INSTALLATION

AND

CARE

OF

NICAD

STORAGE BATTERIES

MANUFACTURERS

NICKEL CADMIUM BATTERY CORPORATION
EASTHAMPTON, MASS.

Booklet 227
9th. Edition

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FILLING AND CHARGING

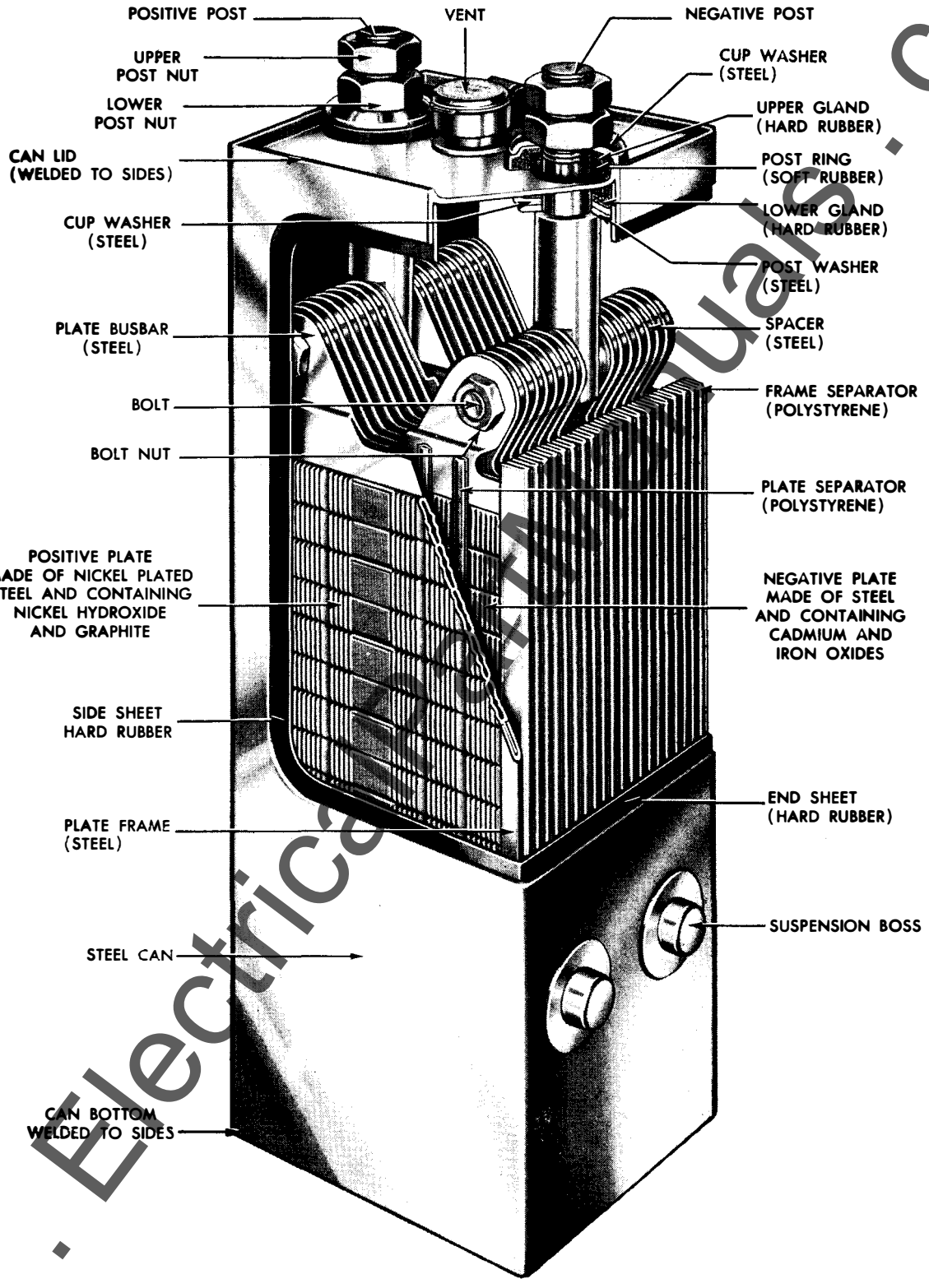
OF

NICAD

STORAGE BATTERIES

NICKEL CADMIUM BATTERY CORPORATION
EASTHAMPTON, MASS.
U. S. A.

Booklet 230
2nd Edition



CUT-AWAY VIEW OF NICAD CELL

ON ARRIVAL

Nicad Batteries are shipped to all points in continental U.S.A. filled with electrolyte of correct specific gravity, charged and ready for service.

On receipt unpack the battery immediately and examine it thoroughly for any damage caused during transportation. If necessary, claims should be entered at once with the carrier. Remove all packing material that may be adhering to the cells or the trays. Make sure that no small parts are thrown away, such as hydrometers and electrolyte level test tubes. Inter-tray connectors and jumpers will be found secured to the inside of the packing case.

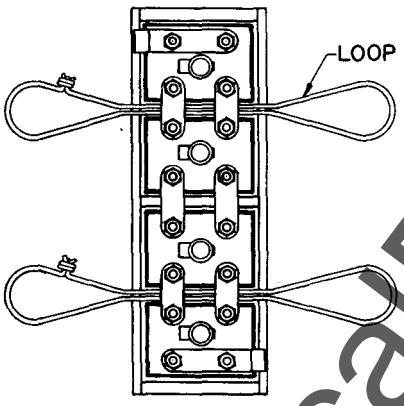


FIG. 1

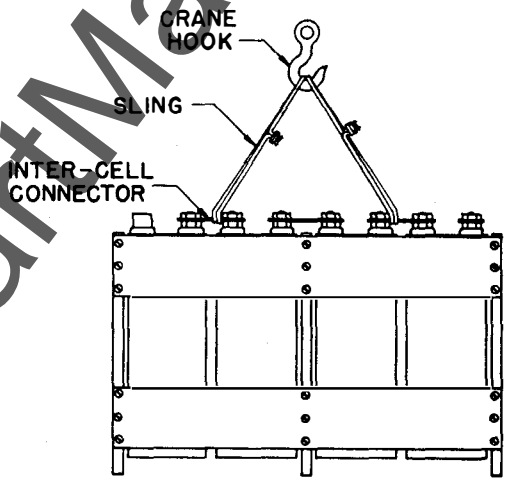


FIG. 2

Cotton rope slings are packed with large batteries. To lift the trays pass the slings under the connectors between the cell posts, NOT around or under the trays. Do not use metal slings or chains as they will short-circuit and damage the cells.

Remove the wooden shipping plugs from the cell vents immediately on arrival, regardless of whether the battery is to be used or stored.

Close the vent caps and discard the plugs. Do not leave the caps open.

The electrolyte level of every one of the cells should be checked individually. The level should be of the same height in all the cells and at least $\frac{1}{2}$" above the tops of the plates.

Some slight variation in the specific gravity may be found between individual cells. These variations should be disregarded as they will disappear on charging the battery.

Extensive yellow stains on the packing material indicate that Electrolyte has been spilled in transit and this should be replaced immediately with ReFill Electrolyte of 1.180 specific gravity if available.

If ReFill Electrolyte is not available, add enough water to cover the plates and procure Nicad ReNewal Electrolyte of 1.200 specific gravity from Nickel Cadmium Battery Corporation. On its arrival empty out all the old electrolyte and fill the cells with ReNewal Electrolyte to the maximum level, that is halfway between the tops of the plates and the top of cell container.

If the battery is not placed in service within 90 days it should either be put on continuous trickle charge at 1.40 volts per cell, or given a freshening charge at approximately the normal charge rate for three hours once each 90 days until it is put in service.

Nicad batteries can be taken out of service in any state of charge and left idle for long periods of time without fear of deterioration.

New Nicad batteries can be stored indefinitely without attention if they are shipped dry. The electrolyte is then shipped separately.

Once the cells have been filled with electrolyte, they should be charged and put into service immediately.

For the filling and charging of Export batteries, which are always shipped "dry," that is discharged and empty of electrolyte, see Nicad Booklet No. 230, regularly packed with all Export shipments.

Every Nicad cell is stamped on the top with a Manufacturing serial number and a Cell type number. Both numbers must always be quoted in all correspondence for the purpose of identification at the factory.

INSTALLING THE BATTERY

Place the battery in a dry, clean room and in such position that it can be easily inspected and watered.

Avoid placing the battery in a very hot room or where it will be exposed to corrosive gases or fumes.

Unless the ventilation is ample do not install the Nicad battery near Lead Acid batteries.

Batteries on mobile equipment, such as vehicles or ships, must be securely fastened in place.

All battery rooms and compartments must have ample ventilation and drainage and at the same time keep out cinders, road dirt, soot, dust, rain, snow and sea water.

Accumulations of dirt and moisture on top of and particularly between the cells will cause corrosion and leakage of cell containers.

Any holes or gratings which permit ready entry of dust, water, etc., must therefore be closed up. Four small drainage holes should, however, be provided in the bottom, one at each corner of the compartment.

Compartments which have previously housed Lead Acid batteries, must be washed out, neutralized with ammonia or washing soda solution, allowed to dry thoroughly and then painted with asphalt paint. Wood liners, should be removed and, if required with the Nicad battery, replaced by new ones.

Ample space should be provided above the battery for inserting the electrolyte level test tube and the hydrometer into the cells.

If the battery is top loaded, that is installed in the battery compartment from the top, and access to the battery is by means of a removable or hinged cover a minimum clearance of 2" (50mm) should be allowed between the top of the battery and the underside of the cover.

If the battery is side loaded the clearance between the battery and the ceiling of the battery compartment should be at least 8" (200 mm).

Small stationary batteries may be placed directly on a clean, dry floor or on a suitable wall shelf. Larger batteries should be placed on racks. Racks of suitable construction are furnished by Nickel Cadmium Battery Corporation and the advice of its Service Department is freely available concerning any proposed installation.

Trays with extended ends for instance are available. These permit the battery to be placed on the floor as they provide several inches of clearance between the cell containers and the floor.

BATTERY RACK
SINGLE TIER

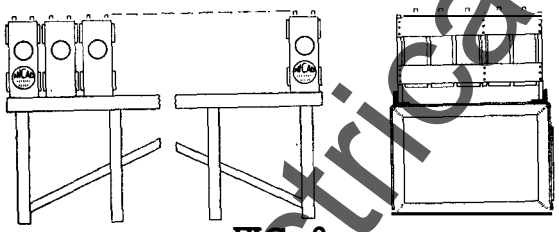


FIG. 3

BATTERY RACK
DOUBLE TIER

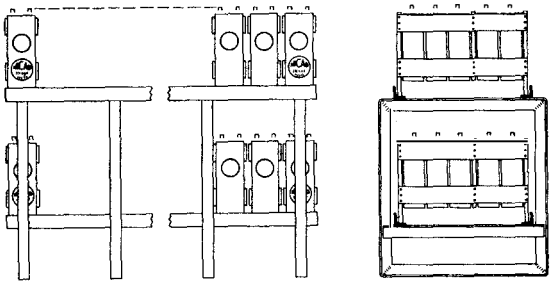


FIG. 4

BATTERY RACK
TWO STEP, 2-ROW

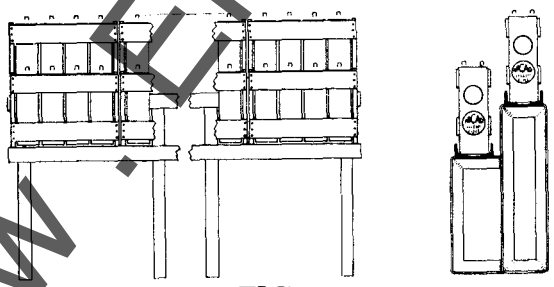


FIG. 5

SHOWING STEEL RACKS
AVAILABLE FOR
NICAD BATTERIES

Check the electrolyte level and the specific gravity and be sure that the battery is thoroughly clean and dry before placing it in position.

No material or object should ever be placed or allowed to lodge in the open spaces between or underneath the cells. These air gaps serve as electrical insulation between the cells and are therefore an essential part of the design of the battery. For this reason they must be maintained open, clean and unobstructed at all times.

The cell containers must not be grounded and the bottoms of the cells must therefore never be allowed to rest on any object. Battery trays should never be stacked directly on top of one another, for instance, nor should water or spilled electrolyte be allowed to lodge under the battery.

All cables leading to the battery posts should be fitted with and properly soldered to cable lugs. Solderless or bare copper connectors are not recommended.

All wiring to the battery should be properly spaced and firmly secured to prevent any chance of a short-circuit.

No wires or cables should ever be allowed to rest on top of the cells.

Never connect any device or instrument to the battery that would constitute an unnecessary constant drain, however small, as it would ultimately discharge the battery completely if the battery should be left standing on open circuit at any time. Voltmeters, for instance, should only be connected to the battery by means of a normally-open push button switch.

Most storage batteries are connected to form a single series of cells. Where the battery consists of more than one tray, be sure that the Negative end terminal of each tray is connected to the Positive end terminal of the following tray. Cells wrongly connected in circuit will receive a reverse charge and will be damaged if the condition is allowed to continue.

If the battery has been stored for some time give it a freshening charge before putting it into service.

On completing the installation make sure that no loose objects such as screws or tools have accidentally been left in the battery compartment.

Tighten all cell post nuts. Loose electrical connections will heat up and may cause sparking.

Verify that every person who is going to take care of the battery has a copy of this booklet. Further copies may be obtained free of charge.

Mount the Instruction Card accompanying the battery in a conspicuous position for future reference. Do not mount the card on the battery itself.

CHARGING

The Positive terminal post of every cell is indicated by a + mark on the cell container. When charging always connect the Positive terminal of the battery to the Positive lead from the current source. Only Direct Current (D.C.) can be used for charging storage batteries. If only Alternating Current (A.C.) is available a rectifier or a motor generator is necessary to convert the Alternating to Direct Current. Nickel Cadmium Battery Corporation will be glad to suggest suitable equipment.

A reasonable amount of overcharging, particularly at low or trickle charge rates, has a beneficial effect on Nicad batteries and when in doubt at any time as to the state of charge it is therefore always advisable to overcharge rather than to undercharge. When in doubt always overcharge!

The "Open Circuit" voltage is the voltage of a storage battery cell when standing idle; i. e., when the cell is neither on charge nor on discharge. It is a characteristic of all types of storage batteries that, provided the cell has been standing idle for a sufficiently long time, the open circuit voltage is independent of the state of charge of the cell and can therefore not be used to measure the state of charge of a battery.

The open circuit voltage of a Nicad cell is approx. 1.30 volts.

Nicad batteries possess the characteristic common to all storage batteries that their voltage rises throughout the charge. Hence when the battery voltage ceases to rise and the charge current remains steady it is an indication that the battery is fully charged. The actual voltage of a fully charged battery still on charge will depend on the magnitude of the charge current; the heavier the charge current the higher the battery voltage.

Several methods of charging batteries are described on pages 7 and 8.

CHARGING ENGINE STARTING BATTERIES

The Generator voltage regulator should be set so as to hold the battery voltage between 1.45 and 1.50 volts per cell. Readings should be taken at the battery terminal posts with the voltage regulator at proper working temperature, with its cover in place, and only after the battery voltage has ceased to rise.

If the engine is started infrequently, as in emergency-standby services, and depends on an automotive type generator for re-charging the battery or if the engine is operated only for very short periods at a time (insufficient to keep the battery in a fully charged condition), it is recommended that the battery after being fully charged be put on constant trickle charge, preferably from a metal oxide rectifier, and at a voltage equal to 1.40 to 1.45 times the number of cells in the battery. At the above charge voltage the battery will be found to require watering about every 6 to 9 months.

TRICKLE CHARGING OR FLOATING

Fully charged batteries floated across the line should be charged at a voltage equal to 1.40 times the number of cells in the battery. Where the discharges, although momentary, are relatively heavy and frequent the voltage should be raised to 1.45 times the number of cells in the battery in order to ensure that the total input will exceed the total output over a period of time as otherwise the battery will become slowly discharged and will consequently require so-called equalization or over-charges from time to time to bring it back to a fully charged condition.

The battery voltages recommended above will hold the individual cell voltages below 1.47 volts, the voltage at which the cells will begin to gas and hence to consume water. Slight variations in voltage between the individual cells of a battery on float should be disregarded as they are of no importance. One of the most valuable features of the Nicad battery is that its floating voltage is not critical, provided of course that it is high enough to compensate for the loads imposed on the battery from time to time. Floating at voltages even above 1.47 volts per cell will not harm the battery in any way but its water consumption will be increased and consequently the amount of attention required.

Trickle charging, in practice, cannot be used as a substitute for charging at normal or near-normal rates on account of the very long time that would be required to charge the battery fully and is therefore used only to keep already fully charged batteries in a fully charged condition.

Trickle chargers should be equipped with a variable resistance and a voltmeter of suitable range and accuracy.

Nickel Cadmium Battery Corporation will gladly furnish information on suitable Metal Oxide Rectifiers for trickle and high rate charging of Nicad batteries.

CONSTANT CURRENT CHARGING

This method consists of charging at a constant current, not for a definite length of time or to a definite end voltage, but until the battery voltage ceases to rise, indicating that the battery is fully charged.

The length of time required to charge the battery by this method will therefore depend on the magnitude of the charge current and the state of charge of the battery at the time it is put on charge.

It is usual to insert a variable resistance of suitable size between the line and the battery and to adjust the resistance from time to time by hand during the charge so as to hold the charge current reasonably constant.

An initial line voltage of 1.40 volts per cell is necessary at the beginning of the charge and a final line voltage of 1.85 volts per cell should be provided for. In theory practically any rate of charge may be employed, provided that the electrolyte temperature, which is the sole limiting factor, is not allowed to exceed 145°F (60°C).

Too high a charge current, however, particularly if the electrolyte specific gravity is outside the permissible limits of 1.160-1.200 may cause the electrolyte to froth and to be forced out of the vents.

When charged by the Constant Current method and the normal (7-hour) charge current Nicad batteries will commence to gas only after about 4½ hours have elapsed, that is when the battery voltage has risen to about 1.47 volts per cell.

If a period of more than 7 hours between discharges is available, it is therefore always advisable to charge at a lower rate than the normal as this will reduce power costs and gassing and consequently the amount of water required by the battery from time to time. As an example a 100 ampere-hour battery has a "normal" charge rate of 20 amps. (for 7 hours), but may conveniently be charged at, say, 14 amps. for 10 hours or 10 amps. for 14 hours. The specific gravity of the electrolyte remains practically constant during charge and discharge and there is therefore no necessity to take specific gravity readings.

ASCERTAINING STATE OF CHARGE

Open circuit voltage readings, that is, when no current is passing into or being delivered by the battery, can NOT be used as an indication as to the state of charge of any storage battery.

The density of the electrolyte of the Nicad battery does not change appreciably on charge or discharge and specific gravity measurements therefore do NOT indicate its state of charge at any time.

To determine the state of charge it becomes necessary to take simultaneous current and voltage readings.

There are several ways of doing this and for services where it is necessary frequently to ascertain the state of charge some satisfactory method can generally be worked out.

For certain applications involving heavy rate discharges of short duration, such as switch tripping, it has been found advantageous, for instance, to install permanently by the battery a voltmeter and a fixed resistance forming an artificial load equal in value to the normal load. Voltage readings obtained while the battery is connected momentarily to the artificial load indicate the ability of the battery to carry the normal load.

The Nicad Service Department will be glad to furnish information regarding methods and equipment.

DISCHARGING

Heavy discharges of short duration (as used for engine starting for instance) will not damage the Nicad battery.

Do not, however, discharge the battery below 1.10 volts per cell at rates from 8 to 10 hours, or below 1.20 volts per cell at lower current rates. Overdischarging, that is, discharges regularly continued below these end voltages will damage the battery and is an indication that the battery is too small for its work.

MAINTENANCE

Keep the cells and their trays dry and clean externally at all times. Moisture and dirt allowed to accumulate on top of and particularly between the cells will permit stray currents to circulate between the cells. This condition will cause corrosion through electrolysis of the cell containers.

For this reason any water or electrolyte spilled on the cells or the trays must be wiped off. Use compressed air, or better still, low pressure steam to clean the cells and the trays. Do not allow any dirt to enter through the vents when cleaning the cells. After cleaning re-grease the cell tops with petroleum jelly. This will protect the metal.

Keep all vent caps closed. In order to prevent air from entering the cells raise the caps only to check the electrolyte, never for charging.

Always check and service only one cell at a time.

Never place or drop any metal articles, such as post nuts, cable lugs or tools, on or between the cells. These will cause heavy short circuits which may damage the cell containers.

Never approach any storage battery with an open flame, such as a lighted match, as the gas given off on charge by all storage batteries is an explosive mixture of hydrogen and oxygen.

Use A Flashlight To Examine The Battery.

Never allow sparking to take place near any storage battery.

Keep all connections tight.

Use only spirit thermometers, obtainable from Nickel Cadmium Battery Corporation, when taking temperature readings.

Ordinary mercury thermometers introduced into a storage battery cell may break, in which case the mercury running down into the cell and in between its plates will cause sparking and explosions.

Always keep the plates covered with electrolyte. Serious damage will be caused by exposing the tops of the plates to the air. If electrolyte has been spilled from the battery, proceed as described on p. 4.

All tools and accessories for the proper maintenance and operation of Nicad batteries can be procured from the Nickel Cadmium Battery Corporation, Easthampton, Mass. See p. 20.

DAMAGE FROM IMPURITIES

Impurities of all kinds must be kept out of the cells as they have a harmful effect and will eventually ruin the battery.

Even minute amounts of Sulfuric Acid, for instance, will irretrievably wreck a Nicad battery by attacking and corroding its steel plates and cell containers. To prevent contamination never use any tools or utensils such as hydrometers, funnels, rubber hose, battery fillers, etc., which have been used at any time for servicing Lead Acid batteries.

Any vegetable oil or grease accidentally introduced into the cells will cause them to froth on charge.

ELECTROLYTE

The electrolyte (the "solution") in Nicad batteries is alkaline and consists of specially purified Caustic Potash (KOH, Potassium Hydroxide) dissolved in distilled water, NOT SULFURIC ACID as used in Lead batteries.

The specific gravity of its electrolyte does not change with the state of charge of the Nicad battery but remains practically constant on charge and discharge.

The electrolyte will begin to freeze and form a slush at about minus 20°F. This, however, will not damage the battery.

The use of any other electrolyte than that furnished by Nickel Cadmium Battery Corporation will damage the Nicad Battery. Ordinary commercial grades of Caustic Potash, for instance, should never be used as they are not sufficiently pure.

ReFill Electrolyte of 1.180 specific gravity and ReNewal Electrolyte of 1.200 specific gravity are available in drums holding 5, 10, 15, 20 and 130 lbs.

The drums are provided with two plugs. When using the drums remove both plugs. This will permit air to enter the drum and allow the liquid to run out in an even stream. Use an enamelware or glass pitcher and a funnel made of enamelware or glass for filling cells with electrolyte or water. Earthenware, hard rubber and plastic utensils are also suitable.

ReFill Electrolyte is used to replace electrolyte accidentally lost in transit or other ise, while ReNewal Electrolyte is used when changing the electrolyte, as described on p. 17.

If electrolyte should be lost by accident from any of the cells, replace the lost quantity with ReFill Electrolyte. If ReFill Electrolyte is not available take the battery out of service and add enough water to cover the plates (so as to prevent damage to the plates by exposing them to the air) and procure ReNewal Electrolyte. On its arrival empty out all the old electrolyte and fill the cells to the maximum level with the ReNewal Electrolyte. Charge the battery and check that the specific gravity is correct and uniform in all the cells before putting the battery back into service.

The Electrolyte will readily absorb Carbon Dioxide from the air to form Potassium Carbonate which has the effect of lowering the capacity of the battery. Electrolyte must therefore be stored in airtight containers. The cell vent caps should be kept closed at all times except when adding water or checking the electrolyte and this should always be done as quickly as possible, opening only one vent cap at a time.

When handling electrolyte wear goggles and avoid splashes.

The electrolyte is injurious to skin and clothing and must therefore always be handled carefully. A generous quantity of concentrated Boric Acid solution should be kept handy in an open bowl for neutralizing any accidental splashes on clothes or person. Use an eye cup for eye injuries.

Do not use Boric Acid on cells or trays.

CHECKING THE ELECTROLYTE

All types of batteries lose water through natural evaporation but particularly when gassing freely on charge. While there are no injurious or obnoxious gases given off by the Nicad battery, traces of the Potassium Hydroxide are carried away with the gas resulting in a gradual lowering of the specific gravity of the electrolyte over the years.

The level of the electrolyte as well as its specific gravity must therefore be checked periodically as serious damage will be done to the plates if the electrolyte level is allowed to sink below the top of the plates or the specific gravity below 1.160.

Electrolyte Level Test Tube.

Nicad Part No. 95976.

FIG. 6

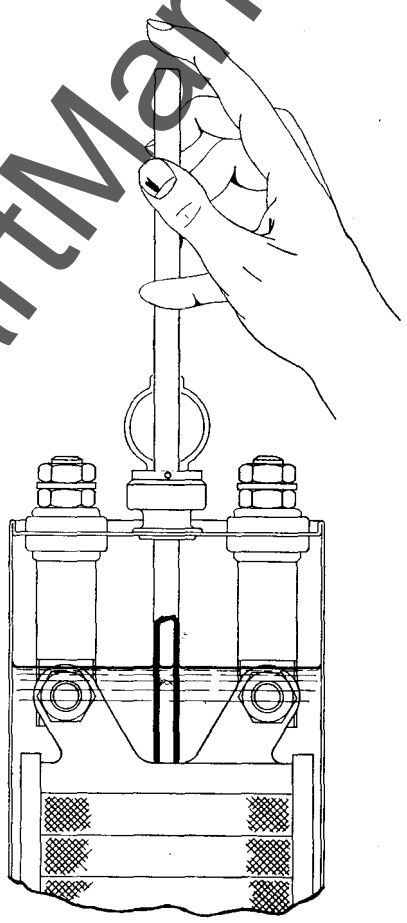


FIG. 7

The electrolyte level is easily ascertained by inserting the 3/16" (5mm) bore plastic tube, shipped with the battery, through the vent until it rests on top of the plates, then placing the finger tightly over the end and withdrawing the tube for inspection. Be sure to return the electrolyte in the tube to the cell from which it was withdrawn.

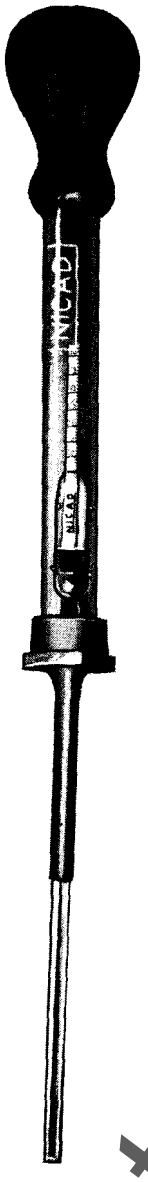


FIG. 8

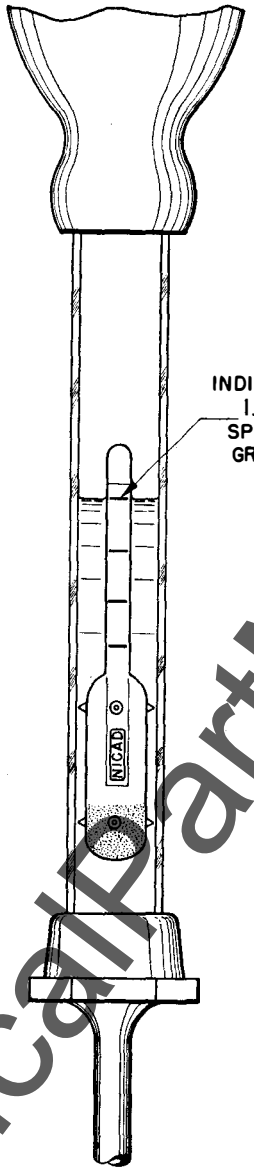


FIG. 9

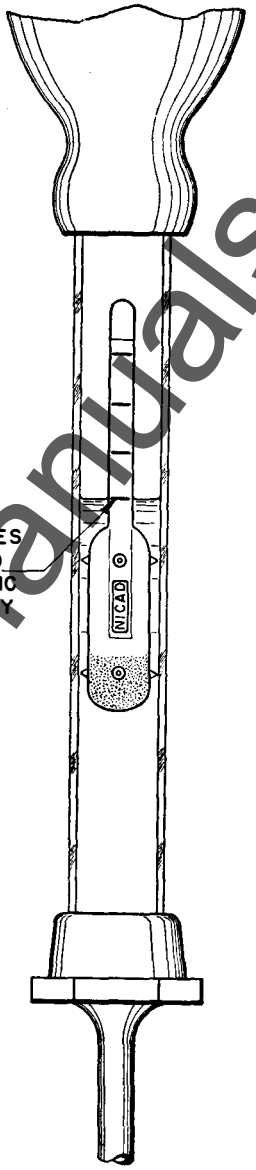


FIG. 10

A Hydrometer, Nicad Part No. 64091, is used to check the Specific Gravity of the electrolyte, which should be between 1.160 and 1.200. The illustrations show the positions of the float in electrolyte which is too weak, Fig. 9, and too strong, Fig. 10.

Use only the Nicad hydrometer, shipped with the battery, to take specific gravity readings. First rest the tip of the nozzle firmly on top of the plates in the cell, then squeeze and release the bulb. This method will prevent CELOIL, see p. 18, from being drawn up into the barrel. Draw up sufficient solution to permit the float to move freely and then tap the glass barrel of the hydrometer gently with the finger to prevent the float from giving a false reading by sticking to the barrel wall.

The maximum level of the electrolyte is halfway between the tops of the plates and the top of the cell container. At this level the specific gravity should not be less than 1.160 or more than 1.180.

The electrolyte level should at no time be less than 1/2" (12 mm) above the plates. At this minimum level the specific gravity should not be less than 1.170 or more than 1.200.

These figures apply to normal temperatures. When extreme temperatures prevail and the observed hydrometer readings are outside the limits 1.160-1.200 it will be necessary to apply temperature and electrolyte volume correction factors as described below.

In order to arrive at the true specific gravity of the electrolyte at 72°F., i. e., the temperature used as a base for purposes of calculation, first measure and record:

1. The electrolyte specific gravity,
2. The electrolyte temperature,
3. The electrolyte level above the plates.

If the electrolyte temperature is above 72°F add to the specific gravity reading 0.001 for every 4° above 72°F.

If the temperature is below 72°F, subtract 0.001 from the specific gravity reading for every 4° below 72°F.

For every 1/4" of electrolyte above the top of the plates add 0.005 to the specific gravity reading.

The following examples show typical calculations.

Ex. 1 Hydrometer reads 1.190
Electrolyte temperature is 96°F; add ..... 0.001 x (96 - 72) ÷ 4 = 0.006
Specific Gravity, corrected for temperature (only) is 1.196
Electrolyte level is 1 3/4"; add ..... 0.005 x 1 3/4 ÷ 1/4 = 0.035
Specific Gravity, corrected for both temperature and volume is 1.231

Ex. 2 Hydrometer reads 1.190
Electrolyte temperature is 40°F; subtract 0.001 x (72 - 40) ÷ 4 = 0.008
Specific Gravity, corrected for temperature (only) is 1.182
Electrolyte level is 3/4"; add ..... 0.005 x 3/4 ÷ 1/4 = 0.015
Specific Gravity, corrected for both temperature and volume is 1.197

FIG. 11

Where extreme operating temperatures prevail a Spirit Thermometer, Nicad Part No. 91791, is necessary in order to apply proper temperature correction factors to the hydrometer readings.

Samples of electrolyte drawn from cells which are gassing must be left to stand until the gas bubbles have disappeared as otherwise false readings will be obtained. For this reason specific gravity and electrolyte level checks should be timed to be made only when the battery is on discharge or has been standing fully charged on open circuit for a few hours.

Specific gravity readings should not be taken on cells to which water has just been added, but deferred until the water has had time to mix properly with the electrolyte during a subsequent charge.

Always return the sample of electrolyte to the cell from which it was taken.

After use wash out the hydrometer thoroughly with water to remove all traces of electrolyte, as any electrolyte allowed to remain in the hydrometer would absorb Carbon Dioxide from the air to form a thin coating on the float which would cause false readings.

ADDING WATER

Always check the electrolyte level before adding any water to the cells. The maximum permissible level of the electrolyte is halfway between the tops of the plates and the top of the cell container.

DO NOT OVERFILL!

Compared to Lead Acid and Nickel Iron batteries Nicad batteries use very little water particularly when they are on float or trickle charge and maintenance personnel accustomed to handling the former two types must therefore be on their guard against overfilling Nicad batteries.

As an example batteries on float at a voltage equal to 1.4 times the number of cells in the battery will be found to require watering only about once a year.

If the cells are overfilled the electrolyte will well out of the vents on charge and saturate the trays causing electrolysis between the cells, corrosion of the cell containers, and troublesome grounds in the electrical circuit.

Overfilling will also dilute the electrolyte to such an extent that the specific gravity will become too low and the plates will be damaged.

Maintain the correct electrolyte level by adding periodically proper quantities of distilled water only. Do not add electrolyte and do not use so-called "Distilled water for Storage Batteries" as it generally contains small amounts of Sulfuric Acid through being stored in carboys having contained Sulfuric Acid intended for use in Lead batteries.

Some waters fit for drinking may be usable but if it is contemplated to use undistilled water it is always advisable to forward a correct analysis or a sample of the water to be used to Nickel Cadmium Battery Corporation, transportation prepaid, for analysis, free of charge, and approval before use. The minimum quantity of water is 2 quarts and the minimum quantity of electrolyte is 1 quart for proper analysis. Ship in thoroughly cleaned glass bottles. Tag for easy identification.

Send by Railway Express. Do not send by mail.

Whereas the quantity of any impurities introduced into the battery each time the battery is watered may be insignificant, the cumulative destructive effect over a number of years will be considerable.

Distilled water is so inexpensive and in most cases so easily procured that its use is easily justified in terms of battery life.

Stills for producing distilled water at very low cost are available from a number of reliable manufacturers.

Store distilled water in clean, air-tight glass containers.

CHANGE OF ELECTROLYTE

Batteries which are charged at heavy rates for long periods and hence gas freely, with consequent loss of water and Potassium Hydroxide carried away by the gas, may require a change of electrolyte during their life. When the specific gravity of the electrolyte, at a height of ½" (12 mm)above the tops of the plates, has fallen to 1.160 further operation of the battery will cause a rapid reduction in its life. At this point the battery should be discharged at the 8-hour discharge rate to a voltage of about 0.5 volt per cell and have its electrolyte changed.

Remove the cells from their trays and working on only one or two cells at a time turn them upside down and empty out the electrolyte. Do not rinse the cells with water or electrolyte. Avoid splashes, wear goggles.

Fill immediately to the maximum height, that is, halfway between the tops of the plates and the top of the cell container, with ReNewal Electrolyte of 1.200 specific gravity. Do not leave the cells to stand empty as air allowed to enter a cell will damage its plates.

The 1.200 ReNewal Electrolyte should of course always be procured in advance and be available before starting to empty the cells.

While performing the above operations, the trays or cells should not be stacked on top of one another nor should the cell posts be allowed to touch anything except insulation. No chance short-circuiting of the cells should be permitted. The trays should be examined for damage and any broken parts replaced. Note that the trays are so designed that there is a clear space between the cells and the surface on which the trays rest.

After being thoroughly cleaned, preferably by steam or compressed air, the cells and the trays should be allowed to dry thoroughly and then painted, or preferably dipped in NICADVAR, a corrosion resisting asphalt-base varnish specially prepared and furnished by Nickel Cadmium Battery Corporation. After the battery has been reassembled it should be given a 14 hour charge at the 7-hour charge rate before being put back into service.

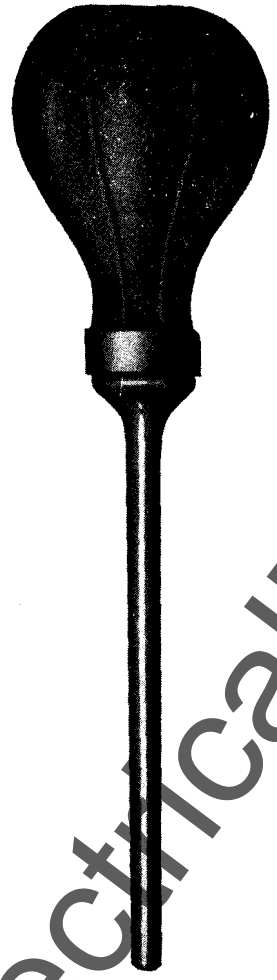


FIG. 12

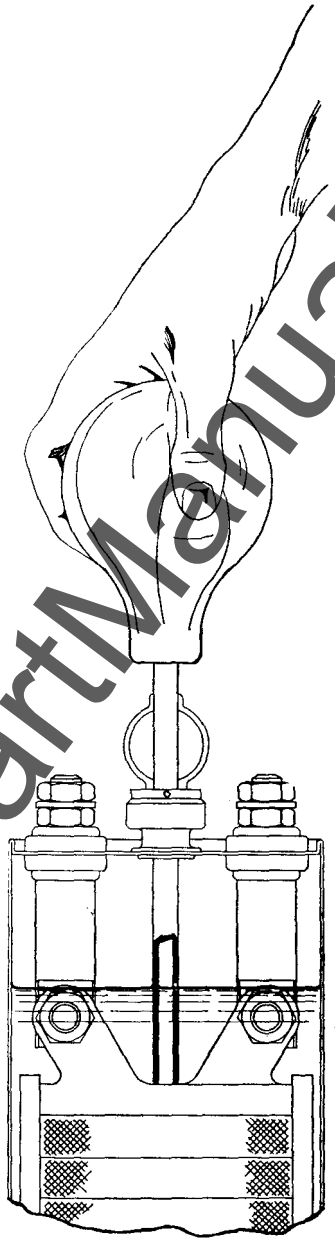


FIG. 13

Filler Bulb, Nicad Part No. 11166, is a very useful tool for adjusting the electrolyte level in a large number of cells to the same height above the plates. A small transverse hole in the hard rubber nozzle determines the electrolyte level automatically. Please note that the filler bulb cannot be used in cells containing Celoil.

CELOIL

In stationary and also in very large mobile batteries which are either on float or charged by generators provided with voltage regulators, it is common practice to float a ¼"-½" (6-12 mm) deep layer of CELOIL on top of the electrolyte in order to retard the natural evaporation of water from the electrolyte.

CELOIL is a pure, acid-free and non-saponifying oil specially prepared for this purpose and furnished by Nickel Cadmium Battery Corporation in quart cans.

LAYING UP

When a Nicad battery is to be laid up for a few months give it a full charge at the 7-hour charge rate, check that the specific gravity of electrolyte is at least 1.160 and that the electrolyte level is at least ½" (12mm) above the tops of the plates.

Remove a few of the intercell connectors to break any stray currents and store the battery in a cool place free from dust and moisture.

If batteries are to be stored or stocked for lengthy periods they should be fully charged as described above and then put on constant trickle charge at 1.40 volts per cell.

RETURNING CELLS

In case a cell has to be returned to the factory for any reason, it should be discharged at the 8-hour rate to about 0.5 volt. The electrolyte must be left in the cell.

Tighten the post nuts and drive a tapered rubber or wooden plug of suitable size into the vent hole. Turn the cell upside down. Leave it standing in this position for 24 hours and then check that no electrolyte has leaked out.

Put the cell in a large quantity of liquid absorbing material, such as sawdust, and ship to Nickel Cadmium Battery Corporation, Easthampton, Mass., transportation prepaid. Do not send through the mail.

ELECTROLYTE AND ACCESSORIES FOR NICAD BATTERIES

	Size Lbs.	Part No.	Will Make 1.200 Spec. Grav. Electrolyte Gals.
SOLID ELECTROLYTE In Non-Stoppered, Non-Returnable Cans	5	33101	1.6
	10	33102	3.2
	15	33103	4.8
	20	33104	6.4
	100	33105	33

		Refill, 1.180 Spec. Grav. Part No.	Renewal, 1.200 Spec. Grav. Part No.
READY MIXED LIQUID ELECTROLYTE In Stoppered, Non-Returnable Cans	5	33131	33136
	10	33132	33137
	15	33133	33138
	20	33134	33139
	130	33135	33140

	Part No.
HYDROMETER Complete with Syringe	64091
Float (only)	64092
Syringe (only)	64093
Syringe Glass Barrel (only)	64095
Hydrometer Holder	64096
ELECTROLYTE LEVEL TEST TUBE	95976
THERMOMETER, —20°F. to 160°F.	91791
FILLER BULB, Specify Cell Type No.	11166

POST NUT WRENCHES	Openings	3/8	1/2	5/8	13/16	1	1-1/4	1-1/2
	Part No.	97732	97733	97734	97735	97736	97737	97738

	Part No.
PETROLEUM JELLY, in Stoppered Non-Returnable Cans Size 1 Quart	32982
CELOIL, Non-Saponifying Pure Mineral Oil in Stoppered Non-Returnable Cans Size 1 Quart	32782
NICADVAR ASPHALT VARNISH, in Stoppered Non-Returnable Cans Size 1 Quart	32882

NAME PLATE Specify Cell Type Number	Small	Large
	64481	64482

	Part No.
ACID WARNING LABEL (Affixed to All Trays)	64484
VOLTAGE REGULATOR SETTING LABEL (Affixed to all 6 volt and 12 Volt Starting Batteries)	64485
SAMPLE BATTERY PLATE	76927
CUT-OPEN SAMPLE CELL	52021
INSTRUCTION BOOK	227
WALL CARD Specify Cell Type Number and Number of Cells in Battery	251

Please note that Filler Bulbs cannot be used with batteries having Celoil.

PARTS FOR NICAD BATTERIES

POST NUTS	Dims. Across Flats	3/8	1/2	5/8	13/16	1	1-1/4	1-1/2
	Part Nos.	74472	74473	74474	74475	74476	74477	74478

INTER-CELL CONNECTOR WASHERS	O'all Dias.				59/64	1-3/16	1-13/32	1-19/32
	Part Nos.				97465	97466	97467	97468

POST CUP WASHERS	O'all Dias.	3/4	55/64	1	1-9/32	1-31/64	1-11/16	1-29/32
	Part Nos.	97262	97263	97264	97265	97266	97267	97268

POST GLANDS, RED	O'all Dias.	51/64	29/32	1-3/64	1-21/64	1-17/32	1-47/64	1-15/16
	Part Nos.	63213	63215	63217	63219	63221	63223	63225

POST GLANDS, BLACK	O'all Dias.	51/64	29/32	1-3/64	1-21/64	1-17/32	1-47/64	1-15/16
	Part Nos.	63153	63155	63157	63159	63161	63163	63165

VENT CAPS, Complete with Spring and Cotter Pin,	Small	Medium	Large
Part Nos.	96501	96502	96503

BOSS CUPS	Small	Large	Giant
O'all Dia.	7/8	1-1/4	1-1/4
O'all Height	21/64	3/8	1/2
Part Nos.	45833	45834	45835

For all items above, specify also the Cell Type Number and the Cell Manufacturing Serial Number stamped on the Cell Cover.

For all items below, specify the Cell Type Number. For jumpers, specify also center distance of holes or send sketch.

INTER-CELL CONNECTORS
INTER-CELL PARTITION CONNECTORS
INTER-TRAY CONNECTORS
INTER-TRAY JUMPERS
INTER-TIER CONNECTORS
INTER-TIER JUMPERS
END LUGS
END CONNECTORS
BATTERY TRAYS

CELL DATA

Cell Type No.	Capacity at 8-Hr. Rate Amp. Hours	Charge Current 7-Hour Rate Amps.	Liquid Electrolyte, per Cell lbs.	Correct Electrolyte Level above the plates inches
ETO 5	10	2	0.5	1
7	15	3	0.7	1
9	20	4	0.9	1
11	25	5	1.1	1
EKS 7	30	6	1.3	1 1/4
9	40	8	1.7	1 1/4
11	50	10	2.0	1 1/4
13	60	12	2.4	1 1/4
15	70	14	2.7	1 1/4
EBZ17	80	16	4.0	1 1/2
19	90	18	4.4	1 1/2
22	105	21	5.2	1 1/2
25	120	24	5.8	1 1/2
28	135	27	6.5	1 1/2
31	150	30	7.3	1 1/2
ERX23	165	31	7.4	1 3/4
25	180	36	8.2	1 3/4
27	195	39	8.9	1 3/4
29	210	42	9.7	1 3/4
33	240	48	11.0	1 3/4
37	270	54	12.7	1 3/4

Cell Type No.	Capacity at 8-Hr. Rate Amp. Hours	Charge Current 7-Hour Rate Amps.	Liquid Electrolyte per Cell lbs.	Correct Electrolyte Level above the plates inches
MAW 5	16	3.2	0.7	1
7	24	4.8	1.0	1
9	32	6.4	1.3	1
11	40	8.0	1.6	1
MPF 9	52	10.4	2.0	1 1/4
11	65	13.0	2.4	1 1/4
13	78	15.6	2.9	1 1/4
15	91	18.2	3.3	1 1/4
17	104	20.8	3.7	1 1/4
19	117	23.4	4.2	1 1/4
MZN17	128	25.6	4.5	1 1/2
19	144	28.8	5.1	1 1/2
22	168	36.0	6.0	1 1/2
26	192	38.4	6.9	1 1/2
28	216	43.2	7.9	1 1/2
MSK21	240	48.0	9.4	1 3/4
23	264	52.8	10.5	1 3/4
25	288	57.6	11.6	1 3/4
27	312	62.4	12.7	1 3/4
29	336	67.2	13.7	1 3/4
MXD25	384	76.8	15.2	2
27	416	83.2	16.7	2
31	480	96.0	19.5	2
35	544	108	22.2	2
39	608	121	24.5	2

NOTES

This space is provided for your convenience in recording date of installation, trickle charge or other voltage settings, watering dates and similar information.

NICAD

MADE IN U. S. A.

NICKEL CADMIUM BATTERY CORPORATION
EASTHAMPTON, MASS.

Booklet 227
5th Edition

Printed in U.S.A.