Fusing Charts

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The dimensions on the attached charts show ideal measurements for Commutator Fusing. It should be understood that it is not expected that these exact dimensions will be used. However, the closer the actual dimensions to these ideal dimensions, the better the fused connection.

The dimensions on the charts are usable only to three (3) decimal places for inch measurements and two (2) decimal places for metric measurements.

Slotted Commutators

The commutator slot's dimension must have a definite relationship to the wire size, or fusing will be difficult or even impossible. This relationship is shown on the attached charts. The charts are computed for two wires of the same size, one on top of the other in the commutator slot.

There are two width dimensions used for commutator slots. One is for hand insertion of the wires into the commutator's slot. The other is for machine insertion. The width for hand insertion is usually slightly wider than the wire's coated diameter. This is so the wire can be easily placed in the slot manually. Some consideration must be given to holding the wire in the slot until it is fused. For machine insertion, the slot's width is slightly smaller than the width of the coated wire. This is because the device that inserts the wire into the slot forces it, so that there is an interference fit. If there was no interference fit, the wire would fall out of the slot before it is subsequently fused in place.

Commutator slots were originally used for soldered connections, and must be modified for fusing. When designed for soldering, the slot was wide enough to allow solder to flow into it and around the wire. If we try to fuse into a slot designed for soldering, we will not get an acceptable joint. We must have a slot with little or no space between its walls and the wires. When we fuse with this type of slot, we deform the wire to the shape of the slot. This pushes the wires to the walls of the slot and into its corners, forcing out all of the air. If we used the solder type slot, we would not be able to push the wires against the walls, as the walls would be too far apart.

The ideal slot is one which has a smaller width than the uncoated wire's diameter. Commutator lead connecting machinery is available for pushing wires into slots with smaller widths. An example of this is number 20 AWG wire, whose nominal insulated diameter is 0.0339 inches (0.812 mm), which can be inserted into a 0.0333 inch (0.845 mm) wide slot with a properly tooled commutator lead connecting machine.

For hand insertion of the wires into a slot, the slot must be larger in width than the wire's diameter. Normally, a 0.003 to 0.005 inch (.076 to 0.127 mm) difference between the coated wire's diameter and the slot's width is acceptable, but the smaller this difference, the better the connection.

Normally, the commutator fusing machine mechanically indexes the armature from one commutator bar to another. The same is true for machines that insert the wire into the commutator. For this reason, the slots must be aligned on their segments so they are spaced equally apart, to form a geometrically perfect pattern or either the fusing electrode or insertion tool will not contact the area of the segment where the wire is located. For fusing, the slots can be up to 0.010 inch (0.250 mm) off of this pattern, depending upon the wire size. For machine insertion, the slots cannot be more than 0.001 inch (0.025 mm) off, or the insertion blade might break by hitting the surface of the brush track.

When fusing armatures with larger size wires (larger than number 23 AWG-.023 inches or .574 mm in diameter) which are coated with class H insulation, to slotted commutators, a riser cut type construction is usually essential. The riser must be high enough, so that the bottom of its slot is at least slightly above the commutator's brush track. This construction forces the heat to travel through both wires in the slot, before being dissipated through the body of the commutator. If the riser is not used, the heat from the fusing electrode will dissipate throughout the brush track, before it reaches the bottom wire in the slot. If the heat does not reach this wire, most likely there will not be enough insulation removed from it to make a satisfactory electrical connection. On the other hand, if excess heat is applied through the electrodes to remove the required insulation on both wires in flush cut commutators, this excess heat could completely anneal the entire commutator segment, and possibly damage the commutator's anchoring structure.

Tang Terminals

There are basically two different types of tangs that can be fused with a commutator fusing machine. One is a flat tang and the other is a projection tang. Normally, the flat tang is used for copper wire. The projection tang was developed for aluminum wire, but can be used with almost any type of wire. The projection tang is a proprietary device.

The attached charts are computed for up to two wires of the same size under a tang.

The projection tang uses the height of the projection to absorb the pressure of the fusing electrode. When using aluminum wire under a flat tang, the wire is usually crushed beyond use. With the projection tang, the wire is protected from this crushing.

The tang must be fully supported. If not, it will become deformed or even break off due to the mechanical pressure imparted during fusing. This is one of the major causes of improperly fused commutators.

There can be no burrs or other rough areas under the tang. If there are any, the wire will be damaged or even cut when the tang is closed during fusing. This condition is normally seen were the tangs are created by milling. The finer the wire being fused, the more critical the need for the elimination of these rough surfaces.

The tang's shape is normally the same as a "U" on its side. Sometimes the shape of a "V" is used, but this shape has a tendency to weaken fine wires during the fusing process. Also, the "V" shape pushes the wire out of the tang as the tang is closed.

American Wire Gauge (AWG)

The standard wire measurement system used in the United States that is derived from the Circular Mil measurement.

British Standard Wire Gauge (SWG)

A wire measurement system that is used in Great Britain and a number of British Commonwealth countries.

Circular Mil (Cir Mil)

A term that is used to universally define the cross-sectional area of an electrical conductor. A Circular Mil is equal to the area of a circle that is 1/1000 (0.001) of an inch in diameter. As the conductor's diameter increases, so does the number of Circular Mils. Circular Mils are used to calculate the current carrying capacity of electrical conductors.

International Electrotechnical Commission (IEC)

This is the organization that developed the current standard metric wire sizes.