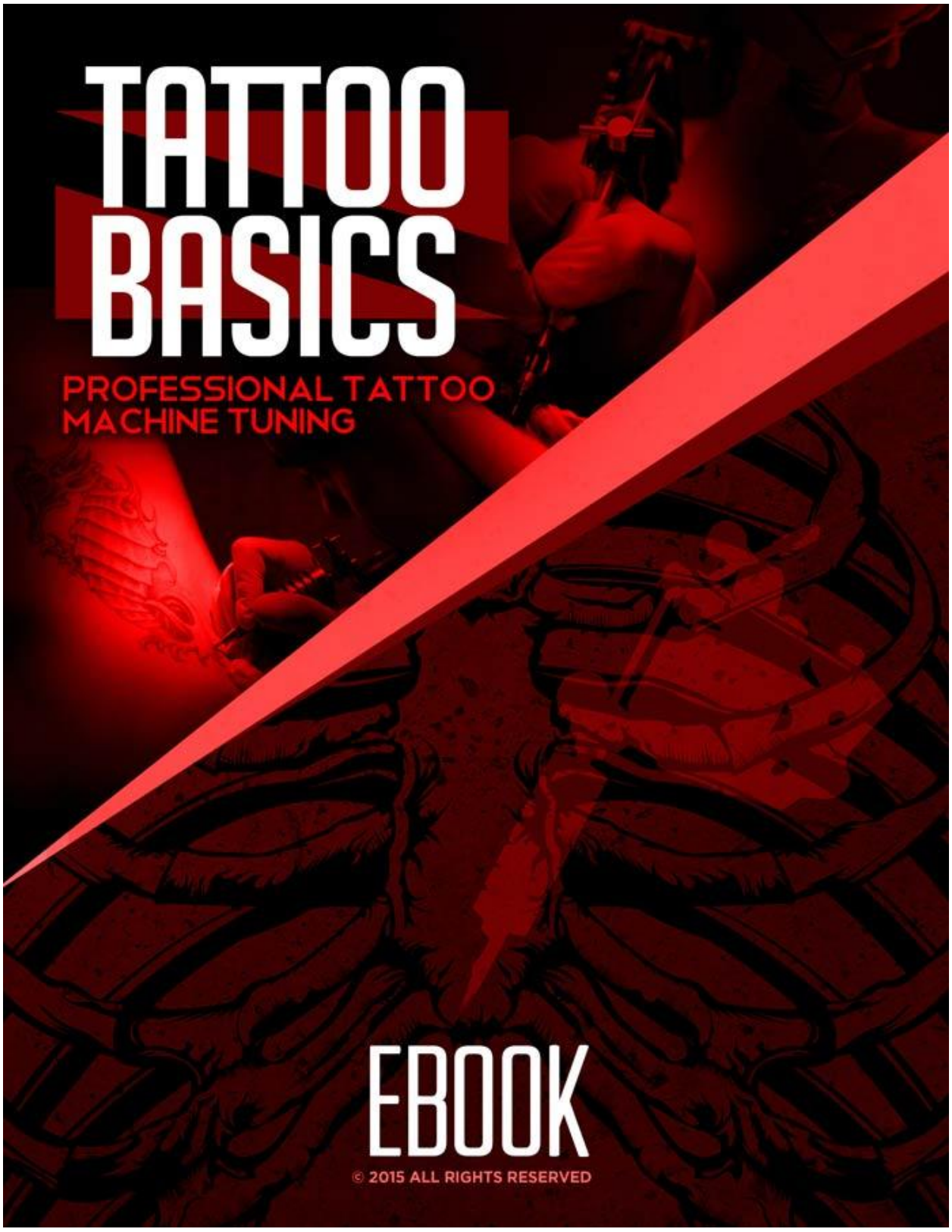

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Professional Tattoo Machine Tuning

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Some tattoo machines come made for lining or shading. Others do not. Regardless, all tattoo artists should know how to tune a tattoo machine to get it to behave how they want it to behave. Some artists like to build a completely custom machine, and others change a few parts or adjust a few parts to get the machine where they want it.

This is stuff that should be taught to you in an apprenticeship, so use this guide to build a foundation, better your understanding, or as a reference. It's also important to remember that there is no end-all, be-all when it comes to tuning your machine. You should know how to make adjustments and it helps to know what other artists prefer, but it's going to come down to what makes you feel most comfortable.

First, a very basic rundown of how a tattoo machine works.

As electricity passes through the wires in the coil, it causes the coils to become electromagnetic. The magnetized coils pull down the armature bar. This causes the front spring to lose contact with the contact post, breaking the circuit and causing the coils to lose their electromagnetism. The rear spring pulls the armature bar back up, and the front spring reconnects with the contact post, reestablishing the electromagnetism of the coils. The cycle repeats dozens of times every second.

Table of Contents

1. Machine Frame
    - Geometry
    - Material
    - Weight
    - Vibration
2. Coils
    - Wire Wraps Layers
    - Spacers
3. Armature Bar
    - Length
    - Weight
    - Material
4. Springs
    - Tension

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- Stroke
- Hit
- Taking Measurements

5. Rotary Machine

1. Machine Frame

Geometry

Height: Base to Spring Saddle

The height of the machine from its base to the rear spring saddle will determine the size of coils that can be used with the machine. You can use shorter coils with a larger frame, but you'll need a yoke to lift the coils closer to the armature bar. Obviously, you cannot fit larger coils on a shorter frame.

Front Binding Post

Also check out the location of the front binding post. If it's positioned in front of the front coil core, it's probably a shader. If it's positioned in line or behind the front coil core, it's probably a liner. Some machines allow you to move the front binding post farther or closer to the top of the machine. When the front binding post is beyond the front coil, it requires a longer spring which makes for a slower machine. When the front binding post is more in-line or behind the front coil core, it can use a shorter spring which makes for a faster machine.

Cutback Machines

The cutback gets its name from tattoo artists cutting their frame back where the front binding post fits. They would add a shorter front spring, too. Today, cutback machines come with the front binding post closer to the machine's rear, and with a shorter spring. The front binding post is typically in-line with the front coil core, or slightly behind it. A cutback machine is intended to run faster.

Most cutback machines are used for lining, but you'll find some used for shading. A common use of cutback shaders is for portrait work.

Material

The material with which your machine is made should be considered, too. Your coils require a conductive base to form a horseshoe magnet. If your frame is made of a conductive material, the frame can act as that conductive base. Otherwise, you need a yoke. Conductive frame materials include iron and steel. Generally, if the frame is not made of these materials, you should use a yoke. Brass, aluminum, and plastic are examples of other materials used to construct frames.

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Frame material largely determines the weight of the machine, too. Iron and steel machines are generally heavier, and aluminum machines are usually lighter. Also note whether the machine is cast from a mold, or if each individual part is attached using bolts.

2. Coils

Wraps

Coils come in different wraps, or layers. Some mistakenly believe that the wrap is the number of times a wire is wrapped around the coil. It is actually the number of layers of wire wrapped around the coil. Coils are generally found in 6-, 8-, 10-, and 12-wrap configurations. Coils are found with even layers because the wire must start and end at the bottom of the coil. Which you choose depends on what you'll use the machine to do.

Generally, 6- and 8-wrap coils are used for lining machines, and 10- and 12-wrap coils are used for shading machines. More wraps allows for a stronger magnetic pull. However, with more wire wrapped around the coil, more voltage is required to allow the electricity to reach the contact point. When using larger needle groupings such as magnums, the increased magnetic pull helps to drive the needle.

Some artists prefer to use a 10-wrap coil for all tasks unless using particularly large needle groupings such as 15 magnums—in this case they would use 12-wrap coils.

Magnetic Strength: Coil and Wire Specs

Coils come in different sizes. You'll commonly see the 1-inch mini coils and the 1¼-inch standard coils. This will affect the amount of wire wrapped around the coil, but it will not affect the number of wraps. It would require more wire to wrap 10 layers around a 1¼-inch coil than a 1-inch coil. Coil cores may have a diameter of $^{5}/_{16}$-inch or ⅜-inch.

The standard wire gauges are 22, 24 and 26 AWG (American wire gauge), although you'll find variations. The lower the number, the thicker the wire. For example, 22 AWG has a diameter of 0.253-inches; 24 AWG has a diameter of .0201.

Wire of a thicker diameter—such as 22 AWG—results in a stronger pull than wire of a smaller diameter because more current flows through it. The more wire in the coil, the greater the magnetic pull. So the larger the coils, the larger the diameter of the coil core, and the more wraps, the more wire for a stronger the pull.

A 10-wrap, 1-inch coil with 24 AWG wire will not have the same pull as a 10-wrap 1½-inch coil with 22 AWG wire. What's more, an 8-wrap coil with 22 AWG wire has a similar pull as a 10-warp coil with 24 AWG. One way you can figure out how strong a magnetic pull is with your coils is to consider the resistance.

Wire gauge also affects electrical resistance, measured in ohms. The higher the gauge (smaller diameter), the greater the resistance. Longer wire provides greater resistance because there is a greater

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distance for the current to travel. So a 10-wrap 24 AWG wire will have more resistance than an 8-wrap 24 AWG wire. Meanwhile, an 8-wrap 24-gauge wire will have more resistance than a 10-wrap 22-gauge wire.

Aluminum and copper magnet wire are most commonly used in tattoo machine coils. They are good conductors and relatively inexpensive compared to silver and gold, which are also good conductors. Aluminum has a higher resistivity than copper, so be sure to keep this in mind. Most coils use copper wire because it is generally cheaper than aluminum.

1.5 Coils

Most tattoo machines come with two equally-sized coils. Some, though, will come with one larger coil, and one smaller coil. This is called a 1.5 coil configuration. The idea is that the front coil will create a stronger pull. The pull on the front of the armature bar is more important than the pull on its rear because it's easier to pull the armature bar from the front than from the back. With a stronger pull, the front coil can more easily pull down the armature bar, which can allow you to run the machine at a lower voltage. Machines differ, though, so see what works best for you.

3. Armature Bar

Weight

The armature bar affects the way the machine runs, too. If the armature bar is heavier, your machine will run slower than one with a lighter armature bar. Generally, a heavier armature bar is used for shading, and a lighter armature bar is used for lining. It comes down to personal preference, though, i.e. the speed at which the artist prefers to run the machine. One way to reduce the weight of the armature bar is to include slots that remove some of the material.

By using a heavier armature bar, the artist slows the machine without increasing the air gap. By using a lighter armature bar, the artist speeds up the machine without decreasing the air gap.

Size

You'll see armature bars of different lengths and widths. A wider armature bar will provide more surface area for the magnet to grab, making it easier to pull it down. Common widths are ½-inch and ⅜-inch.

In terms of length, some armature bars will allow for a longer distance between the end of the armature bar and the rear spring saddle. Generally, armature bars for shaders are shorter (1-½-inch) and those used with liners are longer (1-⅝-inch). The shorter armature bars allow for a longer stroke because the pivot point is further from the spring deck and isn't as restricted as longer armature bars that are closer to the spring deck.

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Material

The armature bar has to be made of a magnetic metal like iron or steel so that it is pulled down by the electromagnetic coils. After all, that's the basis of how the machine runs. If you go with a steel armature bar, make sure you use one made of low-carbon steel. Carbon is diamagnetic, which means it creates an opposing magnetic field when exposed to a magnet. Its diamagnetism is overpowered by iron when combined to make steel, but when higher levels of carbon are used, the steel can lose some of its magnetic properties.

4. Springs

Tension

Rear Spring

When the rear spring tension is increased, a higher voltage is required to create a stronger magnetic pull to bring the armature bar down to the coils.

You can swing the rear spring to the back and bend it slightly upwards to increase the tension. Do not try to bend it downwards to reduce the tension; this can weaken the spring. The thickness, or gauge, of the spring will also affect the tension of the spring. The higher the gauge, the greater the tension.

Also keep in mind the spring's width relative to its length. If you increase the width of the spring relative to its length, the tension increases.

Front Spring

Increasing the front spring tension will cause the machine to run faster. When there's more flexibility in the spring, it will stay in contact with the contact post a bit longer. When there's less flexibility in the spring, it will 'bounce' off of the contact post faster. The length of time that the front spring contacts the contact post is called the duty cycle. You'll see it measured in percentages. For instance, if the duty cycle is 50%, the front spring touches the contact post for 50% of the time and does not touch it 50% of the time.

A longer front spring is used for shading, while a shorter front spring is used for lining. The front spring in a shader will usually extend beyond the front coil. The front spring in a liner usually will not. A cutback machine that has a short front spring is called a cutback machine. The short front spring makes it faster because it increases its tension. Remember, the greater the width relative to the length will increase the tension of the spring. More tension makes the machine run faster.

Hit

Think of this as how hard the needle will hit your client's skin. Greater spring tension (higher gauge) means a stronger hit. Lower tension (lower gauge) means a softer hit. A lot of artists prefer a harder hit

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for lining and a softer hit for shading. A common front--rear spring gauge combo for a liner is 18-20. For a shader, it's usually 16-18.

Stroke

The stroke refers to the distance that the armature bar must travel from the coils to its position where the front spring meets the contact post. Some refer to it as the 'throw'. A longer stroke will result in a slower machine and will require a higher voltage to pull the armature bar down to the coils. A shorter stroke will run faster and can be run at a lower voltage.

Increasing the tension on the rear spring by slightly bending it upwards increases the stroke. Without adequate tension, the stroke is going to be off. Just readjust the contact post for the new tension.

Pay attention to the air gap, too. The air gap is the space between the front spring and contact post when the armature bar is pulled down to the coils. Many set it at the thickness of a nickel for shading and a dime for lining, although a lot of artists consider this very basic and much of it is personal preference.

Angled Rear Spring Saddle

An angled rear spring saddle, meaning the front of the saddle closest to the coils is angled upwards, reduces the need to bend the rear spring to add tension. This reduces the chance of weakening the spring, thus extending its life. The angle also helps the armature bar hit the front coil flat while leaving a paper thin margin above the rear coil.

5. Capacitor

The capacitor works to reduce the spark created from the electromagnetism being turned off and on so quickly. Including the capacitor also helps to speed up the machine. Generally, a 22uf capacitor is used with liners, and a 47uf capacitor is used with shaders.

6. Contact Screw

The contact post is commonly made of brass or copper for their sturdiness and conductivity. Some are made of silver, although silver is a softer metal and might get dinged up by the set screw.

As far as its angle in relation to the front spring, artists have differing opinions as to whether you should aim for a 90-degree angle. With the contact post at a 90-degree angle to the front spring, you'll get more contact area on the spring for greater conductivity.

This comes back to machine geometry. Shaders often use longer front springs, so shader machines will position the contact post in front of the front coil. A liner or cutback machine often uses a short spring, so the contact screw will be closer to the rear of the machine—many are located above or behind the front coil core.

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7. Taking Measurements

Artists will measure their machine's specs in different ways. Some choose to simply go by the sound that it makes when it's running. Others use manual tools to measure spring tension and other specifications, while some turn to the digital power supplies to measure things like the duty cycle, speed, voltage, amps, etc.

A spring tension gauge is a manual tool used to measure the spring's tension in grams. A torque arm is placed on the armature bar, and the artist will press down on the gauge's handle until the armature bar touches the front coil. The scale will indicate spring tension. A tool to align the armature bar is also available.

8. Rotary Machine

Most think of the coil machine when they think about tattoo machines. A lot of people don't consider the rotary tattoo machine, which uses an electric motor instead of magnetic coils to drive the needle. The motor moves the needle up and down without the use of coils, armature bar, or springs. It runs very quietly and with minimal vibration, and because it does not include coils and the armature bar assembly, it can weigh much less than the coil machine.

Artists have different feelings on the rotary machine. Some like it; some do not. It comes down to preference above anything. Those who like it note that there is less that can go wrong with the rotary machine than the coil machine, reducing time spent on tuning and maintenance. Others say the opposite is true; that rotary machine shave more that can go wrong because of the motor.

As for performance, it's again personal preference. A lot of artists say the rotary machine causes more trauma to the skin, but others say that it just takes adjustment from the artist to avoid chewing up the skin. The coil machine will puncture and retreat from the skin quicker than the rotary machine. The artist needs to make sure to account for this while tattooing.

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