EDISON STORAGE BATTERIES FOR ELECTRON RELAYS*

By

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It is a well-known fact that the "wing" circuit of an electron relay must be energized by a source of electrical energy entirely free from pulsations of electromotive force.

Notwithstanding the splendid work which has been done in "ironing out" the commutator ripples of dynamo electric machines, there are frequent periods when, owing to any one of a number of causes, non-periodic pulsations result, which seriously affect the operation of the relay.

It is for this reason that batteries, both primary and secondary, have been found the most satisfactory sources of electrical energy for the wing circuit.

Until recently, batteries of miniature dry cells have been employed and have proven fairly satisfactory when absolutely new ones could be readily obtained from the factories; but such cells have a comparatively short period of usefulness, produce a "frying" sound in the receiver when polarization of the elements occurs, and are relatively expensive because of the necessity of frequent substitution by new ones, etc. These disadvantages are pronounced on shipboard, where the dampness makes the life of such a battery particularly short and uncertain, where the unreliability of any piece of apparatus is emphasized, and where a reserve stock of dry cells cannot be depended upon because of their rapid deterioration at sea. On long cruises this uncertainty is of considerable moment.

About a year ago, radio engineers and those upon whom devolves the responsibility of maintaining radio apparatus at remote land stations and aboard ship, cast about for a more dependable and more economical battery for this service.

My attention was first called to this demand by Professor Alfred Goldsmith, who, having used Edison storage batteries in the Radio Telegraphic and Telephonic Laboratory of the College of the City of New York, was familiar with their ruggedness and dependability.

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The Edison type "WI-T" cell was thereupon developed and several batteries of these cells were sent to Professor Goldsmith for an extensive series of tests. After due time and a few minor changes, the commercially available battery appeared, incorporated with a standard Edison storage battery for heating the filament. Both have proven highly satisfactory in practical service and have been adopted as the standard for electron relay service by at least one Government.

Because of the prominent position which the new battery occupies in radio engineering, I have been invited to prepare an illustrated description for the radio profession.

A battery of *any* kind, for use in radio work, must, above all things, be *dependable*, even when subjected to the greatest of all abuse—neglect. Of course, when under the eye of a trained battery expert, almost any kind of a storage battery will give good service, if the demand upon it is such as does not necessitate ruggedness; but small units, widely scattered and in the hands of many who may be entirely unskilled in storage battery practice, seldom receive more attention than an occasional charge (which may be a prolonged overcharge at excessively high rates), and the replenishment of the solution with distilled water from time to time. In very small cells, the total liquid content is not sufficient to fill the smallest hydrometer; therefore the specific gravity of such a cell cannot well be ascertained. To remove all the electrolyte from *any* storage battery cell, when the cell is in a charged condition, will positively injure it; so that hydrometer readings of the electrolyte which are so necessary to keep some types of storage battery in condition are a practical impossibility in miniature cell operation. It is therefore requisite that a type of battery which requires no hydrometer readings should be used, and that such a battery should also incorporate the virtue of not being injured by oft-repeated overcharging, or by standing idle for protracted periods in a charged, semi-charged or, in some cases, totally discharged condition. Also if, by chance, the battery be charged in a reverse direction—a frequent error in small battery practice—the battery should not be injured.

When used on an aeroplane, it is of great importance that vibration and concussion should not injure the battery. It should also continue to operate for a short period, at least, even when completely inverted, and should not lose enough electrolyte by such temporary inversion as to affect its operation when right side up.

It should also be of as light weight as is consistent with rugged constructions.

All these and many more characteristics, so necessary for absolute dependability, are possessed by the Edison storage battery.

As is well known, the Edison storage cell consists of a plurality of inter-connected positive tubes and a plurality of inter-connected negative pockets, immersed in a solution of caustic potash. The positive tubes are of perforated, nickel-plated sheet steel. These are loaded with alternate layers of nickel hydrate and pure nickel flake. The negative pockets are likewise made up of perforated nickel-plated sheet steel, and are loaded with iron oxide. For a description of the very interesting processes of manufacture and of the chemical phenomena which take place in the Edison cell, the reader is referred to the various engineering bulletins and published articles on the subject.

The number of tubes and pockets that make up the elements of a cell depends on the capacity required. In the wing circuit of ordinary electron relays the current rarely exceeds a few milli-amperes, and a single positive tube with four negative pockets provide ample capacity. The manner of uniting these parts to form the cell elements is illustrated in Figure 1, which also shows the steel container. Figure 2 shows the completed cell. All steel parts, it should be noted, are nickel-plated, the plating being *welded on*, in accordance with Edison standard practice.

Two of these cells are combined to form a "twin" cell by connecting their containers together, and grounding the inner positive of one cell and the inner negative of the other to their respective cans. The completed twin is known as type "WI-T."

At the low discharge rates used in electron relay work, the average voltage during discharge of a twin cell is 2.56, and the final voltage, when re-charging becomes necessary, is 2.4. Hence, 16 twin cells are employed for a 40-volt battery and 42 for a 110-volt battery.

The ampere-hour capacity of one of these cells is 1.25, and the normal charging rate 0.25 amperes. Hence, under normal conditions, the time of charge is five hours; but in an emergency, the normal charging rate can be greatly exceeded, without injuring the cell. The low discharge rate in the wing circuit enables a battery to run from several hundred to several thousand hours continuously, on one charge, depending upon the characteristics of the relay bulb.

To correspond with the different sizes of electron relay which have been standardized, two sizes of Edison storage battery units are furnished. For ship and shore work the unit is known as type "42-WI-T-5-B-4." It consists of 42 cells of

Metal Container

Elements

FIGURE 1—Edison "WI" Cell Parts

FIGURE 2—Edison Type
"WI" Cell, Complete

the twin type described above (type "WI-T"), contained in the same case with five cells (6 volts) of the "B-4" type for heating the filament. The average voltage of the 42 twin cells at the low rate of discharge is 107.5, which is suitable for the wing circuit of the ship and shore relays.

For aeroplane service, the unit is known as Type "16-WI-T-5-M-20," and consists of 16 twin cells in the same container with five cells of type "M-20" for furnishing the filament current.

FIGURE 3—A Tray of 21 Twin Cells

The average voltage of the 16 twins is 40, as required for aeroplane relays.

The more important specifications of these two units are given in the following tables:

FIGURE 4—Plan View of a Tray of 21 Twin Cells

TABLE I*

Edison Storage Battery Unit

Type "42-WI-T-5-B-4." (Figure 5.)

For Electron Relays for Ship and Shore Stations.

"42-WI-T" Battery:

Ampere-hour capacity.....	1.25
Watt-hour capacity.....	135.
Discharge rate in wing circuit of electron relay, milli- amperes.....	0.2 to 5.
Average voltage on discharge at this rate to 100 volts..	107.5
Normal charging rate, amperes.....	02.5

FIGURE 5—42 Type "WI-T" (110 Volts) and 5 Type "B-4" (6 Volts)
Edison Cells Mounted in Steel Container

* Further information relative to these cells and their distribution may be obtained from Miller Reese Hutchison (Inc.), Orange, New Jersey.

"5-B-4" Battery:

Ampere-hour capacity.....	75.
Watt-hour capacity.....	450.
Normal charging rate, amperes.....	15.
Normal discharging rate, amperes.....	15.
Average voltage on discharge at normal rate to 5 volts	6.

Weight of unit complete, contained in heavily-janned weather-proof steel box, equipped with carrying handles and securing means.....100 lbs. (45 kg.)

Over-all dimensions of steel container, inches,
 $18 \times 19 \times 10\frac{3}{16}$. (45.7 $\times$ 48.3 $\times$ 25.9 cm.)

Edison Storage Battery Unit

Type "16-WI-T-5-M-20" (Figure 6)

For Electron Relays for Aeroplane Service.

"16-WI-T" Battery:

Ampere-hour capacity.....	1.25
Watt-hour capacity.....	51.
Discharge rate in wing circuit of electron relay, milli- amperes.....	0.2 to 3.
Average voltage on discharge at this rate, to 38 volts..	41.
Normal charging rate, amperes.....	0.25

"5-M-20" Battery:

Ampere-hour capacity.....	12.
Watt-hour capacity.....	72.
Normal charging rate, amperes.....	2.5
Normal discharging rate, amperes.....	2.5
Average voltage at normal discharge rate to 5 volts..	6.

Weight of unit complete, contained in heavily-janned weather-proof steel box, equipped with carrying handles and securing means.....35 lbs. (16 kg.)

Over-all dimensions of steel container, inches
 $9\frac{5}{8} \times 11\frac{13}{16} \times 8\frac{1}{2}$ (24.5 $\times$ 30 $\times$ 21.6 cm.)

The lay-out of the ship and shore station unit is shown in Figure 5, and of the aeroplane unit in Figure 6.

These batteries for electron relays are also furnished in individual boxes, where desired. Figure 7 shows the lay-out of type "42-WI-T" battery and container, for the wing circuit of

ship and shore electron relays; Figure 8, the lay-out of type "5-B-4" battery for the filament circuit of these relays; Figure 9, the "16-WI-T" battery for wing circuit of the aeroplane set; and Figure 10 the "5-M-20" battery for the filament circuit of the same.

FIGURE 6—16 Type "WI-T" (40 Volts) and 5 Type "M-20" (6 Volts) Cells Mounted in Steel Container

FIGURE 7—42 Type "WI-T" (110 Volts) Edison Cells Mounted in Container

FIGURE 8—5 Type "B-4" (6 Volts) Edison Cells in Steel Container

FIGURE 9—16 Type "WI-T" (40 Volts) Edison Cells, Mounted in Steel Container

FIGURE 10—5 Type "M-20" (6 Volts) Edison Cells in Steel Container

SUMMARY: The development of a new type of Edison nickel-steel storage battery for use in the plate circuit of electron relays is described. This is a small 1.25 ampere-hour, 2.56-volt twin-cell. Normal discharge lasts several thousand hours.

Various assemblies of these for 40 and 110 volts, in conjunction with various filament-lighting Edison storage battery sets, are described in detail, with electrical operating data, weights, and dimensions