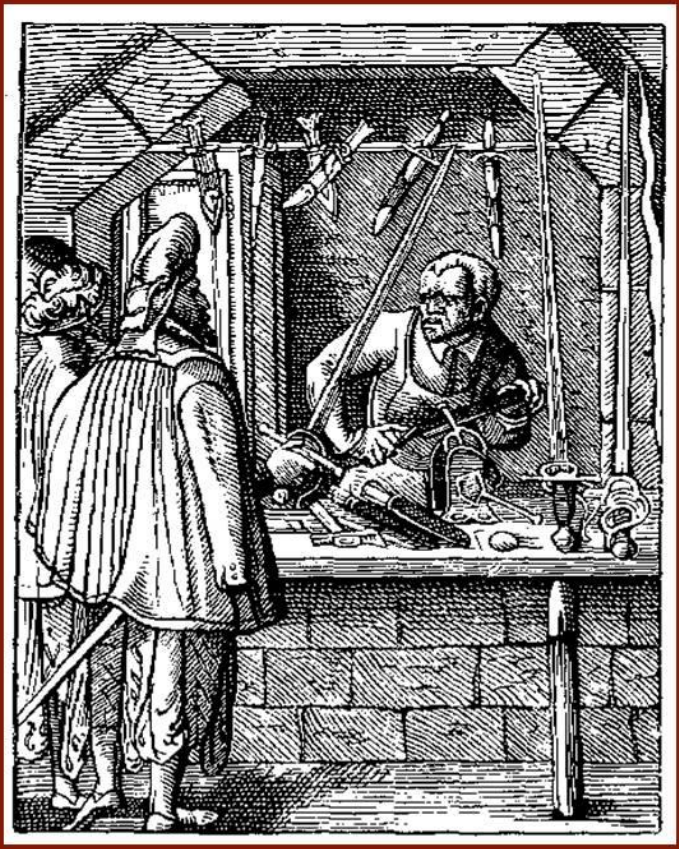
THE CARE AND FEEDING OF ALL THINGS FENCING



BY
MICHAEL MERGENS

THIRD EDITION, 2012

The

Care and Feeding

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All Things Fencing

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Third Edition

Alex Ryjik, Virginia Academy of Fencing, 2004

Baghdad, Iraq 2004

Dan Gorman, Camp Victory, Iraq, 2004

Coach, Galveston Fencing Club 2001

Bill and Marietta Towry El Paso, 2004

VAF fencers Frank Kelley, John Genn, Mike Burack

St. Andrews Celtic Festival, 2005

Rod and Betsy Fleming, Author and Laura, John and Nicole Trojanowski, and Hazel and Peter Powers, Texas Fencers all!

The Crew – Detroit 2011

The August Armorers, Coaches College, 2005

The love of my life, Laura; author, leaving for Bosnia, 2000

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PREFACE

In writing this book I have taken the opportunity to compile information and knowledge gained from over thirty years of experience in working on fencing equipment. I was led to do this by the realization that, while there are many books on fencing techniques, training and psychology, there are very few complete works on the equipment itself. With the growth of the sport I have run across many individuals that have started asking for this kind of information. This Third Edition builds on the previous work included in the First and Second Editions.

This work has as its genesis a plaintive request from my brother-in-law, Prof. Mark Webb, the faculty advisor for the Texas Tech Double-T Fencing Club, to tell him how to fix his equipment after having a disastrous tournament due to weapons problems. After an hour and a half and twelve pages later, I had something that I thought gave a fairly concise run down on how to troubleshoot, maintain and repair weapons and some other related equipment. I have since had this small piece linked to by several websites and have passed it on to many appreciative fencers. Such reception of my work inspired me to write this book.

But like any literary work, it isn't done in a vacuum. There are many people who have helped review, comment or provide information contained in this book. I would especially like to thank Maitre Bob Lightner, friend and fellow soldier, who has provided encouragement, ideas and not too subtle suggestions as to how to make this a better book. A good portion of this was written while I was serving on Active Duty with the US Army and during a short stint in Iraq, and Bob's support, drawn on by his own experiences while serving in Vietnam, during this stressful time was most appreciated.

I would also like to thank the pre-eminent World Class Armorers who have helped me edit this work, Mssrs. Dan DeChaine, Dr. Joe Byrnes and Ted Li. Their kind words, editing (had I only known that two of them were professors of English!) and technical input have been instrumental in keeping this work on track.

Many thanks also go out to the many hundreds of fencers and armorers that have directly or indirectly contributed their comments or discussions on the subject at hand. It is to them that this book is dedicated. I would especially like to thank Brian Rosen, Frank Kelley, Bill Hall, Craig Gault, Ovy Waddops, Joe Biebel, and Walter Flaschka for their inputs and use of information contained here.

I would also like to acknowledge Jerry Dunaway, a friend and someone dedicated to the Art of the Sword with whom I had the pleasure of knowing and working with for many years. Jerry built a wonderful program at South Houston High School in Pasadena, Texas for over 15 years. He and I encouraged each other to grow programs that served the southeast area of Houston over the years and exchanged numerous ideas about Armoring, many of which are contained in this book. Sadly, Jerry passed away on May 4, 2011. He will be missed by many, myself included.

But most of all, this work would not have been possible without the support and love that I have received from my soulmate, spiritual guide and best friend who has supported me in my fencing career more than any one person has, and that is my companion for life, Laura. She has learned more about fencing, without being actively involved, than just about anyone I know. She has also been a pillar of support when things weren't going so smoothly and always willing to slap me up the side of the head when I either got too frustrated or took myself too seriously!

INTRODUCTION

Fencers at all levels, either recreational or competitive, at some time will need to either fix or clean their equipment. It may be as simple as replacing the rubber tip on their practice weapon or as complex as completely rebuilding an electric one or repairing a broken spring in a scoring reel. The longer fencers stay in the sport, and the more competitive they become, the more they will be involved with maintaining and repairing their weapons and equipment. It is important that maintenance and repairs are done correctly to insure safety and conformity to equipment rules, as well as making sure they work correctly.

This book is intended to provide information on basic and intermediate repairs to equipment along with suggestions and information for the average mechanically-inclined individual to construct various parts, items and training aids. It is intended **not** to be a compendium of all possible repairs or to deal with every piece of equipment in the fencing world, but to give most fencers and starting Armorers as complete a single source of information as is currently available.

This book is also written by an American primarily for an American reader; and as many of the terms used in this book may be unfamiliar to a non- American, I have attempted, with the help of a British National Armorer, Mr. Steve Hyman, to include an appendix containing a 'translation' of terms from what is commonly used in the USA to those found in the UK and elsewhere in the world of speakers of the Queen's English.

Also, the Rules cited throughout this book in the footnotes, are from the USA Fencing Rules[1], dated January 2013, which are derived from the international governing body, the Féderation Internationale d'Escrime (International Fencing Federation, FIE). As with any national set of rules, there may be some that may appear different from what an international reader may be familiar with, for example, what a Head Armorer at a US national level tournament may be able to do with respect to issuing penalty cards. Rules differences are mostly within the realm of operations, and do not affect actual bouting or material rules. You should always consult the rulebook governing your particular national fencing organization to ensure the proper application of rules.

The techniques for repair and maintenance described in this book are ones the author has routinely used on his personal and organizational equipment. Other techniques or alternative ones will be included as practical. Every Armorer has personal techniques they have developed over the years that work for them. Some of the ones included here may or may not work for you, for whatever reason. Feel free to use this text as a starting point to develop your own.

However, when it comes to testing equipment, there are very specific techniques and specific values that are outlined in the Technical section of every rule book. These rules are all based on those set forth by Signalisation Electrique et du Matériel et des Installations (Committee for Technical Matters, SEMI) of the FIE and do not vary from country to country. Consistency in testing and certifying weapons and equipment helps to insure a safe and, as far as equipment is concerned, a level playing field.

Refereeing, on the other hand, is subject enough for several other books.

[1] In 2010 the United States Fencing Association changed the operating name of the organization to USA Fencing. Since there is a rather large US government organization that has been using the acronym USAF since 1947, I have continued the use of USFA as the acronym of USA Fencing.

CHAPTER 1 - BITS AND BOBS (THE WEAPONS)

Before you can have a discussion on how to maintain or repair your equipment, you have to know what it is that you've got. This chapter will discuss the various parts of the weapons and some of the different variations on those parts. Again, this is not meant to be a comprehensive discussion of all the parts ever made, but is limited to those items commonly found in the fencing community today. Finally, how all this goes together will be discussed in the last section.

- Blades
  - Dry (F, E, S)
  - Electric (F, E)
- Grips (F/E, S)
- Pommel nuts (F/E, S)
- Guards (F, E, S)
  - Thumb pad
- Connectors (F/S, E)
- Body cord restraint (F/S, E)
- Tips (F, E)
  - Barrel
  - Screws
  - Springs
  - Tips
  - Wire

Figure 1-1 Weapon Parts

All weapons, electric and non-electric, also known as dry weapons (or in England, steam weapons (God only knows why![2])), consist of basically the same parts: Tip, Blade, Guard, Thumb pad, Handle and Pommel nut (the thing that holds all the bits and bobs together).

The differences between dry and electric weapons are the items that detect and transmit signals to the scoring equipment. For instance, for saber it is the presence of a connector (electric) and for foil and epee, the presence of a groove in the blade, along with a threaded tip end, and the presence of a connector, wire(s) and tip.

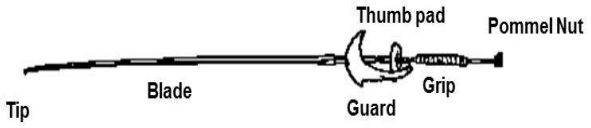

Figure 1-2 Parts of the Weapon (Saber Shown)

This chapter is organized as listed in Figure 1-1, at the left. Note that following each component the weapon it applies to is listed (F = Foil, E = Epee and S= Saber[3]). If there is commonality between the two weapons, they are separated by a slash (/).

[2] Actually, it was because steam was the most widely available power source before electricity, therefore pre-electric = steam or, in our case, dry!

[3] Purists will argue that this word should be spelled "Sabre", however, as a former Cavalryman; I choose to use the American-English, "Saber".

1.1 Parts Is Parts

Now that you know what the Bits and Bobs are, you might want to consider a few things before you start buying equipment. As you use your equipment over time, you will find particular types of equipment or features that work better for you, or that you are generally more comfortable with. You may discover that you prefer two-prong connectors to bayonet, or French grips to pistol, etc. When you get to that point, it is a good idea to make sure that all your weapons have the same kinds of parts, and if possible, from the same manufacturer.

For example, if you are using pistol grips, it is easier if the pommel nut you use is consistent on all your weapons. This means that you only need to bring one type of tool to the strip in case they need to be tightened.

Makes sense, right? Same applies to tips. For foil, in the US there are really only two basic designs of tips commonly used: French and German. And, no, they are not compatible. Go figure. Not only are the tips different, so are the barrels, springs and screws. While the differences in the tips themselves are obvious, it isn't necessarily so with the other items and they can be easily mixed up.

If you are fixing weapons for a group (team, club, horde, etc) you will have to know the differences in these parts. It is best to keep them separated in small marked containers. If you are able, it would be a good thing to try to set a standard set of equipment for your organization, which unless you have dictatorial powers, is almost impossible. But you can try.

1.1.1 Blades

Blades are the main component of your weapon. With the exception of one type of epee blade (which will be discussed later) they are made by forging (a process where a piece of metal is heated up, and pounded into shape between two metal dies). Many blades are made this way with a semi-automated process, which includes grinding the blades to the final shape. Most are made of one piece, but there are some that have the tang (see discussion below on the various parts of the blade) welded on. This simplifies the process some, but can have some disastrous consequences when trying to bend the tang when you assemble the weapon. There is more on that later (see Sec 1.2.1.2).

The exception to this technique is the Leon Paul folded metal epee blade. This blade starts off life as a piece of sheet metal that is bent down the length of the metal to form a V-shape. The tip end is formed into a circular shape (for threading) and a tang welded onto the other end.

This has resulted in a more durable blade that is lighter and has some unique flexing characteristics. In order to make these characteristics resemble other forged blades, Leon Paul came up with a way to put ridges along certain sections of the blade that cause it to flex like these blades.

Blades consist of the tip, blade and tang. As discussed below, the tip varies based on whether or not the blade is electric or dry. The blade itself has a strong part, the forte, which is the lower 1/3 of the blade near the tang, and a weak part, the foible, which is the upper 1/3 of the blade from the tip back towards the tang.

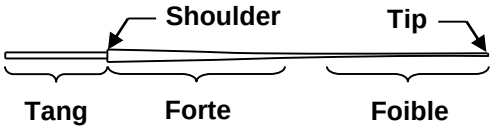

Figure 1-3 Parts of the Blade

Blades come in four different lengths, 0, 2, 4 and 5. These roughly correspond to 30", 32", 34" and 35" respectively. The length of the blade is measured from the shoulder where the tang meets the blade to the tip. The shorter lengths are generally used by younger fencers, and the #2 length blade is required for Under-10 year old competitions at the US national level (Youth Circuit events).[4]

Each type of blade has a different cross section. Foil blades are rectangular, while epee blades are triangular, or "V" shaped. While most saber blades have a rectangular foible and a triangular forte, there are some that are completely rectangular in shape.

Figure 1-4 Typical Blade Cross Sections

[4] In 2012, this requirement was changed to specify a maximum length of 32.5" (82.5cm)

The other part of the blade is the tang. This is what holds the other components of the hilt to the blade. It comes in two basic lengths depending on the grip used, referred to as French and Pistol.

Additionally they are threaded in two different standards, M6 x1 and 12-24 UNC[5]. Most blades manufactured today are made with the metric standard. However, there are some old blades, there out there, and some from one American manufacturer, that have the 12-24 UNC thread. This thread is slightly smaller, and pommel nuts of this size will start on a metric thread, but will either jam on them or not hold.

It is possible to convert a M6 x 1-threaded tang to a 12-24 by using a die, and is described in Chapter 5.2.2.3. It should be noted, though, that when doing this you can come away with threads that are not of the best quality due to the nature of the metal (depending on its quality) and how much material you are removing. In this case these threads end up very ragged and in some cases can be a safety concern.

For blades designed to be used with two or three piece pommel nuts, there is a slot cut in the tang which one part of the pommel nut fits over and is used by the other pommel part to provide tension against the blade (instead of engaging threads on the tang). This system was sold by Leon Paul for some time, but is not generally used now (see Fig 1-26).

While not widely used, there is a third style of blade tang. This one is designed to be used with an Italian grip. This grip has two unique features, the ricasso and quillions, with the ricasso being a part of the tang (see Fig 1-12). This is a flat section that is between the grip and the guard. This tang cannot be used with any other kind of grip; however, a French grip blade can be used with the Italian grip. The remaining features of the Italian grip will be discussed in Section 1.1.2.

There are two types of blades as was pointed out previously, dry and electric. All three weapons have dry blades, where foil and epee have specific electric ones. In saber there is only one style of blade that serves both as dry and electric (the foil cross section in Fig.1-4 is for an electric blade).

Electric foil and epee blades differ from dry ones in that they have a threaded tip. There is also a groove along the length of the blade, and this groove goes through the threads for the wire to pass through.

Figure 1-5 Typical Blade Ends (Nail head, left, Threaded, right)

Dry blades for these two weapons have a small “nail head” on the end that a rubber tip fits over. The electric foil blade has a groove that runs the entire length of the blade that the wire fits in, while the epee uses the natural Vee-shape of the blade to provide a groove for the wires.

The material that most blades are made of is a carbon steel, which will rust if not treated. For all blades, a small amount of corrosion is unavoidable. Oils and acids from your hands will cause chemical changes in the surface of the metal that will act as places for rust/corrosion to start. See section 1.4.1, Basic Maintenance, Blades, for more on how to eliminate/control corrosion.

Blades used in international competition must be certified by the FIE. A common mis-conception is that they are required to be made of a special steel, called maraging steel. They are not, it just has to have the FIE certification.

For certification, a manufacturer has to provide 10 blades (chosen at random) for testing. The blades must pass a flex test that bends the blades at least 25 cm (10 inches) at least 14,000 times for foil and 8,000 times for epee. ALL the blades must pass without a failure.

Maraging steel has the advantage of increased durability and therefore is less prone to breaking. Maraging is short for martensitic aged stainless steel. It has about 4% carbon and alloyed with 4 other elements. It gets its toughness from the heat treatment and ‘pickling’ it received during manufacture.

[5] See discussion on thread size in Chapter 5

It is incorrectly thought that these blades are supposed to break “clean,” that is straight across the blade, and therefore are not as dangerous. A study by the FIE has concluded that there is virtually no difference in the way maraging blades break as opposed to other ones, just less frequently.

Figure 1-6 Broken Blade with a ‘Spike’

Blades that are certified by the FIE have special markings that include the manufacturer’s two letter identification and the FIE shield and initials. If the blade is non-maraging, the mark will include the letter ‘N’.

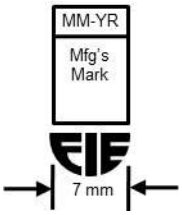

Figure 1-7 Design of FIE Blade Marking

Figure 1-8 Examples of FIE and blade manufacturer markings

Blades also come in a variety of stiffnesses. There are minimal standards for each of the blades, with the strictest being for saber. All saber blades used in competition today must conform to the S2000 standard. Blades meeting this standard are marked on the blade with the date of manufacture, which means that if they were made after 2000, then they meet the S2000 requirement.

This was instituted to prevent “whipovers”. A whipover is similar to the ‘flick” in foil. This is where the forward motion of the blade is abruptly stopped and the momentum results in the end or tip of the blade bending over the opponent’s guard (in the case of saber) or coming in at such an angle as to hit around a parry or on the opponent’s back (foil). Some epee blades are also capable of being used for flicking, but it is not as common as with foil blades.

Figure 1-9 Extreme Whipover!

World Championships and Olympic events are the only competitions where the stiffness of a blade is tested. Competitions that most fencers will attend will not require this test.

But! Measuring the flexibility of a blade will give you the answer to the trivia question, ”What is the minimum required length of a blade?” You can look through the rule book forever and not find the answer specifically written!

To measure the flexibility, the blade is clamped 70 cm from the tip of the weapon, with the blade parallel to the floor. Where the end of the weapon is at rest is the 0 point (this will vary from weapon to weapon due to the bend in the blade). A weight of 200 grams is suspended either 3 cm (foil and epee) or 1 cm (saber) from the end. The distance that the end of the weapon deflects <u>must</u> fall between two points. If it deflects either too much (too flexible) or too little (too stiff) it can’t be used. See Table 1 for the values for each weapon.

Now back to our trivia question: ”What is the minimum required length of a blade?”

Answer: 70 cm! Why? Because a blade **must** be at least 70 cm in order to be tested for flexibility! Voila!

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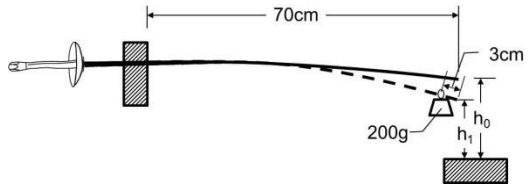


Figure 1-10 Set-up for Measuring Blade Flex (Foil)

“Whippier” blades tend to be softer and will bend or kink (a condition where there is a sharp bend in the metal that is very difficult to remove) more readily than stiffer blades (see Section 1.4.1 on how to fix this).

As the blade is bent and re-bent it will work the metal so that eventually it will break. This is known as a ‘fatigue’ failure.

A blade comes straight and is normally bent or curved slightly after it is installed (see Section 1.2.3 for how to put the bend in the blade). The bend in the blade acts as a sort of shock absorber. When properly applied as the point contacts the target the blade will bend away from the target. This also means if the blade breaks after it hits the target, the broken end of the blade will tend to travel away from the opponent.

The bend is required to be smooth and continuous and in the main axis of the blade[6]. The amount of bend varies according to the type of weapon. In foil and epee, the maximum bend is 1 cm (.39 in) between the point where the guard meets the blade and where the tip meets the blade. For saber the maximum bend is 4 cm (1.57 in). See Section 1.4.3 on how to measure it.

Another problem with bending is what is referred to as “S-bends.” This is a condition where there is a bend at the tip of the blade that goes in the opposite direction to the normal curve of the blade. This is not an acceptable condition as it is both unsafe and in violation of the rule on the bend being in only one direction.

[6] USFA Rules m.8, m.16 and m.23

The figure below shows the difference between a normally bent blade and one with an s-bend in it. It also shows where the maximum bend is measured.

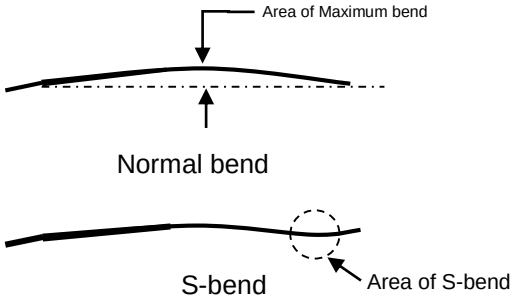


Figure 1-11 Blade bends

1.1.2 Grips

There are basically two types of grips: straight grips and orthopedic grips. Straight grips are the French and Italian types, and orthopedic grips are commonly referred to as ‘Pistol’ grips. There is a right handed and left handed style for each of these, with the exception of the Italian grip. They also come in various sizes. In selecting a size grip, the fencer should also take into consideration the size of the hand (with the glove on) and the size of the weapon. But most of all, the grip should feel comfortable in your hand. You are going to spend a lot of time holding it.

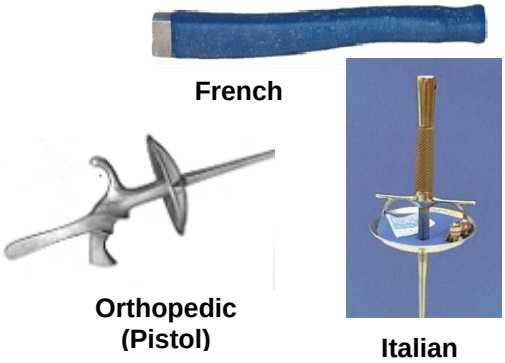


Figure 1-12 Typical Grips

The basic requirements for grips are:

1. Grips must be the correct length; <20 cm
2. Prongs on pistol and Italian grips may not extend beyond the guard diameter
3. Pistol grip prongs must be smooth and rounded

4. Grips must be able to be held in only one position in the hand (the French grip is specifically exempted from this requirement)

Straight grips include the French and Italian styles. As mentioned before, the Italian grip is not very common and the French grip is what most beginners will use. Most competitive fencers use the Pistol grip; however, there are some that continue to use the French grip in competitions, and this trend is increasing among epee fencers.

Along with this increasing trend, the rule concerning the overall length of the grip has had to be enforced at the National and International level. The length of the grip, and depth of the guard, can easily be measured using what Armorer's call the 'Crab Gauge'[7].

Originally designed by Rocky Sorenson, the guage depicted below, is used to simultaneously measure the length of the grip and guard to ensure that they are less than 20 cm and 5.5 cm respectively. The other side of the gauge is used to measure Saber grips and guards.

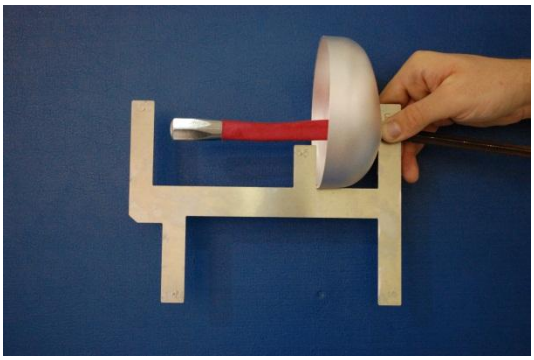


Figure 1-13 The 'Crab Gauge'

Three types of French grips are shown below; corded, leather wrapped and rubber (or plastic), the latter being the most common today.

(a) Leather (b) Corded (c) Rubber

Figure 1-14 Typical French Grips

About 2009 Leon Paul introduced another type of French style grip. This was made of carbon fiber and resembled a tennis racket handle. It is larger and bulkier than other styles and is held to the blade with an internal pommel nut (see Fig. 1-27), as opposed to one of the style normally used (Fig. 1-29). This pommel nut is larger than the standard 8mm sized nut and requires a 10mm socket (see Section 1.1.5).

Figure 1-15 Leon Paul 'Tennis Racket' Grip

Shown below is the offset Spanish grip that is illegal[8] for use in competitions as it can be held in more than one position (either around the protrusions or by the end of the pommel).

Figure 1-16 Spanish Offset Grip

The left-handed and right-handed French grips can be differentiated by the curve of the grip as you look down on it. With a right-handed grip, the concave curve is to the left and with the left-handed one it is to the right.

To determine the top and bottom of the grip, if you look at it from one side (as shown below), there is a thick (guard end) and a thin (pommel end), as shown below. From the top, it is the same thickness from guard to pommel.

[7] It is called the Crab Gauge because it looks like a gauge that crab and lobster fishermen use to measure the size of their catch to ensure they are of legal length

[8] Rule m.4.6, USFA Rule Book

Figure 1-17 Locating the top of a French Grip

There are a wide variety of orthopedic grips. Listed below are the most common varieties found in fencing today. Pictured also is an example of the different sizes available for one particular (and probably the most popular) style, the 'Visconti'. The bottom two rows of grips are a relatively new style with a limited following from Zivkovic Modern Fencing Equipment Co.

American
Belgian
Visconti
German
Russian
Hungarian
Chinese
Zivkovic

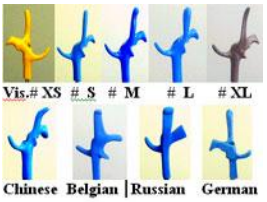


Figure 1-18 Selected types of Orthopedic Grips

A relatively new pistol grip has an upper protrusion that essentially wraps around the index finger from the top. This is called the Rambeau grip, and is available from Allstar Germany and American Fencing Supply

Figure 1-19 Rambeau Grip

For foil, an insulated grip is not an absolute requirement, but it is highly recommended. Excessive sweat can cause your weapon to become "live" that is, ungrounded and capable of becoming valid target! There are some manufacturers that make un-insulated grips and these can be used with electric weapons, but it is not recommended for foil. If you are going to use one of these, you should be aware of this and change gloves regularly if you sweat a lot.

In the past it was recommended to cover the extremities of the un-insulated grip (pistol) or pommel nut (French) with insulating tape. This was because in older scoring machines, you could ground your weapon against your lamé and prevent your opponent from scoring.

Taping of the pommel nut of French grips used for epee is allowed; however, a recent ruling of the Fencing Officials Commission (FOC) during the 2011-2012 fencing season has limited the amount to **only** one layer of tape can be used. The reason for this was because some fencers were putting so much tape on the end of their weapons it was providing a ball which could be gripped and give more control.

Modern scoring machines have circuitry that can detect this and still allow touches to score. There are some older machines, though, that may still be in use, so be sure that if you are in an area that may have them and are using an un-insulated grip that the extremities are insulated. Un-insulated grips should be used for dry or practice weapons.

Some very old machines (ones using electro-mechanical relays) can give a nasty shock when you have a combination of bare metal on the grip, or un-insulated grips, a damp glove, and it is not properly grounded. This happens when you are touched by your opponent's foil tip!

Epee, on the other hand, **SHOULD** use an un-insulated grip because if hit it would be grounded (see Section 1.3, How Does it Work), or electrically connected, to the weapon and therefore not set off the scoring machine. The likelihood of this is very small, but possible. The other aspect of this, though, is that, and is the case with foil, excessive sweating can cause your uniform to become conductive and be grounded, therefore touches wouldn't register against you. Not necessarily a bad thing, but can cause problems during a bout (tantamount to cheating). If you are prone to sweating heavily, then, as was stated earlier, change gloves regularly. That said, insulated grips can help alleviate this kind of problem, too.

However, when using an orthopedic grip, it is forbidden to have any covering, like tape, on the grip. The reason for this is because there were instances in the past of fencers hiding a micro switch under the tape, which allowed them to 'score' at will, i.e. cheat.

The Saber grip comes in only one shape, straight. It differs from the French grip in that it is thicker at the guard end when viewed from the top. The grip is also similar to the French grip in that it also comes in rubber, plastic, cord wrapped or leather wrapped. There have been attempts to develop orthopedic saber grips, and in June 2012, one was approved by the FIE for use. It is called the Poignée PRAT©, and is shown below.

Figure 1-20 Saber Grip, top, normal, bottom, Orthopedic

Finally, the grip portion of the Italian grip is a short tubular piece that, like the French and saber grips, can come in plastic, rubber, checked wood, or cord or leather wrapped. It does not have a left or right-handed version.

In the section on blades it was pointed out a blade with a long tang, as is used with a French grip, can be used with an Italian grip. In order to do this, a piece that is known as a "false ricasso" is used between the guard and grip. This is usually nothing more than a flattened piece of copper or brass tubing that separates the guard and grip and provides the smooth, flat surface of the normal grip.

1.1.3 Guards

Each weapon has its own distinctive guard. The purpose of the guard is to protect the weapon hand from being hit by the opponent's blade.

They are made of either steel (or steel coated with chrome), aluminum, dura-aluminum (an aluminum alloy) or titanium. Each of these materials has advantages and disadvantages. Steel is strong, but heavy and subject to corrosion; aluminum is light but deforms relatively easily; dura-aluminum is light and resists deforming; titanium is both light and strong, but expensive.

Guards that are used with electric weapons need to be conductive on the side towards the opponent.

Saber guards come in left and right-handed versions, while epee guards can be mounted for either hand (see below). There are also maximum and minimum size requirements for each of the guards.

1.1.3.1 Foil guards

Foil guards are circular, disc shaped with a rectangular hole in the center of the guard. The center of the guard may be reinforced with a circular steel plate that is riveted to the guard. This plate is often subject to corrosion and should be maintained on a regular basis. See Section 1.4.2, Basic Maintenance, Guards on how to do this.

The overall shape of the guard should also be smooth and rounded. If the guard is severely bent or damaged, it isn't legal for use. Below is an example of what has been called the 'Taco Guard', which is not legal for use because of its extreme deformation.

Figure 1-21 The 'Taco Guard'

The foil and epee guards also have a small groove in the opening that will accommodate the wire and the insulating sleeve(s) to pass through. Foil guards must range between 9.5 – 12 cm (3.74 – 4.72 inches) in diameter[9].

[9] Rule m.9, USFA Rule Book

1.1.3.2 Epee guards

Epee guards are larger and deeper than foil guards as they protect the hand from being touched by the opponent (yup, the weapon hand is target!). Also, the hole in the center of the guard is offset to one side depending on the "handedness" of the guard (see figure below). The construction of these guards is similar to foil guards in that they may have a steel reinforcing plate around the hole.

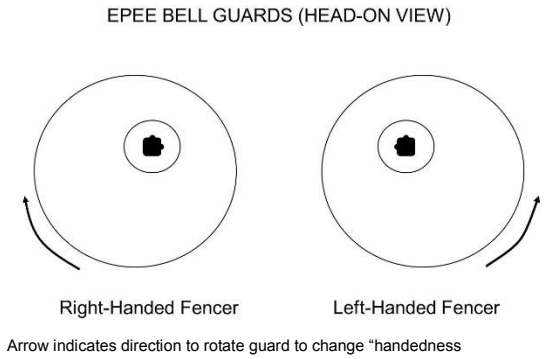


Figure 1-22 Epee Guards

The same basic maintenance tips concerning corrosion and rivets apply for epee guards. Epee guards can have a maximum diameter of 13.5 cm (5.31 inches) and the depth of the guard has to be between 3 – 5.5 cm (1.18 – 2.17 inches). Also, the offset of the hole from the center of the guard can not exceed 3.5 cm (1.38 inches).[10]

There are, however some guards that do not have the reinforcing plate, or have one mounted on the inside of the guard. This is important to note because when measuring the length of the blade the thickness of the reinforcing plate is included in the blade length if it is mounted on the front, as our illustrations show! If your blade is too long when mounted in this kind of guard, in order to shorten it you must then grind away the shoulder of the blade where it meets the tang (which could be a very long process!). Not that this happens very often and unless you are competing at World level competitions you are not likely to run across this situation. It is good to know that these kinds of guards are out there for this reason.

A particular disadvantage of using an epee guard without the reinforcing plate, especially an aluminum guard, is that material can fail, as shown below.

Figure 1-23 Failed Epee Guard

The picture above is a weapon that failed during a national level event. Fortunately for the fencer, he discovered it after he had he lowered his weapon and tested it against his opponents guard, only to discover that the guard slid off the end of his weapon and clattered onto the metal strip!

The surface of the epee guard needs to be smooth, that is without deep dents that may catch an opponent's point, and rounded, similar to the foil guard. It is up to the opinion of the head technician as to what is or is not acceptable as there are no written guidelines for this.

1.1.3.3 Saber guards

These guards are unique in shape and designed to protect the hand from the point and the edge of the opponent's blade. There are two basic designs, Hungarian and Olympic. The difference is the shape of the forward portion of the guard, the Hungarian having "lobes" to either side while the Olympic guard is smoothly curved around the edges. The picture above is an Olympic style guard.

[10] Rule m.17.3 ,USFA Rule Book

For electric saber the inner portion of the guard is insulated, normally with paint. If the guard is to be used with an electrical weapon, the area around the hole should be clear of paint so that when the connector is installed, there is metal-to-metal contact and continuity. While the hole for the blade is not always offset, there are left and right-handed versions of saber guards. Some guards may also have reinforcement plates like foil and epee guards and are subject to the same maintenance needs. The Saber guard has to be able to pass through a 15 x 14 cm (5.91 x 5.51 inch) rectangular opening.[11]

Figure 1-24 Saber Guard – Example of Removed Paint on the Inside

In addition to the requirement for insulation on the inner portion of the guard, electric saber guards also need a rubber or plastic insulating sleeve that covers the portion of the guard from the pommel to about 7-8 cm (2 3/4 – 3 1/8 inches) from that point.

1.1.3.4 Italian Guards

Italian guards for foil and epee, have quillions mounted as a part of the guard. These are of the same base material as the guards. Above is an example of an Italian guard. Note that the ends of the quillions do not protrude beyond the edges of the guard.

1.1.4 Thumb Pads

Thumb pads are the protective covering located on the inside of the guard. They are circular in shape and are made of a variety of materials, the most common being vinyl covered foam and felt. Pads used with electric weapons have a cut-out that fits around the base of the connector. The only restrictions on the size of the thumb pad is that it can not extend beyond the edge of the guard and it can not be thicker than 2 cm (.75") (which complements the requirement that a grip cannot be of such a design that the thumb can be more than 2 cm (.75") away from the guard).[12]

Figure 1-25 Typical Thumb pads

The thumb pad also has a hole in the middle of it that fits over the tang of the blade. It can be bigger than the end of the grip because there is no requirement that the pad be held between the grip and the guard. However, if the pad can slide up or down the handle, it is not allowed in electrical foil or epee since its purpose is to cover and protect the wire(s).

According to Dr. Joe Byrnes, this is known as the Canadian "Hole Too Big" rule. At the World University Games of 1982, the Inspectors, supported by the overall Directoire Technique, ruled that, since the thumb pad was intended to protect the wires from the fencer's fingers, any pad that had a hole big enough to slip along the handle was prima facie illegal.

Their description for this, which caused great confusion at first, was "Hole Too Big." Since there were not enough new replacement thumb pads available, they compromised on insisting that the pad be 'engaged' by the grip, i.e. nipped by it so it couldn't slip up, and let in a naughty finger.

1.1.5 Pommel Nuts

The pommel nut is one of the most important, but least talked about, parts of the weapon. Its sole function is to keep all the parts of the weapon together! Well, for the most part. French grip pommels are also designed to act as a weight for balance, too. Each type of grip has its own type of

[11] Rule m. 24, USFA Rule Book

[12] Rule m.4 para 6(b), USFA Rule Book

pommel nut. And many of those nuts have different styles. The basic requirement of the nut is that it be threaded to the same thread standard as the blade you are trying to thread it on to.

For French grips/blades there are three basic styles as shown below. The 2-part pommel, is still sold by Leon Paul, and while it was fairly rare, in recent years has made a resurgence in use.

Figure 1-26 French Grip Pommel Nuts

Orthopedic or pistol grips have basically three types of pommel nuts as shown below: outside hex, slotted and inside hex.

Outside hex nuts look like an elongated hex nut that is used in most assemblies. The exterior size of this nut is usually 8mm. There is an exception, though. The Leon Paul Carbon Fiber Grip uses a 10mm shouldered hex nut (see Fig. 1-27 below).

Figure 1-27 Leon Paul Carbon Fiber Grip Pommel Nut

The tool for installing or tightening the 8mm nut is readily available from most fencing suppliers. However, if you have a fairly extensive tool collection, you can use an 8mm deep-well socket, 2" extension and ratchet driver.

Figure 1-28 8mm Deepwell Socket, Extension and Ratchet

As was pointed out before, you should be careful when using ratchets, as you can over-tighten the nut and either snap the tang or strip the threads of the nut.

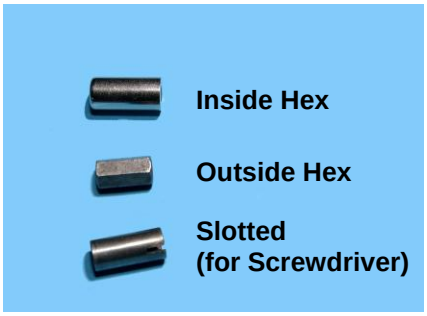


Figure 1-29 Orthopedic Grip Pommel Nuts

The advantage of this nut is that you do not have to be concerned with how deep the hole in the grip is compared to the length of the tang. If the tang is longer than the hole, the tightening tool will not interfere with the nut.

Slotted pommel nuts are round nuts that have a slot cut in one end of them. Normally this kind of nut needs a very large (5/16" wide blade) screwdriver to install the pommel nut.

The problem with such a large tool is because of the size of the end of the screwdriver and the length of the shaft, you can put a huge amount of twisting force, or torque, on the nut. Such a large amount of torque can cause the end of the nut to deform or shear off. Also, if the tang is too long, you can't properly tighten the nut as it interferes with the seating of the nut and the end of the tang will push the blade out of the slot!

The inside hex nut is similar to the slotted nut, and is some cases is combined with it, that is, with a slot cut in the head. The inside hex nut has a hexagonal key broached in one end of the nut. The size of this is nominally 6mm, but rarely, sometimes a 7/32" inside hex pommel is found. It has the same

problem the slotted nut has, in that if the tang is too long, as you tighten the nut the end of the tang will push the tool out of the socket and then you can't properly tighten it.

The tightening tool for this kind of nut is also readily available from fencing suppliers, but you can also buy a metric "T" driver set from a hardware store for about as much as you can pay for one special tool.

Figure 1-30 T-Driver Set

Saber pommel nuts are either inside hex, hex or flat sided. They are installed with wrenches, normally an adjustable crescent wrench. As shown below, the inside hex nut is also insulated. This prevents the weapon from grounding against the lamé and making the weapon valid target!

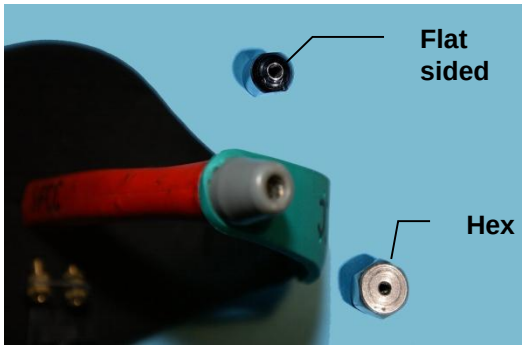


Figure 1-31 Saber Pommel Nuts

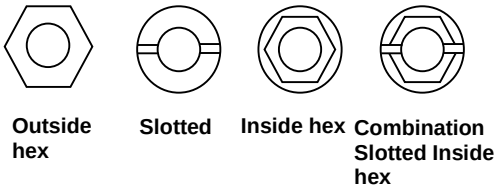


Figure 1-32 Pommel Nut Ends

Figure 1-33 Pommel Nut Tools

Since 2010 there has been a different kind of pommel nut available. This one is different not so much as in design, but function. There has been a desire of some epeeists and foilists to get better performance from their weapons by changing the balance point closer to the guard.

To do this the most logical way would be to add weight to the back of the weapon. The method that is now used for French grips is to make the pommel nut out of a denser material, which is tungsten, either machined from a solid piece or sintered. **NOTE**: Depleted uranium is even denser, but I understand that the military and the Nuclear Regulatory Commission kinda frowns on just letting anyone use that stuff!

The current French grip pommel nuts are of the same basic design as regular ones made of steel. There are two places to get these – Leon Paul and Rick Zehr's Tungsten Fencing (www.TungstenFencing.com). Leon Paul offers 200g, 150g and 110 g versions of this nut.

Figure 1-34 Tungsten Fencing Pommel Nut

Tungsten Fencing also makes a weight extension for pistol grips, which require a slight modification to the tang of the grip.

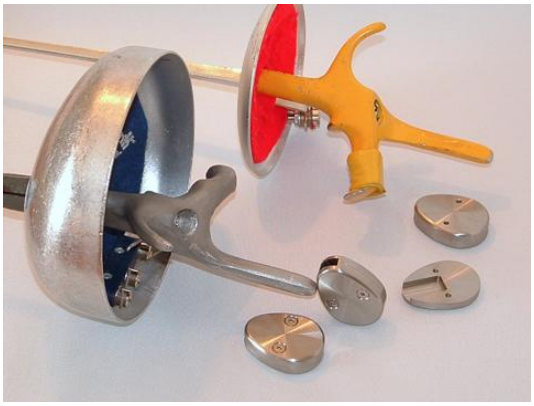


Figure 1-35 Tungsten Fencing Pistol Grip Extension.

If you are using this kind of pommel, you need to be careful in not exceeding the maximum weight for the weapon[13].

1.1.6 Connectors

Connectors are where the weapon and scoring equipment interface. In this section we will make a slight departure from discussing only what pertains to the weapon and include a discussion of the connectors found on the body cord as well.

Most electrical connections, like the connection between the weapon and body cord, are pin and socket (or jack) connections. This is also known as a male-female connection. If you don't understand that analogy, well, that's a discussion your parents should have had with you a while ago.

For foil and saber, there are basically two types of connectors: two prong or "bayonet" connections. The two more common designs are shown below.

Two Prong **Bayonet**

Figure 1-36 Typical Foil Connectors

The two-prong connector has two holes, or jacks, of different sizes: 4mm and 3mm. The 4mm hole accepts a standard electrical pin called a "Banana Plug", which is convenient if you are building your own pieces of test equipment. The holes are located 15mm center to center from each other. The reason the two holes are of different size is so that the connector and body cord can be hooked up only one way. In engineering this is known as "idiot-proofing."

For the two-prong connector shown above, the nuts on the back side of the holes are 8mm for both holes. For the older Prieur style two-prong connector shown below, the nuts on the top and the nut on the 4mm hole are 8mm. The nut on the back side of the 3mm hole however is 7mm.

Figure 1-37 Old Prieur Foil Connector (7mm nut, left and 8mm nut, right)

For foil, the 3mm hole or jack is insulated from the connector and is where the blade wire from the tip, or B line, connects. For saber, this jack is shorted (or grounded) to the connector through the 4mm jack. That is, there is an electrical connection between the two. This is what makes the entire saber "active" or has the ability to complete the connection to set off the scoring machine when the blade makes contact with the opponent's lamé or mask.

A standard foil two-prong connector is converted to a saber connector by one of two ways. First, disassemble the 3mm jack and remove the insulation pieces and then reassemble the jack/socket with two #10 washers, making sure there is electrical connection between the socket and the body of the connector. When you reassemble the connector, make sure the 15mm spacing between the jack's remains. You can do this by inserting a two-prong plug into the jacks and then tightening the retaining nut.

[13] Rule m.6 for Foil and m.14 for Epee, USFA Rule Book

Figure 1-38 Converted Foil Connector, Washer Method

The other method is to take a piece of bare wire (about 1" long), attaching it to the 3mm socket underneath the flat piece of the connector, loosening the 4mm socket and attaching the wire to it in the same manner as you attached it to the 3mm socket.

Figure 1-39 Converted Foil Connector, Wire Method

The bayonet connector, which is also known as a Leon Paul connector (named after the manufacturer, Leon Paul-UK), is a bit more mechanically complicated.[14]

The inside of the connector has a metal plate with a spring behind it. When the tip of the body cord connector is inserted and twisted, the proper electrical connections are made, and the body cord's bayonet locked into the connector. The wire from the tip is connected the circular brass plate through a connection on the side (labeled "To tip" below) of the insulated or insulating plastic portion of the connector. The rest of the connection to the weapon (what would be the large, 4 mm jack or 'ground'), of the two prong connector is made by the floating plate and spring that is a part of the plug portion of the body cord.

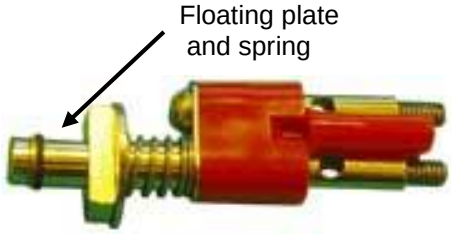


Figure 1-40 Leon Paul Body cord connector (without covering)

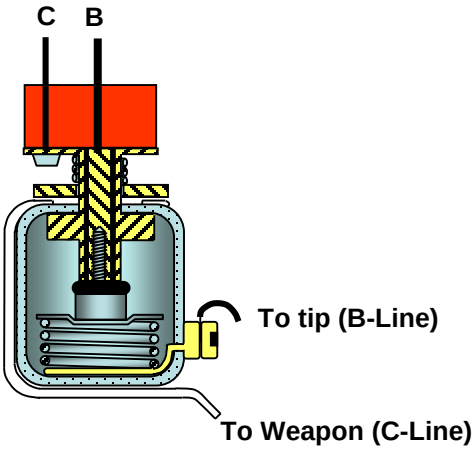


Figure 1-41 Cross Section of LP Connector and socket

One problem that has occurred in the past with this particular connector is that over time the bracket that holds the parts together can bend to a point to where it no longer works as it is supposed to. It is very disconcerting to have your connector fall apart during a bout, so a simple fix is to take a small plastic wire tie and wrap it around the bracket and the body, as shown below. Newer versions of this connector have corrected this problem, and is shown in Fig. 1-43 below.

Figure 1-42 Using a Wire Tie to Secure a Bayonet Socket

[14] This style connector is now made by many other manufacturers, not just Leon Paul

Figure 1-43 Leon Paul New Style Socket

A variation of the bayonet style connector is the Italian-type Bayonet or Carmimari connector[15], which uses a plug with two lugs or projections on either side. The plug fits into the socket and then is twisted so that the lugs lock into the J-slots on either side of the body of the connector. Locking pressure is provided by a spring in the socket.

This style of connector, while offering a more secure attachment and being a simpler design than the Leon-Paul bayonet connector, is much less common.

The Carmimari connector is one of three Italian manufactured connectors of this type. The other two, Nuova Scherma and Negrini, however, are not commonly found in the US. Also, the three different types do not work well together.

Figure 1-44 Examples of other less common locking connectors

[15] This style is now refered to, and sold by, as the 'Negrini' style socket

For epee, the connector has three sockets. Each one accepts a 4mm plug. Since each of the sockets are the same size, the "idiot-proofing" technique used with a foil connection isn't possible. Well, it is, only if you use a 3mm socket for one of the end sockets. But, using all 4mm sockets is more economical, therefore, the sockets are positioned so that one pin/socket is 15mm (.59") from the center socket and the other is 20mm (.79") from the center one.

This same arrangement is used in all other connections between the various pieces of the scoring apparatus (i.e. body cords, reels, floor cords and machines).

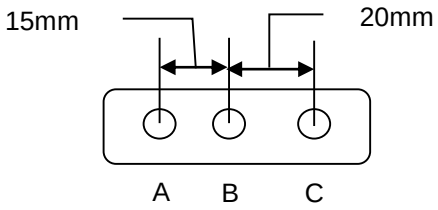


Figure 1-45 Standardized Socket and Pin spacing for Epee, Reel and Floor Cord Connectors

The connector shown below is one of the more common ones in use today. The wires to the tip are connected to the A and B connectors, while the C connector goes through the metal bracket to the rest of the weapon.

Figure 1-46 Typical Epee Connector

One of the requirements for a connector is that there must be a way to lock the connector and the plug to each other.

With the bayonet style this connection is accomplished by the twisting of the "lug" of the plug inside the body of the connector and the spring inside the connector pushing up on the contact point once it is locked in.

With the two other styles of foil/saber connectors there are basically two types of retaining devices.

The first is integral to the plug of the body cord, as shown on the right in the illustration below (Fig. 1-47). This is a spring loaded latching system that utilizes a plastic or metal catch that engages the connector to the edge of the socket.

The other is a separate plastic piece on the connector that hooks over the plug and holds the end of the body cord to the connector. Notice that the top of the connector curves toward the hole at the bottom of the connector opposed to the curving outward of the connector shown at the beginning of the chapter.

NOTE: The spring type retainer can work with the older style connector. Before you use this arrangement, test it out during practice to make sure it will lock in the plug. If it doesn't and you have a metal retainer like the one shown, you can bend it slightly so that it catches the edge of the connector.

In the center of the illustration below are the more common two-prong connectors found in use today.

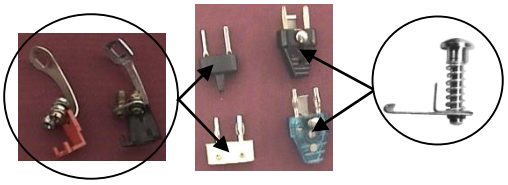


Figure 1-47 Examples of Foil Retaining Devices

Below are examples of the more commonly found epee plugs and connectors. The plug on the left is a two-piece plastic housing held together with three screws and hex nuts. It is probably the most common design in use today. The plugs on the right are somewhat simpler in design. They consist of a body that holds the plugs and a boot through which the wires pass and covers the body.

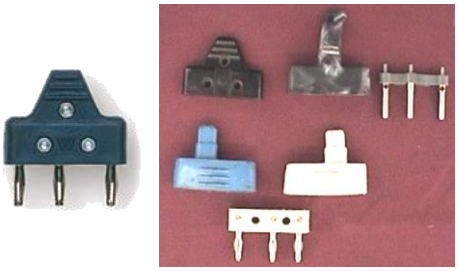


Figure 1-48 Examples of Three Prong Connectors

The retaining device is also needed for epee. The more common type is the "bail latch" design shown on the left below. Other kinds include an elastic strap, shown on the right.

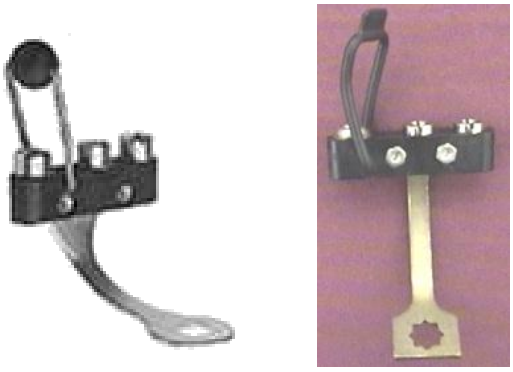


Figure 1-499 Examples of Epee Retaining Devices

1.1.7 Points

We have discussed all the parts of the weapon with the exception of the business end, the point. Well, business end for foil and epee, and sometimes saber. Saber is the only weapon that can score with the edge, but there is no special characteristic about the edge that we need to discuss, so that leaves our discussion of points to focus on foil and epee.

For the purpose of clarity, we shall call the entire assembly the point, while the specific part that actually is the end of weapon is the tip. In most discussions these two terms are incorrectly used interchangeably, but we will follow the convention stated above.

1.1.7.1 Practice Tips

As was pointed out in the previous section on blades, dry foil and epee blades have a small "nail head" on the end. Over this is placed a plastic or rubber tip, like the one shown below (installed on the end of the blade).

Figure 1-50 Plastic Practice Tip

The bottom of the tip has a small rectangular opening which squeezes over the nail head and is captured on the end of the blade. Some schools require that this tip be further secured with tape. Normally white athletic tape is used. Since the tip is rubber or plastic, it will eventually wear out and the nail head will stick through it. Frequently check your tip and replace it if necessary.

Figure 1-51 Plastic Practice Tip covered with tape

A technique for installing the tip on the end of the blade is to put the new tip in your mouth. Force some saliva (spit) into the opening and then work the tip on to the blade.

Don't like the idea of spitting on your equipment or handling hot plastic?? Then you can also use a small amount of petroleum jelly (Vaseline). The only problem with this is that, where the spit will dry and leave a good friction fit, the Vaseline won't and the tip could slide off.

Another technique is to take the tip and put in a cup of water and put the cup in the microwave for 2 – 3 minutes. This softens the plastic so it will slip over the end of the blade and once it cools, it will contract around it to form a good seal.

There are also dummy electrical points that can be used for practice. These are solid metal pieces that are shaped like their electrical cousins and threaded to fit on a regular electrical blade. The give an approximate weight and feel of a regular point, but do not have the "give" that a spring loaded point does. There are some dummy points that have internal springs designed to give the point the same feel as a real point, but they are not all that common.

Electric Foil and Epee points are quite simply, spring loaded electrical switches. Like other switches, they consist of the current/signal carrying device (wires), a moveable pole (tip), a reset device (spring), a mechanical retaining device (screws) and a body to hold it together (barrel). The discussion here will focus on the different types of pieces and leave the discussion of how they work for a later chapter.

1.1.7.2 Foil Points

Electrical foil points normally consist of a wire, with a contact (also called a cap) and insulating cup on one end; a barrel, two screws, a spring, and a tip. There are some screwless points available, but they are expensive and not that common. We will discuss them at the end of this chapter, and they have a tip, barrel, spring and wire.

The following illustration is an exploded view of the two commonly encountered types of designs. Note that the left hand, or French design shows the where the screws fit into the contact collar.

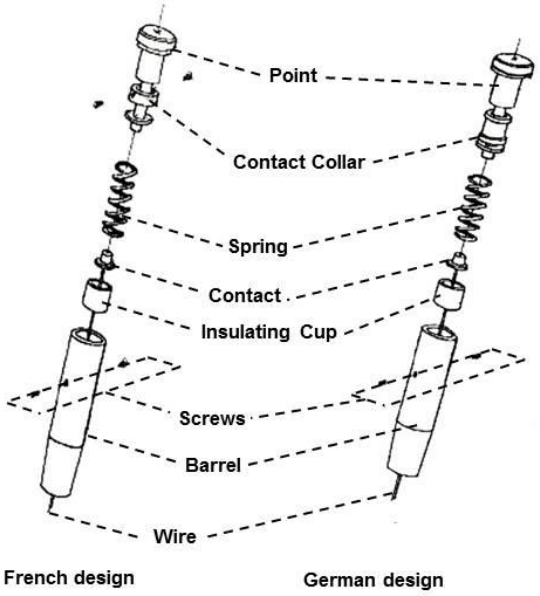


Figure 1-522 Foil Points

It would be almost impossible to describe all the different variations and manufacturers of both foil and epee points. At one point several years ago, there were over 25 different foil points (many which, of course are no longer made or used). It is important that you try to use the same manufacturer and design as much as possible to keep from mixing up the parts, since a lot of manufacturers' parts will not fit in the points of other manufacturers. Or in their own, sometimes! And because of their size, it

is difficult to tell the differences in many of them, without using a magnifying glass, or a micrometer.
As was pointed out in the beginning of this chapter, in the section called "Parts is Parts," there are two basic designs of foil electrical points: French and German. There is also a third kind of design that is not as common as the other two, the Collarless (or English)[16] design, and will be briefly touched on here.

While the basic components for each are the same, the primary difference is in how the collar that holds the tip in the barrel is designed. The collar is what makes the electrical connection between the tip and the rest of the weapon.

In the French tip (A), the collar is threaded, while the hole through the barrel is countersunk and smooth. Therefore it makes a mechanical threaded connection between the collar and screw and then makes a pressure connection between the screw and the barrel.

In the German tip (B), the collar has a C-shape cross-section. The hole through the barrel is threaded and the screw makes the mechanical threaded connection with it, while the bottom of the screw makes a pressure connection with the collar. It has the added function of preventing the collar from flying out of the end of the barrel. These points are generally made to a tighter tolerance than are the French designs and therefore have a smoother action. The disadvantage of these points is that the wall thickness of the barrel is thinner which makes them prone to deforming or cracking, as well as being made of a softer material that wears out more easily. One manufacturer has begun making a barrel with at thicker wall. This has had the effect of introducing a screw that is longer than those normally found.

The Collarless (C), or English (Leon Paul), design really isn't collarless. The contact flange is thicker; much like the collar and the electrical connection, as well as the mechanical restraint, comes through the two screws that hold the tip in.

Refer to Figure 1-53 for the following discussion. The illustration shows a cut away section of each type of design.

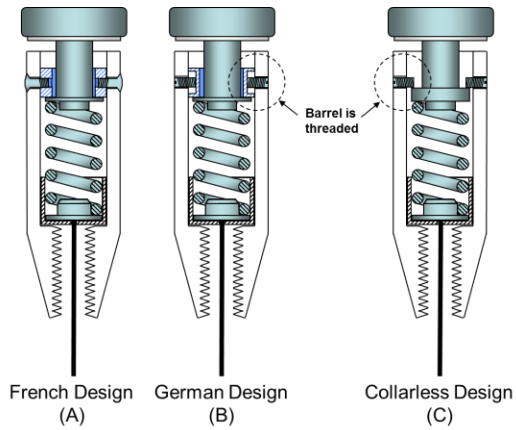


Figure 1-533 Cross Sections of Typical Foil Points

1.1.7.2.1 Tips

The tip of the foil point is the part of the weapon that actually makes contact with your opponent and causes a touch. It too, is an assembly of four or five pieces. These pieces are the tip, an insulating sleeve, the collar and the retaining ring or cap. Some tips have only the plastic insulating sleeve while others may have it covered with another metal piece. The addition of the metal sleeve is to prevent the insulating sleeve from crushing or deforming when the retaining ring or cap is installed. The purpose of the insulating sleeve is to electrically isolate the tip from the collar. This is important because of the manner in which the point works.

The diameter of the tip is required to be 5.5mm to 7mm (.217 - .276 inches).[17]

The illustration below shows a cross section of a tip that has a metal sleeve over the insulating sleeve.

The tip assembly is held together by drilling or forming a dimple in the end of the post of the tip.

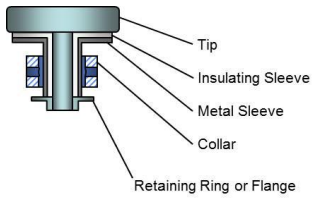


Figure 1-54 Cut away view of a foil tip

A foil point is a normally closed switch. That is, when it is at rest (with the spring fully extended), as shown on the left in the illustration below. An

[16] This design is currently being marketed by Leon Paul.

[17] Rule m11.1, USFA Rule Book

electrical current continually flows through the circuit. When the flow of electricity is interrupted (the circuit is broken, temporarily) it activates the device. This is similar to an 'electric eye' that is used as the safety feature of garage door openers; break the 'beam' and the door goes back up.

The circuit works as follows: current flows from the wire (B-line) to the contact to the spring to the retaining ring to the collar to the screw(s) to the barrel to the blade (C-line).

In order to actuate the switch, the tip needs to be depressed, as shown on the right below. At that instant the circuit is broken and either the off-target light or on-target light goes on (depending on whether or not the tip is in contact with the opponent's lamé).

If the tip was solid metal, it could remain in contact with the collar as it is depressed. In that case, the circuit would not be broken, therefore no light. Kind of defeats the purpose of the whole thing, doesn't it? This is why there is an insulating sleeve!

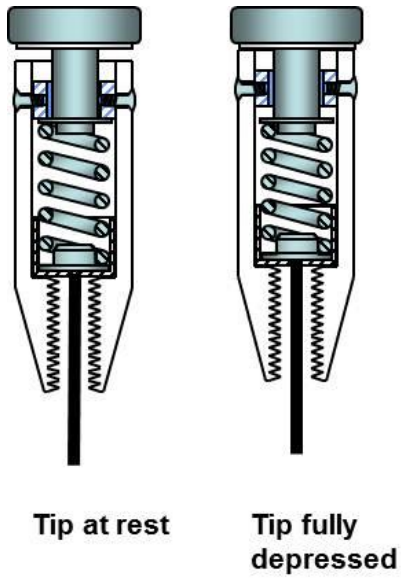


Figure 1-55 Illustration showing the operation of a Foil Point

Once the pieces are assembled, the sides of the dimple are deformed outward or "pinged" to hold the pieces together.

This is the manufacturing practice most used today. In the past, though, the contact flange was screwed on to the center post of the tip. But, alas, that practice has been dropped because of the added cost to form the threads on the two parts.

The illustration below shows basically what the end of the post looks like before (during assembly) and after (assembled) pinging the end. I point this our because this assembly technique will sometimes loosen and do either one of two things: (a) cause intermittent opens (also known as "ghost" white lights) or (b) fail and the tip fly out of the weapon. When this happens, the spring will keep the retaining ring in contact with the collar (because the collar is still held in place with the screws) and the circuit remains closed, therefore no lights or indications that anything is wrong.

Figure 1-56 Illustration of affixing the Collar to the Tip

1.1.7.2.2 Screws

The screws used in most foil points serve two purposes as were mentioned in the previous section – to hold the point together and to provide the electrical connection between the contact collar and the barrel.

Another feature of these screws is that they are SMALL. It is 56 good idea to use magnetized jeweler's screwdrivers when working with these screws. It is also good to have a magnet strip, like a kitchen magnet, below where you are working to catch screws when they fall.

As with the tips, there are two types of screws associated with the different styles: French and German.

The French style screw is similar to what is normally called a countersunk screw. This is a screw that has an angled bottom to the head of the screw that fits into an angled hole in the mating piece.

The German style screw has no head, only a slot cut into the top of it. This is also the style for all epee screws. Below are illustrations of each type.

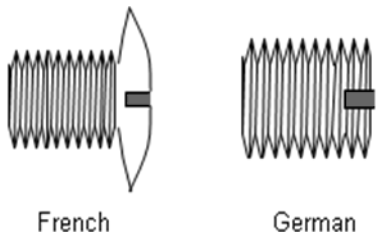


Figure 1-577 Foil Tip (Grub) Screws

Each manufacturer has minor variations for their particular screws, or have different screw designs altogether and care should be taken about mixing them up. Some use larger diameter screws and some a bit smaller, some longer, some shorter. Sometimes the difference is so slight that you can use a smaller diameter screw with a particular tip, but they don't tighten as well and can cause problems.

When installing them you can easily cross thread them, so a technique to use is to hold the tip down with the forefinger of one hand, put the screw into the hole holding it with the screwdriver and then turn it about a quarter of a turn counterclockwise (left) till you hear or feel a small click. And it is a VERY small click. That is the leading edge of the thread of the screw finding the leading edge of the thread of the collar. You can now screw it in safely.

Some designs of tips allow for longer screws, while others don't, like the collarless design. Be careful, though, if you use longer screws than what your tip is designed for. A longer screw can bind, or lock up, the tip because the collars are threaded all the way through.

Another reason could be that the walls of the barrel may be thicker and the shorter screws will not fully engage the collar and give a reliable contact.

Care should also be used when installing German screws because since they have no head to stop them (if there was no tip in the barrel) you could screw them all the way through and they'd fall into the barrel!.

This is also particularly dangerous because if you over tighten the screws, they can deform the contact collar. A deformed contact collar can deflect enough to contact the tip and bind it, or deform enough to make it difficult to remove the tip.

The deformed collar isn't as much as a problem as stripped screws. Stripping is where the threads break off and make it impossible for the screws to hold the parts together.

In the case of collars, this is because the material that is used by some of the makers of tips is not as good as it can be. There are, however, two companies that are currently making 'knock-offs' of the German design, which are actually better than the original manufacturer.

When installing screws in the Collarless design, it is necessary to screw them in until they make contact with the tip and then back it off a ¼ turn. One manufacturer, Leon Paul, uses the same screws for their collarless design as they do for their epee tips. It keeps them from having to carry two different styles of screws for basically the same function.

1.1.7.2.3 Barrels

Barrels are the housing that holds the point together. It is a cylinder that has a taper on one end that attaches it to the blade. The inside of this end is threaded with a M3.5 x .6 thread. The outside diameter of the barrel must not be more than .3mm (.012 inches) smaller than the tip being used with it[18].

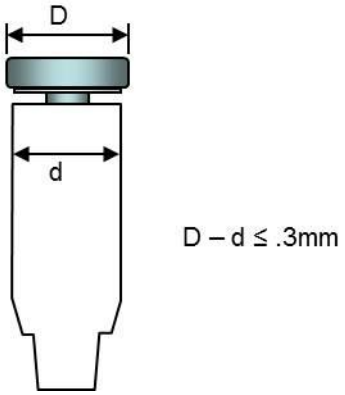


Figure 1-58 Required Difference between foil tip and barrel

A large number of designs include two flats on the tapered end that you can use a wrench on to help with the installation. Foil barrels with this feature use a 5mm (or 5.5mm) and epee barrels a 6mm open-end wrench, or you can use a small adjustable wrench.

18 Rule m.11 (f) 1, USFA Rule Book.

Be sure that the barrel is round. Sometimes during use or if you use vise-grips to install the barrel, it can become egg-shaped, or oval. In this case, the contact collar will not properly fit into the barrel and cause problems in removal and operation. This can be remedied by using a mandrel, or piece of solid, hardened metal, of the correct size.

Another problem is denting of the barrel. This can be remedied by the use of a reamer, which is a tool similar to a drill bit, but has cutting edges that are parallel and aligned with the axis of the tool.

This problem is especially prevalent with German style barrels because of the thin walls. Recently, FWF has come out with a thicker walled barrel which minimizes this problem. But they have created another one in that it requires a longer tip or grub screw!

Figure 1-59 Mandrel and 4.5mm Reamer

The key feature to be aware of for barrels is to make sure that the distance from the end of the barrel to the holes for the screws is less that the distance from the bottom of the large diameter end of the tip to the screw holes in the contact collar.

You can measure this before assembling the point by holding the barrel vertically, aligning the holes in the barrel and the contact collar and sliding the tip into the barrel. The hole in the contact collar should be either below or lower than the hole in the barrel.

If the hole in the contact collar is below the hole in the barrel, be sure to check the travel of the tip once it is assembled, the travel of the tip cannot be greater than 1mm (.039 inches)[19].

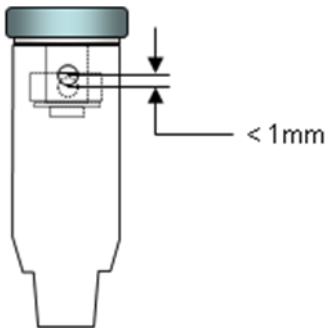


Figure 1-60 Quick method of determining the travel of a foil tip

1.1.7.2.4 Springs

The spring is the part that connects the retaining ring and the rest of the tip, to the contact collar. It is also what returns the tip to the normal position after it has been depressed.

Just as there were many different tips, barrels and screws, there are also many different springs. There is also a distinction between the French and German designs. The spring is required to be strong enough to take 500 grams of pressure to break the contact between the retaining ring and the contact collar.[20]

The length of the spring is not that critical, but nonetheless important. If it is a bit long, who cares? It will compress! However, if it is too short…….oops. But care must be taken that the spring is not too long because it can bend outward and contact the side of the barrel and thus maintain electrical contact and the weapon won't register a touch. Also, if it is too long, it can compress completely to where once installed, the point won't move!

The inside diameter of the spring must be big enough that it fits not only the end of the retaining ring, but between the contact and insulating cup of the wire. If it is too small or too big, electrical contact won't be maintained and, well you get the picture.

Care should be taken with very shiny springs. For some strange reason, probably Teutonic vanity, a certain manufacturer chose to chrome plate their springs(or had them outsourced to a plater that didn't have the same quality standard as the manufacturer!). Unfortunately, either the plating process was not very good and/or because the spring is a moving (deflecting) part, the plating would flake off. These metal flakes floating around in your

[19] Rule m.11 (f) 4, USFA Rule Book

[20] Rule m.11 (f) 3, USFA Rule Book

point could cause spurious connections and cause it to malfunction.

1.1.7.2.5 Wires

Like the tip, the wire is actually an assembly of three pieces; the wire, the insulating cup and the contact.

The wire itself is a very thin gauge wire (26 -30 AWG) that is insulated. Most wires come with a cloth material insulation; however, some newer ones have a plastic insulation. German and some other wires also come with a varnish over the wire itself that has to be scraped off in order to make a good electrical contact.

The insulating cup does just that, it insulates the contact from the barrel and blade. It should fit snugly in the barrel and should not be forced in. It should, however, fit tightly enough so that it will not turn inside the barrel once it is installed. Also, the height of the cup should not be much higher than the contact inside it.

The contact is a small metal, usually copper or brass, piece that looks like a small hat with a flat brim. And it is sometimes called a "top hat." It has a small diameter hole drilled through it in which the wire is soldered. It is possible to replace the wire if it is broken; that will be discussed in Chapter 6.3.2, Rebuilt Wires.

There is also a requirement that there be additional insulation covering the wire, once it is installed, from the place where it leaves the blade all the way to the connector. This is called spaghetti insulation. It is a thin plastic tube that goes over the wire. A source to make your own is what is called "hook up wire." Cut a length of this wire and then slide the insulation off of it! It normally has an inside diameter that easily fits over the wire and its cloth insulation.

1.1.7.3 Epee Points

Epee electrical points consist of two wires, a tip, two screws, a contact spring, a main or pressure spring and a barrel. The design of the epee tip is essentially the same for all manufacturers.

As with the foil points, there are also screwless designs for the epee, and are discussed at the end of this chapter. Again, needless to say, though they also consist of a tip, barrel, wires and spring(s).

The Figure 1-61 shows an exploded view of a typical epee point.

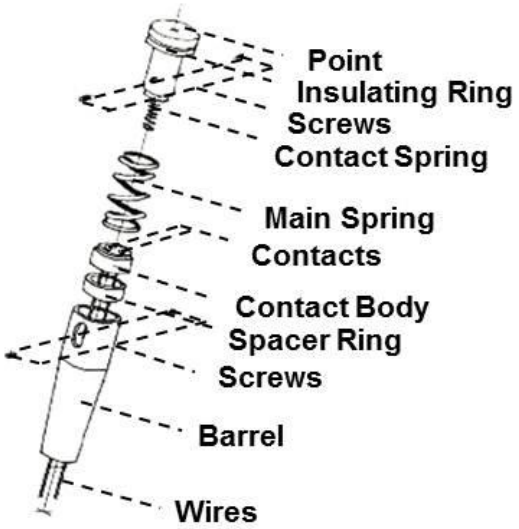


Figure 1-61 Epee Point

1.1.7.3.1 Tips

The epee tip is, like its foil cousin, the part that makes contact with the opponent and scores the touch. It is also an assembly, only it consists of four pieces: the tip, insulating sleeve, the metal collar, and a contact spring or post.

The metal collar is thicker than the one found on a foil tip because it serves the purpose of being where the screws engage to hold the tip into the barrel.

The insulating sleeve isolates the tip from the rest of the weapon so that it can provide the grounding circuit so that you cannot score against your opponent's weapon.

The center post of the tip is where the contact spring is held, thus the signal goes from the tip through the center post to the contact spring to the contacts.

Yes, it is possible to score a touch by just hitting your opponent's tip, but it is fairly obvious that you didn't hit them (seeing as how you are at least 36 inches away from any valid target!), so it would be annulled.

A cut away view of a typical epee tip is shown below. Note that the tip is press fit together, and with age can come apart. The tip can be held with a screw, but the screw cannot extend above the flat of

the tip and cannot be greater than 2mm (.079 inches) in diameter.[21]

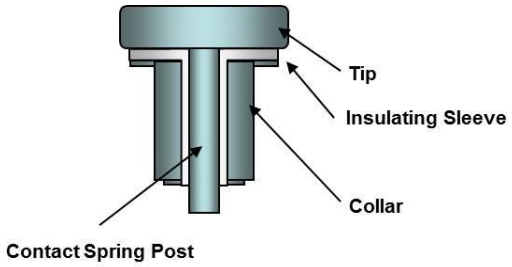


Figure 1-62 Cut-away view of an epee tip

What is not shown is that the end of the post can be threaded and the insulating sleeve recessed in this area. These features allow for minor adjustments of the length of the contact spring. Why these adjustments are necessary will be discussed in the section on springs.

The requirements for the tip size are that it be 8mm (.315 inches) ± .03mm (.001 inches) in diameter. The diameter of the insulating sleeve and metal collar must also be recessed (or smaller in diameter) it is recommended that that diameter be less than that of the tip by .3 - .5mm (.011 to .020 inches). The reason for this is so that you cannot have contact between the collar and tip when there is contact between the tip and the barrel on the curved surface of the opponent's guard.[22]

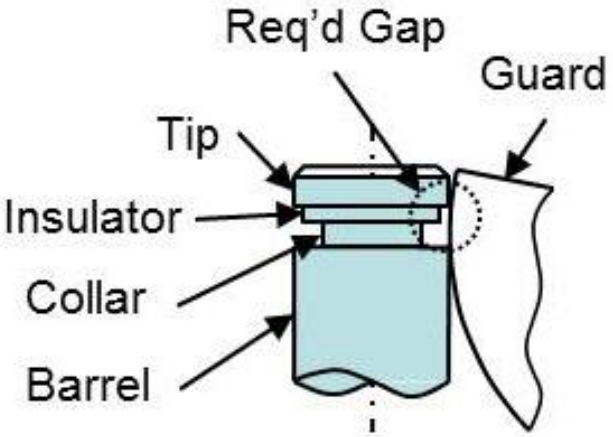


Figure 1-63 Illustration of the relief of an Epee point against the guard

[21] Rule m.19 (f) 4, USFA Rule Book
[22] Rule m.19 (f) 1, USFA Rule Book

1.1.7.3.2 Screws

Epee screws sole function is holding the tip in the barrel. The requirement is when screws are used that there to be two screws spaced equally apart.[23] Unlike foil, these screws do not provide an electrical connection. They do not have a flared head (like French foil screws) and travel in slots on each side of the barrel[24].

While there is no requirement that the head of the screw be below the surface of the barrel once installed, it is a good idea if it is. An exposed head can be damaged and thereby difficult to remove[25]. Screws can become loose with use, so be sure to check their tightness often. Also, a missing screw will disqualify your weapon from use during a bout.

Recently a new style of epee screw was introduced by Fencing Fan (www.fencingfan.com) called the NEPS (New Epee Point Screw – catchy title!). that has some unique features that make it an improvement over previous designs. Most notably is the fact that it has a hole through it, along with a solid collar around the middle of the screw. The other feature is that the slot is on either end of the screw.

The collar around the screw limits how far you can screw it in – and is a nice feature because you are not bottoming out against the tip, and eh edges created by the slots won't rear up the tip. When tested on older barrels, the collar may not fit through the slot. Newer barrels, on the other hand, may be fine.

The main issue with these screws is that they are evidently made of stainless steel – therefore non-magnetic, so the use of magnets to hold them in one place or to magnetize the tool is useless. The too, however; is made of ferritic metal – so it can be magnetized, but since the screws can't, so what (unless the material of the screws is changed).

[23] Rule m.19 (f) 5, USFA Rule Book
[24] There are some designs where the slots are in the tips and the screws stay stationary in the barrel, but not normally used.
[25] The most common thread size for these screws is M2 x 0.25.

Figure 1-64 NEPS Screws and Driver
(Photo courtesy of FencingFan®)

1.1.7.3.3 Barrels

The epee barrel is like the foil barrel in that it is similarly shaped and can have flats on the tapered section that facilitate installation. It is threaded with a M4 x .7 thread.[26] The diameter of the barrel can not be less than 7.7mm (.303 inches)[27] (which also happens to be the caliber of the British Enfield rifle, which was widely used at the time the electrical epee point was invented!). It also has two slots on either side in which the screws travel. It is important that these slots are free of any burrs or nicks that would interfere with the travel of the tip.

The same cautions discussed previously about the barrel becoming oval apply to the epee barrel. In this case it will cause the tip to drag or bind and interfere with the proper function of the point.

1.1.7.3.4 Springs

As was pointed out in the beginning section on epee points, there are two springs in an electrical epee point; a contact spring and a main spring. The purpose of the main spring is similar to the spring in the foil point, with the exception that it **DOES NOT** provide an electrical connection.

[26] Rule m.20 (g) 4, USFA Role Book
[27] Rule m.19 (f) 1, USFA Rule Book

The spring has to be strong enough to support 750 grams, without allowing the contact spring to come into contact with the contacts of the wire.[28] In other words, the spring can deflect a certain amount and still hold up the weight, unlike the foil spring which can not deflect so that the contact will be broken.

The same conditions exist for the epee main spring as do the ones for the foil spring with respect to length and diameter. While it is not important that the spring remain out of contact with the barrel; if it is too small it can touch the contact spring which could cause problems.

If the spring does have too large a diameter, sometimes caused by too many compressions of the spring or because of a manufacturing defect, the result is that it rubs against the inside of the barrel, causing a grating sound, the classic 'noisy' point.

The problem pointed out previously, in the section on foil points, with the chrome plated springs is much more serious with an epee point. The metal flakes coming off the spring could short out across the two contacts and give a spurious on-target light.

The contact spring is a small diameter spring attached to the tip, as we discussed earlier, whose function is to make the electrical connection between the two contacts on the ends of the wires. Electrically this is known as a normally open switch, that is, in the normal state, at rest, the circuit is open and the current does **NOT** flow; when the switch is closed, then the current or signal flows.

The length of this spring is critical, as is the fact that the end of the spring be ground flat. This flat surface will insure that the spring contacts both contacts at the same time. If the spring has been trimmed to length by snipping an end off, the coils on the end will be of different length and one side will contact before the other. While timing-wise this may be infinitesimal, it could mean the difference between one light and a double touch.

[28] Rule m.19 (f) 2, USFA Rule Book

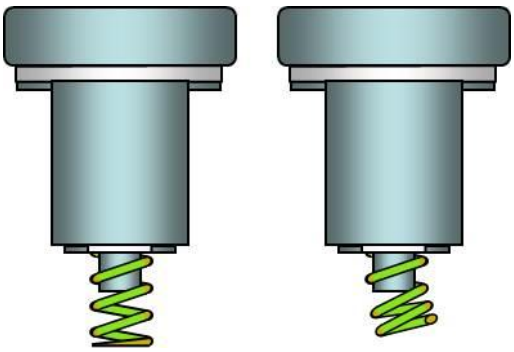


Figure 1-65 Example of a Straight (left) and Bent (right) Contact Springs

The reason why the length of the contact spring is so critical is that there must be a minimum of .5mm (.020 inches) of travel in order to make contact. Additionally, the overall travel of the tip has to be greater than 1mm (.039 inches). Therefore, as illustrated below, the distance between the bottom of the tip and the barrel must be at least 1.5mm (.059 inches).[29] The illustration below shows this requirement graphically.

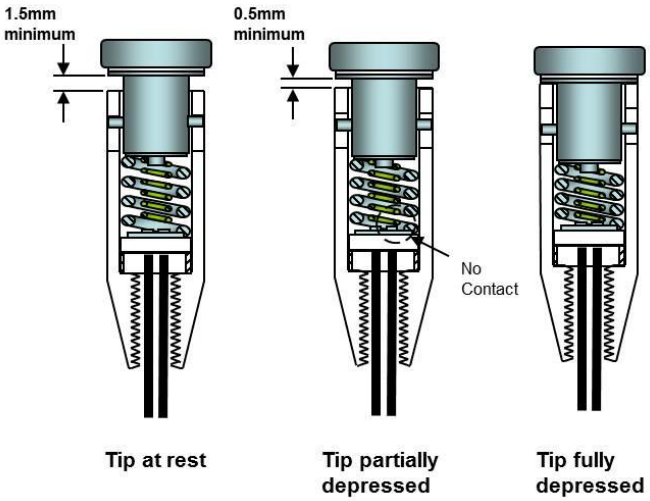


Figure 1-66 Illustration of the required clearances and operation of an Epee Point

The length of the contact spring can be adjusted one of two ways. As was pointed out earlier, the contact spring is either fitted over or threaded on to the center post of the tip. In order to shorten the spring, rotate it clockwise; to lengthen it, rotate counter-clockwise[30]. This is fine for minor adjustments. A good rule of thumb is that a 1/8th of a turn, changes the length 0.1mm (.004").

The second method is to cut a portion of the spring off with a small pair of wire cutters or nippers (see Chapter 6.3.3, Advanced Repairs, Spring Tweaking). If you resort to this method, be sure that you trim from the end that attaches to the tip, remembering the discussion earlier about the end of the contact spring needing to be ground flat.

1.1.7.3.5 Wires

An epee point has two wires that are an assembly of the wires, contacts, contact body and sometimes a spacer. The wires are thin gauge (26 – 30 AWG) like the foil wires and are insulated in the same manner (noting that the German and some other wires are coated with varnish and need to be scraped before connecting them). They are each connected to a contact that is pressed into the contact body, which is an insulating plastic material. The method of connecting the wire to the contact can be either solder or crimping. Either way makes it difficult to attach new wires to the contacts if they break.

The spacer ring is a feature that may be found on some wires. Its function is to make sure that the contacts are positioned such that the contact spring can reach them. When disassembling the point, check to make sure that this ring is removed, especially if the wire you are replacing it with does not have a spacer ring.

NOTE: Some manufacturers also sell contacts separately, so it is possible to make your own wires.

The wires for an epee also require the spaghetti insulation described in the previous section on foil wires, for each of the two wires.

1.1.7.4 Saber Point

As we said at the beginning of this chapter, the saber point has no moving parts and is integral to the blade. It does have some features, though, that should be noted.

[29] Rule m.19 (f) 4, USFA Rule Book
[30] This is done looking at the tip from the bottom of the tip.

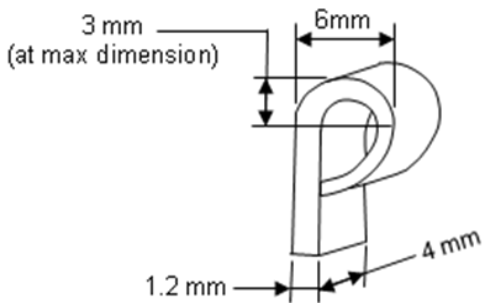


Figure 1-67 Minimum Saber Tip Dimensions

The point can be either a solid formed tip or the blade folded over on itself; the point must have either an open loop or be a solid 'rounded' or tear-drop shaped point. The dimensions of the point when viewed from the end cannot exceed 4 x 6 mm (.157 x .236 inches) and cannot be longer than 3mm (.118 inches).[31](Fig. 1-67)

1.1.8 Screw-less Points

Both epee and foil have screwless versions of points. What separates these types of points from conventional points is the small screws that hold the tip in to the barrel have been replaced by an assembly that screws into the end of the barrel. The function of the tip is unchanged. The assembly captures the tip with a threaded sleeve that has a slot on each side that interfaces with a special wrench used to install the tip into the barrel.

1.1.8.1 Foil

There are currently two manufacturers making screwless foil points, Schermasport (Negrini) and Estoc. The designs of these two points are basically the same. The key feature is that the collar of the conventional point has been changed to be a larger threaded piece that still retains the tip and provides the electrical path for the signal current. An illustration of a screwless foil point and pictures of the Schermasport and Estoc foil points are shown in Figs 1-69 and 1-70.

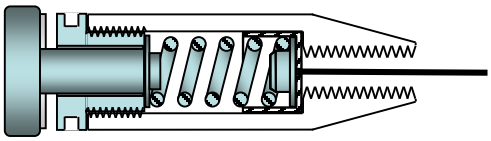


Figure 1-68 Cross Section of a Screw-less Foil Point

Figure 1-69 Schermasport Screw-less Foil Point and Tip

Figure 1-70 Estoc Screw-less Foil Point

Unfortunately, whether it be national pride or some other selfish reason, none of the parts from either design are interchangeable between the two points. Nor are the springs interchangeable with conventional points. Therefore if you are trying out the screwless design, make sure that you segregate your parts from the rest of your parts "stash" lest you mix them with disastrous results.

1.1.8.2 Epee

There are three manufacturers of screwless points: Schermasport, Estoc and an "SG" which is either a Russian or Chinese manufacturer. The difference between the three tips is the approach each manufacturer takes with respect to the contact spring. Two of the three still uses a spring (the Russian/ Chinese version and Estoc) while the third (Schermasport) uses a solid contact post that is assembled into the tip with a spring behind it.

The Schermasport tip has a screw in the end of it that is used to assemble the contact post and the spring into the tip. This screw is **not** used to adjust the travel of the contact, only to keep the parts together. This point also has an O-ring that is used as a locking and sealing feature. When making adjustments to the contact point, it is recommended to remove the O-ring and reinstall it when the adjustments are complete.

Making adjustments to the contact distance is done **before** assembling the point on to the blade. Adjustments are made to the wire contacts, not the contact post. Assemble the wire into the barrel and hooking the wires to either your test box or an ohmmeter.

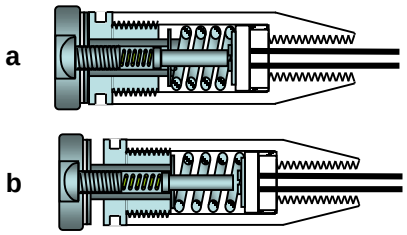
[31] Rule m.23 (c), USFA Rule Book

Install the tip and check the travel with the .5mm shim. If the contact post makes contact (and is indicated by the test box or ohmmeter) you need to remove some metal from the wire contacts. To do this requires a either a small file or fine sandpaper (200 grit or finer) glued to a flat surface. Push the wire contact body out of the barrel and remove some of the metal by filing or sanding it off. Make sure that you keep the file or sandpaper as flat and perpendicular to the wire body as you can. Repeat this until you have the proper travel.

The Estoc tip has a design similar to conventional tips, in that it has a contact spring that is adjusted in the same way that a conventional contact spring is adjusted. While the contact spring may look similar to a conventional contact spring, they are not particularly interchangeable. The Estoc spring is a bit shorter. A German contact spring may be used as a replacement, but it may need some trimming.

Figure 1-71 Schermasport Screw-less Epee Point and Tip

Figure 1-72 Estoc Screw-less Epee Point



Schermasport Epee Point
(a) at rest and (b) depressed

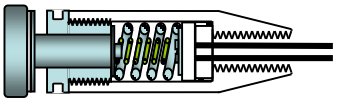


Figure 1-73 Cross Section of an Estoc Point

The SG point is basically the same as the Estoc point; however the adjustment of the contact spring length is done with a VERY small screw that is accessed through the end of the contact spring. It has a problem, though, that is not associated with the adjustment technique, but rather with the design of the tip and barrel.

This point does not have the requisite difference in outside diameter between the tip and barrel (.3mm, as discussed earlier in the chapter). Because of this flaw in its design, the point is **illegal**. While the head of the SEMI committee has pointed this out to vendors and distributors of this point, they continue to sell it.

In 2005 a unique, and innovative, epee tip design was introduced by zipfencing®, called the 'ziptip®'.

This design falls into the screw-less category, well, because it doesn't have any screws! What was unique about this design is that the collar and screws have been replaced by a single plastic piece.

To keep the tip in the barrel, there are two tabs with bosses that fit into the existing slots of the epee barrel. They are also designed to fit either French or German design barrels.

Figure 1-74 ziptip® Epee Tip
(Rendering courtesy of zipfencing®)

To install the tip, align the tabs with the slots and simply press the tip in until the tabs snap into place (you may have to twist the tip a bit). To remove the

tip, there is a simple tool that presses in both tabs at the same time. Be careful, just because the tool presses in the tabs, it doesn't hold the tip down, so it can go flying if you don't keep a hand on it!!

Figure 1-75 ziptip® Tip Removal Tool
(Photo courtesy of zipfencing®)

The tip is also unique in that it is designed to use either French or German contact springs.

To adjust the contact spring, leave out the main spring and insert the tip into the barrel so that the tabs are 90° to the slots. Test with the .5mm shim and adjust the contact spring accordingly. When you are finished, put in the main spring, align the tabs with the slots and press in.

It should be noted that these types of tips are <u>not</u> legal for international competition, but are legal for all US competitions.

In the early 1980's there was a type of screwless epee point, called a Mion tip, that was sold that had a solid contact point that was adjustable without removing the tip from the weapon. This adjustment was done by means of a screw in the center of the tip. The .5mm travel difference was taken up by a spring that was a part of the contact assembly (thus making the wires much more expensive). While this was an extremely easy point to adjust, it was also VERY easy to make 'adjustments' to once the weapon had been inspected, thus making it susceptible to fraud. This point was made illegal and discontinued.

It is illegal to make any adjustments to the travel from outside of the point. In the 1990's Prieur bought the drawings and patent for the design and tried to market it under their name. It remains an illegal point, though.

1.2 Putting It All Together

For the purposes of discussion for this chapter, we are going to assume that you are assembling electric weapons. If you are assembling dry or practice ones, the steps are the same, except for the threading and attaching of the wires and the installation of the connector.

The techniques for assembling weapons are consistent for all the weapons, so to keep the discussion as short as possible, we will use the foil as our basis. Included in this chapter are exploded views of the epee and saber.

Before you get started assembling your weapon(s), make sure that you not only have everything you need, but that you have reviewed the safety and skills listed in Chapter 5.2

A good place to begin is with all the parts of the weapon; blade, guard, connector, thumb pad, grip, pommel nut, "spaghetti" insulation and lock washer(s). Tools you'll need include:

Workbench
Razor blade
Vise
Screwdriver
Jeweler's screwdriver
Appropriate pommel nut tool
Wrench for connector (8mm and/or 7mm, depending on your connector)
Tip tape (foil only; not required for epee or saber)
Body cord
Test box (or Ohmmeter)
Test weight

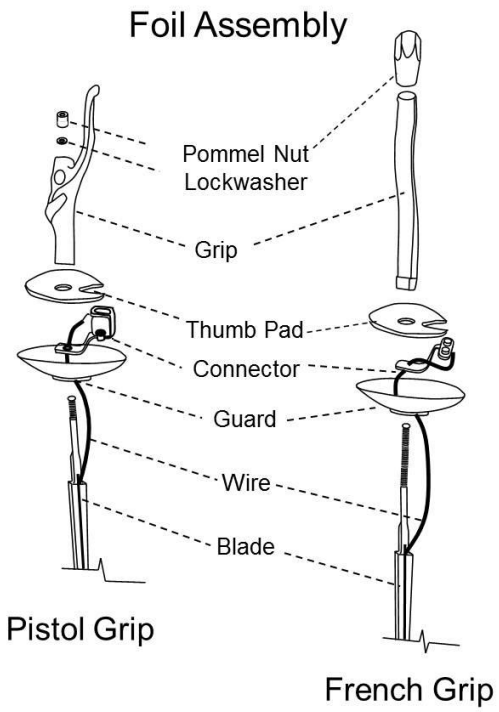


Figure 1-76 Foil Assembly

1.2.1 Preparation Work

Once you have the tools and workplace organized, there are some things you may want to do to the blade before you assemble it to the rest of the weapon. First make sure the tang is the appropriate length for the grip that you are using, and second is to cant, or bend, the tang relative to the rest of the blade.

The first makes sure you can assemble the weapon correctly and the second offsets the angle of the blade from the normal position of the hand and helps keep the point of the weapon oriented toward the center of the opponent. The amount of bend is a personal preference, but it should be noted that it can't be so excessive as to prevent the weapon from passing through the appropriate opening or cylinder for weapons' check or makes the grip extend beyond the diameter of the guard.

1.2.1.1 Cutting the Tang

If you find that the tang is too long, that is you are converting from a French grip to a Pistol grip, then you have to cut it to an appropriate length.

Cutting the tang can be done using basically four tools: hacksaw, Dremel® cut-off wheel, bolt cutters, and grinding wheel. Whichever of these are used,

make sure that the blade is securely held in a vise or other holding device.

NOTE: Blades are tapered; vise jaws are straight - which makes holding difficult. If possible use a soft jaw (aluminum facing) or plastic that conforms to the shape of the blade to make sure it is secure.

Before you start cutting, make sure that you measure what length you need to fit the grip you are going to use. This is normally to a point just inside the opening of the grip minus about 1/8". This technique supposes that you are using an outside hex pommel nut. If you are using an inside hex pommel nut, make the cut about ¼" shorter than stated.

Other methods of measuring this length are: a) to use the old blade (provided it was a pistol grip length blade) or b) to take a screwdriver and measure from the front of the grip up through the hole to the where the bottom of the hole where the end of the pommel nut stops and add ½".

You can mark this point with whiteout (correction fluid), a marker, or wrap a piece of masking tape around the tang with one edge at the point where you want to cut.

When using a hacksaw, it is advisable to draw the blade across the place where you want to cut several times (most hacksaw blades are mounted so that they cut while pulling toward you) to begin the cut.

Once started, you can cut in earnest. The same goes for when using a Dremel® cut-off wheel. Start easy and then cut aggressively.

Cut on the left side of the wheel (as you look down on it) or else the tool will grab and either get away from you or be harder to control.

There are two types of cut-off wheels for Dremels®, a thin and thick wheel. The thin one is better used to grind the wire groove of the blade, while the thick one is best used to cut off tangs. The thin one will work, but it won't last as long and has a higher probability of shattering.

The use of bolt cutters is a technique that is both quick and safe. Well, safe as long as you take some basic precautions. The main issue here is that they don't really cut completely. They cut about 60% of the way through and then snap the rest causing the scrap end to fly away from the cutter. This is a danger to people in the immediate vicinity, primarily the one using the cutter! Here again safety goggles come in handy. Some folks like to look away at the last moment, but unless you have a good grip on the tool, this method can cause it to slip and mis-cut. The key is to use a steady pressure on both handles as you cut.

A technique for keeping the cut end from flying away is to take a 6 – 8" piece of wire with old alligator clips on either end (or an old saber mask cord) and connect one end above the cut and the other below it, thus when the cut is made the end piece will only fly as far as the length of wire (unless you accidentally cut the wire, too!)

Figure 1-77 Cutting the Tang with Bolt Cutters and safety strap

In cutting a tang with a grinding wheel, first mark the spot where you want to cut as was discussed previously. Using the corner of the wheel start cutting a small groove around the circumference of the tang. Keep going around until you have cut about a third of the way through the base metal. At this point you can place the end of the tang to be cut off in a vise with the cut just above the jaws of the vise. Now pull on the blade and snap the piece off.

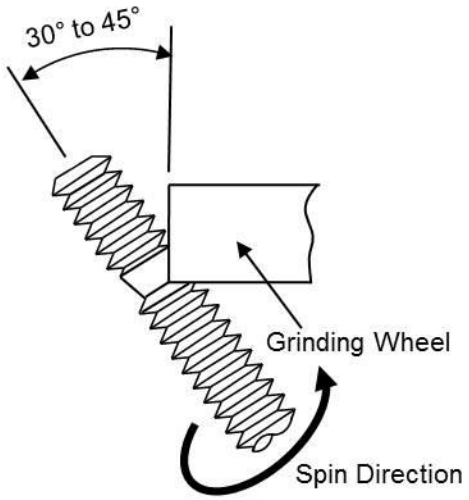


Figure 1-78 Using a grinder to cut a tang

This technique has the dual advantage of leaving the end of the threads intact and a taper that will help guide pommel nuts on during installation. The snapped end can also be dressed with the grinding wheel as described below (but not really necessary, it just makes it look prettier).

As stated above, after the tang is cut it may be necessary to "dress" the end of it. This can be done by either filing or grinding. While not always mechanically necessary, it may be required in order to clean up the leading edge of the threads of the tang.

Dressing the end of the tang also aids in the starting the pommel nut as it is threaded onto the tang. File or grind the end using the appropriate method as described in the Chapter 5.2, Basic Skills and Safety.

You should end up with the end of the tang looking like Fig. 1-80.

You can achieve this same thing using a grinding wheel. In this case, lay the tang on the tool rest and slowly rotate the blade while pressing the end of the tang against the face of the wheel.

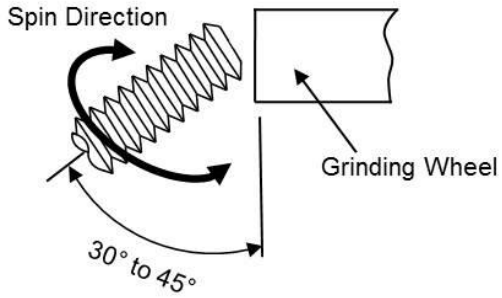


Figure 1-79 Dressing the end of a tang with a Grinding wheel

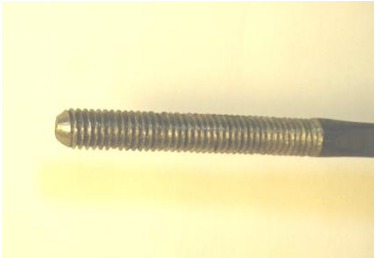


Figure 1-80 A dressed end of a tang

1.2.1.2 Bending the Tang

In order to bend the tang,or what is known as setting the cant, there are several methods. One of the easier methods, providing you have a large enough vise and strong enough workbench, is to clamp the blade in the vise, tip up, wire groove away from you and with the shoulder where the blade meets the tang about ¼" above the jaws of the vise. Grab the blade about 3 – 4 inches above the vise (you may want to wear heavy work gloves) and firmly and steadily pull towards you.

Now reposition the blade in the vise with the blade vertical and the wire groove toward the "handedness" that you want the blade to be. That is, if you want it to be a right handed blade, the wire groove goes to the right, if you want it to be a left handed blade, it goes to the left. Remember the blade (not the tang) needs to be straight up and down and again the shoulder needs to be about ¼" above the jaws. Grab and pull towards you.

Figure 1-81 Bending the tang, by hand

The angle that you want to achieve in both directions is about 5 to 10 degrees. The illustration below shows in the dotted lines where the tang should be when you are finished bending it. The photo shows a blade once it has been bent using the techique described in the next paragraph.

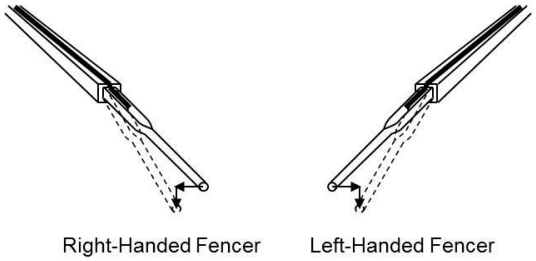


Figure 1-82 Directions for bending a tang

An alternative method is to reverse the blade in the vise, that is with the point down and use a 2-foot length of 1/2" diameter pipe (or smaller, but such that it fits snuggly over the tang) placed over the tang for leverage to bend it.

Figure 1-83 Bending the tang, with a pipe

Or even better still, a third method is to use a large (12" or larger) crescent wrench or box end wrench with the tang through the opening and the wrench parallel to the blade and then squeeze the blade and wrench together. Be sure that the point where the wrench and tang meets is about ¼ to ½" above the shoulder.

Figure 1-84 Bending the tang, with a Crescent Wrench

A tool developed by the author combines the best of all these methods. The main feature is that it uses

the same set up as found with the wrist adapter found in Chapter 7, which a square hole in one end that fits up next to the shoulder and ensures that the bend happens as close to the blade and tang interface as possible. This results in a sharper bend that eliminates the problem of 'banana' bends in the tang that make installing French grips, and some pistol grips, more difficult.

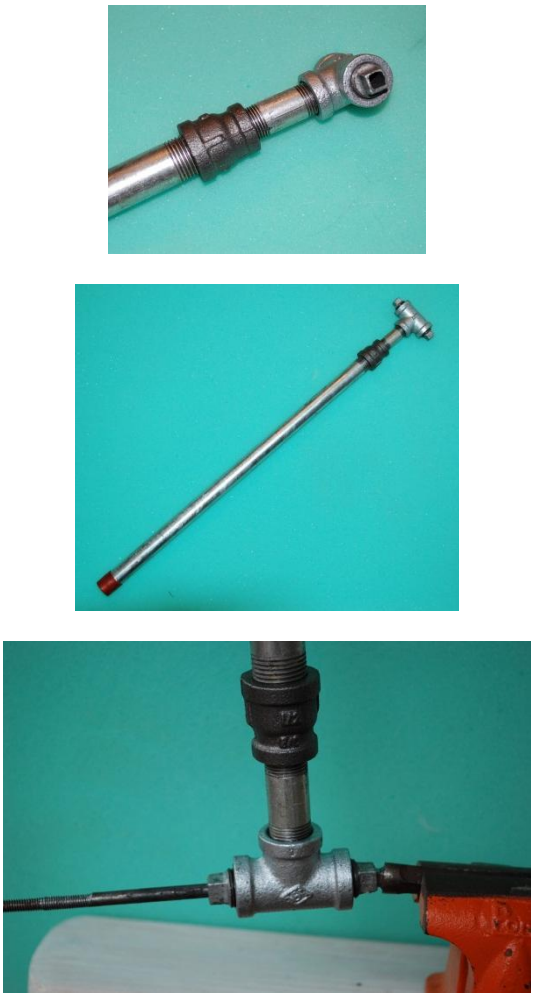


Figure 1-85 Author's Tang Bending Tool

The other feature is that by being a right angle to the bending direction, you have better control.

So why is control important? Because, fencers can be very picky about the cant of their weapons. So being able to replicate the cant from a broken blade to a new blade can be a bit tricky, especially when you are trying to bend a tang that is somewhat brittle.

Another tool the author has made (based on the suggestion of Brian Rosen) can be used to measure the angle of cant in both the downward and lateral directions. The Fig 1-86 below show how it is used and the feature that allows you to record the fencer's information for future reference.

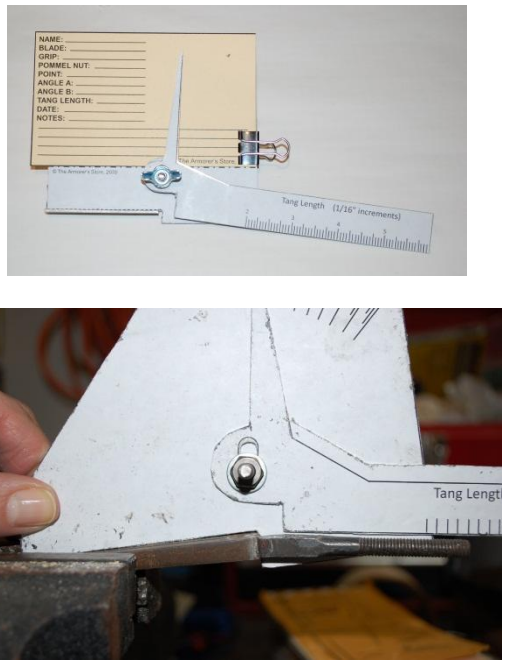


Figure 1-86 Tang Gauge

1.2.1.3 Modifying the Grip

Once you have the bend in the tang you want, you may want to modify the front of the grip you are using. For French grips this step is really not necessary. For orthopedic or pistol grips this step will help prevent jamming of the pommel nut against the sides of the hole in the grip. This is especially true of pommel nuts that use an outside hex tool or socket.

To modify the front of the grip, take the grip and slide it on to the tang. Next, scribe, or mark, a line across the top of the grip parallel to the line of the shoulder of the blade. The line should start at the point of the face of the grip FARTHEST away from the shoulder of the blade. As shown in the figure below, the shaded portion is the part to be removed. To remove this, either cut it off with a hacksaw or grind it off with a grinding wheel specially designed to remove aluminum**.**

SAFETY NOTE: DO NOT GRIND ALUMINUM WITH A REGULAR GRINDING WHEEL!

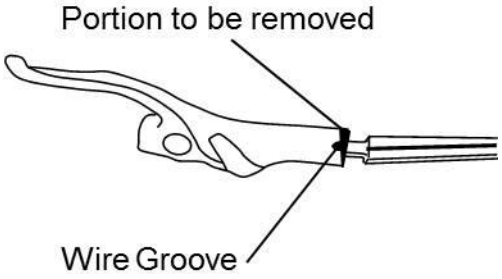


Figure 1-87 Modifying a Pistol Grip

When the angle of the face of the grip is right, take either a small round file or a round Dremel® drill or router bit and cut a wire groove in the upper section of the grip.

1.2.2 Assembly

Now that you have done the prep work, you are ready to put the weapon together. This discussion pre-supposes that you are using a blade that is already wired and has the point installed. If you are starting with a bare blade, wire and un-assembled point, please see Chapter 6.3.1, Advanced Repairs, Rewiring, for the section on re-wiring the blade.

The first step is to mount the blade in the vise as shown below.

Figure 1-88 Wired Blade Mounted in a Vise

Once the blade is positioned in the vise, the next thing you want to do is install the spaghetti insulation over the wire.

The insulation should be long enough to reach from the base of the guard to the connector with a bit of slack in it, a minimum of about 2 ½" inches, but not so long as to become entangled with other components. A maximum length of about 4" should be sufficient.

Before you start installing the insulation, make sure that the end of the wire has been trimmed with a pair of cutters and that there is no frayed end to the cloth insulation on the wire itself.

To start installing the insulation, carefully thread it over the end of the wire and begin to twist the insulation in either a clock-wise or counter clock-wise direction (depending on the twist of the cloth insulation on the wire, you want to go in the direction of the twist) with your thumb and forefinger and a slight downward pressure.

Be sure to hold the wire with your left hand and try not to force it into the insulation and cause a kink in the wire. If you are having trouble with the insulation coming unraveled and blocking the progress of the wire, take a short amount of the insulation off the end of the wire, trim the end again and put a small drop of clear nail polish on the end of the wire and let it dry. Then install the insulation.

If you are using spaghetti insulation that has a severe curl to it or a kink, from previous use, a handy tool to use is a clear soda straw. Insert the spaghetti insulation into the straw and hold about ¼ to 3/8" of out of the end of the straw while you thread it on to the wire. Using a clear straw will allow you to see when the wire comes out of the insulation.

Figure 1-89 Using a soda straw with a kinked wire

Once the insulation is on the wire, install the guard by first slipping the wire through the opening. Grab the wire with one hand and then with the other slip the guard over the end of the tang through the hole. Make sure the notch in the opening aligns with the

wire groove as the guard seats on the shoulder of the blade.

Figure 1-90 Feeding the wire through the guard

This method works if the free length of your wire is longer than the tang. If it isn't, and you are working with a French length tang, tape the wire to the tang with a small amount of tape.

If you are working with a pistol length tang and the wire is shorter than the tang, you have a problem. The wire is probably not long enough to properly attach to the connector and should be replaced.

Next to go on is the connector. It goes on basically the same way as the guard; however it should be oriented 90º to the wire groove; to the left for a right-handed fencer and to the right for a left-handed fencer. A good way to remember which side it should go on is that it goes on the palm side of the hand as you hold the weapon.

Figure 1-91 Installed connectors; left handed (right) and right handed (left)

Figure 1-92 Installing the connector over the tang

Next to be installed is the thumb pad. If you have taped the wire to the tang in order to install the guard and connector, remove the tape. Gently bend the wire over along the connector, and slip the thumb pad over the end of the tang. The cut-out in the thumb pad should align with the connector.

Figure 1-93 Putting the thumb pad on

The grip is then installed with the small notch in the front of the grip aligned with the wire groove and the wire passing through it, as shown below (the notch is on the side of the grip where the Armorer's finger is positioned in the illustration).

Figure 1-94 Installing the Grip

It may be necessary to lift the edge of the thumb pad up to make sure that the wire is not pinched by the grip. If it is, it will cut the wire when the grip is tightened, and cause much pain and agony in having to re-wire the blade.

Once you are sure that wire is aligned correctly, use your thumb or forefinger to hold it in place while the grip is installed, as shown above.

When the grip, connector and wire are satisfactorily aligned, install a lockwasher over the end of the tang.

A simple way of doing this is to take the jeweler's screwdriver and place the lockwasher over the end.

Holding the lockwasher next to your hand, place the tip of the screwdriver on the end of the tang and tilt it in line with the tang and let the lockwasher slide down the screwdriver over the end of the tang. Voila! Now install the pommel nut and tighten.

Figure 1-95 Using a small screwdriver to install a lockwasher

Some Armorers have suggested that wrapping the threads of the tang with thin Teflon® tape, normally used in plumbing applications, will help keep the pommel nut tight. Or another method is to use a thread lock (see Chapter 6.3.1, Advanced Repairs, Rewiring, for a discussion of the kinds of thread lock).

In the case of the Teflon® tape, this tape is normally used to keep joints from leaking, not to keep them tight. Also, Teflon is used because of its low coefficient of friction. In other words, it's slippery! So while it will make the interface of the nut and the thread a little tighter because of the increased amount of 'stuff' between the two parts, it will not maintain the friction necessary to keep them from moving in relation to each other.

Loctite®, also known as thread lock, while great for most assembly situations, is not ideal for high stress/shock applications. So in this case while it may seem to be a good solution in the short term, it isn't the best for a long term application. In plain English, it's okay for the first couple of months, but you'll still have to tighten the pommel nut after a while anyway. Bottom line: if you use a lockwasher, don't worry about the other 'techniques'.

When the grip has been tightened it is time to install the wire on the connector.

Trim the wire about ½" to ⅝" from the end of the spaghetti insulation and remove the wire insulation up to the end of the spaghetti insulation.

Remember, if you are using German wires to remove the varnish before connecting it.

To do this, you can either use a lighter to burn the varnish off, or use fine grade sandpaper (220 grit or emery cloth). Be sure to test the continuity after you clean off the wire.

If you find it easier to manipulate the wire when it is full length, you can just wrap it around the socket, tighten the nut and then trim it, making sure you didn't leave any insulation on the wire.

Now that the insulation is removed, install the wire on the appropriate socket. In the case of foil, it is the smaller or 3mm socket, if you are using a two-pronged connector.

If you are using a bayonet style connector, the wire is wrapped around the small screw at the base of the connector.

It is sometimes easier to manipulate the wire around the connector if you use a pair of tweezers. Just grab the end of the wire and use the tweezers like an extension of your fingers to wrap the wire around the screw or socket at least once.

Figure 1-96 Using tweezers to wrap the wire around the connector

Be sure that when you install the wire the spaghetti insulation comes up to the connector. There should be no bare wire visible between the insulation and the connector. This is also true for two-prong and epee connectors, also.

When installing the wire to the small socket of the newer German (or German 'clones') two-prong connectors, pass the wire and insulation from below the sockets through the small hole in the connector.

Next loosen the nut on the small diameter socket so that there is enough space between the small washer and top of the socket to slide the wire under.

Take the end of the wire with a pair of small needle-nosed pliers and wrap the wire UNDER the washer clockwise, or so when you tighten the screw it will tend to pull the wire toward the connector. Hold the top of the socket with the screwdriver and then tighten it from the bottom with a wrench. This will prevent the wire from being stressed by pulling when turning the upper portion of the socket.

1.2.3 Setting the Blade Bend

Next, if you are installing a brand new blade, you need to put a bend in the blade.

This bend is necessary because it makes the blade want to bend in a predictable direction. As was discussed in the chapter on blades, it makes the blade act as a bit of a shock absorber.

To put the bend in the blade position the blade under your foot as shown on the left below, preferably on a carpeted surface. With an even pressure pull the weapon up, keeping pressure on the blade. You may have to repeat this step a couple of times to get the bend you want. Also, do not do this with a cold blade. Warm it up a bit by rubbing it back and forth in a rag or towel.

NOTE: DO NOT DO THIS ON THE FENCING STRIP![32]

The rules strictly prohibit bending or straightening a blade on the fencing strip and a fencer can be penalized for doing it

Make sure, though, that you do not put a bend in the blade that exceeds one centimeter, for foil and epee, and 4 cm for saber!

Figure 1-97 Placing the blade under your foot at the foible

Figure 1-98 Pulling the blade from under your foot

[32] Rules t. 46, t.61, t.70/d, USFA Rule Book

1.2.4 Finishing Touch - Tape

Now you have, or should have a fully functioning weapon. Functioning yes, but not legal.

You still have to install the insulation tape to the tip end of the weapon. This tape extends as close as possible to 15 cm (6 inches) from the bottom of the barrel. First cut a strip about 5 ⅝" long. Lay it along the wide side of the blade aligning the side of the tape and blade. The end should be about ½" from the top of the barrel and not covering the screws. Fold the tape over the edge of the blade and smooth it down. Repeat all around the blade.

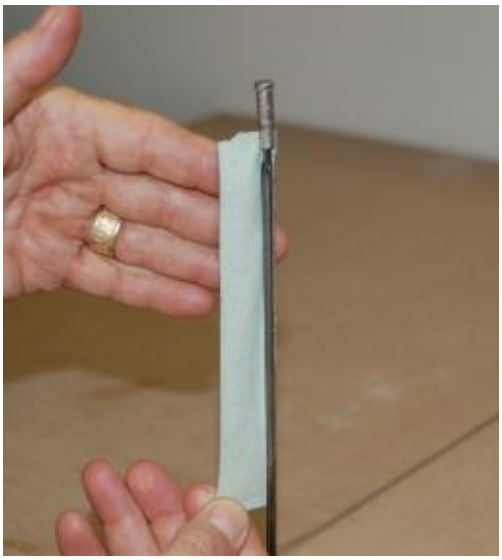


Figure 1-99 Taping the Blade

Next cut another piece of either the same color tape or contrasting color about 1 to 1½" long and wrap it around the barrel aligning the edge of the tape with the top of the barrel, You can also have a slight bit of tape extending above the top of the barrel. If you do, take the weapon with the grip facing away from you, and use the smooth part of a fingernail to fold over the extra tape by turning the weapon slowly clockwise.

Figure 1-100 Taping the Barrel

Now you have a weapon that should be legal. To be sure, do a functions check with the body cord, test box and test weight as described in Chapter 1.4.3, Foil, Basic Maintenance.

Assembly of the epee and saber follow the same basic steps as foil, except that epee has two wires to connect to the connector and no tape around the end of the blade.

As we pointed out earlier saber doesn't have any wires. However, make sure the end of the guard goes between the grip and the pommel nut, over the tang of the blade. Also, when you assemble the saber, make sure that the tang does not extend beyond the pommel nut.

As was stated in several of the preceding chapters, there are many requirements associated with the physical characteristics of each weapon. These requirements can be found in Book 3, Material Rules of the USFA Rule Book. A table summarizing each of the specifications for each of the weapons is included below.

Appendix F, the Armorer's Cheat Sheet contains a much more detailed table, annotated with the rule that applies to each specification. Please feel free to remove it and laminate it for daily use!

Saber Assembly

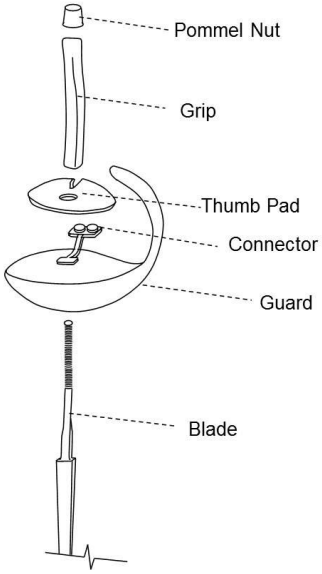


Figure 1-101 Saber Assembly

Epee Assembly

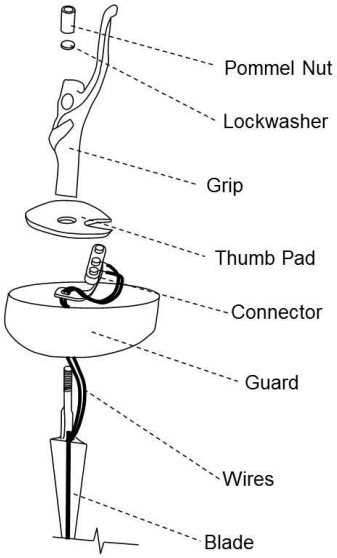


Figure 1-102 Epee Assembly

Table 1 – Weapons Specifications

Feature	Foil	Epee	Saber
Max Blade length[33]	90 cm	90 cm	88 cm
Grip and Guard length	20 cm	20 cm	17 cm
Over all weapon length	110 cm	110 cm	105 cm
Max blade bend	1 cm[34]	1 cm	4 cm
Max guard diameter	12 cm	13.5 cm	15 x 14 cm
Min guard diameter	9.5 cm		
Max guard depth		5.5 cm	
Min guard depth		3.5 cm	
Min flex bend[35]	5.5 cm	4.5 cm	4 cm
Max flex bend	9.5 cm	7 cm	7 cm
Max weapon weight	500 gm	770 gm	500 gm
Max allowable resistance	2 ohms	2 ohms	1 ohm
Allowable total point stroke	< 1 mm	>1.5 mm	
Lighting stroke	> 0.000 mm	1.0 mm	
Point pressure weight	500±2 gm	750±3 gm	
Point max diameter (dim)	7 mm	8.05 mm	
Point min diameter (dim)	5.5 mm	7.95 mm	

[33] Measured from the tip of the point (installed) to where the blade leaves the guard.
[34] This is a recent rule change in the US. Previously it was 2 cm.
[35] As determined as follows: With the blade fixed at 70 cm, and oriented so the bend in the blade is down, from the tip end of the blade and a 200 gm weight suspended 3 cm from the tip (for foil and epee, 1 cm for saber). The flexibility is measured as the difference between the rest position of the blade and the position of the blade with the weight suspended from it.

1.3 How Does It Work?

In order to understand how to make sure something is working correctly, it is necessary to know how it works, right? Makes sense; so knowing how the circuits of each of the various weapons works will help you to track down and fix problems.

Purely mechanical systems are fairly easy to understand, at least for a mechanical engineer, like yours truly, but electrical? That's a different story. It's hard to trust things you can't see, like electrons.

In order to understand this, it may be easier to think of electricity as something you can see, like water. The purist engineers who read this will probably cringe at the thought, but I have found that this analogy works for most people who have forgotten their basic physics classes (or who have yet to take them!).

In our analogy, the water molecules, good old H_2O, are the much smaller electrons. The pipes that the water travels in are the wires in our system. The pressure driving the water is the potential, or voltage; how fast the water flows is the current, or amperage; the roughness of the inside of the pipes, that cause drag, is the resistance, and like water, that seeks the lowest levels, electricity will seek a lowest level, which is called the ground.

A circuit is any path that water or electricity can flow through. Both will always take the path of least resistance. In other words if it is stopped it will look to find another open path.

Where our analogy differs is in the area of valves and switches. Here we have to think backwards, that is, when valve is closed it stops the flow of water; when a switch is closed, the electricity flows.

So armed with this analogy, hopefully it will help you to understand the functions described in the following sections.

1.3.1 Foil

The foil works on what is known as a "normally closed circuit". A "normally closed circuit" is one that is, well, normally closed. That is, when at rest, or in it's normal state, the circuit is connected from one end to the other. If there is an energy source in the circuit, like a battery, electricity will flow through it until the circuit is broken.

In the case of a foil when it is hooked up to the scoring machine there is a flow of electricity at a very low voltage and current down the wire, through the tip, and then down the blade. This electrical current is very low, in the milliamp range and voltage range of anywhere from 5.2 VDC (volts direct current) to a maximum of 12 VDC.

The figure below (Fig. 1 -103) shows, by the dashed line (—·—·—·—), how the electricity flows from the B-line (wire) through the connection between the flange on the tip, through the screws, to the barrel and down the blade, C-line (ground) when the tip is at rest.

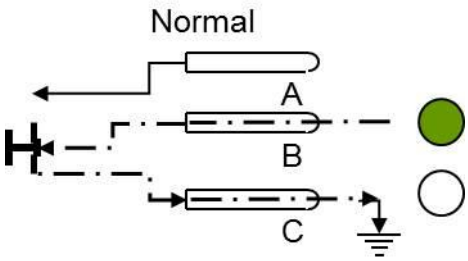


Figure 1-103 Basic Foil Circuit

When the tip is depressed, the connection between the tip and barrel is broken. In other words, the circuit opens. When this happens, the lack of an electrical signal triggers the scoring machine and the white light, or off-target light, is turned on, as shown in Fig. 1-104 below. Note that the dashed line is gone from the B and C-lines, indicating a broken circuit.

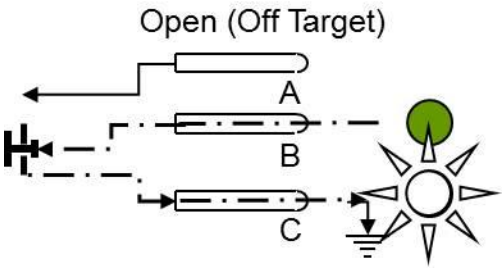


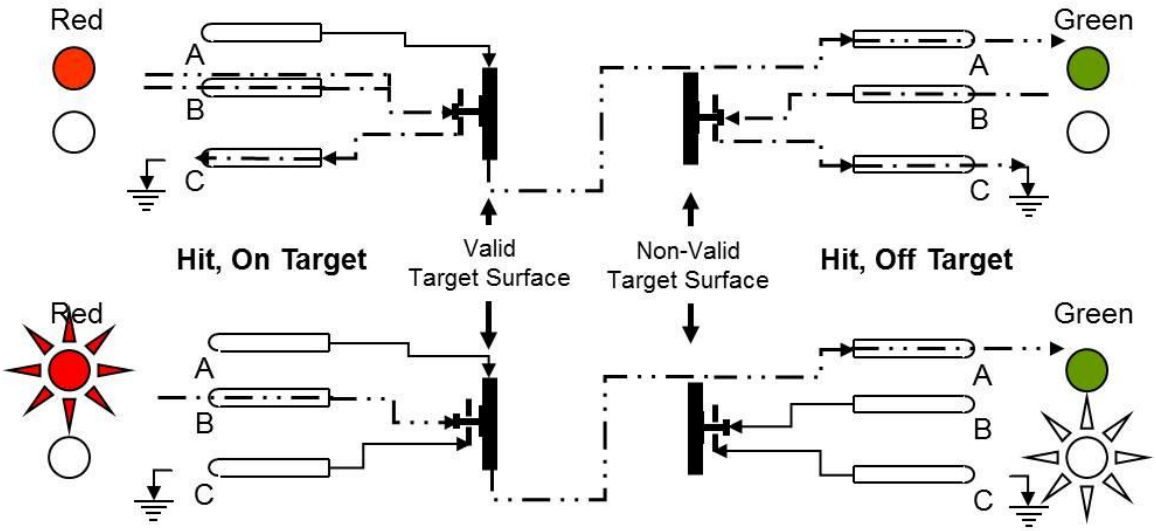
Figure 1-104 Foil Tip Depressed; White Light illuminated

Scoring on valid target, that is, to turn on the colored light, is a lot trickier. In order to explain this, the illustrations below, are divided into two sections; on

the left is a hit on valid target, and on the right is a hit on non-valid target.

The illustrations are further divided into the upper and lower portions. The upper portion shows the two weapons the instant they come into contact with the surfaces. The surface on the left is a valid surface, in this case, the opponent's lamé. The surface on the right is a non-valid surface, say, the opponent's arm, mask or other non-target surface.

The instant the tip on the left comes into contact with the lamé, the current, or signal, which has been going through the wire and the weapon back to the scoring machine, and keeping the white light off, now also goes back to the scoring machine by way of the opponent's A-line through the opponent's body cord's lamé clip, as shown by the double dashed line (–··–··–··–). Note that the signal also continues to go through the original path.



With the signal coming from the opponent's A-line, the machine now says "Ah ha! The left has made contact with the right! Let's see what he does." It doesn't say anything about the right, because there has been nothing to tell it there is anything different with the right because the tip hasn't been depressed.

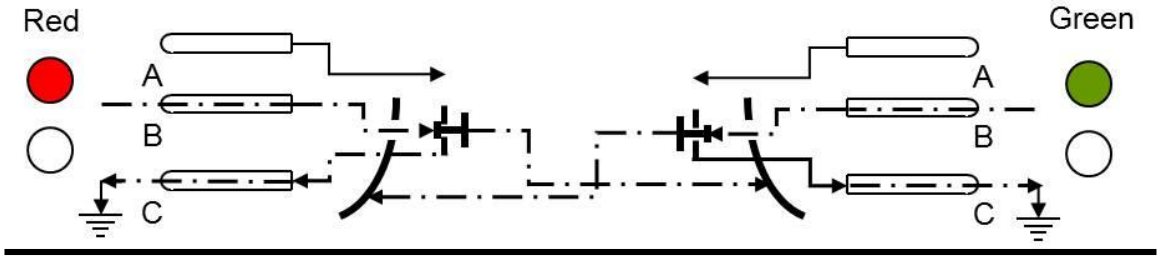
A switch, internal to the scoring machine, is now thrown so that when the circuit on the left is broken, that is the tip is depressed, as shown in the lower left of the illustration, power goes to the colored, in our example, the red light, instead of the white light.

At this point the machine also says "OK, so you've made contact with the opponent's valid target and I'm getting a signal through their A-line and broken the B-C circuit, but you've got to leave it in this condition for a while before I decide to light up the light." No, the machine isn't lazy; it's set that way to make sure the touch lands solidly and this delay is 15 milliseconds. If within that time either the A-line connection is broken, or the B-C circuit is reconnected, the machine won't turn on the lights and fencing continues.

When a weapon lands on the opponent's weapon or the grounded strip, no lights go off because of the following. When the left's weapon initially contacts the opponent's weapon, in this case on the guard, the signal (which remember is flowing now between the B and C-lines) now has two paths through which to flow to ground. Since it going to ground, it's not concerned how it gets there, just as long as it does. And as long as it does, no white lights!

So when the circuit is broken, that is the tip is depressed as shown on the right below, the signal is still flowing to ground and everyone is happy! Only, now the signal is flowing through the opponent's C-line to ground instead of the fencer's C-line.

When the tip is removed from the grounded surface, the tip moves back to the original position, which happens in less than 15ms, the circuit is re-established through the fencer's own C-line and everything remains copasetic. This is why it is important that the connector is in contact with the guard when you assemble the weapon.



1.3.2 Epee

Since the entire body is target in epee, the circuit is much simpler. Where the foil point is a normally closed circuit, the epee is a normally open circuit, like your light switch at home. This means that no electricity or current flows through the circuit until the switch is thrown or closed, as illustrated below.

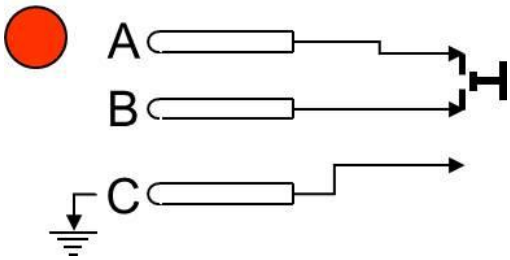


Figure 1-105 Basic Epee Circuit

When the tip is depressed, the contact spring of the tip makes contact with the two wires, the A and B-lines, and completes the circuit. This means the signal now flows from the B-line to the A-line and turns on the colored light[36]. Below shows how the signal flows.

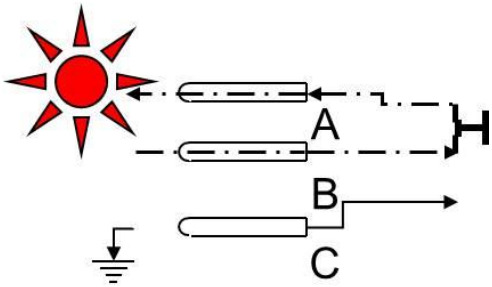


Figure 1-106 Epee Circuit – Valid Touch

[36] Since there is no off target in epee, there is no circuit for the white light; even so, the light is still a part of the scoring machine, so it is left in for the purpose of illustration!

The grounding circuit is a bit more complicated, but not much. As the tip contacts the grounded surface, either the opponent's weapon or the grounded strip, nothing happens.

Because the tip has not been depressed and no contact with the wires made, the weapon and box continue in their peaceful coexistence.

Only when the tip is depressed and contact is made by the contact spring with the A and B-lines do things get interesting! Now the signal flows not only from the B-line to the fencer's A-line, but it also flows through the opponent's C-line to the scoring machine.

This second signal nullifies the light circuit, thus preventing it from activating and turning on the light. So, no touch. The illustration below shows how that circuit flows.

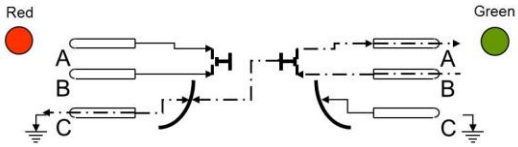


Figure 1-107 Epee Circuit – Grounded Touch

1.3.3 Saber

The saber circuit is the simplest of the three weapons. Because there is no wire or mechanical/electrical tip, the shorted connector (that is the B and C lines are connected) makes the entire weapon "live", similar to the foil in that there is a flow of electricity through the weapon.

In order to score, all the weapon needs do is to make contact with the opponent's lamé, mask or manchette (overglove). This completes the circuit through the opponent's A-line.

The B-C-line connection also serves as the ground for the weapon to prevent it from being able to score against the opponent's weapon. It is the same principle as in foil in that, if the weapon contacts the opponent's weapon, the signal will still flow through to ground (although it shouldn't be any worry since the B-C-line connection remains closed).

There are several parts of the weapon, such as the pommel and the lower portion of the guard, that are insulated to prevent the weapon from accidentally coming into contact with the fencer's own lamé, thus making his or her weapon valid target for the opponent! Make sure that when you do a visual inspection of your weapon, the insulation on these parts is in good repair.

1.4 Basic Maintenance

"This is your rifle; it is your best friend. Take care of it and it'll take care of you"

Sounds pretty trite, or John Wayne-ish, but if you've been in the middle of a tournament and all of a sudden every weapon you had dies on you, it comes home to roost.

While not absolutely reliable, most electric fencing weapons will last at least one or two tournaments without causing you much trouble. The tricky part is figuring out which those one or two tournaments they are!

But all is not lost. Like anything mechanical/ electrical, basic preventative maintenance is essential to keeping things running smoothly.

This chapter will show you how to check out your weapons and insure that they are compliant with USFA rules.

Before every tournament (and preferably not the night before) you should take out all your weapons and check them over - **Thoroughly**.

Don't just gloss over the fact that there may be a little rust on the blade or guard. Or, yeah it works, but that little flutter in the light when you are testing the point doesn't mean anything, etc. Know the aspects of each weapon you fence and what will get you in trouble either on strip or at the weapons check-in.

1.4.1 Blades

As was discussed earlier in this chapter, in Section 1.1.1, Blades, the main thing we are concerned with in maintaining the blade is corrosion. For all blades, a small amount of corrosion is unavoidable. Oils and acids from your hands will cause chemical changes in the surface of the metal that will act as places for rust/corrosion to start

This surface corrosion can usually be removed with a fine grit sandpaper or Scotchbrite® green scouring pad. Even using these materials not all of the corrosion will be removed and will leave a mark, or what's known as a patina, behind, which is OK.

There are several methods that can be used to keep corrosion to a minimum. A light coat of machine oil (the kind that is used for sewing machines, or 3-in-1®) works fairly well. Another method is to use a good silicone car wax. And finally, some fencers have used gun bluing to coat their blades. Bluing is not a cure to corrosion, it only controls it. If it is used, you must also apply a light coat of oil. In all cases, make sure that you wipe the blade well after coating it.

Some manufactures have a colored coating applied to their blades, which is supposed to be a protective coating. Because it is alodine it is conductive. It being a thin coating, it will wear off after a while.

The best way to reduce corrosion is to keep the blade away from moisture. If you live in a humid environment, like near a lake, river, or ocean, keep your blades in an air-conditioned area. Do not store your blades with your wet clothes (jackets, gloves, etc.).

Another way to control moisture is to use desiccant packs. There are a number of places on the internet that sell these. Unfortunately, they wear out over time, although there are some that can be re-used after they dry out by reactivating them in a microwave.

Blades with excessive corrosion, such as ones that have been stored for a long time in a wet or humid environment should be thoroughly cleaned and inspected before use. Deep pitting from corrosion can seriously weaken a blade, making it dangerous to use. Be sure to inspect the blade carefully once the rust has been removed to make sure there are no visible cracks.

Removal of the rust will also be much appreciated by your fellow sallemates and competitors (as well as yourself if you store them next to your "whites") because they can leave stains on uniforms that are nigh on impossible to remove.

During use, the edges of the blades will become nicked. It is a good idea to occasionally run a file along the edge to de-burr it. Do not be overly aggressive with your filing. The edge of the blade must be chamfered at 45° (±.5°) x 0.5mm (±.1mm)[37], not that anyone REALLY checks this, but it illustrates that the edge must be such that it can't cut.

[37] Rule m.8, USFA Rule Book

If your blade has a kink or too much of a bend, the best way to remove it is to use the ring end of a 10" or larger crescent wrench, similar to what is shown in Fig 1-84.

Slip the ring over the end of the blade and place the edge of the ring on the point of the kink (with the curve of the blade pointing away from the wrench). Gently squeeze the blade and wrench together until the blade is straight. Reposition the wrench above and below the bend and repeat until you have a smooth curve.

Too remove too much curve from the blade, use the same technique as above, only start at the bottom of the point where you want to start removing the curve, and work you way up towards the point.

1.4.2 Guards

The metal reinforcing plate that is used on many guards, for all three weapons, are usually made of steel and because of that, they are subject to our old friend corrosion.

As with blades, this piece should be lightly sanded on a regular basis to insure that it remains conductive.

Since this plate is attached using rivets, they should also be checked regularly to make sure they remain tight. If they become loose, you can usually tighten them by placing the front side of the guard on a metal surface and using a small hammer, pound them flat again.

Since most guards are made of aluminum, they have a tendency to deform when they are abused during fencing. This is especially true with beginning foil fencers as they learn that fencing is not a contact sport like football or basketball!

Most often the problem with foil guards is that they get bent out of shape, the most serious being the 'taco' shape, see Fig. 1-21. If the guard is too severely deformed it should be pounded back into shape with a small ball peen hammer. If not, the referee has the option of rejecting the weapon for use on the strip.

1.4.3 Foil

Now that we know the theory of how the foil circuit works, let's make sure we're ready to fence!

Start with the basic function. For this you are going to need the following items:

Working body cord
500 gram test weight
Test box (or ohmmeter)
Your foil

We are going to assume that you are going to use the test box built from instructions in Chapter 5.3.6, or a similar device. A good test box to use is the one shown in Fig. 108. as it can detect intermittent shorts.

If you are going to use an ohmmeter, or advanced test box (like the one below, built by the author, Fig. 109) be sure that the meter is zeroed before using (see Section 5.2.2.5) and that it has the proper range (0 – 20 ohms).

Figure 1-108 Favero Test Box with Intermittent detection

Figure 1-109 Author's Advanced Test Box and Cables

Plug the weapon into the test box using your body cord. You should get a light (red or green, depending on how your box is wired). Now depress the tip. The light should go off. So far, so good.

Now place the guard on the edge of a table, point up, and place the 500g weight over the tip. The light on the test box should still be lit.

Push the weight down, the light should go off. Let go of the weight. The spring should lift it back up and the light should come back on.

Now place a penny, nickel or quarter on the weight[38]. The light should still be on, that is, the spring should still hold up the weight and the coin(s).

If the light goes off with the added weight, this means that the spring is VERY close to the tolerance of 500 grams. This is not necessarily a good thing because it is very likely the spring could go soft on you during a bout and cause it to fail the next time you fence.

Also, even though the rules state the foil test weight should be 500±2g; many weights in use at tournaments are not. This is because there is nothing to make manufacturers certify that their weights are in compliance with the rules.

By doing this test with the extra weight it will give you some added insurance that your weapon will pass a weight test on strip.

Weights should be checked on a calibrated scale. Normally a three-beam scale used in chemistry classes is accurate enough to get within the ±2 grams.

You can purchase your own digital scale that is very accurate for a modest cost on-line. Beware, though, some of these sites are also connected to drug paraphernalia, so they may not be sites you want to be associated with by browsing them.

Figure 1-110 Weight Testing a Foil

NOTE: After EVERY bout, you should check your weapon with the weight in use at your strip[39].

With the weapon still plugged in, check the wire that goes to the connector. The spaghetti insulation should go all the way to the connector (no exposed wire, insulated or not). Gently wiggle the wire. The light should stay lit. If the connection is going to break, this should make it fail. Better now while you can fix it without the *angst* of trying to do it during the tournament.

Now check the barrel. Is it tight? If not, tighten it (but not more than ¾ of a turn; if it is that loose, you run the risk of breaking the wire).

Is your handle tight? If not, tighten it, too. A loose handle can be the source of intermittent off-target lights. Remember our discussion of how a foil works? And the reason why the connector needs to be in contact with the guard?

[38] According to the US Mint the following are the specifications for US coins

	Penny	Nickel	Dime	Quarter
Weight	2.500 g (3.00g for pre-1982)	5.000 g	2.268 g	5.670 g
Thickness	1.55 mm	1.95 mm	1.35 mm	1.75 mm
Diameter	19.05 mm (.750 in)	21.21 mm (.835 in)	17.91 mm (.705 in)	24.26 mm (.955 in)

[39] For those using Euro coins here are the specifications on those:

	2 €	**1 €**	**.5 €**	**.2 €**
Weight, g	8.5	7.5	7	5.7
Diameter, mm	25.75	23.25	24.25	22.25
Thickness, mm	1.95	2.125	1.69	1.63
	.1 €	**.05 €**	**.02 €**	**.01 €**
Weight, g	4.1	3.9	3	2.3
Diameter, mm	19.75	19.75	18.75	16.25
Thickness, mm	1.51	1.36	1.36	1.36

Now, shake the weapon. The light should not flicker or go out. Beat the weapon against your foot. The light, again, shouldn't flicker or go out.

Check the wire in the blade for the entire length of the blade. Has it popped out of the groove? Are there any places where it looks like the insulation has worn away? In both cases, re-glue the wire.

Check your tip tape. Is it in good shape? If not, replace it. Why? Because if the tip AND the blade make contact with your opponent's lamé, the hit won't register. Remember, you want it to be 15cm (about 6") down the blade, measured from the bottom of the barrel. There is no tolerance on this, that is 15cm is a minimum length, but don't go overboard. If your opponent hits your blade and you have tape almost half way down it, it will register as an off target.
This brings us to removing corrosion from your blade, tip and bell guard, as was discussed earlier. Another thing about corrosion is that it is non-conductive; therefore any contact with it will result in an off-target (not supposed to happen). Use the Scotchbrite® pad to remove the corrosion and then wipe off the blade with a paper towel. It is also a good idea to give the blade a good rubbing down even if you don't have corrosion to remove any burrs from the edges of your weapon.

Next, check the bend in your blade. To do this, lay your weapon with the bell guard off the edge of the table, blade bend up (the weapon should be resting on the tip and the point where the blade goes through the guard). A 1cm high block should **not** be able to pass any point under the blade[40]. If it does, take some of the bend out of the blade until the block will not pass under it.

Figure 1-111 Checking the Bend of a Foil

Lastly, with the weapon connected to the test box, or if you are lucky enough to have one handy, to a scoring machine, take the blade and bend it back and forth. Watch the light for any flickering that may indicate a fault that you didn't catch during the visual inspection or the off-target light goes off.

If you are plugged into a scoring machine, take a working weapon and plug it into the opposite side. This will keep the machine from buzzing and resetting the off-target light while you are trying to work. Also, if you have a fault that you missed earlier, it will set off the machine. This is a much better indicator than a flickering light.

You should now have a bright shiny, working weapon. If any of the foregoing results in a fault, go to Chapter 6.2, Basic Repairs.

1.4.4 Epee

So now you are ready to check out your epees!

The procedure is essentially the same as it was for foil. Start with the following:

Working body cord
750 gram test weight
Test box (or ohm-meter)
Set of test shims (1.5mm and .5mm)
Your epee

Plug your weapon into the test box. This time there should be NO light (remember, this is a normally OPEN circuit!). Depress the tip. The light should go on. Release the tip and it should go off. OK, so how tough is that?

Take the 1.5mm shim and place it between the tip and the barrel. It should slide in. If you are in a hurry, or don't have a set of test shims, a brand new, shiny, US penny is nominally 1.55mm thick. If it fits between the tip and the barrel, you're good to go!

Figure 1-112 1.5mm Shim Test

[40] This is a recent rule change in the US. Previously it was 2 cm.

Now take the 0.5mm shim and place it between the tip and barrel and depress the tip[41]. The light should NOT turn on. Rotate the shim 90°and re-test. The light should still not turn on. This is a good test to ensure that the tip of the barrel and the bottom of the contact spring are parallel.

Figure 1-113 0.5mm Shim Test

Check to make sure that you have both screws in the tip. Tighten them (why should I do that? They're already tight. Guess again!).

Check the spring with the 750g weight. Place the weight on the tip. Press the weight down, the light should go on. Release the weight, the light should go off! Again, put pennies, nickels or quarters on it to make sure you have enough extra strength so that it won't be a problem (remember the chart from the previous section).

Figure 1-114 Weight Testing an Epee

[41] The tolerance of the shim thickness is ±.05mm

Check the two wires at the connector. Do the same test as for foil.

Again, check for corrosion. This is especially important for epee because if the light goes off after you've tested tips and bell guards at the start of the bout; you lose, unless you can replicate the fault.

Check the bend in your blade the same way you did for foil. The 1cm block should not be able to slide under the blade with the weapon resting as described for foil.

Figure 1-115 Checking the Bend of an Epee

Lastly, with the weapon connected to the test box, or, again, if you are lucky enough to have one handy, to a scoring machine, take the blade, and the tip depressed and held down, bend it back and forth. Watch the light for any flickering that may indicate a fault that you didn't catch during the visual inspection. If you are connected to a scoring machine, hold down the tip until the machine resets. If you have a fault that you missed earlier, it will set off the machine. This is a much better indicator than a flickering light.

Again, you should now have a bright shiny, working weapon. If any of the foregoing results in a fault, go to Chapter, 6.2.2, After the Bout, Basic Repairs.

1.4.5 Saber

To check out your weapon you need the following:

Working foil body cord
Test box (or ohm-meter)
Your saber

Plug your saber into the test box using your FOIL body cord (that is unless you normally use a body cord modified with the pins shorted). You should get light (red or green, depending on how your box is wired, but is should be the same as for foil).

Voila. Done. Simple.

That is unless you DON'T get a light. Then pull the body cord plug out of the connector and short it across the guard. If you have a light now, check the connector to make sure the two jacks are in metal-to-metal contact with the connector (did you accidentally use a foil connector to assemble the weapon? Did you scrape the paint away from around the hole on the back side of the guard?).

Check the rest of the weapon for corrosion and remove it, although in saber this is not as big a problem as it is for epee or foil where a non-conductive surface can be construed as either target or non-valid target, respectively, and set off the scoring machine.

Make sure the pommel nut is tight and that the bend in the blade conforms to the rule of being bent only in the upper 2/3's of the blade. Check the bend in the blade as you did for foil or epee. The 4 cm block should not pass under the blade

Figure 1-116 Checking the Bend of a Saber

Again, you should now have a bright shiny, working weapon. If any of the foregoing results in a fault, go to Chapter, 6.2 Basic Repairs.

CHAPTER 2 - OTHER BITS AND BOBS (THE REST OF THE STUFF)

In this chapter we will discuss the remainder of the equipment you need in order to fence safely, the uniform and what connects you to the scoring apparatus. It needs to be pointed out again that this is not meant to be a encyclopedic rendition of all the items that are currently available in the fencing community, but only a representative sample of the more commonly found items.

The items to be discussed are:

- Body Cords & Mask Cables
- Masks
- Jackets
- Knickers
- Gloves, Shoes and Socks
- Lamés

2.1 Masks

The mask, or as some of the unwashed masses sometimes refer to as a helmet, is the most important piece of fencing safety gear that you can own. It is what protects your mug from ugly scars, or worse, death.

In order to be approved for use by the FIE in competition (or for any reputable manufacturer to sell) it must go through a rigorous testing regime. While FIE approved masks are not specifically required for most competitions, it is highly recommended that you get a mask that is approved by the FIE for 800 Newtons or better.[42] If you cannot afford a mask of that rating, then make sure that you get the highest rated mask that you can afford. An example of FIE markings for acceptable masks is found in Fig 2-1.

The mask consists of several parts: the bib, the mesh, the reinforcement band, safety strap and the tongue or device to hold the mask to your head.[43]

Figure 2-1 Examples of FIE markings for Masks

The pictures below show several various designs that will be discussed in this chapter.

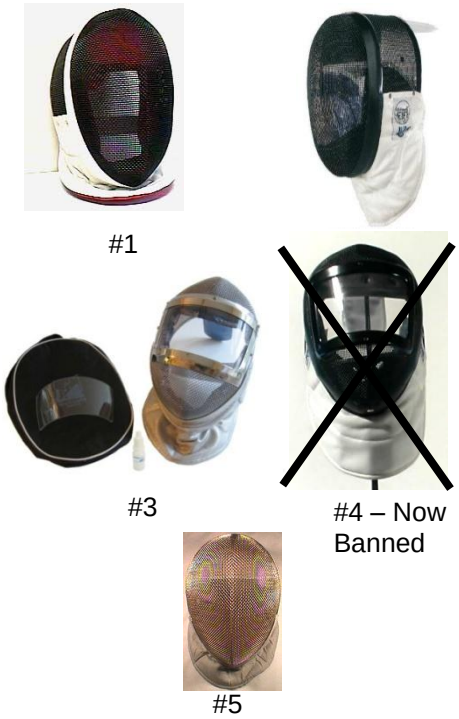


Figure 2-2 Mask Types

The bib is the cloth part of the mask that covers your throat. It must extend 10 – 12 cm (3.94 – 4.72 inches) below the reinforcement band and must have a layer of Kevlar (the bullet–proof vest material) or similar material in it and have a rating of 1600 Newtons.

It should also not curl up or crease, as shown in example #1 in Fig 2-2. If it does, that will expose your neck and you will not be allowed to fence with that mask.

The bib should also be permanently fixed to the mask. Many years ago, many masks had a snap in bib which made it easier to remove and clean or replace if it got worn out. Those style masks are no

[42] A Newton is a measure of force that is equivalent to .224 pounds force
[43] See Section 2.2 of Appendix A to the Materials Rules of the USFA Rule Book for exact requirements for masks.

longer approved for use in competitions. That doesn't mean they aren't still in use at some clubs and schools, though.

The exception to this, though, is the newer Leon Paul X-Change mask. This mask does have a removable bib that can be replaced. It does this by means of a channel that is attached to the bottom of the mesh, into which the top edge of the bib slides into. Because it has continuous contact across the entire front of the mask, it doesn't have any way for a blade to penetrate or slip into the interior of the mask. This is also handy if you fence both foil and epee, as you need only one mesh and two bibs!

Figure 2-3 LP X-Change Mask and Exchangeable bibs

The mesh is divided into two pieces, the front and the sides (or trellis). The material itself (for a FIE approved mask) is a stainless steel wire that is woven so that the opening in the mesh is no greater than 1.9mm (.075 inches). The woven mesh can be dipped in solder to reinforce the connection of the mesh[44] or mechanically double crimped, as is the case with all FIE approved masks.

The mesh is then covered with a plastic insulation, except for saber masks, which will be discussed later. The insulation is important because of our old nemesis, sweat, especially in foil. If the mesh was un-insulated and the bib was soaked with sweat it would make an electrical connection with the fencer's lamé and thus make the entire mask target! Bad. But the insulation makes hits to the mask off target. This is a good thing!

A variation of mask that has come about after 2000 is the visor mask shown in examples #3 and #4 in Fig 2-2. It has a clear polycarbonate, or as it is known by its trade name, LEXAN®, face shield

In 2011, in response to a failure of the visor during an international event (and fortunately with only minor injuries) this style mask was **banned** for **all** foil and epee competitions. It is, however, still acceptable for use in saber competitions.

The visor, or face shield, is marked with the date of manufacture and is required to be changed out every two years. The markings are listed as mm/yyyy, with the exception of one manufacturer (who in 2010 was changed to the format listed). Therefore, it is important to double check this date.

In 2011 there was a change to the marking of the Lexan visors. Instead of the life of the visor being measured from the date of manufacture, it is now measured from the date of sale. This means that when a visor is **sold** the vendor is supposed to affix a sticker that has the month and year of sale marked in such a way that it can't be altered. Some vendors have a small punch, similar to a conductor's ticket punch, to mark the information, while others use a permanent marker.

If the visor has been stamped with the date of manufacture, this date takes precedence and the life of the visor is determined from this date, not the date it was sold.

The visor is held in by means of a metal frame with either screws or threaded studs, which must have all fasteners (both screws and nuts) present. Most manufacturers use a hex nut on the inside of the mask, however one is now using an acorn nut, which covers the ends of the screw. Most likely, this is to conform with the new ruling, which states that the screw (or bolt as they call it) must not protrude past the nut that holds it.[45]

NOTE: if you are missing a nut, you can use the nut from a body cord connector to replace it – it is a standard M3 hex or acorn nut!

[44] Except for FIE stainless steel masks, which are double crimped as stated.

[45] USFA Rules, Appendix A, Section 2.1.2, paragraph 2.

The face shield can also be covered with what is known as a sacrificial mylar sheet. This is a sheet with adhesive that is removable and helps prolong the life of the face shield. When the face shield becomes scratched or cracked, though, it needs to be replaced.

A perceived issue with the polycarbonate or Lexan visor is that it is prone to attack by polyvinylchloride (PVC), which will weaken the material. Because of this any contact, or storage of the visor material in the presence of PVC is to be prevented.[46]

The mesh is also part of the side and top of the mask. This flat area should be 10 -12 cm (3.94 – 4.72 in) wide and of the same material as the front mesh. It is connected to the front mesh by a mechanical means, either sewn with wire, rivets or solder, but is normally welded. This is covered by the reinforcement band and in a foil/epee mask this is normally rubber or heavy cloth; for saber masks it is either metal or lamé material.

The tongue of the mask is the flat part on the back of the mask that holds the mask to your face. It is normally a heavy gauge wire frame covered with plastic material. It is welded to the underside of reinforcement band at two places.

There is a mask that does not have a tongue that is made by Leon Paul. It has a plastic piece that is held to the back of the head by means of three adjustable elastic bands. This has been ruled legal because it does have a strap that goes straight across the back of the mask.

Figure 2-4 LP X-Change Head Strap

A safety strap is required of all masks for competition. This strap is usually two elastic bands attached to the side and rear of the mask and is held together by Velcro®. It is placed so that it holds the mask below the tongue to prevent it from flying up during the fencing action. This strap can also be three pieces with two short pieces attached to either side of the mask and the third the connecting piece between them. Again the most common method of closure is Velcro®. The strap is required to be worn against the head, not the tongue of the mask.

As was said before, saber masks are somewhat different from those we have discussed previously because for this weapon, the head is target and therefore the mask has to be conductive. To do this the mesh is un-insulated, the reinforcement bar is metal or covered with lamé material, as are the edges, and the bib is covered with lamé material. An example is pictured above as #5.

The saber mask also has a visor version and as we said before. The problem with this mask is that LEXAN is non-conductive. If your opponent uses one of these masks for saber, this portion of the face is no longer target (that is, it won't register on the scoring apparatus). However, the size of this window is specified, so if you use one too, it evens out. Hopefully.

Some manufacturers have begun to offer masks with different colored mesh, ranging from lime green to dark blues and reds. Some competitors have even taken to painting designs on their masks.

While neither of these are banned for use in tournaments, it should be pointed out that if in the latter case, that of decorating your mask, it must be done tastefully and cannot offend anyone, and for use in FIE competitions, must be approved before the competition. So swastikas or obscene gestures, etc. are out.
In October of 2007 the FIE agreed to make a significant change to the target area for Foil that will now include part of the bib of the mask. This rule change, which was in effect for Senior World Cup and above tournaments starting in January 2009, and for Junior World Cup events by October 2009, necessitated the addition of the same kind of conductive material used in lamés to the front of bib[47] and to two tabs attached to the inside of the bib.

As of August 1, 2012 these bibs are now required for **all** foil competitions, both for FIE and USFA events.

[46] Para 2.1.2(3), Appendix A, USFA Rule Book

[47] Rule t.27.2, FIE Rule Book

There are also changes affected the foil lamé and mask cord, and the specifics of those changes will be discussed in Sections 2.2 and 2.8.

The conductive material that is part of the bib must cover an area that is 1.5 to 2 cm (.6 to .78 in) below the chin[48] and cannot overlap the inside of the bib.

The two tabs will be attached on either side of the inside of the bib in a way that will make contact with the conductive material attached to the bib. They are to be 2 cm x 1 cm with a tolerance of +.5 cm (.78" x .40", tolerance of +.20"). They will be attached in such a manner as to NOT be visible when not in use.

Many current masks can be modified by installing a retrofit bib over the existing bib. These are attached by a variety of methods, including Velcro, sewing and heat-activated adhesive. However, in 2012 the Velcro method of attachment was banned, so now the lamé material has to be permanently affixed to the bib. Also, because the lamé material may be too slick, foil masks are not allowed to be used in epee competitions.

For an FIE mask to retain its certification, the retrofit bib must be FIE certified and from the same manufacturer. That is if you have an Uhlmann mask, you need an Uhlmann retrofit bib.

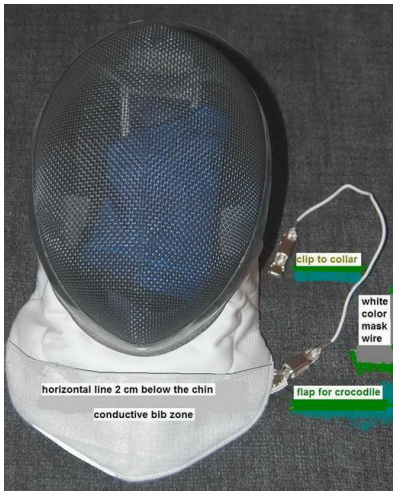


Figure 2-5 Foil Mask With Mask Cord

[48] Rule t.47.2, FIE Rule Book

2.2 Body Cords and Mask Cables

There are basically two types of body cords, one for epee and one for either foil or saber.

One end of the body cord attaches to the scoring machine, by either the reel or in the case of world level saber competitions, the wireless transmitter, and the other to the weapon.

The reel end of the body cord is always the same three pin configuration as was discussed in the connector chapter. The other is configured to whatever connector you have on your weapon. Ok, another "duh" moment.

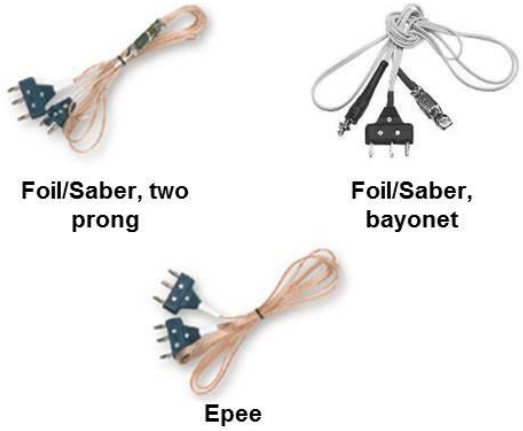


Figure 2-6 Examples of Body Cords

The epee body cord, shown at the bottom of the illustration above, has a basic one-to-one connection from one plug to the other. That is, A-line to A-line, B-line to B-line, C-line to C-line, whereas, the two prong foil/saber body cord, shown on the top left, has A-line to the clip, B-line to the 3mm small pin and C-line to the 4mm big pin.

The bayonet foil/saber body cord, shown on the top right, has A-line is connected to the clip, B-line is connected to the center pin/probe and the C-line is connected to the metal piece that grounds to the weapon.

If you don't remember which line is which, refer to the Figure 2.7 below.

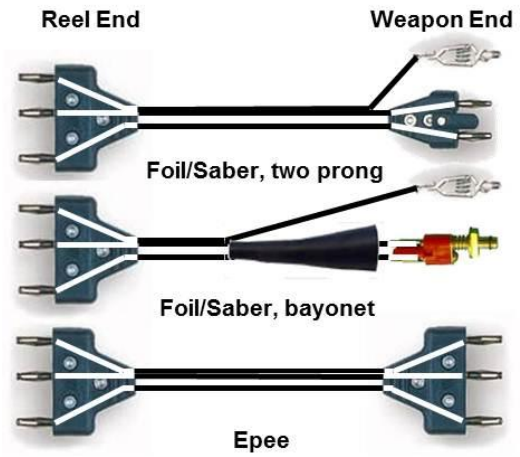


Figure 2-7 Wiring of Body Cords

Some saber fencers will take a small piece of wire and wrap it around the two pins of a foil cord, thus creating a short between them, which has an effect similar to the one created by having both jacks of the connector shorted or in contact with the body of the connector.

This technique is not normally found at higher level competitions and should be used only in an emergency.

As a precaution, if you are a foil fencer, be sure to check for this condition if you borrow a body cord from a saberist.

For saber and foil there is a short cord that connects the jacket to the mask to make the mask target area. There are two clips similar to the one found on the body cord, on either end. The two styles, straight and coiled are shown below.

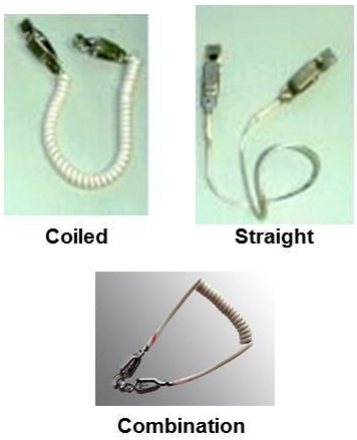


Figure 2-8 Saber/Foil Mask Cables

For the 2008 Olympic Games, there was another style of mask cord that was used, and accepted by the FIE that is a combination coiled and straight cord.

This cord had a 10 cm (4”) straight section on both ends and a 10 cm (4”) coiled section in the middle, for an overall length of 30 cm (12”).

As was stated in Section 2.1, Masks, the change to the Foil target area has added the requirement for a mask cord for foil.

While they are the same in configuration as the saber mask cords, that is, they can be coiled, straight or the newer combination, the notable difference is that they are required to be white or clear in color.[49]

When attached, they must be connected to the tab described in Section 2.1 on the fencer’s non-weapon side and to the tab at the center and bottom of the collar of the lamé. See Section 2.8 for a more detailed description of the requirement change for the foil lamé.

Figure 2-9 Attaching the Foil Mask Cord to the Mask

The wires of most modern body cords are secured into the end of the plug’s connection pins by a set-screw. Most older body cords had a soldered connection.

The set-screw is a short, slotted screw that usually has a pointed end. Depending on the angle of the point, the set-screw either makes a connection by pressing the bare wire against the pin, or by piercing the insulation of the wire and connecting with the wire underneath. This latter arrangement is most

[49] Rule m.27.3, FIE Rule Book

common with the Leon Paul bayonet style connector and requires periodic tightening.

Shown below are several examples of set screws:

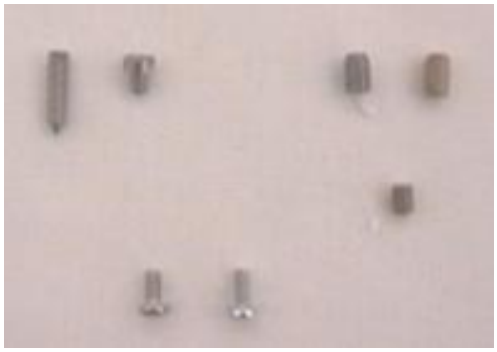


Figure 2-10 Set Screws

Shown below are several examples of common pins:

Figure 2-11 Pins

Note that the pins shown have what appear to be small pieces of metal springs along the sides. The small leaves or springs, is how each pin maintains contact with the sides of the socket.

There are also pins that are solid or split down the middle (see the previous chapter for an example of the solid pin in the photo of the epee plugs). In order to work, the solid pin connector relies on the design of the plastic piece that holds them. This piece is shaped like a shallow 'V' when viewed from the top. This feature provides the pressure to pins in order to maintain contact with the socket.

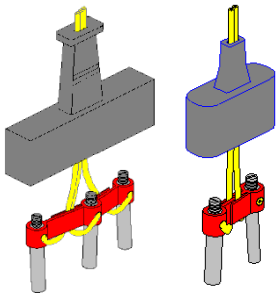


Figure 2-12 Illustration of V-shape (Leon Paul) Connector (Epee, left; Foil, right)
(Courtesy of Craig Gualt)

Some manufactured wire ends of body cords may have a metal or solder plug covering the end of the wire. While this feature may offer some advantage for an electrical connection (more like easier for the manufacturer to assemble) it is not necessary.

NOTE: For most solid body connectors, the screw used is a M3 x 10mm cheese head slotted screw.

If you are repairing the body cord and are concerned about whether or not to save/recreate this feature, don't be. However, if you feel ABSOLUTELY compelled to do this, you can make a reasonable facsimile by tinning the end of the wire as was discussed in the chapter "Basic Skills".

Usually the connecting wire is a high strand count wire similar to speaker wire. Unfortunately it is very difficult to find speaker wire with three connected wires (it normally comes in pairs), but that doesn't mean that you can't use the two wire variety to make your own body cords.

Take a length of wire and separate the two and use the single wire for the third line. To keep them together, you can use either a full length piece of shrink tubing and hold them together the entire length or short pieces (about ½" long) space about 4 – 6 inches apart. The former method makes for a fairly stiff body cord and is also much more expensive. What method you use depends on what your "cheapness" factor is.

The clip, which is found on foil and saber body cords, and saber mask cords, is the mechanical connection between the lamé and saber mask and the body cord.

Figure 2-13 Body Cord Clips

The requirements for the clips are[50]:

1. It be a crocodile clip (square ended, as opposed to pointed, alligator clip) The clip must be at least 1cm wide and have an opening of at least 1cm.

2. The connection between the clip and the wire must be visibly soldered and not covered with any insulation.

3. When a part of the foil/saber body cord, the length of the wire between where it connects with the clip and where it splits from the other two wires is at least 40 cm (15.75 inches) long.

4. For saber mask cords the length of the straight saber mask cable is 35 – 40 cm (13.78 - 15 inches).[51]

5. The maximum length of the coiled saber mask cable at rest is 30 cm (12 inches).

When checking for continuity between the various connections, the resistance of the lines must be 1 ohm or less[52]. A high resistance can be indicative of corrosion, a loose connection, or a partially broken wire.

[50] Rule m.29, USFA Rule Book for # 1, 2 & 3
[51] Rule m.32, USFA Rule Book; the cord may be soldered to the mesh of the mask, but must be 40 cm long with a crocodile clip properly affixed to the other end.
[52] Rules m.29 & m.31, USFA Rule Book

Figure 2-14 Crocodile vs. Alligator Clips

2.3 Jackets

The jacket is the part of the uniform that covers your arms and torso, front and back.

It can have its opening on either the side or the back. If the opening is on the side, the opening has to be on the side opposite to the weapon arm. That is, if you are right-handed, the opening has to be on the left, and vice versa.

The reason for this is that you cannot have any part of the jacket that would trap your opponent's point. Also, by having the opening on the same side as the weapon arm, you are exposing a weakness in your jacket to your opponent and it wouldn't be safe.

The fencer on the right in the picture below obviously didn't read this portion of the chapter! (Note the glove and opening of the jacket are on the same side!).

Figure 2-15 Examples of Jackets

A back closing jacket can be used with either weapon arm. While this design is good for clubs and schools, where it is difficult to estimate the number of left-handed and right-handed fencers and have sufficient equipment on hand for each of them, for the individual, it is somewhat cumbersome to get in and out of. That is unless you are one of the rare

individuals who is ambidextrous and uses either hand to fence with. Then this design makes sense!

When putting on a jacket, a design feature that should give you a clue as to how it goes on is the tapered or pointed lower piece of material that is connected to the jacket by means of a strap, also known as the cuissard. Like your weapon, the pointy end goes in front! Make sure that you step through the strap first before putting on the jacket, if it happens to be buckled in place.

For foil and epee this pointed feature of the jacket is necessary because that portion of the torso is target. Older saber jackets are cut straight across in the front because it was not target; however, because of the requirement to protect the vital portions of the body as defined by the FIE, all newer jackets must have this feature.[53]

The length of the jacket should be such that the lower sides of the jacket come at least as far as the point of your hips. This is important for two reasons. First, in foil, this defines the target area. And secondly, it also insures that there is sufficient overlap between the jacket and the knickers, or pants, to provide a double layer of cloth in this area. That overlap is required to be at least 10cm (3.97 inches) when you are on guard.[54]

For use in competitions the jacket has to have a closure method that is smooth and as was stated before, cannot trap the opponent's weapon. Many older jackets had buttons up the side and can be used in the Salle or school, but not for competition. Most closure methods are either zippers or Velcro.

The exception to this is around the collar. Here there can be a folded over piece of the collar that is intended to trap an opponent's point if it gets below the bib of the mask and slides upwards to the exposed neck and underside of the chin. An example of this is shown below.

Also for competitions, the material used cannot be so smooth as to cause the opponent's point to slip off (no vinyl or latex please, aside from the fact that some fencers shouldn't be seen in public in such attire! The author included!).

[53] The upside-down protective triangular piece on the front of the jacket is called a 'cuissard' and the 3cm strap that passes between the legs is called the 'cuissard strap'.
[54] Rule m.25.4, USFA Rule Book

Figure 2-16 Example of folded over collar

The material used should also be rated at a minimum of 800 Newtons, especially in the areas designated as vital by the FIE.[55] It must be pointed out that the requirements for competition are for those competitions sanctioned by the FIE or where FIE approved equipment is required. For most other competitions, equipment requirements are determined by the organizing committee.

The jacket should also have a double layer of cloth on the inside of the weapon-arm (down to the elbow) and armpit areas.

The thought here is that should a broken blade have enough energy to penetrate the first layer by doing so, it would dissipate a majority of that energy. This would leave insufficient energy to penetrate a second layer of cloth.

In addition to the double layer of cloth, the seams of the inner and outer sleeves need to be offset in case the blade finds this weakness in the sleeve. Fine in theory, but as an added measure of protection fencers are required to wear a second piece of equipment under the jacket, called a Plastron (see next section).

The color of the jacket is normally white; however, the rules do specify that the color can be any color, except black, provided the rest of the uniform is the same color. Dingy grey is not considered a color.[56]

At national level competitions, the fencer's name is required to be stenciled on the back of the jacket/lamé. The letters are to be dark blue in color, Roman letters in block style, and 8 -10 cm (3.15 – 3.94 inches) high[57]. The name should be centered between the shoulder blades. National colors/designs can also be stenciled on the leg. For international events, the fencer's country initials go under the fencer's name.

[55] The specification as to where "vital" areas are is defined in Section 3.2, Appendix A, USFA Rule Book
[56] Rule m.25(3)(d), USFA Rule Book
[57] Rule m.25 (3)(h), USFA Rule Book

Some clubs have stenciled their club logos on the lamés owned by the clubs. For use at national level tournaments, the name of the fencer still needs to be stenciled on the lamé.

The reason for the white color of fencing uniforms, and the one that is most accepted today, is that before electrical scoring, a specially designed tip which was dipped in a dye (phenolphthaline).

When the opponent was touched, the dye showed up and the president of the jury, or now known as the referee, removed it with a cloth soaked in vinegar.

This method of scoring was eliminated after fencers discovered they could soak their uniforms in vinegar or lemon juice, let them dry, and once the sweat from their bodies soaked the uniforms, the vinegar would come out and prevent the dye from marking them! This method of was replaced by electrical scoring as soon as the technology became practical and in 1936 at the Olympic Games became required for epee[58].

2.4 Plastron

The plastron is a sort of half-jacket that is worn on the weapon arm side of the body. As shown below, the plastron depicted is for a right-handed fencer.

It is important to note that for the plastron, where the sleeve meets the torso, there cannot be a seam (where the two pieces are sewn together). Again, this is to prevent the broken blade from finding a weak spot in the construction after going through the jacket.

It is also vital because a blade entering the body in the armpit has nothing between it and the heart and lungs except soft tissue, so this makes the area particularly vulnerable.

Figure 2-17 Plastron

With the introduction of newer, stronger materials that jackets were being made of, there was a thought that the plastron was no longer needed. Unfortunately there were several injuries, and even a death as result of this practice. As a result of these injuries, plastrons are now **mandatory** for all competitions.

2.5 Chest Protection

In addition to the protection provided by the jacket and plastron, women are required to wear breast protection. Aside from the normal aversion to hitting a woman there, the blunt trauma caused by hits to the breast can cause internal damage and possibly lead to later medical complications.

This protection can be in the form of plastic or metal disks (or as have been referred to as “combat yarmulkes”)(shown below) that fit either into pockets on the inside of the jacket; special sports bras or even the inside of a normal bra or sports bra.

Figure 2-18 “Hubcap” Style Breast Protectors

[58] Although, electrical scoring technology had been commercially available before 1900, it didn’t become required until 1936.

There are also one-piece plastic breastplates with formed features (of various sizes) (shown on the right below) as well as flat plastic ones (shown at the bottom) for children.

Figure 2-19 Examples of single piece chest protectors

Some men use this latter breastplate, especially if they are protecting a previous injury or surgery site. However, it has been worn by male foilists in an attempt to take advantage of the longer point depression timings enacted by the FIE. The theory is that the harder surface will make the point bounce off before the 15ms time limit and thus not register a valid touch.

When this practice first started, the breastplate was worn just under the lamé, but the FIE has since ruled that the breastplate must be worn under the jacket (or next to the skin, but is more openly interpreted to mean that a t-shirt or similar under-garment can be worn under the breastplate).

2.6 Knickers

The part of the uniform that covers your legs and lower abdomen is called (in the good ole U S of A) the knickers[59]. They are not pants, because they don't go all the way down to your ankles. Well, they shouldn't but if you are one of those unlucky kids whose parents insist on buying things large so that you'll "grow into them", they may, but aren't supposed to.

The knickers are specifically designed to fasten below the knee. While this is the only specification listed in the rule book, there is one other that states it must cover the abdomen, to include the inguinal areas (below your belly button and between the hips) and the genital organs **BY MEANS OF A PROTECTIVE CUP**[60].

Now this requirement is gender non-specific, but is generally understood that it is for male fencers, and is rarely checked for by referees. But makes good sense, especially if the possibility of progeny is in your future, but mostly because it prevents excruciating pain!

In order for the knickers to protect the areas listed in the previous paragraph and to satisfy the overlap requirement that was discussed in the previous chapter, they are high waisted, as shown below. They are held up by a pair of suspenders or with shoulder straps built in. And sometimes by the ubiquitous "Duct Tape"! For knickers that are FIE approved, sometimes there will be a panel of KEVLAR, or other approved material, over the front portion of the upper leg (quadriceps).

Under no circumstances are fencers allowed to fence in anything other than knickers. Some areas at one time had thought to allow lower level competitions to let fencers use sweat pants. This is in violation of the insurance policies of the USFA and will not protect tournament organizers in case of an accident (that is if the tournament is being run under the auspices of the USFA or one of its member clubs).

Figure 2-20 Knickers

As stated in the section on Jackets, the fencer's country logo can be stenciled on the each leg must conform to the requirements as stated previously.

2.7 Gloves, Shoes and Socks

These three items complete your basic ensemble for fencing, and are no less important than the items

[59] Which of course in **other** English speaking countries, means 'ladies undies'.

[60] Section 3.2, Appendix A, USFA Rule Book

previously discussed, and, more importantly, are required for all sanctioned competitions.

Requirements for the glove and socks are very simple. The glove must have a gauntlet, or extension that covers approximately half of the forearm of the weapon arm[61] (as shown on the left below).

Gloves

Yes, Virginia, the glove is worn on the weapon hand. There is no requirement to wear one on the non-weapon hand. It can also be slightly padded, which is a good thing in saber and epee!

For competitions and electrical fencing, the glove should also have a feature that allows the body cord to come through the glove and be able to attach to the weapon without interference. Saber gloves have an additional requirement that will be discussed in the next chapter on Lamés.

In order to know what size glove to order, you can determine this with a simple measurement. Take a sewing tape measure (a cloth measuring tape) and wrap it around your weapon hand, at the top of the palm, ***thumb not included***. Take that measurement (in inches) and round it **UP** to the nearest ½ inch. That is your glove size and, better yet, you can use that size to buy that nice pair of leather ones for driving with!

Figure 2-21 Measuring to Determine Glove Size

[61] Rule m.25.6, USFA Rule Book

The section of the rule book that says anything about socks implies that they must be white.[62] But at most competitions, socks can be colored (one competitor insists on wearing purple socks!) and may also have various logos and manufacturer's designs.

The socks must be constructed so that they hold themselves up and go to the bottom of the leg of the knickers. The key is that they must stay up! Or at least be up when the Referee says "Fence". If your socks repeatedly fall down, you can be penalized for "delay of bout".

Most knee length athletic socks will work, but specialty socks made for fencing may also include extra thickness or padding for the shin, which is desirable. Socks used for soccer may also have this extra protection.

The illustrations below show socks offered by some vendors and how they are to be worn (on the left).

Figure 2-22 Socks – properly worn

There are no specific requirements for shoes in the rule book, other than the implication that you have to wear them!

Most any type of athletic shoe can be worn. Most competitions do draw the line at wearing street shoes, though, because they don't offer the proper support or traction and therefore are considered unsafe.

Below are examples of commercially available fencing shoes.

Figure 2-23 Typical Fencing Shoe

[62] It does so by stating that the competitor may wear a folded down portion of the upper part of the sock showing their national colors and may be 10cm in length.

Figure 2-24 Common shoes showing rounded heel

The key features of shoes that are made specifically for fencing are that the heel is rounded and padded and that the inner side of the instep is covered with a scuff resistant material (for those who drag the back foot when they lunge). The shoes can be either low-top (above) or high-top (left, below).

Figure 2-25 Asymmetric Style Shoes

There is one design of shoe that was made specifically for "handedness" of the fencer. These asymmetric shoes (shown above) have features designed into them specifically for the function of the front and rear feet. For example, the shoe for the rear foot has a slightly higher top on the inside of the rear foot to support the ankle. Unfortunately, the manufacturer discontinued these shoes, but here are a limited supply out there – in strange sizes – but they are difficult to find.

2.8 Lamés

In this section we will discuss the parts of the uniform used specifically for electrical foil and saber fencing. The jackets, gloves and masks described here are all conductive and define the valid target areas for each weapon. The saber mask and connecting cord have been discussed in previous chapters. The saber glove was alluded to in the preceding chapter and will be discussed in more detail here.

This chapter is entitled Lamés because the name of the jackets used for electrical fencing. Lamé is actually a French word for metallic cloth. And that is just what fencing lamés are, metallic or conductive pieces of clothing.

The original lamé material was decorative and was usually made of gold or silver; not very practical for fencing today!

For use in fencing, the material was made using copper or copper alloy threads woven in the cloth (MUCH cheaper!). But copper has a bad habit of corroding and turning green (copper oxide) and becoming non-conductive and other metals were too stiff and brittle to be used.

As metallurgy has improved it was possible to weave stainless steel threads that were flexible enough and tough enough to be used in conjunction with cloth, as well as other alloys, such as nickel.

In addition to the stainless steel and nickel alloys there are some lightweight materials that are also used. Manufacturers of these materials are not exactly forthcoming with what the actual material is, but they do work well.

As was stated before, the lamé defines the target area. For Foil, this is the torso minus the arms and the head. For saber this is the entire torso from the point of the hips up, less the hands from the wrist bones down to the fingers. In both cases the lamés fit over the standard fencing jacket. Unlike the pictures below, when worn the lamé needs to be closed all the way up.

The requirements for jackets, such as the size of collar, and closure, also apply to lamés. As with Jackets, there are back zip and side zip versions, as well as men's and women's designs.

Figure 2-26 Lamés

There is a requirement that the conductive material of the lamé be insulated electrically from the fencer by means of a layer of non-conductive material. One of the lightweight design lamés has an open mesh on the inside of the lamé that is there to promote circulation of air in order to help keep the fencer cooler and drier. While this may to some be technically in violation of the requirement, it has rarely, if ever, been rejected for use in competition.

The change to the foil target area that was first mentioned in Section 2.1 has also required two changes to the foil lamé. First, there needs to be a conductive tab affixed to the lamé at the center and bottom of the collar at the back of the garment. The size of the tab must conform to the same specifications as for the tab on saber lamés, 2cm x 3cm (.79" x 1.18").

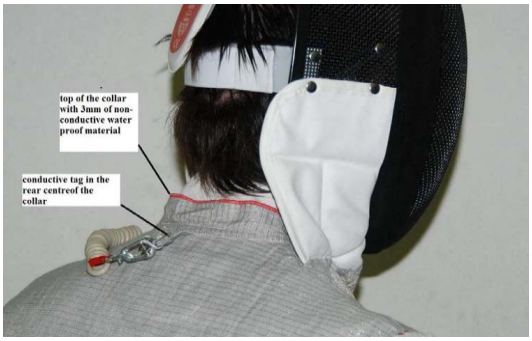


Figure 2-27 Changes to the Foil Lamés

The other requirement is to help prevent touches due to excessive sweating by requiring the top 3mm (.12") of the collar to be covered with a waterproof material, similar to the material required for the inside of the lamé.

The requirement for the fencer's name to be stenciled on the back of the lamé is the same as for the jacket.[63] There is also a requirement for the conductivity of the material and that is that there can not be more than 5 ohms of resistance between any parts of the lamé[64]. This resistance is also a function of the pressure of the probe used to measure the resistance. It is measured with a 500 gram weight. Refer to Chapter 5.3.6 on how to make your own tester.

Of special concern is the area where the name is stenciled on the back of the lamé. This area must also conform to the 5 ohm resistance requirement.

Although not visible in the picture on the left above, the cut of the foil lamé is required to be straight across the hips (the bottom of the lamé has to be even with, or below the crown of the iliac (hip) bone when standing, on guard or lunging[65]) and back from where it diverges from the tapered front. Also, the diagonal edges of the 'cuissard' (the triangular piece in the front of the jacket and lamé) must be a straight line from the hip bone to the cuissard strap. No French cut lamés please.

The saber lamé, as shown on the right above, also has the tapered front, but it is made of non-conductive material. The cut of the jacket is also straight across, like the foil lamé.

The saber lamé also has a small, minimum 2cm x 3cm (.79" x 1.18"), conductive tab at the back of the neck where the mask cord connects to. The tab can be sewn on one, two or three edges.

The saber glove has conductive lamé material either sewn on to the cuff or has a conductive over-glove, as shown on the left and middle below. Whether the conductive material is a part of the glove or an over-glove, there must be conductive material folded under the cuff to a length of at least 5cm and have elastic material around the cuff or some device to insure that electrical contact is maintained between the glove and the sleeve of the lamé. The lower picture in the middle below shows the inside of the over-glove and the conductive material folded under the edge.

The over-glove must also have a device that fixes it in one position[66]. This is normally called a finger loop. The manchette on the left is not legal because it doesn't have a finger loop.

If you find yourself in this situation, as one National Team did at the 2012 Saber World Cup event, there is a quick fix. Sew an elastic hair band onto the manchete, and satisfy the requirement!

[63] This stenciling can be done either by the vendor selling the jacket/lamé or if you want to invest the time and effort, you can do it yourself. See Chapter 6.2.7.1, Basic Maintenance for details.
[64] Rule m.28(a), USFA Rule Book

[65] Rule m.28, USFA Rule Book
[66] Rule m.33(3), USFA Rule Book

Figure 2-28 Saber Over-Glove or Manchette

2.9 Carrying Cases

There are many different ways of carrying and storing your equipment. One of the simplest is a tapered cloth bag that has a zipper that runs the length of the bag. Many vendors offer this kind of bag with their beginner/starter kits. This is good for carrying a couple of weapons, your mask and uniform, and some extra items. An alternative is to purchase a large duffle bag that is readily available at most sporting goods stores. While this is good for toting things back and forth between home and the salle, it may not be the best for traveling.

Figure 2-29 Typical Weapon Bag

For traveling, many of the major equipment suppliers offer a variety of soft carrying cases, mounted with wheels. These bags can carry a lot more equipment, but they are fairly expensive, but have a lot of extra features that may or may not be desired. An alternative to these specialty bags come from another sport sector …. Golf!

There are a number of different golf bag carrying cases that work wonderfully to transport weapons, uniforms, masks, shoes, tools, etc. They can range in price from $30 to $300, be made of inexpensive plastic or reinforced fiberglass

An advantage of these bags is that they will protect your equipment from the ravages of the baggage handling gorillas at the airport, although, even they can manage to abuse these bags pretty well, too.

Figure 2-30 Soft-sided equipment bags

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Figure 2-31 Hard Case equipment carriers (Golf Bag Carriers)

A disadvantage with these bags, though, is that because they are hard they sometimes may be difficult to put into small cars or spaces. A soft bag can compress somewhat and be maneuvered into tighter spaces.

Another disadvantage the hard shell cases has is that unless you have a separate bag to keep your weapons in, they tend to be difficult to manage when

you open the case, unless you put them in the bottom and stack all your other stuff on top of them. But, then that means that you have to unpack the entire case to get to them, which means strewing your stuff all over the place at a tournament. And at large events, space is at a premium.

A solution to this problem is to take 1" webbing, sew a plastic latch to the end, rivet it to one side (best done on the hinge side of the lid) and attach the other end to the latch side of the lid. Attach three or four of these to the lid, based on what you feel will secure your weapons in this side of the bag. If you want this side of the bag to hold your uniforms, etc, you can sew mesh material to the straps (make sure you reinforce the edges of the mesh). If you do this, you want to make the end where you connect the straps together as close to the edge of the lid as possible.

Figure 2-32 Retaining Webbing

Another thing you can do to protect your weapons while transporting or storing them is to cut 36" (90 cm) lengths of ½" or ¾" PVC pipe[67] to slip over your blades. This will help keep them from banging around in your bag and getting tangled with each other. Unfortunately, though, if you live in a humid environment it can increase the occurrence of rust if stored in a garage or car for extended periods of time.
Some fencers have also taken thin bungee cord, (1/8") diameter, drilled a hole in the end of the pipe and installed a loop that stretches over the guard and around the grip. This helps secure the pipe to the weapon so you can carry them without worrying about becoming separated.

Remember, if you have a saber visor mask, do not store it with your weapons protected with PVC pipe!

A small bag can be used to carry body cords or other items. You can also use them to carry your tools and test equipment. A good source of these kinds of bags is the kind that comes with cosmetic free gifts (also a good way to get in good with your spouse or female significant other!). You can also get small tote bags from sports stores or the home improvement stores.

If you maintain a number of spare blades, a good way to store them is to make a container similar to the Copper Soaking Tube described in Chapter 3. In this case use 3" or 4" PVC pipe and components instead of copper ones. To assemble these parts use a two-part PVC glue, the first part cleans the joint, the second is the glue.

Also, you can use silicone desiccant packages in the bottom of the tube to keep them from rusting. Just make sure they are in a container that won't be punctured by blades and have ventilation holes so that the moist air can get in!

2.10 Basic Maintenance

2.10.1 Body Cords/Floor Cords

Body cords probably need as much periodic maintenance as weapons do, and should be checked whenever you check your weapons prior to a tournament.

Checking out body cords and floor cords involves a basic continuity check of the wires and making sure the connections are tight. You can do this with the LED or Advanced test box or the ohmmeter.

For the two prong foil/saber body cord using the LED test box, plug in the three prong end into the test box. Short across the two pins on the other end and the red light should come on. Then take the alligator clip and connect it to the thin prong. The green light should come on. Check to make sure the wire to the alligator clip is soldered on, not covered with insulation and that the cable, not including the clip, is at least 40cm (15.75") long[68].

For the bayonet foil/saber body cord the process is the same as above, except short across the center pin and the floating plate. To test the alligator clip, press it against the floating plate.

For the epee body cord and floor cords, plug it in and short across the center prong and the one

[67] You can also use clear tubing or similar type of material.

[68] Rule m.29, USFA Rule Book

closest to it and the red light should come on. Short across the center prong and the one farthest away from it and the green light should come on.

If you are checking with the Advanced Test Box or ohmmeter, check each end. Resistance should be less than 1 ohm for each line of a body cord[69] and 2.5 ohms for each line of a floor cord[70].

To do this plug in each end, or connect the ohmmeter ends to the pins, and wiggle the wire while pulling slightly on it. This will give an indication of intermittent connection when the needle of the meter fluctuates (moves back and forth).

Some pins occasionally need a slight leaf-expansion as part of their regular maintenance routine. With a jeweler's screwdriver or the blade of a small penknife, slightly separate the leaves from the pins to ensure a tight fit into the sockets (as was discussed in Chapter 2.2).

In order to check that the connections are tight (loose connections are usually indicated by a high resistance), start by disassembling the housing around the pins.

NOTE: Take a piece of masking or painter's tape and place it over the nuts on the shell, or housing. This will keep them from falling out and will make it easier to reassemble.

Since we mentioned high resistance, this would be a good place to discuss the ever-present, dreaded **LEON PAUL DISEASE.** It is called this because it is a common problem with the Leon Paul design for connectors (as shown in Fig. 2-12). This is because they use a piercing setscrew and corrosion builds up between the wire and setscrew[71]. Fortunately, there is a ***very easy*** fix – pull the cover back and with your jeweler's screwdriver, back the setscrews out a couple of turns and retighten them!

Check to see that the setscrews are tight and that the wires are firmly seated in the ends of the pins. When checking for tightness, you might want to loosen the screw ¼-turn before re-tightening. Reassemble (easier said than done!).

An easy way to be able to get to the set-screws, is to drill a 1/8" to 5/32" hole though the body of the connector over where the set screws are located. It also helps to have the screws all on the same side when you assemble the connector.

The hardest part about re-assembling connectors is how to keep the pins aligned and in their slots in one piece while trying to align and screw in the second part of the connector.

A trick is to insert the pins into the corresponding sockets of your test box! This will hold the pins in the correct alignment while you fit the two parts of the connector body around them and screw them together!

Also, when assembling the two-prong and three-prong connectors, be sure that you place a piece of shrink tubing about 1" long over the wires and position it where the wires exit the body of the connector. This will act as a bit of a strain relief for the wires. You can also take several lengths of shrink tubing, with the longest first, then shorter ones over it to give a better amount of strain relief. Shrink the tubing with a heat gun.

For connectors that have the cage or "leaf springs" pins the can, after a while, deform (flatten) and cause an intermittent connection. If this happens you can take a small jeweler's screwdriver and gently bend the leaf spring out a bit, as shown below.

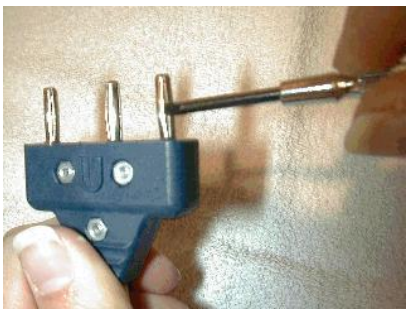


Figure 2-33 Spreading the springs on a pin

However, if you are in the middle of a bout, and get intermittent lights due to a loose connection, a quick fix is to lick the pins and provide a "wet" connection. Be careful doing this with a foil connector, especially if you are still connected to the scoring machine. As will be explained in more detail later, the foil circuit is a normally closed one and has a current running through it all the time, so if you happen to lick both the pins at the same time, you might get a mild shock!

[69] Rule m.29 & m.31, USFA Rule Book
[70] Rule m.55.5, USFA Rule Book
[71] The dissimilar metals set up a galvanic corrosion situation.

For the two prong end that has the retaining feature built into it, as depicted earlier, the small screw that holds the retainer together occasionally needs to be tightened. There is nothing more frustrating than to have it come out in the middle of a bout and have to change body cords, let alone trying to find all the pieces before resuming fencing!

Figure 2-34 Clip Maintenance

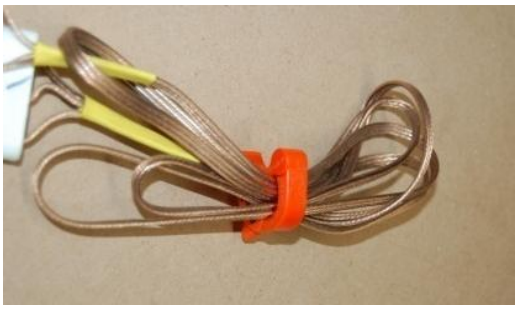
NOTE: When putting this back together a good trick is to put the retainer and small screw together and insert into the hole. Next, put your index finger over the small screw and hold it firmly. Now take the spring and pin and press it into the other side, finding the hole where the small screw is (this may take some jiggling around). Once you find the hole, press the pin down and turn it, screwing it ON TO the small screw. Then tighten with a small screwdriver!

Finally, when storing your body cord, do not coil it up tightly. Doing so puts a tremendous strain on the strands of the wire and can cause them to break.

Epee body cords can be secured with either a rubber band or a loose overhand knot. Several vendors are now selling a plastic locking device, similar to a cable clamp, which are also available at hardware stores, for use with body cords.

But an easier way to coil them is to fold the cord in half, and then in half again. Then tie the cord in a loose overhand knot. For foil/saber body cords, you can also take the line with the clip and wind it loosely around the cords and pass the end through the end loop. **DO NOT CLIP THE ALLIGATOR CLIP TO THE WIRE!!!** This will result in the wire being cut over time.

Floor Cords, which are essentially twenty foot long epee body cords and connect the reel to the scoring machine, need to be checked periodically, but not as often as body cords, because they don't see the kinds of use a body cord does. See Section 3.3 on how to coil them.



Epee Body Cord Secured With a Cable Clamp

2.10.2 Mask

A visual check of your mask is always a good thing. Make sure the bib is in good repair. Check the mesh of the mask. Are there any really deep dents? If so, take a rubber mallet and gently beat them out. Are there any obvious broken wires? If so, the mask is unsafe and shouldn't be used. Also look for wires pushed out of position. Sometimes you can merely push them back and they'll be OK. If you have a mask punch, test it yourself.

At a tournament, though, if the mask fails for any issue that would make it unsafe and non-repairable, according to the rule book m.25(7)(d), the mask **must** be "made visibly unusable". For US Armorers, this had been interpreted as being marked as unsafe, usually with the word '**UNSAFE**' or "**FAILED**" written on the outside of the bib with permanent marker.

Also, the mask is confiscated and returned to the fencer at the end of the tournament, or disposed of by the Technical Staff.

An unsafe mask is just that, an unsafe mask. It is NOT ok to use for practice and not for tournaments. IT IS UNSAFE. Dying in practice makes you just as dead as if you died in a tournament!

If a fencer decides to use an unsafe mask outside a tournament, they do so at their own risk but that risk is not worth the potential of having your face or brain run through with a broken blade.

The mesh of the mask is tested with a spring loaded punch, two different styles of which are shown in Figure 2 – 35, below.

Figure 2-35 Mask Punch Testers

The testing device or punch has a spring inside rated at 12 kg. The needle-like end of the punch is positioned in the openings of the mesh (as perpendicular to the surface of the mask as possible) with the operator's thumb over the end of the punch.

Note that both of the punches, shown above, are round, and will tend to roll off a table. To prevent this, take a plastic wire tie and wrap it around the body and trim off the excess. The little 'nub' or locking feature will keep it from rolling, as shown in the bottom picture.

A steady downward pressure is applied to the punch until the operator can either feel the end of the plunger on their thumb, or in the case of the punch above, the thicker exposed portion of the end goes into the body of the punch. The mesh should not deform or allow the straight part of the punch to penetrate. If this happens, the mask is unsafe for fencing.

Figure 2-36 Proper Way to Hold a Mask Tester While Testing of a Mask

The mask should be tested in several places, with no set number or locations. The checker uses their discretion in selecting where to test. Many times, they will test areas that are dented or appear to have had the mesh damaged.

Take the mask between your hands, with them on the trellis pieces one either side. Squeeze the mask several times and feel for any 'krinkling' or movement of the mesh. This means that the trellis portion of the mask has separated from the front of the mask. This is a failure, and makes the mask unsafe.

Check to see if the rivets that hold the lining and the tongue of the mask are all present and tight. Missing rivets can be replaced. Note that some saber masks have a metal plate that covers the corner where the bib meets the mask. Check to make sure that the rivets are in place, tight and that the edges of the brackets are not bent away from the mask.

Inspect the bib attachment to the mask. If there are any areas where a blade might catch and penetrate this area, use a hot-glue gun to re-attach the trim or either sew, or replace, the bib to the mesh. An alternative is to use dental floss to sew the bib to the mask.

Also check the insulation on the mesh. Are there large bare or rusty spots? If there are, and your bib gets soaked with sweat, you can get a connection between your lamé and mask, making your mask valid target!

Thoroughly clean the rust off and touch them, or any other bare spots, up with glossy black Rustoleum paint (mask off what you don't want painted with masking tape and newspaper). Then check the location later with your punch to ensure that the rust did not degrade the mask beyond its ability to withstand the 12k punch test.

For visor masks, check to make sure the lexan was manufactured, or sold, within two years and that all the screws and nuts are present and tight. Also check to see that there are no deep gouges in the visor. These are potential failure sites.

Note: The nuts used to hold the visor in are the same size as the ones used on body cords! They are M3 hex nuts, and use a 5.5mm socket or wrench.

If you have had your mask for a while and have been really working out with it, AND your spouse wonders how you manage to stick your face in it without getting sick, you might want to consider washing it.

You can do this either by using the technique for the lamé or just stick it in the dishwasher with regular soap (no jet-dri) and take it out before the drying cycle and let it air dry.

Sometimes new masks come with the tongue not bent, as shown in Example #2 of Chapter 2.1. If you buy a mask in this condition, you need to bend the tongue either yourself, or have the vendor do it. If you opt to do it yourself, extreme care should be taken when forming this piece to your particular head.

To do this, take your left hand and place it palm down on the top of the mask so that you can wrap your thumb and either index or middle finger around the tongue. While supporting the tongue, use your right hand to bend the tongue down. If you try to bend the tongue down without supporting it like this, you stress the weld points and could snap the welds and ruin your mask.

2.10.3 Lamé

Two things about lamés: continuity and cleanliness. In order to check continuity, set the ohmmeter for 1-20 ohms, and keep one probe in one spot. Take the other probe and put slight pressure on it, or use the tester you made from the instructions in Chapter 5 (if you don't have a weight, finger pressure will do for a quick check) and run it all over the lamé. Resistance should not exceed 5 ohms. Be sure to check the back, too, especially if you have your name stenciled on.

A technique to use when checking multiple lamés is to take a piece of good lamé material and then tape it to the surface of your work area. Next, connect one test lead (negative or black) of the ohmmeter securely to it.

Hold the lamé in contact with this piece of material with your non-dominant hand (that means if you're a righty, then hold it with your left!). Use your other hand to hold and move the test probe/weight that has the other test lead attached to it, around the lamé to check the resistance. This technique is especially useful if you are at a large tournament and have to check everyone's lamé. It saves having to attach and detach the one test lead every time.

Figure 2-37 Testing a Lamé

If you have a spot that is over 5 ohms, try taking a Scotchbrite® pad, 220 grit sandpaper or a fine sanding sponge or block and rub it gently to see if that gets rid of the resistance.

To wash a lamé, fill the bottom of the bathtub with about three inches of cold water, or fill a sink with cold water; add about ¼ cup of ammonia (or something with ammonia in it, like Windex) and capful of Woolite® fabric cleaner.

Gently work the mixture into the lamé for about 5 – 10 minutes or let it soak overnight. Rinse thoroughly with clean water repeatedly. Once you think it is completely rinsed, do it again. Lay out a bath towel, lay the lamé on the towel and roll it up. Gently squeeze the rolled up towel/ lamé to remove the water, and then hang it up to let it air dry.

Check the resistance again to make sure nothing has gone south (bad) in the meantime.

Lamés should not be folded. Hang them on a hanger when storing them. Folding could cause multiple broken wires in the conductive materials over time. If you are traveling with your lamé, a good technique is to lay it out flat on a towel and roll it length-wise. This prevents putting any folds into it that may break the metal threads and ruin the lamé.

2.10.4 Clothing

To check out your clothing and this includes all parts of it; jacket, knickers, plastron, socks, shoes and gloves, first do a smell test. Most fencers have a terrible sense of smell when it comes to their own clothing, so get your spouse, significant other or someone you trust to tell you the truth to check it out

for you if you doubt your ability to truthfully admit that the cat is not really trying to bury it, but just making a bed for itself.

The most onerous of these smells is “glove hand”. If you suffer from this condition, WASH YOUR STUFF! It’s white, so there isn’t a much of a chance of screwing it up. All clothing comes with washing instructions. Read them.

Next check to be sure that all the fasteners work properly. Does the Velcro still hold? Clean the gunk out of the hook portion (lint, stray threads, etc.). Is the zipper, especially the bottom where the two sides interlock, in good shape? Most jackets have a fairly mediocre zipper. If you or your SO[72] or mom is handy with a sewing machine, it might be a good idea to replace the zipper with a medium to large toothed sports zipper.

Are there any rips or tears in the material? If so, sew them up. Check the seams of the jacket, especially under the arm. If there are any open areas or ones that look like they are coming undone, sew them up with either heavy thread or dental floss (which is much stronger and will probably outlast your clothing!).
If you always practice using the same jacket and a lamé, be sure to check the material around the armpit. The metal fabric of the lamé will abrade the jacket material and cause holes in it.

Remember, safety is as much a concern for practice equipment as it is for competition equipment.

[72] Significant Other, or as known in the Author’s household, the Irritating Companion For Life, i.e. the Author.

CHAPTER 3 - SCORING EQUIPMENT

Scoring equipment is the collection of components that translate the signal of a touch into a visual indication of the touch. This is also where the term 'turning on the light' comes from. A simple enough concept, but fairly complex in execution.

Consider a simple light circuit. You have a power source, wires, a switch and a light bulb. Scoring equipment works basically the same way, only with some complications, such as when the distance between the switch and the rest of the equipment keeps changing, and the switch has to be turned on for a specific amount of time before the bulb lights up, it also has to tell the difference between when one switch changes and the other switch changes, how long one light is on before the other one won't go on, and if the switch should turn on a white light or a colored light! As was said, a few minor differences between the simple light circuit and the scoring equipment.

Electrical scoring for epee became mandatory in the 1936 Olympics, although it had been available commercially since before 1900! The first systems were based on mechanical relays in order to determine the timings. Great care was needed in using these systems because if they were not properly grounded an electrical shock to the fencer could be fatal!

The popular TV Detective show, Magnum P.I. used this as the premise for a murder mystery, by the time of the episode in the 1980's this type of problem was highly unlikely, although this could have been possible with older machines used in Europe due to their being powered by 220 Volts.

Next was foil in 1956, a few years later some solid state components (transistors) were incorporated into the machines and eventually, integrated circuits. In the 1980's saber was electrified and by 1989 was mandatory.

While the saber circuit today is a very simple affair, the development and the many compromises on how to score with the weapon led to many changes that were somewhat painful to watch evolve.

Especially painful was the experimentation with "capteurs". These were small devices connected to the inside of the guard that were to measure how hard the weapon struck the opponent. One of these devices had a small pin with a round head on it surrounded by four contacts, while others used a ball-and-spring mechanism and one used a brass plunger supported by a rubber membrane.

The theory was that if the weapon hit a target going fast enough (or with enough momentum) the weapon would stop and the momentum of the device would cause it to deflect and make a connection with the contacts. OK in theory, but the internal components would act as a spring and continue to bounce back and forth, so now a dampening medium, which, oh by the way, had to be non-conductive, had to be added, etc. It was all mechanically too complicated and in the end it was eliminated and the compromise was that the weapon only has to make contact with the opponent's valid target area.

The other compromise, that had more far reaching consequences, was the inability of capteurs to detect off-target hits. The elimination of the capteur also eliminated the ability to detect a hit against a non-conductive surface. Therefore the solution was to eliminate the off-target light, thus eliminate the stopping of the bout for a non-valid hit.

This chapter will discuss the components more commonly found at larger competitions. There are other, older, components still in use by some organizations, but these are slowly disappearing due to lack of technical support by the manufacturers and just plain wearing out due to age.

The components are:

The scoring machine
Reels
Floor cords
Metal strips

The illustration below shows a typical setup. Reel-less and wireless systems will also be briefly discussed in a separate section.

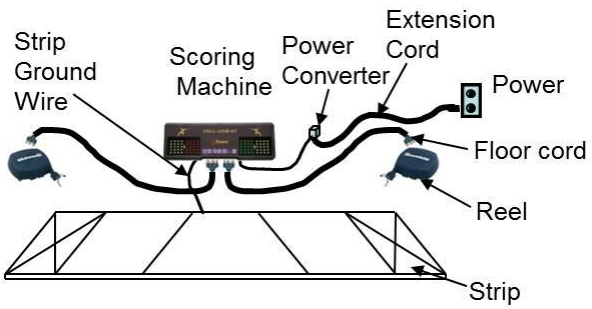


Figure 3-1 Scoring System Components

3.1 Scoring Machines

Scoring machines are the heart and/or brains of the scoring system. This piece of equipment is what keeps track of the various timings, resistances, signal blocking, etc, but more importantly it displays touches! Machines can be either very simple, primarily used for club or salle situations, to very complex, used for world and national-level events.

Basically they all have the same functions:

Power switch
Weapon selection switch (most are three weapon, but there are still some two weapon machines out there)
Buzzer (or audible signaling device)
Off target lights (white or yellow)
On target lights (red and green)
Floor cord connections (two)
Strip ground connection
Power connection
Power indicator lamp

Some of them may also have the following features:

Volume switch
Timer
Remote control
Score indicator
Penalty indicator
Variable reset times
Random priority circuit

Today scoring machines use solid state electronics which are very reliable. One of the great fencing Urban Myth's is "There's something wrong with the box (machine)!" There is very little that can go wrong with a well-built scoring machine and if it does, it is usually something that shuts down the entire system. If that happens, the only recourse is to send the machine back to the manufacturer for repair. You should in no way attempt to repair the machine at the board level by yourself.

As with most electrical devices, the power, and polarity (which part of the connector is positive and which is negative), used with them is critical. Most machines today require 12 volts, DC. Some may have an internal transformer, but most have a standard power converter that is used by many electronic devices. Some can even run off batteries, which is convenient for strips set up in the middle of the gym with no handy outlets or extension cords. For any of the devices, make sure that you know what the voltage is you are using as well as what voltage the machine requires.

Two of the machines shown below (Leon Paul and older SG12, although newer SG series machines are using LEDs) use standard bulbs for illumination, but more and more, machines are using Light Emitting Diodes (LEDs). LEDs are much more reliable and last much longer than do incandescent bulbs, and are not prone to failure due to rough handling.

There is one problem though, and that is several machines use yellow LEDs for the off target lights instead of white. The reason for this is purely economic. White LEDs are very expensive (white light being a combination of many wavelengths of energy, where primary colors are very specific wavelengths and easier to produce electrically), and yellow aren't. While this doesn't seem to be a real problem to most people, those who have red-green deficient eyesight may find that they can confuse the green and yellow lights if they are not paying attention to the machine. This is more a problem for referees than for fencers, although fencers may argue a call if they only catch sight of the machine momentarily before it resets.

An important feature of current scoring machines is the anti-fraud circuit. This was pointed out in Chapter 1.1.22, Grips. The reason that foil grips were required to have the extremities insulated was that if they came into contact with the fencer's lamé it would block touches from registering on them. Initial efforts to detect this, and to allow referees to be able to annul or award touches when the touch was blocked by the weapon being in contact with the lamé, was a yellow indicator light. But this light didn't stay on very long (in most cases only as long as the weapon was touching the lamé) and it was difficult to substantiate the violation.

The anti-fraud circuit that is found in modern solid state machines can detect this condition and allow the opponent's touch to register, thus it is no longer absolutely necessary for the grips to be insulated for foil, especially for higher level tournaments where scoring machines with this feature are required to be used.

From time to time the FIE will change the various timings and conditions for blocking signals. In the past this was a major issue because it normally required sending the machine back to the manufacturer to have it modified for the new timings. However, today this is easily handled with either reprogramming the machine or replacing a chip on the circuit board.

This capability has prompted the FIE to adjust timings more frequently in the thought of "improving" the game. This is kind of like wearing spandex clothing. Just because you can, it doesn't necessarily mean you should!

A collection of the various types of machines (and the manufacturer) used in tournaments today is shown below. As was stated throughout this book, there are many other kinds of equipment that may be in use around the country, but these are the most common as found in the author's experience. The sizes of the machines shown are only approximately relative to each other and not necessarily representative of their actual relationship.

Figure 3-2 Examples of Scoring Machines

A recent entry into the scoring machine market is a software based system called Virtual Scoring Machine (VSM). It runs on a laptop computer, but requires an adapter box sold through the company. It has many features found on the higher end scoring machines that make it an attractive alternative for clubs/salles that are looking for a relatively inexpensive scoring system.

Figure 3-3 Examples VSM Screens and Adapter

Their website is:
http://www.virtualscoringmachine.com

3.2 Reels

Reels are the most complicated and the second most expensive piece of equipment involved in fencing. Second most expensive, that is, except when you realize that you need TWO of them, and depending on how much your scoring machine costs, they might become the most expensive investment for a complete scoring set up. All of this is to do nothing more than ensure that the fencers stay electrically connected to the scoring machine as they move up and down the strip.

Reels are comprised of the following basic parts:

- Case
- Cable (wires) with connector
- Cable spool
- Commutator (rotating contact)[73]
- Contacts (brushes)
- Connector
- Spindle
- Spring(s)

The cable, which has a connector the fencer plugs into, is wound around the spool, and has the commutator attached to it. The wires of the cable are connected to the commutator. The contacts, or

[73] Or some may have a mercury-wetted contact.

brushes, are mounted to either the connector, or some other stationary part of the reel and they stay fixed in one place while the commutator rotates, thus maintaining electrical contact between the connector on the end of the cable and the connector mounted on the case. The spool is mounted on a spindle and is connected to the spring(s) in such a way that one end of the spring is fixed to the spool and the other to the case.

Is this complicated enough? I thought so.

This is how the reel works. As the cable is pulled forward by the fencer, the spool rotates and tightens the spring. As the tension on the cable lessens (by the fencer moving toward the reel) the stored energy in the spring rotates the spool in the opposite direction and re-spools the cable. Because the end of the cable is connected to the commutator and the commutator is in contact with the brushes and the brushes are wired to the other connector, any electrical signal is passed through the entire reel from the weapon and/or lamé to the floor cord and the scoring machine. The maximum resistance in each line of the cable is 3 ohms[74].

OK, that's much simpler, isn't it?

Reels can be either horizontally or vertically oriented. The easiest way to explain this is, whichever way the diameter of the spool is oriented determines whether it is horizontal or vertical (flat or upright). Most reels are flat, with some major brands being upright, as shown in the examples shown below. At the end of this chapter exploded views of a Leon Paul vertical and the Uhlmann flat reel are shown.

("Turtles")

("Pizza Boxes")

Figure 3-4 Horizontal style reels

[74] Rule m.55 1, USFA Rule Book

("Uprights")

Figure 3-5 Vertical Style Reels

The connector on the end of the cable has to have a method of being able to secure it to the fencer. This is done by means of a snap like the one shown below. It shall also have a restraining device to hold the end of the body cord and cable connector together. This device is normally similar to the one found on the epee connector, or may be what is known as a bail type restraint. A bail restraint is one that snaps over connector and usually has a small rubber ball that provides the pressure on the plug to hold it to the connector. See Chapter **1.1.6**, Connectors for an example.

Figure 3-6 Typical Spring Clip

Another feature found in some reels is a jack for a ground connection to a metal strip. While most scoring machines also have this feature, some tournament organizers prefer to make the strip ground at the reel instead of at the scoring machine as it is less likely to be damaged during fencing. The reason for this is because the reel is set up past the end of the strip where the fencers are less likely to spend most of their time while fencing. Supposedly. Unfortunately, this arrangement can defeat the anti-fraud circuit, and is not a recommended grounding strategy.

Finally, some reels also come with a handle for carrying them about. They also, in some cases, make a handy way of fixing them in one place. In the final section of this chapter tips on how to set up a strip will be discussed. Techniques for holding the various reels in place will also be presented.

Some basic precautions need to be made when using reels. The primary one being that you NEVER, well, almost never (sometimes mistakes **DO** occur), let go of the end of the cable when it is

fully, or even partially, extended out of the reel! By allowing it to rewind or run free the connector on the end can whip around and hurt someone or worse yet, damage the connector. It could even cause the connector to break off and cause untold grief to the poor mistreated and much maligned Armorer who has to repair it.

There is one reel that has attempted to build in features that will guard against this heinous act. The new Favero reel has an internal braking system that slows down the rotation of the spool for about the last 3 meters (10 feet) of the cable. It also has a compression spring that goes over the cable and is attached to the connector that acts as a shock absorber when the connector runs into the case.

3.3 Floor Cords

Floor cords are the components that connect the reels to the scoring machine. Basically, they are extra-extra-extra long epee body cords; on the order of 10 meters (32.8 feet). Why? Because the length of half the strip is 7 meters and scoring machines are usually set at least 1 meter (3.3 feet) from the strip, about 1 meter above the floor and the distance to the connectors on the scoring machine is about .5 meters. Ergo, 9.5 meters, with .5 meters lagniappe[75] .

The requirements for floor cords are also basically the same as for the epee body cord in terms of number of wires and connections. The acceptable resistance, though, is 2.5 ohms per line[76], as opposed to 1 ohm for the body cord.

When coiling and storing floor cords, they should be coiled in such a way as to make a figure-8, and not a circle. Many people simply take one end of the floor cord and begin wrapping it around their hand and elbow. The natural tendency of wire is to twist into the figure-8. So if this is the natural state it wants to be in, then let it! It tends to be better on the wires over the long run. As with body cords, if you use one end to wrap around and secure the coil, do it loosely. Do not subject the wire to sharp bends.

Another method is called the over and under method. This method, used by most electricians and sound techs, for coiling cords allows the cord to be thrown such that it uncoils in a straight line without tangling.

To do this, first take the cord and hold one end in your hand with the end toward your body. Reach down with your other hand, and with the palm toward your body, grab the cord.

Now take the hand that has the long end of the cord in it and move it to your other hand, with the back of your hand toward the ceiling. Transfer the cord into the hand with the short end of the cord. You should now have a single loop of cord in your hand.

Now comes the tricky part.

Reach down and grab the cord, as you did before. This time, when you bring that hand toward the other, rotate the hand with the long end of the cord so that the palm is now facing the ceiling and transfer the cord to the other hand. Repeat the first step, and alternate the steps until you reach the end of the cord.

Once you reach the end, take a length of the cord (about a foot) and wrap it around the middle of the coil and pass the end through the end loop.

This method feels a bit awkward at first, but with practice, it'll become second nature – like your fencing! If you want to see a YouTube clip of this method, do an internet search for 'Extension Cord Coiling'

[75] A Creole term that means 'just a little extra!"
[76] Rule m.55 5, USFA Rule Book

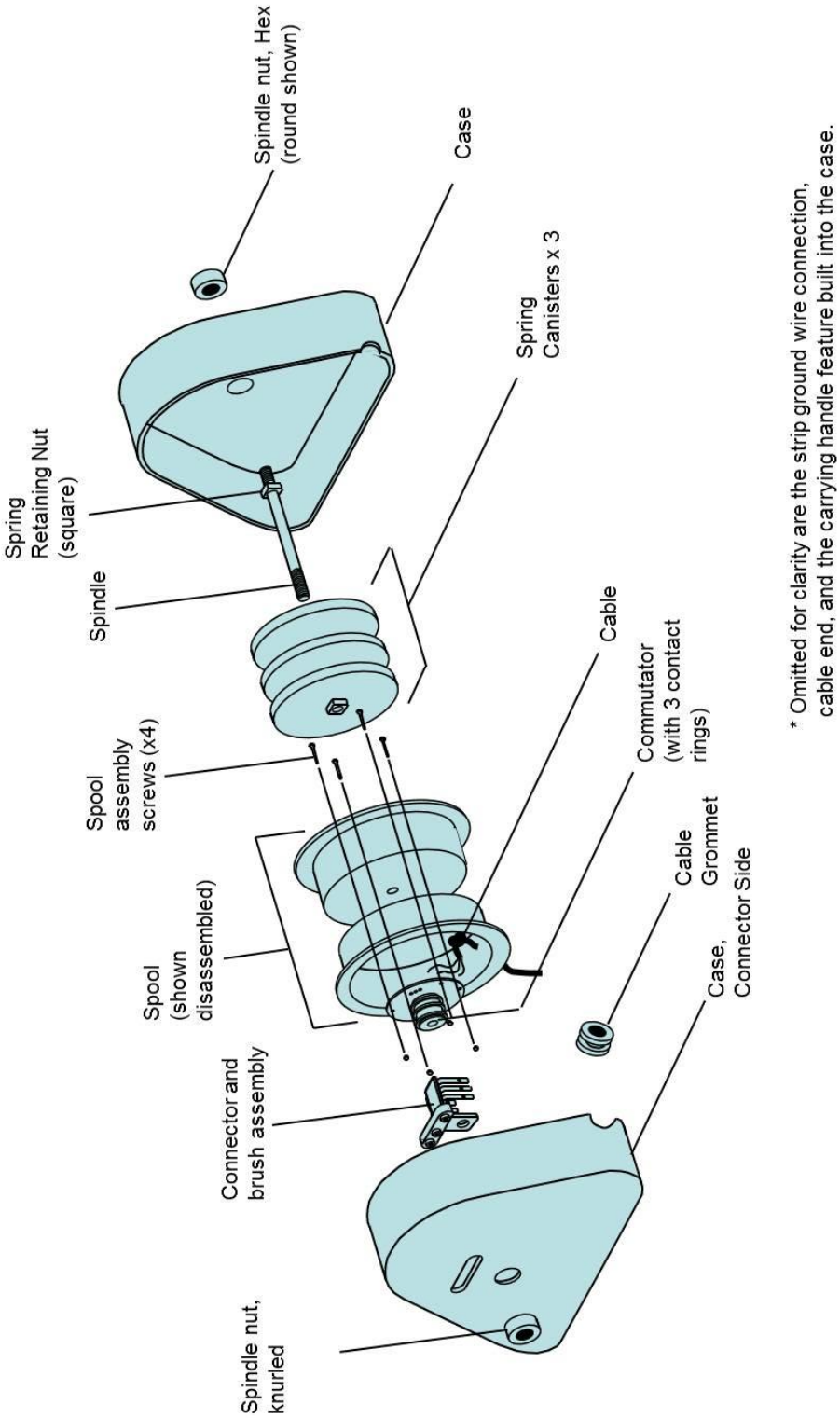


Figure 3-7 Typical Vertical Reel – Exploded View

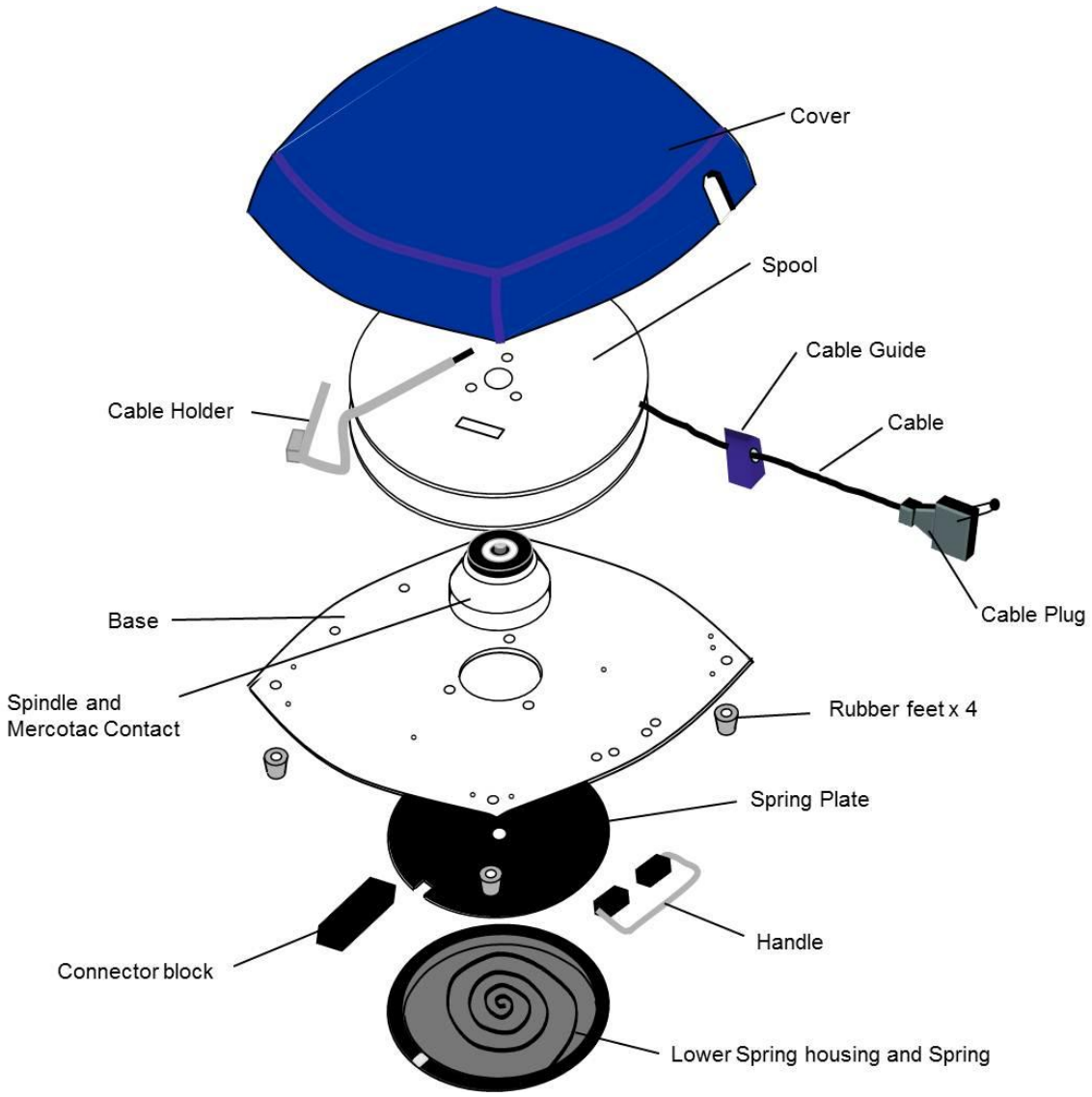


Figure 3-8 Uhlmann Flat Reel – Exploded View

3.4 Metal Strips

Metal strips were developed to provide a grounded surface so that epee touches to the strip would not register, this also worked for foil and theoretically for saber. It has been found that for saber, this was not the case; therefore a grounded strip is not required.

Early metal strips were two-meter-wide lengths of copper, bronze or brass mesh. This extremely fine mesh was used for a variety of applications in industry, most notably the paper industry where it was used as a draining surface for continuous paper manufacture. Many of these strips are still in use today, although their weight and deteriorating condition are making them cost prohibitive to replace.

Because of the environmental concerns with paper manufacture most companies have either closed in the United States or moved overseas, therefore the availability of used mesh is extremely low and the price of copper also makes it more economical for these companies to sell it as scrap rather than make it available on the open market.

Recently, however, several clubs have been able to find a source of stainless steel mesh that seems to work extremely well. Specifically, it is a .017" diameter woven wire mesh with a mesh size of 14 (number of openings per linear inch, measured from the center of a wire to a point 1" away). The material is 304 stainless steel and standard widths are 60" and 72" (1.5 m and 1.8 m). The particular vendor that the author purchased from is Dorstener Wire Tech (http://www.dwt-inc.com), however, it appears to be a common enough mesh that other vendors and/or manufacturers may also carry it. The key to the sizing of the mesh is to make sure that the opening is less than half the area of a foil point.

The advantage of the stainless steel mesh is that it is slightly lighter than copper, a stainless steel strip with dimensions of 15.25 m x 1.8 m weighs about 110 pounds, whereas one the same size made of copper weighs about 200+ pounds because the mesh of a copper strip is much denser than a stainless steel one.

Another advantage of stainless steel is that it doesn't corrode, is tougher and orders of magnitude cheaper. The disadvantage, though, is that you cannot easily solder it, so repairs can be difficult. Although, the grade of stainless steel, 304 has excellent welding characteristics, welding such small diameter wire is problematic. But, If you have the ability to weld mesh, 316L is a much better grade, but more expensive.

EXTREME care needs to be taken in handling the edges of the raw mesh, as they are very sharp. Work gloves are a must when handling the strips. Depending on the manufacturer, 'selvage' edging is available for complete rolls. This is an edge where the wire is woven back on itself along the edge. Make sure to check with the particular manufacturer when ordering your material.

The Richmond Fencing Club has set up a couple of these strips and had kindly consented to share how they installed the mesh strips permanently. As the pictures below show, the set them up over their existing strips (which allowed the paint lines to show through, and they didn't need to paint lines on the mesh).

They started by anchoring one end of the mesh to the floor. Then they took two pieces of metal, with holes drilled through them, and attached them to the other end. To this they attached five pieces of rope by means of S-hooks and tied the ends together.

The tied ends were attached to a block of wood. A car jack was placed between the edge of the floor and the block to provide tension on the mesh. The metal bar was then screwed down to the floor.

Setting up a temporary metal strip requires a sub-surface such as carpeting or paper (old newsprint works well). Extreme care needs to be taken when using these strips on wooden floors because the constant movement back and forth during fencing will act as a fine sand paper and ruin the finish on a varnished floor.

Strips also need to be stretched fairly tightly when installed to prevent the mesh from bunching up and causing uncertain footing for the fencers.

Finally, the edges of the strip need to be taped securely to the floor (3" wide duct tape or gaffer's tape is normally used). Copper, brass or bronze strips are also prone to be 'holed' or even torn by hard hits. They also tend to loosen up after a few hours of fencing and often need to be re-stretched.

To set up a copper (or stainless steel mesh) strip, first sweep and clean the floor. Then check the floor for holes, dents or other irregularities that may

damage the strip once it is laid down. If you are using some type of under-layment, or cushion, position it on the floor. Next, position the rolled up strip at the beginning of where you want it to be installed. This is a two-or three-person operation because copper strips are HEAVY! They weigh upwards to 250 to 300 pounds. Remove the tape securing the strip and roll it out about 5 feet.

Take a piece of tape and place it across the end of the strip, extending about a foot to either side. Now take pieces about two feet (2') long and tape the end lengthwise. When you are finished, it should look similar to the illustration below.

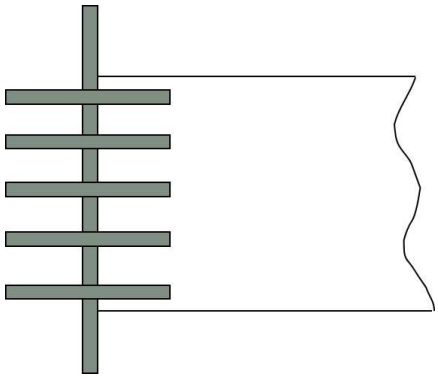


Figure 3-9 Taping Pattern – Strip end

The next step is going to require a minimum of five (5) people; two to do the real work, the other three to kind of shuffle along, and two rolls of tape. Take the three 'shufflers' and place them on the end of the strip that you just taped down, facing the un-taped end. Put the two other folks, each with a roll of tape, on either side of the strip. Start the shufflers shuffling. As they shuffle toward the other end of the strip, the tapers follow along, taping the sides of the strip down. All five people should stay abreast of each other while doing this. When you reach the other end, tape that end like you did the first.

Figure 3-10 5-Person Strip laying technique

An alternative to the above technique is to use a 6 foot long table with one person sitting on it, pulled along by two other people to stretch and smooth the strip out. An example of what that looks like is shown above in Figure 3-10.

A handy gadget to have (or two, as you see above), if you are doing large numbers of strips on a continual basis, is what is known as a 'tape layer machine', as shown below. These wonders of engineering genius are great for applying tape to the sides of the strips without having to worry about back strain, or the tape breaking as you pull off a 50' or 15 meter length. They are available from sporting goods stores on-line for about $40 to $50 a piece.

Figure 3-11 Taping machine

Even if you are using the tape laying machine, something you can do is have two of your students (if you are also a coach) that need foot work drills do continuous advances the length of the strip, one on each side, keeping their front foot on the tape. This should ensure the tape is firmly affixed to the floor.

To pack up the strips and get them ready for the next competition, make sure all holes have been repaired prior to rolling the strip back up.

Refer to Chapter 6.3.7, Advanced Repairs, Copper Strips for more information.

In order to do this, a minimum of three (3) people are needed to properly roll the strip back up.
After the repairs have been made to the strip, sweep the strip off with a broom to make sure it is clean before you roll it back up.

Remove the tape from the strip and the floor with one person standing on each end to make sure the strip does not try to roll itself back up prematurely.

Strips normally have a large diameter cardboard tube that they are rolled up on. These tubes can be

obtained from a carpet store, as they are the same size that carpet comes on.

Place the cardboard tube on top of one end of the strip and tape it to the tube with four (4) six-inch pieces of tape. Carefully begin rolling the strip back onto the tube, making sure that each layer matches the prior layer. Make sure you don't "candy-cane" the strip back onto the cardboard roll!

As you roll the strip, visually inspect it for missed holes and lose wires. If a small wire strand has started to unravel, cut it with a pair of scissors, don't pull it with your hand, you will make the unraveling worse!

Once you have rolled the strip completely back up in a tight roll, tape the roll together in four places with a complete circle of tape (not the small pieces previously used) to secure the bundle together.

A good way to store and transport your fencing strips is in green PVC pipes that measure 8-inches in diameter. These pipes have end-caps on them to prevent them from getting wet when transporting them in the back of a pick-up truck, especially in the hot, humid areas like Florida, Louisiana and Texas (oh, and Mississippi and Alabama, too). Or cold, wet areas like Seattle, or Wisconsin. They are constructed similarly to the blade storage tubes described in Chapter 5.3.2.3, only with 8" PVC components.

Place the strip in the green-colored PVC plastic container, and tap the end-caps back onto the container prior to transporting the strips back to their storage area. Please make sure you put "Strip Number 1" into the PVC container, labeled "Strip Number 1" and the same with the other strips you have used.
Because of the cost of copper and the ability to obtain fairly complex extrusions in aluminum, modular metal strips are becoming more common.

These strips are interlocking sections one and a half or two meters wide and come in either 1 meter or 50 cm long sections and are about 1.5 to 3 cm high. The sizes of sections are not standard and depend on the manufacturer. They have a roughened surface and strip markings either with conductive paint or alodined on the surface.

Alodining is a chemical coating process that leaves the surface of aluminum conductive, whereas the more common anodizing process leaves the surface non-conductive.

A cable system on either side provides tension to keep the sections from moving relative to one another, although, when setting up the strip, and during subsequent use, the straightness of the strip needs to be checked and may need to be adjusted.

For those who do not have the finances to afford either copper or modular strips, there are several home-made variations that can be used in fixed facilities. One of the more common utilizes perforated aluminum or stainless steel sheet (the latter being fairly expensive!) affixed to the floor and electrically connected using mechanical contact. While the perforations (which should be smaller than 5.5mm so a foil point won't catch) initially provide traction, after use the surface can become fairly slick, so care must be used when fencing on this kind of surface.

In 2009/2010 a new, lightweight, conductive strip was introduced by several manufactures. In essence, these are vinyl strips with a conductive material bonded to them. This material is either lame material or a similar conductive cloth. By lightweight, it is relative. A 17 meter strip weighs about 70 lbs., but when you compare that to several hundred pounds for a copper one, that seems pretty lightweight!

These strips are installed in pretty much the same manner as the copper ones, except the taping of the sides is not as critical. Depending on the floor they are set up on, you can use painter's tape (similar to masking tape, but a bit stronger) to tape them down as they don't tend to slide much. One issue with them, though, is that as they get older the edges tend to curl up, which means that they will need to be taped down, or the edge becomes a trip hazard.

The other issue with these strips is that that the conductive material has a great amount of variability in how durable it is. As more and more of these strips become available, the quality is slowly improving, but they are still fairly prone to developing holes. This is most evident with strips used for epee.

Repairing the strip is very similar to how copper strips were repaired, only not with a soldering iron! Small holes can be repaired with metal tape that is

applied over the hole, and then rubbed with the end of a hammer or pounded with a rubber mallet.

Once you have done this, check to make sure you have connectivity with the patch and the rest of the strip. To do this you can use an LED test box and a body cord. Plug the body cord into the test box and then touch one of the pins on the other end to the patch and one of the others to the strip. If you have connectivity, the LED will light up. TA-DA!

Large rips should be repaired by gluing the material back down to the vinyl with either hot glue or super glue, and the edges covered with metal tape, using the technique described in the paragraph above. Check to make sure the patch is in good connection with the strip.

Another issue with these strips is that they attract dirt, which will affect the grounding characteristics of the strip. These should be swept before fencing begins and at least once more midway through the competition.

Another homemade version utilizes paint with aluminum, or similar metal, shavings mixed in. While initially this may appear cheaper, this surface can easily become worn and require frequent refurbishment and in the long run be as expensive as other alternatives.

3.5 Reel-Less Systems

A reel-less system is one that is defined by the absence of a normal take-up reel. The oldest involves the use of an elastic material (usually 'bungee' cord) that provides take-up and tension on the cable that connects the fencer to the scoring machine. The newest reel-less system uses micro-processors and transmitters that are worn by each of the fencers and is known, erroneously, by some as a 'wireless' system. The FIE specifically prohibits systems that use wireless or infra-red communications technology, so this system is significantly different and will be discussed in detail later.

3.5.1 Overhead System

An overhead system is one where the mechanical aspects of the reel have been replaced by a series of pulleys and flexible cord. They are usually used in fixed facilities, and while some may be portable, they are rarely seen outside of where they are normally set up. They can be set up either on the floor or overhead (which is how they are normally set up).

As the illustration below shows the components of one type of a reel-less system are two fixed pulleys, two floating pulleys, two cables and a length of shock or bungee cord. The cables can be regular reel cables either hardwired to the scoring machine or with plugs attached. The ends of the bungee cord are attached to the floating pulleys and it rides over the fixed pulleys. It is necessary for the bungee cord to be allowed to move freely back and forth, but still have enough tension maintained on the cable to prevent it from drooping or having so much slack in it that the fencers could become entangled in the cable.

Be sure that the ends of the cable near the scoring machine are anchored so that there is no strain on the connection of the cable to the machine. Care should be taken with the handling the ends of the cable when fencers are hooking up and un-hooking. Like the reel system, the bungee puts tension on the cable and when it is let loose, will fly across the strip. Usually at eye height. And with the clip and retainer flopping around either they or the connector itself could cause serious injury.

A good idea is to hook the ends of the cable together. This keeps the ends from dangling and hitting people.

Also, because of the fixed length of the cable, fencers should be extra careful about running off the end of the strip when fleching against an opponent. The bungee will let you go further than the cable will with the result of damaging the cable. A reel will normally follow the offending fencer (unless fixed to the floor) and not damage the cable.

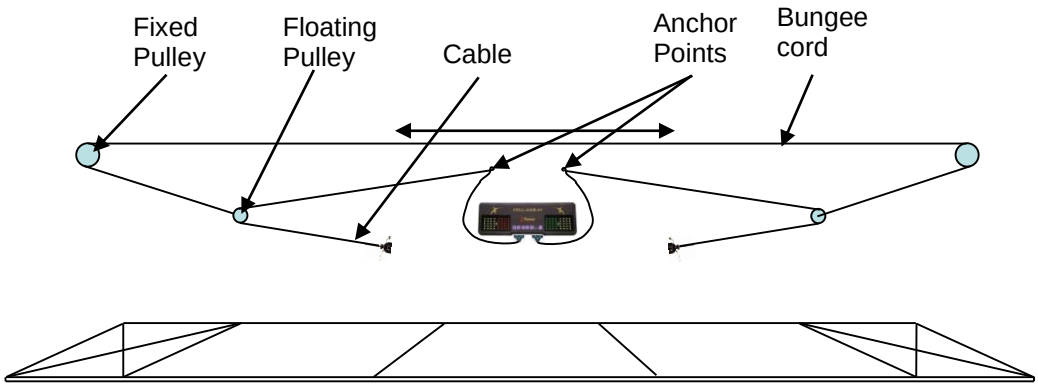


Figure 3-12 Overhead Reel System

When setting up a reel-less system, the fixed pulleys should be set to one side of the strip (for floor mounting, about 1 meter from the side of the strip) and beyond the ends of the strip (1- 2 meters). An overhead system should also have the fixed pulleys set as close to the ceiling as possible, but not any higher than about 3.5 - 4 meters (11 -13 feet).

3.5.2 Official Reel-less Systems

As was previously mentioned, a very recent innovation was the introduction of a "wireless" scoring system for saber, and and a similar system was recently tested for foil. While saber was the last of the weapons to become electrified, the compromises made to make it so, were the ones that allowed it be the first to go reel-less.

Because of the advances in technology in recent years, microprocessors and transmitters are small enough to be worn on the back of the masks or attached to the lower back of the fencers.

The biggest breakthrough was the use of the fencer's own body capacitance, or the ability of the body to store and conduct electricity.

As a result, fencers wear a conductive undershirt, which has to remain dry (and therefore frequently needs replacing during the course of an event).

In this system the scoring machine is actually worn by the fencers and is connected to indicator lights mounted in the fencer's mask. The communication between the two scoring machines takes place through the blade of the weapon. The indication of a touch can be communicated to a spectator display by wireless communication, but the official indication of a touch comes from the lights mounted on the fencers.

As was said before, the compromise of not differentiating between touches on and off target and only having lights for valid touches allowed for the ability of the machine to go reel-less. Also because the metal strip in saber is not part of the circuit, there is no need to detect contact with the strip. The Olympics of 2012 saw the use of the wireless scoring system for all three weapons; and not without many issues. Much work needs to be done before these systems are to be used universally.

3.6 Wheelchair Fencing

This is a very specialized form of fencing that has some unique pieces of equipment associated with it. Specifically they are: the wheelchair, the frame, apron, floor cords and grounding cables.[77]

The requirements for the other equipment – weapons, clothing, lamés, etc. are exactly the same as for able bodied fencers.

3.6.1 Wheelchairs[78]

The wheelchairs that are used for fencing are, or can be, normal chairs, however there are some special requirements that they must meet. As shown in the illustration below, the back must be 90° ± 2° and at least 15cm high from the top of the cushion with the fencer sitting on it. The cushion cannot be more than 10cm high, with the fencer sitting on it.

[77] IWF Rules for Competition, March 2011

[78] Rule m.25(9), IWF Rules for Competition

The chair wheels may be cambered, that is, at an angle to the floor, but must fit within the frame. The chair may, or may not, have a grab bar on the non-weapon side of the fencer and a minimum of 20cm long. There is no side guard on the weapon arm side of the chair. The height from the floor to the seat has a maximum distance of 53cm. The chair must be insulated.

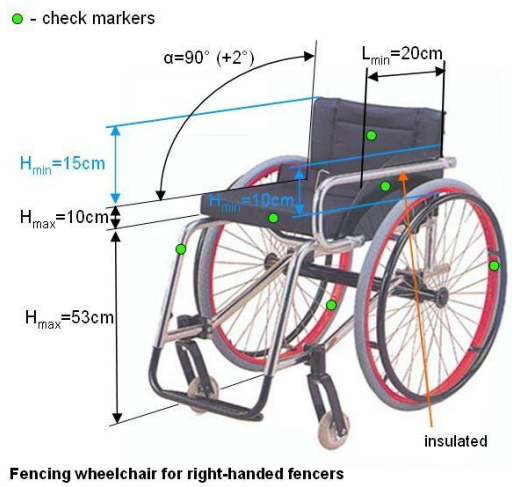


Figure 3-13 Fencing Wheelchair

3.6.2 Frames[79]

Frames basically consist of two bases, which the wheelchairs are secured, devices for securing the chairs, and an adjusting mechanism connected to the two bases which are used to change the distance between the bases so the fencers can be separated correctly. The connection of the adjusting mechanism to the bases is angled so that the bases are at an angle of 110°± 2°. There are two types of adjusting mechanism, as illustrated below – a ratchet style (left) and a rack and pinion style (right). The mechanism on the left is held to the frame by three threaded studs welded to the frame and the one on the right has a slide fit secured with a bolt.

Figure 3-14 Frames and Adjusting Mechanisms

The wheelchairs are secured to the frame by a set of hooks that fit over the wheels and can be adjusted forward or back to accommodate different sized wheels. The frame on the left uses an aircraft style seat track and fittings; while the one on the right uses a fixed bar that the restraint slides on.

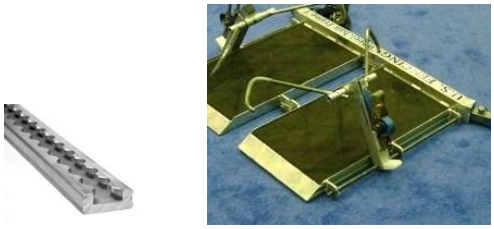


Figure 3-15 Wheelchair Restraints

As was said previously, the adjusting bar is designed to be attached to either side of the frame bottom. This is so that the orientation of the frame can be configured to accommodate the combination of fencers, left and right-handed. In the illustration below, the arrow points in the direction the fencer is facing for each combination of fencer.

[79] Rule m.61, IWF Rules for Competition

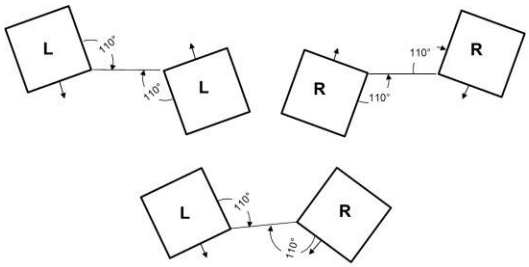


Figure 3-16 Frame Layouts

3.6.3 Floor Cords

The connection to the scoring machine is through a modified floor cord. In actuality, it is normally a piece of reel cable with a three-prong cord on one end and a regular reel socket on the other end. Since the fencers are sitting in chairs that are fixed to the frame, there is no need for reels!

Figure 3-17 Wheelchair Floor Cord

3.6.4 Apron[80]

For epee, and because the chairs are required to be insulated, the chairs and lower portions of the fencers are covered with an apron made of lamé material. These aprons are then connected to the piste grounding plug on the scoring machine. This way, any hits on the material will not trigger the scoring machine, since it acts like a grounded piste. The apron is required to be secured so that 1. It doesn't cover valid target and, 2. It covers all the way to the floor.

3.6.5 Basic Maintenance

The basic maintenance techniques for floor cords and lamés are found in Sections 2.10.1 and 2.10.3. Frames need to be checked periodically for cracks or other issues concerning the adjusting and restraint systems.

The frames with the ratchet style adjusting mechanisms have exhibited problems with the threaded studs. Recently the author came across several sets of brand new frames in which the studs have snapped off, like the picture on the left. This is possibly due to a number of factors, like insufficient penetration of the welds, no post welding heat treating, etc. Regardless of the cause, the lack of all three studs is a concern, because the other two are not able to handle the loads generated when a fencer lunges.

The criteria for the frames is that they remain on the floor during the actions, but because of the flexing of the frames, sometimes fencers can lift the back of the frames at least 2 inches off the floor! One fix for the problem is shown on the right. It is a hex head bolt, held with a hex nut to the frame, and then the washer and hex nut to hold the adjusting mechanism. The problem with this is that it holds the mechanism up too high, and creates even more stress.

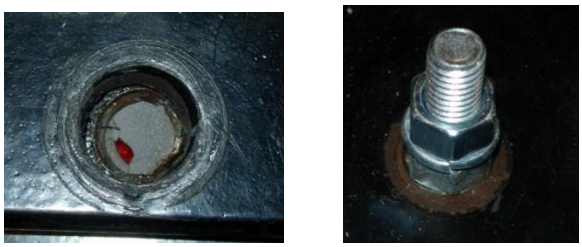


Figure 3-18 Threaded Stud Issue

An alternative solution is to use a 7/8" carriage bolt. First prepare the hole by making it square with a Dremel or grinding tool. This will allow the adjusting mechanism to lay flat against the frame and keep the bolt from twisting when the frame and mechanism are connected. It also has the advantage of the carriage bolt having a rounded head so that the frame, when set up on carpet, slides more easily and the bolt head doesn't raise the frame up off the floor unevenly.

Figure 3-19 Prepping the hole

[80] Rule m.62, IWF Rules for Competition

3.7 Strip Set Up

Just like our section on putting weapons together, there are a few things to consider when you are setting up a strip. The first thing to consider is the space available. Is there plenty of space for the strip itself plus the scoring equipment AND the referee?

For a regulation strip you need an area about 18 meters by 7 meters (59 feet by 23 feet). This will include sufficient run off at the ends of the strip, a 4 meter area for the referee, and 1 meter between the strip and the scoring machine. The width can be adjusted somewhat by using a 1.5 meter wide strip and crunching the space for the referee.

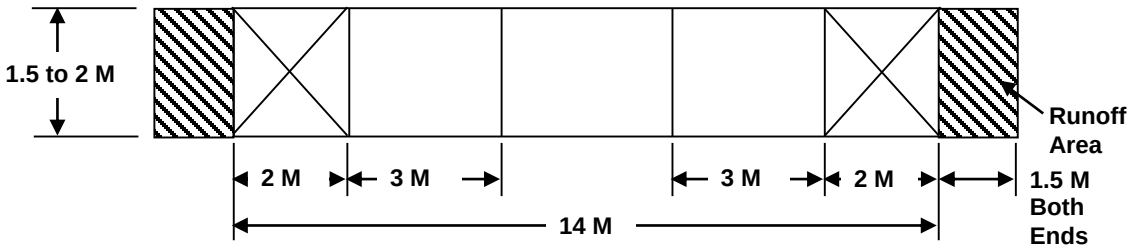


Figure 3-13 Strip Dimensions

Lay out your strip. If you are installing a metal one, be sure that you have adequate padding underneath it. If you are using a copper strip be sure that the padding isn't like a feather pillow because hits to the strip will cause large tears in it that will require quite a bit of effort to repair.

If you are taping the outline of a strip to a smooth floor, a good, and fairly inexpensive, tape to use is painter's tape. Although it will tear up by the end of the day and portions of it may need repair periodically, it comes up very easily and does not damage the finish. Well, that is for floors with a finish in good repair. It is always a good idea to test out the tape on a corner of the floor to make doubly sure that it won't harm the finish. Especially if you want to use the venue again for another tournament!

If you are laying out multiple strips it is a good thing to have a length of chain (or cord that doesn't stretch) that is marked at 1.5, 2, 5, 7, 9, 12 and 14 meters and at least 14.2 meters long, similar to the picture below.

Figure 3-14 Strip Layout Chain

Ok, the other dimensions make sense, 1.5 is the minimum strip width and the others are the distances of the various lines. The 14.2 is to be able to check to see if the corners are square. Remember, the diagonals of a regular rectangle are equal! See the diagram above for strip dimensions.

Next locate the nearest power source. Is your extension cord long enough? You should also have a sturdy table to set the scoring machine on. This is in case it gets jostled by the fencers during a bout. The cases of most machines are pretty robust and can take a pretty good whack, but still every effort should be made to keep it from being hit by flailing blades.

Locate the reels at the end of the strips. Place them about a half meter to the side and a meter past the end of the regulation strip. This will keep them out of the path of the fencers. Now lay out the floor cords. It is a good idea to secure the end of the floor cord near the scoring machine around the leg of the table. This will prevent the scoring machine from flying across the room should someone snag the floor cord. It is easier to splice a floor cord back together than replace a scoring machine. Once the floor cords are laid out and connected to the reels and scoring machine, they should be laid out straight and taped to the floor, with the excess length coiled under the table.

Once the floor cords and reels are in place, it is time to secure the reels. Most often this is done with duct tape or gaffer's tape. The most common method, used with the two most common reels, is to place two long strips of tape in an "X" over the flat Uhlmann reels or to take a long strip of tape and place it through the handle on top and back away from the strip for the Leon Paul reels. Sometimes a cross piece of tape is placed over the main pieces once they are taped to the floor.

Figure 3-15 Uhlmann Reel X-taped

Figure 3-16 Leon Paul Reel X-taped

An alternative to crossing tape over the Uhlmann reels is to take the handle and lay it out in front of the reel. Take a piece of tape about 18" long and lay it down, sticky side up. Pass one end through the handle for about 6" and fold it back over onto the remaining tape. Now fold the handle back underneath the reel. Now the tape goes back under the reel and affixes to the floor. If need be place a couple of cross pieces of tape on it for good measure.

Or you can pass the tape through the handle, sticky side up and attach it to the bottom of the reel and then fold the handle back toward the bottom of the reel and stick the tape to the floor as shown in the second illustration below.

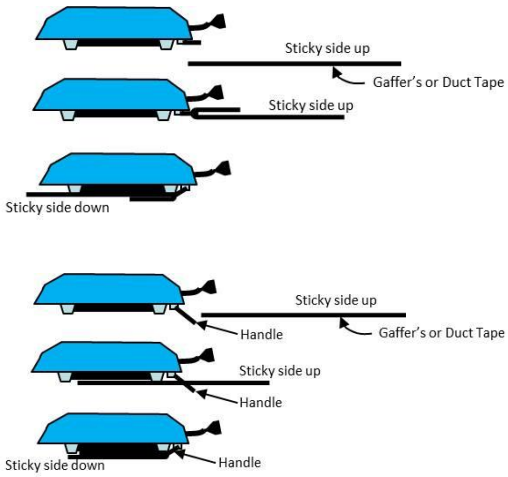


Figure 3-17 Uhlmann Reel, Handle Taping

Master Armorer, Ted Li, has come up with a way to modify Uhlmann reels that makes it easier to tape. As shown below, a 9" 20 gauge strap (Simpson Strong-Tie, P/N LST A9) is attached to the handle with two clamps, washers and pop-rivets. The tape is placed on the surface shown in the top photo, and then the handle folded under the reel and the tape attached to the floor. This is the technique adopted by the USFA, and all their reels are taped down with this method.

Figure 3-18 Uhlmann Reel, Ted Li Taping Modification

If you are using a wooden floor, another item to use (especially in gyms where they don't want you to use duct tape because it could ruin the finish) is rubber material used to keep carpets and rugs from sliding.

Cut a square piece of material and place it under the reel.

To increase the area of contact between the reel and the floor, use the skid plate described in Chapter 5.3.9.

Also, if you are set up on a wooden floor, a piece or two of old carpet placed by the strip for the purpose of providing an area where fencers can straighten or bend their blades is a good idea, as is shown in Chapter 4 in the discussion of setting the bend in a new blade.

Once everything is in place, all you have to do is apply power, test the system and you should be ready to go!

3.8 Basic Maintenance

Maintenance for scoring equipment is fairly easy, as there is only three things that need maintenance: Floor Cords, Reels and Strips.

3.8.1 Floor Cords

Maintenance on floor cords is the exact same as for Body Cords. You need to periodically check to make sure that the connections are all tight, and that the resistance of each line is 2.5 ohms or less.

When storing floor cords, make sure that they are not wound too tight and that they are secured.

3.8.2 Reels

While reels may be the most mechanically complicated of the pieces of equipment, checking them out and maintaining them is relatively easy. It's when you have to fix something that things get, well shall we say, interesting. Remember the reel has two basic functions: transmit signals between the fencer and the scoring machine and to collect up the cable when the fencer is finished pulling it the length of the strip.

So, with that in mind, first check to see that the take-up function works. This part is oh so simple.

Step 1: Put the reel on the floor.

Step 2: Grasp the cable connector and start walking away from the reel (preferably in the same direction as the cable was pointing when you started).

Step 3: Walk until you have just about reached the limit of the cable.

Step 4: Still holding the cable connector (remember, the wrath of the Armoring Gods will descend on you if you let go of it, especially when it is just about fully extended!!!), walk back to the reel.

You should feel the reel putting tension on the cable as you do this and it should wind the cable back up. Ta da!!

Now check the electrical aspect of the reel. If you are really clever, you would have done this next part while you were doing the mechanical check.

Check the cable for worn or broken spots in the cable's insulation. Some older cables and reels do not have a sheath that covers all the wires, but have the three wires tightly twisted together. Be sure to check their insulation, too.

Next, check the continuity of the wires. A simple way to do just a continuity check is to take an epee body cord and plug it into either one of the connectors and the other end into your test box.

Now short across between the C and B-lines of the open connector of the reel. You should get……? Yup, a red light (provided your box is set up that way, if not, you didn't follow the instructions in Chapter 5.3.6, did you?)!

Now short across the A and B-lines, and you should get a green light. A handy bit of test equipment to have for this is a 6" piece of wire with a banana plug on each end. Just plug one end into each of the lines you are checking and you complete the circuit.

Another neat piece of equipment to have is a three prong connector that has a wire inside that connects all three pins together. When you plug this into either end of the reel, and then connect it to the test box, you should get two lights. If you only get one, then you know that the outside lines, A or C are bad (depending on which light is lit). If you don't get ANY lights, then it's a good chance that the B line is bad (or the A <u>and</u> C lines are bad, or maybe all three are!).

Favero makes a small LED test box that has the feature of being able to detect intermittent shorts. If you use this type of test box you can hook it up and pull out the wire of the reel to check to see if there

are any breaks in the line that will only show up when the wire is being moved back and forth.

Figure 3-19 Favero Test Box

Once you have checked the continuity, it is also a good thing to periodically check the resistance (it should be less than 3 ohms[81]) in the lines to make sure that there aren't any abnormally high resistances that may interfere with the function of the scoring machines. As resistance values vary from reel to reel and from manufacturer to manufacturer, it is best to insure that you have consistent resistances for each line. They don't have to exactly match one another; but they should be close, that is, within a couple of tenths of an ohm. If not, you may have either a loose connection or one that is about to fail.

Also, you should occasionally take the case off or open it up to clean out the interior of "dust bunnies" or "ghost droppings", which are collections of dust, dirt and lint. This is especially true if you use your reels on a regular basis for practice. The insulated cable moving back and forth in the reel can generate an amount of static electricity that will attract lint and dust. Also, some of the cable insulation is not rubber, but fabric, and as this wears, the lint will also collect inside the case of the reel.

If you are checking a vertical reel, while you have the case open, it is also a good idea to check the contacts and brushes. This is fairly easy to do in the upright reels where you can remove the connector side of the case by loosening and removing the knurled nut and sliding the case off the spindle.

When you do this, be sure the cable grommet does not come loose and take the pre-tension off the spool. If it does, it is easily fixed and will be covered at the end of this section for when you put it all back together.

The connector and brush assembly can then be removed. To do this, hold the assembly body with your left hand and with the thumb of the right push one side of the three brush springs away from the contacts and lift the assembly off the spindle. You can then inspect the brushes. They should be smooth and shiny. If not, either you haven't used the reel in quite a while, or they are not riding on top of the contact rings correctly.

Clean the brushes with either a rubber eraser or extra-fine sandpaper. Clean the contact rings, too and wipe both items down with IPA to remove grit, oil or other nasties.

Now reassemble the reel in the reverse order you took it apart. If the cable grommet has come loose and the spool pre-tension is lost, then take the cable connector and spin the spool 6-8 times clockwise and place the cable grommet back in its spot in the spring side of the case and reassemble the connector side of the case (making sure you align the connector assembly with the cut-out in the case.

Something to specifically check on an Uhlmann flat reel is the cable grommet. It is made of a plastic that is softer than the cable and over time will wear away. The grommet should be replaced as soon as it looks like it will completely wear through. If it does, the case is made of the same material and the cable will cut through this thinner plastic quite quickly.

To prevent this, make sure that when you use the reel for practice you use a retaining system to keep it oriented down the strip and not at an angle that will cause the cable to wear on one side of the grommet.

Figure 3-20 Typical side wear on an Uhlmann reel

This problem is not confined to Uhlmann reels; the Favero reels have this problem, too. The complication that arises with these reels is that they have a spring that is supposed to act as a shock absorber to prevent the connector from experiencing a shock that could snap the wire. The issue is that

[81] Rule m.55 1, USFA Rule Book

because of the wear to the grommet, the spring can slip inside the case and this causes a problem in not only the operation of the reel, but to the connector.

This method has been shown to work with segments that have been entirely cut through or moderately worn. While this is not a permanent fix, it will extend the life of the segment significantly.

For a segment that is moderately worn, hold the segment so that you can fill the groove with baking soda. Fill the groove part way with soda and then apply the superglue, a drop at a time, until the color of the baking soda changes from white to grey, and stops smoking. Yes, this is an exothermic reaction – it makes heat. Repeat until the groove is completely filled. Once the part cools a bit, take a small file and smooth out the repair to match the opening in the rest of the segment.

For a segment that is completely cut through, place a piece of painters tape on the outside and back of the segment and follow the steps listed above, with the exception that you should do the repair in several layers. This is done by filling up the groove about one third of the way full with baking soda, then applying the superglue, and repeating this process until the groove is completely filled.

One fix for the problem of the connector slamming into the case is show below. It is a rubber stopper with a hole drilled through it (this is similar to a lab stopper). The cable is wrapped around the stopper and secured with a zip tie.

This is also good for reels that are mounted above the floor. By putting the stopper about 3 feet from the connector, the end of the cable will hang where fencers can easily grab them.

Figure 3-21 Reel Cable Stop

CHAPTER 4 - READY? FENCE!

Now that you have learned what everything is and how it works, you're ready to jump on the piste and begin your journey toward the finals!

Well, maybe not. There are a couple of things that have to happen first before you hear the phrase that is this chapter's title. First, especially if you are at a large tournament, is to have your equipment checked by the Armorers at the Weapon Control and then when you report to strip. This chapter will tell you what to expect at both places.

4.1 Weapon Control

At all major tournaments, especially North American Cups and International events, there is an important function performed by Armorers, and that is the Weapons Control process.

At the high level events, this is truly a control process, in that ALL of your equipment is checked for conformance to the material specifications, within reason (they don't take metallurgical samples of your blades!). But at certain levels in the completion, they will take physical control of your equipment until it is time for you to fence.

But this is not the level of weapons control that you are likely to encounter; instead, you will normally go through a process that entails checking your body cords, mask cords, saber glove/manchette, mask and lamé. There are a few things that you should know about the process and what you can do to help speed it along.

First of all, the job of the Armorer is to make sure that your equipment is in proper working order, not to find something wrong with it. As Dr. Volkman was quoted as saying, "I never failed a piece of equipment, I merely reported it". They are there to help you, not to see how miserable they can make your life, so if you approach them openly, honestly and courteously (the promise of a six-pack helps), then it should be an all-around pleasant experience. For both of you!

So, please, if your equipment is not conforming to the specifications or is not working, don't take up other fencer's time by arguing with the person doing the checking. If there is a problem, or you suspect that the person isn't performing the check correctly, seek out the Head Armorer and bring it to their attention.

It is important to note, that you do not want to get into a heated, screaming, and shouting argument with the Armorer, because, at least in the U.S., they may have the authority to issue a Red or Black Card, if it has been agreed to by the tournament organizer. The other thing they could do, is refuse to check your equipment, and therefore, you can't fence at all!

It is always a good thing to make sure that you check your equipment the before going through Weapons Control. Also, if it is possible, especially for a large tournament, have your equipment checked the afternoon before you compete. It saves much consternation when you have an 8 AM start time and you show up at 7:30 with 100 people already in line to get their stuff checked! Also, the Armorer's table is a BAD place to find out your equipment isn't working!

Before you get in line to have your equipment checked it is appreciated by the Armorer if you have everything that is going to be checked out of their bags. In other words, don't schlep your fencing bag through the line and then dump everything out when you get to the table.

Have your body cords unwrapped and all previous inspection tags removed (a good way to carry them is draped around your neck), lamés off their hanger and zipped up (shiny side out, please), and masks out of their carrying bags (and your old socks out of them!). Hand the equipment to the Armorer in the order he/she asks for it. It helps to keep their work area clear so they can do their checks.

If you are in line to have your equipment checked, please be aware of your position, especially if you are near the head of the queue. Please don't make the Armorers have to yell. It makes them hard to get along with after a while.

If your equipment fails, it fails. And yes, equipment purchased moments before from a vendor can also fail (last time I checked, none of them offer a guarantee that their stuff will pass, but most will replace it immediately if it does fail, and you have the receipt!). If you wish to discuss the issue with the Armorer, please do so when there is not a long line of folks waiting to get their equipment checked.

Remember, the folks in the Armory are the experts. Upon occasion, they may ask for a second opinion from either their colleagues or the Head Armorer to be doubly sure of their finding. That doesn't mean they don't know what they are doing, it's just that they want to give you, the fencer, the benefit of any doubt before pronouncing judgment on their finding. Once the 'verdict' is rendered, though, it is final.

Armorers will do the standard tests that are outlined in this book. Sometimes someone will come up with a 'bright idea', like the infamous "body cord jerk test", which was where you would grab the connectors and the wire and give it a jerk. The theory was that if the body cord connections were going to fail, this action would definitely make that happen. This 'test' has been debunked and forbidden. Remember, Armorers are there to inspect and verify, not to fail, equipment.

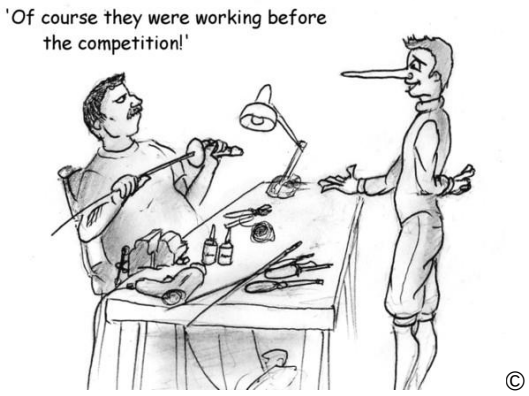
Once the equipment is checked and passes, it will be marked. In the case of masks and lamés, it is a stamp that is unique and placed in approximately the same spot on all pieces checked. Body cords are marked with either a piece of colored tape or colored wire tie, and because there is only a limited selection of colored tape, chances are that the same colored tape could be used as a previous tournament. To make minimize confusion, all other tags need to be removed when you go through Weapons Control. This is not like a ski jacket, where it is a badge of honor to see how many lift tickets you can hang off it.

Once equipment is checked, the 'certification' is good for the length of the tournament. Don't show up to the next one expecting to get by just because, 'Well it passed last month!'

Armorers are pretty busy people at a tournament and don't normally do repairs for personal equipment. This is especially true if there are vendors present at the venue that are doing repairs (they claim unfair competition!). If they do have time, though, they will at their discretion help diagnose, and do minor fixes.

Normally there is a station set up at the Armory that has a test box, working body cords and a test weight. Fencers are encouraged to uses these items to check their own equipment. Most times, though, these items are chained, leashed, tied, anchored, or otherwise secured because, even though they are supposedly inanimate objects, when no one is looking they sprout legs and go running off to hide.

This is a similar phenomenon that occurs with Armorer's tools that are borrowed. As a result, most Armorers do not loan out tools, so please don't ask. Not even if you offer to leave your firstborn as collateral. Most Armorers have already raised their children and the prospect of raising another is so frightening it takes years of therapy to get them back to a semblance of normal! Well, normal for Armorers, that is.



(Cartoon Courtesy of Pete Russell, used by permission)

4.2 Reporting to Strip

When you report to the strip to fence you are required to have all your gear either wearing it, as in the case of clothing, or with you, as in the case of weapons and masks. This includes having all safety required clothing, i.e. plastron and chest protection and at least two WORKING weapons, two WORKING mask cords and two WORKING body cords.

Before fencing begins, the referee, after checking to see that everyone in the pool is present, will check to see that everyone is wearing a plastron (and chest protectors for women), has stamped masks and lamés and two marked body cords.

At the beginning of a bout, the referee will check both fencer's weapons by weight testing (foil and epee), and for epee, the 1.5mm and .5mm shim tests.

For foil and epee, the weight is pulled down and released. For foil this will result in an off-target light that should go off and stay off once the weight is released. For epee this will result in a colored light that should go off once and stay off once the weight is released.

They should also check the condition of the weapon, such as tip tape for foil, the presence of two screws for epee, required guard insulation for saber. They can, if in their estimation it is necessary, check the bend in the blade of the weapons. They should also check for obvious signs of corrosion and condition of the guard.

If during the tests a weapon, or after checking the body cord, it is found to be in non-working condition; the offending piece is confiscated by the referee and kept for the remainder of the bout. The fencer is issued a YELLOW card. If the next piece of equipment is found to be defective, they are issued a RED card for non-conforming equipment. Remember, you were supposed to show up with two WORKING weapons, two WORKING body cords, and two WORKING mask cords!

Once the Referee is satisfied that all the safety and weapons checks are complete, the fencers are asked to test their equipment to ensure the scoring system is working correctly.

Foil: The fencers approach each other and holding their masks in front of their faces with their non-weapon hand (or placing their non-weapon arm across and away from their bodies at about neck height), touch each other nearly simultaneously on valid target area. This should result in two colored lights. If not, then the referee will start troubleshooting the system using the techniques outlined in Chapter 6.1.1

Epee: The fencers approach each other holding their masks as described above, and in sequence, push the tip of their weapon against their opponents guard. This should result in……nothing. Should a light go off, the referee will start troubleshooting the system using the techniques outlined in Chapter 6.1.26.1.

Saber: The fencers approach each other holding their masks, with the mask cord attached to the mask and their lamé, out away from their body, and simultaneously touch their weapons against the opponent's MASK, not the lamé. This should result in two colored lights. If not, then the referee will start troubleshooting the system using the techniques outlined in Chapter 6.1.3.

Should equipment fail during a bout, it will be confiscated as was stated before, but no card issued. If the replacement piece should fail after being exchanged for the broken piece, the appropriate penalty will be assessed.

CHAPTER 5 - GETTING STARTED

Now that you have the information on what everything is, how it works, how it goes together and what the basic maintenance needs of each piece of your equipment is, it's time to jump in and get to work fixin' stuff!

Whoa, cowboy, before you do that you may want to take some time to get yourself, your tools, and your workplace organized. You need to make sure that you know how to safely use the tools and techniques that you'll need to do those repairs, the hazards associated with various chemicals that are commonly used!

Make sure that you have all the things (tools, materials, parts, etc) that you are going to need handy. There is nothing more frustrating than to get two thirds of the way through a project and have to stop to run to the store, toolbox, etc, to get something you forgot.

In this chapter, we will touch on the workspace, the basic skills and safety considerations that will make working on your equipment a much less frustrating experience and some tools, jigs and fixtures that you may want to make or obtain, to make life a little simpler.

5.1 Workspace

Before you begin working on your equipment you need to make sure that you have all the parts, tools, instructions, etc. that you are going require in order to do the job correctly.

It is also important is that your workspace is clear and well lit. Make sure the lighting you use is such that it doesn't cause shadows or glare. This is much easier on your eyes. Use of a lighted magnifying lamp is also recommended, especially for older eyes and when working on tips and smaller parts. Most importantly, make sure that when working with chemicals that you are in a well-ventilated area.

Normally a tabletop is a great place to work, however, if it is your mom's/wife's $20,000 antique Louis XIV dining room table under the $50,000 crystal chandelier, I'd think twice about it.

An alternative, especially if you live in a limited space like an apartment, is a Workmate-style folding workbench. This portable workbench can be set up quickly and is fairly inexpensive (less than $100 for a good one) that has a number of features that make working on weapons and equipment easier.

Figure 5-1 Portable Workbench

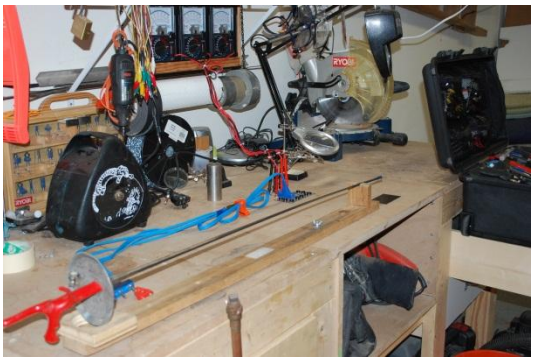
If you have the luxury of having a garage, basement, shed or other place of spousal banishment (i.e. doghouse) in which to set up a more permanent workspace, lucky you! A good suggestion is that you organize your space so that tools, parts, etc. are arranged so that the more commonly used items are within arm's reach. Ok, that's a "duh" too, but over time the items you commonly use will change, so be aware of that.

Another handy item to have is a small container, like a Tupperware sandwich box, to keep small items in. Before you start work, collect the things you'll need and place them in this container. This will not only keep them all in one place and not rolling around your workbench (or the floor) and getting in your way, but help you organize your work. I use a small "kidney" bowl, left over from one of my emergency room visits.

Also, a fairly inexpensive organizer from one of the home improvement stores (a small 12 drawer parts organizer) is great for holding extra tip parts, connectors, etc.

Below are two examples of workspaces. One is the author's space in his garage and the other is a larger workspace that supports a large permanent Salle[82]. The workspace that you choose to set up of course will be dictated by the space, number of tools and the kinds of repairs that you normally do.

[82] The space is that of my good friend, Frank Kelly of the Virginia Academy of Fencing.



Author's (New) Workspace

Salle Workspace
Virginia Academy of Fencing, circa 2008

5.2 Basic Skills and Safety

In order to successfully troubleshoot and maintain your equipment using the techniques contained in this book there are several basic mechanical and electrical skills that you need to have or develop. Most of them can be improved with time and practice, much like your fencing. But before you exercise any of them, it is important that you understand the safety considerations of each of them. There are many that, once you hear them, are from the "First book of Duh!" while others may not be so obvious.

By virtue of the fact that you have purchased this book, you have said that you are interested in the quality of your equipment and repairs. It also means that it pains you to have to shell out money for someone else to do it! One area, however, where you don't want to scrimp and save money is in the area of safety and the quality of tools you use. Actually, these two items go hand-in-hand. Cheap tools are more likely to break and/or damage your equipment, not to mention your body. Good tools are essential to quality work and they will last a very long time. So suck it up and spend the cash for good tools up front; in the long run it will save you money, time, and frustration.

Finally, many of the skills listed in this chapter can be found in various other references. One of the better on-line one sites for basic skills is www.diynet.com. This site has a great deal of good information that will help answer questions you may have on the skills and techniques discussed here.

5.2.1 Safety

How many times have you had to open something, oh, say a bottle of beer (without the modern convenience of screw-off caps), and didn't have the right tool (in this case a bottle opener)? Well, who needs that when you have things like counter edges to slam against, or a key to work under the edge, or, as is a favorite method from my Alma Mater, using the inside edge of your school ring, to pry off the cap. While these will get the job done most of the time, they are neither efficient nor particularly safe. Hands can slip, glass can break and worse yet, beer gets spilled (a near capital offense in some parts of the world and more importantly, within the Armorer's Community)!

5.2.1.1 Tools

When using tools it is important that you use not only the correct type of tool, but size of tool. In the case of screwdrivers it is important that tip of the blade fit as closely as possible to the slot on the screw. If it is too small, you can damage the head of the screw to the point where it is impossible to extract it without resorting to the extreme measure of using drills and extractor tools. While using extractors IS a method when working on car engines, it usually results in throwing away a perfectly good tip when you can't get the tiny screws out of the barrel.

All is not lost, though, there are ways to retract or remove damaged tip screws, but that will be covered later (see Chapter 6.3.9).

When using wrenches and sockets it is also important to use the correct-sized tool. If you are working with parts built to metric standards, as is the case with most fencing equipment, the investment in metric tools can save hours of frustration.

While there are many tools in standard English measurements that come oh-so-close to metric sizes, there is enough difference to cause tools to slip and round off corners to such a degree as to make the part useless.

Adjustable tools like crescent wrenches and vise-grips can be used in many of these cases; but make sure that they are adjusted tightly enough to do the work, but not so tightly that they crush or damage the part.

5.2.1.2 Rotating Equipment

Rotating equipment, while not all that common when working on fencing gear, presents three hazards. The first is to the eyes. Grinding operations throw off bits of metal in a dazzling display of sparks that can also fly into your eyes. Make sure that when you are grinding that you have eye protection, normally safety goggles with side-shields.

The secondly hazard, is hair, especially if you have a long, luxurious mane. Dremel® tools rotate at up to 20,000 rpm or higher. At that rate it takes about 4 nanoseconds to wrap up 12 inches of hair and either rip it out of your scalp or crawl up the side of your face and head leaving a bloody trace where the cutting wheel laid open your skin. Make sure that if you have long hair, you keep it pulled back and secured out of the way.

The tip of a Dremel® rotates to the right as you look down on the tool. In order to help keep the tool from catching and running away from you, move the Dremel® to the left as you grind or cut.

Figure 5-2 High Speed hand-held drill

Finally, high-speed rotating wheels can grab and throw objects that are being worked on if they are not securely held. If you are using a portable grinding device, use a vise to hold the object you are working on. When using a grinding wheel, hold it against a tool rest, which is normally a part of the grinder.

Additionally, when you are using a grinding wheel, make sure that the rotation of the wheel is down towards the ground. This will put pressure on the workpiece and help hold it against the tool rest.

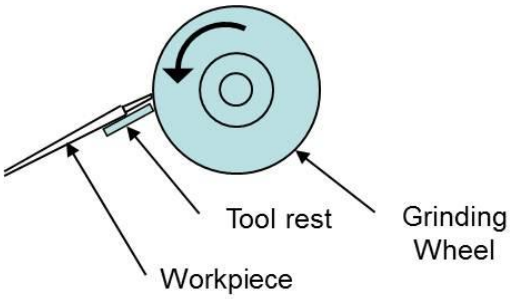


Figure 5-3 Proper positioning of the workpiece on a grinder

5.2.1.3 Cutting tools

Knives and razor blades are designed to do one thing. Cut. They don't care if it is plastic, wood, or human flesh, especially if the blade is dull. A dull blade is more likely to slip because of the greater pressure exerted on it to make it cut. Using single blade razors, or #11 blade X-Acto knives, is a great way to scrape off dried glue or cut "spaghetti" insulation. These are readily available at most hardware stores. Single blade razors come in packs of 100, so don't be shy about using new ones regularly as they can become dull rather quickly.

5.2.1.4 Heat

A solder gun or soldering iron has the obvious hazard of heat, lots of it, which means of course that you must be careful how you handle them. That is, the obviously hot items, meaning not only the tool but the part you are working on! Don't get too anxious to pick up that connector you just finished soldering. Let it cool for a moment. And while you are waiting to do that, make sure that you carefully place the tool (gun or iron) down, or in its holder. Use both hands to handle the piece you are working on; don't try to move it around while holding the soldering iron. To prevent burns to the surface you're working on, a ceramic tile works well.

5.2.1.5 Chemicals

Of the chemicals described in this book, the most dangerous is acetone. It is one of the strongest solvents available on the commercial market today. It is highly volatile (burns/explodes easily) and in some states it is considered a carcinogenic precursor (helps cause cancer). If you are going to use this chemical, make sure that you use it in a well-ventilated area, away from open flames (such as pilot lights on hot water heaters) and with protective clothes. With regard to the later, latex gloves, which are readily available in the paint section of hardware stores, work great. Be sure that when you dispose of used acetone it is done through a company certified in hazardous materials disposal. Companies that handle oil and paint products are usually able to do this.

Among other potentially dangerous chemicals are the classes of cyanoacrylates, more commonly known as super-glues or CAs. In addition to their ability to bond most anything to anything else, including fingers to fingers, with amazing strength, they can, when heated, create toxic fumes. This is especially important to keep in mind when grinding old glue out of blades during the rewiring process. Using a well-ventilated workspace and staying away from the grinding process, meaning keeping your nose away from the grinder, will help prevent any problems.

NOTE: if you should happen to glue your fingers together, or any other body parts, a non-acetone nail polish remover works to dissolve the glue. It takes a while, but it will work. Eventually. Another technique is too put water on the two body parts and slowly peel them apart. CA's strength is in the area of tension and shear, but not peel.

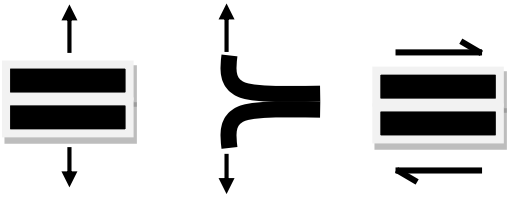


Figure 5-4 Types of Forces

5.2.2 Skills

Again, to many this section may seem to contain many items that, unless you grew up like many of the older generation with a complete auto repair shop in your garage, fall into the "all too obvious" category. But many new and younger fencers have not had that luxury, so here are some quick tips on how to use these tools effectively.

5.2.2.1 Screwdrivers and Wrenches

As was said before, the selection of properly sized tools is key to correctly using them. In the case of screwdrivers there are two basic types – Philips (or crosshead) and Flat-tipped. These of course come in various sizes and lengths. You want to select both the tip size and length that will allow you to move a screw without exerting too much force on the head of the screw.

Figure 5-5 Combination Screwdriver

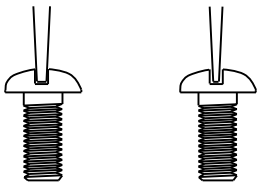


Figure 5-6 Proper fitting of a screwdriver

This goes for both inserting and removing screws. If the tip is too small, too much force will either round off the edges of the slot or break one side off. This can also happen if the length is too long because it allows more torque (or twisting force) to be applied to the screwhead.

Be careful, too, not to over-tighten screws. Too much force can also cause the threads of the screw to shear off and thus strip either the screw or the hole. The problem is the different strength of the two metals used. As you continue to twist the screw once it is tight, you reach a point where something has to give. And that is the weaker of the two materials. If you are lucky, that is the screw. But, as normally happens, you lose both parts. Generally, stripped screws and holes are not economical to repair.

Sometimes re-tapping the hole or chasing the threads to re-form them can repair the hole. And it is possible that this can permanently fix the problem, but many times not. Cutting or chasing threads will be discussed later in this chapter.

When using wrenches it again is important to choose the correctly sized one. It was pointed out previously what the problems were with using wrenches that are slightly too big and the result of rounding off the points of nuts.

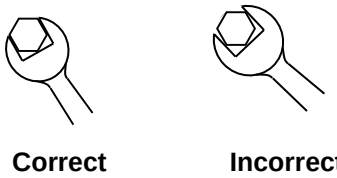


Figure 5-7 Proper fitting of a wrench

When working with pommel nuts it is possible to use a deep-well (a longer than normal) socket with an extension and a ratchet handle. Here again our old friend torque comes into play because the leverage the ratchet handle gives you can provide enough force not to only strip the threads but also to shear the tang of the blade off. Not good

Vise-grips

Combination Wrenches

Crescent (Adjustable) Wrenches

Figure 5-8 Examples of Different Types of Wrenches

5.2.2.2 Cutting, Filing and Grinding

These techniques are used primarily when converting or trimming the tang of a blade. They can also be used when modifying other parts like the guard or grip. They involve tools such as a hacksaw, file or grinding wheel.

Filing involves the use of a hardened, serrated piece of metal that may have a rectangular, square, half round or round cross-section. While there are many different sizes and shapes of files, they are all used in the same manner. If you are using them to cut aluminum, though, they need to be cleaned on a frequent basis. This is done using a wire brush (or file card), brushing diagonally across the width of the file in the same direction as the cuts of the teeth. There are files that are made especially for aluminum, called Nicholson® files.

Figure 5-9 Files and Handles

When using a file, hold with both hands at an angle of about 30° to 45° relative to your body. This is the direction you are going to file. With firm (remember, you are trying to take a little bit of material with each stroke, not all of it in one shot!) short strokes (about 3”) push the file away from you.

Files are meant to be used in one direction; stroking forward - not pulling backward. Don’t drag the file back across the workpiece, as this will wear off the sharp edge of the teeth and dull the file.

Figure 5-10 Proper Use of a File

When using a grinding wheel, be sure that you hold the workpiece securely and against the tool rest, as was described earlier. Also, grinding generates a LOT of heat, so make sure you have a small can of water handy to periodically cool the work piece off.

Figure 5-11 Bench Grinder

SAFETY NOTE: DO NOT USE A GRINDING WHEEL FOR GRINDING ALUMINUM!

Aluminum is a soft metal that cuts very quickly and will “gum” up in the wheel. As this happens, the metal heats up the more you grind and will expand to a point to where it can cause the grinding wheel to shatter.

5.2.2.3 Threading

This brings us to a discussion about screw threads. This is probably the trickiest of all the mechanical skills discussed here. This involves either cutting (making new threads) or chasing (repairing or following existing threads).

Either one of these operations uses taps (internal) or dies (external) cutting tools with their own unique handles, as illustrated below

Taps **Dies**

Tap Handle **Die Handle**

Figure 5-12 Threading Tools

As Armorers we are mostly concerned with chasing threads as the primary use of taps and dies in maintaining weapons. That doesn't mean to say that we don't have the occasion for cutting new threads. Such a case is repairing the ends of foil and epee blades when the tip breaks off, or the threads on a tang need to be extended when changing out grips. See Chapter 6.3.8 for a more detailed description.

Cutting threads from scratch involves many variables and can be a bit frustrating at first, but like any other skill described here will improve with practice.

Threads are a unique combination of two tools: the ramp and the shaft, or rod. The way they are combined is essentially the ramp wrapped around the rod. Their combination allows parts to be joined, moved back and forth, etc.

In order for two threaded parts to be joined, they must have diameters (rod and hole) and pitches (the angle of the ramp) that are the same. So how can we know which is which?

Threads come in standard sizes, in both English and Metric. Since fencing is an international sport, the parts that we are concerned with are all in Metric, with the exception of some blade tangs, which are becoming rarer and rarer.

In designating a thread size there are two things needed: Diameter and Pitch. In metric standards, the designation is stated as: Mxx X #, M standing for Metric, xx being the nominal diameter of the thread in millimeters and # being the distance between the threads in millimeters. For example, M6 X 1 means a metric thread, 6mm nominal diameter and 1 mm between the threads.

In the inch system, the difference is that the number represents the number of threads in an inch of length. The first number is a bit trickier. Inch fasteners below ¼" are designated with numbers 0, 1, 2, 4, 6, 8, 10 and 12. As was said earlier, the only inch thread size we are concerned with is 12-24 UNC.

Screws can have different pitches for the same diameter, such as coarse or fine. For the inch system a thread designation of UNC or UNF is used to differentiate between coarse and fine threads, respectively. For the metric system, there is no additional designation; however, the smaller the number, the finer the thread.

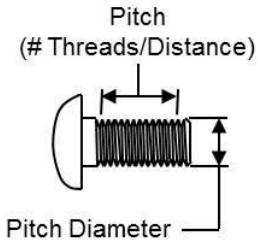


Figure 5-13 Thread Terminology

If you would like to know more about the subject, *Machinery's Handbook*[83] is a great reference for determining pre-drill sizes and discussions on the different classes of threads (how closely they are toleranced, precision, etc.). For our purposes, cutting of new threads will be limited to either extending existing threads or going from one size to another.

As was stated previously, we are mostly concerned with fixing threads, especially on the end of the tang after it has been cut. One of the easiest methods for fixing or reshaping the leading edge of the thread, that is, where the threads start on the shaft, is done before you begin cutting.

If you can find a stainless steel hex-nut that fits the threads on the tang you are cutting, or even a pommel nut, thread it onto the tang below the point

[83] See Tab 10, Page 1629, 25th Edition for a detailed discussion of threading.

where you are going to cut. Make your cut and then back off the nut to re-form the leading edge. Simple. You can also do your dressing of the end of the tang before backing off the nut and still have a nice clean thread.

Figure 5-14 Using a Pommel Nut as a Thread Former

Sometimes the end of the tang is so goobered up (or in other words, damaged) or when you try to thread a pommel nut on, the threads are so tight (or full of grease and dirt), it takes a great deal of force to get it to go on, and it is necessary to re-cut or chase the threads. Before you try this, though, try cleaning the threads with a wire brush.

First, file or grind the end of the tang flat and then grind a chamfer around the end of the tang, or piece you are going to thread. See **Error! Reference source not found.** for a detailed description.

Next, using the correct sized die, which is securely held in its handle, place it over end of the tang and carefully rotate it clockwise in the direction of the threads (to the right) until you feel the threads engage. Be **ABSOLUTELY** sure that the handle is perpendicular to the piece you are threading.

NOTE: The technique described here can also be used when cutting 12-24 threads from existing M6 x 1 threads.

RULE OF THUMB: Righty –Tighty; Lefty – Loosey, (that is, looking down on the screw or fastener, turn right to tighten, left to loosen)

Once the die is engaged in the threads or you can feel it begin to "bite" into the metal, start turning the handles two or three times. The cutting edges of taps and dies are tapered and cut more metal as you go farther along. If you are chasing threads it should go fairly smoothly.

Be careful if you are chasing threads and you feel the die "bite" into the metal, you might be cutting across the existing threads and starting to cross-thread them – a bad thing. If this happens, back the die off until you feel it click into the leading edge of the existing threads (that is if you haven't damaged them).

If you are cutting new threads, it should get a bit harder due to more cutting surfaces coming into play. At this point, back off the die a full two (2) turns. This will break the chip that is forming from the cutting and clear the cutting path.

It is also a good idea to use a cutting fluid such as a light oil to help keep chips clear and remove the heat created by the cutting action of the die. Repeat this process until you have cleared or extended the threads to the desired length.

The above process is the same for tapping holes. Again, the key to this process is to keep the tools perpendicular to the workpiece as you start. Once you get started, the tool will tend to align itself, but it is possible to get it off axis and cause problems.

Table 2 – Standard Thread Sizes used in Fencing Equipment

Part	Thread
Tang[84]	M6 x 1
Barrel, Foil	M3.5 x .6
Barrel, Epee	M4 x .7
Tip, Epee[85]	M2 x .25
Tip, Foil, German	M1.7 x .25

5.2.2.4 Soldering

Soldering is the primary way that electrical connections are made between wires and components. This ability is as much technique as it is skill. One of the most important things to remember when soldering, is that less is better. That is, a little solder goes a long way. Big globs are a sign of a poor connection.

In order to insure proper electrical connection between the three parts: the connector, the wire and the solder, it is most important that the workpiece itself be heated to a proper temperature. If the solder and wire are heated so they fuse, but not the connector, then a condition called "cold soldering" occurs. This condition is an incomplete fusing that can lead to either high resistance, intermittent (iffy) or broken circuits.

[84] As was noted in the preceding paragraph, some manufacturers still use the old standard English thread of 12 x 24.
[85] These are the most common sizes; however, there is no standardization for screws per the SEMI

Soldering Gun **Soldering Iron**

Figure 5-15 Soldering Tools

To prevent cold soldering, there are several things that should be done prior to soldering.

The first is to make sure that the heat source (gun or iron) has sufficient power to raise the parts to the right temperature.

The biggest problem faced in soldering is what holds the workpiece. If it is large and metal, it works as a heatsink and draws heat away from the part. Small clips or hemostats (locking tweezers) are best to hold parts while soldering.

The next challenge is to make sure all the parts and your iron/gun's tip are clean. One of the problems in this regard is the flux or material used to help make the solder flow.

Most solder used today has this incorporated into the solder, but after repeated use it can build up and become a hindrance to good connections.

Make sure that you are using a rosin core solder and not acid core. The acid in the latter will cause damage to your gun/iron and also possibly cause corrosion in your soldered connection. A method to clean the parts as well as the tip is described below.

Another important thing when soldering wire to a connector is to "tin the wire" beforehand. This works best with stranded wire, that is, wire made up of many smaller strands. To do this, you may have to remove the insulation from the wire.

There are almost as many ways of doing this as there are people, techniques range from biting the wire and using your teeth (not very accurate when trying to remove only a little bit of insulation, and tough on the dental work) to trying to cut through the insulation with a razor blade without cutting the wire.

The cleanest and easiest (once you make the investment) is to use a wire stripping tool. These can range in complexity from a simple blade with a notch or hole the size, or gauge, of the wire in it so that it will cut through just the insulation, to one that has multiple gauges and a clamp that will hold the wire, cut the insulation and strip the cut insulation off the wire with one squeeze of the hand. Whichever tool or technique you use, make sure that you cut the insulation and not the strands of wire.

Once the insulation is removed, it is best to start with a clean tip on your soldering tool. To do this, bring the tool up to the proper heat and then wipe it clean on a damp sponge. Once the tip is clean, melt a small bit of solder back on the tip. Next, place the hot tip of the tool against the wire for a couple of moments and <u>then</u> touch the solder to the wire. The solder should melt and flow into the wire. Be careful not to use too much solder; the strands of the wire should still be visible and not look like a solid piece of wire.

Once the tip has been cleaned and the wire tinned, the part to be connected to the wire should be cleaned. It should be free of grease, corrosion, and old solder. Grease can be removed with rubbing alcohol or acetone (See previous discussion on safely using acetone). Corrosion (or oxides) can be removed with fine sandpaper or emery cloth. Old solder can be removed by heating the part and quickly cleaning it with a damp sponge, as in cleaning the tip or using a de-soldering tool.

Now you are ready to connect the two parts. First heat the part being held and melt a small bit of solder on it. If you are soldering a connector on to a wire, make sure the hole through which the wire passes is clear. Then thread the wire through and heat the two parts together until the solder flows. Be sure to let the parts cool sufficiently before handling or testing the connection. Some connectors have a tab that the wire can be wrapped around before soldering. This adds to the strength of the connection, and should be used in connections that experience a lot of mechanical stress.

5.2.2.5 Electrical Testing

For the most part, electrical testing involves measuring continuity and resistance, which is what we are most concerned with in maintaining equipment.

Continuity is making sure that we have a solid electrical connection. To do this we use the resistance-measuring feature of the ohmmeter. A perfect connection will register 0 ohms (or a really good one will measure very close to 0 ohms) while

an open circuit will register infinite ohms. Mostly this is a go/no go kind of measurement; just to see if you have electricity flowing through the circuit or connection.

Resistance is a measure of how much 'drag' there is on the flow of electricity through the wire. Too much 'drag' or resistance in your weapon, body cord or lamé will cause it to malfunction.

To test electrical connections for either continuity or resistance we use an ohmmeter, which is normally a combination meter that also can measure voltage and in some cases current.

There are two kinds of meters: digital and analog. The digital meters have a numeric output display, while an analog meter has a needle and scale display.

Digital **Analog**

Figure 5-16 Ohmmeters

Each has its advantages and disadvantages. While more precise, the digital meter is not as responsive or as sensitive to changing (intermittent) fluctuations in resistance, unless you have a very expensive meter.

Analog meters have the ability to adjust the zero to remove the resistance inherent in the test leads and therefore will give a more immediate and accurate measurement of resistance.

To do this, cross, or short, the two leads and adjust the needle so that it reads 0 ohms. This way you make sure you are measuring the resistance in the part and not the part plus the wires that connect the tips to the ohmmeter!
Use the lowest measurement scale (normally 0 – 20 ohms, or the Rx1 setting) to do this. It is best to avoid analog meters with a Rx1 center scale higher than 25 ohms because they aren't very accurate.

To help read the meter, some analog meters have a small mirror behind on the face of the scale. In order to correctly read the value of the scale, the user must align the image on the mirror with the needle. This makes sure that you are looking straight at the scale and getting an accurate reading.

5.2.2.6 Drilling

This process is more associated with the construction of parts or jigs/fixtures, but nonetheless a few things that are important to point out.

There are two types of drilling machines that you will most likely encounter: hand drills and drill presses.

The most common is the hand drill, which can be either battery-operated or corded; that is having a cord that plugs into the wall.

Most hand drills today are variable speed, which means the more you pull on the trigger the faster they go. This is important because different materials cut better at different speeds.

Also, it is important to start off fairly slowly when drilling to make sure that the drill-bit doesn't "walk" or twist away from where you want to drill the hole. The use of a center punch to mark where the hole is to be drilled will help minimize this from happening.

Another technique is to install the drill in the chuck so that only enough of the bit is extending past the chuck to go through the material. This is especially effective for small bits.

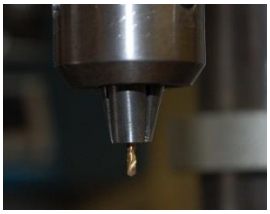


Figure 5-17 Drill Bit for Short Holes

Keeping the drill perpendicular to the hole is also important, more so for deep holes, and many hand drills today have a level built in to help.

A drill press is a device that uses a stationary platform and moves the drill bit into the piece by a lever. They can be either free standing or bench top. Using a drill press will give you a very straight and perpendicular hole.

Drill Press **Hand Drill**

Figure 5-18 Types of Drills

When drilling a hole, it is advisable to do two things: first, have some kind of backup material behind the part you are drilling and to have it securely held. This prevents the part you are drilling from deforming, or in the case of wood, causing breakout splinters, or burrs as the bit exits the material.

Here again, as was pointed out the beginning of this chapter, quality drill bits are important. Cheap ones will either break or tear up the material and end up damaging the part, or worse, you!

Secondly, is to have a way to secure the piece you are drilling. This prevents the piece from twisting in your hands and doing damage to the part or, as you will read often in this book, yourself!

As you become more proficient in using some of the tools and skills discussed in this chapter, you may come across others that will help improve your ability to repair and maintain your fencing equipment. When you do, it is always good to remember that quality tools and equipment will not only save you money in the long run, but also be safer to use. Be sure to take the time to learn how to properly use the equipment.

5.3 Tools, Jigs and Fixtures

In this category there are several pieces of equipment that you can make for yourself relatively easily. The tools and materials needed to make them are listed along with step-by-step instructions. The SKU numbers, which are what stores use as a standard identification for products, that are also listed are the ones normally found in large home center stores to help you find what you need more readily.

5.3.1 Wiring chain

Figure 5-19 Wiring chain

This is an important jig when rewiring a blade (replacing the wire). There are a couple of vendors that sell this jig, but it is just as easy to make your own without having to travel to a large tournament or order it. Besides, you can make a bunch of them and give them away to your fellow budding Armorers.

Below is a chain that shows the adjustment piece, as well as a ¾" copper cap for using on French grips.

Figure 5-20 Multi-Functional Wiring chain

What you will need:

Table 3 – Wiring chain

Tools	Materials	SKU
Drill, with 1/8" bit	2 – 1/2" copper caps	0-39923-03764-0
Center punch (or nail)	38 – 39" of small chain	0-20418-06472-2
Small hammer	~ 6" piece of 1/2" dowel	
Needle-nosed Pliers		
Vise		

Step 1: Place the dowel in the vise horizontally with about 1" of dowel sticking out the side.

Step 2: Place one of the copper caps over the end of the dowel and with the nail and hammer mark the location of the hole you are going to drill 1/8" from the edge of the cap. Drill a 1/8" hole in one side of the cap. Do the same for the other cap.

Step 3: Using the pliers, remove and save one of the links from the end of the chain by bending the link back enough to remove it from its neighbor.

Step 4: Take one of the caps and feed the end of the link you just removed from the outside to the inside of the cap and crimp the link closed. Open the other end of the link enough to be able to reattach the link to the chain (about 1/8").

Step 5: Attach the link and cap on to the chain 2 ½ to 3" from the end of the chain.

Step 6: Attach the other cap to the opposite end of the chain.

Step 7: On the free end of the chain take the last link and bend it open to about ¼" wide to form a hook.

Another variation is to either make one of the caps 1" to 1 ½" diameter, or add an additional cap to the end of the chain. This will allow for one end to be slipped over the end of a grip when trying to re-glue a 'popped' wire without taking the weapon apart.

An alternative to this is to use two film canisters (or 5/8" PVC caps) with about 28" of string, made in much the same way, with the exception that this is a fixed length jig. Very cheap and quick, but not as safe or reliable.

5.3.2 Soaking Tube

Figure 5-21 Soaking Tube (Copper Shown)

The next handy item to have is a soaking tube. This is very helpful for holding acetone when removing an old wire and glue from a blade. Two different constructions are presented here, one of copper and the other of iron, which are both readily available at home improvement or hardware stores.

5.3.2.1 Iron tube

Table 4 – Soaking Tube, Iron

Tools	Material	SKU
2 Plumber's wrenches	42" black iron pipe, ¾" dia,* threaded on both ends	0-19442-60815-6
	2 – ¾"threaded caps**	0-19442-14684-9
	Plumber's Goop	
* or larger if you intend on doing more than one blade at a time ** make sure that these are all the same size!		

Step 1: Apply Plumber's Goop to the threads on one end of the pipe.

Step 2: Thread one of the caps on to the end of the pipe with the goop and using the two wrenches, tighten the cap securely on to the pipe.

Step 3: Thread the other cap to the pipe and use it when storing acetone.

5.3.2.2 Copper Tube

Table 5 – Soaking Tube, Copper

Tools	Material	SKU
Plumber's solder and flux	42" copper pipe, ¾" *	6-85768-23649-8
Propane torch	1 – ¾" cap**	0-39923-30630-2
Emery cloth	1 – ¾" threaded female adapter **	0-39923-30150-5
Vise	1 – ¾" black iron end plug**	0-19442-14853-9
* or larger if you intend on doing more than one blade at a time ** make sure that these are all the same size!		

Step 1: Dry fit the cap and the threaded female adapter on to the tube to make sure they fit.

Step 2: Remove the pieces from the tube and fix the tube in the vise horizontally. Take the emery cloth and sand the end of the pipe on one end and the inside of the cap so they are somewhat shiny.

Step 3: Apply flux to the cleaned end of the pipe and fit the cap firmly over the end of the tube.

Step 4: Unroll about 4" of solder. Carefully light the torch and evenly heat the two pieces until you see the flux start to bubble from underneath the two connected parts. At this point touch the end of the solder to the joint. The solder should melt and flow up under the cap. This is called "wicking". Keeping heat on the two parts, go all the way around the tube with the solder. Be careful not to use too much (so that it leaves lumps of solder around the joint).

Step 5: Repeat for the other end with the threaded female adapter.

Use the end plug in the same way as the second threaded cap for the iron tube.

If all this seems too complicated, it is a standard plumbing technique. If you take the parts to a standard plumber, he can do it for a small fee. Don't know a standard plumber? Check the phone book; just don't call them to come to your house to do it, though. $100 for a housecall is a tad steep price to pay for such a simple tool. Or you can also check out Home Depot, HGTV, DIYNET.com, or any self-help home repair book for more detailed instructions and pictures. Or find a buddy to do it.

5.3.2.3 Traveling Copper Tube

If you find that you are having to travel with a team or to a location by air and don't have the room to carry a 40" piece of tubing, but do have a regular suitcase, this Traveling Soak Tube works wonderfully. Basically it connects in the middle and because the upper section is a greater diameter, the bottom fits inside the top to save space.

Table 6 – Traveling Soaking Tube

Tools	Material	SKU
Plumber's solder and flux	18" copper pipe, ¾" dia	6-85768-23649-8
Propane torch	18" copper pipe, ½" dia	6-85768-23650-4
Emery cloth	1 – ½" cap	0-39923-30630-2
Vise	1 – ½" to ¾" threaded reducer	0-39923-01505-1
	2 – ¾" threaded female adapter **	0-39923-30150-5
	1 – ¾" black iron end plug	0-19442-14853-9

Step 1: Take the ½" diameter tube and dry fit the cap and the threaded reducer on to the tube to make sure they fit.

Step 2: Remove the pieces from the tube and fix the tube in the vise horizontally. Take the emery cloth and sand the end of the pipe on one end and the inside of the cap so they are somewhat shiny.

Step 3: Apply flux to the cleaned end of the pipe and fit the cap firmly over the end of the tube.

Step 4: Unroll about 4" of solder. Carefully light the torch and evenly heat the two pieces until you see the flux start to bubble from underneath the two connected parts. At this point touch the end of the solder to the joint. The solder should melt and flow up under the cap. This is called "wicking". Keeping heat on the two parts, go all the way around the tube with the solder. Be careful not to use too much (so that it leaves lumps of solder around the joint).

Step 5: Repeat for the other end with the threaded reducer.

Step 6: Repeat steps 1 to 5 for the ¾" diameter tube and the two threaded female adapters.

Use the end plug in the same way as the second threaded cap for the iron tube. To travel with, the ½" diameter tube fits inside the ¾" tube. Be sure that you have a tight seal before using with acetone.

5.3.3 Blade Storage Tube

Have a bunch of extra un-mounted blades that you need to keep together and minimize corrosion? A handy device to have is a Blade Storage Tube. The design is basically the same as the Soaking Tube, only made with 2 ½" or 4" PVC pipe components.

Table 7 – Blade Storage Tube

Tools	Materials
Saw	36" – 2 ½" or 4' diameter PVC Pipe
File	2 ½" or 4" PVC End Cap
	2 ½" or 4" PVC Thread Adapter
	2 ½" or 4" PVC Threaded Plug
	PVC Cleaner
	PVC Cement

Step 1: Dry fit the end cap and the threaded adapter piece on to the pipe to make sure they fit.

Step 2: Remove the pieces from the tube and fix the pipe in a vise horizontally. Take the PVC Cleaner and using the brush included in the can, swab around the outside of the pipe on each end, and the inside of the end cap and adapter (not the threads!). Let dry (about a minute or so).

Step 3: Apply the PVC Cement to the cleaned ends of the pipe and fit the end cap and adapter over the ends of the tube. Give each piece a full rotation to make sure the cement is evenly distributed. Let dry.

Step 4: Place the blades in the tube and screw the threaded plug in place.

5.3.4 Weapon Rest

Figure 5-22 Weapon Rest

This is a fixture designed to hold your weapon horizontally while you work on it. It is a simple wood construction that takes three skills: sawing, drilling and hammering (or screwing, if you prefer)

Table 8 – Weapon Rest

Tools	Materials
Cross-cut saw	48" - 1 x 4 piece of wood to make the following: 1 – 40" x 1 x 4 * 1 – 1 ¾" x 1 x 4 *
Hammer	
2 ¾" hole saw (drill bit)	
Drill	2 – 1 ½" finishing nails (or wood screws)
Tape measure	wood glue
	Kitchen magnet (the thin kind that advertisers use.You know, the one that has the pizza place phone number on it!)
* 1 x 4 is a standard size of wood that really measures ¾" x 3 ¾" after it is milled and finished	

Step 1: On a stable surface cut the two pieces from the 48" 1 x 4. Save the extra for the next step.

Step 2: 3" from one end and 1 7/8" from one edge of the 40" length of wood, mark the location to drill the hole. Place the extra piece of wood under this spot as a backup piece and drill a 2 ¾" hole through the top piece.

Step 3: Make a notch in the second piece like the figure below.

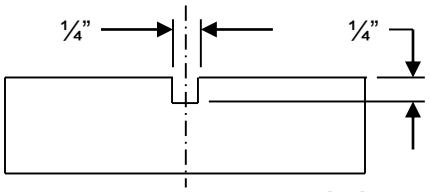


Figure 5-23 Weapon Rest – End Piece Dimensions

Step 4: Glue and nail (or screw) the smaller piece 3' from the end opposite the hole.

Step 5: Glue the magnetic strip (magnet side up) longways on the end opposite the hole.

Now you have something that you can lay or clamp to your work surface that will support the weapon while you work on the tip. The magnet prevents the small bits from getting away from you. Below is a dimensioned drawing of the base piece

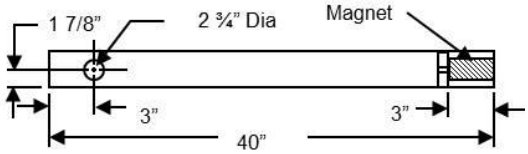


Figure 5-24 Weapon Rest – Base Piece Dimensions

If you have the luxury of being able to modify your workbench, you can make your weapon rest so that it can be held to the work surface without clamps. To do this you will need 2 hex-head bolts (I use ¼-20 UNC) long enough to go through the tool rest and the top of the workbench and 2 T-nuts (the same thread as the bolts).

Position the weapon rest where you want it and drill a hole slightly larger than your bolt about 6" from one end, through the weapon rest and the top of the workbench. Install one of the T-nuts from the bottom of the workbench. Take one bolt and bolt the weapon rest to the workbench, align the rest parallel (of if you prefer, angled however you want and is best for you) to the front of the bench and drill another hole about 6" from the other end. Install the remaining T-nut and bolt the weapon rest down.

5.3.5 Foil Tip Cleaning/Setting Tool

Figure 5-25 Using the Foil Tip Cleaning/Setting Tool

This is a small tool that will help clean the space between the plastic cup and the copper "hat" where the spring is seated. It can also be used in the cup seating process when rebuilding a tip or rewiring.

You can easily cut this with a tubing cutter into several shorter lengths to provide your club with several inexpensive cleaning tools. It cost me a whopping 73 cents, including tax! This tubing is roughly the same diameter of a foil spring and, by inserting this tool into an old foil point, one can easily polish the oxidation off of the top hat contact button by just twisting the tool against the top hat and saying some magical armoring words (to impress the mere mortal fencers that have come to you to work miracles on their finicky machinery!).

Table 9 – Foil Tip Cleaning Tool

Tools	Material	SKU
Hacksaw, or tube cutter	1/8" x 12" round brass tubing	14121 10127
Tube flaring tool		
Emery cloth (or fine toothed file)		
Old foil cup w/"hat"		

Step 1: Trim approximately ¼" off each end of the tube.

Step 2: Cut the tube into four (4) approximate 3" lengths.

The following steps are for each piece cut in Step 2.

Step 3: Carefully file or sand down the ends (the ones that were cut) so that they are flat and as perpendicular to the tube as you can.

Step 4: check it with the old foil cup and "hat" and look for proper fit. If needed, use the flare tool, or a small jeweler's screwdriver, to flare it out just a hair. Recheck. NOTE: Since some tips are a bit larger diameter than others (to accommodate differing diameters of springs) it would be good to have two ends of slightly different diameters.

5.3.6 Weapon Test Box

Single LED Version

Double LED Version

Figure 5-26 Test Boxes

This section covers a simple test box that you can make from parts readily available from an electronics supply shop like Radio Shack. The cost of parts should be about $7 - $8 and requires a fairly accurate mechanical measuring device. You can make either a box with two LEDs or one combination red-green LED.

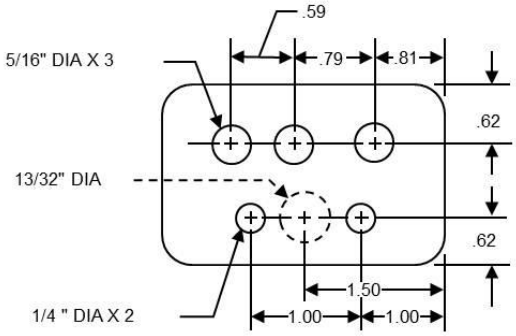


Figure 5-27 Weapon Test Box – Hole Drawing

Table 10 – Weapon Test Box

Tools	Part	Qnty	Radio Shack P/N
Two LED Tester			
Drill (or drill press)	Enclosure	1	270-1801
Drill bits: 5/16" ¼"	Banana Post	3	274-725B
Needle nosed pliers	Battery Holder	1	270-398B
Nippers	LED, Red T-1	1	
Wire strippers	LED, Green, T-1	1	
Solder gun or iron	LED Bezel	2	276-079
Solder	Resistor, 147 Ω	1	
	Batteries (AAA)	2	
One LED Tester			
	Enclosure	1	270-1801
	Banana Post	3	274-725B
	Battery Holder	1	270-398B
	LED	1	276-025A
	Resistor, 147 Ω	1	
	Batteries (AAA)	2	

Step 1: Mark and drill the location of the holes on the box lid as shown in the drawing above.

NOTE: To insure the accuracy of the location of the holes for the plugs, put a dab of white-out on the tip of each pin an epee plug and touch it to the surface of the lid while it is wet, then take a small nail and press it in the center of the mark to give the drill bit a guide as to where to start.

Another method is to take a solid (Prieur style) epee body plug and using a transfer punch (a rod with the

same diameter as the hole you are using a guide that has a small point on it), mark the holes, as shown below.

Figure 5-28 Marking Holes with an Epee Plug and Transfer Punch

Step 2: Install the banana posts in the 5/16" holes, but do not tighten. Insert a three pin plug into the posts and then tighten the nuts on the backside. Add a drop of superglue to the threads and the nut to keep them from backing off. Insure that the solder posts are lined up in the same direction, it make soldering to them easier.

Step 3: Determine the positive and negative leads of the LED; the long lead is positive and the short one negative. For the combined LED, the center lead is the positive; test the other two to find out which is the negative for the red or green LED.

About 1/8" below the bottom of the LED bend the positive lead at a right angle as shown below. Do the same for the negative lead, only oriented 90º from the positive lead.

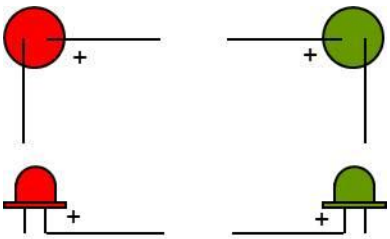


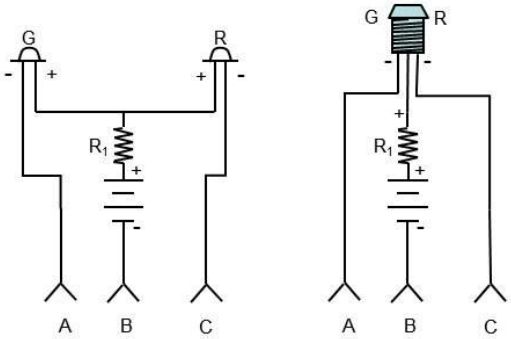
Figure 5-29 LED Lead Bending Diagram

Step 4: This step can be done one of a number of ways, but probably the easiest is to install the LED holders through the top of the lid in the ¼" holes. Now place the LEDs in the holders, but don't press them all the way in. Align the positive leads and twist them together and solder them. Trim the excess leads.

Step 5: Twist one lead of the resistor around the joint you just made and solder.

Step 6: Now seat the LEDs in the holders by pressing on the center of the bottom of the LED until it snaps into place. Solder the negative lead of the green LED to the A-line post and the negative lead of the red LED to the C-line post.

Step 7: Solder the red (positive) lead of the battery holder to the free end of the resistor (you may want to trim all but about ¼" of the resistor lead and twist the two together before soldering). And solder the black (negative) lead of the battery holder to the B-line post. The schematic is shown below.



Two LED **Single LED**

Figure 5-30 Weapon Test Box - Schematic

Step 8: Install the batteries and place the battery holder in the bottom of the box. Take a piece of paper cut to fit inside the box and place it over the battery holder.

Step 9: Fit the lid of the box onto the box so that the posts don't interfere with the battery holder (this may take some maneuvering) and secure the lid.

Step 10: Take a working epee body cord and plug it into the box. Short across the B and C-lines, the red LED should light up. Short across the A and B-lines, the green LED should light up. When you are finished, you should have something that looks like the boxes at the beginning of this section.

5.3.7 Water Bottle Lamé Resistance Tester

Lamé Tester

A quick and cheap do-it-yourself lamé tester can be made with a brass nut and bolt and a .5 liter water bottle. This comes from Ovy Waddups of the Fencing Institute of Texas, who got the idea from Bill Hall. While probably not what the FIE had in mind when it specified the 500 gram test weight, it still works and can be used at a major competition, if they have a scale to certify the weight. And adjusting the weight is as simple as it gets! Add or delete water!

Table 11 – Lamé Tester

Tools	Material	SKU
Small flat file	5/16 – 18 UNC X 2" long bolt, brass[86]	0-08236 72014-3
4mm drill bit	5/16 hex nut (brass or stainless steel)	0-08236 72030-3
5/16" drill bit	#12 Finish Washer	0-08236 70745-8
Vise	.5 Liter plastic bottle (with cap)[87]	
Hand drill or drill press	5-minute epoxy	
2 x 6" crescent wrench	at least .5 Liters of water	
Emery cloth		
Accurate gram scale with at least 500 g capacity		

Step 1: With the file, round off the end of the bolt into a hemi-spherical shape. Smooth with the emery cloth.

Step 2: Approximately ½" from the end of the bolt, file a flat on one side of the bolt. Drill a 4mm hole through the bolt at this spot.

Step 3: Drill a 5/16" hole in the center of the water bottle cap.

Step 4: Mix a small amount of the epoxy and coat the bottom side of the bolt head. Insert the bolt from the inside of the bottle cap and thread on the hex nut. Coat the area on the top of the cap where the bolt comes through with more epoxy. Run the hex nut down and tighten. Let epoxy set (approximately 5 – 10 minutes).

Step 5: Place the water bottle and the cap assembly on the scale. Fill the water bottle with water (a little less than .5 L) until all the pieces weigh 500 g. Screw the cap back on the bottle.[88]

To use the tester, you will need a 2 foot test lead with a standard banana plug on one end. Plug the banana plug into the hole in the end of the bolt, zero out the ohmmeter on the end of the bolt and hold the bottle in your hand as you run it over the lamé, making sure the bottle doesn't leak!

5.3.8 Hex Pommel Nuts

Figure 5-31 Coupling Nut

Hex pommel nuts are very easy to make. Ok, you say, but why when they are so plentiful? Sometimes you find yourself in a position where you need one, and the only way to get it is through mail order. All this takes is a trip to the friendly hardware store. And, it takes only two of the skills described in the previous chapter; drilling and tapping! This section will address how to make 6X1mm and 12 – 24 UNC pommel nuts.[89]

[86] The rules specify that the weight must be made of brass or copper, for conductivity. Brass hardware is more readily available than is copper!
[87] Or an 18-oz bottle. 500 milliliters is equal to 16.9 ounces.

[88] Or you can just fill it up with water and go with it as is. It will be a little heavier than required, but only by about 25 grams. Close enough for government work!
[89] See Chapter 4.4 for a detailed discussion of Pommel Nuts

Table 12 – Hex Pommel Nuts

Tools	Material	SKU
For M6 X 1: Drill bit 5mm (.1968" or #9) M6 X 1 Tap	3/16" Threaded Rod Coupler[90]	0-30699-19106-2
For 12-24 UNC Drill bit .173" (#17) 12 – 24 UNC Tap		
Tap handle		
Cutting oil		
Vise		
Drill (hand or press)		

Step 1: Set the coupler in the vise and drill out the threads with the size drill appropriate to the size pommel nut you are going to make. Be sure that it is set as vertically as possible.

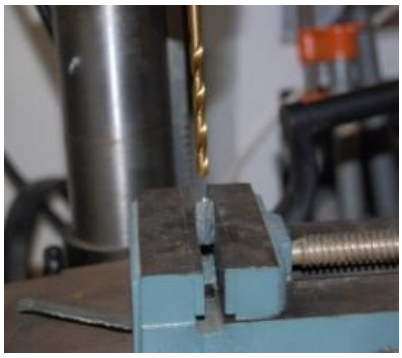


Figure 5-32 Drilling a Coupling Nut

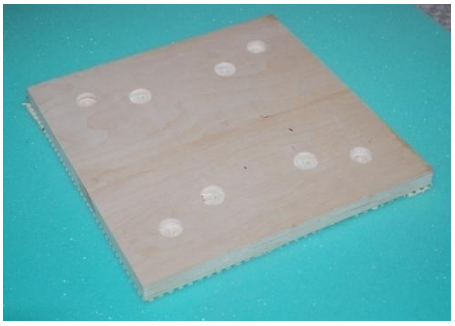
Step 2: Tap the threads for the size pommel nut you are going to make (12-24 UNC or M6 X 1).

Figure 5-33 Tapping the Coupling Nut

[90] You can use the same size coupler for both sized pommel nuts.

Figure 5-34 Coupling/Pommel Nuts modified left, unmodified right

5.3.9 Reel Skid Plate



A Reel Skid Plate used with an Uhlmann or a Leon Paul Reel

To help reduce the tendency of reels to migrate down the strip as fencers move back and forth, a device that helps increase the area of contact between the reel and the floor is a device called a 'skid plate'. And remember, you need two per strip!

Table 13 – Reel Skid Plate

Tools	Material
Table or Hand Saw	5/8 " to ¾" thick Plywood or MDF
Drill (hand or press)	Rubber anti-skid carpet material
¾" Spade Bit	Spray Adhesive

Step 1: Cut a piece of 5/8" to ¾" thick plywood, or Medium Density Fiber (MDF) board (which is heavier than plywood) cut to the dimensions of the outer dimensions of the reel

Step 2: Drill the holes to diameter and depth indicated in Figure 5-35 Dimensions for a Skid Plate for both Uhlmann and Leon Paul Reels that correspond to the feet of the reels.

Step 3: Now glue a piece of rubber material on the bottom side of the plywood using spray adhesive.

If you are using both upright and flat reels, put in two sets of holes so that you can use the boards with

either kind of reel. If need be, the board can also be taped to give added protection against slipping.

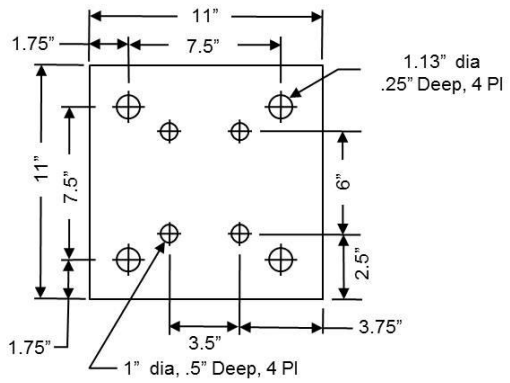


Figure 5-35 Dimensions for a Skid Plate for both Uhlmann and Leon Paul Reels

5.3.10 Portable Scoring Machine Stand

This is a stand that the Author built for the Ronin Fencing Club. It stores two Favero 5 machines, 4 Favero Reels, 4 floor cords and an extension cord. It can be modified to accommodate any machine or reel combination.

A Mobile Scoring Machine Stand

NOTE: You can modify this design to use Uhlmann reels and SG machines by eliminating parts E & F and 2 of D. If you do this, the dimension of part C is 3 1/8" wide. This will necessitate another piece of 1 x 4.

Table 14 – Mobile Scoring Stand

Tools	Material
Table or Hand Saw	1/3 sheet of ¾" Plywood or MDF
Drill (hand or press)	2 – 1 x 4 x 8'
¾" Spade Bit	1 – 2 x 4 x 8'
	2 – 2" dia locking swivel casters
	2 – 2" dia swivel casters
	8 – 1 ½" L-brackets
	8 - #6-32 CSK x ¼" l screws and 8 - #6 hex nuts
	8 - #6 x 3/8" woodscrews
	34 – 2 1/4 " Coarse thread drywall screws
	AR - 1 ½" Coarse thread drywall screws or wood screws
	1 – Power Supply

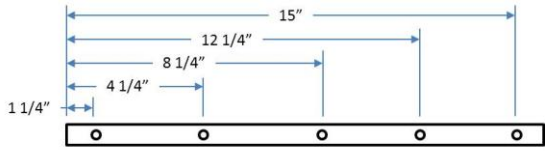
Step 1: Cut the pieces from the plywood, 2 x 4, and 1 x 4's to the dimensions in the Table below.

Part	Qnt'y	Stock	Dim
A	1	¾" Plywood	16" x 65"
B	6	1 x 4	16"
C*	6	1 x 4	2"**
D*	4	1 x 4	1 ½"
E	2	1 x 4	22" x 1 ½"
F	1	¾" Plywood	22" x 3 ½"
G	2	¾" Plywood	3½" x6¼" **
H	1	¾" Plywood	16" x 7 7/8"
I	2	2 x 4	18"
J	2	¾" Plywood	18" x 9 3/8"

* These pieces can be ripped from the same 1 x 4 piece

** These dimensions should be adjusted to 3 1/8" and 8 ½" respectively for Uhlmann reels

Step 2: Drill the pilot holes in part B pieces as shown in detail A.



Detail A

Step 3: Attach two of part B to the bottom, and on each side of part A. Mark and cut out slots for the 2 x 4's as shown in detail B.

Step 4: Attach 1 of part C to part A, starting at the top of part B attached in the previous step, with the 2 ¼" drywall screws. Ensure that you start with the 1 ¼" hole on the left.

Step 5: Measure up 13 7/8" from the top of part C you just installed, and attach 1 of part C as you did in the previous step. Repeat for the next piece. Flip part A over and repeat for the other side.

NOTE: If you are doing this for Uhlmann reels, the measurement is 10 ½".

Step 4: Attach part D to the bottom most part C with the 1 ½" Coarse thread drywall screws, aligning the ends and the bottom edge. Repeat for the other side.

Step 5: Align the center of part B with the center of part C and match the ends and secure with 1 ½" screws. Repeat for the remaining attached part C.

Step 6: Attach the remaining two part D to the top of part A. Align and center part F on top of these parts and secure. Then attach part E to either side, aligning the edge with the top of part F.

NOTE: If you are attaching SG machines to the stand, this step can be skipped and the two part D and parts E and F are not needed. If you are attaching the SG machines to the front of the stands, measure the mounting holes on the back of the machine and install two pan-head screws at the height you wish.

Step 7: Assemble the two part I's and part H by laying the part I's parallel to each other on a flat surface. Place part H on top and align the edges so that the 2 x 4's remain parallel. Secure part H to the 2 x 4's.

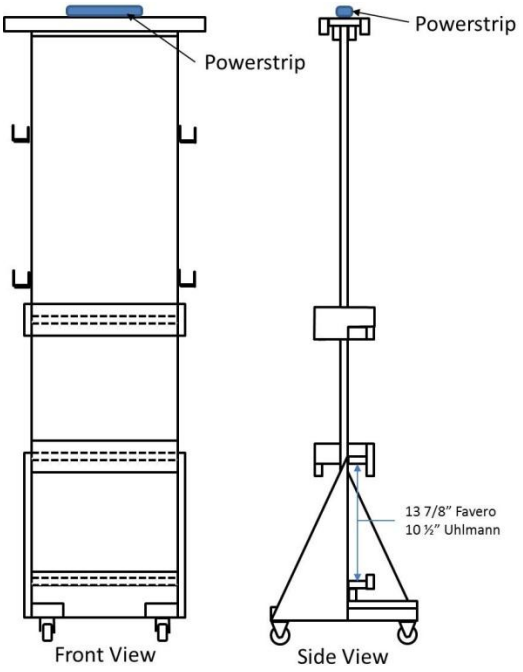
Step 8: Attach the 2 x 4 assembly from Step 7 to the bottom of part A subassembly. Attach parts J to either side, aligning the long sides to part A and ensuring that the 2 x 4 subassembly is perpendicular to part A.

Step 9: Attach parts G to the ends of the upper parts B & C so that they form a stop on the side part J is attached to. See Side View below.

Step 10: Attach the casters to the bottom of the stand.

Step 11: Assemble two of the L-brackets with the #6 screws and nuts into a U shape. Repeat until you have 4 assemblies. Attach them to the sides of the stand approximately as shown in the Front View, below.

Step 12: Attach the powerstrip to the stand using 4 wood staples and two 8" wire ties. Additionally you can drill two ¾" through part F so that the power plug ends to the machines can fit through.



CHAPTER 6 - TROUBLESHOOTING AND REPAIRS

Troubleshooting is the act of following a systematic procedure for finding a fault with a piece of equipment so that you can repair it (if you can!). This chapter is divided into two sections, the first describes the things that should be done on strip in the event of a malfunctioning piece of equipment, and the second describes how to look at the individual piece to figure out what to do after the fencing is finished.

6.1 On Strip

This section is devoted to troubleshooting the scoring system when on strip. You might call them immediate action drills for fencing malfunctions. The key thing to remember here is that time is of the essence and you want to find and eliminate the problem as quickly as possible.

If something is loose, and can be easily fixed, i.e. tightened with tools already at the strip, do so. But if something is broken, replace it immediately. After the pool, give the broken bits to the Armorers to fix. It gives them something to do after the equipment checks are finished, besides wow each other with their latest toys!

For those who are more visual in their processing, flow charts are located in Appendix D for each weapon.

It should be noted that for each of these flowcharts, it is assumed that once a piece is found to be defective, it will be replaced and the system tested out. It also assumes that if the action doesn't find the defective part, you move to the next step.

6.1.1 Foil

OK. So now you show up to the strip with your shiny new weapons and functional body cords.[91] You start fencing (for the sake of discussion, we'll start off with foil). Then something goes wrong and the Referee calls halt or you call for the halt because you think something is wrong with the equipment.

Here are the steps to take to find out what the problem(s) is/are. Yes, multiple things can go wrong at once. However, before <u>you</u> do anything to try and find out what the problem is, make sure the Referee is right there with you as you go through the troubleshooting process. This is because, if there is a question of awarding or annulling a point against you, the Referee needs do the troubleshooting. The main point here being; because you found the fault, and not the Referee, you have just invalidated any possibility of your opponent's touch being annulled. The assumption is that by touching the weapon before the Referee does, you may have done something to the weapon that caused it to malfunction after the action stopped, thus making it impossible to determine if the fault occurred before or after the halt.

OK, so we've determined something is wrong. For argument's sake, let's assume there is no question of a point being awarded or annulled, and that the problem is on your end.

Step 1: Lights or no lights?

At this point, there are two possibilities: The white light goes off for no reason, or there appeared to be a hit and nothing happened. If it is the first, go to Step 2. If it is the latter, we'll go to Step 5.

Step 2: Broken or Loose?

Since we have determined that the white light is going off for no apparent reason, there are, again, two possibilities: The white light goes off continuously (with the accompanying annoying buzzer) or The white light goes off intermittently, that is, the light goes off for no apparent reason, resets, and then goes off again sometime later, again, for no apparent reason.

If the light is going off continuously, there is a 99.99999% chance that something is broken, which means go to Step 3.

If the light is going of intermittently, then something is either loose, or corroded. In this case go to Step 4.

Step 3: Something's Broken

Broken in this case can mean either a broken part or connection. OK, another duh moment, but is like any other trouble shooting process that involves

[91] Remember, you are required to report to strip with two (2) WORKING weapons, mask cords and body cords.

electrical equipment, be it fencing or a washing machine, Step 1 always is: Is it plugged in?

Check to make sure that ALL the connections are still plugged in, starting with the body cord to weapon, and work your way back to the scoring machine. Normally, this can be done quickly from where you are standing. Sometimes you have to walk to the end of the strip (someone may have tripped over the floor cord and unplugged it from the reel!)

If everything is plugged in, then you need to start looking for the broken component of the scoring system. The easiest way is to start at the weapon and work your way back to the scoring machine.

Step 3.1: Weapon

Before you do anything, look at your blade. Is it still in one piece? A rather obvious question, but in the heat of the moment it has been overlooked.

A quick way to check to see if the weapon is the problem is to take the body cord out of the weapon socket and place the edge of the guard between the pins of the plug (assuming you are using a two prong connector), twist so that the two pins contact the guard.

Figure 6-1 Shorting the Body Cord Against the Guard, Two Prong

Figure 6-2 Shorting the Body Cord Against the Guard, Bayonet Plug

If the blinking off-target light stops blinking and remains off, then there is something wrong with the weapon. Hand your non-working weapon to the Referee, who will keep it until the end of the Bout, and replace it with one of your back up weapons. Remember, you are supposed to come to the strip with at least two working weapons. After you hook back up, test weights and test for valid touch against your opponent's lamé. Was that your last working weapon? Bummer. Perhaps you can borrow one, or if you have a sympathetic Referee, the situation might be salvageable.

Step 3.2: Check the tip

As we did when checking out our weapon before the tournament, start at the tip. Make sure you still have one. Did it fly out? Is the barrel still there? Are the screws still in? Pretty obvious stuff.

If you still have a tip, twist it to make sure the tip, or the spring inside the tip, isn't stuck. You can also place the blade on the floor (next to the strip, not on the strip) put your foot on the blade about 12" from the tip and flick the tip against the floor to see if that will dislodge the tip. This works sometimes, but not always. It also has the unintended consequence of possibly wrecking the barrel by distorting it. Mostly it makes a lot of noise and looks like you have some magical technique.

Step 3.3: Body Cord

If the white light still stays on after you check it against the guard, then the next thing to do is check the body cord. First, check for any obvious broken wires, connectors, etc. If everything seems OK, partially pull the cord out of the reel socket (but making sure they are still making a connection with

the socket). Next, take you blade or a small screwdriver or other piece of metal and short across the B and C pins of the connector. If the light persists on going off, move to the reel.

Figure 6-3 Shorting Across the B and C Lines of the Body Cord

Step 3.4: Reel and Floor Cord

Now the problem is the Referee's, since everything that is your responsibility has been checked.

To check the reel, partially unplug the floor cord from the reel, like you did when you checked the body cord, and short the B and C lines with a piece of metal, like you did with your body cord or plug your body cord. If the light goes off, then move to the scoring machine and perform the same procedure with the floor cord.

If you're the lights still goes off, then there may be a problem with the scoring machine. To double check, turn the scoring machine off; wait 15 – 20 seconds and turn it back on. If the problem still isn't fixed, call the Armorer to strip.

Step 4: Something's Loose

OK, so if during a bout you get spurious off-target lights, in other words, white lights that go off for no apparent reason, in this case you need to check for something that's loose. This can be any number of things: a loose barrel, loose grip, or a loose connection.

Step 4.1: Weapon

Start at the tip. Check to see that it moves freely. Twist it to make sure that the spring and the tip are moving smoothly. Sometimes dirt or foreign object inside the tip will interfere with the tip resetting, so twisting it can sometimes break it up to a size where it won't mess with the proper functioning of the tip.

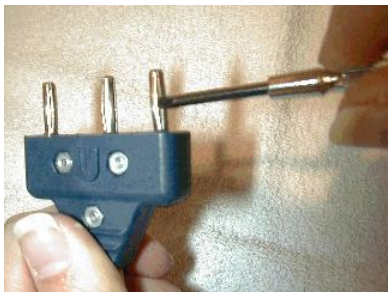
Next, check to see if the barrel is loose. If it is, and you have a wrench or visegrip handy, tighten the barrel. Sometimes, you can hand tighten it to just get yourself through the bout. If you do use your hand to tighten it, frequently check to make sure it stays tight. If the problem is persistent, sometimes the Referee will confiscate the weapon if they feel it will continue be a problem during the remainder of the bout.

Finally, check to see if your grip is tight. A loose grip will also cause intermittent breaks in the circuit, too, because it is what holds the connector in contact with the guard and the blade, and completes the circuit. Remember, the C-line is grounded to the weapon.

Step 4.2: Connections

Sometimes the body cord connection will be a bit loose in the socket and as you fence can cause a break in the circuit long enough to set off the scoring machine. To check this, wiggle the connector in the socket and see if it causes the white light to go off. If this is the case, there are a couple of things you can do. The first and quickest is to just lick the pins and stick it back in (in foil, lick them one at a time. If you lick them both, you'll get a mild shock!). This is a quick, temporary fix and may get you through the rest of the bout, but won't last you through the rest of the pool or tournament.

Another quick fix is to wrap the body cord around the grip and hold it in place with your weapon hand. If that doesn't work, either, it is a good idea to ask to replace the body cord. Finally, if you have the equipment at the strip, and the Referee lets you, take your small screwdriver and spread the small metal leaf springs out, as was discussed in the section on Connectors.



Spreading the springs on a pin

A longer term fix would be to change the angle between the two sockets by taking two small rods, one 3mm and one 4mm in diameter, insert them into

the connector sockets and spread them apart slightly. This will make a slight force fit of the plug in the connector.

Figure 6-4 Rods with 3mm and 4mm Ends

Figure 6-5 Changing the Angle of the Connector Sockets

Step 4.3: The Last Resort

This is where you must take drastic action; you smack you weapon against your foot! That's right. And you may have to do it a couple of times. Sometimes there is a break in the wire that isn't complete or is shorted out to the blade and the impact of fencing temporarily causes it to come away from the weapon and set off the off-target light. Hitting the side of your weapon against your foot can reproduce that effect and cause an off-target light, thus the problem is the weapon. QED. If not go to Step 4.4.

Step 4.4: The Reel

Sometimes there is a problem with the reel. To test it, give the reel wire a short, sharp tug and let it go back. This can indicate either a small break in the wire, or a dirty contact. If this action causes the problem, call the Armorer to strip!

Step 5: Nothing, or Not the Right Thing, Happens!

Step 5.1: Not the Right Thing Happens!

A 'Not the Right Thing Happens' situation is where you just KNOW you hit your opponent in a valid spot, mostly because he's on his knees rubbing the spot where you hit him, babbling something about really going to be bruised in the morning, and you get an off-target light.

Step 5.1.1: Crocodile clip

First thing to look for is if the alligator clip is still attached to your opponent's lamé. If it is not, then reconnect it and test. If it is connected, test your tip against the alligator clip. If it still registers off target, chances are that the A-line is broken somewhere between the alligator clip and the scoring machine. If this is the case go to Step 5.1.3

Step 5.1.2: Opponent's Lamé

If the previous test does register an on target light, then ask to test your opponent's lamé in another spot, because there is a possibility that the place you hit was dead. If you are testing for dead spots, let the Referee take your tip and test the area where you think you landed (in this case, pretty easy to find since he was rubbing it!) You want to let the Referee do it, because one, you know that sumbitch's gotta hurt so you don't want to add insult to injury! and two, because he can award a touch for you if he determines that there was a valid hit, but the equipment malfunctioned. If the questionable spot tests valid and several other points around it do too, and the Referee can't recreate the fault, then fencing continues. If he can recreate the fault, then the opponent has to replace their lamé, and as was said before, possibly award the touch for you!

Step 5.1.3: A-line

If you continue to get an off-target when you test the lamé (it's unlikely the WHOLE thing is dead!), start tracing the problem back to the box, starting with the opponent's body cord, specifically, the A-line. If you are following the steps outlined above, then you have already tested the body cord at the alligator clip, and we are assuming that the clip is still attached to the body cord.

At the reel to body cord connection, pull the body cord out far enough to keep contact with the socket, but far enough to let your tip be able to contact the prong closest to the center prong. Push the tip so that you get a light. If it is valid, then the opponent's body cord is bad. If not, then it is either the reel or the floor cord that is bad, so repeat this process for

each of the connections going back to the scoring machine.

Figure 6-6 Testing the A-Line of the Body Cord

Step 5.2: Nothing Happens!

OK, so your opponent is doubled over as was described in Step 5, but in this case, there is no light! Here again, as is the case with all electrical apparatus, we default to the universal first step: Is it plugged in? Check to see that there is still power to the scoring machine! A good indicator is that most machines have a power indicator LRL[92], is it on? No? Check the power cords to see if someone didn't accidently trip over it and unplug the machine.

Step 5.2.1: Tip

Do you still have one? Did the tip fly out and leave the collar still connected? Did it become jammed so that it doesn't depress? Another possibility is that the wire broke in such a way that it is shorting to the blade. If this is the case, then no amount of mucking with the tip will make the machine go off! If any of the above, change weapons and test.

Step 5.2.2: Call the Armorer to Strip!

For Foil, the tip issue is the most common problem. If there is power to the scoring machine and changing weapons still result in no lights, then professional help is needed. Just don't loose your competitive focus waiting for the problem to be fixed!

6.1.2 Epee

Because Epee is based on a normally open circuit, it will not give you the kind of warning, or indication that something is wrong, like Foil will.

Step 1: Lights or no lights?

In Epee, the most likely problem is going to be 'No Light', that is a hit that doesn't register, which we'll cover in Step 2. The other problem is a light that comes on when something is hit, that SHOULDN'T cause a light to come on. Remember, in the Epee mode, a scoring machine should not give an off target light. If it does, check with the Armorer.

Step 2: No lights?

Since this is the case that you are most likely to encounter, we'll start here. Unlike Foil, in Epee, it is imperative that if you suspect something is wrong, that is you are sure that you hit valid target, in time, and nothing happens, ask for a halt, and then **DON'T TOUCH ANYTHING!!!** Because you are most likely in a situation where the validity of a touch is in question, the Referee is responsible for checking out the equipment. If you present your weapon to the Referee to check AFTER you touched, or messed with something, it is impossible for the Referee to say whether or not the weapon was malfunctioning at the time of the action in question.

The Referee will check the weapon by first checking to see that the wires at your connector are still in good shape, see if you are still plugged in and finally depress the tip. If the weapon is dead, replace it. Don't spend much time messing with it. If the next one is dead, remember the first rule of electrical equipment: Is the power on?

Also, ask your opponent to test his weapon against an ungrounded surface to see if his weapon is working. If yes, then begin tracing the problem back to the box as you did in foil, starting with body cord, go to Step 3 if no, Call The Armorer!

Step 3: Tracing back to the Box

This process is basically the same as it was for foil, with one MAJOR exception: you need to test between the ***A*** and ***B*** lines, not B and C!!!

Step 3.1: Weapon

As we did with foil, start with the weapon. Take the body cord out of the weapon socket and place the edge of the guard between the A and B pins of the plug and twist so that the two pins contact the guard. If the light goes on, the problem is definitely the weapon. Replace it, test weights and shims, test

[92] LRL = Little Red Light

against your opponent's guard and prepare to resume fencing.

Step 3.2: Body cord, Reel and Floor Cord

If the light doesn't go on, the next step is to start tracing the problem back to the box. Start at the connection between the body cord and the reel. Partially pull the cord out of the reel socket (but making sure they are still making a connection with the socket). Next, take your blade or a small screwdriver or other piece of metal and short across the A and B pins of the connector (the ones closest together). If the on target light goes off, move to the connection between the reel and the floor cord. And repeat the process back to the box.

Figure 6-7 Shorting across the A & B lines of the Body Cord

Once you have completed the process, go back and test the weapon, because if one of the components between the weapon and the box failed, it doesn't mean that the weapon is necessarily bad. Could be, but not necessarily.

Step 3.3: Can't find anything wrong?

One condition that may be the problem is related to a touch to the hand/glove that didn't register. In this case, check to see if the following exists: Wet glove and uninsulated grip. If the two things are present, then what has happened, is that the opponent's hand/glove has become part of the grounded circuit, so no touches will be registered!

Step 4: Lights!

OK, so you hit your opponent's weapon or the metal strip and you get a light. Hmmmm, that's not supposed to happen. What this means is that the grounding circuit is broken. This can happen one of two ways: either there is corrosion on one of the parts of the circuit, or there is a broken C-line somewhere. First, check for corrosion.

Step 4.1: Corrosion

As we did with the checking of the weapon in Step 1, make sure this process is done by the Referee. It is basically the same process as trying to determine dead spots on lamés. Taking your tip, the Referee should try to recreate the problem between your weapon and the opponents. Look for obvious areas of corrosion on either the guard or your tip. If a spot is found, it might be able to remove it with a quick brushing of a rough material that is at hand.

Step 4.2: Tracing back to the Box

This process is much trickier and involves the cooperation of your opponent because the problem may be in either one of your ends. Look for the obvious things first: broken wires or loose grips. Failing that, Call the Armorer!

6.1.3 Saber

Electrically, Saber is much simpler to troubleshoot.

Step 1: Lights or no lights?

As in foil, there are two possibilities for lights, continuous off-target, or intermittent.

Step 2: Continuous Lights

When a saber gives off a continuous white or off target light, either the body cord has gone bad or the connector has lost the electrical connection between the two jacks. Short the body cord against the blade of the weapon (remember, the guard is insulated on the inside!) and begin tracing the B-C connection back to the scoring machine, as you did in Foil.

Step 3: Intermittent Lights

If the white light comes on intermittently, then the connector and/or handle are loose or the pins are loose in the sockets. To remedy the first, tighten the pommel nut, to remedy the second, check the section on foil above.

Step 4: No Lights

If hits to your opponent's mask do not register, the first thing to check is the mask cord. Is it still attached to the mask and/or lamé? Is it still in working order (you didn't slice one of the clips off,

did you?)? Check the integrity of the mask cord by touching it to the blade. The added complication here, is that the tab on the lamé may have gone bad.

Step 4: Follow the A-line!

If the mask cord is attached and there is no apparent problem with it, begin tracing the A-line back to the scoring machine, as you did in Foil

6.1.4 Remote

Yes, the remote. There are basically three things that can go wrong with the remote:

Dead Batteries
Damaged buttons
Not synchronized with the machine

If you come up to a scoring machine and the remote is not working, the first thing to do is look at the buttons, especially the one that starts and stops the timer. If the membrane is broken, or missing, have the Armorer replace it with a new one (if one is available).

The SG remotes have a faceplate that is easily replaced. Simply open the case, disconnect the ribbon connector, and peel off the old face plate. Thread the new connector through the slot, align and stick the new one on, and reconnect the ribbon cable.

A quick way to check to see if the batteries are dead entails a sophisticated piece of equipment that just about everyone carries today – a cell phone. Well, a cell phone with a camera, that is.

To check the remote, turn on your phone's camera. Point the end of the remote at the camera and press any of the buttons. If the batteries are working, you should be able to see the lights light up. If not, chances are the batteries are dead.

How does this work, you ask? Simple, the LEDs in the remote work off Infrared light – and cellphone cameras can see this!

If the batteries are good, then the last step is to synchronize the remote with the machine. For SG machines, simply press and hold the two red buttons on the machine at the same time. Then point the remote at the machine and press any button. The machine should beep, and the numbers displayed on the timer should change – this means the remote is now 'talking' to the machine. Test to make sure.

Another, less common problem is when a referee is near the end of the strip, the machine doesn't seem to work. And the previous problems are diagnosed as being OK. The problem, especially with older SG machines is that the detector on the machine doesn't have the right 'field of regard'. Think of this as peripheral vision. The machine can't see 'out of the corner of its eyes'. Unfortunately, the only way to fix this is to replace the sensor. Not something you can readily do during a tournament. And the only person authorized to do this for SG machines in the U.S. is Ted Li.

6.2 After the Bout, Basic Repairs

Before you get started on repairs, you want a clear workspace where you can lay the weapon out horizontally, as well as having a vise handy that you can hold the weapon over the edge of the table.

To work on the weapon horizontally the ubiquitous Duct Tape or masking tape comes in handy. No, don't tape the weapon to the table, instead put the tape roll on its side and rest the bell guard edge in the middle of it. This will keep it from rolling around while you work on it. Also, a small block of wood with a V-groove in it helps lift the point off the table and keeps it from sliding around.

Figure 6-8 Using a roll of Duct tape as a weapon rest

Or you can use the weapon rest you built from Chapter 3!

Figure 6-9 Using the Weapon Rest

When you are working on the tip, place a small magnetic strip or magnetized sewing pin catch under it and use this to hold the screws, tip and spring. There is nothing more frustrating than trying to find the small screws in carpeting, and springs are round and roll, too.

Remember the corollary to Murphy's Law: A tool or part dropped will roll to the most inaccessible spot! Either that or it will land where it can do the most damage (also known as the Law of Selective Gravity).

6.2.1 Foil

If during your testing you do not get a light (or if the light doesn't go out when you depress the tip) first try twisting the tip, sometimes the spring will pop out of the little plastic cup on the inside of the barrel.

If that doesn't fix the problem, check the connection at the body cord connection. Wiggle it. If the light does not come on, the problem will most likely lie within the wire. Remove the tip tape from around the barrel and remove the screws. Be careful you don't shoot the tip across the room!

Before you start testing the wire for continuity or resistance, you need to get the Ohmmeter ready. First, turn on your meter and set it to the lowest ohm reading (0-20 ohms, normally the RX1 setting). Take the leads and touch them together. If the reading on the scale is greater than 0, then adjust the meter to read 0, by using the adjustment device on the meter. What this does is make sure that when you are measuring the resistance in something, you are not including the resistance in the test leads, too.

Once the ohmmeter is zeroed out, place one probe down the barrel to contact the center of the bottom of the barrel (this is the end contact of the wire).

Holding it there, place the other probe on the small pin connector at the other end. If the wire is good, you should get a reading of about, or less than 1 ohm. If the circuit is open, the resistance is infinite, that is, the needle is pegged to the left. If the wire is bad you need to go to the advanced repair section and replace the wire. If you have a bayonet style connector, hold the probe on the center contact of the connector or to the outside of the body where the wire connects to the connector.

If when you place the probe in the barrel it contacts the side of the barrel, and it is still touching the small diameter connector (B-line), and there is resistance, then the wire is grounding or shorting out against the blade somewhere. Again, the wire will have to be replaced.

While you have the tip disassembled, it is a good idea to clean it out. To do that, take the brass tip cleaning tool we built in Chapter 3 and place it over the contact and twist it back and forth. Then take a small piece of fine sandpaper and roll it up so that it will fit in the barrel and lightly sand the sides of the barrel.

Another tool that is handy to have is an Otoscope (shown below). Yup, it's the thing that Doctors use to look in your ears! You can buy them online at www.drmomotoscope.com. It is great for looking into the tip to see if there are any problems with the contacts.

Figure 6-10 The Otoscope: Tip Inspector

Take a Q-tip dipped in Isopropyl Alcohol (IPA or rubbing alcohol) and rub it down inside the barrel. Be careful, IPA is 30% water, so make sure to use a dry Q-Tip, rag or paper towel to wipe after using IPA.

Repeat until there is no dirt on the Q-tip. Then take a dry Q-tip and wipe the inside of the barrel again. Look at your tip and make sure there is no dirt or corrosion on it, either.

WARNING: DO NOT USE ACETONE TO CLEAN THE TIP!

The cup inside the barrel is made of plastic and the acetone will eat it up and, well, you might as well skip to the section on replacing the wire.

If in testing you find that the spring will not hold up the weight, replace it by disassembling the tip and putting in a new one. Make sure you have the same diameter and length (there are many different ones out there!) spring as the one that you are replacing! If not, it won't seat in the cup properly and will ground or short out against the side of the barrel.

Reassemble the tip and check the weight. There are ways to adjust the spring that involve heating it to remove some of the temper (and the lifespan of the spring!) or cutting it shorter, but this is more of an art than science and not recommended to be done by mere mortals. This is in the realm of professionals, or at least the realm of the Advanced Repairs section.

If the wire is broken at the body cord connector, take a razor blade and gently cut through the spaghetti insulation about ⅜ to ½ inch down from the break and remove it from the wire. Be most careful not to cut the wire!

Strip the insulation from the wire. If you are using German, and some wires from other nationalities, too, scrape the wire with a sharp knife blade to remove any clear varnish coating and reconnect it.

One way to do this is to lay the wire along the bell guard and either gently scrape it off with a razor blade or if you are in a hurry, scrape it over the edge of your guard (assuming you have a well loved weapon and the edge of the guard is dinged up).

Another way to remove the varnish is to burn it off with a lighter. If you do this, make sure you clean the residue off the wire before reconnecting it.

Be careful when reconnecting the wire. The nut needs to be snug, not tractor tight (i.e. you need three men and a boy with a 4' cheater pipe to get it loose!)

If the barrel is loose, take the vise grips and lock it around the bottom of the barrel snugly (again, not too tight, you don't want to make the barrel egg-shaped) or use a 5mm or 5.5mm wrench, if the bottom of the barrel has flats for this purpose.

Take a small crescent wrench and close it around the thin part of the blade about 2" below the barrel. Loosen the barrel slightly (about a ¼ turn) and then tighten the barrel. Again, be careful about how much you tighten it or you'll find yourself in that nasty section about rewiring the blade.

Over tightening the barrel, can give you a barrel looking like the one on the left below, that split while being installed, or worse, like the one on the right that has completely split in half!

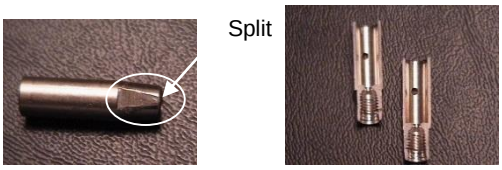


Figure 6-11 Examples of Split Barrels

Here is another example of a barrel that split while being installed.

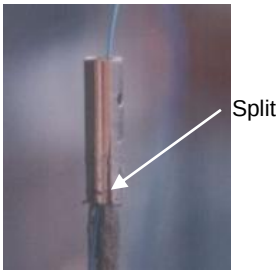


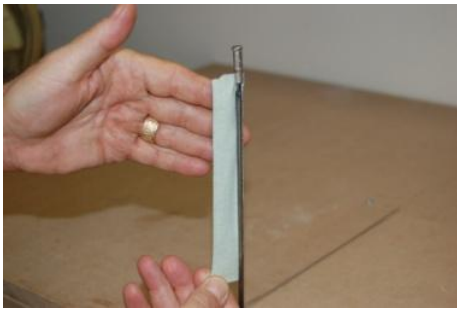
Figure 6-12 Barrel Split During Installation. Damn.

Reassemble the tip by securing the weapon in a vertical orientation (tip up, klutz). Drop in the spring and then put the tip in. Align the holes in the small copper collar of the tip with holes in the barrel. If you are using German tips, remember, there are no holes, just a groove.

Remember, the screws and springs are also different so don't mix them up! Best advice is to make sure you use only one kind of tip, German or French (or collarless). As history has shown us, they don't coexist well

Be sure that once you snug them down the tip moves freely. Sometimes screws get mixed up at the manufacturers and they are a bit long. This will cause them to bind against the central post of the tip. If you are using the collarless design, screw the screws in until they barely touch the central post and then back them off ¼ turn. Test to make sure you have a good connection. Twist or spin the tip to make sure everything is seated.

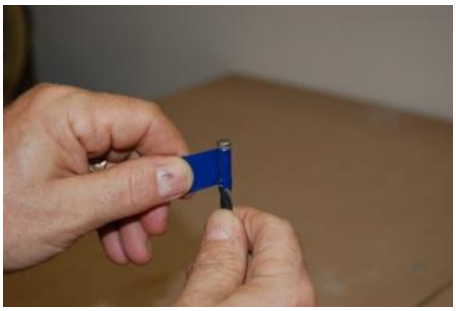
Replacing the tape is easily done in either orientation, horizontal or vertical. First cut a strip about 15 cm (6") long, or about the length of a US dollar-bill. Lay it along the wide side of the blade aligning the side of the tape and blade. The end should be about ½" from the top of the barrel and not covering the screws, this way you don't have to remove all of the tape to work on the tip.



First step to taping a Foil blade

Next, fold the tape over the edge of the blade and smooth it down. Repeat all around the blade.

Cut a piece of either the same color tape or contrasting color about 1 to ½" long and wrap it around the barrel aligning the edge of the tape with the top of the barrel. Smooth it around the barrel. Some Armorers will leave a VERY small amount of tape above the top of the barrel and smooth it down with their fingernail to make **ABSOLUTELY** sure that there is no way to have any way to contact the opponent's lamé.



Placing tape around the tip

If the wire has popped out of the groove, take the wiring chain and place one cup over the tip and the other over the end of the grip (if you are using French grips, you might consider removing the grip and placing the cup over the end of the tang.).

Shorten the chain to a point where the wire lies back in the groove (usually a really good bend of about 14", if you were to place the weapon like you were to check it for legal bends) and with the guard down, and the wire pushed back into the groove, run some super-glue into the area where the wire came out.

It is important that the glue runs away from the tip or else you end up gluing all the bits of the tip together. On the other hand, don't put so much on that it runs all the way to the guard, either. Refer to wire replacing section (again) if this happens.

You may also want to occasionally run a piece of rolled up fine sandpaper in the holes of the connector and then clean out the residue with IPA.

6.2.2 Epee

The repair techniques for epee again closely parallel those of foil. The tip, however, is a bit more complicated; although removal is the same (take out the screws and don't shoot the tip across the room!).

If, when doing the shim test previously discussed, the 1.5mm shim will not fit in between the barrel and tip, you might consider filing down the end of the barrel till it does.

This can be a bit tricky, but then again, the problem could just be a burr, or a nick on the edge of the barrel, that is preventing it from fitting, so filing is a good immediate fix. If not, then you may need to replace the tip. Or, God forbid, replace the barrel! Ah, yes! And then we are back to that nasty rewiring section, again.

If, with the 0.5mm shim between the barrel and tip, and the tip depressed, the light goes on, the contact spring (the itty-bitty one on the end of the tip) will need to be shortened.

If the light doesn't go on, the spring may need to be lengthened to get it closer to the 0.5mm distance. Or it may be just right! Check with feeler gauges, if you have them.

The contact spring can sometimes be adjusted by twisting it left or right (lengthen or shorten) depending on the make of the tip. All "standard" tips have a threaded central post that allows for this kind of adjustment.

Attach the weapon to a test box and without putting the screws back in, test it until it just barely goes off with the shim in; back off the spring about 1 turn. Test again. The light should not go on.

When cleaning the barrel, make sure the contacts on the end of the wire (there are two) are clean. To do this, take a small pencil eraser and lightly buff the ends or clean them by gently scraping them with a jeweler's screwdriver. Clean with IPA.

After reassembling the tip, make sure the TWO screws are in place. Check the movement or travel of the tip. It should be smooth. If not, check the grooves the screws travel in. Look for burrs that may be causing them to catch. Carefully remove the burrs by filing

Follow the other foil related repairs for the wire, connector and tip.

6.2.3 Saber

Aside from replacing defective parts, the repairs to a saber involve primarily ensuring the insulation at the lower portion of the guard is in good order. A quick repair technique is to wrap this area with several layers of heavy non-conducting tape. Gaffer's tape or similar insulation tape used for foil will also work. This insulated area should extend 7-8cm (3 to 3 ½ inches) from the pommel.[93]

6.2.4 Body cord

As was pointed out in previously in the section on Body Cords/Floor Cords, the two primary problems encountered with body cords/floor cords (and for clarity sake, we will just refer to body cords because there is no distinction in repairs between body cords and floor cords); broken wires and contact pins. The exceptions to that being the spring loaded retaining clip found on two prong connectors and the lamé clip.

Assuming that you have run a continuity check and determined that you have a broken connection, you are faced with a decision. Which end do you check first? Normally the body cord sees most of its stress on the weapon end.

For foil and saber body cords, this is easy to find, for epee, not so easy. That is, unless you compete at larger tournaments where they do equipment checks. At these events a piece of colored tape, or other form of marking, is placed around the wire on one end of a body cord. The fencer normally places this end into the reel socket because it makes it more visible to the Referee.

So, check the weapon end of the body cord first to see if you have a broken connection. For the foil A-line, this could be fairly obvious: The clip is missing! OK, not to panic. If you have the old clip, de-solder the screw, open the prongs holding the wire and remove the screw. Trim about 3/8" of insulation from the end of the wire; twist the strands together and wrap it clockwise around the screw. Tighten the screw and re-crimp the prongs around the wire, but not so tightly that you cut the insulation or wire. Now solder the screw and wire together. To make this easier you may want to tin the end of the wire before you assemble it to the clip.

When you solder the wire to the clip, you need patience because it will take a while for the screw and clip to heat up to a point where the solder will flow. If you have tinned the end of the wire an indicator that the screw is hot enough is when the solder of the wire begins to melt (provided you have put the heat source on the screw and not the wire!). Always make sure that there is still at least 40cm (15.75 inches) of free cable, between the end of the clip and where the wire joins the rest of the body cord.

If the wire is broken (or the connection to the clip is good, but you still have a bad line) before you go taking apart connectors the following is a technique you can use to detect which end is bad. Since we already know which line is bad, take a straight pin, like one used in sewing, and stick it through the insulation of the bad line about an inch from the connector on one end (preferably the one that you think is bad).

Now check for continuity. If it is good, then the break is on the end where you thought it was, if not, then it is on the other end!

Now take apart the connector. When you do this, take a piece of painter's, or masking tape, and put it over the back of the connector (the side with the hex nuts). This keeps them in place and makes putting the connector back together much easier.

Check to be sure that the set screws are tight. Recheck the continuity. If it is good, and that means you have less than 1 ohm resistance, reassemble the connector. If the break is obvious, trim the insulation and reconnect the pin and check for continuity, making sure that also trim back the other lines in the connector. Hmmmm, still no connection.

There are two ways to find where the strands have separated in the wire. First grab the exposed strands with a pair of pliers and pull. If they are broken just about where the wires come out of the connector, then they should just slide out and by judging their length, you can find where the break is.

[93] Rule m.24, USFA Rule Book

Or you can use the pin method described above to isolate where the break is. A third way, but more time consuming, is to cut the wire, trim the insulation and check for continuity repeatedly until you have a good connection.

If you have a wire that is broken at or beyond the connector, be sure that you shorten the wire to the other pin(s) accordingly, or you will have problems when reassembling the connector.

If you are having problems with set screws, or the small screw that holds the spring clip together, backing out, as possible solution to prevent this is to use a thread locking compound called Loctite®. This comes in several grades that are differentiated by color. For this application you want Loctite® Purple (222), which is specially formulated for low torque, small screws.

If you use this to keep your small screws in place (and yes, this can be used for tip screws, but EXTRA care is needed when you do it) the following is a recommendation on how to do it. First, drop a bit of Loctite® into a small container. Next, holding the screw with either a magnetized screwdriver or small pliers, dip the screw into the Loctite®. Now dab the end of the screw on a paper towel to remove the excess liquid. Install the screw and wipe any excess off. Be sure to check continuity afterwards.

Putting a connector back together can be, well, frustrating at best. The main problem is keeping the pins all aligned and seated in one half of the connector while trying to place the second half on top of it and screwing them together. Or, and toss in keeping the nuts in place – which is why you put tape on the back side, remember?

A very handy tool to use when you are putting it all together is – your test box! Or your weapon. Just put the pins in the correct sockets, align them so they will fit in the connector, clamp the two parts of the connector over them and screw it together. Simple.

The other tricky part of putting a connector back together is the retainer of the two pin connector. The problem here is trying to hold the little screw that holds the pin, retainer, and spring together with a screwdriver while pressing in on the pin, and aligning the screw, etc.

The simpler way to put all these parts together is to first put the screw, and tine star washer, in the hole of the retainer clip and then hold it in in place with the connector with your finger. Next take the pin and spring and insert tehm from the other side. Now, align the pin with the hole on the side of the screw – this may take some wiggling around. And now the magic – twist the pin so that it screws onto the little screw! Once you have it as tight as you can, tighten with a small screw driver.

6.2.5 Mask

Many of the basic repairs to masks were discussed in the Chapter 2, Maintenance; however, some of them need to be elaborated on.

Many of the components of the mask are held together with rivets. All of these are required to be in place in order to make the mask safe to use. One that is often overlooked is the one that secures the tongue to the top of the mask. Others are the ones that hold the metal plates over the corners of the lamé material on the sides of saber masks.

These are easily replaced by drilling out the old rivet, and installing new ones. There are two types of rivers: solid and hollow. To install the former, you need a solid bar or anvil that can fit up inside the mask which the end of the rivet that goes through the hole rests on. Take a hammer and pound the rivet until it is firmly seated. The metal is soft enough that it will deform on the back side to hold the piece in place. The hollow ones are installed in basically the same manner, only you don't need as big a hammer as the solid ones.

When removing dents from the mask, it was noted that a rubber mallet be used to do this. The ability to do this depends on the size of mallet you use. If it is a small one, you can lay the outer face of the mask on a work surface and with short strokes, beat out the dent.

But if you have a large mallet, you can take a piece of round wood (or closet rod) with a soft covering over it, like a piece of rubber and put in a vise. Place the mask over the piece of wood with the dent centered on it, and use the mallet to gently pound out the dent.

CAUTION: using a too hard a surface can remove the double crimp (or flatten the wires) and create more damage.

Once the dent is removed, make sure that the surface of the mask is smooth by running your fingers over the mask and feeling for changes in mesh. More importantly, though, check the area of repair with a mask punch to make sure the mask is still safe to use.

When practicing electric foil, over time, the lamé material can cause the inside of the bib to abrade and get holes in it. While this is not a problem that will cause the mask to be rejected at an equipment check, it can be repaired by sewing or gluing another piece of material over it. See the next section on how to do this.

Some masks have a removable inner bib that is attached with Velcro. You can make your own by sewing Velcro patches to the inside of the bib and cutting a piece of material, terry cloth is normally used in the removable bibs, to fit. It is best to finish the edges of this piece of material to prevent fraying and having bits of material floating around the inside of your mask.

Oft times, the rubber banding around the outside of the mask, or the protective covering on the back of the trellis comes loose. A lot of folks just glue it back in place with hot glue, which is OK for a temporary fix. For a more permanent one, though, you can use Plumber's glue. Just use as directed, **BUT**, do not use the mask for 24 hours! The fumes from the glue **will** affect you fencing, especially if you pass out from them.

6.2.6 Lamé

The most common problems encountered with lamés are tears and dead spots. With tears or rips, they are easily repaired by sewing the edges together. The trick here is to make sure that you have continuity across the repair. That is done by folding over an edge of the lamé material and then sewing it together. This technique is also used when covering a hole with a patch. This technique can also be used when covering a dead spot with new material.

When doing this repair, first mark out where the dead spot is. To do that, lay out the lamé flat with one lead of your ohmmeter attached to the lamé (or laid out on a piece of lamé material as was described in the section on lamés earlier). With the other lead on the dead spot, move it towards the edge of the lamé until you have continuity. Mark that spot. Go back to the spot where you started and repeat the steps in a slight different direction. Keep doing this until you have completed a 360º pattern. You should now have the area of the dead spot defined and can cut a patch to fit over it. And yes, dead spots can cover a VERY large area. If it is too large in your estimation, it may be time to purchase a new lamé. Keep the old one for material to repair the new one, when it needs it!

Figure 6-13 Determining the Extent of a Dead Spot

To make a patch, first cut a piece of material that is about ¼" larger in both directions, than the size of the area that you are trying to cover. Next, cut the corners of the patch off at 45°. Fold the edges over and sew, or glue[94], the flat square piece over the area. See the illustration, courtesy of Craig Gualt, below.

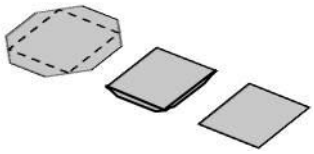


Figure 6-14 Steps to Making a Lamé Patch
(Illustration Courtesy of Craig Gualt)

If you have a fast growing child who will probably outgrow the lamé before it goes bad, and would like to sell/give it to someone else, but don't want to have the name permanently stenciled on it, a solution is to have the name stenciled on a piece of lamé material and that sewn onto the lamé much like a patch. Thus, when it comes time to move on to another sized lamé, the patch can be removed (and used on the new lamé) and the old one can live to fight another day, under a new name.

When sewing on patches, if continuity may be a problem, you can use thin beading wire instead of

[94] Super glue or conductive epoxy is used for this operation – just be sure that you have continuity between the patch and jacket/mask.

regular thread. This is available at most craft or specialty beading stores.

6.2.7 Clothing

Periodically check clothing for ripped seams, torn spots, worn out elastic and/or Velcro and zippers. This is necessary to make sure that you have safe and reliable clothing.

Repairs to clothing involve basic sewing techniques. When you make sewing repairs, it is a good idea to use a heavy thread or dental floss, as noted earlier, they will last longer. You can find most items like Velcro, elastic and zippers in the Notions section of a fabric store.

If you have a large tear in a non-FIE piece of clothing, you can cover it with a patch, but the patch has to be such that it won't catch a point so, the edges need to be as flush to the original material as possible.

If you have tear in a piece of FIE clothing, you cannot repair it with a patch and retain the FIE certification of the clothing because the material the clothing is made from carries the certification, not the design or manufacture. And, it is probably impossible to get a piece of the original material to use as a patch.

If you come across a problem with the insole of your shoes, that is you have worn a hole through it in either the heel or toe, it is fairly easy to fix.

Remove the old insole and replace it with one that easily found in the footcare section of any pharmacy or grocery store. When you remove the old insole, use it as a template to cut the new one from. When you do this, though, make sure that you replace the insoles of both shoes at the same time.

6.2.7.1 Stenciling

We talked earlier about stenciling your name on the back of your jacket/lamé. Most manufacturers will do it for you, at a price. There is also a vendor that attends most major national events who will do it there at the venue. But if you are someone who likes to do your own, or just can't stand the thought of paying someone to do something you know you can do yourself, here is how to stencil your own name (or if you are a club and want to keep track of your jackets) on to your jacket/lamé.

The hardest part of this process is getting a stencil of your name or club. One way is to go to the local reproduction store, like Kinko's, and get one made, but make sure that you have either the dimensions you want or a jacket with you to make sure you get the correct sized stencil and refer to the specifications outlined in Chapter 2.8

Another way to get a stencil is, if you have access to a computer and either MS Word® or PowerPoint® is to print out your name on a sheet of paper. To do this, use a bold font size from 315 to 395, of any of the following styles: Arial, Arial Narrow or Verdana. 315 size font is equal to 3.15" and 395 is equal to 3.95" in height for these font styles (clever, those Microsoft engineers!). In order to change to such a large font, simply highlight the font size box and type in the number of the size you want. Remember, the size of the lettering needs to be between 8 and 10 cm (3.15 t0 3.95") tall and 1 to 1.5 cm (.39 to .59") wide.[95]

Make sure that the name will fit on the jacket/lamé. You may have to play around with the font size a bit to get it right. Once you do, use spray adhesive to glue the paper to a stiff material like a manila folder and cut out the stencil with a ruler and very sharp Exacto knife. Be sure to keep the inner pieces of letters like A, P, O, Q, R, etc.

If you purchased your stencil, see if you can get it with an adhesive already applied. If not, you can use spray adhesive to attach it to the material to keep it from moving around.

Now you are ready to apply the stencil. Lay out the jacket/lamé on a flat surface. Be sure the space you are working in is well ventilated and somewhere where you don't mind getting some paint on the floor, or surface you're working on.

Dry fit the stencil onto the jacket/lamé. When you are satisfied with the placement of the stencil, mark it somehow within the area you are going to be covering. A good technique is to use a pen and mark the lower left corner of the first letter and the upper right corner of the last letter.

Remove the stencil to a place away from the jacket or lamé and turn the stencil over and LIGHTLY spray adhesive to the back of the stencil and the little inner pieces. Let dry for about 15 – 30

[95] Rule m25.3, USFA Rule Book

seconds. Now reposition the stencil on the jacket/lamé, aligning the marks. Make sure you have the inner pieces positioned, too. If the stencil has a backing, remove it. Make sure that the edges of the stencil are pressed flat on to the material.

Now, using masking tape and newspaper, mask off the area around the stencil to make sure that no over-spray will get on to the jacket/lamé. Be generous with this masking. Newspaper is cheap; jackets and lamés aren't!

For this application blue Krylon paint is a good spray-paint to use. Shake the can per the directions and holding it about 12 inches away from the material, spray lightly back and forth along the length of the stencil. Be sure to start and end beyond the ends of the stencil cut outs on either end. This will prevent an excess of paint from building up on the end letters. When stenciling a jacket, keep spaying until you get the color you want.

For lamés you do not want too much paint on it because it will interfere with the conductivity of the material. You may want to experiment a couple of times on an old lamé that still has some good spots on it to see how much paint you can apply before you affect the conductivity of the material. A good idea is to go over the area lightly with a Scotchbrite® pad when the paint is dry. Be sure to check the conductivity and resistance of this area when you are finished.

Once the paint is dry (use a hair dryer to speed the process) remove the stencil. An alternative to paint is fabric dye applied with an airbrush. The problem with dye, though, is that it will wick (spread by soaking into the adjoining fibers) around the edges of the stencil and not give as sharp an edge as paint. The recommendation is to experiment first with old material and various application methods before trying it on your new jacket/lamé.

6.2.8 Reels

Basic repairs to reels primarily involve the cable connector. This is the part of the reel that sees the most stress during use and as a result, the wires in the cable will tend to break or separate. The repair for this is the same as for the body cord. First determine which wire is bad, disassemble the connector, determine where the break is and repair it.

When repairing the socket, though, most often the wire is connected to a terminal lug, which is a small metal part that has a hole in one end that fits the outside of the jack and a small hole on the other through which the wire passes and to which it is soldered. De-solder the old wire from the terminal lug and solder the new one on. Be sure you tin the end of the new wire first.

Also, since the cable is under tension, a good way to keep the cable from being sucked up into the reel if you accidentally let it go, is to pull about two feet of cable out of the reel and tie a loose knot in it (with a large loop in it to prevent the wires from being kinked).

Figure 6-15 Knotting the Reel Cable

Once the repair is completed, check resistance and continuity. If the resistance remains high, you may have to replace the wire.

Another common repair is for when you get a high resistance value when checking the wires. For upright reels this can be an indicator of corroded brushes. To check this, lay the reel on its side, connector up. Remove the knurled nut and lift off the case.

Next remove the connector/brush assembly by lifting it straight off the spindle. Inspect the brushes and remove any corrosion by lightly sanding them with an extra fine sandpaper or emery cloth. Wipe with IPA.

Just to make sure that the high resistance was due to the brushes, check the resistance between the contact ring and the cable connector. If the high resistance persists, check the physical connections of the wire to the cable connector and/or Commutator assembly. As a last resort, disconnect the wire and check it for resistance.

If is high, use the technique as described in the body cord repair section to see if the entire wire is bad or just a section of it. If it is just a section of the wire, remove it. If you do remove a section, be sure it doesn't make the wire too short to be of use.

For a horizontal reel, first check the connections of the wire for signs of high resistance by starting at one end and checking the resistance at each connection back towards the other until you find where the resistance drops. Now check the resistance between that point and where you started until you isolate the point of high resistance. Repair or replace the components as necessary. If the problem is in the slip ring assembly, do not attempt to try and repair this piece. It can be more trouble than it is worth. Also, this part is generally very reliable, so be sure to double check everything before declaring it the source of the trouble.

Finally, the other component that will need periodic replacement is the cable grommet. To replace this part it is necessary to remove the cable connector from the cable. You may or may not have to remove the terminal lugs from the wires. Hopefully not. Remove the old cable grommet and thread the wires through the new one. Be sure that it is oriented in the same direction as the one you removed. Secure it to the casing and reassemble the cable connector.

6.3 Advanced Repairs

Ok. Here we are at the point where you tackle some of the really tough parts. And this is where more art than science comes into play, which is gained more through experience than by instruction. But you have to have a basic understanding of the methods in order to gain the experience. This is also where we depart from the previous organization of discussing specific weapons or pieces of equipment and focus on specific tasks.

6.3.1 Rewiring

Actually, this is not that difficult and the process works the same for both foil and epee. (Sabers don't have wires. That would be WAY too complicated for saberists!). This repair just seems daunting in the beginning, but with time will become much easier.

If, God forbid, you are at this point here's what to do, but first, here's a few of the things you'll need:

1. A weapon, with a broken wire (duh!)
2. Pommel nut tool (preferably one that'll work with the kind of pommel nut you have on the weapon)
3. Tools, chemicals, etc. associated with which method you choose to remove the wire with (see the following paragraphs for details)
4. Small Screwdriver, piece of hacksaw blade or dental pick
5. A new wire (or rebuilt one, see the section in this chapter on how to do this)
6. Body Cord
7. Ohmmeter or Test Box
8. Dremel Tool (w/ #409 cutoff wheel)

First disassemble the entire weapon. That includes removing the barrel and tip from the blade as well as the grip, connector, and guard. Save all these parts, especially the tip. When you take apart the point, place the pieces either in a small jar or on a piece of magnetic strip, like shown below.

Figure 6-16 Point Parts on a Magnet

If you are wiring a new blade, skip the next two paragraphs, with the exception, that you should thoroughly clean the blade with IPA, methanol or denatured alcohol (depending on what is available to you) to remove any grease or dirt that may have remained on the blade after manufacturing or shipping.

Now comes the tricky and critical part, removing the old wire and glue. Take the soaking tube you made in Chapter 3 and fill it with acetone and put the blade in it for about 30 to 60 minutes. Take the blade out and strip out the wire. Cap the tube and use the acetone for the next job.

It is recommended that you replace the acetone and clean out the soaking tube periodically or the old glue and gunk will build up in the bottom.

Take a dental pick, small screwdriver, short piece of hacksaw blade, or anything else that will fit in the groove and scrape out any old glue or bits left

behind. You have to make sure you get it all out. Re-use the acetone bath if necessary.

NOTE: When you do this, be sure you dispose of the used acetone in an environmentally safe method, usually through a certified hazardous waste handler.

NOTE: If you don't have an acetone bath or soaking tube, you can do the same thing using Brake and Carburetor Cleaner. Just spray it on and let it sit. It takes a little longer, but still works fine, but is hell on the carpet and grass, so do it in a well-ventilated garage or on the driveway.

An alternative method, that is a bit more time consuming and doesn't involve hazardous chemicals, is to use a paint stripping heat gun. This item is a fairly common item found at any paint or home improvement store.

To use this technique, put the blade in a vise and get a grip on the wire, if you can. Now heat the blade using the heat gun with a slow, direct vertical motion, pulling on the wire until it comes loose. Be careful not to overheat the blade and to let it cool before going on to the next step.

Lastly, if none of the above items are available, you can take your Dremel tool and grind the wire out. This is fairly time consuming, and will also create a large amount of dust and fumes, so wear your PPE![96]

Once the old glue is removed, and the blade is dry, use a piece of folded over fine (220 grit) sandpaper to clean the groove, as shown below. You may have to repeat this step several times. Clean out the grit and dirt with IPA (or the other cleaners previously mentioned). Once the blade is REALLY clean, you are ready to start putting it together.

Figure 6-17 Cleaning the groove

The above cleaning process can also be accomplished by using Dremel® tool with a #409 cut-off wheel. However, when doing this, be sure that you do it in a well-ventilated area because the heat of grinding will cause noxious fumes to be created by left over glue (similar to the grinding out the wire). A breathing mask or respirator is a good thing to wear while doing this. Also, be sure that you wear eye protection. Remember our section on safety when grinding.

Inspect the tip end of the blade and make sure that the inside of the groove does not have razor-sharp edges or burrs. If they do, smooth them down with either a file or sand paper before you start putting the tip and wire on to it. This will prevent you from accidentally cutting the new wire at this critical point at the tip of the blade inside the barrel.

Once the blade is clean and se-burred, take your replacement wire and unwind it, making sure that you smooth out any kinks in the wire. With the wire straightened out, pass it through the barrel with the cup end still remaining outside the barrel. You can take the insulating cup and contact cup from the old point and make your own wire, but that procedure will be covered in following section.

Take the barrel and with the wire placed in the groove, start threading it onto the blade. Do not completely thread it on yet. Stop halfway and make sure that the wire slides back and forth freely. Once that is done, complete the tightening of the barrel. Be careful not to over-tighten the barrel and cause it to split (as illustrated earlier). If you hear a light "ting" while you are tightening the barrel **STOP!** It means that the barrel will not tighten any more., and may have already split (that would produce a loud "ting"). If it does split, discard it and replace it with a new one.

If you think that the barrel might come loose at a future point will be a problem, you can use Loctite®, or Thread Lock on the threads to hold it in place. The terms 'Loctite' and 'Thread Lock' are sometimes used interchangeably. Loctite is the manufacturer's name, while Thread Lock is the product name.

Loctite® is not normally used, but if you insist, be my guest. There are several grades of this stuff. The one to use is Loctite® 242® (Blue). Use only a tiny drop on the threads of the blade and make sure it doesn't get on the inside of the groove, on the wire or up into the barrel. If you do, well, go to back step

[96] Personal Protection Equipment – goggles and respirator

one. Above all, in my humble opinion, make sure you don't use Loctite® 266® (Red), it's also known as the "It ain't comin' loose even for the Rapture" grade.

Now pull the wire through the barrel to where the cup starts to enter the barrel (you should have the blade secured in a vise, tip up, at this point).

If you insist on pushing the wire through, make sure that the amount of wire going down through the top of the barrel equals the amount of wire coming out of the bottom of the barrel! It is easy to ball the wire up in the bottom of the barrel if you don't pay attention.

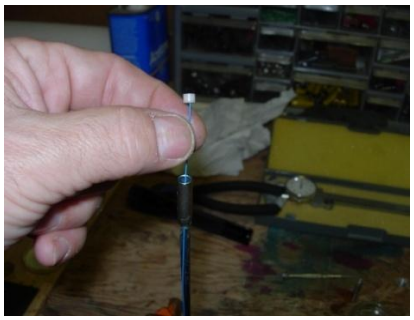


Figure 6-18 Threading the wire through the barrel

Now, take your point setting tool and with one hand on the wire pull it through while pushing with the setting tool. If you have the blade in a vise, you may want to lightly tap the cup into place with a SMALL hammer. Once it is seated we are ready for the really fun part.

Figure 6-19 Setting the cup

Place the tip of the blade against something and put a slight REVERSE bend in the blade. That is with the groove up, the blade should bend away from it (groove on the concave side of the bend). The bend should not be more that 1 –2" from the straight.

Now take the wire and hold it against the tang and start wrapping the extra portion around it TOWARD the tip. Secure it with either a piece of tape, with the end folded over into a tab for easy removal later, or a small clamp. Release the pressure on the blade and the wire should pop into the groove.

In order to glue the wire into the blade, there are several types of glue that can be used. They fall into basically the viscous (thick) and low viscousity (thin) kinds of glue. The viscous, which will generally stay where you apply it, is used in either a technique known as bottom gluing or top gluing, or even a combination of these.

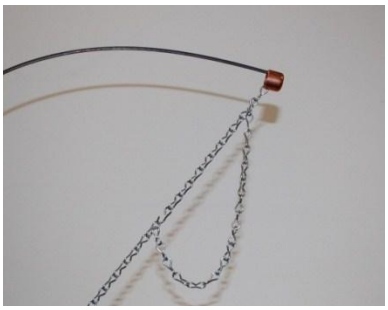
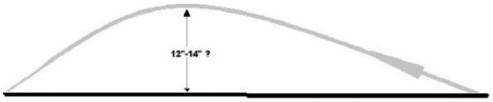


Figure 6-20 Wiring chain adjustment

Take the wiring chain and put the tip in one cup and the end of the tang in the other. Shorten the chain like we discussed earlier for fixing popped out wires (12 to 14" bend). Make sure the wire is fully seated the entire length of the blade.



Blade Bend Dimension
(Illustration courtesy of Erik Blank)

With the tang end down, start gluing AWAY from the tip for about 10 to 20 cm (4" – 8"). Let that dry for about 10 minutes.

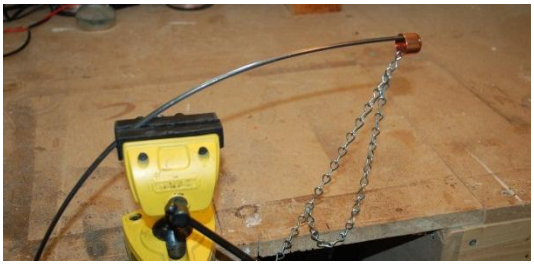


Figure 6-21 Positioning the blade for gluing away from the tip

Now turn the blade the other way with the tip lower than the tang, but still above the point where the first gluing stopped. Apply glue from the base of the blade (where it goes into the guard) to the point where you stopped gluing the first time.

Figure 6-22 Positioning the blade for gluing away toward the tip

Make ABSOLUTELY sure you don't let glue run into the tip. If you do, well, hell, you're already in this section, so you might as well start over at the beginning.

Let it hang this way for about 20 minutes (or overnight if you have the time) or until you're satisfied it's dry. If you use an accelerant, the drying time is significantly reduced.

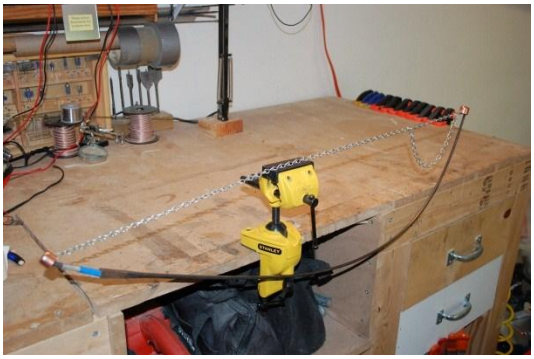


Figure 6-23 Positioning the blade for drying

Once the glue has dried, gently release the tension on the wiring chain. Don't let the blade snap loose. You could lose an eye, or woise. Make sure the wire is completely glued in and that there are no areas where it is above the groove.

This is a good time to take your ohmmeter and check for continuity of the wire. Also make sure that there is no connection between wire and the blade. If there is, there is no amount of pushing on the tip that will make the scoring machine go off!!

Now take a razor blade and gently scrape away the extra dried glue from the blade. Remember, this is non-conductive also and will cause off-targets in foil, but more annoying, will give your opponents points in epee!

Now reassemble your weapon using the techniques discussed earlier. When you are finished, make sure you check the weapon thoroughly to make sure it is working properly.

6.3.2 Rebuilt wires

If you wish to save a few dollars on wires, there is a way to resurrect old ones by building your own. Well, resurrecting may not be the proper term, but by salvaging the insulating cup and the "top hat" contact, you can make a new wire.

To do this you will need either 30 or 28 AWG wire-wrap. This is a very fine gage wire used to make board level repairs to printed circuit boards.

You can also use magnet wire for this application, but it is not recommended because the removal of the insulation is somewhat difficult and the strength of the wire is not as good as wire-wrap.

When you removed the tip from the blade, chances are that you twisted the wire off at or very near the bottom of the contact. Take a straight pin or small jeweler's screwdriver and push the contact out of the insulation cup.

Sometimes the cup will be jammed inside the barrel, or during someone else's rewiring job may have GLUED it in because they didn't follow the instructions in the previous section! If this is the case, then soaking the barrel in acetone will break up the glue, but unfortunately, it'll destroy the cup, too!

Either way, the following can be used to extract the cup. Take a drywall screw and grind the end flat. Insert it into the end of the barrel and twist to the right. The threads of the screw will engage the cup and spin it loose. As you twist, pull the cup out of the barrel.

To make the new wire, hold the contact, or "Top Hat" with a pair of hemostats (locking tweezers) and place them in a vise.

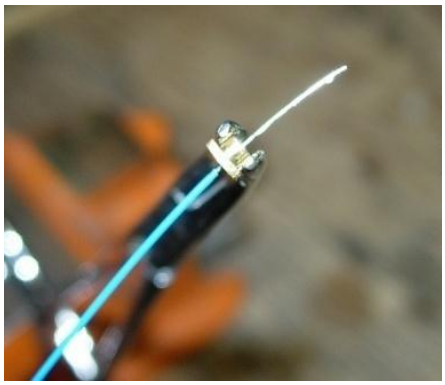


Figure 6-24 "Top Hat" held in a hemostat

Unroll about 1 meter (40") of wire and cut. Remove about 1/4" of insulation from one end. Now place the soldering iron to the contact until the solder that is holding the wire in begins to melt.

This is the tricky part. If there is enough wire exposed, pull the broken part out. If not, you have to take the new wire and push it out. Easier said than done sometimes, but it can be done. Remember to keep the heat on the contact while you are doing this.

Once the old piece of wire is out, thread the new wire into the hole making sure that the insulation of the wire comes right up to the bottom of the contact. Remove the heat source and let the contact cool (making sure that you hold the wire in position until the solder solidifies). If you have problems removing the old piece of wire, you can use a solder-sucker, found at electronic stores and hobby shops, to try and remove the excess solder and hopefully the piece of wire, too.

Thread the end of the new wire through the insulating cup. Remove the hemostats from the vise and close the jaws until they are just barely open. Put the wire between them and place the insulating cup on top of them. Pull the wire through until the contact is on top of the cup.

With a small screwdriver, or the point cleaning tool from Chapter 3, seat the contact back in the cup, making sure the wire doesn't crimp in the bottom. You can also use your tip setting tool for this.

There are some epee wires that can also be remade, however because the contacts are much smaller and sometime the wire is crimped into the contact, it is much more difficult. The trick with the soldered contacts is the removal of the broken wire. Since the top of the contact is solid, you cannot push it through, so you have to have a bit of wire sticking out of the bottom to pull on in order to remove it.

If you do not wish to rebuild wires from existing parts, or you have a bunch of insulating cups, but no contacts, or you just have to have cloth insulated wires, or you just like to build them from scratch, two vendors sell all the different parts necessary to construct foil and epee wires. You can get these parts from either Leon Paul or Allstar Fencing equipment. See Appendix B for their websites and addresses.

There are several alternative wiring techniques that are a bit unconventional, but do have their own merits.

Joe Biebel, 2003 Vet 50 World Foil Champion, has a method for wiring a foil that does not utilize the brass contact "top hat".

Remove the "top hat" from the insulating cup and using a jeweler's screwdriver, widen the hole in the bottom of the cup. Replace the cup in the barrel. When utilizing this technique it is important that the insulating cup fit snugly in the barrel.

Glue approximately 1" of wire into the top of the blade, leaving about 1/2'" of wire extending beyond the end of the blade. Let it dry completely.

Carefully install the barrel and cup, threading the wire through the insulating cup, but don't tighten it, and check the length of wire to make sure it is long enough. Carefully remove the barrel and cup. Next, strip the insulation off of the exposed wire to about 1/16" from the end of the blade and trim it to about 1/4" to 5/16" long.

Reassemble the barrel and cup onto the blade and this time tighten it down. Once they are installed, take a jeweler's screwdriver and bend the wire over inside the insulating cup. This will provide contact between the spring and the wire. Be careful, though, when installing the spring, as you have lost the aligning feature of the "top hat". Additionally, there is a slight lengthening of the distance for the spring and may make some springs too light.

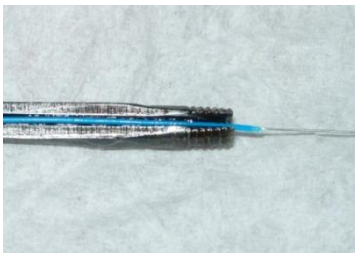


Figure 6-25 Joe Biebel method wire ready for barrel installation

One of the advantages to this method is that if the barrel comes loose, it can be tightened without fear of breaking the wire! You can also remove the barrel and reinstall it without breaking or having to remove the wire. Just be careful to straighten the wire with a pair of tweezers or needle-nosed pliers.

Another method is to make a small conical spiral with the wire, flatten it out and solder the flattened end into a solid piece. With a bit of care, you can use and install it like a regular wire. This method also loses the aligning feature of the "top hat"

6.3.3 Spring tweaking

As was alluded to in Chapter 1, adjustments to springs is something that is not normally done, however, there are those of us that are always in search of the perfect adjustment. This section will give a few techniques for making adjustments to springs, but the reader is cautioned that this, again, is more art than science and expertise will be gained more by experience than by instruction.

Before starting, it is best to understand the principle involved here. The strength of a spring is measured by how much force is required to change the length of the spring a given distance. The controlling factor in this is known as the spring constant and is a function of the size of the wire, material, and temper. It is symbolized by the letter k.

Thus, $F=k(\Delta L)$, where F is the force needed to change the length of the spring and ΔL is the change in the length in the spring. This works well when F is less than the force required to permanently deform the spring. If the spring is permanently deformed it can alter the characteristics of the spring.

That all said, then it is easy to figure out how to alter the spring to get it to where you want it. If the spring requires more weight to deflect it than you want, shorten the overall length. If you want more, lengthen it. Simple. Except that unless you know the exact spring constant, k, for the particular spring you are working with you don't know how much to add or remove. As springs are normally too heavy (require more force than necessary) most people will snip a bit of the spring off until they get the length/strength they desire, normally by trial and error.

A soft or light spring can be made "heavier" by stretching it, or apply enough force to deform it to a new overall length. This again is done by trial and error because now you add the variable of how much force is needed to permanently deform the spring. Once that is done, though, the spring is more susceptible to being permanently deformed and will lose its spring characteristics.

Removing some of the spring's temper will alter the spring constant. This is done by heating either the entire spring, or just one end, to anneal, or soften, it. This method is the most imprecise of the three and is definitely a last resort, as in the majority of cases, you end up destroying the spring.

Because of their small size most springs can be altered by the application of a flame from an ordinary disposable lighter. Place the spring over a small screwdriver (with an insulated handle) and heat the spring until it glows. Remove the heat and let it cool. You can experiment with trying to re-temper the spring by heating it to a point where the metal glows red and then quenching (rapidly cooling) it in either water or oil.

6.3.4 Adjusting Epee Contact Springs

You can also tweak the epee contact spring length by trimming it, or as was discussed earlier, screwing it onto the central post of the tip. If you trim the spring, it is a good idea to put the trimmed end up, that is, away from, the contacts. It does little good to tweak the travel of the spring when the portion that makes the contact is un-even, and one side contacts before the other.

To make a fine adjustment, you need use a set of feeler gauges. These are a series of strips of metal that vary from very thin (.005") to relatively thicker ones (.100") in incremental steps. These are very useful in determining exactly how much the contact spring must be lengthened or shortened. It should be noted, though, that VERY precise shims are expensive and will come in increments of .001". OK, so what? Well, depending on how precise you want

to be, .5mm = .0197", where .51mm = .0201", a .0004" difference! In machining terms in order to get that level of accuracy it cost 4 times as much as to get .001" accuracy.

Figure 6-26 Feeler Gauges

The thickness of most gauges used for checking weapons on strip can vary quite a bit; therefore you want to err on the high side. If you use a .020" shim you are just at the limit of the tolerance. If you use a .021" shim, you are close to .03mm above it. Pretty darn close!

But if you want to be sure EVERY time, use a .017" shim, which is .437mm.

6.3.5 Reel Springs

Mechanically reels are very reliable; however, with age and repeated use, the mechanical parts do wear out and break. The part that is most susceptible to failure is the spring. In both the upright and flat reels, repairing this part is somewhat involved and should not be undertaken without an experienced Armorer handy. If one isn't, though, hopefully this section will help you get through it with a minimum of problems.

First of all, how do you know that it is the spring that is bad? Well, one of the first indicators is that the reel doesn't seem to have the umph that it used to when it retracts the cable. Another is that you hear it break, you hear it come unwound, or it simply refuses to retract.

Springs used in reels are long strips of metal about ½" wide and about 20' long. When they are wound inside a container they tend to push to the outside wall, much like a poster when it is rolled up in a tube.

Because the natural state of the metal is straight, it keeps trying to get there, and when you take the inside end of the metal and try to force it to wind up around a central shaft, it wants to resist and return to the outer edges of the container, hence its "springiness."

Because the metal used in springs is tempered, it tends to be very tough and somewhat brittle, well brittle by metal standards, that doesn't mean that it will shatter if you drop it like a piece of glass! What it does mean is that it is not easy to bend or machine. And guess what? One end of the spring is usually bent back on itself and the other has a hole in it! Great, so if the ends are what tend to fail, how do you fix them? This is the tricky part and what will take some experimentation on your part.

In order to work the material you have two choices, work with it in an as tempered condition or anneal (soften) the metal with heat. If you choose to work with the metal in the as tempered condition, you will need some patience and proper tools. In order to form a new hole in the inner end of the spring you will need a hand punch and die set. A punch and die set is similar to a paper hole-punch, except a lot tougher. The two pieces are made of hardened steel and have sharp edges and when enough pressure is put on them, they shear a shape through the metal, in our case a hole. A hand punch set is available at a fairly reasonable price from Harbor Freight, at www.harborfreight.com, Model #44060.

SAFETY NOTE: **When you are working with spring steel, be sure to wear safety goggles in case the tool or the metal shatters.**

When forming the other end, or bending it back to form a hook, you will need patience and a bit of experimentation. Because the metal has so much, what metallurgists call stored energy, in the metal matrix, it will tend to break if you try to deform it too quickly or too much. So the key here is to bend it a little at a time and let it "rest" between bends. It can be a bit frustrating, so before you try it on one of the only two reels your club owns, you might want to get an old spring from someone (or buy a replacement one from the manufacturer and use the old one) to experiment with.

The other, less costly, method is to anneal the metal, form it and then re-temper the metal. Now, this is only a quick and dirty solution. Tempering is a science unto itself and requires fairly precise temperature controls as well as heating times and quenching media. But for our purposes, we can get pretty close and perhaps save a few dollars by extending the life of a spring a little while longer.

Because equipment, heat sources, etc. vary so much exact times and temperatures will not be given here. It is best to experiment a bit on your own to see what works with the equipment you have for best results.

To anneal the metal, a propane torch is the easiest to use. Place the end of the spring in a vise with about 6" of it exposed above the vise. Use the torch to heat the end of the metal to a red-orange glow for about 5 seconds. Let the metal air cool. Test the material to see if you can drill a hole through it. If not, repeat the heating cycle. Once you have gotten the metal to an annealed state and formed it, it is time to re-temper.

That is done by heating the part and quickly immersing it in a quenching medium. This medium can range from plain water, to oil, to salt water, to sand, or as legend has it, the bodies of Nubian slaves as supposedly was the case for very fine Damascus steel. In our case, we are not exactly sure what the composition of the metal is that we are using, so water or oil is a good enough medium to use for quenching. Old motor oil is OK to use, but be careful when quenching in oil, because it can flame up. Be sure to work outside in an area away from flammable material.

Heating and quenching the end of the spring now becomes tricky because you have to transfer the hot end of the spring to the quench medium. OK, seems easy enough, but remember, you have about twenty feet of spring stretched out around you! That's fine, just as long as you plan ahead and rehearse how you are going to shut off the propane torch, grab the metal, loosen the vise, carry the metal to the quench bath and dunk it in. If you try to do this on the fly, you may end up either setting the garage on fire or branding yourself with the hot end of the spring!

Once you have accomplished all that, you should have a usable spring again. Unfortunately, you can't be entirely sure how good a job you've done until you reassemble the reel and use it for a while.

6.3.6 Reels

We touched earlier on how to disassemble the contact side of the upright reel and clean the brushes and dust bunnies out, and to some extent how to fix the connection between the commutator and the cable. We also showed in Chapter 6 what the upright and flat reels look like in a representational exploded view. Now we are going to talk in detail about taking apart the rest of the reel.

But before we do that, let's talk a bit about the differences in design and why they are that way. Horizontal reels normally have a much greater diameter spool, the reason being that a lower profile of the reel is desired. Because of this it is possible to get sufficient force out of only one spring, although there are some designs that utilize multiple / compound springs, specifically the "pizza box" style reels.

Vertical reels, or upright reels, need to maintain a somewhat low profile, albeit, not as low as a horizontal reel, but lower nonetheless. To do this, and still have enough force to maintain the proper tension and reeling capability, it has three springs.

The three springs are set up so that they are independent of each other. That is, they are not connected directly to each other, so they act in series. As you can see in the lower right of the illustration below (using the Leon Paul reel as an example) the spring canister consists of a back plate (the red piece) that has a square hole in it. The spring hooks on to this piece, while the inside of the spring is connected to a round hub with a square boss, or extrusion, on it (the red piece in the upper right of the illustration).

The back of the first spring canister (to the far right) locks into the square boss that is attached to the spindle. Since the spindle is held tight to the case, it does not rotate, so neither does the first spring canister. The center hub of the first canister locks into the back of the second spring canister; the center hub of that one locks into the back of the third canister and the center hub of that one locks into the spool.

So, now you have the three canisters hooked to each other and anchored on one end by the case. When the cable pulls out it tightens the far left spring, which after a while, will start to tighten the second spring and then the third spring. This is known as a serial hook up or "compound spring" system.

If all three springs were hooked up to the spindle together, you'd not only be fighting all of them at the same time, but you would be limited by the amount you could pull them before you completely wound them tight around the spindle. Thus we are able to

get our 20 meters of distance from a relatively small diameter set of springs.

That is a fairly long winded explanation of how the springs work, but does it pass the “so what” test? It is given as background information so that when you start tearing into the innards of your reel, you have some understanding of what is supposed to happen when it operates. Generally if you know what is supposed to happen, it can help you find a cause when it doesn’t.

6.3.6.1 Taking Apart a Vertical (Leon Paul) Reel

Vertical, or upright reels, are fairly straightforward to disassemble. With the exception of a screwdriver and possibly a small wrench, there are no special tools that are needed to take it apart. The main thing to remember is that the cable is under a certain amount of pre-tension and that must be released before you can take the reel completely apart.

If the cable comes off the reel and there is no tension at all, then usually one of the center hubs has come detached from the spring. If there is initially some tension, but then it slips, then the hooked end of the spring has either broken or come loose.

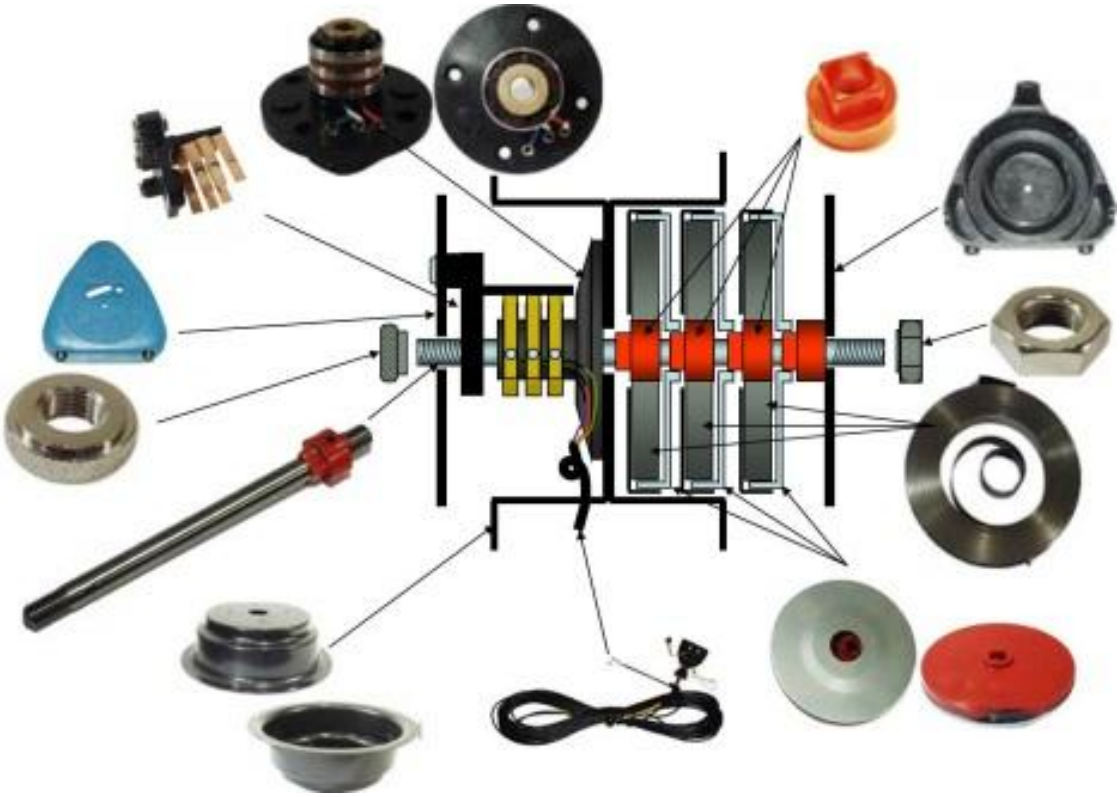


Figure 6-27 Parts of a typical Vertical Reel (Leon Paul parts shown)

So, as we talked about earlier in Chapter 3.2, the reel has a certain amount of pre-tension on the springs. When taking the reel apart to get to the springs, it is necessary to release this pre-tension. Do so slowly and carefully. The cable connector whipping around can do some serious damage.

Once the pre-tension is released, you can lift the various components off of the spindle. Remember, the spool and spring canisters just fit together and are not fastened to each other.

When you handle the spring canisters, be careful that the metal outer case is securely attached to the back plate. If it comes loose, the spring inside will, well, spring out. Sometimes the coils will just form a sort of ball, but more than likely it will just come out and try to assume that 20’ straight piece all at once.

If you are not wearing eye protection, this could be very dangerous.

We are going to assume that you managed to get the spring out of the canister without damage to yourself or those around you. So now you have this greasy 20' length of metal lying on your garage floor. Did we say greasy? Oh, yeah, it is lubricated with graphite grease that makes it slide against itself more easily. This grease is pretty hard to get out of clothing and material, so it's a good idea not to do it on your spouse's or SO's new white Berber carpet. It's also a good idea to wear some latex gloves when handling the spring, too.

OK, we've now made our fix to the spring and we are ready to re-assemble it. This is a tricky and time consuming endeavor. Start with the back plate lying flat on the work surface. You may want to drill a hole in a piece of wood that is big enough for the boss on the back side of the plate to fit in so it does lie flat. With the receptacle for the hook on the left, hook the spring onto the back plate with the opening of the hook to the left and the spring running towards you.

Now start turning the back plate counter-clockwise feeding the spring into the plate. You should be coiling the spring from the outside in. As you are doing this, you want to maintain a downward pressure on the coiled spring to prevent it from coming unsprung like we discussed earlier. When you are finished re-coiling the spring, reinstall the cover plate. Carefully.

Now, reassemble the reel in the reverse order you took it apart.

The flat reels are a bit more complicated but only in the area of how the electricity is transferred from the cable to the connector. In the case of the popular Uhlmann reel, it is done through a rotary slip-ring called by the manufacturer's name, a Mercotac. While this particular rotary switch is readily available from the manufacturer, it is rare that it should ever fail. Therefore when troubleshooting a short circuit or electrical problem you should concentrate on the wire connections and the wire itself first.

Another unique feature of this reel is the fact that the ground, or C-line, goes through the mechanical system of the reel! That is, the C-line is connected to the metal spool and the connection from that to the spindle and bearing is then transmitted to the grounded C-line connector, then to the C-line of the floor cord. If there is a problem here, check the electrical connections of the cable connector, the connection to the spool and then check for dirt or corrosion.

6.3.6.2 Taking apart an Uhlmann reel

To take this reel apart you need the following tools:

Screwdriver
10mm open end wrench

Turn the reel upside down and with a large bladed screwdriver, remove the four (4) raised, round screws. Once the cover is off the reel, turn it upside down and use it as a place to put your different screws as you disassemble the reel, as shown below.

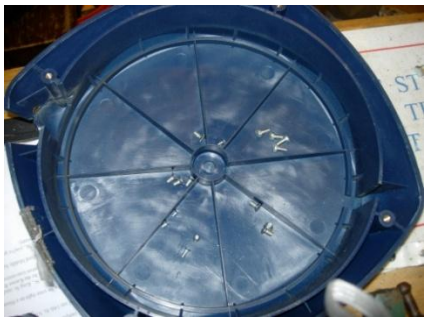


Figure 6-28 Using the cover as a place to keep the screws

Once the cover is off, there is, as you look down on the reel, a metal arm that is attached to the base plate of the reel by two flathead screws and to the center of the spool by a plastic connector. To remove this arm, it is necessary to remove one of the rubber feet. This is done with a 10mm open-end wrench. Once it is removed, you can access both of the flat head screws.

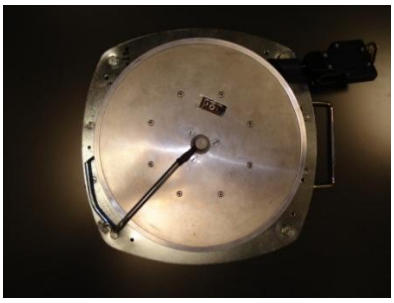


Figure 6-29 Arm location

By pulling straight up on the plastic connector in the center of the spool, you can disconnect the two

wires that run from the connector on the bottom of the reel to the rotary switch that is a part of the spindle. Unless you remove the connector assembly/block from the bottom of the baseplate, this arm will remain attached, but can be moved out of the way.

In order to remove the tension on the spool, you must remove the two screws that hold the plastic grommet or wire guide to the baseplate. Be sure that you hold on to the end of the cable while you are removing the last screw, and then let it unwind counter-clockwise.

Now the spool can be removed from the spindle assembly, which is done by removing the three flathead screws at the top of the spool.

NOTE: The spool will not be able to be fully detached from the reel because it is wired to the spindle assembly as shown below.

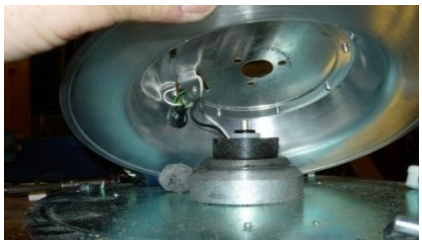


Figure 6-30 Underside of the spool

Also note the large dust ball that was formed on the inside of the spool!

The ground, or C-line, of the cable is connected to the body of the spool, while the A and B-lines are connected to a small terminal strip. The two lines from the rotary switch (the black and white wires shown above) connect to the corresponding lines at the terminal and then up through the switch to the plastic connector, that was removed in the beginning, to the connector on the baseplate (shown in the lower left of the picture above).

At this point, unless the connection at the terminal strip is de-soldered, you cannot remove the spool. In order to complete the disassembly of the reel, it is necessary to turn it over again and remove the spring and its associated parts.

CAUTION: When removing the spring be sure to maintain a hold of the spring and to wear eye protection.

With the reel turned over, take a small bladed screwdriver and remove the four screws that hold the plastic spring housing to the baseplate. NOTE: there is one screw that is longer than the others and it is offset about 1” (2.5cm) from one of the other three, which are spaced evenly around the housing. It is important that you remember where this screw goes during re-assembly.

Once the screws are removed, carefully lift up the cover, sliding your hands under it to support the spring. The center of the spring is attached to the spindle by a bent end that is held in a slot on the end of the spindle. This attachment is shown in the picture below.

Figure 6-31 Spindle to spring connection

In order to remove the spring from the spindle, take a large bladed screwdriver and work it under the point where the spring goes into the spindle and pry upwards. When that is removed, there is a plastic sheet that goes between the spring and the baseplate. Take this sheet, or plate, and place it over the spring and spring cover. Use two spring clips as shown below to hold the sheet, or plate in place to prevent the spring from escaping”.

Figure 6-32 Using clips to keep the spring from coming undone

With the spring assembly removed, you can now remove the three flathead screws that hold the spindle assembly to the baseplate.

Removing the rotary, or MERCOTAC, switch from the spindle assembly is a fairly delicate task and should not be done unless it is absolutely necessary. To do this, grab the upper end of the switch with a pair of pliers and gently, but steadily pull it up and out of the spindle assembly. The two wires that carry the A and B-line signals are attached to the lower end of this switch.

A replacement switch can be obtained from either Uhlmann or the manufacturer, MERCOTAC at http://www.mercotac.com and the model number is 205. BUT, this part rarely goes bad, so be sure that you check all connections and the cable before deciding to replace it. Below is what the two pieces look like.

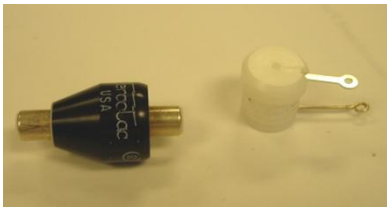


Figure 6-33 MERCOTAC Rotary Switch

Further disassembly of the reel will involve the removal of the spindle and the bearing, which quite frankly, involve much more effort than it is worth, and should probably be done at the factory. But if you insist on doing it, it will require a press of some kind to accomplish.

Re-assembly of the reel is done in the reverse of the foregoing discussion; however, two things should be noted. First, when re-assembling the spring to the baseplate, remember that the long screw goes through the metal retaining piece attached to the spring housing, and that it is oriented in a specific location. This is illustrated in the picture below.

The other thing to remember is that when you re-assemble the spindle assembly to the spool, there is a slot that the two wires from the rotary switch must pass through. This is shown in the second picture below.

Figure 6-34 Metal Retaining spring and long screw location

Figure 6-35 A and B wire connection to the rotary switch

For this reel, it is necessary to put 8 turns of pre-tension on the spring before final assembly. This can be done by either turning the spool (once the springs are installed) or you can turn the spring and then install the retaining screws.

The newer Favero reel is a bit more complicated than the Uhlmann reel and utilizes three springs and a unique braking system. For a more detailed discussion on the disassembly of this particular reel, it is suggested that you visit the Favero website and download the maintenance manual.

Also, Leon Paul has a very good description of their reel on their website. Please refer to Appendix B for the URL's for these two vendors.

6.3.7 Copper Strips

Because copper strips are so precious, repairs to them must be made immediately or as near to immediately as possible. Sometimes this may be in the middle of a competition! A measure of how precious they are is the fact that it is a penalty for dragging your tip or straightening your weapon on a strip!!![97] If competitors see holes or tears in a strip, once the fencing has stopped, they should inform the Referee, who will determine if a Strip Technician should be called to repair it.

[97] USFA Rule Book and Penalty Chart

If you are the lucky one to go do this you will need the following tools and materials:

Soldering iron (heavy duty)
Solder Flux
Rubber Mallet
Solder (solid, not resin or acid core)[98]
Metal tape
Folding wooden "floor protector"
(or a piece of 6' x 6" x 3/8" plywood)
Emery cloth
Sharp knife
25' extension cord
Extra strip material and metal shears

When you arrive at the strip, first find where the repair is. Now plug in your extension cord and soldering iron. Be sure that you place the soldering iron in a safe place and in its holder. While you are waiting for it to heat up, slit the tape on the side of the strip across from the repair site. Slide your wooden floor protector under the strip (and between the strip and any under-layment, like carpet or newsprint). Next try to arrange the pieces of the tear or hole as close as possible and lightly sand around the area to be soldered.

Apply flux to the area and heat the copper strip with the soldering iron. Touch the solder to the strip, not the soldering iron, when it is hot enough to melt the solder. Make sure that the solder flows around and through the mesh. If the hole or tear is longer than about a half inch, it may be necessary to do this repeated around the hole or tear. Remember, you are sitting on a HUGE heatsink, so this may take a while.

Figure 6-36 Repairing a Copper Strip

If the hole or tear is large, and will take a long time to repair, consult with the referee and/or the Bout Committee to see if the pool or bout can be moved to another strip.

[98] Plumber's solder

To make a repair to a large tear or hole, you can cut a patch from your extra material and solder it in, or you can take your metal tape, cover the area and pound the tape in with the rubber mallet. Then apply solder around the patched area. This is a very temporary repair and time should be taken to either solder around the edges of the tear, or cut a patch and solder it over the hole.

When you are finished, make sure you re-tape the area you cut, after retrieving your floor protector! And clean up the area so that fencing may continue.

6.3.8 Rethreading the Blade Tip

There is the rare occasion where the threads of the tip may either need to be repaired or re-cut. If you find yourself in this situation, the technique described for threading earlier in the book needs to be modified, only slightly.

Things you'll need:

Blade with a broken tip
Large safety pin or .025" thick wire or metal shim
Soldering gun
Solder
Die handle
Threading die (4mm or 3.5mm, depending on what kind of blade)
Small hand file

As was discussed previously, the end of the blade needs to be prepared. To do this, grind an area around the end of the tip about 1/8" down from the end of the blade. Be sure to not grind too much or the threads won't be deep enough to be effective.

Since there is a groove running through the threads, a regular die will get hung up on the edge of the cut. In order to be able to make the cut, a piece of metal needs to be inserted in the groove. This can be a pin that is soldered into the wire groove, as shown below, or similar piece of wire or metal shim. The size of the wire groove is about .025" x .025".

Figure 6-37 Broken blade tip prepared for rethreading

Once the shim is in place, secure the blade in a vise, tip up, and based on which blade you are rethreading, start cutting the threads.

As the author found out, with much frustration and soldierly vocalization, and much to the amusement of his classmates and Mr. Dechaine, maraging blades are **VERY** hard, and require a bit more effort to get the threads started.

Once you do get the threads started, just follow the technique described earlier to cut the threads. When finished, remove the pin or shim by heating up the end of the blade enough to melt the solder.

Figure 6-38 Rethreading a Blade Tip

Clean up the groove and remove any sharp edges.

6.3.9 Removing Damaged Grub Screws

As we alluded to previously, damaged grub screws are difficult, at best, to remove. But not impossible! In most cases, the amount of work to successfully remove damaged screws, primarily from foil points, is more work than one would normally want to invest (especially when new points are relatively inexpensive). But as we have already established, one of the main reasons that you have purchased this book is that you are basically 'frugal' and want to know the best and cheapest way to maintain and make last your equipment without a lot of cash outlay.

French screws when damaged are most likely to have the slot deformed in such a way that you can't get a screwdriver to engage the screw. In this case the first thing to try is to take a single edge razorblade and try to scribe a new slot in the screw. The metal is soft enough that sometimes this will work.

Another technique is to use small screw extractors. A set is available from several outlets, the Moody 58-0670. These work well with screws that are not too stuck.

If, however, you can't get a screw out using the first technique, then you have to resort to more drastic measures. This normally means that you need to try and drill out the screw. If this is the route you are going to take, then you need the following:

A drill press
A drill vise
Small Jewelers file
The following drill bits:
- #55
- #56
- #57

A Jeweler's Screwdriver
A dental pick

Step 1: Position the point in the drill vise horizontally.

Step 2: Take a small flat file and file the head of the screw as flat as you can.

Step 3: Use the #57 drill bit, installed as shown below, to drill out the screw. Use the Jeweler's screwdriver to try and back out the screw. If you can't, go to the next step.

Step 4: Use the #56 drill to expand the hole. Try the Jeweler's screwdriver again. No luck? Go to the next step.

Step 5: Use the #55 drill to expand the hole even more. At this point you have removed the majority of the screw, so use the dental pick to remove the remaining portions of the thread.

Step 6: Repeat for the other screw, if necessary.

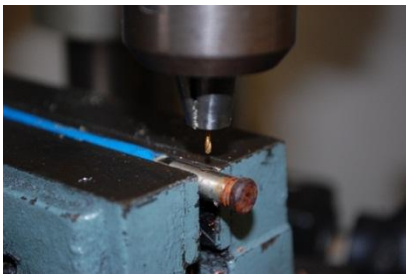


Figure 6-39 Drilling Out Damaged Grub Screws

CHAPTER 7 - TRAINING DEVICES

This chapter will cover some ideas for various kinds of training devices that, while not specifically in the realm of the Armorer, are items that you can offer to build or will be asked to maintain. I will draw the line, however, at an expansion of the Armorer's duties to include building maintenance, car repairs, and any other sort of help that may be asked of someone that is so adept at repairing most anything.

Most training devices are objects that involve things that are hit with weapons. That by its nature means that the materials used to make these devices needs to be fairly robust and the construction pretty rugged.

7.1 Target Pads

The first of the devices that you will most likely encounter are Target Pads. Theses are generally pieces of material over a padding which the student practices lunging at. It may have a series of circles, hearts or other patterns for the student to try and hit accurately, repeatedly. There are several commercially available pads, to include an electronic one that will record on target, and off target hits, as well as your reaction time. There are two versions, one with a single target and another with four and several training modes. The cost of these however is fairly steep.

Figure 7-1 Electronic Target Device

There are also devices known as "buzz boxes" that are electronic devices that plug into a fencer's body cord and can indicate when the tip is depressed sufficiently to indicate a touch. Some can also be programmed with appropriate timings to simulate the current FIE requirements.

These are worn either on the wrist or attached to the fencer's back and have buzzers to indicate a touch. A problem that may occur with these devices is when both fencers have devices that have the same buzzer. "Hey that was my touch" "No it wasn't, that was my buzzer, not yours" "Oh, yeah? Prove it!" etc. Possible, but not likely as it is fairly obvious who would have scored the touch, except in the case of a double touch in epee.

Figure 7-2 'Touch Box' – Worn by Fencer

Other target pads have included old chair bottoms, cushions and leather covered foam. An easy, durable pad that you can make yourself is made from some indoor/outdoor carpeting, low grade carpet pad and duct tape. It can be mounted to a piece of plywood and mounted to the wall, or permanently affixed to the wall. The materials are readily available at most home improvement stores.

To make a pad, determine the shape and size of the pad you want. 12" x 18' is a fairly good sized target that can be set up length wise so fencers of various heights can use it. When you have determined the size (and quantity), plan on three times as much padding as carpet. Cut the pieces to the size and shape you want. Use a spray adhesive to glue the pieces together. You can also use the adhesive to glue the pad to the plywood backing. Use the duct tape to go around the edges of the pad to finish it off.

Figure 7-3 Target Pad Layers (Carpet Padding)

Example of a large Target Pad

Examples of how the pad is layered and the finished pad are shown above.

If the thought of duct tape as a major decorating item in your salle is too distressing, you can make the outer covering, or carpet, larger by approximately 5 – 6" on all sides and fold it over and staple it to the wooden back piece, like you would upholster a chair seat.

Figure 7-4 Completed Target Pad, with targets

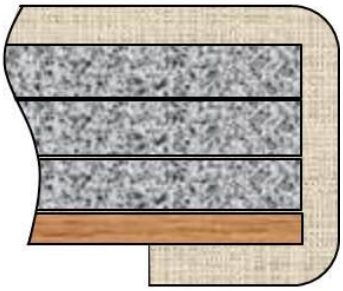


Figure 7-5 Cross section of overlapping the cover of the pad

7.2 Fencing Dummies

Another piece of training equipment commonly found in training situations is the fencing or target dummy. No, this is not the coach. This is a mechanical representation of an opponent's arm with a spring mounted weapon attached. The student can practice a variety of moves against it and get a somewhat realistic response (beat the blade and it beats back, etc).

The dummy pictured below is one the author built from plans provided in Dr. Rudy Volkman's "Big Book of Fencing".

Figure 7-6 Dr. Volkman's Fencing Dummy

The Author has designed a dummy that has several features that give it much more versatility. It can be set up for either right or left handed fencers, can be adjusted for different heights, and a leg made of two pieces of wood, joined in the middle as a "knee" and an old shoe attached to the bottom. The arm and leg can be covered with foam and an old coach's leg protector or heavy cloth so that both leg and toe touches can be practiced by epeeists.

Figure 7-7 Author's Practice Dummy[99]

[99] Detailed plans for this dummy are available from the Author at his website; the part referenced in Fig 7-8 is also available.

An alternative to the wrist design of Dr. Volkman's, which requires some welding to accomplish, is a design which the author has developed that uses common plumbing items to build a wrist that is not only capable of being made with the skills described at the beginning of this book, but interchangeable so any weapon can be easily, and quickly, attached to the arm.

The parts required for this design are common galvanized plumbing items found at any hardware or home improvement store:

Table 15 – Wrist Parts

Qnty	Part	SKU
1	3/8" T-connection, galvanized	0-19442-14918-5
3	3/8" Plugs, galvanized	0-19442-14854-6
1	¼-20 UNC x 1" Socket head cap screw	
1	¼" Flat Washer	
1	¼" Lock Washer	

Tools:

Small Square File (< ¼" sq)
#7 Drill Bit
3/16" Drill Bit
¼" Drill Bit
1/4 – 20 UNC Tap & Tap Handle

Illustrated below are how the pieces go together, along with the mechanical drawing.

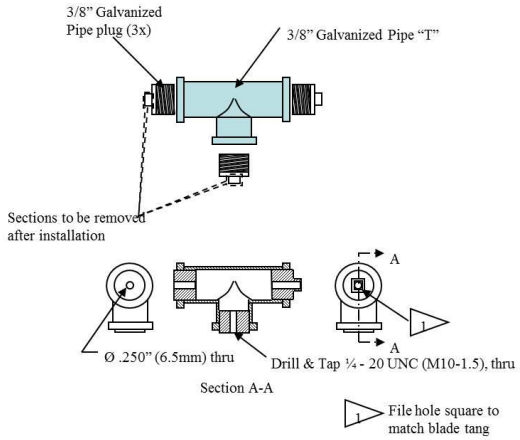


Figure 7-8 Modified Wrist Dimensioned Drawing

To assemble, first install the two plugs on either end. Be sure to snug them down very tight. Remove the square section from one of the plugs by cutting it off with a hacksaw and file flat. Using a center punch, mark a spot in the center of the face of the plug you just removed and drill a hole through BOTH plugs (drilling through one and then the other).

With a small square file, file the hole in the plug with the square end still on it, square to match the tang of the blade you are going to install on it[100].

Now install the remaining plug and remove the square section as you did before. Drill and tap a ¼ - 20 UNC thread through this piece. Install your guard and blade on to the assembly, using a standard pommel nut. Use the ¼-20 Socket Head screw, ¼" flat washer and ¼" lock washer to attach the modified wrist to the dummy as illustrated below.

A ¼-20 Wingnut, as shown in Figure 7-10 is alternative way of connecting the wrist to the plate.

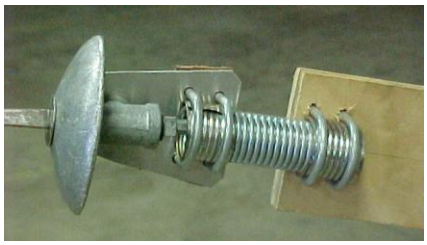


Figure 7-9 Modified wrist joint mounted on Dr. Volkman designed arm.

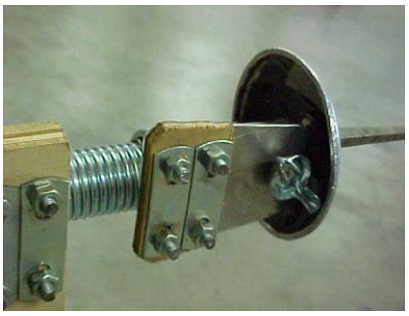


Figure 7-10 Modified Wrist Joint Showing The Alternate Wingnut attachment

This technique can also be used for an epee and saber, thus making your target dummy very versatile. To make a saber attachment, a length of ¼" PVC or copper pipe can be used to fit between the t-connection and the pommel nut.

[100] The blade you are going to use should be a pistol grip length.

Figure 7-11 Attaching a saber to the Modified Wrist

Another variation of the arm involves very little manufacturing, except for some sawing and filing. It is a design that comes from Walter Flaschka in Mississippi and uses the following materials:

Materials

Qnty	Part	SKU/Part Num ber
3	3/8" x 8" turnbuckles, with eye-bolt ends	McMaster Carr P/N 30125T601
2	½-13 X 2" long hex head bolts	McMaster Carr P/N 91236A720
2	½-13 Hex Nuts	McMaster Carr P/N 90473A223
1	6" spring, loop ends	UPC 0-49793-09629-6
4	Belleville washers	McMaster-Carr P/N 93501A033
4	½" Flat washers	McMaster Carr P/N 90108A033
3	3/8 fender washers	0-30699-20126-6
6	3/8-16 Hex nuts, right-hand thread	McMaster Carr P/N
3	3/8-16 Hex nuts, left-hand thread	McMaster-Carr P/N 93425A214
2	½" dia X .875" long Copper tube	6-85768-23650-4
1	5" piece of 3/8-16 all-thread rod	0-30699-17340-2
1	3/8" T-connection, galvanized	0-19442-14918-5
3	3/8" Plugs, galvanized	0-19442-14854-6
1	¼-20 UNC x 1" Socket head cap screw	
1	¼" Flat Washer	
2	¼" Lock Washer	
1	U-Bolts, 1.25" opening	McMaster-Carr P/N 3043T93
1	2" x 6" x .125 thk Aluminum flat stock	
1	Aluminum Can (Soda or Beer)	
1	Pistol grip blade	
1	Outside Hex Pommel Nut	
1	Guard	

Tools

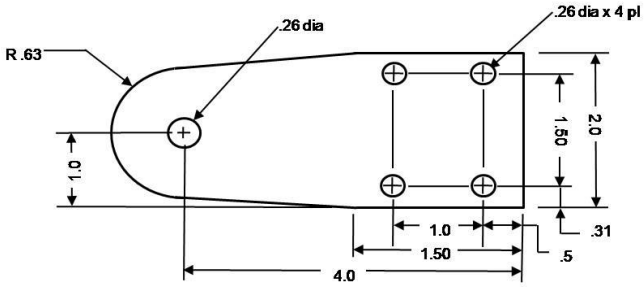
Hacksaw
Jig saw, with metal cutting blade
Open End Wrenches – 9/16", 3/8". ¾"
Dremel tool with cutoff wheel
10" Crescent Wrench
Flat File
9/32" Drill Bit
Tube Cutter
Tin Snips (or heavy scissors)
4" or larger bench vise
Large Screwdriver

7.2.1 Part Details

There are only four parts to make/modify for this assembly: the Wrist Plate, two Fender Washers, the Wrist Adapter and the Spring. The Wrist Adapter (which was described previously) and Wrist Plate can both be purchased separately from the 'The Armorer's Store'[101].

7.2.1.1 Wrist Plate

Lay out this part on the piece of 2" x 6" x .125 thick aluminum flat stock, and cut out with the jig saw and metal cutting blade. File the edges smooth.



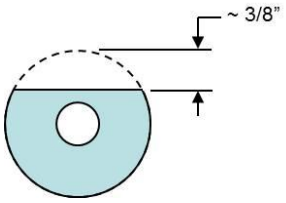
Wrist Plate Details (Dimensions are in INCHES)

This part can also be made from ¼" thick plywood, but it is recommended that it be made of the .125" thick aluminum. It can also be made of thinner aluminum stock, but if it is, a piece of 1.5 x 2 x ¼" thick plywood, with matching mounting holes, should be used when assembling the hand and wrist. See below for an example.

7.2.1.2 Washer

Take two of the fender washers and modify it as shown below. You can do this with a Dremel cut-off wheel or hacksaw.

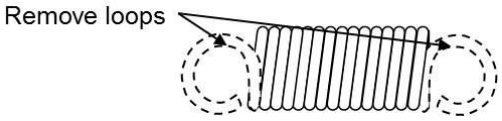
[101] Order Part Number T-012 here



Modified Washer

7.2.1.3 Spring

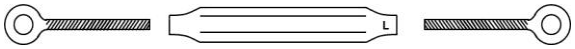
Cut the two end loops off (dashed sections below) of the spring. .



Spring Modifications

7.2.2 Assembly

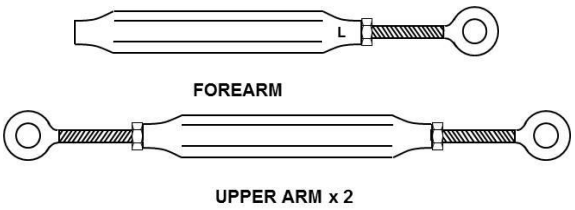
Step 1. Remove the eye-bolt ends from each of the turnbuckles; screw a hex nut onto the threaded portion of the eye-bolt to within about ½" of the end (making sure you use the correct thread, three of the eye-bolts are left-hand threads; these ends are marked with an "L"); and re-assemble two of the turnbuckles completely.



Turnbuckle disassembled

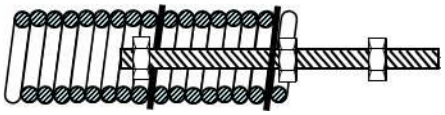
Adjust two of the turnbuckles so that they are EXACLTLY the same length (about 9 1/2" to 10") and the eye ends are aligned parallel to the body of the turnbuckle. Tighten the nuts on the eye-bolts down against the body of the turnbuckle. These are known as Jam Nuts and keep the eye-bolts from twisting.

For the third turnbuckle just assemble the left-hand threaded eye-bolt on to the turnbuckle body, aligning it like you did for the other two, and tighten it down with the jam nut. You should have parts that look like the ones below.



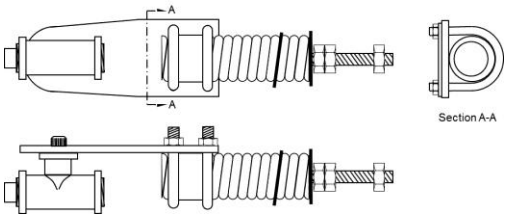
Arm Parts

Step 2. Assemble the spring and 'wrist' as illustrated below. First, insert one of the modified washers between the first coil of the spring, and the other between the coils about 2 ½" from the end where the first washer was installed. Thread a nut onto the threaded rod until about a 1/8" of thread shows above the nut. Drop the threaded rod into the spring so the rod goes through the holes in the washers. Install a hex nut and tighten. Next, install a hex nut over the end of the rod. This is the jam nut for when you attach the 'wrist' to the forearm.



Cross-section of the assembled wrist

Step 3. Cut a 1.5" x 2" piece of from the aluminum can (consume the contents first!). Wrap the aluminum around the spring about ¼" from the end. Assemble the wrist plate to the assembled spring using the two U-bolts as shown. Cut off the excess threaded portion of the u-bolts once they are installed



Assembled wrist and hand

Step 4. Assemble the forearm and upper arms together as shown in Figure 7-12 below.

NOTE: You may have to take the large hammer and pound the copper tube into the loops so will fit into this opening. You can also use an arbor press to press the tubes into the loops.

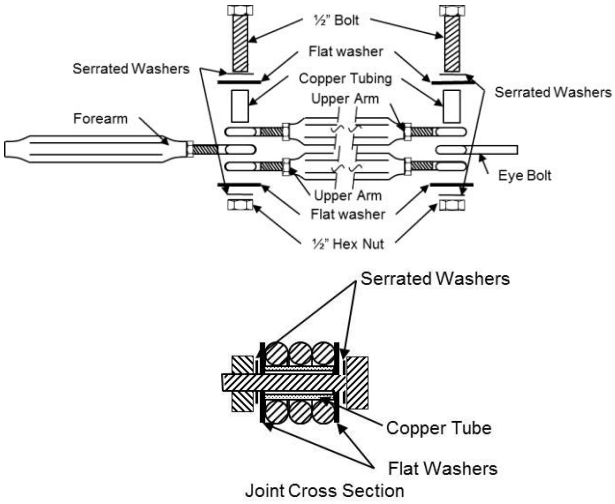
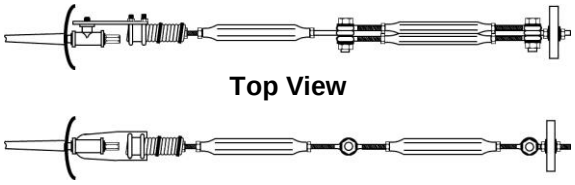


Figure 7-12 Joint Assembly

Step 6. Assemble the wrist and hand to the arm assembly, and tighten the jam nut; attach the blade/guard assembly to the wrist plate using the socket head cap screw (or wingnut). Add the two hex nuts and washers to the eyebolt end. Your finished arm should look like the one below.



Top View

Side View

Figure 7-13 Assembly Views

Figure 7-14 Close-up of the adapter plate and wrist adapter (with alternate ¼-20 Wingnut)

Step 5. Assemble the blade and guard onto the wrist adapter with a standard pommel nut. . Install the modified Wrist Adapter to the Wrist Plate using the ¼-20 socket head cap screw, ¼" flat washer and ¼" lock washer.

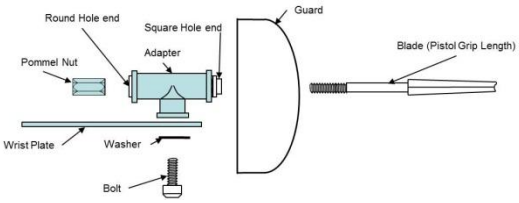


Figure 7-15 Blade Assembly

To mount the arm, drill a hole in the piece you are going to mount the arm to, and attach it with a washer and nut. Be sure to have the nut on the other (arm) side so that it can be adjusted and tightened. To mount the arm, use the holes drilled in the shoulder of the base assembly. Mounted, it should look like the illustration below.

Figure 7-16 Mounting Example

If you want to mount the board on a wall, or eliminate the second hex nut, you can install a 3/8" T-nut on the back side of the mounting board. This way you can screw the arm into the board, but you need the nut on the arm side, too, like the previous mounting option.

A third alternative mounting may be to use what is known as a 'lag eye-bolt' instead of the threaded eye-bolt you took off of the forearm turnbuckle. The lag eye-bolt has a wood screw end and can be screwed directly into the wood. Because of the amount of twist that is imparted by the swinging of the arm, it is recommended that you screw the bolt all the way in. This will mean that you have to have enough wood behind it, so a normal 2X4 won't work; you need to use at least a 4X4 post.

The completed and mounted arm is shown below.

Figure 7-17 Modified Flaschka Arm Mounted

As a comparison, pictures of the original arm are shown below. Note that the difference between the two designs is that the spring has been replaced with a straight tension spring and has the washers installed on both ends.

Figure 7-18 The Original Flaschka Arm

Figure 7-19 Original Flaschka Arm - Wrist

Figure 7-20 Original Flaschka Arm Joint Parts

While Walt's design of the wrist is a good one, it is a bit difficult to assemble, and lacks the ability to readily change out weapons. The author has designed a modified version of Dr. Volkman's designed wrist, not only the part previously discussed, but a redesigned plate that allows for the best of both worlds. The template for the plate is shown below.

WARNING: STUDENTS SHOULD *NOT* WORK WITH THE TARGET DUMMY WITHOUT WEARING A MASK!!

7.3 Other Training Devices

Other items that are of use in training, and are readily available, are:

Tennis balls
6" rubber knives
Bean bags Golf balls
1 meter lengths of rope Various diameter wire hoops

For the purpose of teaching/ practicing point control and hitting moving targets, suspend a tennis ball, golf ball or wire loop on a string from the ceiling. The wire loop is especially good for small children to practice on as it gives them a wider target to aim for until they can develop the coordination to be able to hit the progressively smaller targets.

Another method, which is for more advanced point control practice, is to suspend a golf ball from a string, take a small screw eye (designed for wood) and screw it into the ball (shown below), attach it to a string and hang it from the ceiling.

Figure 7-21 Target Golf ball

To suspend a tennis ball, first make two cuts about ½" in an X through one side and on the opposite side make a ¼" cut through the ball. Take your string and tie a large knot in it, or if it is thin, tie a washer or small piece of wood to one end. Feed the free end through the X cut and then through the other hole. Pull the string and washer/wood/knot into the ball. Now hang the ball in a space where you can safely lunge at it to your heart's content!

Toy rubber daggers, or knives, that are about 6 – 8" long, can be used to teach parries. Because they are so short, the student has to make sure that they parry close to their hands (or the forte of the blade) and not away from themselves (or the foible of the blade). These daggers are relatively inexpensive and can be found at most large toy stores. Or at least will be before they, like toy guns, are considered politically incorrect and inappropriate toys for children!

Instead of rubber daggers, you can also re-cycle old broken foil blades and/or practice foils[102] into parry daggers. Over time a good armorer will collect old French grips, pommel nuts, guards, and broken blades. These can be reassembled into short versions of foils that can be used for parry drills.

To do this, the broken blade needs to be cut to 12 – 14" long and the end ground smooth and covered with tape.

Figure 7-22 An old foil made into a parry trainer

[102] When students move on to electric weapons, they seldom use their practice foils, so see if they will donate them to be used by the club or Salle.

CHAPTER 8 - CONCLUSIONS AND STRAY THOUGHTS

While most people end up being Armorers due to the necessity of learning how to fix and maintain their own equipment, or the equipment of their children or salle, most of them learn by trial and error or by consulting the local Armory Guru, or even haunting online discussion groups. Most of the information is scattered about and not as organized as it could be, though.

There are only two other publications that I know of that attempt to address all the different areas of information related to fixing and maintaining all of the equipment related to fencing, but I believe that this is the first attempt to cover all the different aspects of Armoring that the beginning and intermediate Armorer can be reasonably expected to handle.

I have attempted to include, the majority of equipment suppliers for the US and some of the international ones. With the advent of the Internet, online banking and shopping, several of the European suppliers can be a good place to get quality equipment. The only thing you have to watch is the Dollar to Euro conversion rate. This rate has changed radically in the past few years, so it may or may not be a beneficial route to take. The list of Equipment Suppliers is included in Appendix B.

Appendix C has a list of references that the aspiring Armor can tap into, in addition to this book. Several of them were used as references in this book. There are also certifications by several of the national governing bodies for Armorers. In past few years, the United States Fencing Association's Coaches College has included a one week course in Armoring and is attempting to certify Armorers for working National and World level competitions. The Study Guide for this certification course was also used in providing a basis of this book. I wouldn't say that all of the answers in the Study Guide can be found in this book, but the majority of them are.

In Appendix D, I have included graphical flow charts for the troubleshooting section. Again, these are focused on finding problems with the scoring system during a competition. Trouble shooting weapons is found in the Basic Maintenance section.

Also, be aware, as I pointed out in the Introduction, especially if you haunt any of the on-line discussion groups, that techniques and opinions are as varied as there are people. As with fencing itself, the basics and find what works for you. As you become more confident in your abilities you will begin to develop your own techniques and tricks. Please share them with other established and aspiring Armorers.

I hope that this compilation of information has been a benefit to you and has helped to contribute to a little less stressful fencing experience, knowing that your equipment is good working order and that you don't have to fear not knowing what to do when it breaks or malfunctions.

Good Fencing and Good Armoring!

©

(Cartoon Courtesy of Peter Russell, used by permission)

APPENDIX A: Tool List

Basic Tools

Magnetic strip *
Jeweler's screwdriver(s) *
Pommel nut tool *
8mm outside hex *
6mm allen wrench, *
¾" deepwell socket (you can also use a sparkplug wrench)
large bladed flat tip screwdriver *
Test box *
Test weight(s) *
Epee shims *
Springs *
Screws *
Q-tips *
Tip tape (1" gaffer's tape will work very well) *
Isopropyl Alcohol
Scotchbrite pads *

Intermediate Tools

Wiring Chain *
Clamp
Portable vise
Dental pick *
Vise grips *
Crescent wrench (8" and 6") *
Box end wrenches *
- 5mm (foil barrel)
- 5.5mm (foil barrel)
- 6mm (epee barrel)
- 7mm (foil connector and screwless points)
- 8mm (foil connector)

Small tipped screwdriver *
Mill file (10", 8" and 6")
Set of fine files
Dremel tool with cutoff wheels (both diamond and fiber)
Hemostats *
Point setters *
Nippers *
12kg Mask punch *
Ohmmeter (analog is preferable) *
Razor blades or Exacto knife w/ #11 blades *
Superglue
Acetone
Nail polish remover
220 grit sandpaper *
Small Screw Extractor Set

Advanced Tools

Hand Hole Punch set
Small bolt cutters
Machinist vise
10" crescent wrench
Taps & Dies, with handles
- M6 x 1 (Tang and Pommel nut)
- 12 x 24 UNC (Tang and Pommel nut)
- M4 x .7 (Epee blade tip and barrel)
- M3.5 x .6 (Foil blade tip and barrel)
- M2 x .25 (Epee tip screws)

Reamers
- 5mm
- 4.5mm

5.5mm Nut driver (visor mask nuts)
Small ball peen hammer
2' length of ½" metal pipe
(Or tang bending kit)
Portable workbench
6" bench grinder
A set of feeler gauges
Rubber mallet
Propane torch

And of course, a box to put it all in!

All Packed Up and Ready to Go!
(Items marked with * are in this bag!)

APPENDIX B: Fencing Equipment Suppliers

US Suppliers

Absolute Fencing Gear
(732) 868-9003
(732)868-9133 (Fax)
http://www.absolutefencinggear.com

Alliance Fencing Equipment
(415) 666-3606
http://alliancefencingequipment.com

American Fencers Supply
(650) 359-7911
(650) 359-7913 (Fax)
http://amfence.com

Blade Fencing Equipment Inc
(800) 828-5661
(212) 244-3090
(212) 244-3134 (Fax)
http://www.blade-fencing.com

Blue Gauntlet Fencing Gear Inc.
(800) 819-5180
(201) 797-3332
(201) 797-9190 (Fax)
http://www.Blue-Gauntlet.com

FencePBT.com, Inc.
(800) 422-4728 ((800) 422-4PBT)
(704) 333-3805
(704) 333-8704 (Fax)
http://www.fencepbt.com

Fencing.Net
(877) 452-8024
(770) 452-8025 (Fax)
http://shop.fencing.net

FencingStar
http://www.FencingStar.com

Leon Paul, USA
(404) 325-7272
sales@leonpaulusa.com
http://www.leonpaulusa.com

H.O.M. Fencing Supply
(818) 567-2280
homfencing@hotmail.com
http://www.homfencing.com

Physical Chess, Inc.
(800) 336-2464
(908) 810-8667 (Fax)
sales@physicalchess.com
http://www.physicalchess.com

Sword Masters
(866)796-7348
(318) 458-4691
(318) 424-4737 (Fax)
http://www.sword-masters.com

The Fencing Post
(800)459-7207
(760) 746-7000
(760) 746-7009 (Fax)
saul@thefencingpost.com
http://www.thefencingpost.com

Triplette Competition Arms
(336) 835-7774
(336) 835-4099 (Fax)
http://www.triplette.com

Zivkovic Modern Equipment Inc.
(781) 235-3324
(781) 239-1224 (Fax)
bzivkovic@zivkovic.com
http://www.zivkovic.com

International Suppliers

Favero Electronic Design
Tel: +39 0422 874140
Fax: +39 0422 874141
http://www.favero.com/en/ini-fen.htm

Fechtsport-Langenkamp
TEL: +49 (0)69 84 55 66
FAX: +49 (0)69 83 83 72 78
info@fechtsport-langenkamp.de
http://fechtsport-langenkamp.de

Leon Paul - UK
TEL: 0044 20 8201 7284
FAX: 0044 20 8201 7302
sales@leonpaul.com
http://www.leonpaul.com

Prieur
TEL: (0)1 43 57 89 90
FAX: (0)1 43 57 80 11
http://www.prieur-sports.com

Estoc
TEL: (33) 05 46 26 19 85
FAX: (33) 05 46 26 19 87
http://www.estoc.com

Allstar Fecht-Center
TEL: +49 (0)7121 9500-0
FAX: +49 (0)7121 9500-99
EMAIL: info@allstar.de
http://www.allstar.de

Uhlmann Fecht-Sport
TEL: +49 (0)7392 9697-0
FAX: +49 (0)7392 9697-79
EMAIL: info@uhlmann-fechtsport.de
http://www.uhlmann-fechtsport.de

Negrini Fencing Line
TEL: ++39-45-8001984
FAX: ++39-45-8002755
EMAIL: negrini@negrini.com
http://www.negrini.com

Escrime Technologies/Fencing
TEL: 011 (33) 3 81-61-16-05
FAX: 011 (33) 3 81-61-13-67
EMAIL: EscrimeTec@aol.com, richard-marciano@uiowa.edu,
marciano@sdsc.edu

APPENDIX C: References and Resources

References

'Fencing Armourer and Competition module', Canadian Fencing Federation, Christopher Ramm

Fencing.net Armory Forum, Craig Harkins, webmaster
http://www.fencing101.com/vb/forumdisplay.php?f=30

Fencing Frequently Asked Questions, ©1993-2002 Morgan Burke

LEON PAUL armory website http://www.leonpaul.com/armoury/armoury.htm

USFA Rule Book, September 2011 Edition, United States Fencing Association, 1 Olympic Plaza, Colorado Springs, Colorado

'Magnum Libre d'Escrime', Dr. Rudy Volkman, self published, 1996

'Machinery's Handbook', 25th Edition, Industrial Press, New York, 1996

Resources

'The Manual For The Care And Repair Of Electrical Fencing Equipment' Maitre Bac Tau, Wysteria Press, 2001

'Fencing Volume V: The Manual For The Care And Repair Of Electrical Fencing' Maitre Bac Tau, Wysteria Press, 2006

'Fencing Volume I: The Fundamental Principles and Techniques of Foil and the Care and Repair of Electrical Fencing Equipment' Maitre Bac Tau, 1977

'Electrical Fencing Equipment: How it Works, What Goes Wrong With It, How to Repair It', 4th Edition, Dr. Rudy Volkman, 1996

'How To Be An Armorer Without Losing Your Sanity', Chris Greene

'Choose Yer Weapon, Laddie', Sam Signorelli, HOM Fencing,
http://www.mightypants.org/files/Prep_package.pdf

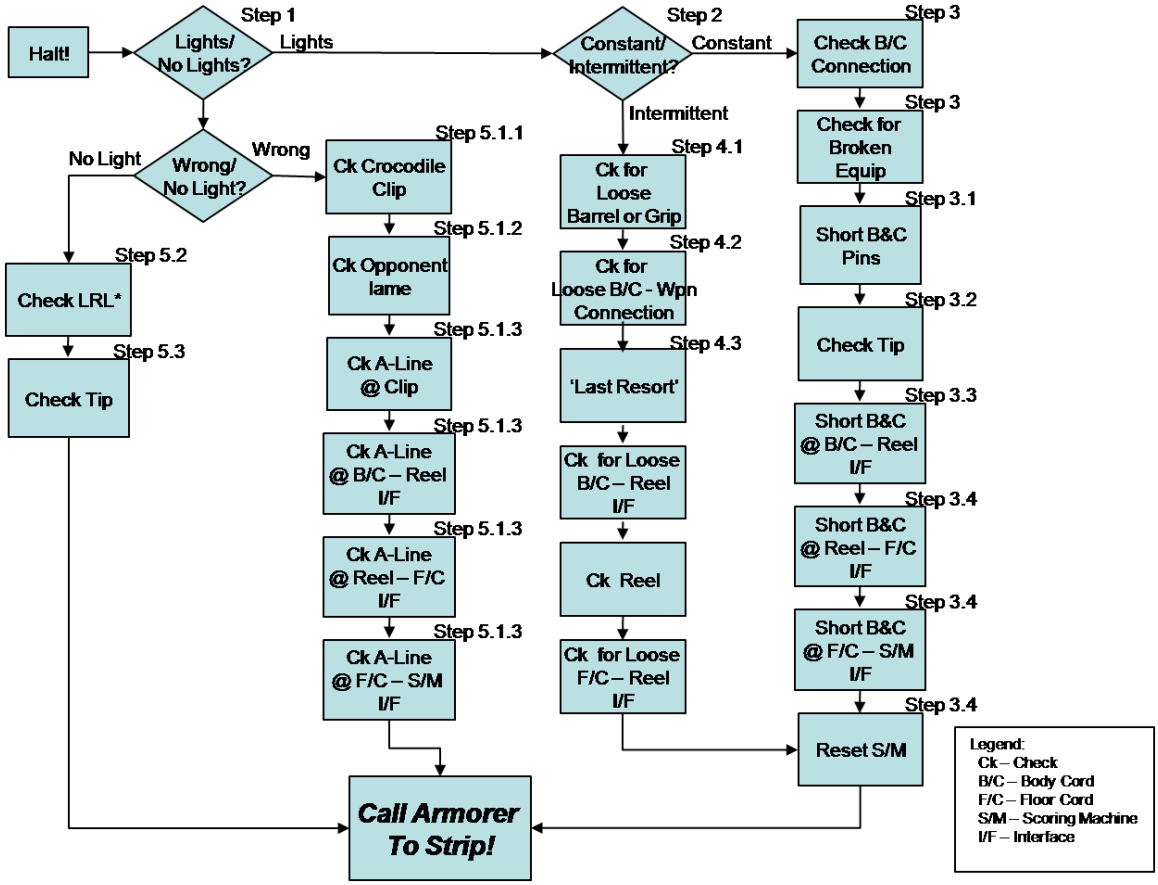
'How to Check Your Mask', on-line video, Sam Signorelli, HOM Fencing,
http://www.youtube.com/watch?v=Tky2vpboENI&feature=youtu.be

'How to Adjust Your Fencing Mask', Craig Harkins, Fencing.net,
http://www.fencing.net/downloads/How-to-Fit-Your-Mask.pdf

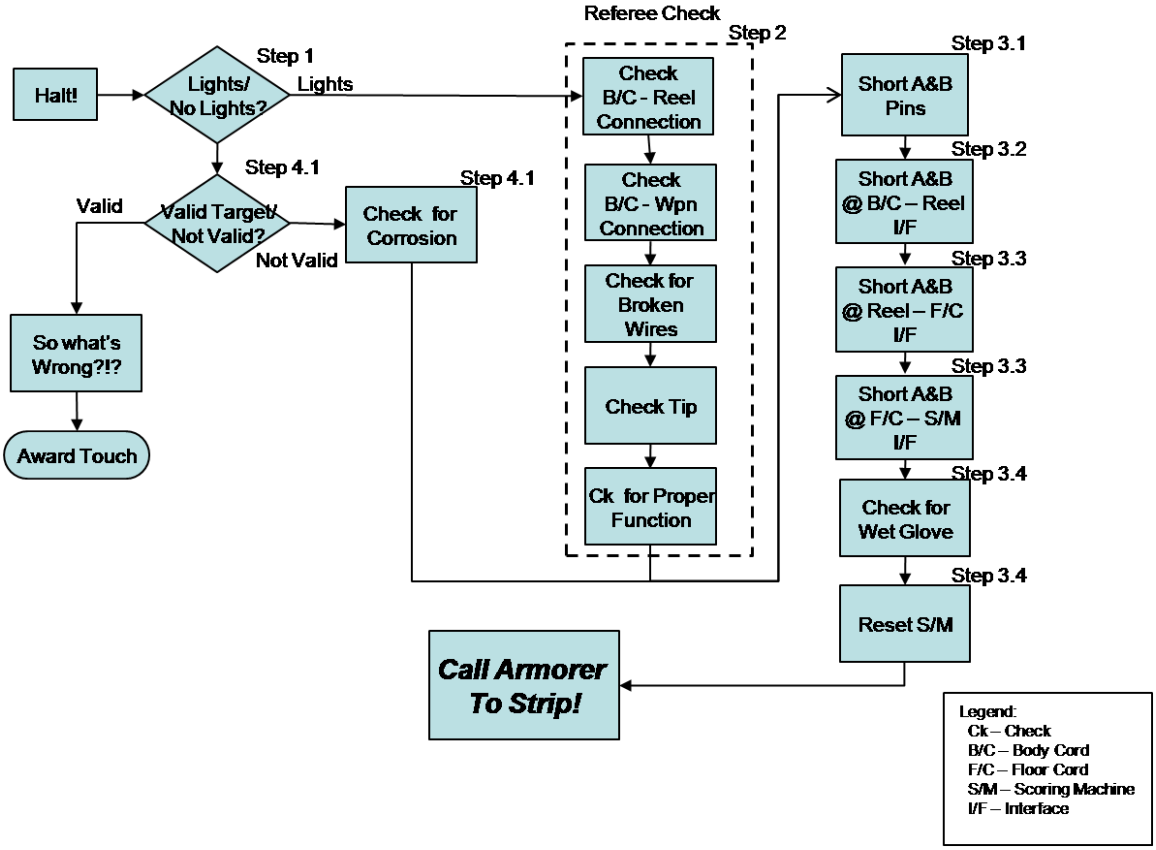
'How to Size Your Contour Mask', Craig Harkins, Fencing.net,
http://www.fencing.net/downloads/How2Size-Contour-Mask.pdf

APPENDIX D: Troubleshooting Charts

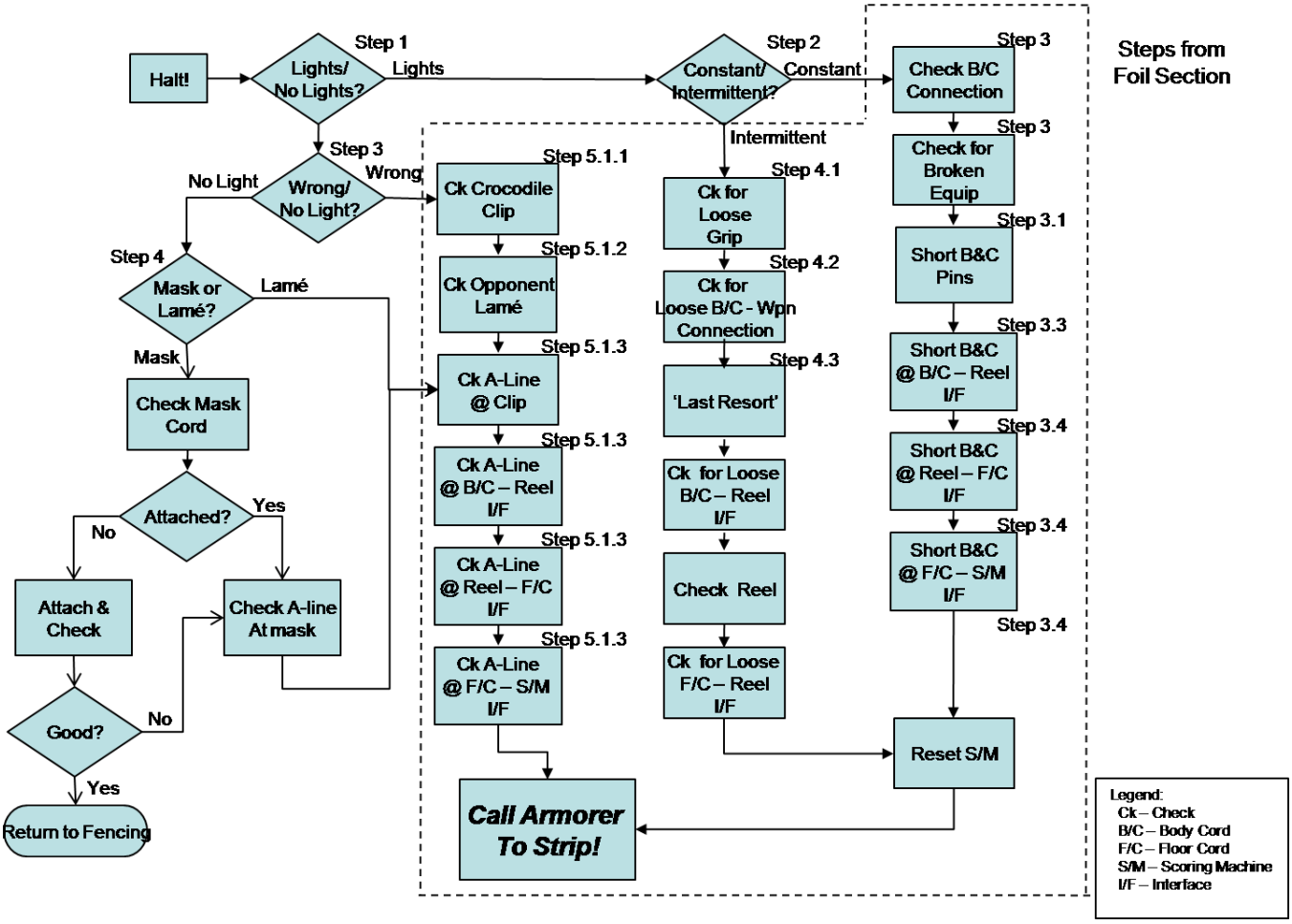
Foil



Epee



Saber



APPENDIX E: American vs British Terms

US	UK
Armorer	Armourer
Body Cords	Body Wires
Body Cord Labeling	Body Wire Identification
Center	Centre
Clip Maintenance	2-pin body wire retaining clip maintenance
Connectors	Sockets
Crescent Wrench	Adjustable Spanner
Floor Cords	Ground Wires
Knickers	Breeches
Mask Cables	Mask Wires
Saber	Sabre
Soda Straw	Straw
Strip	Piste
Strip Ground Wire	Piste Earth Lead
Reel	Spool
Wrench	Spanner
Vise	Vice
Lines	
A Line	**Near** wire spaced 15mm from the centre pin
B Line	**Centre wire** Can be regarded as the “Live” wire
C Line	**Far wire**, spaced 20mm from the centre pin Can be regarded as the Earth or Return circuit

APPENDIX F: Armorer's Cheat Sheet

The Armorer's Cheat Sheet

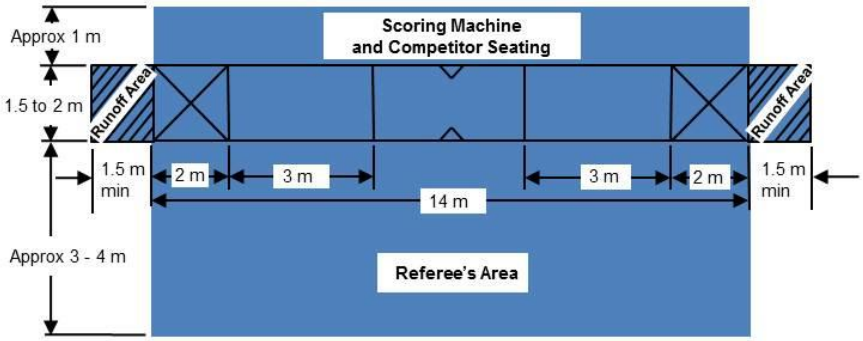
Weapons	Foil		Epee		Saber	
Max Blade Length	90 cm	m.8	90 cm	m.16.2	88 cm	m.23
Max Blade Width			2.4 cm	m.16.4		
Grip And Guard Length	20 cm	m.4.1	20 cm	m.4.1	17 cm	
Max Overall Weapon Length	110 cm	m.7	110 cm	m.15	105 cm	m.21
Max Blade Bend	1 cm	m.8	1 cm	m.16	4 cm	m.23
Max Guard Diameter	12 cm	m.9	13.5 cm	m.17	15 x 14 cm	m.24
Min Guard Diameter	9.5 cm	m.9				
Max Guard Depth			5.5 cm	m.3		
Min Guard Depth			3.5 cm	m.3		
Max Blade Offset	0	m.9.2	3.5 cm	m.17.3	N/A	
Max Allowable Resistance	2 Ω	m.5.4	2 Ω	m.5.4	1 Ω	m.24
Point Pressure Weight	500±2 gm	m.11.3	750±3 gm	m.19.2		
Point Max Diameter	7 mm	m.11.1	8.05 mm	m.19.1		
Point Min Diameter	5.5 mm	m.11.1	7.95 mm	m.19.1		
Barrel Min Diameter	Point Dia - 0.3 mm	m.11.1	7.7 mm	m.19.1 b		
Max Weight	500 gm	m.6	770 gm	m.14	500 gm	m.22
Allowable Point Stroke	< 1 mm	m.11.4	>1.5 mm	m.19.4		
Lighting Stroke	>0.000 mm	m.5.4	1.0 mm	m.19.4		
Insulation	15 cm below barrel	m.13.1			7 – 8 cm of guard, from pommel	m.24
Flexibility test						
Weight	200 gm	m.8	200 gm	m.16	200 gm	m.23
Distance To Hang From Tip	3 cm	m.8	3 cm	m.16	1 cm	m.23
Distance From Clamp To Weapon End	70 cm	m.8	70 cm	m.16	70 cm	m.23
Min Deflection	5.5 cm	m.8	4.5 cm	m.16	4 cm	m.23
Max Deflection	9.5 cm	m.8	7 cm	m.16	7 cm	m.23

Cords, Lamés and Pistes

	Resistance, (per line)		Length		Comment
Body Cords (Foil, Epee, and Saber)	1 Ω	m.29	40 cm	m.29.2b	Min separation of A-line from B & C lines
Crocodile Clip			1 cm wide; 8 x 3 mm opening	m.29.2c	Must be visibly soldered to wire
Floor Cords	2.5 Ω	m.55.5	10 m		
Reel Cords	3.0 Ω	m.55.1	20 m	m.55.3	
Mask Cord, Saber & Foil				m.32	Foil cord must be white or clear
Coiled	1 Ω	m.29	20 - 30 cm	m.32.4	Note: Length does not include
Straight	1 Ω	m.29	30 – 40 cm	m.32.4	length of crocodile clips.
Combination	1 Ω	m.29	10–10-10 cm		Straight, coiled, straight
Lamés	5 Ω	m.28.(a)	Measured between any two points on the Lamé		
Piste (Grounded)	5 Ω	m.57.1	Measured between two points on either end of the Piste		

The Armorer's Cheat Sheet

The Strip – The layout of the strip to include runoff, scoring table and referee area. For planning purpose, a normal sized gym will hold 6 strips.



Thread Sizes – Standard thread sizes for parts. Note: Epee and Foil tip screw sizes are not standardized, the sizes listed are the most common.

Part	Tang[1]	Barrel, Foil	Barrel, Epee	Tip, Epee[2]	Tip, Foil, German[2]
Thread	M6 x 1	M3.5 x .6	M4 x .7	M2 x .25	M1.7 x .25

[1] Some manufacturers still use the standard English thread of 12 x 24.
[2] These are the most common sizes; however, there is no standardization for screws per the SEMI

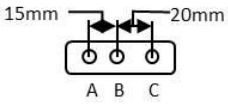
Troubleshooting Tips –

ON STRIP

1. Check to see if you really have a problem – e.g. for epee, make sure the weapon is malfunctioning; Lamés, test for dead spots; broken blades, etc.
2. Check to see if everything is plugged in. To include the scoring machine.
3. Work from the tip back to the scoring machine.
4. Make sure connections are tight: Barrel to tip, grip to weapon, body cord to weapon, etc.
5. Test by shorting across the B & C lines for foil; A & B lines for Epee at each interface.
6. Isolate, and confirm, the malfunction before replacing equipment.
7. Unless easily repaired, do not do repairs at the strip.
8. Remember Safety at ALL TIMES!

AT THE WORK BENCH

1. Check for the obvious problem first: stuck springs, loose barrel or grip, broken blades, broken wires.
2. Always use an ohmmeter to check for shorts.
3. All pins, except foil 2-prong B-line, are 4 mm in diameter.
4. B-line pin on foil 2-prong is 3 mm in diameter.
5. C-line is always ground.



Standard Pin Spacing