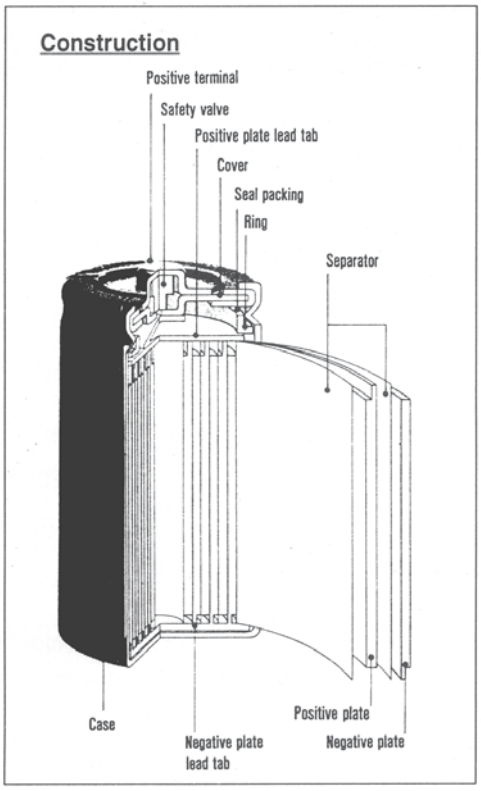
GENERAL INFORMATION ON SEALED NICKEL CADMIUM BATTERIES



BATTERY SPECIFICATION

(1) Cylindrical Sealed Nickel Cadmium Batteries

Construction

The "Ni-Cd" battery consists of positive plate, negative plate, separators, electrolyte, metal case, cover, and safety valve. Positive and negative plates, isolated from each other by separators, are housed in the case. The cover and case of the battery are provided with an insulation gasket for sealing, and function as a positive terminal and a negative terminal respectively.

● **Robust and safe**

Extremely impact and vibration-resistant robust construction. The "Ni-Cd" battery is housed in a cylindrical metal case with a resetting safety valve. This safety device activates without fail to ensure safety even in the case of an abnormal increased in gas pressure in the battery.

● **Easy to handle**

Maintenance free with no need to add water, as it has a sealed construction which allows gas generated during overccharge to be electrochemically consumed inside the battery. Users can handle the "Ni-Cd" like a dry cell, without restrictions on the battery direction or place of Installation

● **Withstands overcharge or overdischarge**

Durable under severe service conditions such as overcharge or overdischarge, "Ni-Cd"'s performance does not deteriorate even when left discharging; it can be used anytime simply by charging.

● **High performance and stable voltage**

Low internal resistance, stable voltage during discharge with large current, and long discharge duration. "Ni-Cd" performs well in a wide range of temperatures.

● **Long life and economical**

Can be used for 500 or more cycles in cycles cycle service (repeated charge and discharge), and four or more years with trickle (or constant) charge.

● **Wide application field**

Capacities are available from 110 mAh to 10,000 mAh. With seven types available for standard, high capacity, super high capacity, super high capacity & rapid charge, large current discharge & rapid charge, high temperature trickle charge and consumer, "Ni-Cd" can apply to any cordless equipment.

TYPICAL BATTERY CHARACTERISTICS

Fig. 1 HOURS RATE CAPACITY CHART
Discharge Current and Discharge Time.

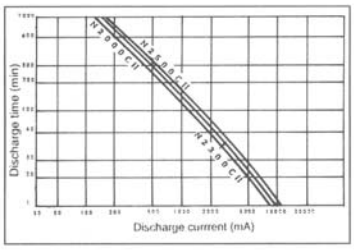
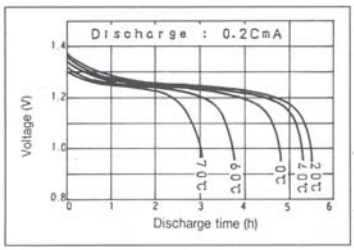
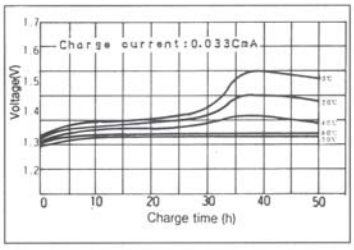


Fig 2 Discharge Charateristos



The DISCHARGE characteristics of "Ni-Cd" batteries change with current, temperature, etx. Although the working voltage changes only a very little with discharge current, it is very stable.

Fig 3 Trickle Charge Characteristics



The CHARGE characteristics of "Ni-Cd" batteries change with charge current, time, temperature, etc. More specifically, the battery voltage rises when the charging current increases, or when the temperature lowers. Towards the end of charging, drops a little due to the battery generating heat.

Fig. 5 Temperature Charateristics

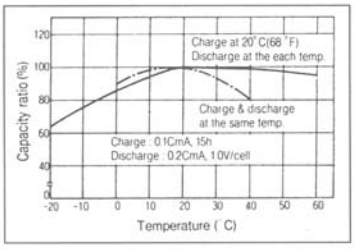
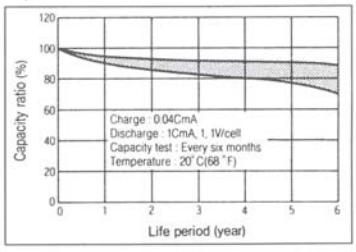


Fig 4 Life Characteristics



Usually, when a battery is stored, the voltage or capacity drops due to self discharge Although self-discharge proceeds accordingly as the temperature rises and the storage period lengthens, the battery voltage or capacity can be restored does not become useless due to storage. Ni-Cd battery's life differs with how it is used In an ordinary state of use, a "Ni-Cd" battery for general use can be charged and discharged more than 500 times.

Charge Method

"Ni-Cd" is more resistant to overcharge or overdischarge and easier to charge than other batteries.
"Ni-Cd" has its own limits because a sealed construction is employed to consume gas from overcharging inside the battery. It is essential to select the appropriate charge method to obtain the fullest possible performance of the battery while taking various conditions (discharge condition, ambient temperature, charge time, charge method) into consideration.

The table below shows the classification of batteries for the charge method by application.

Charge method and Features

Classification of application	Charge method	Features	Remarks
1. Cycle service	Standard charge (Modified constant current charge, constant current charge)	General standard type Fenera high-capacity type High temperatrure trickle charge type Large current discharge type Consumer type	See Fig. A See Fig. B See Fig. C See Fig. D
	Quick charge (Constant current charge, temperature sensor detection type)	Quick charge type	See Fig. E See Fig. F See Fig. G
2. Standby service	Trickle charge (Modified constant current charge, Constant current charge)	High temperature trickle charge type General standard type General high-capacity type	See Fig. H
	Float charge (Constant charge, with current limiter)	Impossible as a rule (Contact us when this battery is to be used according to the float charge method)	See Fig. I

Either the modified constant current charge method or the constant current charge method is recommended for the "Ni-Cd" battery. Avoid the constant voltage charge method because this method suffers fluctuation of battery voltage depending on the ambient temperature and secular change.

1.0 Charge for the Cycle Service

This service consists of repeated charges and discharges when the battery is used as a main power supply for handy equipment (home electric appliances, etc.).

1.1 Standard charge

The most frequently used charge method, is now either the modified constant current of the constant current charge method.

The charge current is about 0.1 CmA (0.1 times the rated capacity) and the charge time about 15 hours.

(a) Modified constant current charge method (simplified charge method).

This charge method, generally referred to as the simplified charge method, is easy and most frequently em ployed for cycle service batteries.

The charger consists of a transformer, diode, and resistor. The impedance defined by the transformer, diode, and resistor ensure charge without substantial fluctuation of the charge current.

Being simple in construction, the charge can be manufactured at low cost.

In this method, the battery voltage rises and the charge current decreases as charging proceeds. But this method suffers in one respect at the end of charge, that is, the battery tends to cause overcharge because the charge current does not decrease sufficiently. It is essential therefore to prevent charging loger than specified. Fig. A shows a typical circuit deagram and Fig. B typical characteristics of charge.

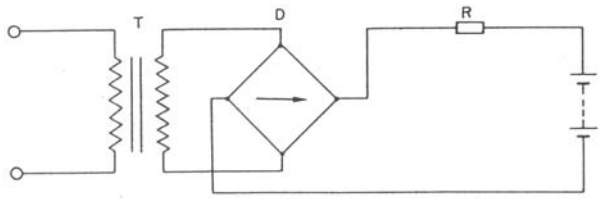


Fig. A Modified constant current charge circuit diagram

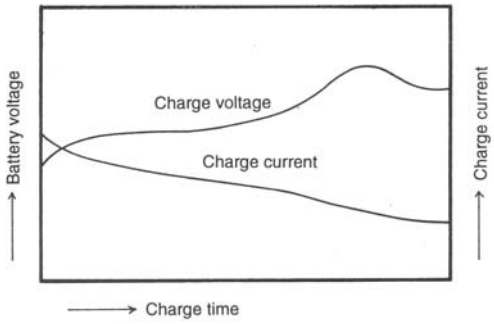


Fig. B Characteristics of modified constant current charge

(b) Constant current charge method.
This method is to charge the battery with constant current.

This is not used much as a circuit for general charger because an expensive circuit is necessary to obtain a highly accurate constant current.
This method is advantageous in that calculation of the charge time and charge amount is easy and that specific charge amount can be easily obtained. Accordingly, this charge has come to be incorporated together with other control functions into the high-grade charger (quick charge circuit of “Ni-Cd” battery for VTR).

Fig. C shows a typical constant current charge circuit and Fig. D typical charge characteristics.

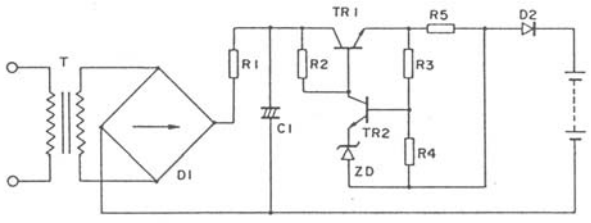


Fig. C Constant current charge circuit

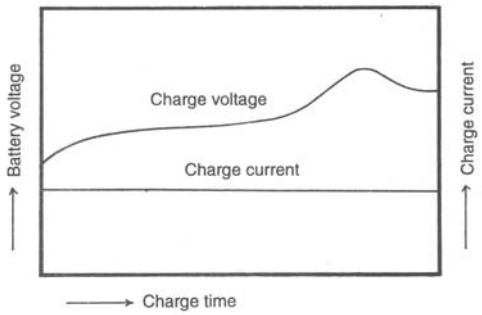


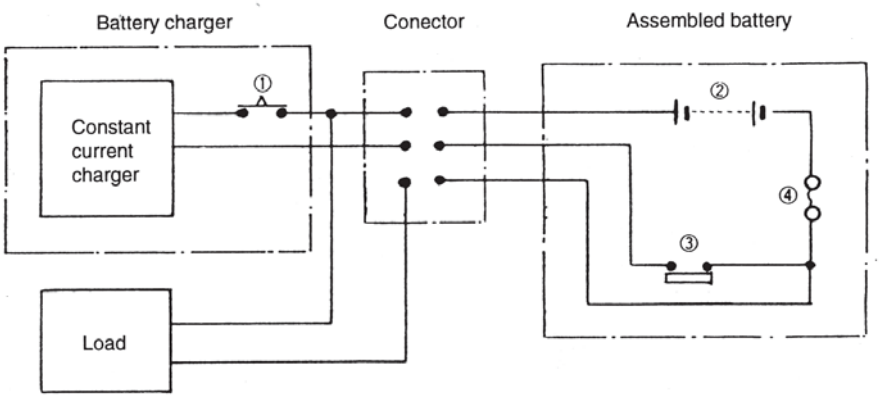
Fig. D Constant current charge characteristics

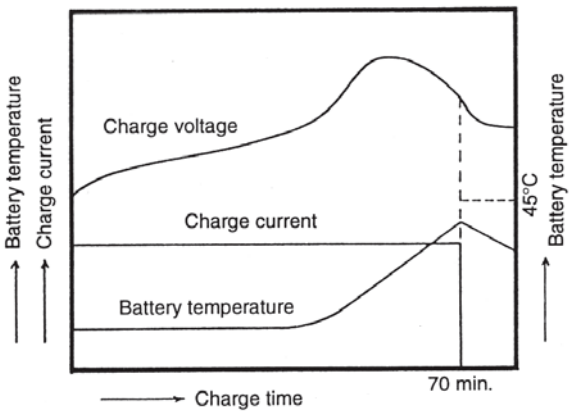
1.2 Rapid charge (temperature sensor type)

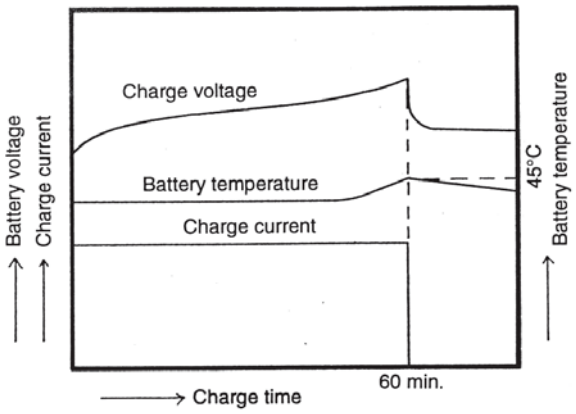
This method is to charge the discharged battery within a short time. In spite of the high cost of the battery and charger, this is extremely convenient as a power supply for handy equipment (VTR, shaver) and is used most frequently.

An example of a typical rapid charge temperature sensor detection system without need of an intricate detec tion circuit or troublesome adjustment is introduced below. In this type of charge, the battery is heated when the gas from overcharge is consumed internally. A temperature sensor bonded to the battery detects this temperature rise to control the charge current.

Fig. E shows an example of the rapid charge (temperature sensor type) system. Fig. F and G show typical characteristics of charge.







2.0 Charge for Standby Service

Power is normally supplied from the AC power supply to the load. The standby service is to supply power to the load from the battery immediately when AC power supply is interrupted due to power failure. This requires the battery to be always charged to ensure power supply at any time.

2.1 Trickle charge

The battery and load are separated as long as the AC power is effective. The battery is connected directly to the load to supply power only when this AC power is off. A typical trickle charge system is shown in Fig. H.

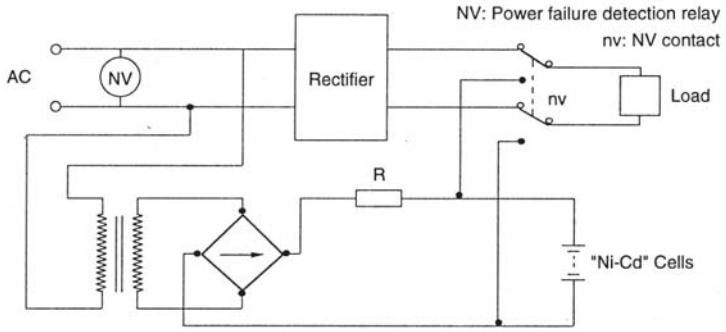


Fig. H Trickle charge system

While the AC power supply is effective, the battery is nomally charged with a small enough current to perform self-discharge. The charger generally used is a modified constant current charger dedicated to the battery. This system is frequently used as an emergency standby power supply for disaster preventive equipment (emergency lighting).

- For less frequent power failures.
  The appropriate-trickle charge current ranges from 0.04 to 0.33 CmA. Setting range should be 0.05 CmA (1/20C) maximum and 0.02 CmA (1/50C) minimum.
- For frequent power failures, recovery of charge within a short period.
  Use this method in combination with the quick charge or constant voltage charge method until the battery capacity is recovered. Then limit the charge current to 0.04 to0.033 CmA.

2.2 Floating charge

This system consists of the load and battery connected in parallel to the charge power supply. The charger supplies DC power to the load, and at the same time charges the battery.
A typical floating charge system is shown in Fig. I
For floating charge, the rectifier used is normally a constant voltage charger Since the load current in not constant and fluctuates irregularly, a protective circuit to control charging depending on the load current fluc tuation is necessary to prevent the battery from being overcharged or discharged.
The best feature of this system is that momentary cutting is eliminated.

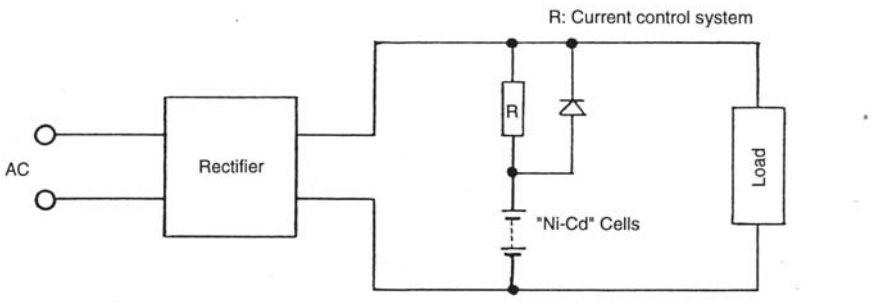


Fig. I Float charge system

RECOMMENDED MAINTENANCE/TESTING PROCEDURES FOR SELF- CONTAINED EMERGENCY LUMINAIRES AND EXIT SIGNS

1. Monthly procedures.

Check that the self-contained emergency luminaires and exit signs function satisfactorily. Replace and defective lamp(s) or starters if applicable.

2. Yearly procedures.

(a) Operate the self-contained emergency luminaires from the battery supply until extinguishes to operation of the automatic lowvoltage cut-off device built into the luminaires. Investigate and repair or replace any luminaire which fails to operate satisfactorily.

(b) Clean all light-emitting and reflecting surfaces.

(c) Replace any defective lamp(s)

3. Battery replacement.

The replacement of batteries/cells in self-contained emergency luminaires are recommended to be carried out in accordance with the following requirements:

(a) Where more than one battery/cell is utilized the complete set of batteries/cells shall be replaced.

(b) Batteries/cell removed from one luminaire shall not be used as preplacements in another luminaire.

(c) Replacement batteries/cell must all be of the same type as originally installed or equivalent.

Handling Precautions for the"NICKEL CADMIUM" Battery

1.0 Charge

1.1 Change Current

(1) Batteries should be charged at less than 0.1 CmA current.

(2) In case charge current exceeds 0.1 CmA, Keep up with it's production speed at the end of charge. Consequently, the pressure inside battery will become high, the safety valve will operated, the performance of the battery may decrease and electroyte leakage may result accordingly.

(3) In case charge current will exceed 0.1 CmA, a charge control circuit will be required. Should this be the case, please contact our company.

1.2 charge Time

(1) Standard charge time at a current of 0.1 CmA is 15 hours.

(2) Exceeding standard charg time may inpair future performance.

1.3 Charge Temperature

(1) Batteries should be charged at ambient temperature range of 0 to 45° C. However, we recommend charging the battery at ambient temperature between 5 to 35 C not to present any adverse effects on its charge efficiency and effective life.

(2) In case of charging at temperatuer less than 0 C, the gas absorption rate drops thus resulting in an internal pressure build-up This can cause the safety valve to operate, which may result in deterio ration of battery perfomance or leakage of electrolyte.

(3) Charge efficiency drops when charging at temperatures exceeding 45 C. As a result, the battery may not be fully charged, and its life may be shortened, and electrolyte leakage may be caused.

1.4 Reverse Charge

(1) Never attempt to reverse charge the battery

(2) If connected reversely, the battery will not only fail to be charged, but this can also result in

reversing battery polarity. Internal pressure can also reach high (dangerous) levels, always check battery polarity before making the charging conection.

1.5 Trickle-Charge

(1) Batteries should be trickle charged at a current of 0.02 CmA to 0.05 CmA (center value: 0.033 CmA)

(2) When trickle charge current is less than 0.02 CmA, battery may not be folly charged.

(3) Trickle charge at a current exceeding 0.05 CmA will result in an over-charge, and this can shorten battery life, and can cause leakage of elecolyte

2.0 Discharge

2.1 Discharge Current

(1) Continous discharge current should be less than 3 CmA.

(2) Short-time discharge curreng should be less than 5 CmA.

(3) If you plan to exceed either of the above values, please contact our company.

(4) In case the battery is discharged at extremely high current, both discharge capacity and voltage, will drop accordingly, and will cause the battery to heat up. This can destroy the battery

2.2 Discharge Temperature

(1) Batteries should be discharged at the temperature range of -20 to 60 C. Note however that “Ni-Cd” performance can be better assured when used at the range of 0 to45 C.

(2) When using H-type “Ni-Cd” designed for high temperature trickle charging, discharge should be made at the temperature range of -5 to 60 C.

(3) Discharge capacity is greatly reduced at extremely low temperatures (-20 C or lower, -5 C lower for high-temp trickle charge H-type), and performance degradation is remarkably quickened when discharged at temperature exceeding 60 C.

2.3 Over-Discharge

Batteries should not be over-discharged. Repeated over- discharge shortens battery life, and can cause leakage of electrolyte.

3.0 Storage

3.1 Storage Temperature, Humidity

(1) Batteries should be stored at the temperature range of -20° to 35° C. Also, keep in a dry place without corrosive substances.

(2) Storage in locations exceeding the above temperature values reduces the performance character istics. Also, storage at high humidity levels, or in the presence of corrosive fumes results in rusting and the “creep” effect.

3.2 Long-Term Storage

(1) Batteries stored over a long period of time (six months or more) should be stored in discharged condition. If possible, avoid storing batteries over two years.

(2) Long term storage should be in cool and dry locations.

(3) The battery’s active materials gradually becom inactive over a long storage period, and initial ca pacity will be low even after charging. In such cases, performance will generally be recovered after several charge-discharge cycles.

(4) When the white crystalline powder appears on the surface of a battery, please wipe it off with a dry cloth before using the battery.

4.0 Life of Battery

(1) Under normal cycle usage conditions, the battery can be charged-discharged over 500- times. Being used under trickle charge conditions, service life will be approximately five years (4 to 6 years)

(2) In case usage conditions are less than ideal, battery life will be shorter. Note particularly that battery life is shortened under usage at high temperatures.

5.0 Packed Battery

(1) Batteries shall be series-connected as long as the total number of cells does not exceed 20. If more than 20 cells are to be connected, please contact our company.

(2) Do not directly solder a "Ni-Cd" to make battery pack. The heat from the soldering operation can damage the insulator plates and other internal parts and can result in electrolyte leakage or shortcircuiting. Please contact our company pegarding connection methods.

(3) When packaging multiple batteries, pay your attention to pack construction and battery arrangemeng considering its heat radiation. High temperatures (internal) can adversely affect performance and shorten service life.

6.0 Instrument design

6.1 Connecting Batteries and Instruments

(1) Do not directly solder leads to a battery.

(2) Lead wires should be soldered to spot-wielded terminal plates.

(3) The heat from directly soldering lead wires to a battery can damage separators, insuiator plates ans other internal parts.

6.2 Parallel Connections

(1) Do not connect batteries in parallel for charging

(2) If batteries are charged in a parallel connection, charge current tends to be non-uniform, resulting in some batteries not being fully charged and others being over-charged. Performace will thus be adversely affected.

6.3 Equipment Battery Location

(1) If possible, batteries used in equipment should be located away from heat producing mechanisms.

(2) Heat produced by engines, cooling systems etc., can raise the intermal temperature of the battery, which will adversely affect its performance.

7.0 Others

7.1 Disassembly

(1) Never disassemble or reassemble the battery.

(2) When the battery electrolyte (alkaline) contaminates the skin or the clothing, please wash it out immediately with plenty of water. If electrolyte gets in one's eyes, also wash it with a lot of water, and see a doctor immediately.

7.2 Handling

(1) Do not pull cables, connectors, etc. By force.

(2) The rough handling of cables can damage or break solder or spot-welded joins.

7.3 Short-Circuits

(1) Never short-circuit the battery.

(2) The high current produced by a short-circuit can damage instruments, and causes the battery to over-heat dangerously.

7.4 Discarding in Fire

(1) Never place the battery in fire.

(2) When the battery being put into fire, it will be dangerous and there will be high possibility of bursting.

7.5 Mixing Batteries

(1) Do not use mixed battery types.

(2) Mixing different type dry-cell, new and old batteries, and different type and dimensions may damage the batteries or the instruments.

7.6 pre-Use Charge

(1) Batteries should be charged prior to use.

(2) Self-discharge may lower capacity to the point that the battery cannot be use.

7.7 Number of Connections, Arrangement

(1) The number of connections should be restricted to 20 cells for ideal performance. Batteries should be arranged for good heat radiation.

(2) When too many connections are used, or when heat radiation is insufficient, the resulting internal heat will rise and it may adversely affect battery perfomance.

7.8 Battery Replacement

(1) The end of effective service-life is indicated by short usage (discharge) time even after the battery has been properly charged. In such cases, the battery should be replaced.