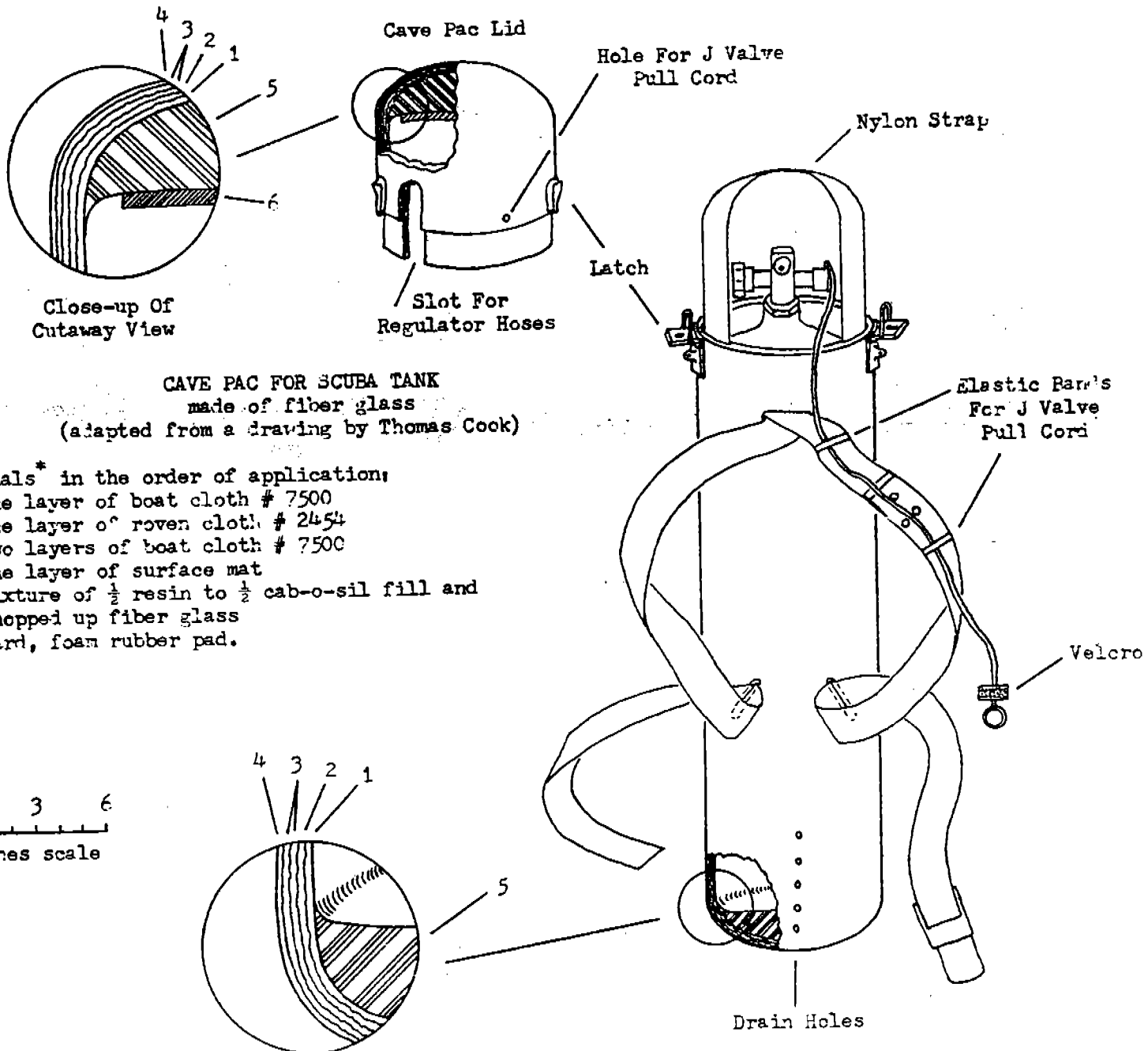


UNDERWATER SPELEOLOGY

OFFICIAL NEWSLETTER OF THE CAVE DIVING SECTION OF THE NATIONAL SPELEOLOGICAL SOCIETY
 © 1975 by THE CAVE DIVING SECTION Vol. 2, No. 3- June 75

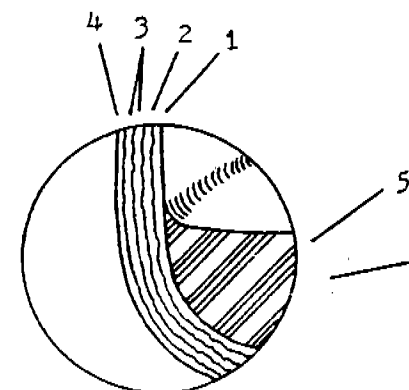


CAVE PAC FOR SCUBA TANK
 made of fiber glass
 (adapted from a drawing by Thomas Cook)

Materials* in the order of application:

1. one layer of boat cloth # 7500
2. one layer of roven cloth # 2454
3. two layers of boat cloth # 7500
4. one layer of surface mat
5. mixture of $\frac{1}{2}$ resin to $\frac{1}{2}$ cab-o-sil fill and chopped up fiber glass
6. hard, foam rubber pad.

0 3 6
 inches scale



Close-up Of
 Cutaway View
 (without scuba tank)

* Supplier -- Allied Resin Corporation, East Weymouth, Mass.

SDM

SPRING CAVE, COLORADO

Jerry Hassemer's trip report in the Colorado Grotto's newsletter; Caving In The Rockies, Vol. 17, November-December (1974) describes the cave diving exploration of "The Sink" at the upper end of the stream passage in Spring Cave. Six people transported diving gear through 3700 feet of passage to the diving site. Al Williams and Jerry were the cave divers who explored 140 feet of six-foot wide passage submerged at a depth of 12 to 15 feet and found two air filled rooms. Visibility was good until silt was stirred up from the gravel floor. They could not find the opening where the stream water was entering the passage.

An existing map of the cave system is included with the report. There is also a description of some of the equipment used by the divers and an account of the problems involved in transporting their equipment through the cave.

ADDRESS CHANGES

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Oliver C. Lloyd, Withey House,
Withey Close West, Bristol BS9 3SX,
Great Britain

J. Billy Young, P.O. Box 260,
Gainesville, Georgia 30501

ELECTION OF OFFICERS

The Cave Diving Section's constitution sets the annual meeting at the NSS Convention as the time for election of CDS officers. Obtaining a majority of members at these meetings has proven to be difficult. The last election was held by mail in December of 1974 because there were not enough CDS members at the 1974 NSS Convention. It is even more unlikely that enough CDS members will attend this years NSS Convention in California inasmuch as nearly all the CDS members live in the eastern part of the United States. The National Association for Cave Diving Seminar, which will be held in Florida during June only one week before the NSS Convention in California, will also probably divert most CDS members from attending the NSS meeting. An ammendment to the CDS constitution may be necessary to allow nomination and election of CDS officers by mail. Anyone having suggestions or comments about the election procedure please send them to Sheck Exley, 1591 S. Lane Ave. # 118C, Jacksonville, Florida 32210.

Currently there are no plans to have a cave diving program at the 1975 NSS Convention.

CONGRESS OF GROTTOS

The CDS is entitled to representation at the Congress of Grottos (COG) at the annual NSS Convention. Internal organizations of the NSS may appoint representatives to the COG. The representatives debate and vote on recommendations concerning policies followed by the board of directors. Only one internal organization can represent each NSS member. Currently the CDS has only one representative vote at the COG. The number of COG votes assigned to the CDS depends on the number of members it represents. A survey will be conducted next winter at the time of membership renewal to determine how many of the CDS members want the section to represent them.

SECOND INTERNATIONAL CONFERENCE ON CAVE DIVING AND RESCUE WORK

by Sheck Exley (NSS 13146)

The 2nd International Conference on Cave Diving and Rescue Work, sponsored by the Cave Diving Commission of the International Union of Speleology (IUS), will be held at Barcelona, Spain, on September 1-7, 1975. The conference greatly contributes to the development and progress of cave diving through an exchange of experience on an international basis. All cave divers regardless of expertise or nationality are urged to attend this week-long event.

Following the paths established by the very successful First International Conference on Cave Diving held in Czechoslovakia two years ago, the second conference will focus its attention on the following topics: the application of cave diving to the sciences, physiology and psychology of cave diving, techniques of cave diving, deep diving in caves, the use of submersibles in the exploration of undersea caves, technology of cave diving, cartography and documentation of underwater caves, training and education programs, rescue and recovery, and the organization of the IUS Cave Diving Commission. A panel discussion on the economic aspects of cave diving technology is also planned.

The total cost of registration, accomodation and meals for all seven days will be approximately \$100 (U.S. currency).

The preliminary program is as follows:

- September 1 - Registration, Opening Session
- " 2 - Papers, Discussions
- " 3 - Papers, Discussions
- " 4 - Practice Dives in Undersea Springs of Garraf Karst
- " 5 - Practice Dives in Undersea Caves of Islas Medas
- " 6 - Assembly of the Cave Diving Commission
- " 7 - Closure of Conference and Reception in Barcelona

Participants in the conference are encouraged to present a 30 minute formal presentation on any of the above listed topics or other aspects of cave diving. Papers can be in English, French or German. A one-page abstract in English, double-spaced, must be submitted to the conference secretariat and a copy sent to the chairman of the IUS Cave Diving Commission by June 6, 1975.

For further information contact the following persons:

Conference Secretariat, Second International Conference on Cave Diving,
Mauricio Serrahima 20, Barcelona, Spain

Frantisek Piskula, Chairman, IUS Cave Diving Commission, nam. SNP 19,
614 00 Brno, CSSR (Czechoslovakia)

Sheck Exley, (U.S. Representative) 1591 S. Lane Ave. # 118C, Jacksonville,
Florida 32210

CAVE DIVING IN THE NORTHEAST REGION

by Tom Cook (NSS 15548)

Most of the diving that is done by our group (Inward Bound) is mapping and trying to connect various cave systems, and a little fossil collecting for the local schools - shells, coral, etc. The members of Inward Bound are on the cave rescue list of the Northeast Region of the NSS. We all belong to the Boston Grotto and there are at least three more cave divers there, but I have not dived with them, and I do not think two of them have dived in New England. I hope to take them out diving soon. They took a cave diving course in the clear springs of Florida, so I think they are in for a rude awakening up here. To us, Florida is the place where visibility is actually over six feet and one does not need half a grotto to help drag equipment through tunnels.

There are no caves in New Hampshire, and I am pretty sure the caves in Massachusetts have no water traps to dive. There are several marble caves (talk about tearing up wet suits and bodies) in Vermont. The best dive there is a tunnel 20 feet by 8 feet that has no known end, however, there is a 1100-foot crawl, 3 feet by 4 feet and smaller to get to it. People who drag your gear there for you never talk to you again. New York is where most of the diving is done and there is a hell of a lot to do; rivers that go underground, caves that empty out into lakes, water traps and all kinds of good stuff. There is really a lot to do, a lot of unexplored passages and mapping, but it is getting the equipment in, in one piece, that is the big hold up. In many cases you have to be a vertical, horizontal, and climbing diver. But it is interesting and story telling is an honored past time around here.

Visibility going in is about 15 feet when the water is not running fast, and zero coming out, unless you are diving Morris Cave, in which case the tunnel is high enough that you do not disturb the silt. That is why helmets are worn over hoods around here and all regulators and tanks are encased in fiber glass "cave pacs". Because of the type of caves and the low visibility, a reel rig is not used. We use a life line of rope that can be felt through the glove. This works very fine as long as there is a trained person on the other end. There are two divers and three rope handlers in the New Hampshire crew.

These cave pacs (see cover diagram) are designed to be pushed, pulled, kicked, cursed, hoisted and dragged through keyhole tunnels up and down drops, mud, breakdown, any and everything. The original pac has been on 15 cave trips, been dropped 15 feet and dragged over water, mud sand, gravel and breakdown. It suffered a crack on the top part, which I glued back together and has held through 5 more trips. Cracks and flaking of plastic are easily fixed in a half hour or less. The pacs are sturdy pieces of equipment and are easy to make if you know how to work with polyester resins.

The inside diameter of the pac is $\frac{1}{4}$ inch larger than the scuba tank. The harness from a scuba backpack is used for the harness of the cave pac. The webbing is threaded through buckles (figure 1) inside the pac to keep the straps from coming out of the pac.

The pacs are transported by the one-inch wide nylon webbing strap which encircles the pac. The webbing is "glassed" into the case during construction and screwed in the bottom when the case is half as thick as it will get.

The webbing is loose from the cap up. It is not used for hoisting, just as a hand strap for dragging.

Heavy duty latches locked with cotter pins are used to keep the case body and cap together. There is also a fiber-glass, rubber-lined cover that fits over the valve to keep out dust and water (figure 2).

Another version of the pac is designed for carrying equipment other than the scuba tank (not illustrated). There is a lining of rubber around the inside edge of the lid of the equipment pac to seal out water. The pac straps are attached to the equipment pac with metal brackets (figure 3). The equipment pacs are blue, rescue pacs are red and cave pacs for tanks are yellow.

It usually takes three to four cavers to support one diver, since equipment must be dragged and carried, long distances underground -- in one case about $2\frac{1}{2}$ miles in one direction. So now if I say, "Want to go caving?", they look to see if there are any cave pacs in my truck before they answer.

We took a three day trip recently and dived a cave in New York. The dive was nice, but, ascending 60 feet and hauling the equipment up and then the mile walk back (it was snowing) in a wet (now frozen) suit forced us from another dive the next day. Typical northeast operating procedure: if it is not snowing, the staging area is flooding or the hauling lines are so fouled on an overhang that it takes half a night to get all the equipment topside. The best part of a NE dive is the stories told later around the campfire.

* * * * *

FUNKVA RIVER CAVE, CZECHOSLOVAKIA

The Windy City Speleoneers, Vol. 14, October (1974) reviews the book Vekum Budoucim by Jan Pribyl and Jiri Keprt, Czechoslovak Academy of Sciences, Institute of Geography. Punkva River Cave is Czechoslovakia's longest cave containing a number of water traps. Several explorers died attempting to force water traps in the cave system. A map of the cave is included in the review.



Fig. 1 Buckle. It Is Used To Hold Webbing Inside Cave Pac.

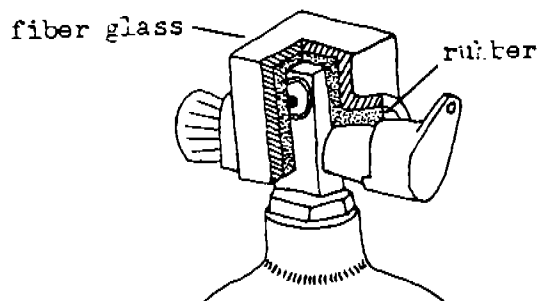


Fig. 2 Tank J Valve With Cutaway View Of Cover.

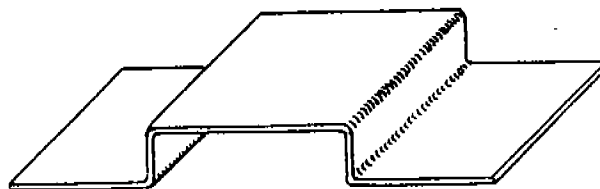


Fig. 3 Metal Bracket. This is Fiber-Glassed Into Equipment Pac To Hold Pac Straps.

CARE AND FEEDING OF NICKEL-CADMIUM BATTERIES

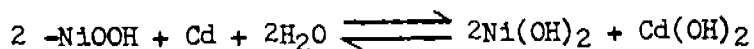
by Glenn Thompson (NSS 13478)

Nickel-cadmium batteries, generally called "ni-cads", are probably the most popular type of storage cells used to power underwater lights. Open, or wet-cell ni-cads purchased from government surplus are perhaps in most common usage because they are reasonable low in cost and are able to perform well in spite of a great deal of physical and electrical abuse. Next in popularity are the 4-amp-hour, sealed-cell ni-cads which usually take the form of D-cell flashlight batteries. These are found mostly in commercially made lights and are more expensive because they are not normally purchased from government surplus.

Many divers own batteries that were purchased without charging or operating instructions, thus the following general information is provided to help ni-cad users get better service from their batteries.

FUNDAMENTALS OF CELL OPERATION

The charge-discharge mechanism of the ni-cad cell can be written in simplified form as follows:



It is basically an oxidation-reduction reaction in which the electrolyte, potassium hydroxide, serves only as a carrier of ions, and is not actually reacting with the electrodes. For this reason the electrolyte remains essentially at the same concentration throughout discharge, enabling the battery to deliver a reasonably constant voltage. This is unlike the lead-acid system where the electrolyte, sulfuric acid, reacts with the electrode material and becomes very dilute when the battery is completely discharged. This property of lead-acid batteries also reduces the conductivity of the electrolyte when at low charge and makes them vulnerable to freezing.

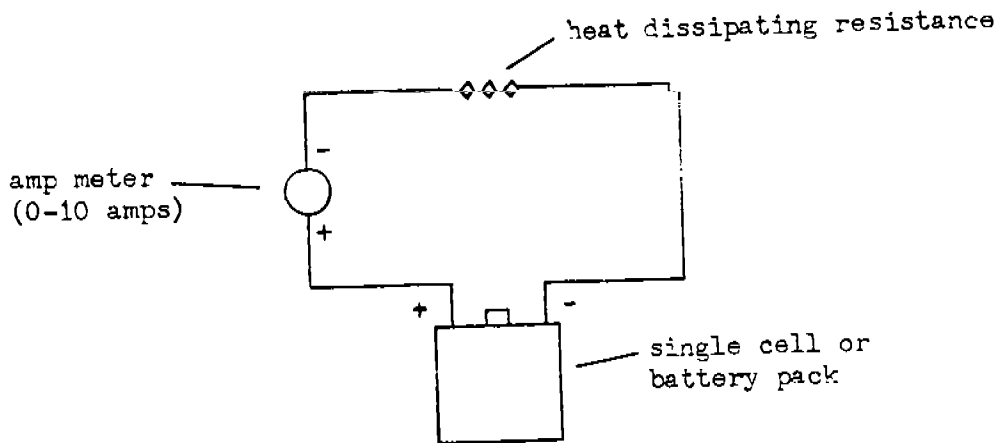
CELL RATINGS

All storage batteries are given ratings in amp-hours or watt-hours which are used to designate their capacity. For example, a 6-volt, 10-amp-hour battery will deliver 1 amp for 10 hours, or 5 amps for 2 hours, or 20 amps for $\frac{1}{2}$ hour. And in either case it will deliver 60 watt-hours (watts = amps x volts, therefore watt-hours = amp-hours x volts). Obviously the amp-hour and watt-hour ratings for a power pack must be known in order to predict how long any given unit will operate. For example, a 50-watt lamp operated from the previous battery would provide light for 1 hour and 12 minutes (60 watt-hours / 50 watts = 1.2 hours = 1 hour and 12 minutes).

When buying surplus ni-cads you can generally expect to get cells that are at, or slightly lower than their minimum listed rating. Ni-cad cells of a given type, purchased from surplus, tend to vary in capacity from one to the next. For this reason it is advisable to purchase one or two extra cells in order to avoid having to make a power pack containing one cell significantly weaker than the rest. However considering that they are reduced to 10 or 20% of their original cost, they are still a bargain.

Many of the used open-cell ni-cads purchased from government surplus are about 20 years old and no longer possess their rated capacity. It is wise to buy and test one or two representative cells of a given type before purchasing enough to make a whole pack. Unused 20-year-old cells are also commonly available from surplus dealers at a slightly higher cost. Be particularly careful when buying these because they are not likely to perform any better than those that have been in use for 20 years.

A simple procedure for measuring the capacity of a single cell or a battery pack is shown below:



Circuit For Determining Average Battery Discharge.

A battery pack, or preferably a single cell, is hooked in series with an amp meter and a resistance which may be anything that can dissipate heat easily such as a piece of nichrome or stainless steel wire, a light bulb, or even a long hose clamp. The rate of discharge is read from the amp meter at regular intervals, say every 5 minutes, and recorded. The following example is provided to illustrate the calculations of a typical test for amp-hour capacity:

Time Minutes	Amp Meter Readings	Ave. Amp Dischg. for 5 Minute Interval	
(instant of start) 0	9.8	$\begin{matrix} \text{>} \\ \text{>} \\ \text{>} \\ \text{>} \\ \text{>} \\ \text{>} \end{matrix}$	Ave. Dischg. for 30 minutes = $\frac{50.75 \text{ total}}{6 \text{ intervals}}$
5	9.2		
10	9.1		
15	9.1		
20	8.4		
25	7.5		
(cell voltage drops to 1) 30	5.1	$\frac{50.75 \text{ total}}{6}$	= 8.46 amps

$$\text{Capacity} = \frac{8.46 \text{ amps} \times 30 \text{ minutes}}{60 \text{ minutes / hour}} = 4.23 \text{ amp-hours}$$

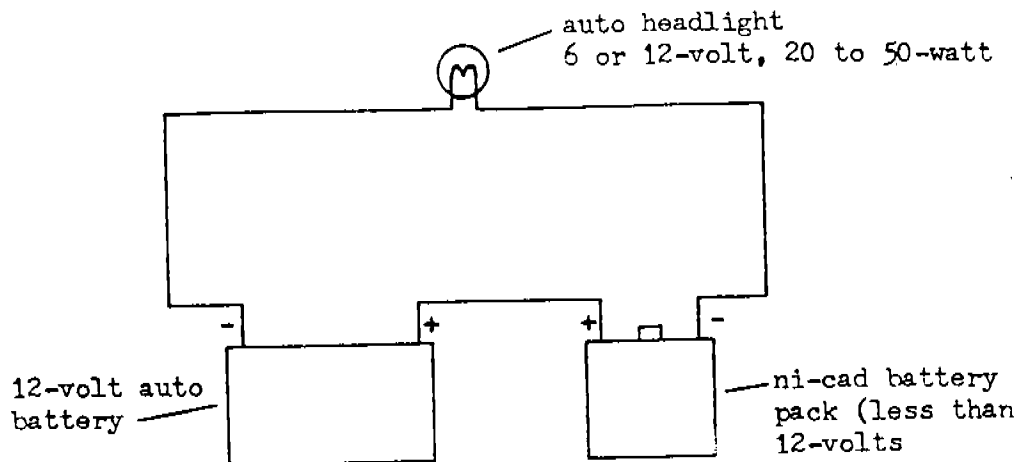
This procedure provides a method for measuring the average discharge of a battery over a relatively long time. The test should be terminated when the potential of the cell drops below 1 volt to avoid damage to the cell. There is very little useful power left in the cell below this point.

If a number of cells are discharged in series (as when the light is in use) the weakest cell will become completely discharged before the other cells. It then becomes reverse charged by the remaining stronger cells. Electrolysis of water takes place and gas is evolved within the cell when this happens. If you hear a short burst of gas escape, as you open your battery case after a long dive, it is likely that one or more of the cells has been discharged beyond its capacity, or reverse charged. Reverse charging is damaging to the cell and should be avoided.

CHARGING

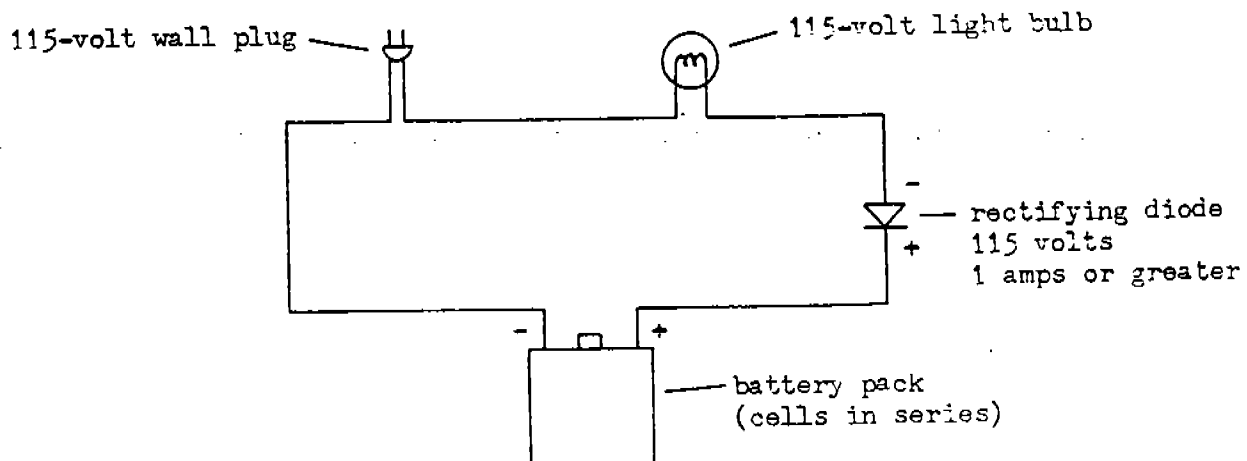
Proper charging is critical in order to obtain the maximum power of a battery. The most important factor to be considered is the rate at which the battery is charged. As a rule of thumb, the maximum charge rate that will bring an OPEN-CELL battery to its maximum capacity is designated as $A = C/5$ hours, where A is the charging current in amps, and C is the amp-hour capacity of the battery. Therefore the maximum charge rate for a 6-amp-hour battery is 1.2 amps ($A = 6 \text{ amp-hours} / 5 \text{ hours} = 1.2 \text{ amps}$). Lower charge rates will also give optimum results. It should be noted, however, that the rule of thumb is scaled to work for a large variety of open-cell ni-cads, including some industrial types that are not designed for the high-rate charge and discharge performance that many of the military types are designed for. High-rate performance cells are usually wide in proportion to their height in order to reduce internal resistance. Some cell types purchased from surplus may take a charge efficiently at several times the $C/5$ hour rate.

Twelve-volt battery packs can usually be charged satisfactorily from an automobile electrical system by simply hooking it in parallel with the car battery (positive to positive and negative to negative). The connection can be made very conveniently by plugging into the cigarette lighter if there is one. The center terminal of the auto-cigarette lighter is usually positive and the outside terminal negative. If a 6-volt battery, or any battery less than 12 volts, is charged from a 12-volt auto system without a current limiting device, it will initially charge at an enormous rate, 20 to 30 amps or more, and the battery will only take a small fraction ($1/4$ to $1/3$) of its full capacity charge. However, 6-volt batteries can be adequately charged from a 12-volt auto system if a resistor is used to limit the charging current. The voltage applied to the resistor will be simply the voltage difference between the auto battery and the battery being charged. Therefore to charge a 2-volt battery from an automobile one would need an 8-volt (or greater) bulb for a limiting resistor; to charge a 7-volt battery use a 4-volt or greater bulb. The idea is to use a bulb that will not get burned out by the voltage difference between the batteries. A 6 or 12-volt light bulb will serve well for this purpose. A good technique is to simply charge the battery through the bulb of the diving light. This simple circuit is drawn below:



Circuit For Charging Less Than 12-Volt Battery
From An Auto System.

Although it is often desirable to charge a diving light from an automobile, it is usually more convenient to charge the battery with 115-volt AC house current. To do this a very simple charger can be built from a light bulb and a rectifying diode that will charge a ni-cad battery of any voltage (up to 115 volts). This simple circuit is shown below:



Battery Charger Built From Light Bulb and Diode.

With a 100-watt light bulb this circuit will charge at 0.45 amps, or, with a 200-watt bulb - at 0.9 amps, and so on. The diode may cost anywhere from 10¢ to 70¢, and can be purchased at any electronics or radio store. The light bulb used will operate at less than half its nominal power. All electrical connections should be made before plugging the charger into the wall outlet to avoid the possibility of being shocked. This type of charger offers several important advantages: (1) It will deliver a constant current to the battery, regardless of the battery voltage. (2) The charging current can be changed by substituting different wattage light bulbs. (The charging current can be calculated from the relationship: $I = W/220$ where I is the charging current in amps, and W is the wattage of the bulb used.) (3) The charger can easily be constructed for \$2.00 or less.

This circuit can be used for charging any type of open-cell ni-cad with little damage to the battery. For sealed-cell ni-cads, it is critical that the recommended charge rate is not exceeded, however the C/15 hour rate is probably safe in most cases. If sealed cells are charged at higher rates, care should be taken to terminate the charging when the cells reach a potential of 1.50 volts each (measured without a load on the battery).

The time required to fully charge a ni-cad battery by constant current methods may be estimated by assuming a 70% charging efficiency. The actual efficiency is practically 100% for the first 2/3 of the charge but starts to drop off when electrolysis of water (evolution of gas) occurs, and eventually drops to zero when full charge is reached. The time required to charge a battery is expressed by the relationship:

$$\text{Charge time} = \frac{\text{amp-hour capacity}}{\text{charging current}} \times 1.4$$

Therefore the time required to fully charge a 10-amp-hour battery at a rate of 2 amps is: $10 \text{ amp-hours} / 2 \text{ amps} \times 1.4 = 7.14 \text{ hours}$. Maximum charge for most open ni-cads is also indicated by a voltage of 1.55 to 1.6 volts per cell (measured without a load).

SELF-DISCHARGE

The most rapid period of self-discharge takes place immediately after the battery is removed from the charger. Any ni-cad battery that has been fully charged loses 10-15% of its charge within the first 24 hours. After 24 hours, self-discharge decreases to about 40% per year. Oxygen liberated by electrolysis during charging is sorbed on the cell plates (electrodes) and accounts for a significant fraction of maximum charge or amp-hour capacity of the battery. However this fraction of the charge is unavoidably lost very soon after cessation of charging by diffusion of the oxygen off of the electrodes. Therefore, anyone requiring maximum battery output for extended dives, should realize, first, the necessity of charging the battery at the proper rate, and second, the importance of maintaining the battery on charge until the last minute before it is to be used.

ELECTROLYTE

The electrolyte used in open-cell ni-cad batteries is a solution of potassium hydroxide (KOH) in water. The concentration is usually 25 to 30% by weight. Potassium hydroxide is normally obtained in solid form from any chemical supply store or chemistry laboratory. A suitable electrolyte can be easily made by dissolving reagent grade (not technical grade) KOH in distilled water. For example, to make a small quantity of 30% KOH electrolyte, simply dissolve 30 grams (1.1 avior. oz.) of solid KOH in 70 grams, or 70 milliliters (2.4 U.S. liq. oz.) of distilled water. KOH solution is corrosive, if you get it on your skin wash it off with plenty of water and then with vinegar.

The most important factor leading to destruction of the electrolyte in a ni-cad cell is exposure to the atmosphere. Carbon dioxide in the air rapidly reacts with the KOH electrolyte to form K_2CO_3 (potassium carbonate). The presence of K_2CO_3 reduces the conductivity of the electrolyte and results in loss of charge capacity of the battery. The white crystals

that form around the tops of ni-cads where electrolyte has spattered are K_2CO_3 , but these are easily removed by rinsing with water. Problems with the electrolyte can be reduced by opening the cells only when it is absolutely necessary. Each time the cell is opened, the space above the plates becomes filled with air containing CO_2 that quickly reacts with the electrolyte to form the unwanted K_2CO_3 .

A second factor that is critical to preservation of electrolyte is the addition of only distilled water. Electrolysis, which consumes water only, occurs during normal charging of the battery, and usually requires that water be added to some cells after every 2 or 3 chargings. Normal tap water should never be added to the electrolyte because it contains bicarbonates, sulfates, nitrates, chlorides and other salts which are harmful to the efficient operation of the cell.

Dealers in surplus ni-cads take no measures to preserve or insure the quality of the electrolyte in the batteries they sell and in most cases the electrolyte is very old and may have been exposed to the atmosphere for long periods of time. For this reason, when buying surplus batteries, it is advisable to rinse out the old electrolyte with distilled water and replace it with new electrolyte.

The foregoing discussion is intended to provide the interested layman with some general information about the use of ni-cad batteries. For a more comprehensive and detailed discussion of the electrochemistry of ni-cad cells of various types, see the Kirk-Olmer Encyclopedia of Chemical Technology, Vol. 3, p. 163-208. Also provided in the Kirk-Olmer reference is an extensive bibliography of technical literature dealing with ni-cad cells.

* * * * *

DEVIL'S SINKHOLE, TEXAS

Bill Helmer has written an article, "Confessions of a Reformed Spelunker", in the Texas Caver, Vol. 19, August (1974). The article contains a humorous account of an elaborate but unfruitful cave diving expedition in the lake at Devil's Sinkhole.

* * * * *

MINE DIVING, MICHIGAN

Terry More (NSS 15798) is planning to dive in two more mines (see his article on mine diving in CDS Newsletter, Vol. 1, page 31, winter, (1974)) this summer, the Holy Oak silver mine and Ropes gold mine. He writes that the Holy Oak looks very interesting and divisible with visibility of 20 feet or so. It is an old mine 1870-80's and the prospects for artifacts are good. The Ropes on the other hand is more recent as mining stopped in the late 30's.

* * * * *

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