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Recycling Mine Cap lamps.

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Many of the lamps of the Oldham or MSA type cap lamp units have found their way into the hands (or at least on to the heads) of cavers. Because of the strength of their engineering design, they survive for many years, far outlasting the lead - acid accumulators that powered them.

The cost of the modern miner's lamp accumulators has become unreasonable, and their performance in caving situations has become unacceptably poor. For example, whereas the old hard rubber cased accumulators from 1960 that I have will still give about 6 hours high beam operation, batteries as little as 3 years old become open circuit, or short circuit, and are unusable. The old batteries used thick sponge - wood separators and tubular *Exide-Ironclad* type positive plates and so the batteries could survive being discharged and neglected. The modern batteries may be cheaper to manufacture but they are far less durable. So when it comes to a matter of replacing the accumulators for miner's cap lamps there are several options:

(1) replace the accumulator with a new one ($100+). If you do this be warned about a change to modern mine accumulators. They are now fitted with a fuse in the lid of the accumulator which is not accessible without special tools i.e. not likely to be able to be repaired in a cave. My advice is to open the lid of the accumulator when you get it and wire a link of two strands of 8 amp or one of 16 amp fuse wire across the fuse. This is easily available for repairing household fuses. This will ensure that the fuse in your lamp will not blow while you are underground. The original fuse was mainly used to satisfy mine safety demands that no spark should be generated by a lamp when in explosive atmospheres, even if a rail car ran over a lamp lead. I have not heard of any cavers having accidents with the old type of accumulator that had no fuse, but a short circuit in the cap lamp would blow a 16 amp fuse rather than melt the cable.

(2) The second option is to buy a "gel cell", a sealed no maintenance (except to keep it charged) lead - acid battery, about $30+. There are a large number of brands, sizes and voltages of these batteries so you can find one to suit your needs. They are not armoured for cave use, have no belt

fixtures and have no strain relief facilities for anchoring the cable of the cap lamp. So to use these batteries some alternatives exist:

(a) find a type that will fit inside the emptied casing of your old miners lamp accumulator. I have seen a battery that will fit inside a modern (plastic) accumulator case.

(b) make or find a strong case with belt fixtures and anchor point for the lamp cable.

(3) The third battery option is to find a nickel - cadmium

accumulator to run the system. This may need a case - belt - cable anchor job like (2) (b). The voltages that nickel - cadmium batteries come in are 1.2, 2.4, 3.6, 4.8 and 6 volts. There are reasons why the 2.5 volt system as is used by the Speleo Technics FX-2 is a good idea, the nickel cadmium cells run out very quickly, and, on a high voltage (e.g. 6 volts) system, as the battery runs down, one cell , the weakest, will run flat first and it will then charge in reverse polarity by the current of the other cells. This is bad for NiCds. With two cells, when one is flat the other does not have enough voltage on its own to seriously back charge the other, besides the light has gone out and the battery will be turned off. The nickel - cadmium batteries are rated as having a life of over 200 charge discharge cycles, but they should be deep cycled occasionally to avoid apparent loss of capacity, and there is no practical quick - top - up charging system that is as good as that for lead - acid batteries.

(4) the fourth battery option is to make up a system to use primary cells. These are the disposable torch batteries that are universally available. For caving the best type is the alkaline cell. A D size alkaline cell should have a capacity of over 10 Ampere/hours and a shelf life of about 4 years. Although they seem expensive, it is often found that in a four year period of caving, the cost of a miners lamp accumulator, gel-cell or nickel - cadmium system is greater that the cost of running a system with primary cells.

To use dry cells a battery holder is needed together with the attributes that a rechargeable battery needs. One solution is the Bonwick pattern dry-cell holders. The first of these was made by John Bonwick for his own use, and used 4 D size dry cells to run 6 Volt torch bulbs in a cap lamp. Figure 1 shows the version of this design that I made, slightly different to John Bonwick's. The batteries are open to the world, but are restrained by rubber bands. This can be made in two cell or four cell versions for 3 Volts or 6 Volts. Although it occasionally falters, a little push on the batteries clears any dirt on the contacts. The unit will fit in a pocket which may be more convenient than on a belt. The 3 volt version with a 300mA bulb should run for 30 hours on two alkaline D cells.

Another do-it-yourself battery holder is the Ackroyd type *sewer light* [1]. These are robust and can be made waterproof, and are made with a technology available to most cavers. I have made these for both NiCd and alkaline D cells. This introduces the topic of:

Interchangeable Systems.

My variation on the Ackroyd Sewer Light design (Figure 2) introduces a combined strain relief and connector (Figure 3). The internals are different from the original, a keyed bottom contact plate, and a heavily engineered top contact/cable entry section. With a lamp fitted with a connector, one can swap from a rechargeable system for every day caving to a dry cell system for expeditions that can be transported in aeroplanes and does not rely on recharging power sources. In between times a pack of dry cells can be a reserve for a rechargeable system on long trips. My systems have 4 Volt gel-cell packs, 3 cell NiCd Sewer Light packs and 3 cell alkaline Sewer Light packs.

The lead acid, NiCd or alkaline cell choice gives you the option of using other than the 4 Volt system used in the original miners lamps. Of the other systems 3 Volt and 6 Volt would seem to be the best idea because if you change voltage you have to find a source of lamps of the appropriate power and voltage.

Lamps (bulbs globes etc)

Quartz-Iodine (halogen) bulbs are only available for high current rating of about 0.8 Ampere or higher. Very white light, very high efficiency.

Gas filled bulbs use very low pressure gas in bulb to stop tungsten filament material depositing on the bulb, blackening it and reducing light output. The gas that works best is Krypton, but Xenon or Argon will work. These bubs can be run brighter without blackening the bulb and as efficiency increases with filament temperature these are more efficient than vacuum bulbs.

Vacuum filled (or emptied) bulbs blacken if run at maximum brightness thus shortening their efficient life. If they are run at a lower voltage they will last much longer but they will be much less efficient. Most bulbs are of this type unless marked otherwise.

Sources of bulbs. Good hardware stores have a range of bulbs in various base styles, mainly vacuum filled but some are Quartz- Iodine. Maglight sellers have some interesting pre-focus gas filled bulbs but they may not focus properly in a miners cap lamp. A 0.7 Ampere bulb will run for 60 - 70% longer on alkaline cells than a 1 Ampere Quartz - Iodine bulb because the batteries become more efficient at a lower drain rate. Petzl sellers have gas filled bubs of lower power rating as well as quartz. Some are pre-focus, some miniature edison screw,(the traditional torch bulb base).

Recharging storage batteries.

NiCd batteries should be recharged at the 10 hour rate or less at constant current for 140% of the charge used. Usually best to run them flat after a trip and charge them for 24 hours at about the 20 hour rate.

Lead acid, including gel-cells, are very easy and fast to recharge with constant voltage electronic regulators. There is no need to limit the maximum charging rate if the regulator has safe area operation limits unless the battery is very hot (do not leave batteries in the sun as the high temperature degrades their operation). Simply connect the battery to the charger and the battery will regulate its own charging rate to safe levels and stop drawing power when it is fully charged. Figure 4 shows the circuit of a good automatic charger for 4 volt batteries (the same regulator can regulate from 2 volts to 24 volts by changing the resistors.) Do not leave gel-cells in a discharged state; they sometimes get into a state where they will not accept charging, the only way to cure this is to charge them. This may mean leaving the battery on a charger for weeks until the minute current that leaks into them starts to build up to the normal charging rate.

Dry cells are unsafe to recharge. Although some recharging is possible, the gas that may evolve can pressurise them and cause them to leak or explode. The state that the cells would be in would be too unreliable for cave lighting.

LITERATURE CITED

[1] Ackroyd, P. (1989) An extremely low maintenance expedition light. Australian Caver No. 121 Pp. 8 - 11

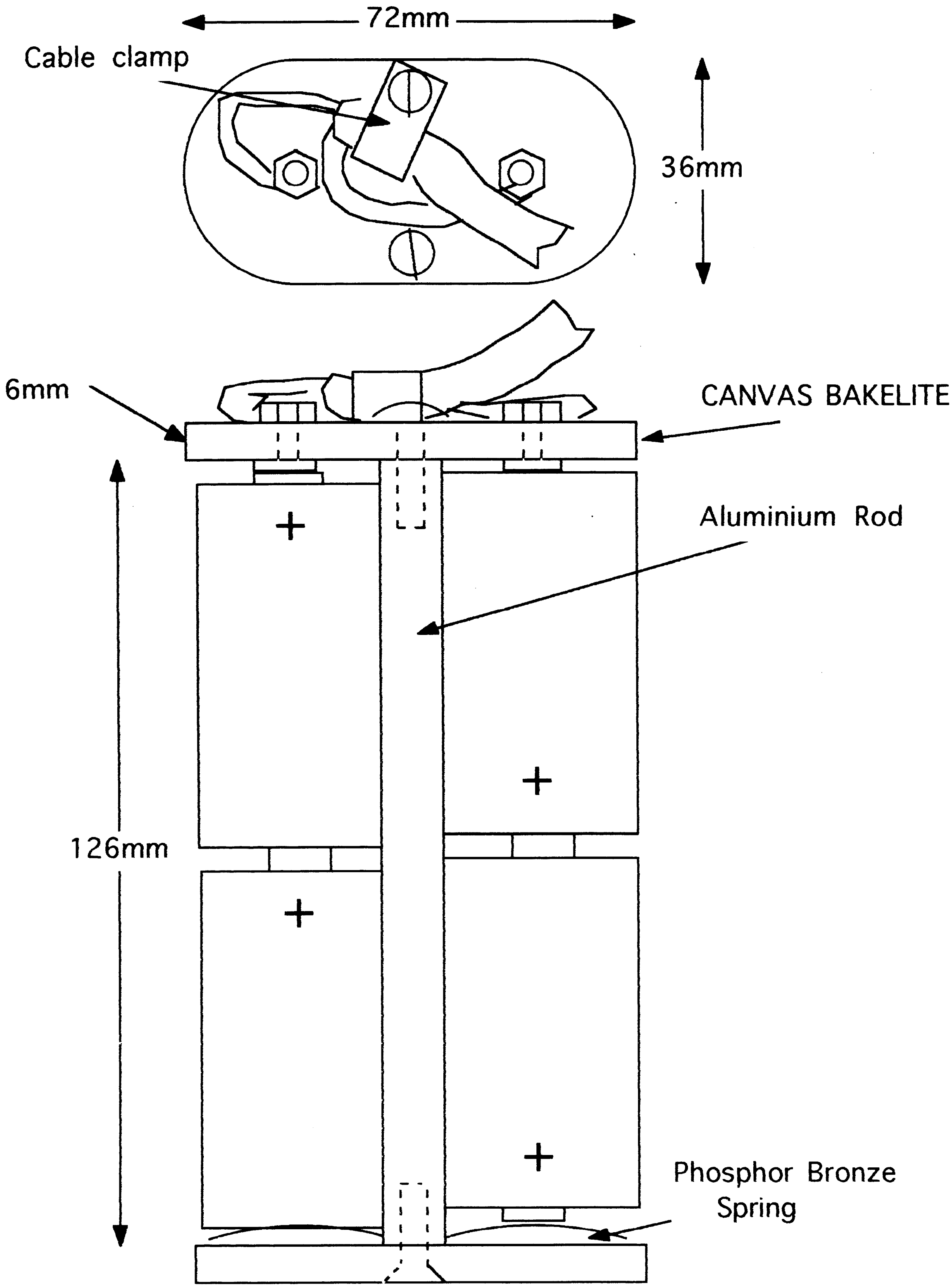


Figure 1. Four cell battery holder of the Bonwick type. The phosphor bronze contact spring is secured with two small screws to the insulating board.

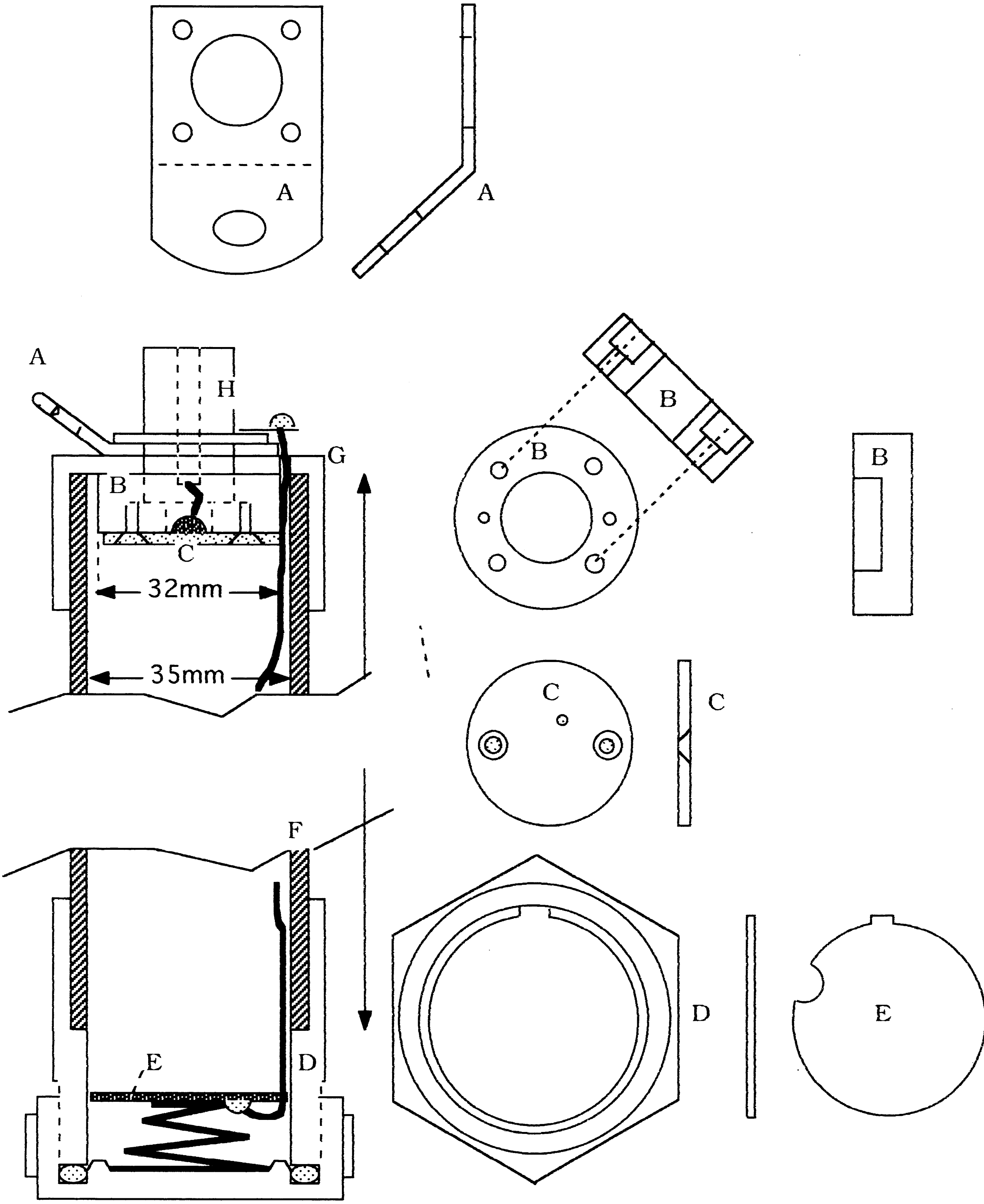


Figure 2. Sewer Light type battery holder. A is the lug to secure holder to a belt, B is made of PVC or wood, C is a brass disc 1.6mm thick, D is the screwed base fitting, E is a keyed disc of 1.6mm. brass, F is PVC 40 mm. tube, G is the cap fitting, H is a UHF co-axial cable connector. Four 3mm countersunk screws which must not contact C pass through B and secure the co-ax connector.

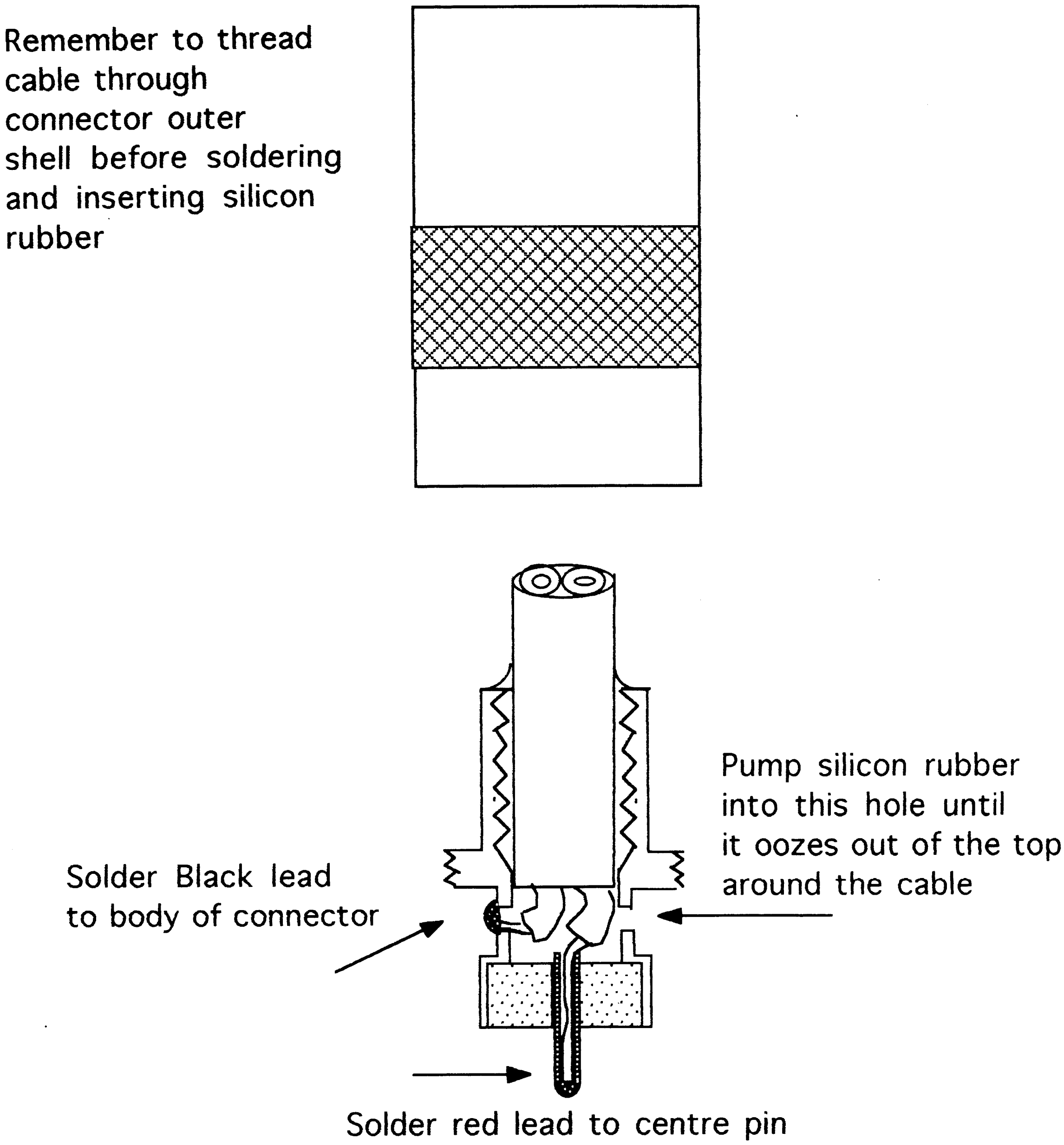
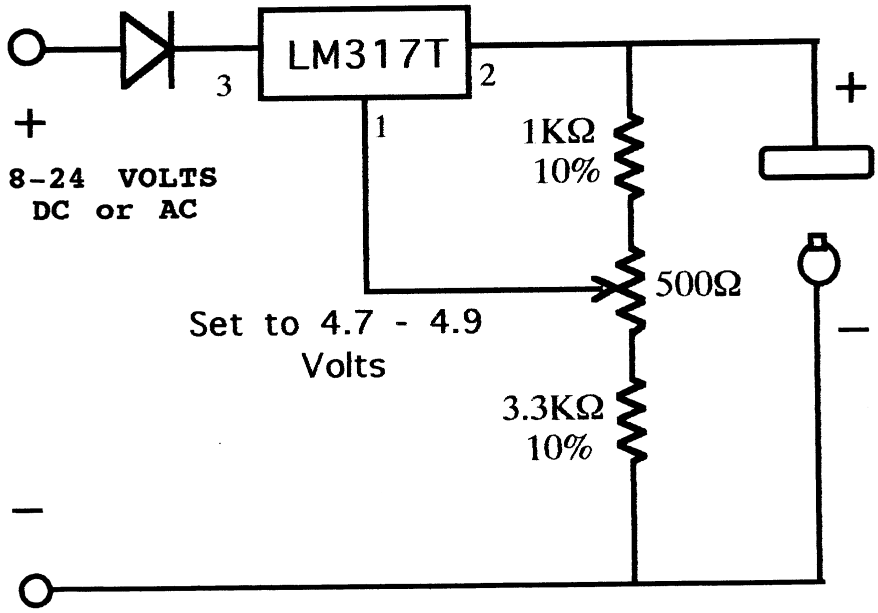


Figure 3. Detail of the fixing and sealing of the co-ax connector to the cap lamp cable. Use the roof and gutter silicone rubber, not the type that smells of vinegar.



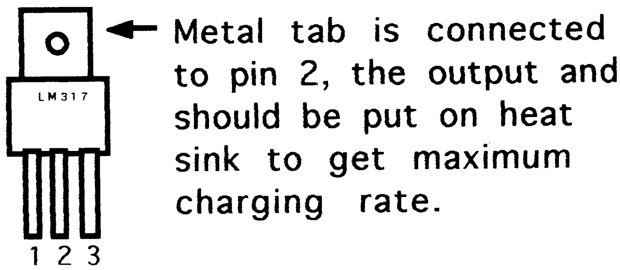


Figure 4. A circuit for a 4 Volt lead acid battery charger. To adjust, connect a 100 ohm resistor across the output terminals and adjust the output voltage measured with a digital voltmeter.