The Illustrated Guide to Building and Tuning Tattoo Machines

By LunaC 2006

Welcome to the world of tattooing...keep it clean and honest, honor the trade and if you are skilled enough the trade will repay you. That being said, I would like to give back to the trade...one of the most frequently asked questions that I recieve is about how to tune and maintain tattoo machines. The problem is that many a tattooist/apprentice buy their rigs already tuned (or so they think) and never bother to adjust more than the tubes and the contact screw, and are too hesitant to tear it all the way down for fear that they'll never get it back together. For many tattooists, "maintenance" means changing the rubber bands. So for those of you who do not know where to start here is my detailed tutorial-if you have any questions mail them to Luna_c666@yahoo.com with the subject line "Re:Tuning Guide". Good Luck!

P.S. The images are original and were taken by a friend as I rebuilt and tuned my own machine-please disregard the crappy tattoos on my knuckles and trust that they do not reflect my own expertise! Thank you.

A quick explanation of theory:

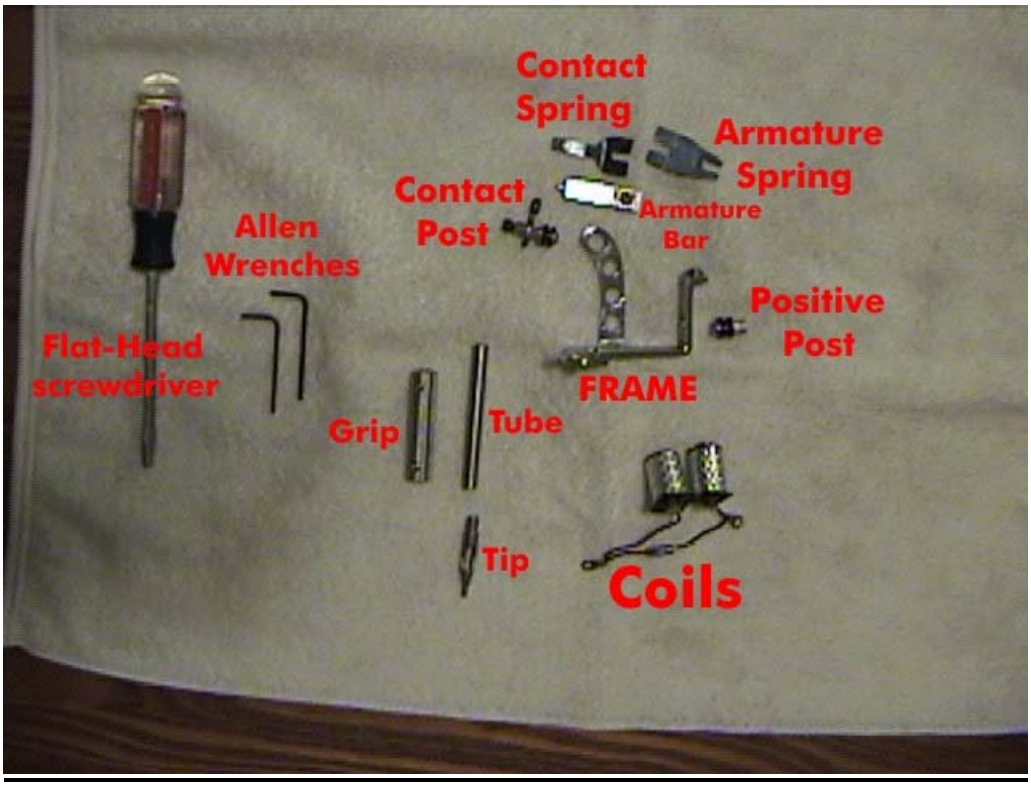
In order to fully comprehend the marvel that is the tattoo machine, we must understand how it works IN AND OUT. I feel this is a necessary preface for this instruction guide and if you feel you know HOW a tattoo machine works well enough feel free to skip ahead.

Tattoo machines function with electromagnetism, as it may well be known. The coils are magnetised by the electric current running through them, which magnetically attracts the armature bar to them (thus pushing the needle), which disconnects the electricity to the coils, their magnetic feilds collapse and the armature spring pulls the armature back into contact with the contact screw (i.e. electricity) which recharges the coils, the magnetic fields expand and the process repeats, extremely fast-somewhere between 60 and 150 cycles per second. There are a few technical terms that I have to run by you: when you pass electricy through a conductor you create a magnetic field, we learned that in second grade with the battery and the nail with the coiled wire around it picking up paper clips (the same priciple in application in a tattoo machine) and the reverse is also true, that is when you pass a conductor through a magnetic field you produce an electric current in the conductor (a principle applied in DC generators, alternators, etc.). When you have a COIL of wire, however, and introduce an electric current into it, magnetic lines of force (force fields, the rainbow pattern magnets make with iron filings) emerge and "cut through" the coils of wire (or collapse into them when the current is DISCONNECTED as well), which produces a voltage spike in the conductor of the coil which can be damaging to certain sensitive electronics. This principle is called "self induction", as it is a self induced voltage spike. If there are two coils together (as is the case on a tattoo machine) and one is connected or disconnected to power, the magnetic lines of force from that one will also produce a voltage spike in the ADJACENT COIL, a principle called "mutual induction". Both of these principles are constantly interacting on your tattoo machine, creating voltage spikes every time power connects and disconnects for every pulse! That is why you use a capacitor on your machine to make it hit harder: The capacitor serves a few purposes in electronics-it can function as a small battery that only holds a charge for a number of minutes, which is not applied on a tattoo machine. The other functions are Radio Frequency Interference filter (also not applied) and it filters out voltage spikes, which is what it is used for in this application. In this way, it filters out spikes in the voltage that would otherwise create opposing magnetic fields and dull out your machines' performance. Thus the capacitor will make your armature bar drop and bounce back without hesitation due to opposing magnetic fields, which will result in your machine "snapping" or hitting quickly and hard. If your capacitor is too big, your machine will get real loud

and ragged sounding, which it may do with a smaller capacitor already -that's okay; as long as it is tuned correctly and you won't be causing any additional stress on your machine. My mentor explained it this way- if you were going to be punctured by a needle, would you prefer it to be on the skin and given pressure enough to pierce the skin, or would you rather it come AT the skin at full speed and "pop" in and back out? The capacitor creates the latter scenario..

Getting Started

TOOLS YOU'LL NEED:



Screwdriver (Most likely a flathead for the coil screws and maybe others, find out which you need)
Allen Wrenches (There are probably two different sizes of allen screws, once again find out exactly ones you need first)
Feeler Guage (I like to buy a few as I can use the leaves for coil shims, however you can purchase washers that are of varied thickness for this purpose)

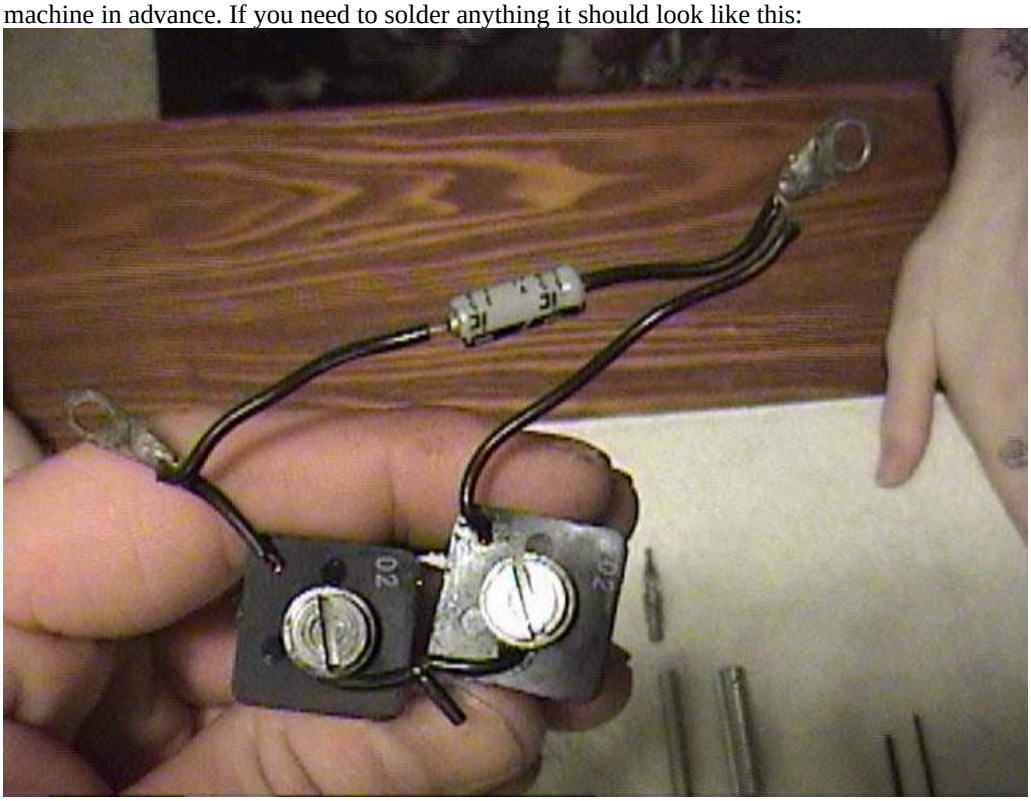
Soldering Iron (If you need to solder anything)
You will also need (1) Straight Armature spring or equivalent device (see shimming the coils)

Note: The machine pictured is a Spaulding & Rogers Puma-good quality and economical value..and it is the most basic tattoo machine design, so it can be applied to almost any type of machine. For those of you with V machines or some other fancy over-complicated hunk of metal, if you can't apply this tutorial then you're on you're own!

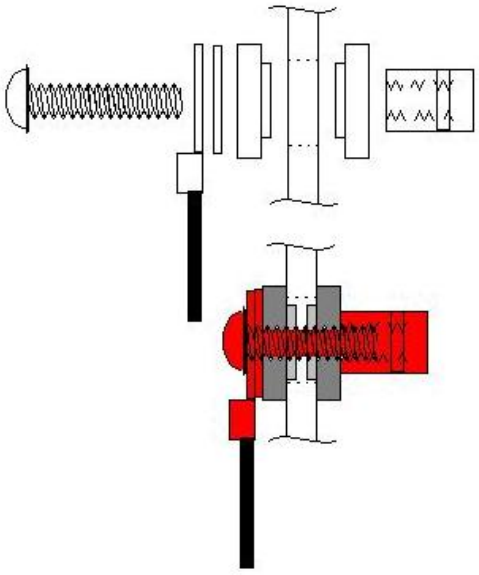
Step One: Attaching the Coils

Begin with all of the pieces of your machine and your tools in front of you in this way:

The first thing that needs to be done is attaching the coils. You should have cleaned all of the pieces of your machine in advance. If you need to solder anything it should look like this:



The capacitor in this picture is a 35mf, however you can use up to 150mf, I would suggest using between 75-100mf personally.
Once you have it wired correctly with the correct connectors on, first attatch the positive post like so:



The Red represents the current flowing through the way it should.

It should look like this:

Now you have to line the coils up on the frame like such, making sure not to pinch any wires, snug them both down making them as even and squared as possible.

This is how it should look now with the coils squared off.

This is temporary so do not over tighten, but they need to be snug and not loose at all. Go ahead an bend the wires so they are in their best positions -like this:

Step Two: Shimming The Coils

For this step you should have a brand new armature spring that you keep crisp and straight-if you do not have that you can make something out of a striaght sheet of metal that is thick enough not to bend out of shape. The point of this is to attach the armature bar to the frame in the lowest possible position that the arm. bar is ever going to get-which is parallel horizontally to the armature post on the rear of your machine-and for it not to move. It should look like this.

Once attached, with your feeler guage, measure the distance between each coil and the base of the arm. bar.

Find the leaf that touches both the top of the front coil (on the left) and the base of the arm. bar perfectly-that is the thickness you need to shim THAT coil-for the rear coil (right) find the leaf that leaves a sheet-of-notebook-papers'-thickness smaller than perfect fit, and that is the proper thickness for the rear shim. Once you know what thickness is needed, you can either A: Find a supplier and order a washer to your specifications especially for this project B: find a pre-packaged assortment of shimming washers and hope they have enough to stack the correct combination OR (my favorite) C: make a shim out of the leaves of the feeler guage-sometimes it can be harder if you need to shim it more than less-you can pre-drill three or four holes in your "spare" feeler guage in the first few leaves together and use tin snips to round it off. Or, if you're lucky enough to know a machinist or have access to machine tools you can get them drilled and cut perfectly. Either way you do it, place the correct shims under the coils, re-attach the coils and tighten it up.

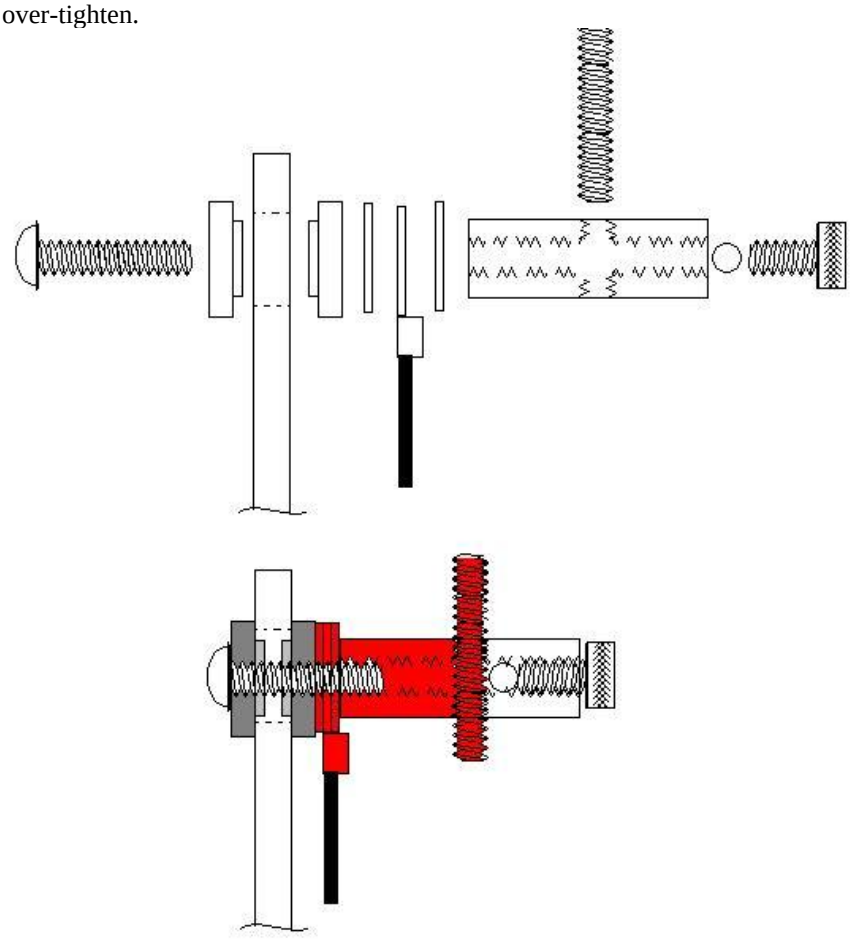
This is where you shim the coils-notice the washers on the coil-screws.

Close the arm bar to the coils again and the front coil should make contact and the rear should have the smallest gap-just enough to see some light through, it should be about like this:

If the rear coil is too high the spring will bow, and if it is too low it will cave in, putting way too much stress on your spring, which will make it break much sooner-and they will break, sometimes right in the middle of a tattoo!

Step Three: Attaching the Contact Post

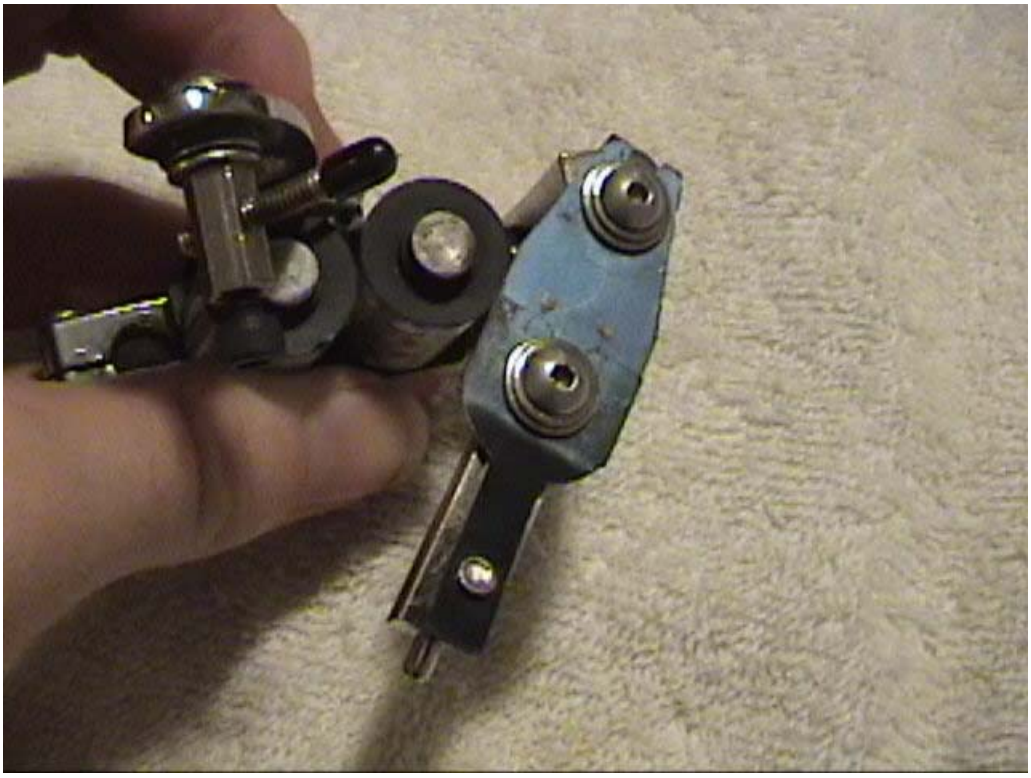
This is pretty simple, stack the washers as such and screw the contact post in until it is at an approximate angle to how it will be and tighten the screw down-this screw will probably need to be adjusted so don't over-tighten.



You should put a washer both in front of and behind the connector loop for the contact post.

Step Four: Tensioning The Springs

This is where it gets a little tricky-this is something that can only be specifically explained with expensive and obscure spring-tensioning tools and meters, so you'll just have to feel this one out. Slide the armature bar onto the arm. post sideways and snug the screw.



Looking at it from the side, pull the arm bar back and bend the spring enough to keep the arm. bar off of the coils but below the contact post.

You don't want too much tension on the arm. spring, or your machine will hit weakly, however not enough and your spring won't pull your arm. bar back up hard enough to make a good connection and will make your machine stall out and sputter.

Now you have to do the contact spring-it should have just enough tension on it to make it move down a millimeter or two when the arm. bar pulls it back up and it makes contact with the contact screw. If this spring has too much tension it will keep contact with electricity too long and re-connect too soon, which will shorten your throw-contrary to popular belief the distance the arm. bar nipple moves when you press it with your finger is not necessarily your throw, your throw is also affected by spring tension, if your arm bar tension is high and your contact spring tension is low, your contact spring may be bent too much from being pushed up too high by the arm spring, making for a very strange throw. I've also heard of a machine that was cutting a figure 8 pattern at the arm nipple instead of just reciprocating-the cause was a broken fork on the armature spring-the springs will do some funny things, so it's best to understand how they function.

Step Five: Adjusting The Armature Bar

The armature bar is also in part responsible for the depth of the throw, as the farther you pull the arm bar out, the more it has to move and the farther it will, simple laws of leverage. The trick is getting it just right-some are more adjustable than others, as some are longer, some are pretty much machined to be exactly right (or so they assume) and not really adjustable. The arm bar does need to make full coverage of the tops of the coils' cores, as repeated impacts will eventually make depressions in the steel-for this reason it is important to get it set in the right spot and have it stay there, because it developes a kind of "memory" to that machine and specifically those coils at THAT height and spring tension etc. First, adjust the arm. bar with the arm. spring post on the frame. The farther out you adjust your armature bar the more throw you will have.


Too Deep

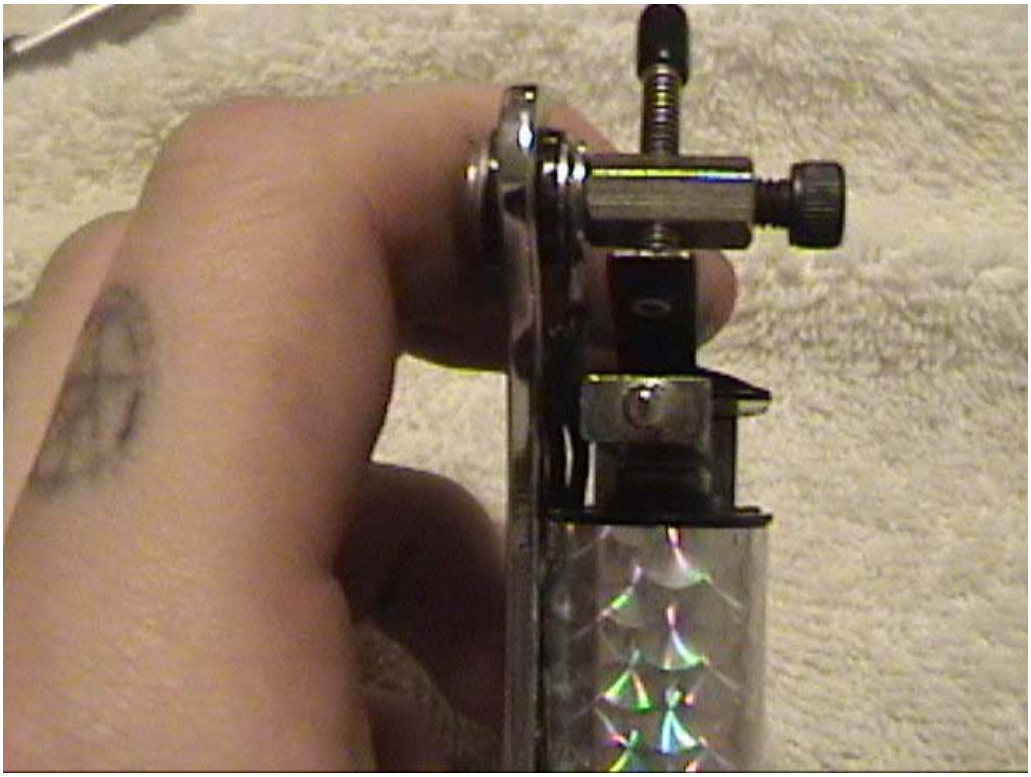

PERFECT!

It needs to be centered from the front (see photo).

It also needs to be centered over the tube-hole (see photos)

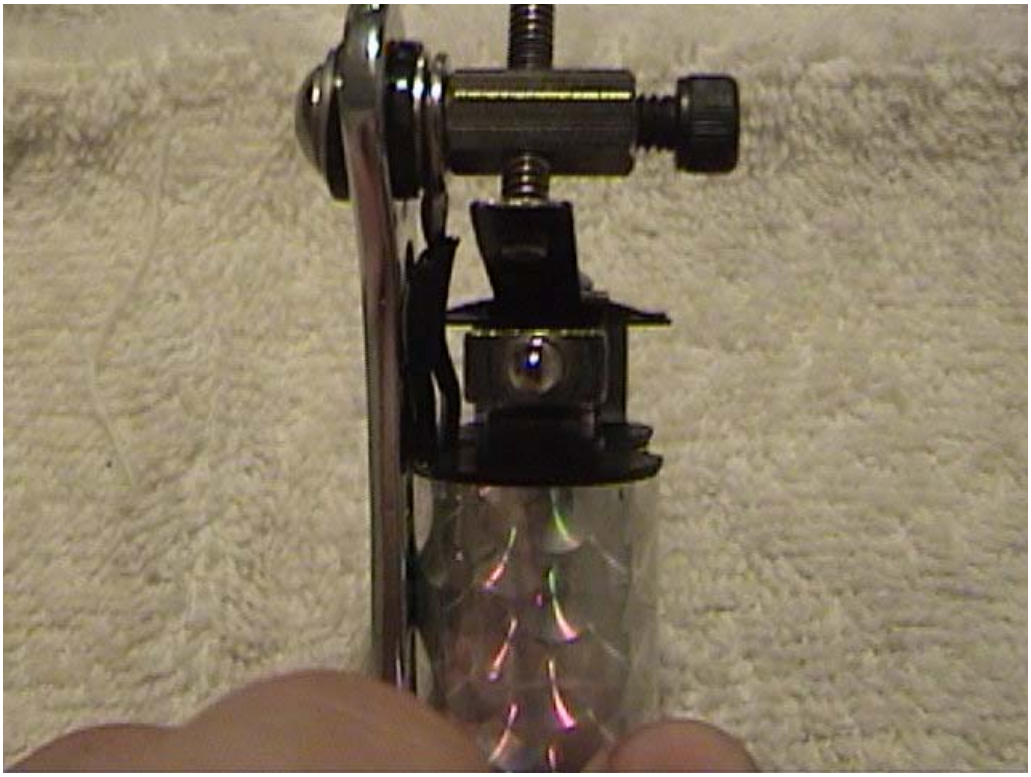
Once you have the arm bar in the right spot, snug up the arm post screw and loosen the arm contact spring screw-this will make your arm bar screwy again, so don't be alarmed. From the front line up the contact spring with the contact point directly under the screw, then from the side pull it out until the angle of the spring is aligned with the angle of the contact screw-adjust the contact screw's angle if necessary. The appropriate angle varies from one machine to the next, but it is roughly 50-55 degrees. Once again, align the arm. bar from the front, the side should be correct but check to make sure, adjust the contact screw and snug up the contact spring screw. If the contact spring is skewed from the angle of the arm bar that is okay, as long as the arm bar is aligned over the coils correctly and the contact spring makes a good connection to the contact screw at a proper angle.

From the side, make sure the contact spring and screw line up..round off the end of the contact spring for a better fit and connection.



Notice in this image the armature bar is too far to the left although the contact spring is aligned. This will cause an abnormal wear pattern on the bottom of the armature bar.

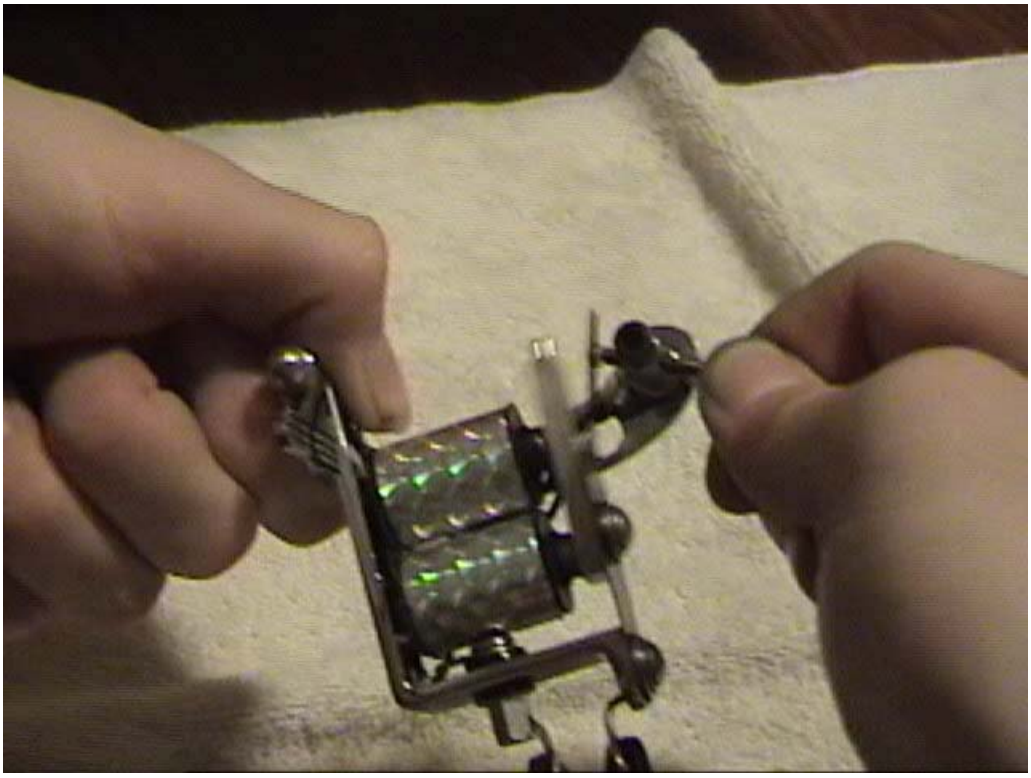
It this image, notice that the armature bar is aligned, but the contact point on the contact spring is off-centered to the right of the contact screw...this is also incorrect and will wear down the points on both the screw and the spring in an awkward manner.

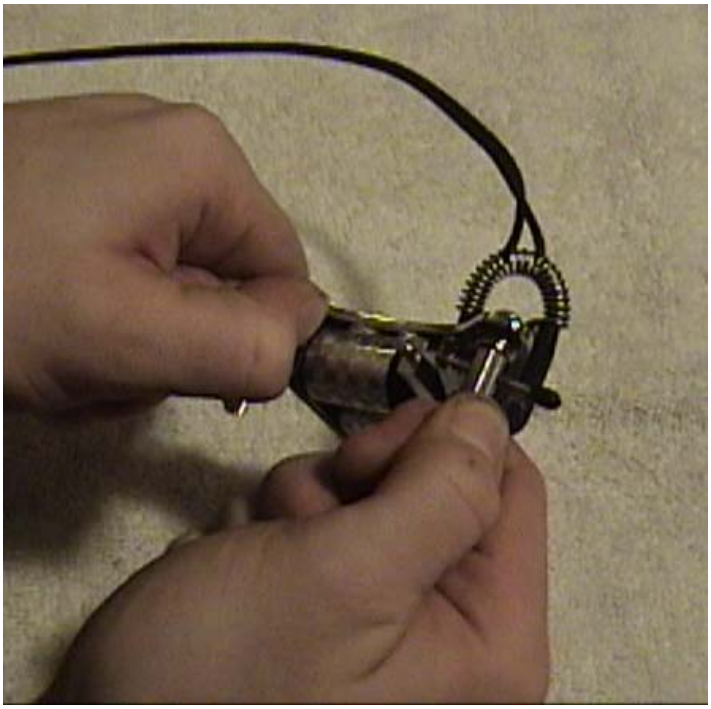


Notice in this image that the contact spring is off-center from the armature bar, yet it is aligned with the contact screw and the armature bar aligned with the tops of the coils-this is the correct position. Not every machine will tune off-centered like this, but it is best to illustrate this possibility to assure you that even if it looks funny like this, this is the correct position.

Step Six: Adjusting The Contact Screw

This is perhaps the easiest and most entertaining step-hook up your machine and buzz it while turning your contact screw. Find the sweet spot(s) (my favorite rig has two! A gentle and a "bastard" cycle) and while holding the screw stop buzzing and run the stop screw in.





By the way, I must add that there should be a tiny nylon bead inside your stop screw hole between your contact screw and the stop screw, this keeps it snug without bending the threads of your contact screw or ruining the end of a nylon screw. Most tattoo suppliers stock them, although I've noticed more than my share of tattooists that do not use them.

If you need to examine your spring tension, throw distance etc. press the arm bar down with the nipple and not with the spring like this:

There you have it! If you need to simply tune your machine, use steps four, five, and six alone. Once you've built a machine from the ground up, there's not much you don't know how to do. I hope this is a big help!

Questions or comments? Please email me at Luna_c666@yahoo.com, subject line "tuning guide"

THANK YOU!