Testing a Pulse Shape, 14k Ni WG

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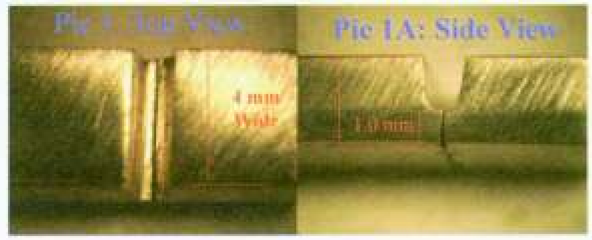
The following is one method of adjusting parameters after altering the pulse shape. This article is not intended to promote pulse shaping as a means of welding nickel white gold, (Ni WG). More importantly, it is primarily intended as a report on the particular method of pulse shaping that was used here, to incorporate pulse shaping into the welding of 14k Ni WG. The method could be used for welding other material as well. This project's secondary intent is to test, by the best means available, if greater ductility can be achieved in 14k Ni WG by the use of a particular altered pulse shape. Also discussed are some details that have been helpful to the welding of Ni WG, with or without pulse shaping. A more comprehensive report on welding Ni WG, as well as basic principles of pulse shaping, weld parameter schedules, instructions, and charts is available. The report contains an informational video as well. For more details on how to acquire this report, call 619-239-5842 or e-mail lasers@mantech.info. The reader will notice that the following results achieved, by the use of pulse shaping, appear to be in favor of the particular pulse shape (PS) and method used. Please note that the testing procedures used for these documented results are rather crude in comparison to what could be done in a real metallurgical lab.

Pictures 1 and 1A show a piece of 14k Ni WG, medium temper, which is 4mm wide by 2.5mm thick. The weld seam is a notched butt joint. The notch is to permit the welding of a thinner section with a lower energy. The reasoning behind having the notched joint is more adequately described in a previous article, titled: "Ni WG Welding". A reasonably tight fitting joint permits a small beam diameter adequate penetration (volts) and melting, (MS), with the least amount of energy. Energy must be balanced (between volts and MS) for the selected beam diameter, so that



a solid 60% penetration is achieved from both the top and the bottom of the joint. Pictures 2, 2A, and 2B show the initial weld. Weld 1 on The Weld Schedule Chart shows the chosen parameters. For more on determining adequate penetration and melting read the article titled: "Proportions and Effects". Fifty percent penetration with a pulse rate of 0 Hz was settled with volts, pulse duration, and beam diameter. Further penetration is achieved with a faster pulse rate of 5 Hz. A faster frequency with balanced energy minimizes air pockets in the weld from inconsistencies in travel speed and welding angle that will occur when the piece being welded is held in the hand as the vast majority of jewelers must do. However, a faster frequency requires caution that the piece be kept in a steady constant motion so that one area of the seam is not overheated and over worked by too much melting.

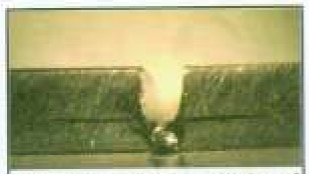
The initial weld that is shown in Pictures 2, 2A, and 2B was performed with a standard pulse shape, (PS). The PS has a direct relationship with total energy (J), as well as energy spread (J/cm^2). Whereas any alteration of the PS from standard by itself

will decrease J, and J/cm², the standard PS allows maximum energy, which is ultimately determined by the balance of volts and duration (MS).

Weld 1, Pictures 3, 3A, & 3B: After the initial weld, the energy is sufficient to simply widen the beam diameter spreading the 1.55J into a wider area, (J/cm²), so as to allow a shallower penetration and melting, but wider filling with 30 gauge, (.010"), 18k, Ni WG wire. More about Ni WG filling is discussed in the article titled: "Ni WG Welding".

Pic 4: Smaller notch cut into top of weld to relieve compression stress while bending to test for ductility.

For this project the weld fill within the notch was filed flat, back to a dimension of 1 mm thickness, and then further notched with a saw blade. Further notching was minimal (Pictures, 4, 4A, 4B), and was accomplished only to relieve compression stress as the piece was bent (similar to the technique used to notch and bend a flat wire around a gemstone for a bezel). While bending weld 1 during the failure test, close attention was given that the sides of the small notch did not make contact before the weld cracked.



Pic. 4A: Weld 1. Side of notched weld.

Pic. 4B: Weld 1, Bend Test

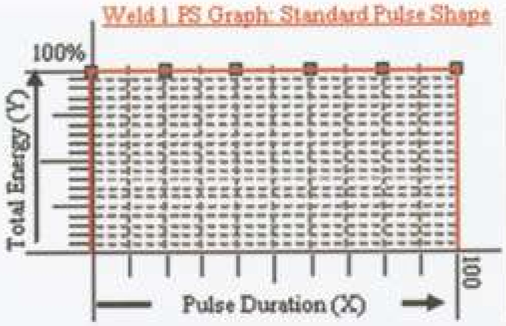
Pic 4C: Weld 1, Air Pockets

If contact was made, re-notching would be necessary again to relieve compression stress while bending further. Human sensitivity was used to feel and see when the weld started to crack. After the beginning of a crack was determined, the bend angle was measured and documented in Picture 4B at 160°. A view of the broken weld from the inside, as seen in Picture 4B, shows evidence of very small air pockets that are very difficult to avoid when holding the piece by hand when welding. Well balanced energy for proper penetration and melting; consistent, even movement of the piece, and good ability to stay in focus, will reduce these air pockets to a minimum.

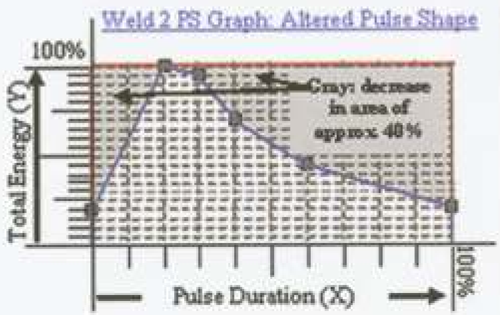
The results of this article's test that are illustrated and discussed here are not as important as the following process for re-adjusting the energy (volts and MS) after the PS has been altered, in any way, from standard. If the particular make and model of machine being used offers: 1.) An energy readout, (Joules), as well as: 2.) An energy spread / concentration readout (J/cm²), then: those displayed readings can be used as references when comparing one pulse shape to another, as well as comparing the visual

Weld Schedule Chart	Energy Spread or Concentration (Joules per square centimeter)						Notes
	Total Energy						
	Volts	Duration	Pulse Shape	Joules, (J)	Beam Diameter	J/cm²	
Weld 1 Pic. 2, 2A ,2B	215	2.0 ms	Standard	1.55 J	0	856.6	Initial weld through 1.0 mm. V and ms balanced to give necessary penetration & melting
Weld 1 Pic 3, 3A, 3B	215	2.0 ms	Standard	1.55 J	13	332.9	Drawing bead around initial weld
Re-Adjustment of Volts and MS after altering Pulse Shape	215	2.0 ms	Altered See PS graph	0.84 J	0	466.8	Altered pulse shape, J & J/cm² decreased
	223	3.0 ms	Altered	1.56 J	0	867.4	re-proportioned volts & ms to bring J back up to target 1.55 J, (Still not enough)
	236	3.5 ms	Altered	2.32 J	0	1283.0	Increased, (re-balanced), volts and ms to compensate for approx. 40% loss of standard pulse shape on gragh. Increased more than 40% until proper effect was achieved.
Weld 2	236	3.5 ms	Altered	2.32 J	0	1283.0	Initial weld through 1.0 mm
Weld 2	236	3.5 ms	Altered	2.32 J	13	498.6	Drawing bead around initial weld

effect of one weld to another with an altered pulse shape. Equally as important, having those references allows us to re-adjust our energy, after altering the PS. As shown on the yellow highlighted portion of this projects Weld Schedule Chart, altering the pulse from standard reduced J and J/cm². Weld 1 initial parameters, (with a standard PS), dictated that we use 1.55 J and 856.6 J/cm² for the initial weld of the 1mm thick stock in Pic. 2. After altering the PS the energy can be brought back up to 1.55 J by increasing volts, MS, or more likely, a combination of both, in order to achieve the required penetration and melting with the altered PS.



Ref.	X	Y
1	0	100%
2	20%	100%
3	40%	100%
4	60%	100%
5	80%	100%
6	100%	100%



Ref.	X	Y
1	0	20%
2	20%	100%
3	30%	95%
4	40%	70%
5	60%	45%
6	100%	20%

Simply increasing the J, and or J/cm² to the targeted reference (in this case 1.55J / 856.6 J/cm²) will not always produce adequate penetration and melting into the same 1mm piece. Of course volts and MS have to be balanced for the chosen beam diameter, regardless of PS, (See Article: "Proportions and Effects"). However, even if the target 1.55 J and 856.6 J/cm² is selected after altering the pulse, the penetration and melting effects are often less than was achieved with the standard pulse shape. Therefore a given J and J/cm² will produce one effect in a particular PS and a different effect in another PS. (See article: "More About Pulse Shaping"). When comparing the effects of a given J and J/cm² in standard PS, to an altered PS, the effect will always be less aggressive in the altered PS.

The difference in effect is related to the percentage of change that was made from the standard to the altered. The blue line, in Weld 2 PS Graph, indicates the altered pulse shape used. The red line is included to show the