being read at the session should be forwarded together with three copies

of an abstract so as to reach the General Secretary, mentioning the Section, before which the paper is intended to be read, not later than September 15th, 1939. Abstracts should be typewritten and must not exceed 200 words. They should not include formulæ or diagrams.

No abstracts will be printed unless accompanied by the full paper at the time of submission.

Rao Bahadur A. Lakshmanaswami Mudaliyar, B.A., M.D., F.C.O.G., Principal, Madras Medical College, Madras, and Sri. R. Gopala Aiyar, M.A., L.T., M.Sc., Director, University Zoology Research Laboratory, Madras, are the Local Secretaries of the Session.