ARMOURERS FAULT FINDING AND REPAIR PAGE

1. How The Equipment Works

A basic understanding of how the system works will help with diagnosing faults. The explanation below is only a guide, not a full specification

1.1 Glossary

Short circuit: A connection. (As per a torch switch in the on position) The rules state the resistance limits.
Open circuit: No connection (As per a torch switch in the off position) The rules state the resistance limits.
Near Pin: The connector contact 15mm from the centre pin.
Far Pin: The pin 20mm from the centre pin.

1.2 Foil

The three wires for each fencer are:
Centre: Wire in foil blade (connects to the point)
Far pin: Foil blade (connects to the barrel)
Near Pin: Jacket

Note that it does matter which way round the two weapon wires are. The inside guard socket is fencers equipment and may be of any design. The bayonet type has the foil wire as the inside contact. The two-pin type is notoriously unreliable. The foil is a "push to break" switch. The design of the switch is not laid down in the rules, only certain parameters such as the shape of the point (diameter & bevel), the threaded end of the blade etc. (see the rules for details). When the point is not depressed, current flows around the weapon circuit. If the circuit is broken (either by a fault or by depressing the point) then off target lamp lights. Foil therefore tends to show up intermittent breaks in the weapon circuit. If there is a short circuit between the foil wire and the blade then no hit will register because breaking the circuit at the point makes no difference; the apparatus still sees a short circuit. If the guard is touching the jacket (or equivalent short circuit anywhere in the system) then the hit will not register. Note that if one fencer cannot register hits, it could be because the other fencer has a short between the guard and jacket. This sometimes happens because a bodywire is wired wrongly. If the point is touching the opponents target and then the point pushed in then the coloured lamp lights. With some boxes, if there is a short between a fencers centre wire and jacket wire then off-targets will register as hits against themselves.

1.3 Sabre

The three wires for each fencer are:
Centre: Sabre blade Far pin: Sabre blade
Near Pin: Jacket

Bodywire is the same as for foil. The inside guard socket is fencers equipment and may be of any design. The sabre (for current rules) is electrically a short circuit. However, since some old club boxes need sensors fitted, this is described here. The sensor was a "shake to break" switch. The design of the switch was not laid down in the rules, only certain parameters. It was basically a metal weight on a spring in a metal cage. When static it was a short circuit. The rules currently require sabres without sensors, relying only on contact between blade and target to register hits. Since the rules are evolving, some sabre boxes are programmable. When sensors are used, they ensure that hits cannot be scored by "laying" blade on the target. To score, the fencer must hit the sabre onto the target so that the sensor becomes briefly open circuit and the blade is in contact with the target. The sensor is very sensitive so almost any contact will register. Fencing without a sensor therefore makes little difference but leads to less equipment problems since only two of the three wires are needed.

An important factor to consider when buying a sabre box is the "whip around time". Ideally get a box which can meet the rules or which is programmable. Cheaper boxes are available but it is annoying to be hit through a parry by a long whip !

1.4 Epee

The three wires for each fencer are:
Centre: Wire in epee blade
Far pin: Epee blade / guard / barrel
Near Pin: Wire in epee bladeNote that it does not matter which way round the two blade wires are.

The epee is a "push to make" switch. The design of the switch is not laid down in the rules, only certain parameters such as the shape of the point, the threaded end of the blade etc. (see the rules for details). When the points is depressed, the contact spring (which is connected to the tip of the point but insulated from the barrel) connects between the two wire contacts. The coloured lamp lights. If the point is touching a metal piste or the opponents guard then no hit registers. Note that the piste must be connected to the far pin at either spool or box. It does not matter which sides' spool is used for the piste connection but competitors tend to be re-assured by connecting both ends.

Epee tends to not show up intermittent open circuits ... they just result in lost hits and may be difficult to repeat. Epee does show up intermittent short circuits between the two wires that go to the weapon. This sometimes happens because the insulation of the wires in the spool end becomes punctured by the sockets.

2. Diagnosing Faults

2.1 Methodical Approach

When fencers suspect a problem and cannot immediately identify the fault, try to stop them changing items until you can repeat and understand the fault. Often fencers concentrate on equipment which could not possibly cause the observed symptoms; often at the wrong end. It is better to positively find the fault rather than change equipment until it goes away because with intermittent faults that could result in faulty kit returning to use elsewhere.

Having identified the faulty equipment, try to take time to clearly label it with a full description of the symptoms. On body wires and ground leads, pull back the connector cover. On spools, wrap the cable round the handle. For foils, slide paper over the blade. If you can repair items on the spot then it may saves carrying faulty kit around.

Consider the possibility of multiple faults. These can result in confusing symptoms and there are many possible combinations. All can be puzzled out if you keep thinking about what could possibly cause the symptoms.

The skill of fault finding includes considering all the clues, not just the obvious symptoms. For example, in a first round pool where the first few fights were OK then a new fencer gets white lights on their lst fight, suspect their foil/bodywire before the spool/groundlead.

2.2 Check List Approach;

The left and right circuits are symmetrical. Some years ago the left versus right scoring was swapped. Some old boxes are still wired for the left socket controlling the right lights. For these boxes swap the ground leads. The following list is for one side only; for the other side simply reverse L/R. In all cases, first check that the box is switched to the correct weapon.

2.2.1 Right Fencer cannot Register Hits

Unplug weapon. If white light then weapon faulty
Unplug body wire. If white light then b/wire faulty
Unplug spool. If white light the spool faulty
Unplug ground lead. If white light then g/lead faulty
If no white light then assume short to near pin at other end Unplug other end's foil, bodywire, spool, ground lead until white light appears. If still no light with nothing plugged into the box then suspect the box (probably the bulb if the buzzer can be heard) Label the faulty equipment.

2.2.2 Left Hand White Lamp Continuously On

Suspect open circuit in left fencers foil circuit (ie. either centre or far pins) Remove Left fencers foil plug and short out on guard. If light stops then suspect foil. Short out centre to far pin at ground lead (spool end). If light does not stop then suspect ground lead. Plug ground lead back into spool. Short centre to far pin at the spool - bodywire connector
If the light stops then suspect the bodywire. Otherwise suspect the spool.
Label equipment before changing it.

2.2.3 Left Hand White Light Intermittently On

Suspect the left fencers foil circuit (centre or far pins). Beat left fencers blade (especially French points)
Is barrel tight on blade ?
Is guard / grip tight ?
Manipulate the Bodywire - foil connector
Manipulate the bodywire to spool connector
Pull at the spool wire
Manipulate the ground lead to spool connector.

2.2.4 Left Hand Coloured Lamp when Either fencers hits Off target

Suspect short from jacket (near pin) for foil cct. in right fencers circuit. Disconnect right fencers bodywire from spool. If white lamp lights but not coloured then suspect short in body wire. Disconnect left fencers spool from ground lead If white lamp lights but not coloured then suspect spool. Otherwise suspect short in ground lead. Similarly, all other possible faults may be logically diagnosed.

3. Repairing Personal Kit

3.1 Labelling

Label your kit. Marker pen ink does not insulate and so can be used on electric jackets, foil guards etc.

3.2 Masks:

Regulations for masks have changed. New Masks which are not rated to at least 350N should not be sold / bought. It is recommended that masks not rated to at least 350N be replaced. Local competitions may allow 350N masks but FIE events require 1600N masks.

Do not beat out dents. Take damaged masks to your equipment shop and ask their advice. Be ready to replace. The strength of masks has steadily increased throughout the history of fencing. Old weak masks tend to reappear from attics. Dangerous masks should be crushed before being thrown away. Do not keep them for beginners !

The elastic around the back of the head is compulsory and it is in the fencer’s interest to ensure that their mask does not fall off. The elastic can easily be replaced. If in a hurry, sew the new elastic on to the old ends to save having to fix it to the mask. The lining can be replaced in some masks but consider if full replacement is due. If the bib is weak then have it replaced by the manufacturer. Small bib abrasions may be covered in Araldite as a temporary repair but do not do this if there is risk of puncture.

Electric Sabre masks have lame on the sides as well as the bib. Look out for the lame becoming detached. If necessary a pop rivet with suitable washers may be used to re-fix it. Use washers with a small enough inside diameter to avoid distorting the mesh but as large as possible outside diameter.

Club masks tend to break where the wire frame in the back of the mask meets the frame around the mesh. To avoid this, try to encourage beginners to adjust them by bending the rear-most segment only, not the joint. If they do break, it is possible to fix the top to the inside top of the mask with pop rivets. Use several rivets from the inside with adequate washers.

Club masks become unhygienic and should occasionally be disinfected and washed. An easy way to do this at the club is to use a cloth moistened with an odourless disinfectant washing solution, then another to rinse and another to dry. Take a pack of J-Cloths and a

bottle of cleaner.

If masks are very dirty then use a bucket of odourless disinfectant washing solution and a small scrubbing brush. Dry naturally to minimise rust.

3.3 Breeches

Regulations for breeches have changed. New breeches which are not rated to at least 350N should not be sold / bought. It is recommended that breeches not rated to at least 350N be replaced. Local competitions may allow 350N breeches but FIE events require 800N.

Old breeches with buttons will need a supply of replacements. Use double button hole thread and tie off well. Elastic leg gaiters need replacement after a few years. To save time just cut off the old and sew new around the outside. Tack a starting point, put the breeches on, tighten the elastic to fit, sew tack the end, remove breeches and sew securely.

If you ever throw away a jacket/breeches/plastron then keep some good material for patches. Sew edges of patches down securely to avoid catching a blade. Do not compromise safety. Replacing worn Velcro above zips is worthwhile and can significantly improve safety.

3.4 Jackets

Regulations for jackets have changed. New jackets which are not rated to at least 350N should not be sold / bought. It is recommended that jackets not rated to at least 350N be replaced. Local competitions may allow 350N jackets but FIE events require 800N.

Zips are best replaced by return to the supplier or someone good at sewing. If necessary an adequate fix may be achieved by cutting off the old teeth and sewing a new zip onto the old zip material. Use strong thread double with small stitches. Tie off well. Velcro at neck flaps is worth replacing if worn out.

A hazard to watch out for with some old jackets is cord ties with spikes. Apparently these are excruciating if sat on so tie the spikes down with the cord. If the fabric starts to weaken significantly then replace the jacket. Watch out for failed stitching around the arm.

Club kit should be stored so that it dries and airs to avoid mould. Avoid contact between foil blades and moist clothing as rust stains are difficult to remove. In personal bags, use covers over blades. These may be plastic piping or conduit (from DIY stores).

3.5 Gloves

A common problem is a tear appearing where the bodywire appears. This can be dangerous as it opens an entry to the wrist. The tear should be tightly sewn up with strong thread. Gloves should be replaced if there are dangerous holes or if the wrist is not safely covered.

3.6 Plastrons

Regulations for plastrons have changed. Now compulsory for all fencers. Now require 350N or better for steamed fencing or events with size 3 or smaller blades. All other fencing to use 800N or better plastron.

3.7 Steamed Foils

Keep a bag of plastic buttons ... they don't last long. Use a knife to cut the old one off and remember that the blade may have metal splinters. Steamed foil blades are usually weaker than electric blades so don't pull too hard when straightening them. Do not use abrasive paper to remove rust; the blade would get thinner each time ! Grinding is forbidden by the rules. If rust is a problem then either replace the blade or rub in some oil with a cloth.

3.8 Bodywires:

Probably the commonest failure overall is the wires breaking at the body wire ends. With transparent insulation the fault is usually visible. Otherwise use a pin as a probe to measure continuity.

Insulation piercing connectors are easiest to repair, just unscrew, push the wires through beyond the break, re-tighten the screws and cut off the excess wire. Re-fix the wires in the cable clamp moulded into the side of the plastic.

If repairing the non-insulation piercing types, be aware that the screws tend to shear off the soft copper strands.

An occasional failure is due to the screw in the end of bayonet plugs not being tight. This is worth tightening occasionally on all the bodywires you can find.

When fitting crocodile clips, leave enough flexible wire between the cable clamp / screw and the soldered moving section. Strain relief is important. Ideally use heatshrink sleeving but otherwise re-use the sleeving from the broken end.

3.9 Lame Jackets and overgloves.

When any lame item is finally thrown away, keep as much good material as possible for patches. To find the limits of dead spots, use an old foil point as a probe for a meter. Sew down the edges of patches well so that a blade will not catch. If the insulation on the inside has to be cut then tape it up well afterwards. If the insulation is not continuous then an off target hit (eg on the leg, arm or mask) could register as on target because of conduction through sweat to the jacket.

3.10 Weapon Repair: Electric Foil

3.10.1 Fault Finding

Most faults may be found with a meter. A bodywire makes convenient connection to the socket. Use leads with crocodile clips. A pin is useful for probing.

3.10.2 Loose Barrel

Repair lose barrels as soon as possible to avoid damaging the wire and also because of the safety risk. Loosen it a little, run in Loctite then quickly tighten with round pliers. If the barrel has flat sides for a spanner then use them. The barrel must only be gripped near where it screws onto the blade. If you grip it near the point then it will deform and the point will not move so smoothly.

There are two common reasons for barrels coming lose; either it was not correctly fitted (tightly with glued, clean surfaces) or the threads are not correctly matched. Some eastern blades have threads which are similar but not identical.

3.10.3 Rewire

3.10.3.1. Obtain a new wire from your supplier. You may either buy a complete re-wire (easiest) or a hank of wire (cheapest). If desperate, enamelled copper wire may be used but take care not to scratch the insulation.

3.10.3.2. Dismantle the weapon. Verify the break in the wire. If the wire is broken near the guard then it may be possible to solder on a new section without re-wiring. If the break is not visible then use a pin to probe along and find how far the wire conducts. Having verified that a rewire is required, hold the blade in a vice and remove the barrel with round pliers. Grip the barrel near the blade to avoid deforming it.

3.10.3.3. Pull out as much of the wire as possible then remove the rest with a scraper. A short length of broken hacksaw blade held in a mole wrench is recommended. Clean the thread on the end of the blade (e.g. with a fine brass wire brush).

3.10.3.4. Retract the grub screws from the barrel enough to remove the point and spring. With some points you have to remove the screws. Look inside the barrel and undo the screws a little more so that they do not protrude inside the barrel. Use a blunt rod or flat bladed screwdriver though the hole where the blade was to ease the plastic cup out of the barrel.

3.10.3.5. If you are fitting a complete rewire (with its new cup and brass insert) then put the old cup in your tool kit for future use. If you are re-using the old cup then remove the brass insert. Unsolder the old wire. Thread the plastic cup over the wire end, solder the new wire in to the brass insert, allow to cool and fit into the plastic cup.

3.10.3.6. Thread the barrel onto the wire but do not pull the cup down into the barrel. Prepare your glue (Araldite is good but messy; Loctite is quick but does not span/fill

gaps).

3.10.3.7. Apply glue to the thread on the end of the blade. Screw on the barrel while keeping the wire moving freely. This is essential to avoid the wire becoming trapped against the end of the blade.

3.10.3.8. Gently ease the plastic cup down into the barrel, taking up the slack with the wire but not pulling hard. Refit the spring and point then tighten the grub screws.

3.10.3.9. Put glue in the groove all the way along and on the wire. If using Araldite you may choose to use latex disposable gloves and smear the glue onto the wire with your fingers. Insert the wire into the groove, keeping it fairly taught but not pulling so hard as to pull the wire out of the cup in the barrel. If using Araldite then run a spreader down the groove over the wire to ensure that the wire is squashed against the bottom and saturated with glue.

3.10.3.10. Put paper around the tang, then wrap the wire around so that it stays tight. Fit the blade under a bench so that it has a slight curve.

3.10.3.11. When the glue is firm, scrape off excess from the top of the blade, refit the sleeving and reassemble the weapon.

3.10.4 Cutting Down Blade

3.10.4.1. Obtain file and hacksaw. For French grips with threaded pommels or for pistol grips you will also need an M6 die in holder.

3.10.4.2. Use the old tang to mark out the required length. Check again before cutting ! Be careful to avoid damaging the wire. Holding the blade in a vice, cut off the excess tang.

3.10.4.3. For French grip pommels using brass adapters, simply use the edge of the file to cut slots, checking the fit of the adapter as you go, then reassemble the weapon.

3.10.4.4. To thread the tang, first file the end of the tang into a cone so that the die can start to cut. This cone should be central on the tang. Check that the tang is reasonably round. Some eastern blades are supplied with tangs that are rather narrow and flat; some lumps may have to be filed off.

3.10.4.5. Apply oil (or cutting compound if you have it) to the die and tang. If your die is adjustable then adjust the die holder for maximum size.

3.10.4.6. Place the die on the tang, keeping it flat. Press down firmly while starting the thread. Once the thread is started then apply moderate downward pressure while rotating it 1/2 turn clockwise. Turn back 1/4 turn then repeat until the length of thread equals that on the old tang.

3.10.5 Adjusting Spring for weight test. The foil point should be able to lift 500g (rule change likely). This rarely requires adjustment. A possible cause of the failure is that the barrel is deformed (eg. trodden on !). To avoid this, keep your weapons in tubing to protect the points. If you have to stretch the spring then simply hold each end and pull. Stretch a little at a time until the weapon lifts the weight, then a little more so that it stays legal.

3.10.6 Pommel will not Tighten. If the pommel nut cannot fully tighten the guard/connector onto the blade then white lights may result. Ensure that the tang is threaded far enough down. With French grips, ensure that the length of tang beyond the brass adapter is not too long for the cavity in the pommel.

3.10.7 Inside Guard Socket. The bayonet type inside guard socket has a sprung brass contact. Eventually the spring weakens and the brass oxidises. It is possible to remove the plastic moulding from the metal frame, stretch the spring and reassemble. This is difficult because the metal frame has to hold the plastic tightly. Cleaning the brass contact may be done with a rolled up scrap of fine emery paper or with a miniature wire brush on a drill.

3.10.8 "Crushed Wire". This term is used to describe the wire being trapped between the blade and the guard/socket/grip, thus puncturing the insulation and stopping hits being registered.

3.10.9 Barrel not Contacting Blade: It is possible for a film of glue to insulate the barrel from the blade. If this happens then a re-wire is likely to be required.

3.10.10 Point Problems. Some French points have a small brass disk riveted onto the back of the point. The swageing of the rivet loosens with time resulting in white lights when the blade is beaten. The swageing may easily be tightened by placing the point face down on a bench and tapping the swaged end with a centre point. This fix will not last long so replace the point soon.

3.11 Weapon Repair: Epee.

Epees require most maintenance because they have two wires, two springs and most designs often need adjustment during competitions.

3.11.1 Loose Barrel. As per foil section, loosen slightly then run in Loctite then tighten with either spanner (if the barrel has flat sections) or round pliers. Avoid deforming the barrel by only gripping near the blade.

3.11.2 Rust on Guard. If the opponent can register hits on the steel part of the guard but not on the aluminium part then it may be because of rust. This may be cleaned off with emery paper.

3.11.3 Rewire. As for foil section but now there are two wires Instead of a plastic cup, the epee has a plastic insert with two holes. The uninsulated ends of the wires are inserted into these holes and the brass contact pins inserted to fix them. It is important that the two contacts are pressed down so that they are level. Uninsulated wire should not protrude outside the plastic insert. After fitting the barrel to the blade, press the plastic insert down into the barrel with a flat bladed screw driver, taking up the slack by very gently pulling the wires. Remember that the wires are only held in by friction with the contact pins.

3.11.4 Cutting Down Blade. See Foil section.

3.11.5 Wire Shorting to Blade/guard (Crushed wire). Carefully loosen the grip and rearrange the wires into the groove. Ensure that the wires are sleeved right up to the notch in the guard.

3.11.6 Adjusting Contact Spring for Travel test. The contact spring must be adjusted so that when the point is fully depressed it does connect both brass contacts but with a 0.5mm gauge it does not. On some points this may be adjusted by screwing the point in or out on a thread in the point. There is no need to replace the grub screws until you have verified that it passes but the point must then be kept the same way round. The spring will not be exactly straight and the contacts will not be exactly level so if you rotate the point 180° it will give a different result. If the contact spring keeps needing readjustment because it is loose in the point then either add a little nail varnish or slightly squash the end of the spring that screws in.

3.11.7 Adjusting Point Spring for Weight test. As for foil, stretch until the test passes, plus a little so that it will stay legal.

3.12 Weapon Repair: Sabre.

Commonest problem is a faulty sensor. Dropping the sensor on the floor may help but otherwise it may require adjustment. The wire from the sensor socket to the inside guard socket is vulnerable; it is best to tape it to the guard under the pad. It is important that the wire is insulated from the guard. If the pommel will not tighten then check that the tang is not too long to fit in the nut and has enough thread. If necessary, fit washers between the grip and pad. A hazard to watch out for with club sabres is sharp slivers of aluminium sticking out of the edge of the guard. These may be removed with a file or if necessary, the guard replaced.

4 Repairing the Apparatus

4.1 The Box.

Before repairing a box, first re-check the symptoms. Consider and check simple possibilities first: could it be simply a blown bulb or low batteries ?

4.1.1 Bulbs.

12V 2.2W MES bulbs are available from the equipment suppliers or by mail order from electronics distributors. Maplin (01702 554161) sells their item WL81C by credit card order and they take orders 24hrs for next day despatch.

4.1.2 Batteries.

When changing batteries in club model Leon Paul boxes, be sure to refit the plastic nut on the threaded stud which holds the plate down. Do check that the threaded stud is screwed into its insert in the base of the box. Do not over tighten the nut or the thread will strip. If the nut is missing then buy a new one. Ever Ready type P996 (or 908S and GP equivalents) is a 6V battery with coiled spring contacts. It is rated at 6.4Ah with an 8.2 ohms load for 30mins/day to 3.6V. Unfortunately the club model boxes give no indication when the batteries are low and incorrect operation is near. The best way to check the batteries is in the box (on foil) with the lights flashing, measure the voltage where the wires join the circuit board. It should be 12V. If it is much less than l0V then change the batteries. This type of battery is available in some garden centres and DIY shops. Lower cost versions are often available in markets. Types with caps over the contacts and a plastic wrapper give confidence that they have not been shorting out in the shop.

It is possible to use a transformer instead of batteries but the value of safety issues (and hastle of mains leads) should be considered.

It is possible to use rechargeable batteries. At the time of writing, RS sell a rechargeable equivalent for approx £35 (ie. £70 per box) with built in mains charger. This is cheaper than the mains option but the battery capacity is small and so recharges would often be needed.

4.1.3 Thoughts for the Future.

If the box is always switched off after use then battery life is acceptable (approx 1 year at 2hrs per week seems typical). This would be more acceptable is the LED on the top dimmed before the low battery caused mis-operation. This could be achieved with a simple modification (add one zener diode).. A future idea for club boxes would be to switch itself off if no hits have been scored for an hour. This would be a simpler modification because no soldering to the circuit board would be required. Apply to the author for details.

4.1.4 Reset Circuit.

One of the commonest problems with old boxes is with the reset circuit. Some boxes use relays for this. The relay cuts the power and cutting the power resets the relay. If you have a problem, return the box to the manufacturer. In most newer boxes the when reset circuit times out, all four lamp latches are reset. This resets the reset circuit without interrupting the power and ensures that reset actually happens before it is released. Knobs for the variable time delay are available from the supplier or from electronics distributors.

4.2 Power Leads.

*** DANGER OF DEATH ***

Be aware that the mains can kill. Fencers are particularly vulnerable because they are moist with sweat covered in wires/lame and may be on a metal piste. If in doubt always safely switch off the supply and remove suspect power leads from where they may be used, cutting off the suspect connector. Mains leads should always be of double insulated cable (each of the three strands insulated with standard colouring and then an outer cover). Never use ground lead wire.

13A UK Mains Plugs: Mains plugs should be wired carefully. The outer cover should extend into the plug and be gripped by the strain relief clamp. Be aware that moulded plugs are not invincible. If suspect then cut them off and carefully fit a new plug. A 3 Amp fuse is suitable. Do contact screws should be tight but not so tight as to cut the strands. Check that each wire is firmly held and that there are no lose strands.

IEC Connectors (the more rectangular type): Ensure that the cable clamp / strain relief is correctly fitted. Any damaged connector should be replaced. Wire it carefully,

avoiding loose stands of wire.

On the (Un) Suitability of Round Bulgin Connectors: The round Bulgin connectors used on older boxes are not rated for mains voltage for applications where they are accessible. The power connections are not sufficiently recessed and so they should always be plugged in before power is applied. The plastic is brittle and tends to crack. The cable strain relief grommet is difficult to fit and so often gets left out. The fibre washer does not adequately ensure that the wire are not twisted when the back is screwed on. The plastic vanes between the screw terminations do not adequately ensure separation of the wires from other terminals if there are lose strands of if a wire breaks. The screw terminations are totally unsuitable. The screws do not press the wires against a flat surface, they shear them off at the edge of the hole, even if they are only just touching the strands. The socket contact unscrew themselves with use and have been known to fall out. Some of the oldest small round Bulgin connectors had solder connections but there was still no proper separator between the wires.

In summary, I do not recommend use of equipment with the round connectors. The following notes are only provided so that if you do repair one of these leads then you do it as safely as reasonably possible. 1. Obtain a new connector and cable strain relief.
2. Obtain silicone adhesive (eg. Dow Corning RTV).
3. Switch on a soldering iron.
4. Cut off the old connector. Open it and note the connections. The should agree with the L N and E moulded onto the new part. (Brown = Live, Blue = Neutral, Yellow/Green = Earth).
5. Thread the back of the connector, the cable strain relief and the washer onto the cable.
6. Remove about 20mm of the outer cover of the cable end.
7. Remove about 6mm of insulation from each of 3 strands. Tin the cable ends with solder. Do not heat for too long or the PVC insulation will shrink back.
8. On the base of the new connector, note the moulded L, N & E. Unscrew the three screws. Melt solder into each of the three wire holes, insert the correct wire, solder it in. While the solder is molten, very gently screw down the screw until it just touches the wire.
9. Apply silicone adhesive to each of the three wires to secure them to the correct area of the base. Apply enough so that no wire could come loose and touch another.
10. Slide down the washer and strain relief.
11. Screw on the connector back, holding the strain relief so that the cable cannot turn.
12. Test each connection in turn and test for shorts between each connection. Allow the adhesive to set. 13. Recommend to your club that this equipment is phased out in time. Apparatus of this vintage is no longer maintained by the manufacturer. Battery boxes are safer.

4.3 Spools:

There are many designs, most of which have similar problems. The use of fixed wire systems instead of spools is not a feasible option for most clubs unless you own your hall. Wireless systems are evolving but there are many hurdles to be overcome to make a low cost, dependable system. Experience is that club members take more care of kit if it looks well maintained. This makes it worth painting spools in club colours. It also makes them easier to find after competitions.

4.3.1 Springs:

Wire does not retract: This is usually because a spring has broken or become screwed up. Each spool contains three spring assemblies (spring in can) connected to effectively form one very long spring. Don't try to repair springs while wearing fencing kit; you are bound to get dirty. A good scheme is to keep a stock of spring assemblies in small box containing a bag of good springs and a bag of failed springs. Educate club members not to let spool ends whip back; this results in the springs screwing up in side or breaking at the centre. Springs usually only break at the outside as a result of long fleches.

4.3.1.1. Repairing spring assemblies:

Wipe the outside of the case. Remove the lid. If tight, hold the spool lid down on a

bench and push the lip with a screwdriver.

4.3.1.2. If both ends of the spring are intact but the end that joins the boss is screwed up then unwind, straighten and refit only that part. If the spring has broken then identify which end of the spring has failed. If it has failed where it meets the outside of the case then skip the rest of this paragraph. Often it is the point where it is bolted to the centre boss. In this case it is possible (but difficult) to repair it without removing the spring from its case. If the spring is very dirty, however, and if you have time, you might chose to take it out and clean it, per the next section. A quick repair is as follows. Safety goggles and disposable gloves are recommended. Carefully unfurl about 50cm and hold the rest of the spring in a vice. You may choose to wear disposable gloves. Remove the screw and broken end from the centre boss. Use the old hole to select a drill bit to drill a new hole in the end. Refit the boss to the spring end. Check which way round it is one of the four possibilities is correct. Hold the spring into the case while winding it back in. Refit the cover; if tight then put the case flat on the bench and hit the cover firmly. Occasionally it is necessary to slightly straighten the crimps in the cover rim.

4.3.1.3. Full Spring Repair:

These instructions assume that the spring has broken where it meets the case. You will need a large enough area to lay out the spring without worrying about dirty oil. Put down a plastic dust sheet so that the dirty, sticky spring does not pickup or put down more dirt. Safety goggles and disposable gloves are recommended. Gradually unwind the entire spring from the case onto the floor. Wipe it (cloth or kitchen paper) to remove the dirty oil. Put the empty case on a bench and carefully remove the nut/bolt securing the end of the spring. Keep the parts ! Drill a new hole using the old end as template. Remove any swarf from around the hole with a larger drill. Refit the end of the spring into the spool, checking that the hole is in exactly the right place. Repeat with a new hole if necessary. Hints for drilling holes in springs: The spring steel is hard and will need a sharp H.S.S. drill. Drill onto a piece of scrap wood and do not press too hard. Avoid kinking the spring near the hole. The length of spring beyond the hole should be similar to the end you removed. For the centre boss this may be about 10mm but for the outside it should be between about 4mm to 7mm. If it is any longer then you will have to file off a corner from the end to get the holes to line up. It is possible to anneal the end by heating then slow cooling. This softens the steel. After drilling, re-harden by heating then rapid quenching. It is usually easier to simply buy a sharp drill bit instead !

4.3.2 Spool End Assemblies:

The spool wires usually break near the fencers end. To check this, hold the rest of the wire still and manipulate the wire near the connector while watching a meter. To "cut down" a spool, unbolt the metal frame and pull the connector out of its rubber boot. Write down which colour goes to which pin (do not rely on it always being the same). Keep the rubber boot and metal frame on the cable but push them back. Cut off the faulty end of cable, cut back the cover and strip the three conductors at suitable lengths. Note that the orientation depends on the holes in the rubber boot. Remove the old wires and fit the new ones ensuring that plenty of wire is trapped under the bolts. Check that there are no loose strands. Tie a knot in the cable to act as a stop at the back of the rubber boot. Reassemble, ensuring that wires do not pass under other bolts or holes. The wires should be on the other side from the metal frame.

4.3.3 Brush Contacts:

The spool contacts do wear out, causing intermittent open circuits. Club armourers should keep a stock. Club treasurers should budget to spend some money on maintaining spools. Some armourers advocate grease on the slip rings. This makes the brushes slide smoothly and works well at first but the grease collects dirt and progressively insulates the rings from the brushes. Spools which have been greased usually need wiping clean after a few weeks ! The most critical adjustment seems to be how hard the brushes press on the rings. If the rings are clean then only a light pressure is needed. Clean rings tend to stay clean and the brushes will then last many years. The plastic moulding which holds the brushes has progressively improved in design. Newer types have steps in the moulding which keep the brushes straight and separate. Watch

out for cracks in this moulding. If a spool is hit from the side, sometimes the connector takes the force.

4.3.4 Feet & Handles:

Spool feet are crucial to stop the spool sliding around or falling over. Never throw old spools away ... all the bits may be re-used. Anyone who has carried old spools without handles will know that the inserts are worth gluing back in when they pop-out. The best adhesive for this is Plastic Padding but Araldite will do.

4.3.5 Bobbins and Wire:

Through the history of spools, different models from different manufacturers have mostly used slightly different bobbins so they are not interchangeable. The life of the wire is greatly extended by the plastic grommet at the entrance to the spool. Never leave this out. To replace the wire, gently release all the tension in the springs, lift out the bobbin and remove the old wire. Change over the spool cable end assembly as per 4.3.2. Do not forget to transfer the plastic grommet. New wires from Leon Paul have a plastic jacket which is much easier to get into the boot than the old cotton covered wires. Fit the wire to the bobbin, return to the spool, tension the springs and re-fit the lid of the case. Optimum tension for the springs is so that when the cable is fully retracted, there is still just a little more tension. Do not over-tension the springs or wires will tend to break more often.

4.4 Ground Leads:

The most common fault with ground leads is with the type of connector for which the wires are stripped and then clamped by screws. In this type, the screws tend to shear off the soft copper wires. The better connectors have pointed set screws which pierce the insulation. This type is less likely to fail but eventually with all types the wires break near the ends. In the Leon Paul type, the pins are sprung in a staggered formation by the plastic moulding containing the pins. This is rather weak but replacement is quick and easy with just a screw driver. It is worth keeping some spares as the same part is needed for bodywires. The three wires should be connected to corresponding pins at each end. If a ground lead does not work after repair then use a meter to check the connections. Some education authorities do not allow mains cable to be used for low voltage circuits. If a ground lead was wired with a spool plug on one end and a mains plug on the other then the risk of death would be severe. For this reason, it is recommended that mains cable is not used for ground leads. Cable with transparent insulation may also allow you to see breaks. Cables which are regularly wound onto bobbins tend to twist. Use large or long bobbins to minimise this. To find open circuit faults in ground leads, use a needle as a probe. It may be pushed through the insulation into the wire. Use your tester (or meter) to check continuity. If you find a break near the end of the lead then cut off the end back a little beyond the break and refit the connector. If the break is in the middle of the lead then a joint will be needed. Separate the broken wire and cut it at least 3 cm either side of the break. Strip the ends back approx 6mm and form hooks. Obtain a suitable length of similar wire (a little longer than the gap), strip the ends and form hooks. If you have access to heatshrink sleeving and a hot air gun then fit it now. Engage the new piece of wire, twisting the hooks, then solder. Insulate with either heatshrink or long life tape (eg. carpet tape). Avoid cheap PVC tape as the adhesive is too mobile and with time gunge will leak out, the tape will dry out and then fall off. The reason for adding an extra piece of wire is so that the strain is taken by the two good wires and not by the joint.

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