Technical Report

Armature Bars

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The armature bar is the major moving component on a tattoo machine. The armature and springs translate electromagnetism generated in the coils of the machine into the kinetic energy that is used to tattoo.

The armature bar on a tattoo machine is the metal bar that is connected by the back spring of the machine to the machine frame. The spring allows movement of the armature. Motion in a tattoo machine is the motion of the armature being attracted to the energized electromagnets, and the armature's consequent return to its initial position by force of the back spring when the magnets are not energized. The front spring of the machine is connected to the armature and moves with it, thereby opening the contact points when the bar is attracted to the magnets. The opening of the contact points breaks the electrical circuit of the machine, turning off the electromagnets. When the back spring returns the armature bar to its initial position, the contact points close, energizing the electromagnets. The needle bar is connected to the front of the armature bar. When the armature moves, the needle bar and needles will move, over the same distance and at the same rate of speed as the armature.

Armature bars currently sold by tattoo supply companies are generally made of cold rolled steel, nickel plated, weighing approximately 13 grams and are 1 3/8 inches long, 3/8 of an inch wide and 3/16 of an inch thick. One end of the bar has a 1/8 of an inch round pin, approximately 5/8 of an inch long to hold the eye of a needle bar. There is a hole 7/32 of an inch from the other end of the bar, threaded to accept a 8-32 screw. This screw secures both the front and back springs of the machine to the top of the armature bar.

The objectives of this report are to examine:

a) what effect mass, and the distribution of mass of the armature bar have on the function of the machine.
b) if there are differences between armature bars made of steel, and armature bars made of iron.
c) what effect different types of spring mounting to the armature have on the function of the springs.

Tests

Test #1

Two armature bars were manufactured of identical material and weight, but weight was distributed differently on each. Both armature bars were run on the same machine with identical tolerances and springs.

Test #2

Three armature bars were manufactured each being of a different weight, and weight distribution. All of the armature bars were run on the same machine with identical tolerances and springs.

Test #3

Two armature bars were manufactured being of identical weight and weight distribution, one made of iron, one made of steel. Both armature bars were run on the same machine with identical tolerances and springs.

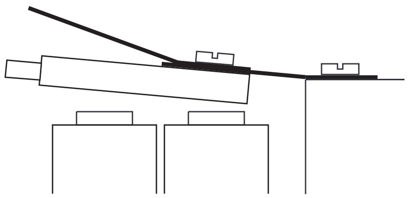
Test #4

Two bars were manufactured being of identical weight and weight distribution, one with a conventional system of mounting springs, one with a prototype system of back spring mounting. Both armature bars were run on the same machine with identical tolerances and various back spring gauges.

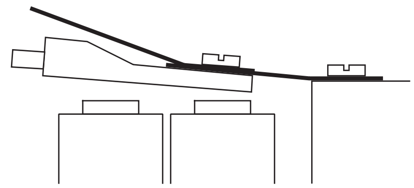
Test Results

Test #1

The armature bar with weight distributed to the front of the bar caused the machine to run slower.



Even

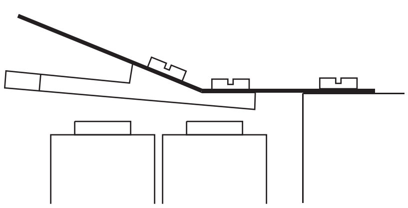


Weight at Front

Armature	Weight	Duty Cycle	Speed	Voltage	Point Gap	Front Spring	Back Spring
Even	12.75 g	50%	154 Hz	3.9	1.0 mm	0.020”	0.019”
Weight at Front	12.75 g	50%	138 Hz	3.9	1.0 mm	0.020”	0.019”

Test #2

The lightest armature bar caused the machine to run the fastest. The heaviest armature bar caused the machine to run the slowest. All other readings were identical.



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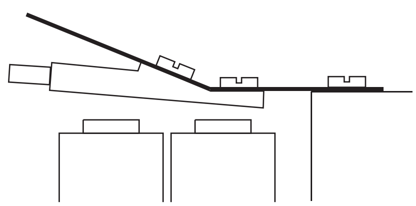
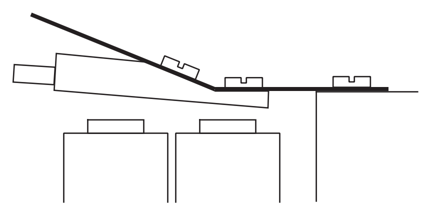


Medium

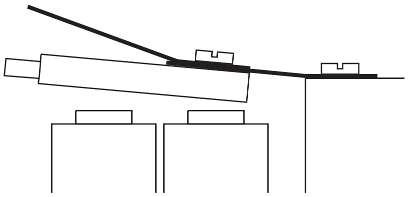


Heavy

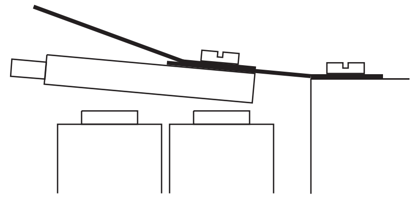
Springs	**Front - 0.014” Back - 0.015”**			**Front - 0.015” Back - 0.016”**			**Front - 0.016” Back - 0.017”**		
Armature	Light	Medium	Heavy	Light	Medium	Heavy	Light	Medium	Heavy
Weight	9.39 g	11.0 g	13.03 g	9.39 g	11.0 g	13.03 g	9.39 g	11.0 g	13.03 g
Speed	136 Hz	130 Hz	112 Hz	140 Hz	132 Hz	121 Hz	162 Hz	143 Hz	129 Hz
Duty Cycle	48%	50%	48%	44%	42%	42%	43%	43%	44%
Voltage	5.3	5.3	5.4	5.3	5.3	5.3	5.4	5.4	5.4
Point Gap	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm	1.5 mm

Test #3

All readings other than speed were identical. Difference in speed was negligible.



Iron

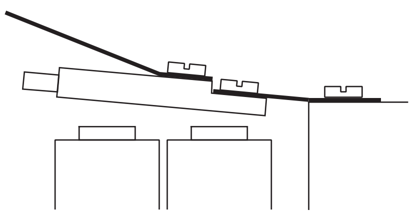


Steel

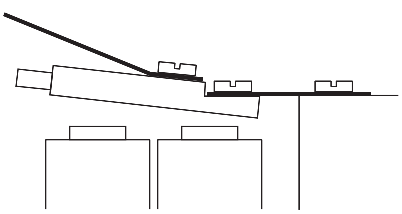
Armature	Weight	Duty Cycle	Speed	Voltage	Point Gap	Front Spring	Back Spring
Iron	13.8 g	40%	119 Hz	5.0	1.5 mm	0.015”	0.014”
Steel	13.8 g	40%	117 Hz	5.0	1.5 mm	0.015”	0.014”

Test #4

Using the prototype mounting system, identical results were obtained with a back spring gauge 0.002” thinner.



Conventional



Prototype

Armature	Weight	Duty Cycle	Speed	Voltage	Point Gap	Front Spring	Back Spring
Conventional	11.5 g	47%	127 Hz	6.0	2.0 mm	0.016”	0.017”
Prototype	11.5 g	47%	127 Hz	6.0	2.0 mm	0.016”	0.015”

Conclusions

Armature bars now in use have two major flaws: they require that the springs must be bent to mount the armature bar in the machine, and secondly most armature bars are approximately the same weight.

Conventionally the back spring has to be bent at the edge of the machine frame. This bend, in conjunction with spring gauge determines the pressure placed on the contact points of the machine. This pressure is an important factor in how the machine will run. Enough pressure must be exerted on the contact points to cause them to open and close cleanly. A great deal of what is considered back spring action is a result of the bend in the metal of the spring acting as a hinge, restricting maximum spring performance. The bend in the spring is also difficult to reproduce when changing gauges or replacing springs. The weakening of the spring at the bend eventually will result in a broken spring.

The speed of a machine is affected by the weight of the armature bar. Distribution of weight toward the front of the armature bar has the same effect on machine speed as increasing the overall weight of the bar. Weight distribution can be used to advantage when a heavier bar is required to slow machine speed. Increasing the weight of the bar by increasing the size of it may be impossible as there are limitations to the size that an armature bar can be, and still fit into a machine frame. Armature bars now in use, weighing approximately 13 grams, evenly distributed across the bar, are best suited to a relatively fast running machine. Attempting to make a machine equipped with this weight of armature bar run at speeds required for coloring requires a large point gap, long stroke and soft front spring. By utilizing the weight of the bar to slow the machine down, proper speed can be achieved with a smaller point gap and shorter stroke.

The material used to manufacture the armature bar has a minor effect on machine speed. The goal in tuning a machine is to attain an exact usable speed, not necessarily the fastest or slowest possible.

Machine speed is determined by a combination of spring gauges, pressure exerted on the contact points and armature bar weight. The weight of the armature is primary in establishing machine speed. Spring gauge is used to fine tune speed and duty cycle of each machine.