

# APPLICATION NOTE

I C s f o r B a t t e r y M a n a g e m e n t

## **NiMH Batteries recharge characteristics under TEA1101 charge management**

Report No: NPO/AN9301

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### **Keywords**

**NiMH/NiCd battery  
TEA1100/TEA1101  
Battery management  
Fast charge systems**

**Date : 20 January 1993**

**Pages: 16**

## Summary

Rechargeable NiMH-batteries of the 4 major, worldwide operating suppliers (Vendor A - D) have been tested on their fast charge characteristics under control of the Philips Semiconductors IC TEA1101,- battery management IC for NiMH and NiCd chargers -. For reference measurements of NiCd cells have also been included.

Tests were performed under several conditions;

- fast charge currents: 1CA and 1.5CA at 25°C ambient temperature
- extreme conditions of batteries' temperature and state of charge

The charge voltage profile of NiMH batteries does not exhibit a voltage drop into overcharge as pronounced as that of NiCd batteries. The evaluations were performed with -dV charge termination of 2 and 4mV/cell.

The test results show that TEA1101 is well suitable to charge NiMH and NiCd cells under both normal and stress conditions.

The implementation of the sensitive negative delta voltage (-dV) cut-off keeps the batteries' temperature rise into overcharge within acceptable limit, - important reliability factor and condition for good cycle performance -.

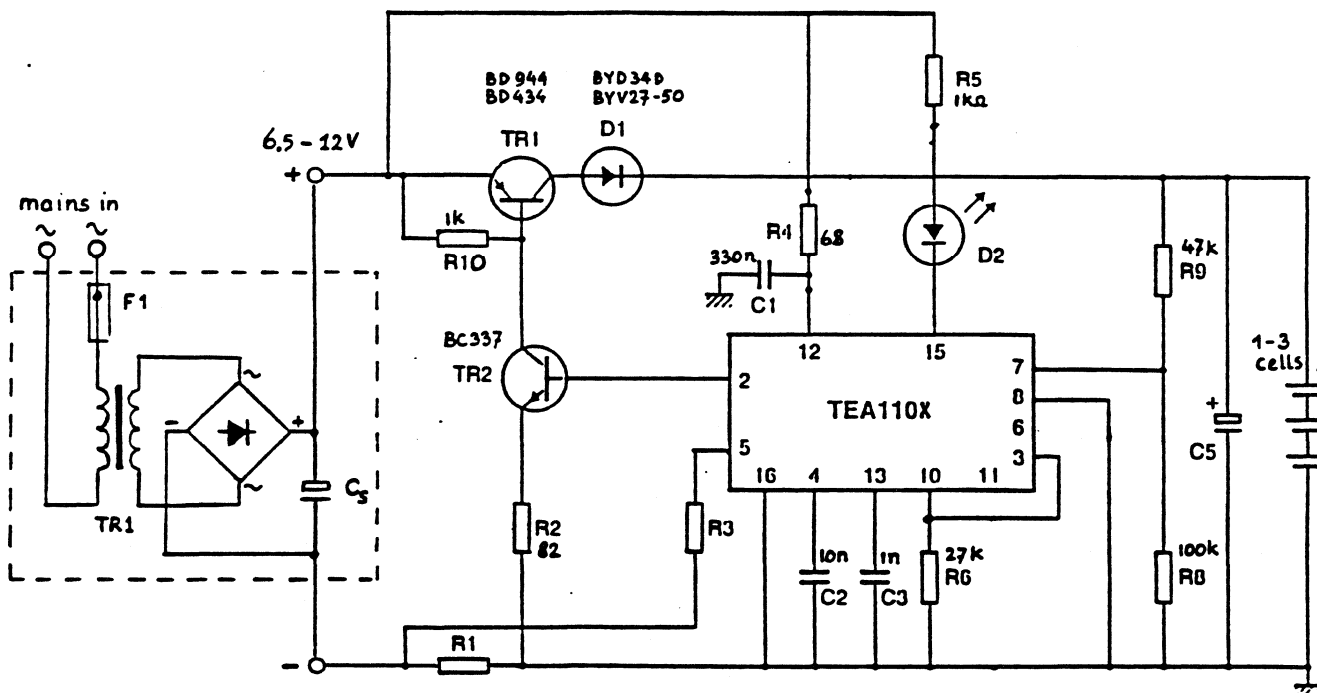
Unlike temperature based charge termination techniques the implemented charge voltage profile termination method remains reliable in case battery ambient temperature may fluctuate due to external influences; e.g. heat generating charging electronics or extreme conditions of batteries' temperature like insertion of a cold or warm battery.

## 1. Measurement setup

The NiMH/NiCd batteries tests were carried out on a Semi Automatic Measuring battery test gear, equipped with a fast charger unit using the Philips Semiconductors TEA1101. This monolithic Integrated Circuit features:

- Battery full detection by battery voltage sensing.  
The TEA110X-family features an accurate and reliable -dV mechanism by currentless voltage sensing and digital filtering techniques, a prevention against false -dV cutoff due to noise and other natural fluctuations during charge.
- protection against minimum and maximum cell temperatures.
- protections against open, short or faulty battery packs.
- time-out function.
- regulation of charge currents in conjunction with a switched mode or a dc power supply.
- interfacing control for a stand-alone current power supply.
- user-interfacing by LEDs

### Circuit diagram of the charger unit.



I <sub>charge</sub> (A)	0.6	1	1.1	1.5	1.65
R <sub>1</sub> (Ω)	0.25	0.25	0.25	0.167	0.16
R <sub>3</sub> (kΩ)	3.24	5.4	6	5.4	6

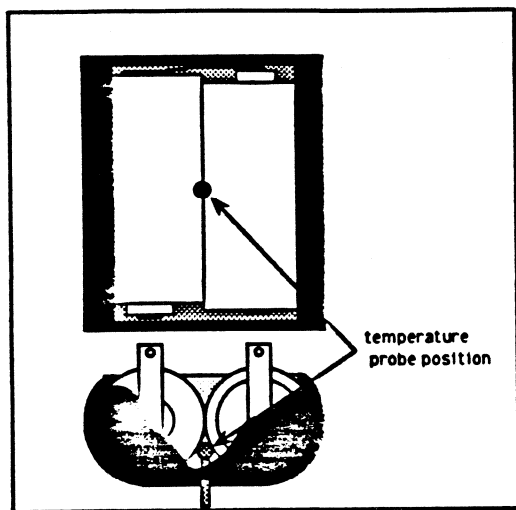
### TEA110X Battery Charger with Linear Regulator Circuit

Details of this circuit and alternative charger configurations have been described in application notes mentioned in references, section 3.

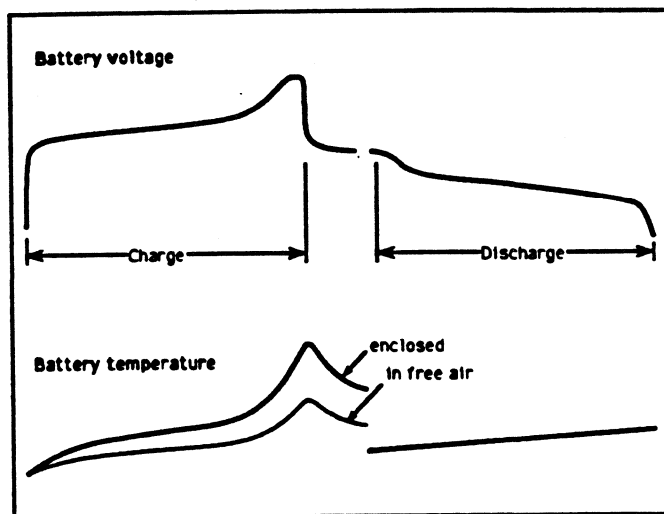
### Battery assembly

Temperature rise of battery cells in an enclosed plastic encapsulation (pack) will be higher than that of cells widely spaced apart in open air.

The measurements have been performed on two cells constructed side-by-side in an open top plastic case. The battery temperature was probed in between the cells, at the confined area side.



Battery assembly



Voltage and temperature characteristics

The end of charge temperature of widely spaced battery cells without an plastic case will be approximately 10°C less than that of the tested enclosed cells.

## 2. Measurement data

### Measurements at ambient temperature 25 °C

The measurement results are presented in voltage and temperature graphs where:

- a) 2 cells battery voltage.
- b) battery temperature.

#### NiMH

-Icharge: 1 CA, -dV: 1/4% ( $\approx 4\text{mV/cell}$ )	Fig. 1 - 4.
-Icharge: 1 CA, -dV: 1/8% ( $\approx 2\text{mV/cell}$ )	Fig. 5 - 8.
-Icharge: 1,5CA, -dV: 1/4% ( $\approx 4\text{mV/cell}$ )	Fig. 9 - 12.
-Icharge: 1,5CA, -dV: 1/8% ( $\approx 2\text{mV/cell}$ )	Fig. 13- 16.

#### NiCd

-Icharge: 1 CA, -dV: 1/4% ( $\approx 4\text{mV/cell}$ )	Fig. 17.
-Icharge: 1,8CA, -dV: 1/8% ( $\approx 2\text{mV/cell}$ )	Fig. 18.

#### Stress conditions

NiMH-battery and charger both at 40°C Tambient	Fig. 19.
NiMH-battery at 0 °C and charger at 25°C Tambient	Fig. 20.
NiMH-battery at 60 °C and charger at 25 °C Tambient	Fig. 21.
overdischarged NiMH battery	Fig. 22.
full NiMH battery	Fig. 23.

## 3. References

- 1 NPO/AN9102b. TEA1100, Versatile battery management IC for NiCd charge systems.
- 2 TEA1100(T) / TEA1101(T). Device specification
- 3 NPO/AN9201. TEA1100, Battery charger with flyback SMPS current regulator
- 4 SPO/AN92004. TEA1100, Battery charger with linear regulator

TYPE : NiMH 1Ah DATE: 15-12-1992  
Voltage vs Charge time

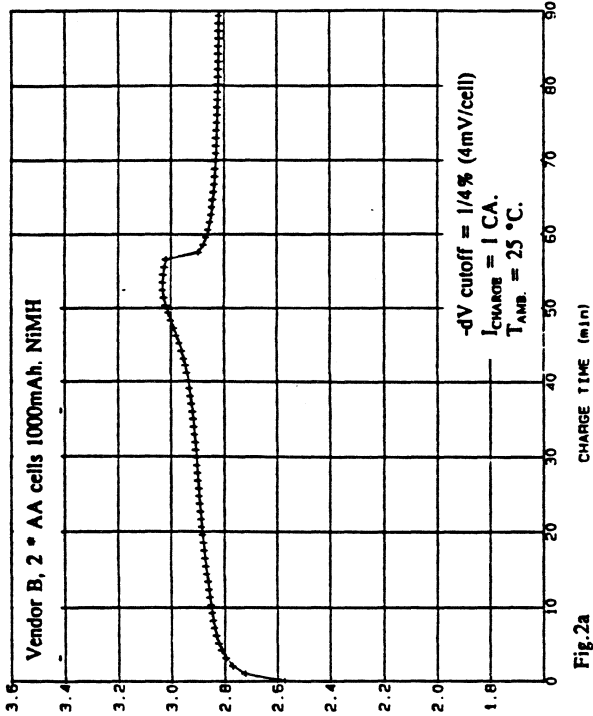


Fig.2a

TYPE : NiMH 1Ah DATE: 15-12-1992  
Temperature vs Charge time

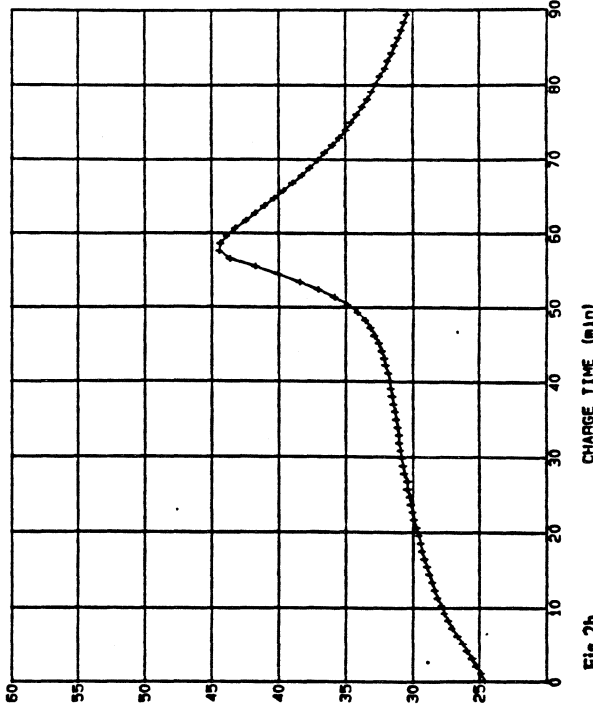


Fig.2b

TYPE : NiMH 1.1Ah DATE: 17-12-1992  
Voltage vs Charge time

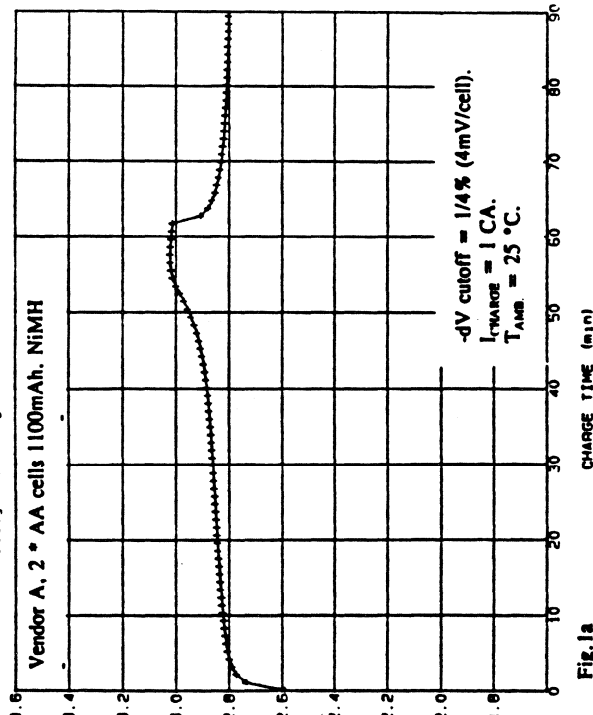


Fig.1a

TYPE : NiMH 1.1Ah DATE: 17-12-1992  
Temperature vs Charge time

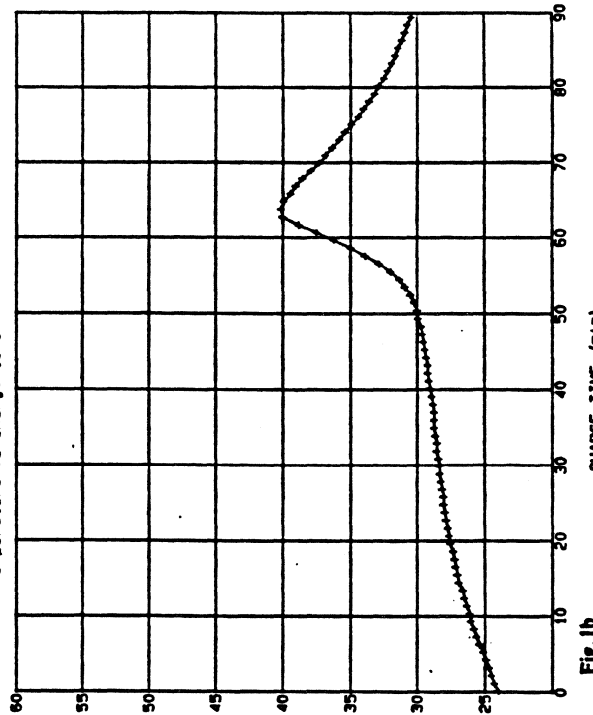


Fig.1b

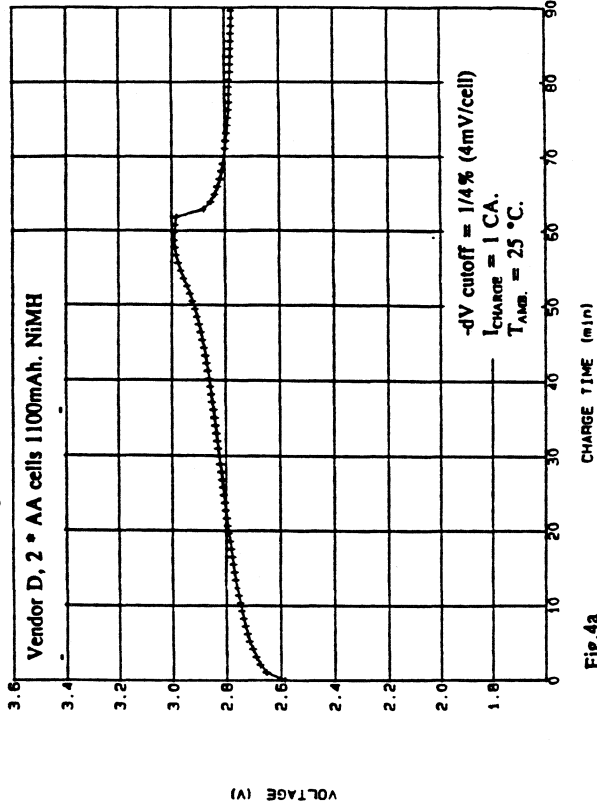
VOLTAGE (V)

TEMPERATURE (C)

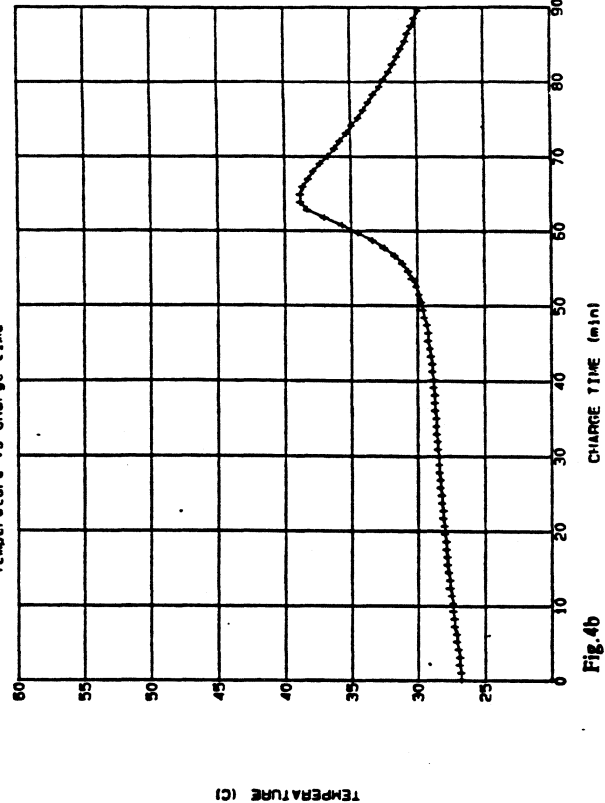
VOLTAGE (V)

TEMPERATURE (C)

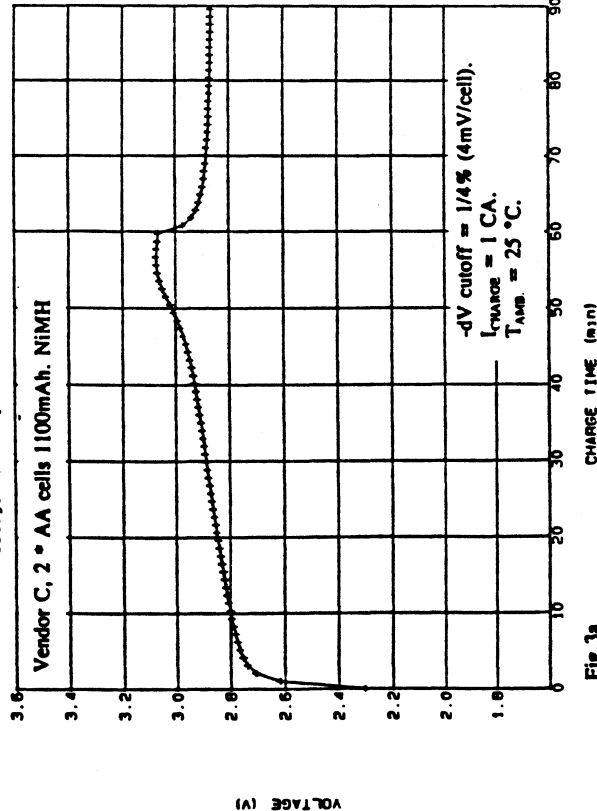
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Voltage vs Charge time



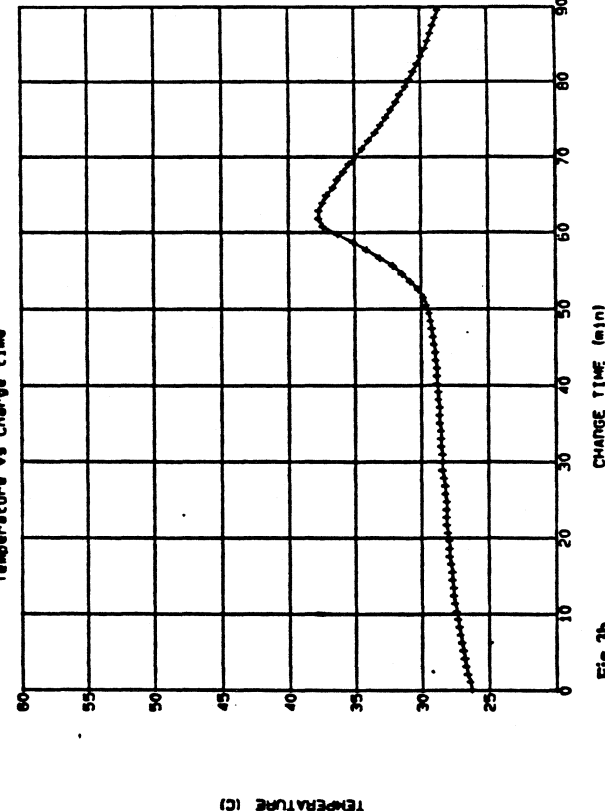
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Temperature vs Charge time



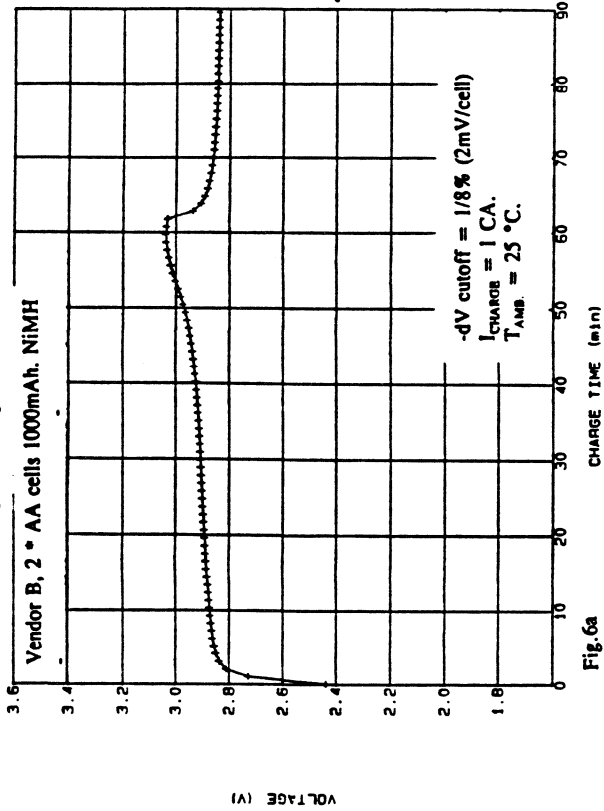
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Voltage vs Charge time



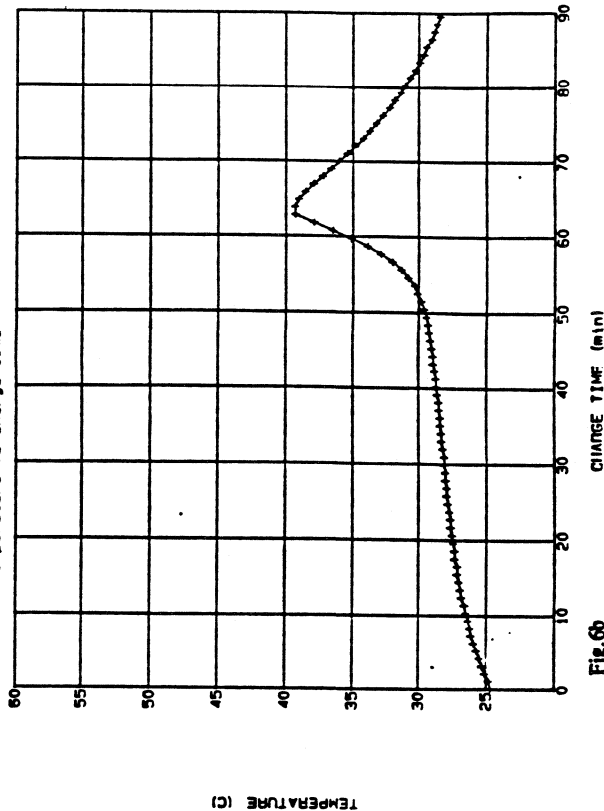
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Temperature vs Charge time



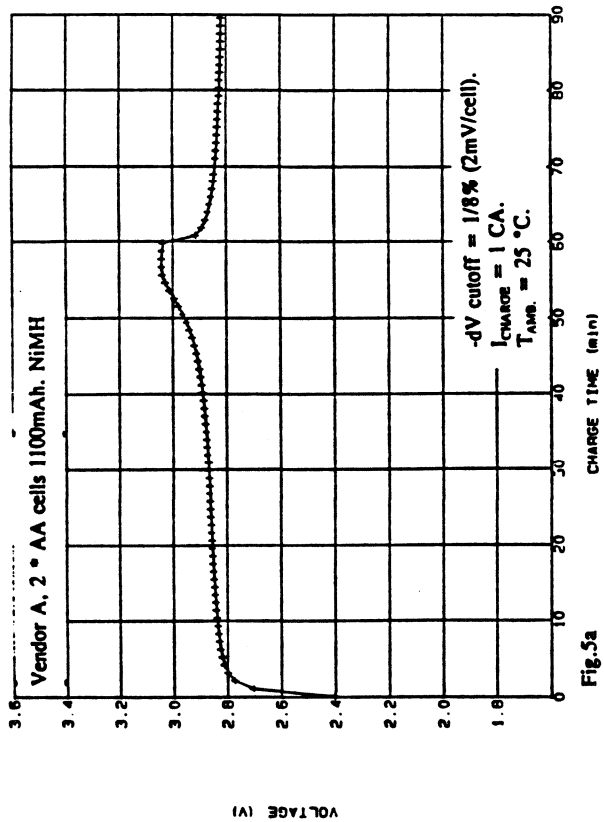
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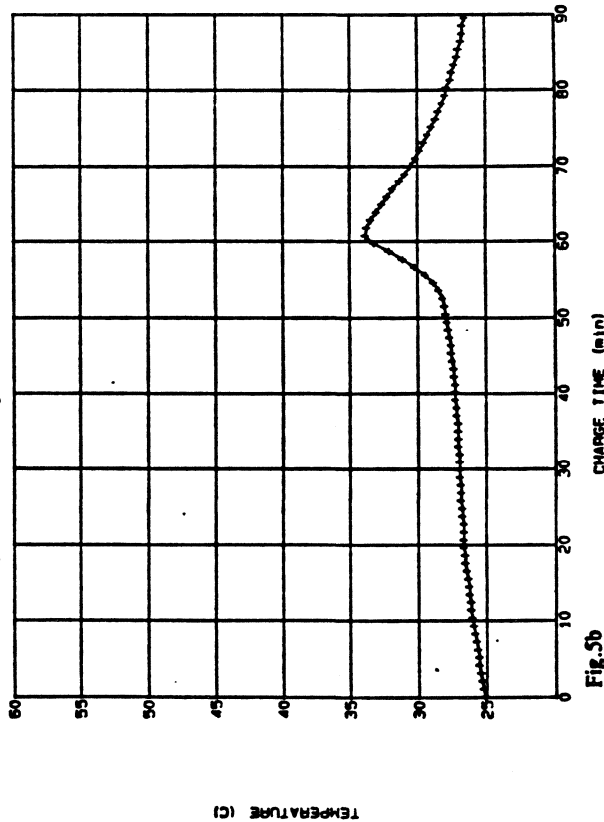
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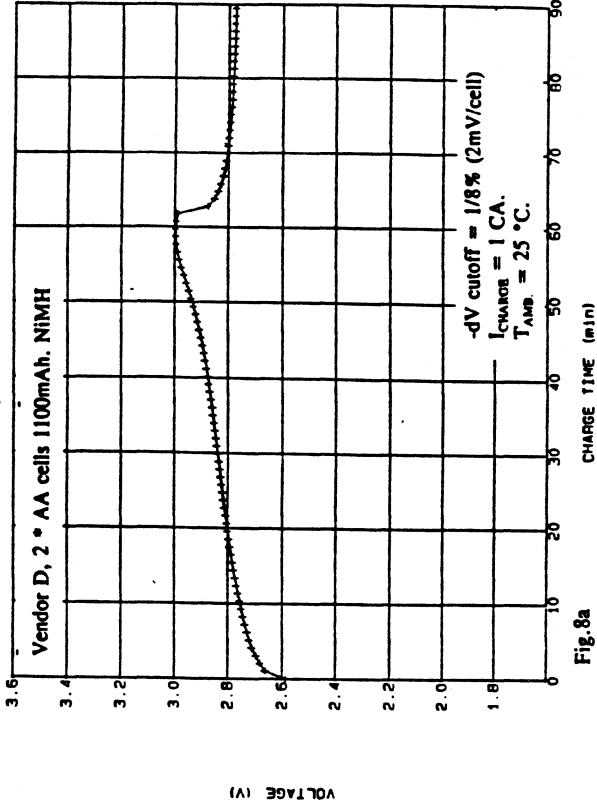


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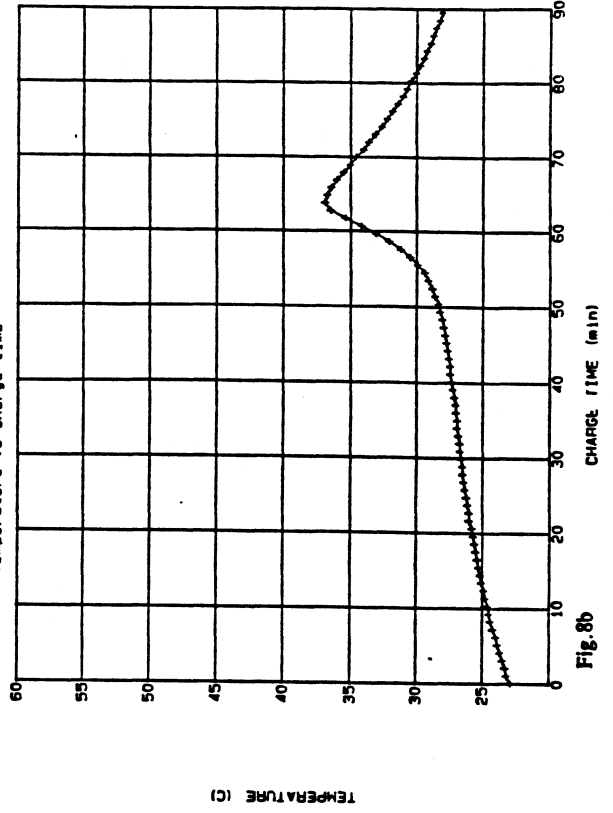




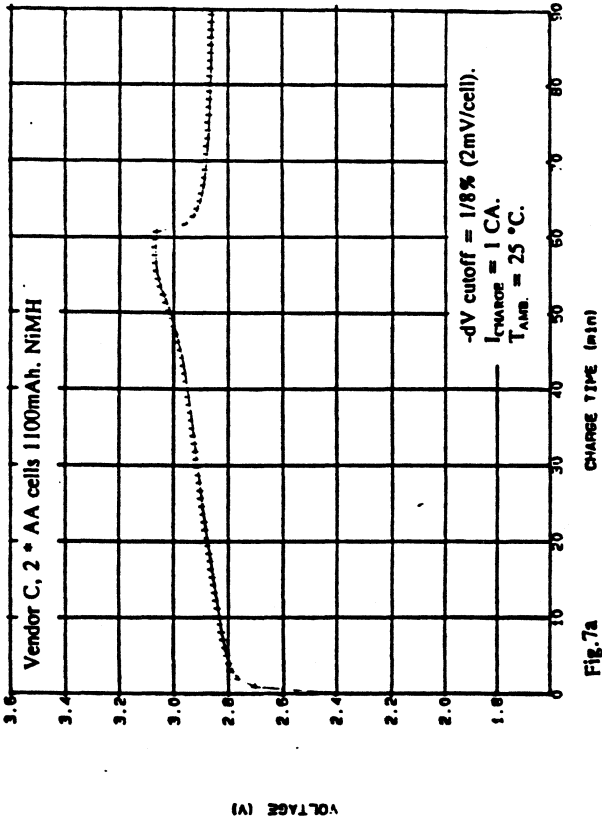
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Voltage vs Charge time



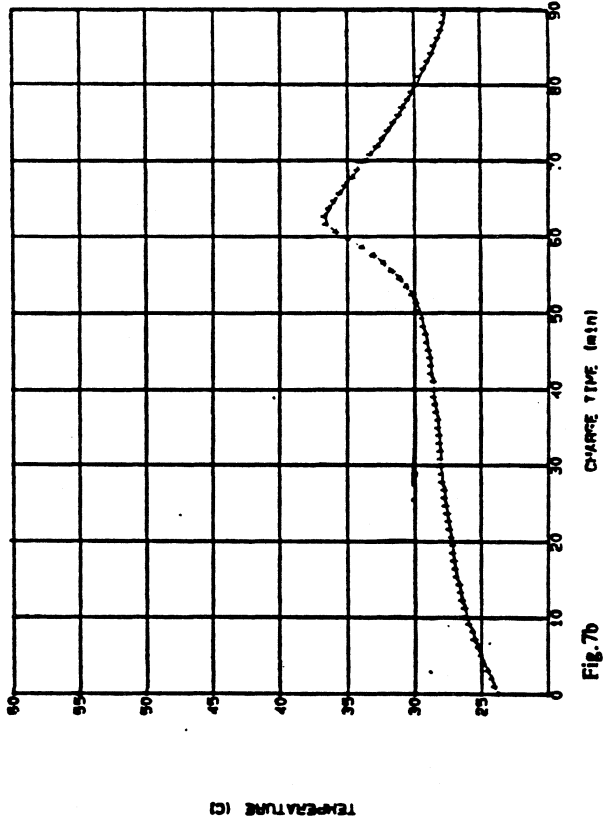
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Temperature vs Charge time



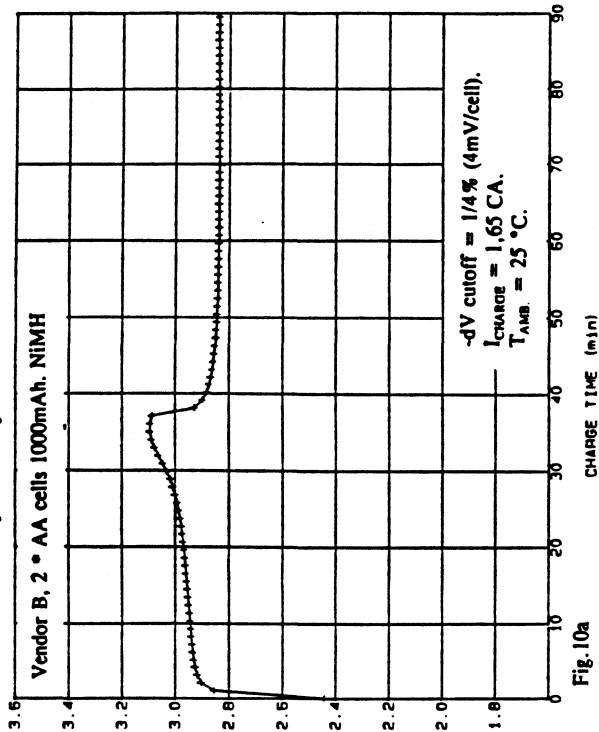
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Voltage vs Charge time



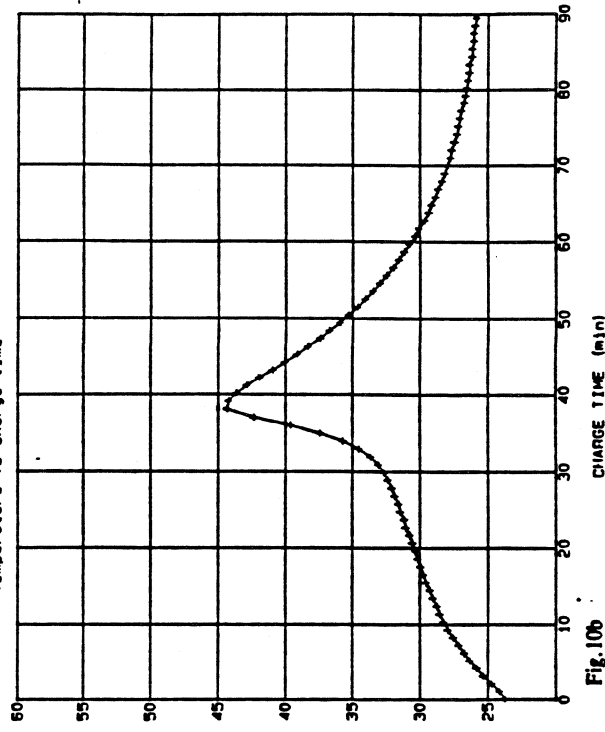
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Temperature vs Charge time



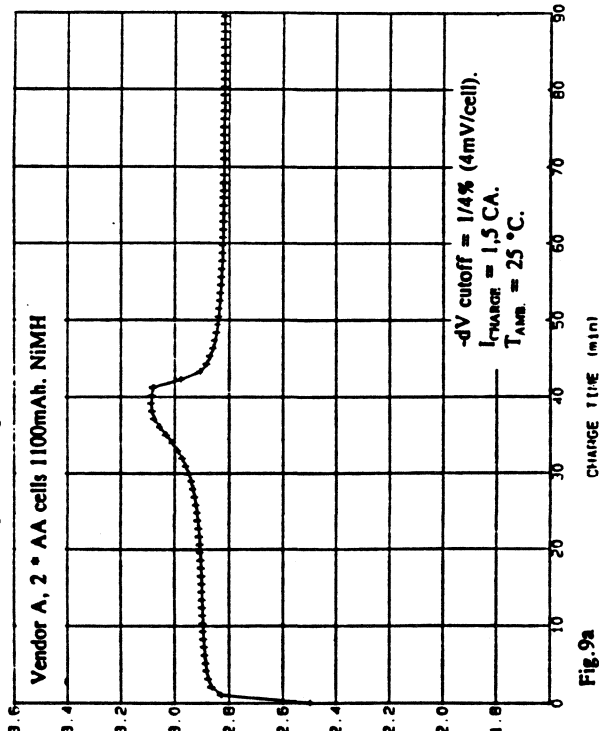
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DATE : 7-01-1993



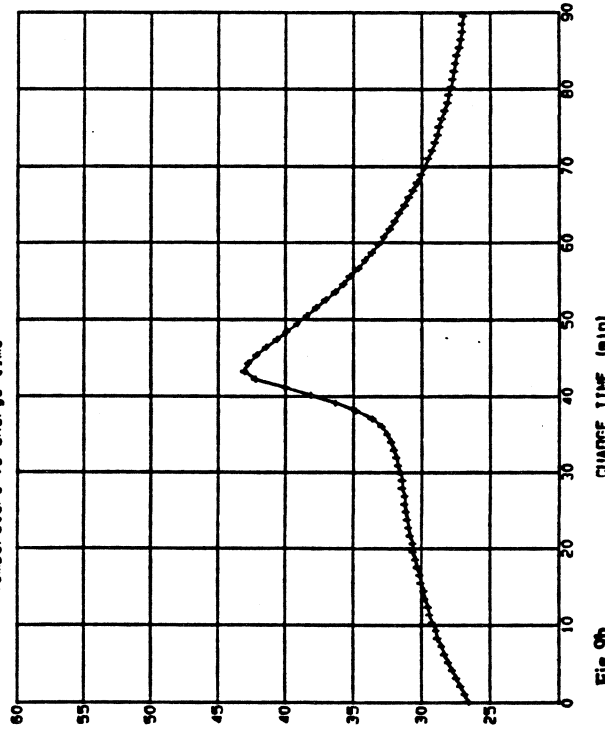
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DATE : 7-01-1993



TYPE : NIMH 1.1Ah  
DATE : 6-01-1993



TYPE : NIMH 1.1Ah  
DATE : 6-01-1993



TYPE : NiMH 1.1Ah  
DATE: 6-01-1993

Voltage vs Charge time

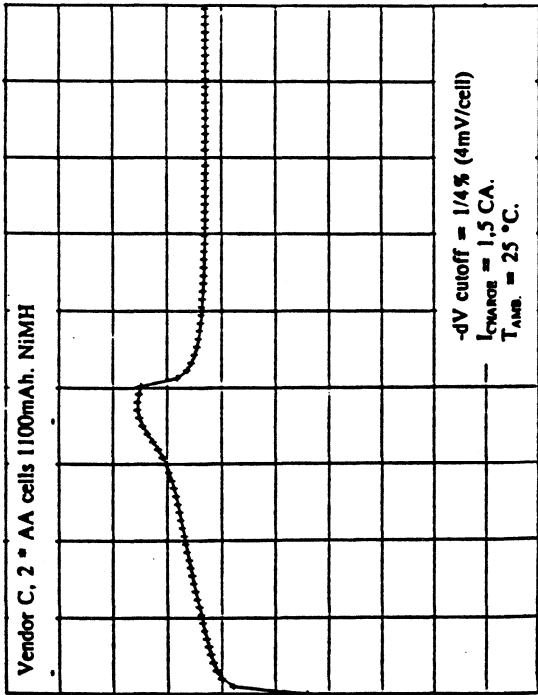


Fig. 11a

TYPE : NiMH 1.1Ah  
DATE: 6-01-1993

Voltage vs Charge time

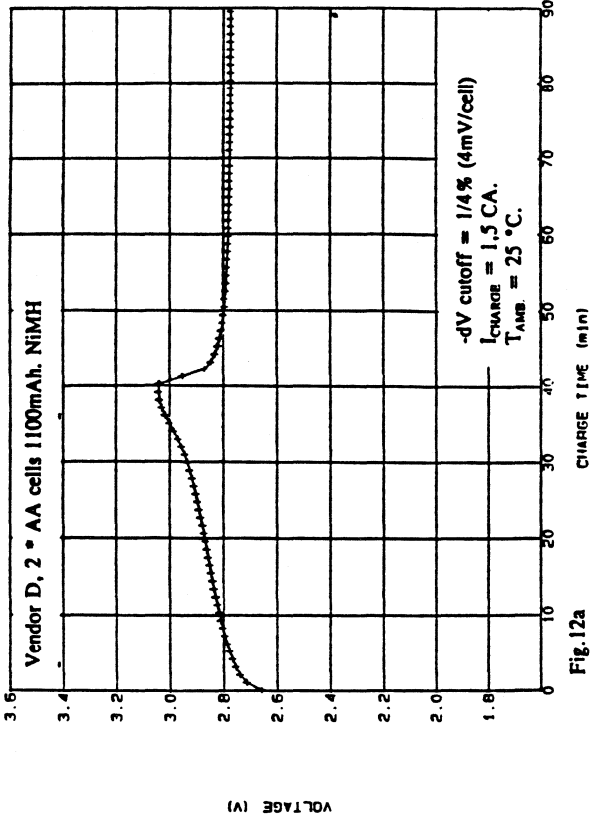


Fig. 12a

TYPE : NiMH 1.1Ah  
DATE: 6-01-1993

Temperature vs Charge time

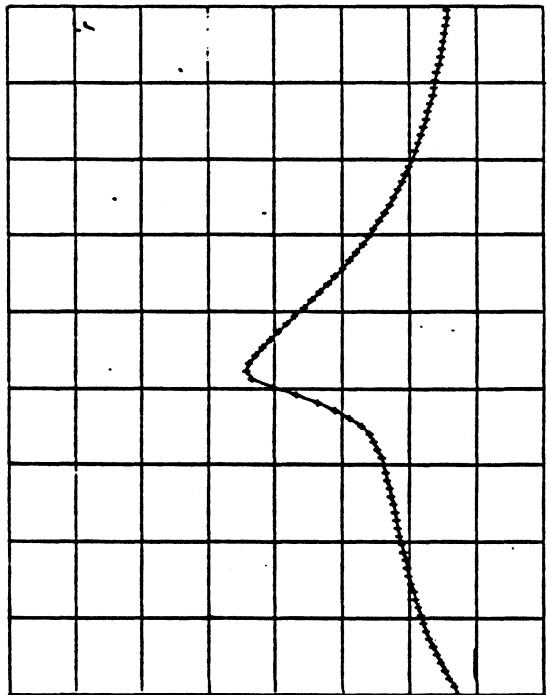


Fig. 11b

TYPE : NiMH 1.1Ah  
DATE: 6-01-1993

Temperature vs Charge time

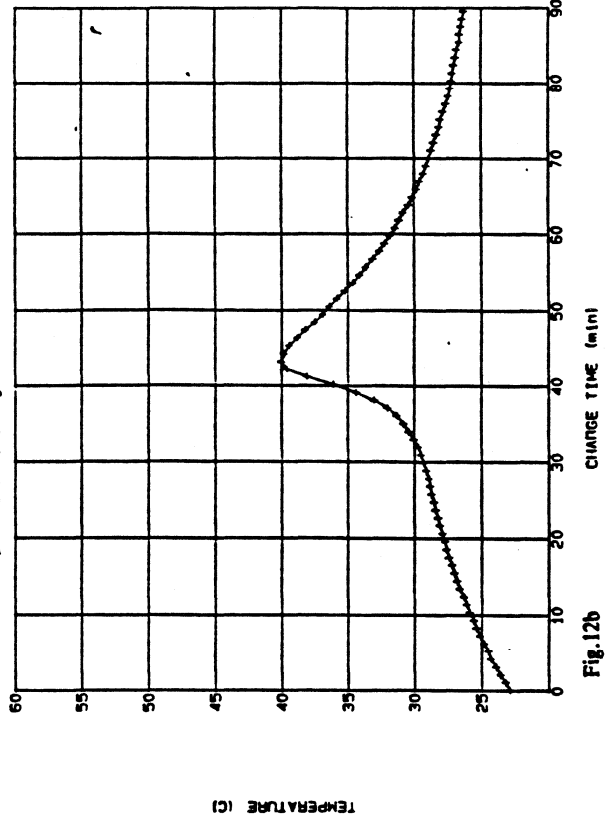
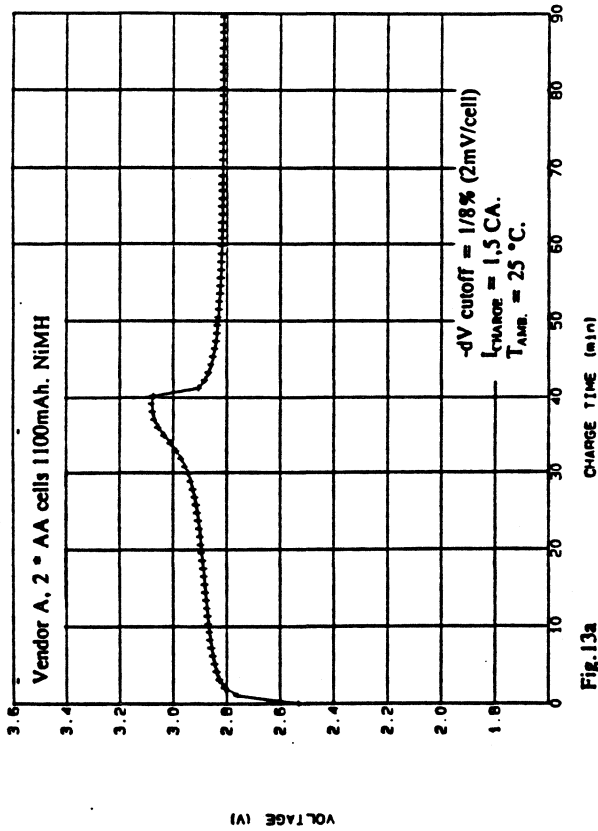


Fig. 12b

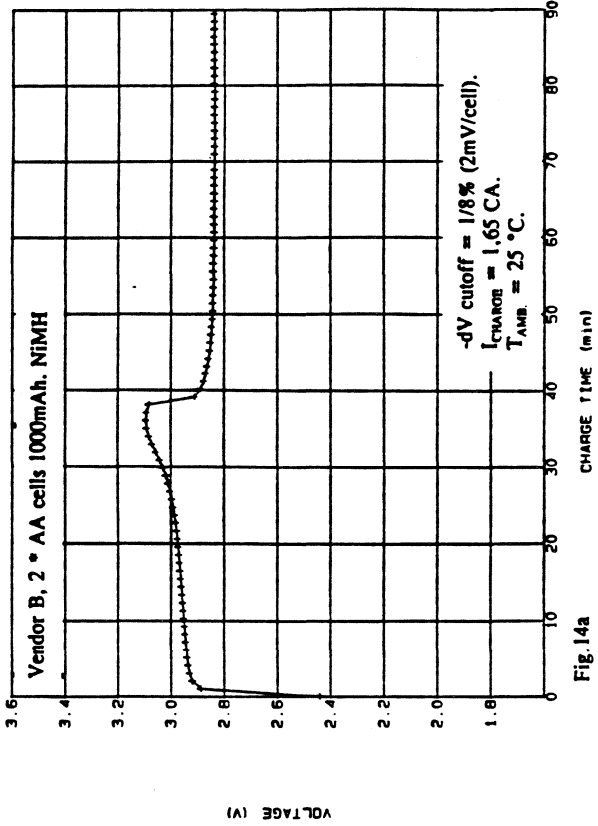
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Voltage vs Charge time



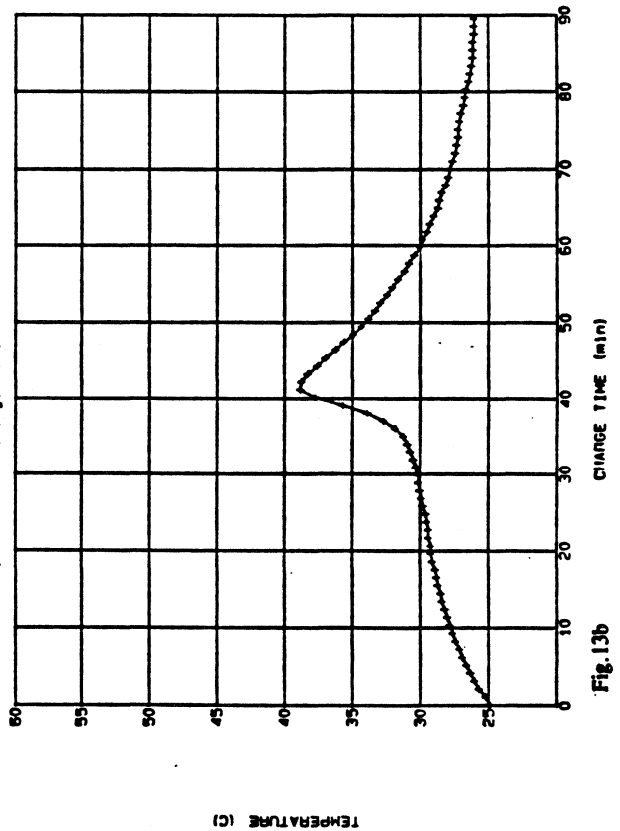
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DATE: 23-12-1992

Voltage vs Charge time



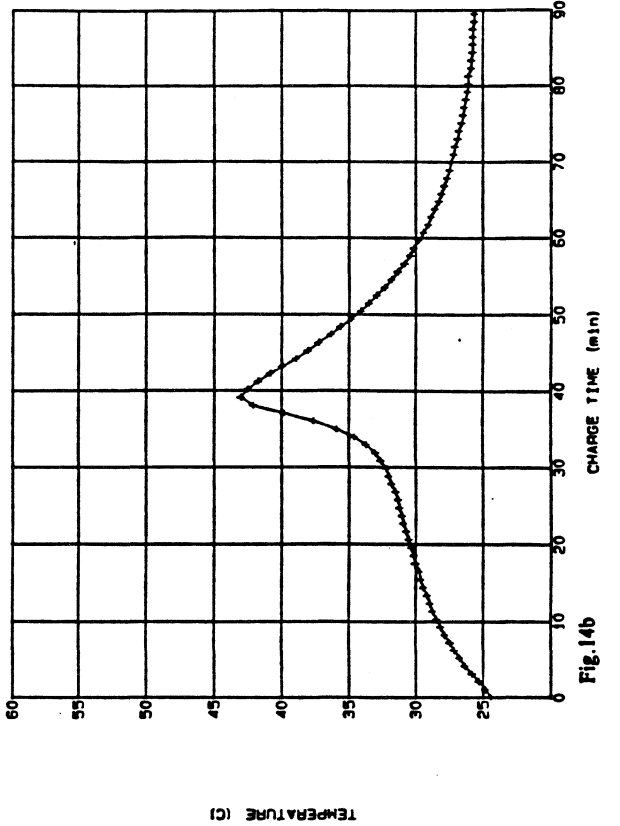
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DATE: 22-12-1992

Temperature vs Charge time

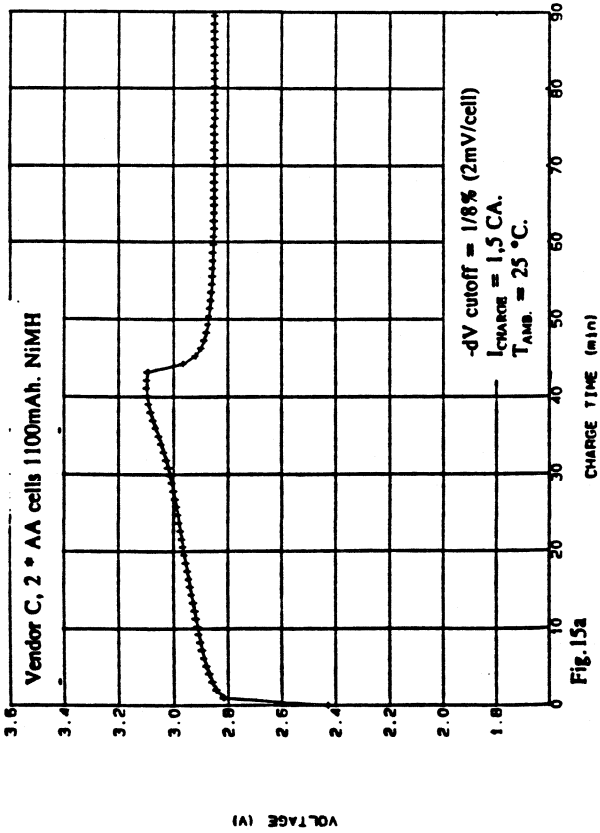


TYPE : NiMH 1.1Ah  
DATE: 23-12-1992

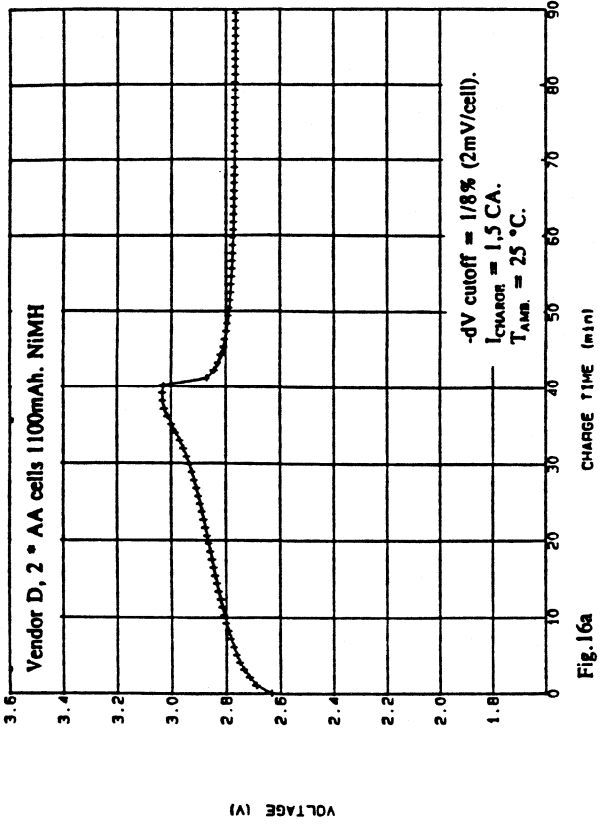
Temperature vs Charge time



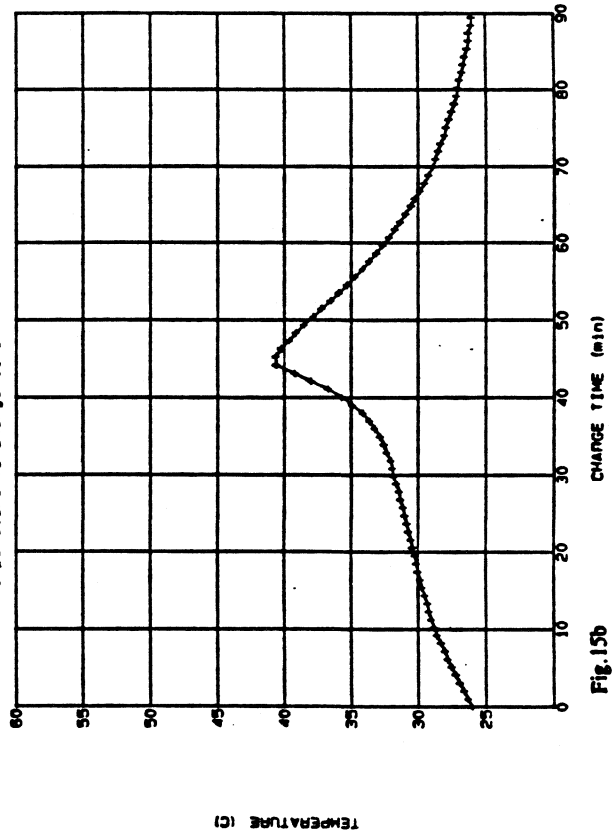
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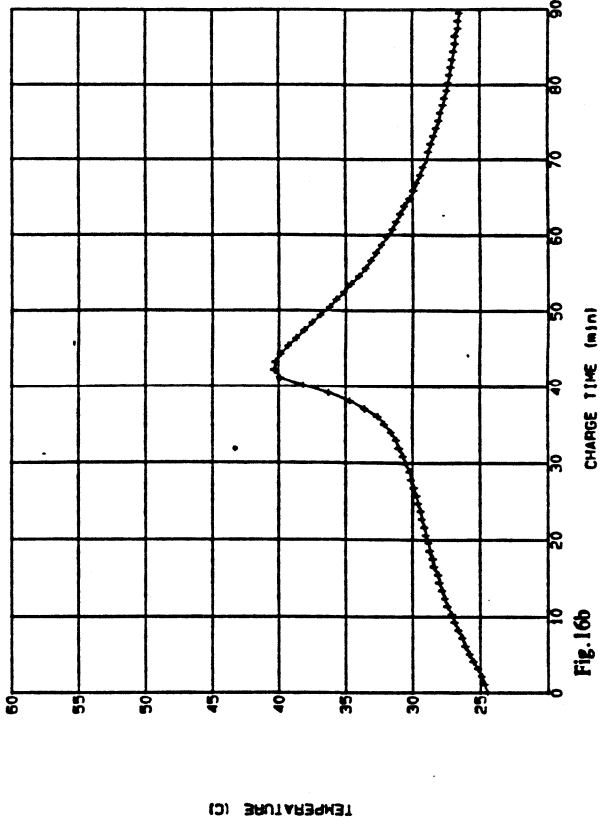
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DATE: 5-01-1993



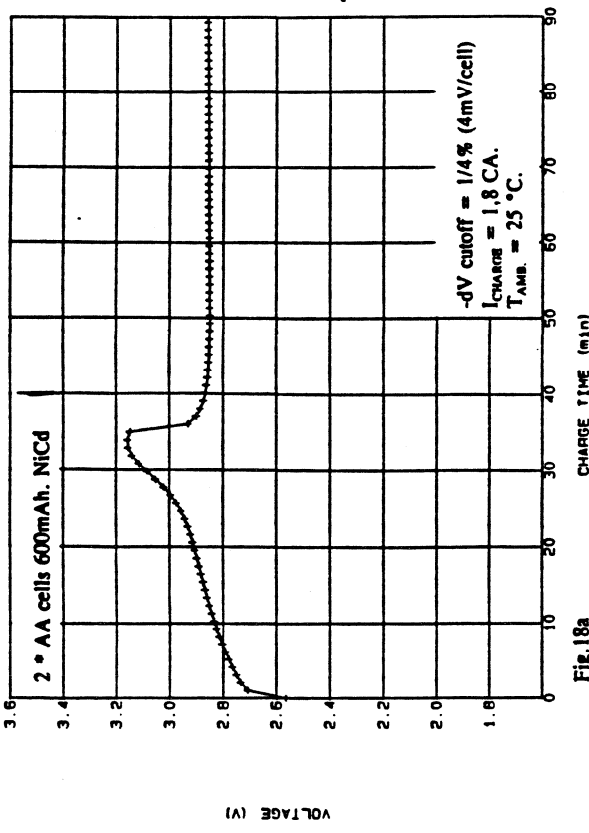
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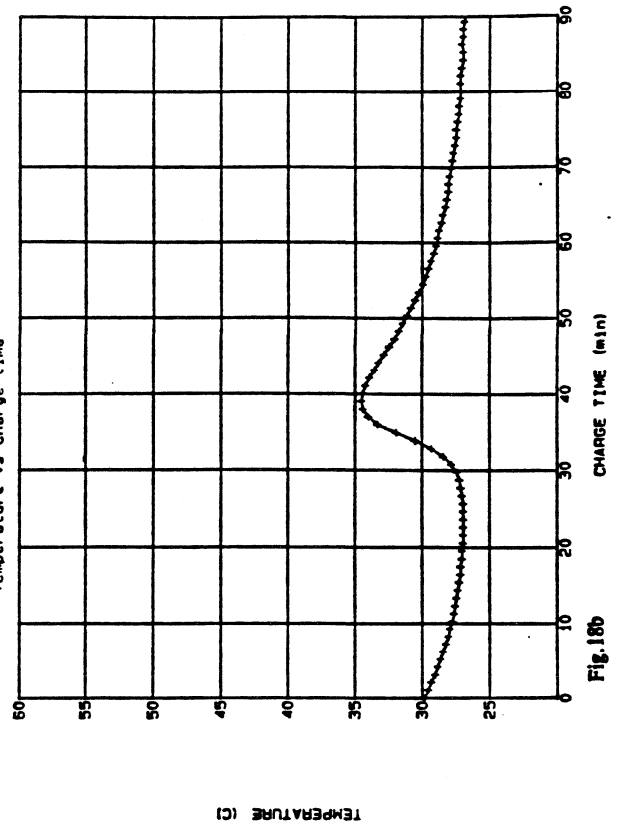
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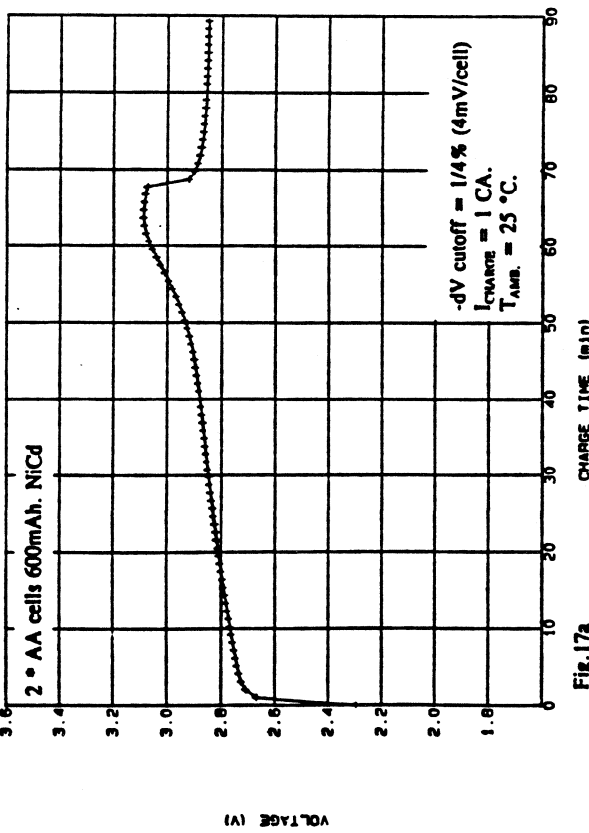
TYPE : NiCd 0.6Ah  
Voltage vs Charge time



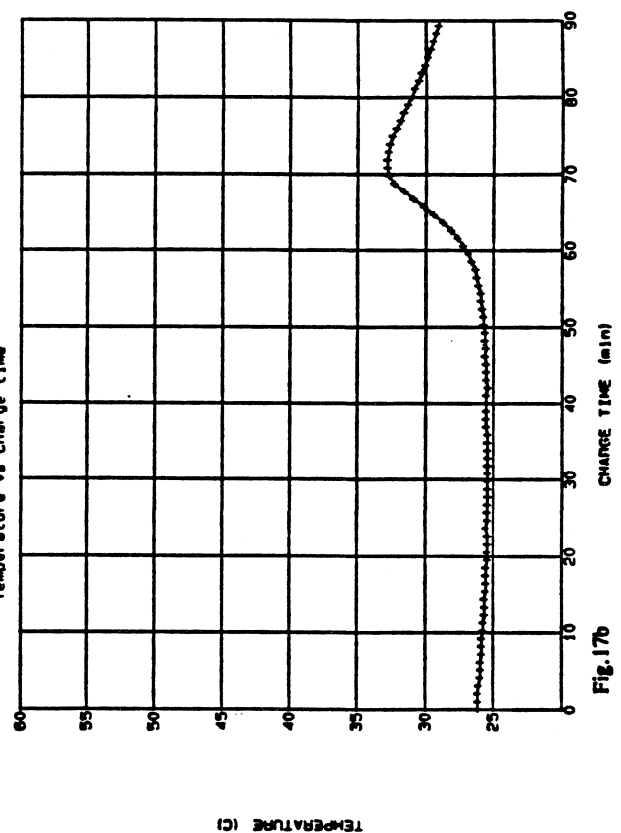
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Temperature vs Charge time



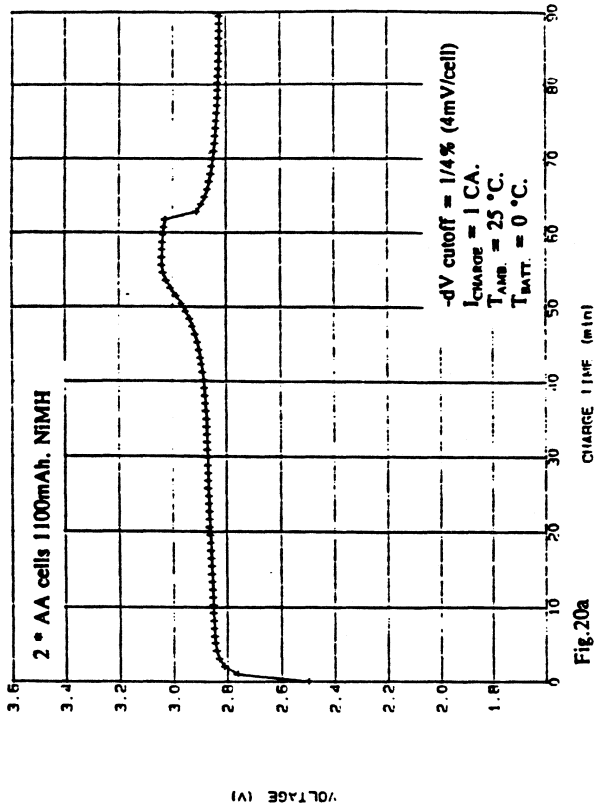
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Voltage vs Charge time



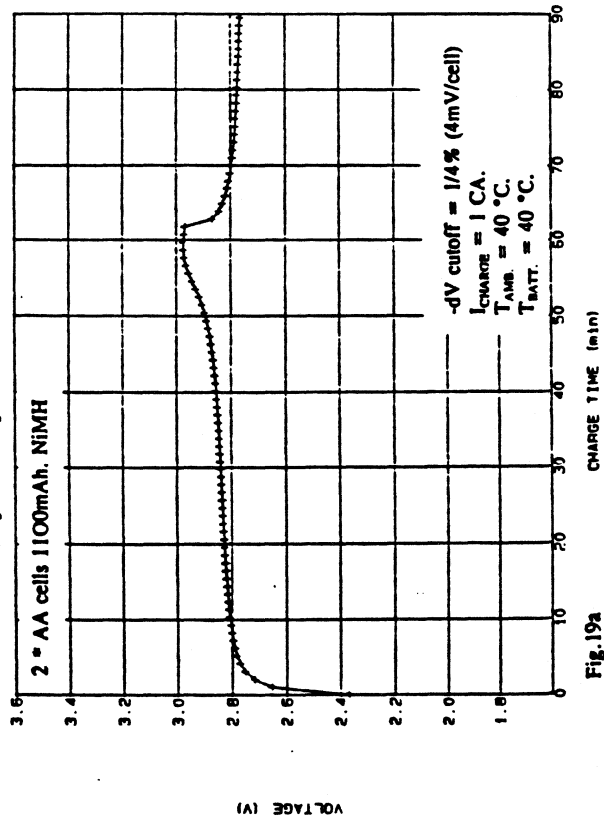
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Temperature vs Charge time



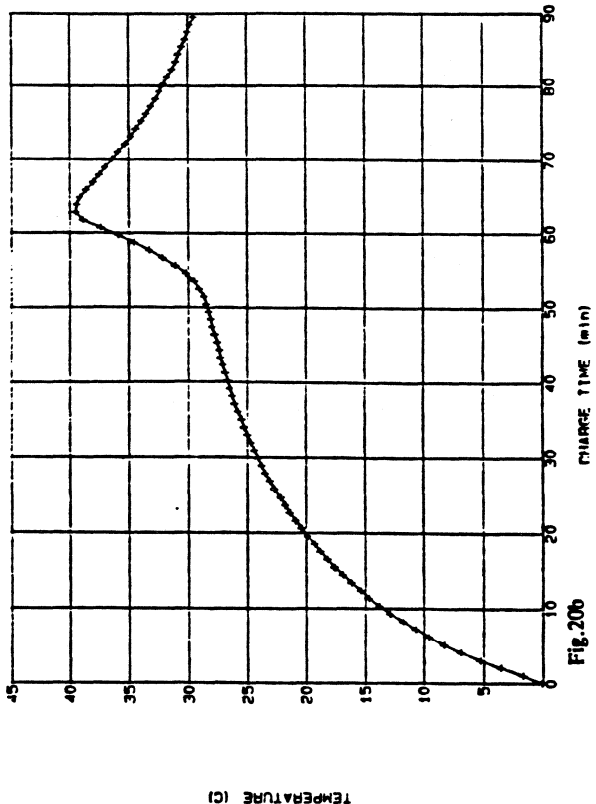
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Voltage vs Charge time



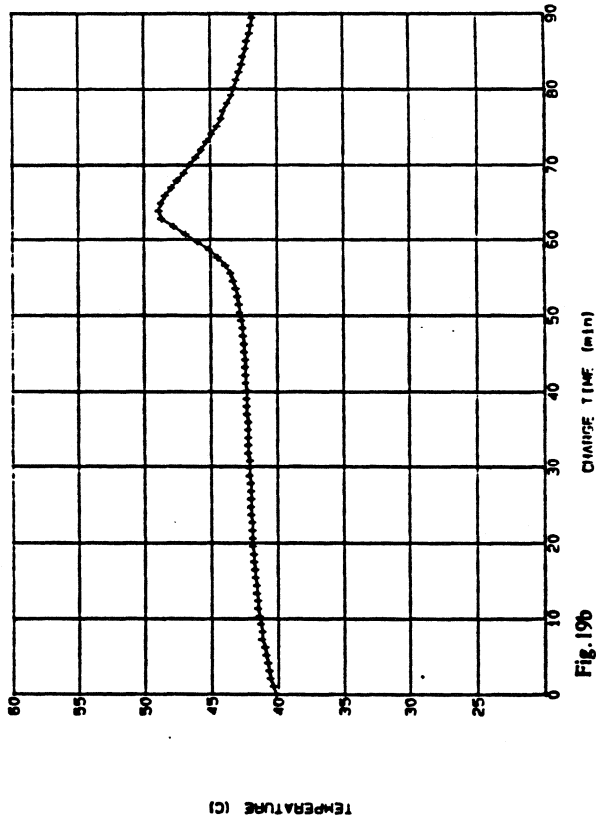
TYPE : NiMH 1.1Ah DATE: 11-01-1993  
Voltage vs Charge time



TYPE : NiMH 1.1Ah DATE: 12-01-1993  
Temperature vs Charge time



TYPE : NiMH 1.1Ah DATE: 11-01-1993  
Temperature vs Charge time



TYPE : NIMH 1.1Ah  
Voltage vs Charge time  
DATE: 14-01-1993

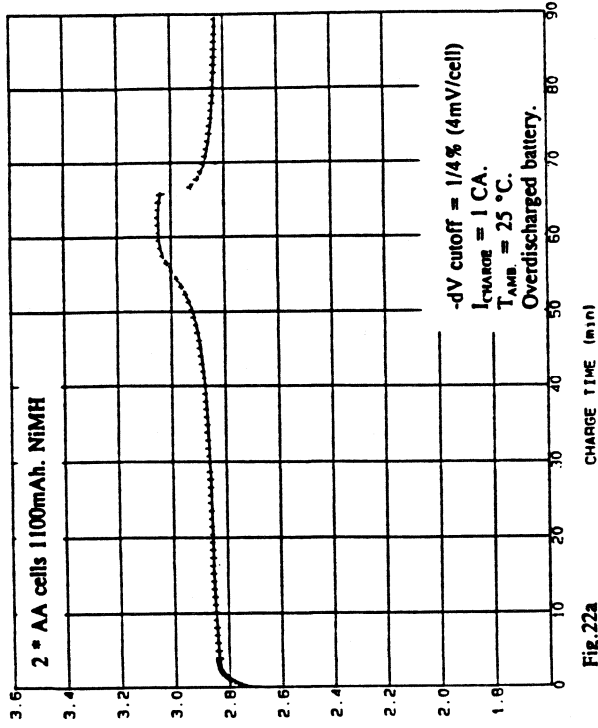


Fig.22a

TYPE : NIMH 1.1Ah  
Temperature vs Charge time  
DATE: 14-01-1993

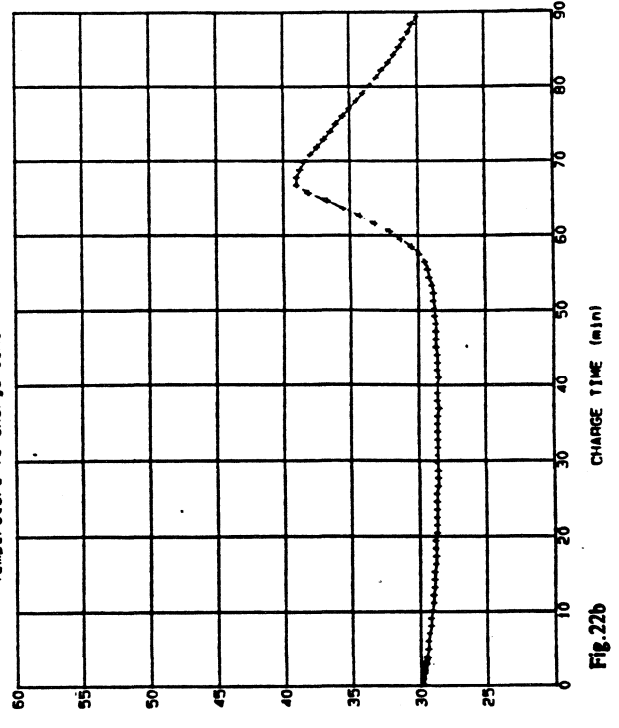


Fig.22b

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Voltage vs Charge time  
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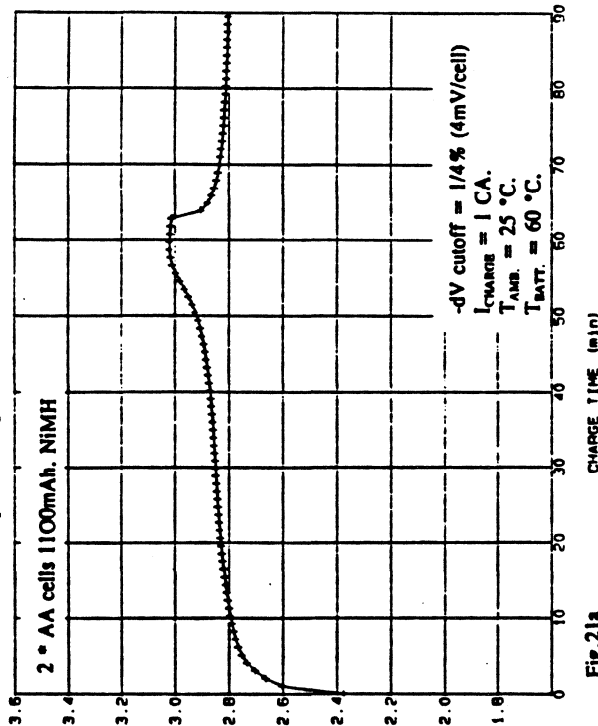


Fig.21a

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Temperature vs Charge time  
DATE: 11-01-1993

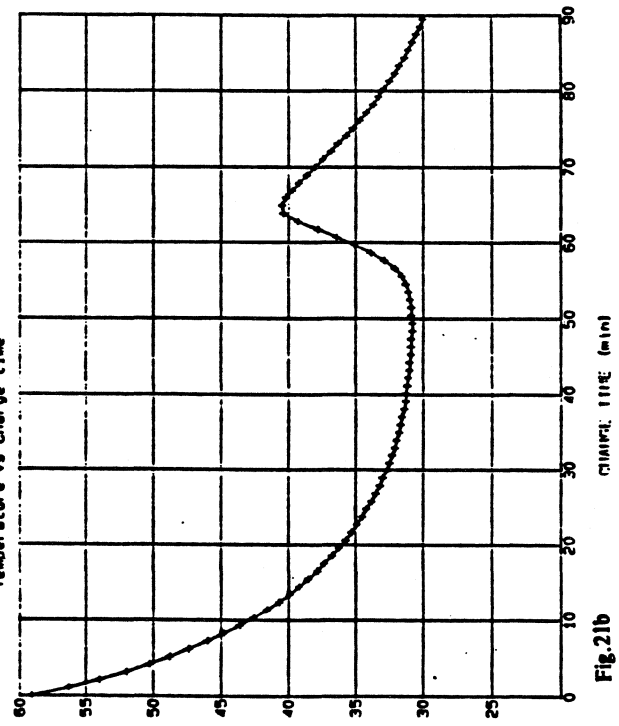


Fig.21b

VOLTAGE (V)

TEMPERATURE (C)

VOLTAGE (V)

TEMPERATURE (C)



TYPE: NiMH 1.1 Ah DATE: 14-01-1993

Voltage vs Charge time

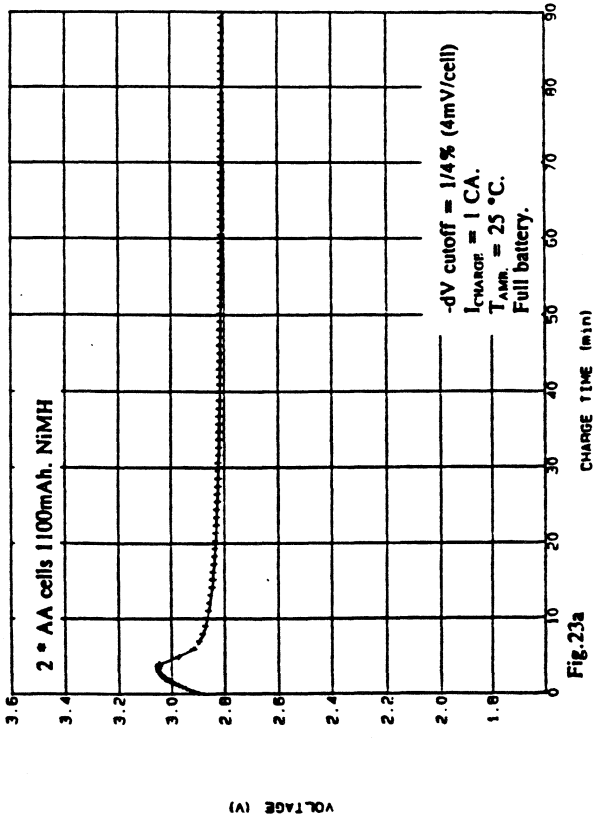


Fig.23a

TYPE: NiMH 1.1 Ah DATE: 14-01-1993

Temperature vs Charge time

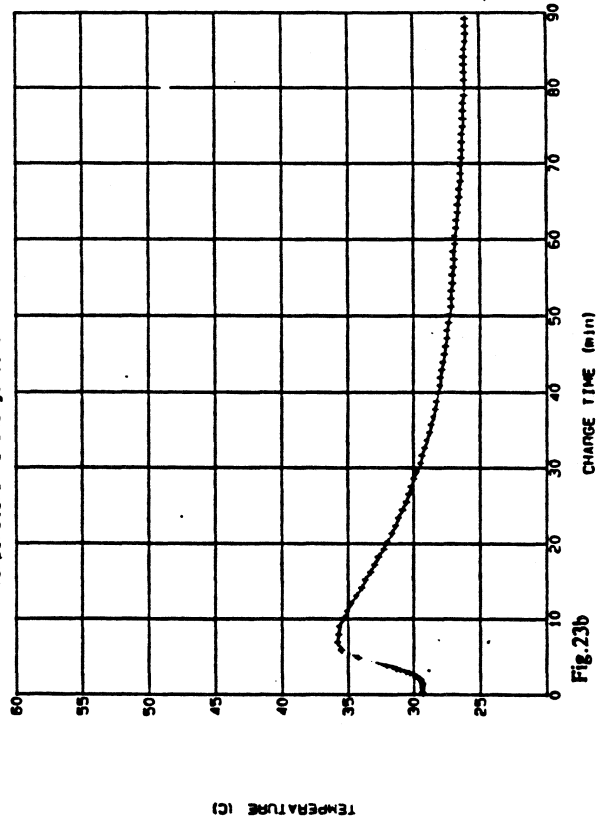


Fig.23b

VOLTAGE (V)

TEMPERATURE (C)