Contents

The Process

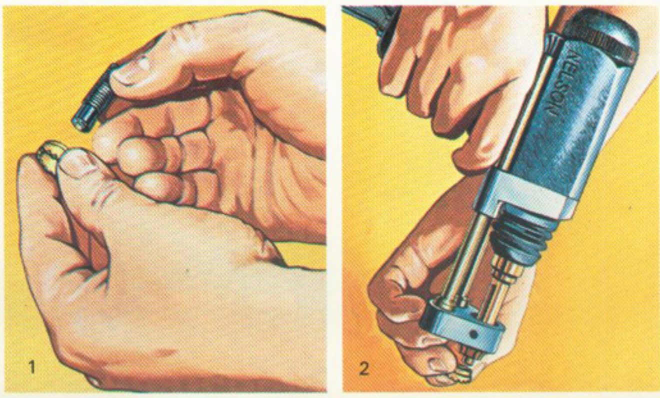
Stud Welding involves the same basic principles and metallurgical aspects as any other arc welding procedure, in that a controlled electric arc is used to melt the end of the stud or electrode and a portion of the base metal. The stud is plunged automatically into the molten metal and a high quality fusion weld is accomplished where the weld is stronger than the stud itself.

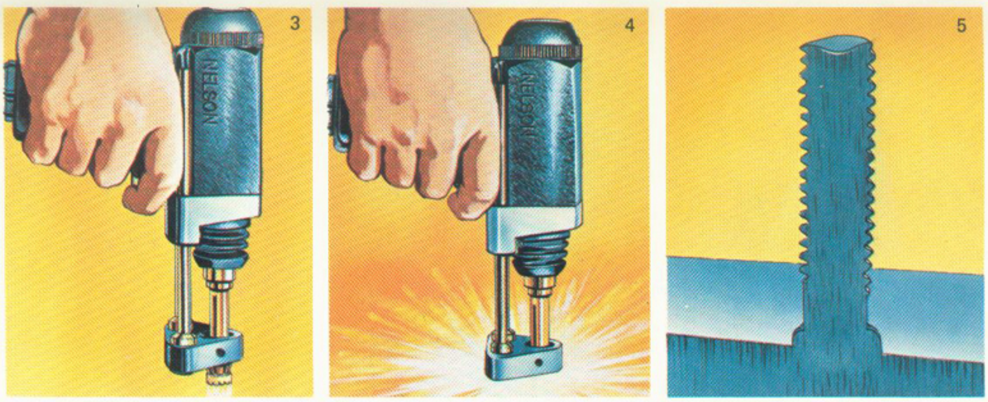
Stud Welding is applicable to mild steel, stainless steel and aluminum. Studs may be fed to the welding gun manually or automatically, depending upon the application. In either case, a simple squeeze of the trigger produces a positive attachment in a split second.

Stud welded fasteners may be almost any size, shape, or type and there are literally hundreds, however, they must be made of weldable materials and one end of the fastener must be designed for welding.

Many conventional DC welding machines may be used, but special power units designed specifically for stud welding are recommended.

Shown here pictorially, the stud welding process starts with (1) a Nelson® stud and ceramic ferrule which are inserted (2) in the stud welding gun. (3) The stud end is pressed against the work and the trigger squeezed. (4) An electric arc between the stud and work creates a pool of molten metal which is confined by the ferrule and the stud is automatically plunged home. (5) The metal solidifies in a split second and the stud is completely welded across its base as the cutaway section shows.





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Stud Welding Methods

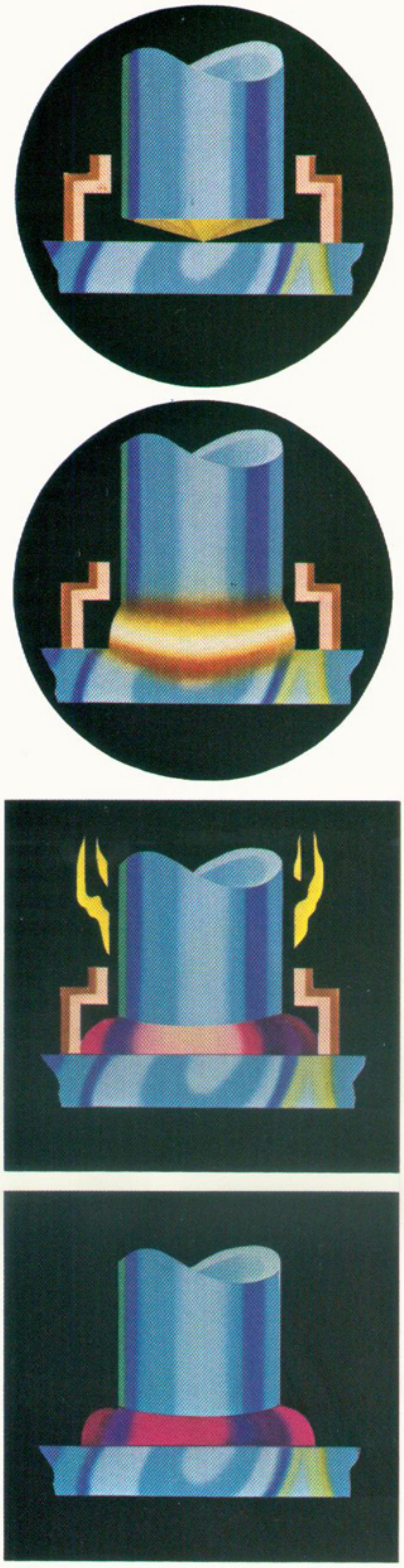
First of Three Common Methods

Electric Arc

Electric Arc stud welding is the most common process and is utilized whenever metal is fabricated. It is used to best advantage when the base plate is heavy enough to support the full strength of the welded fasteners, but is sometimes used with lighter gauge material.

The stud is held in the welding gun with the end of the stud placed against the work. The cycle is started by depressing the trigger button start switch. The fastener is then automatically retracted from the workpiece to establish an arc. The arc continues for a predetermined period of time until a portion of the stud and base plate have been melted. Then the welding gun automatically plunges the fastener into the molten pool of metal and holds it there under spring pressure. At the same time, the welding current is stopped and, when the molten metal solidifies, the weld is completed and the welding gun is removed from the stud.

The molten metal is held in place by a ceramic ferrule which also serves to shield the arc. The weld metal is deoxidized by a flux in the weld end of the fastener, or protected by a shielding gas as in the case with aluminum. This results in a dense, strong weld which will develop the full strength of the fastener and base plate. The weld cycle depends on the diameter of the fastener and the materials being joined, and varies in time from 1/10 to 1-1/2 seconds. Welding currents range from 250 to 3,000 amps.



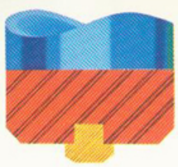


Fig. 1

Cross-sectional view of solid flux locked into the weld end of the fastener. Flux material serves an arc stabilizer and dioxiding agent.

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Stud Welding Methods (cont.)

Second of Three Common Methods

Drawn Arc Capacitor Discharge

Drawn Arc Capacitor Discharge or Stored-Arc® stud welding is in essence a combination of Electric Arc and Capacitor Discharge stud welding. It was developed to introduce more controls into the capacitor discharge process while not sacrificing its many real advantages.

The operation sequence of the Stored-Arc process resembles that of the Electric Arc method. The stud is placed in the gun, the cycle is started by closing the start switch, the fastener is drawn off the workpiece and the arc is initiated. The stud is then plunged back into the molten metal and the weld is accomplished. This approach gives a more precise control over the welding operation by making the control over the elapsed time of current flow independent of the geometry of the welding end of the stud. In effect, time and current controls were transferred from the shape or design of the fastener to the welding equipment itself.

This subtle change eliminated a major quality control and cost problem, and made stored-arc practical for high speed welding where quality control was vital.

Third of Three Commom Methods

Capacitor Discharge

Capacitor Discharge stud welding incorporates a power source utilizing energy stored in a bank of capacitors and solid state controls permitting quick weld fusion in 2-3 thousandths of a second.

Fasteners are engineered and manufactured with a small projection or tip on the weld end and are welded by either the contact or gap method. Heat for fusion is obtained when the bank of capacitors is discharged. The small projection presents a high resistance to the stored energy and rapidly disentegrates, creating an arc which melts the end of the stud and a portion of the base material. The stud is then forced into the molten metal before the conclusion of the arc cycle and upon cooling, a uniform, cross sectional bond is achieved.

A special advantage of the capacitor discharge process is the limited heat generated and the low penetration, so that fasteners can be welded to extremely thin material and material with coated surfaces opposite the weld side.

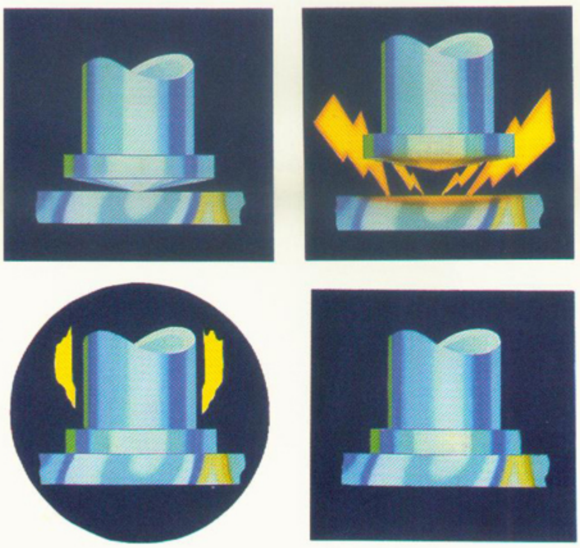
Capacitor discharge lends itself to hand, semi-automatic and automatic feed systems through 5/16" (7.9 mm) diameter in carbon, stainless, aluminum and brass materials.

Gas Arc/Short Cycle

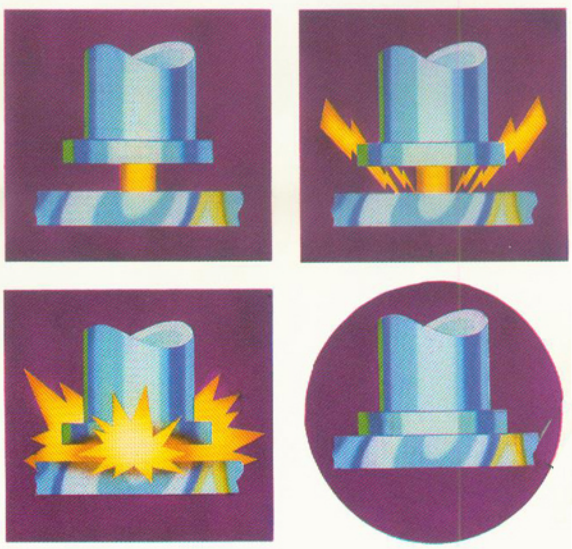
Additional process techniques have been developed which employ the basic electric arc stud welding principle but are limited to specific types of applications.

The "Gas Arc" process uses an inert gas instead of a ferrule for shielding the arc from the atmosphere. This process has been used on both steel and aluminum stud welding applications, with its greatest application and benefit potential being in the "pot and pan" industry whereby Nelson studs are welded to pan surfaces for securing handles and legs. Hex, round and square shaped studs can be hand, semi-automatic and automatically fed with standard Nelson production systems.

The "Short Cycle" technique utilizes a relatively high weld current for a very short period of time via the electric arc process. Short cycle welding is limited in application usually involving small diameter studs to thin base material where the base material strength is the governing factor rather thai the weld strength. Nelson engineers will evaluate all application criteria to determine the most efficient and reliable process to meet your application specification. Hand-fed, semi-automatic and automatic feed short cycle stud welding is available through 1/4" (6.4 mm) diameter.



Drawn Arc Capacitor Discharge



Capacitor Discharge

Select the Proper Welding Method

Designing for Stud Welding

Base Metal:

The base metal must be weldable. Ordinary low carbon steels or austenitic (300 series, other than 303) stainless steels produce proper results. Other steel alloys may be welded but heat treatment may be required to develop full weld strength. Studs may also be welded to aluminum, brass, and copper alloys. Where special materials are involved, weld quality must sometimes be determined by testing of samples. Where there is an uncertainty as to the weldability of certain materials, Nelson sales representatives stand ready to provide technical assistance in making weld quality determinations.

Process Selections:

Nelson stud welding processes fall into two categories: standard electric arc stud welding, and Stored-Arc stud welding. While there is some slight overlap, application areas are usually well defined. Selection should be based on the following considerations: (1) Fastener size. Stud diameters over 1/4″ (6.4 mm) require electric arc stud welding. (2) Metal thickness. Stored-Arc stud welding is usually used if the parent metal is less than 16 gauge (1.52 mm). For heavier metal, stud welding can be used if the fastener design ratio is adhered to. (3) Composition of material. Either process can be used with mild and austenitic stainless steels. Certain aluminum alloys can also be welded with both. The capacitor discharge process can be employed with copper, brass and galvanized sheet. (4) Fastener shapes. Standard stud welding and Stored-Arc can be used for unusual shapes such as square or rectangular pins, collar studs, split pins, hooks, etc.

Fastener Design Ratio – Electric Arc Stud Welding:

The base metal thickness should be at least 1/3 weld base diameter of the welded stud. This assures complete development of fastener strength, so that the weld is stronger than the stud itself. Where strength is not the foremost requirement, base metal thickness may be a minimum of 1/5 the weld base diameter.

Stud Welding Process Variation Selection Chart

Fig. 2

	Electric Arc	Stored-Arc
Stud shape		
Round	A	B
Square	A	B
Rectangular	A	B
Irregular	A	B
Stud diameter or area		
1/16 to 1/8 in. (1.6 to 3.2 mm) diam.	C	A
1/8 to 1/4 in.² (3.2 to 6.4 mm) diam.	B	A
1/4 to 1/2 in.² (6.4 to 12.7 mm) diam.	A	B
1/2 to 1 in. (12.7 to 25.4 mm) diam.	A	D
Up to 0.05 in. (32.3 mm²)	A	A
Over 0.05 in. (32.3 mm²)	A	C
Stud Metal		
Carbon steel	A	A
Stainless steel	A	A
Alloy steel	B	C
Aluminum	A	A
Brass	C	A
Base metal		
Carbon steel	A	A
Stainless steel	A	A
Alloy steel	B	C
Aluminum	B	A
Brass	C	A
Base metal thickness		
Under 0.015 in. (0.4 mm)	D	B
0.015 to 0.062 in. (0.4 to 1.6 mm)	C	A
0.062 to 0.125 in. (1.6 to 3.2 mm)	A	A
Over 0.125 in. (3.2 mm)	A	B
Design criteria		
Heat effect on exposed surfaces	B	A
Weld fillet clearance	B	A
Strength of stud governs	A	A
Strength of base metal governs	A	A

A - Applicable without special procedures, equipment, etc.
B - Applicable with special techniques or on specific applications which justify preliminary trials or testing to develop welding procedure and technique.
C - Limited application.
D - Not recommended. Welding methods not developed at this time.

Stud Selection

Fastener Design Ratio – Stored-Arc Stud Welding:

Base metal may be as thin as .016" (3.9 mm) for steel, .040" (1.2 mm) for aluminum. On such light gauge material, stored-arc studs will cause sheet failure under ultimate load. On heavier material fastener failure will occur under ultimate load.

Standardization:

Standard Nelson studs provide the most economical answers to most requirements. They cost less than special designs and are available for immediate delivery. Low fastener cost is always achieved when the designer can:

- Specify standard stud types.
- Select standard diameters and lengths.
- Use standard materials.

In addition to the in-stock standards, Nelson manufactures a limitless variety of special welding studs. It should be remembered however, that whenever the diameter or length of a stud is changed, the production equipment must be adjusted. Such adjustment is simple, but time consuming and costly. Standardization is ideal from both the purchasing and production standpoints. It is possible to specify such secondary machining operations as cross drilling, slotting, bending, swagging and piercing with many standard Nelson studs. For special shapes, lengths and machining operations, consult your Nelson sales representative.

Selecting Stud Dimensions:

When ordering a standard stud welding fastener, specify the dimensions and terminologies as presented in the Nelson In-Stock Stud catalog. Nelson specifications indicate a before-weld length dimension, which is the overall stud length before it has been welded to the base metal. Electric arc welding studs reduce approximately 1/8" (3.2 mm) to 3/16" (4.8 mm) in the welding process, depending on stud diameter.

Fig. 3

Stud Diameter	Length Reduction
3/16" Dia. Through 1/2" Dia.	1/8"
5/8" Dia. Through 7/8" Dia.	3/16"
1" Dia. and Over	3/16" - 1/4"

Threads:

The standard threads on studs are UNC-2A, prior to plating. Other threads are available on request. Standard maximum thread length is 3".

Power Requirements:

To avoid unnecessary delays or production problems, the designer should know what welding power will be required and the limitations of available welding machines. For data see the section entitled "Welding Power."

Recommended Minimum Plate Thickness of Steel and Aluminum for Arc Stud Welding

Fig. 4

Stud base diameter		Steel			Aluminum			
		Without backup			Without backup		With backup	
in.	mm	in.	mm	Mfrs. Std. Gage	in.	mm	in.	mm
3/16	4.8	0.036	0.91	20	0.125	3.2	0.125	3.2
1/4	6.4	0.048	1.21	18	0.125	3.2	0.125	3.2
5/16	7.9	0.060	1.52	16	0.187	4.7	0.125	3.2
3/8	9.5	0.075	1.90	14	0.187	4.7	0.187	4.7
7/16	11.1	0.097	2.28	13	0.250	6.4	0.187	4.7
1/2	12.7	0.120	3.04	11	0.250	6.4	0.250	6.4
5/8	15.9	0.148	3.8	–	–	–	–	–
3/4	19.1	0.187	4.7	–	–	–	–	–
7/8	22.2	0.250	6.4	–	–	–	–	–
1	25.4	0.375	9.5	–	–	–	–	–

Typical Combinations of Base Metal and Stud Metal for Stud Welding

Fig. 5

Base Metal	Stud Metal
Electric Arc Process	
Low-carbon steel, 1006 to 1022	Low-carbon steel 1006 to 1022 (a); stainless steel, series 300 (b)
Stainless steel, series 300 (b), 405, 410 and 430	Low-carbon steel 1006 to 1022 (a); stainless steel, series 300 (b)
Aluminum alloys, 1100, 3000, 5000, 6000 Series	Aluminum alloy 5356
Stored-Arc Process	
Low-carbon steel, 1006 to 1022	Low-carbon steel 1006 to 1010 (a); stainless steel, series 300 (b);
Stainless steel, series 300 (b) and 400	Low-carbon steel 1006 to 1010 (a); stainless steel series 300 (b)
Aluminum alloys, 1100, 3000 series 5000 series, and 6063	Aluminum alloy 1100

Materials

(a) The low carbon steel or mild steel studs conform within reasonable limits to the analysis shown.

C – 0.23% Max. P – 0.040% Max.
Mn – 0.90% Max. S – 0.050% Max.

(b) Stainless Steels: Stainless steels most commonly used are types 304 or 305. Other grades of 300 series stainless steels are available (except SS-303) when required.

Standard Electric Arc Welding Studs

Fig. 6

Stud Type	Tensile (min.)	Yield (min.)
CPL, CFP, CFP FFP, NBL, 1/4" and 3/8" Dia. H4L, R6P, R7P, CKL, L21, S6L, F3L	55,000 psi	50,000 psi
Stainless 304 & 305 Studs	85,000 psi	40,000 psi
D2L (ASTM A-496)	80,000 psi	70,000 psi
ATS	75,000 psi	30,000 psi
ATC	50,000 psi	35,000 psi
S3L 1/2" and 5/8" Dia. H4L	60,000 psi	50,000 psi

For additional information, refer to the *Nelson Standard In-Stock Stud Catalogue.*

Stud Specifications:

The same general rules that apply to all metal arc welding processes also apply to stud welding. The most common fasteners used in electric arc stud welding are made from low-carbon steels with a minimum tensile strength of 55,000 psi (415 MPa) and a minimum yield strength of 50,000 psi (345 MPa). Capacitor discharge methods generally use fasteners made from C-1008 or C-1010 steels in the annealed condition. Tensile strength is 50,000 psi (345 MPa). Austenitic stainless steel, magnesium-aluminum, silicon-aluminum, and other non-ferrous alloys are most commonly used in the as-rolled condition. Nelson should be consulted on specific applications to assure the proper selection of stud welding process in the best materials. Fig. 2 lists the most common materials used with five different base metals for electric arc, and Stored-Arc stud welding.

Low Carbon Steel – 55,000 PSI Min. Ultimate, 50,000 PSI Min. Yield

Fig. 7A

Stud Thread Dia.	Ultimate Tensile Load (Lbs.) @ 55,000 PSI	Ultimate Torque* @ 55,000 PSI
10-24 UNC	957	36 inch lbs.
10-32 UNF	1105	41 inch lbs.
1/4-20 UNC	1743	7 ft. lbs.
1/4-28 UNF	1990	8 ft. lbs.
5/16-18 UNC	2871	15 ft. lbs.
5/16-24 UNF	3184	17 ft. lbs.
3/8-16 UNC	4250	27 ft. lbs.
3/8-24 UNF	4818	30 ft. lbs.
7/16-14 UNC	5830	42 ft. lbs.
7/16-20 UNF	6490	47 ft. lbs.
1/2-13 UNC	7810	65 ft. lbs.
1/2-20 UNF	8800	73 ft. lbs.
5/8-11 UNC	12,430	130 ft. lbs.
5/8-18 UNF	14,025	146 ft. lbs.
3/4-10 UNC	18,370	230 ft. lbs.
3/4-16 UNF	20,460	256 ft. lbs.
7/8-9 UNC	25,355	370 ft. lbs.
7/8-14 UNF	27,995	408 ft. lbs.
1-8 UNC	33,275	555 ft. lbs.
1-14 UNF	37,290	621 ft. lbs.

* Torque figures based on assumption that excessive deformation of thread has not taken relationship between torque/tension out of its proportional range.

In actual practice a stud should not be used at it's yield load. A factor of safety must be applied. It is generally recommended that studs be used at no more than 60% of yield. However factor of safety may vary up or down, depending on the particular application. **The user will make this determination.**

Formula used to calculate above data as follows:

Where:
D = Nominal Thread Diameter
N = Thread per Inch
A = Mean Effective Thread Area (META) [1]
S = Tensile Stress in PSI
L = Tensile Load in Pounds
T = Torque in Inch Pounds

Tensile Load . . . . **L = SA** **Torque** . . . . **T = .2xDxL**

[1] META are used instead of root area in calculating screw strengths because of closer correlation with actual tensile strength. META are based on mean diameter, which is the diameter of an imaginary co-axial cylinder whose surface would pass through the thread profile approximately midway between the minor and pitch diameters. (A or META = $0.7854\left(D - \frac{0.9743}{N}\right)^2$)

Stored-Arc® Welding Studs

Low Carbon Steel – 50,000 PSI Ultimate, 35,000 PSI Yield
Stainless Steel – 75,000 PSI Ultimate, 30,000 PSI Yield
Aluminum – 21,000 PSI Ultimate, 20,000 PSI Yield

Fig. 7B

Stud Thread Dia.	Ultimate Tensile Load (Lbs.)			Yield Load (Lbs.)		
	Carbon Steel	Stainless	Aluminum	Carbon Steel	Stainless	Aluminum
6-32 UNC	458	687	192	321	275	183
8-32 UNC	705	1,057	296	493	423	282
10-24 UNC	870	1,305	365	609	522	348
10-32 UNF	1,005	1,507	422	704	603	402
1/4-20 UNC	1,585	2,377	666	1,110	951	634
1/4-28 UNF	1,810	2,715	760	1,267	1,086	724

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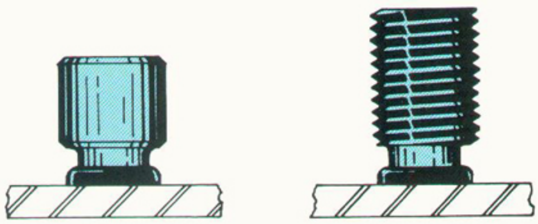
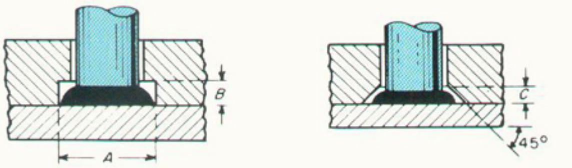
Weld Fillet

Fig. 8



Studs can be designed with reduced weld bases so that weld flash does not exceed the maximum diameter of the fastener. Strength reductions are proportionate.

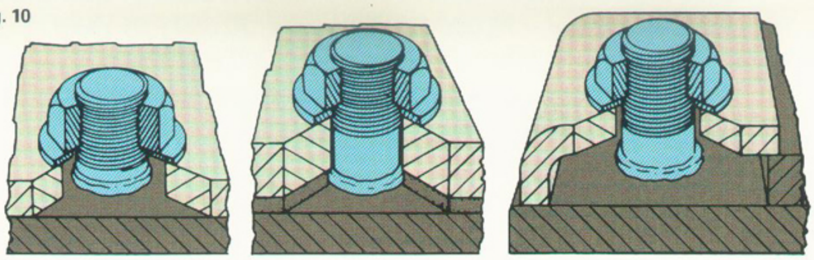
Fig. 9



When a stud is end-welded, a flash forms around its base with the dimensions being closely controlled by the design of the ferrule used. Since the diameter of the flash is generally larger than the diameter of the stud, some consideration is required in the design of mating parts. Counter bore and counter sink methods are commonly used. Dimensions will vary with studs and ferrules. Additional methods of accommodating flash include over sized clearance holes, use of a gasket material around the flash or use of a dog type construction.

Stud Size		Counterbore A		Counterbore B		90 Deg. Countersink C	
in.	mm	in.	mm	in.	mm	in.	mm
1/4	6.4	0.437	11.1	0.125	3.2	0.125	3.2
5/16	7.9	0.500	12.7	0.125	3.2	0.125	3.2
3/8	9.5	0.593	15.1	0.125	3.2	0.125	3.2
7/16	11.1	0.656	16.7	0.187	4.7	0.125	3.2
1/2	12.7	0.750	19.1	0.187	4.7	0.187	4.7
5/8	15.9	0.875	22.2	0.218	5.5	0.187	4.7
3/4	19.1	1.125	28.6	0.312	7.9	0.187	4.7

Fig. 10



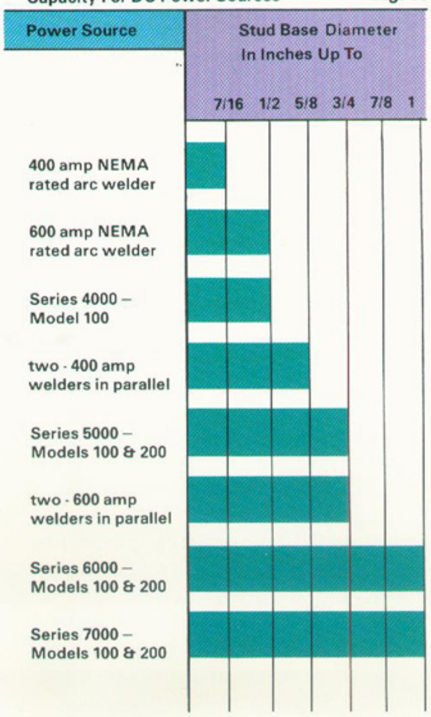
(a) Oversize clearance hole (b) Gasket material (c) Dog clamp

Welding Power

Stud welding requires a source of direct welding current of sufficient capacity for the diameter of the stud being welded. Power sources designed specifically for stud welding are recommended. Conventional DC gas/diesel driven generator welders and rectifier units may also be used for stud welding. Maximum stud welding capacities of various power sources and systems are shown in Figure 11. However, capacities of individual machines vary with length and size of cable used between power source and work, incoming power conditions, the condition of the equipment, and the position in which the weld is made.

Electric Arc Stud Welding Capacity For DC Power Sources

Fig. 11



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Surface Conditions and Stud Location

Work Surface:
Work surface should be clean and free from water, paint, scale, rust, grease, oil, dirt, and zinc and cadmium platings. Aluminum surfaces may require special cleaning if badly oxidized.

Surface Contour:
Fasteners for Stored-Arc capacitor discharge stud welding are most effectively used on flat or nearly flat surfaces. The electric arc process is adaptable to round or angled surfaces since it depends on the ferrule for the formation of the relatively large pool of molten metal. The ferrule which contains the metal pool must be made to fit the contour in question. See Figures 12A and 12B.

Stud Location:
The simplest and most common procedure for locating studs is to lay out and center punch, or to center punch through holes in a template. The point of the stud is then placed in the punch mark. Although operator skill is always a factor in accuracy, this method usually results in tolerances of ±3/64″ (1.2 mm).

When a number of similar pieces are to be stud welded, common practice is to weld directly through holes in a template without preliminary marking. Because there are tolerances in dimensions of the ferrule itself, this method should not as a rule be used if stud location tolerances must be better than ±1/32″ (0.8 mm).

Figure 13A shows a simple template, usually Masonite 1/8″ (3.2 mm) to 1/4″ (6.4 mm) thick. Spacers allow the gases to escape during welding. The recommended hole sizes on the template should equal the maximum outside diameter of the ferrule plus 1/32″ (0.8 mm). The ferrule can be held by a standard ferrule grip, or where clearance is prohibitive, a tube type setup can be used.

Figure 13B illustrates the tube template which permits holding the stud in accurate angular alignment. The template is generally made of Ebonite or Masonite. Bushings may be used to insure a greater accuracy and to extend the life of the template.

The tube adaptor is attached to the foot. Standard copper ferrule grips are used with the tube adaptor. This permits standardization of templates; since it is only necessary to change the copper ferrule grip to weld studs of different diameters. The hole diameter of the bushing or template should be approximately .010″ (0.25 mm) larger than the maximum outside diameter of the template tube adaptor.


Fig. 12A


Fig. 12B

Fig. 13A

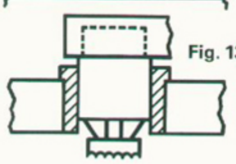



Fig. 13B

Aluminum Stud Welding

Aluminum Stud Welding:
The basic approach to aluminum stud welding is similar to that used for mild steel stud welding. The power sources, stud welding equipment and controls are the same. The stud welding gun is modified slightly by the addition of a special adaptor for the control of the high-purity shielding gases (argon or helium) used during the weld cycle. Reverse polarity is used with electrode (gun) positive, and the ground or work negative. The aluminum stud differs from the steel stud in that no flux is used on the weld end. The weld end has a special tip design which serves to initiate the arc and help establish the longer arc length required for aluminum welding.

Studs range in weld base size from 1/4″ (6.4 mm) through 1/2″ (12.7 mm) diameter and take on many of the sizes and shapes similar to the steel stud, i.e. pins, internal and external threaded fasteners and stand-offs, etc.

Aluminum studs are commonly made of aluminum-magnesium alloy 5356, having a typical tensile strength of 40,000 psi (275 MPa). These alloys have high strength and good ductility, and are metallurgically compatible with the vast majority of other aluminum alloys used in industry. These alloys have proven to be excellent for stud welding, demonstrating arc stability and good over-all performance.

In general, all plate alloys of the 1100, 3000 and 5000 series are considered excellent for stud welding; alloys of the 4000 and 6000 series are considered passable; the 2000 and 7000 series are considered poor. (See Figure 14.) Stud weld base diameters of 1/4″ (6.4 mm) may be welded to 1/8″ (3.2 mm) minimum plate thickness without distortion or burn-through. Studs up to 1/2″ (12.7 mm) diameter may be welded to 1/4″ (6.4 mm) minimum plate thickness without distortion. Refer to Fig. 2 for minimum plate recommendations.

Eight Design and Production Tips:
1. The base metal must be weldable.
2. The proper equipment must be selected.
3. The proper ratio between stud diameter and base metal thickness is essential.
4. Lowest costs are usually promoted by using standard fasteners.
5. The necessity of accommodating the weld flash should be kept in mind.
6. Use of a locating template will insure tolerance specifications.
7. Work surfaces should be clean and dry.
8. Surface contour may be a factor.

Weldability of Aluminum Alloy **Fig. 14**

Base Plate Material			Alloys used as Stud Material		
Alloy Series	Weldability	Strength	Alloy Series	Weldability	Strength
1000	Excellent	High	1100	Poor	Low
2000	Poor	Low	4043	Excellent	Low
3000	Excellent	High	5356	Excellent	High
4000	Good	Low			
5000	Excellent	High			
6000	Good	High			
7000	Poor	Low			

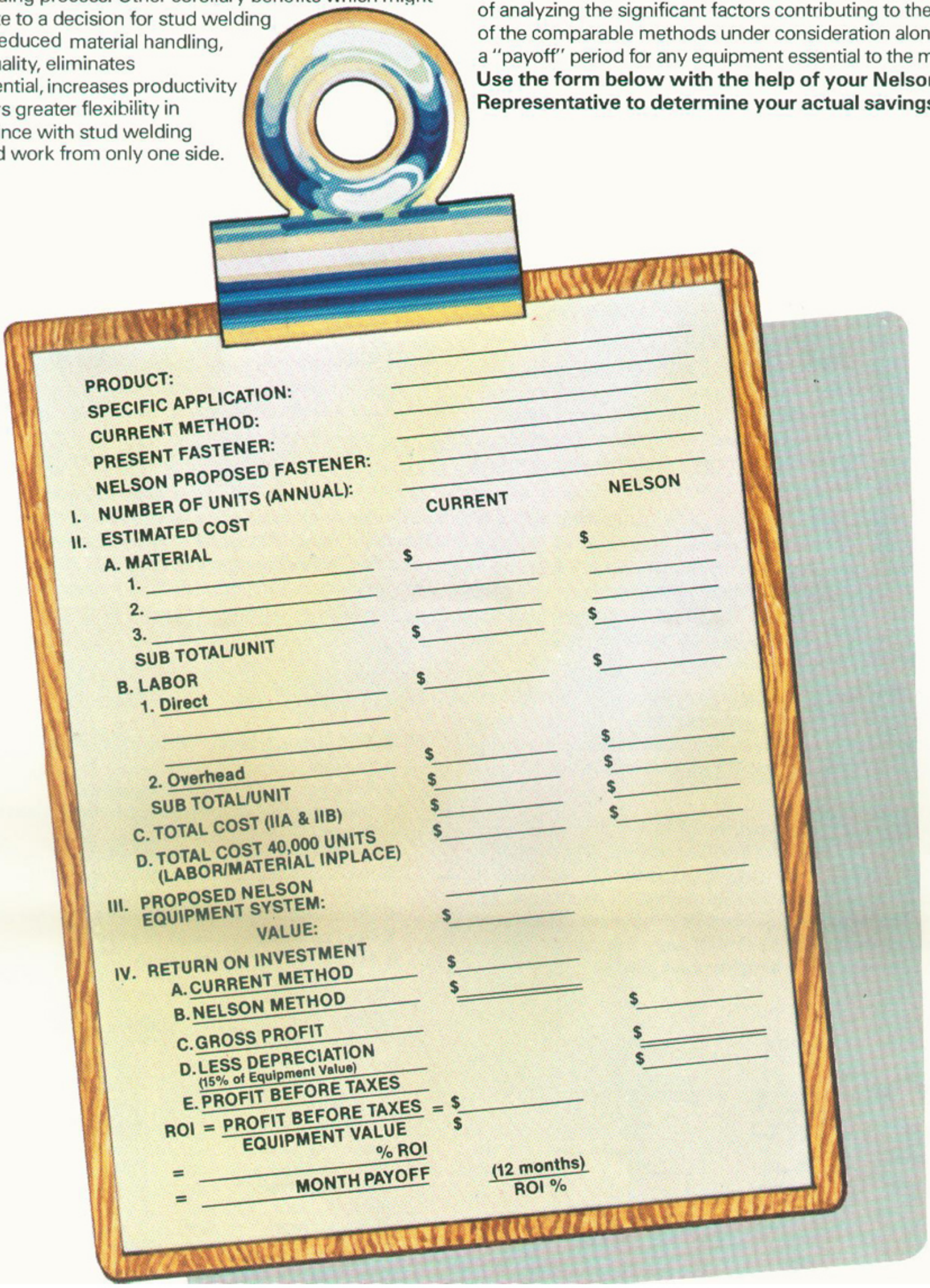
The information is submitted as a general guide.
If more information is required, submit samples of alloys for samples and tests.

Equipment Costs and Evaluation

In addition to the cost consideration, stud welding can provide many substantial benefits that are supplemental to any direct cost advantage. Factors such as elimination of distortion, added strength to the part by eliminating holes and esthetic improvement with an unmarked, exposed surface are realized when designing a fastening system around the stud welding process. Other corollary benefits which might contribute to a decision for stud welding include reduced material handling, better quality, eliminates leak potential, increases productivity and offers greater flexibility in design since with stud welding you need work from only one side.

Once it has been established that stud welding meets design and quality criteria there's a need to confirm the cost/benefit relationship versus other process considerations.

A frequently used method for confirming the request to purchase a Nelson stud welding system is the "Return on Investment" or ROI form. This will provide an orderly means of analyzing the significant factors contributing to the cost of the comparable methods under consideration along with a "payoff" period for any equipment essential to the method. **Use the form below with the help of your Nelson Sales Representative to determine your actual savings.**


PRODUCT: ____
SPECIFIC APPLICATION: ____
CURRENT METHOD: ____
PRESENT FASTENER: ____
NELSON PROPOSED FASTENER: ____
I. NUMBER OF UNITS (ANNUAL): ____

	CURRENT	NELSON
II. ESTIMATED COST		$ ____
A. MATERIAL	$ ____	____
1. ____	____	____
2. ____	____	$ ____
3. ____	$ ____	
SUB TOTAL/UNIT		$ ____
B. LABOR	$ ____	
1. Direct ____		
____		$ ____
____	$ ____	$ ____
2. Overhead ____	$ ____	$ ____
SUB TOTAL/UNIT	$ ____	$ ____
C. TOTAL COST (IIA & IIB)	$ ____	
D. TOTAL COST 40,000 UNITS (LABOR/MATERIAL INPLACE)		

III. PROPOSED NELSON EQUIPMENT SYSTEM: ____
VALUE: $ ____

IV. RETURN ON INVESTMENT $ ____
A. CURRENT METHOD ____ $ ____
B. NELSON METHOD ____ $ ____
C. GROSS PROFIT ____ $ ____
D. LESS DEPRECIATION (15% of Equipment Value) ____ $ ____
E. PROFIT BEFORE TAXES ____

ROI = PROFIT BEFORE TAXES / EQUIPMENT VALUE = $ ____ / $

= ____ % ROI

= ____ MONTH PAYOFF (12 months) / ROI %

B.S.N. the professional fastener

9

Systems and Power Sources

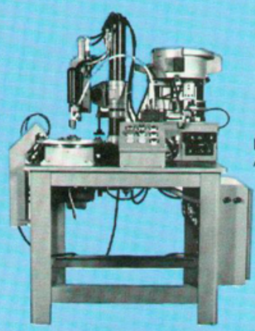
Nelson offers a complete line of stud welding systems and power sources to meet any requirement. Nelson stud welding equipment is widely distributed, easily obtainable and serviced by a national organization. It may be rented or purchased.

A stud welding system consists of a welding gun, cables, timer control, and power source. There are three basic groups of stud welding systems: portable, manual feed; portable, automatic feed; fixed, manual/auto feed. A description of these systems and power sources follows.

Fixed Manual/Automatic Feed Systems

Nelson production systems incorporate stud welding guns, electronic/pneumatic feed mechanism and solid state power/control units that perform reliably on close tolerance and high speed assembly lines.

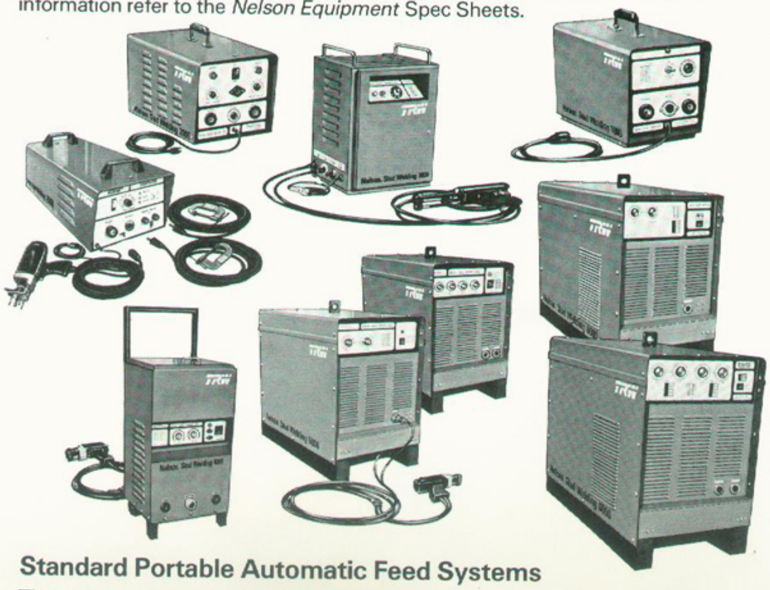
Custom engineered systems featuring as many as 11 guns and feeders have been designed to meet varying customer applications. All efforts are extended to evaluate design requirements in order to provide the simplest and lowest cost system.



Fixed Manual/ Automatic Feed System

Standard Portable Manual Feed Systems

Six systems are presently available with each system designed to economically and efficiently weld a specific range of stud diameters. For complete specification information refer to the *Nelson Equipment* Spec Sheets.



Standard Portable Automatic Feed Systems

Three standard systems consisting of a portable stud welding gun, a power/control unit and feeder are available. These low cost systems provide high production rates, while providing portability. The welding gun can be used within a radius of 20 feet from the feeder. All necessary welding and control cables, air lines, feed tubes, and connectors are furnished. For additional information refer to the *Nelson Standard Equipment* brochure.

Nelson Series 7000, Model 100 Transformer Rectifier Power Unit

The Series 7000, Model 100 is a fully regulated, solid-state power unit designed for construction job site application of large diameter studs and large volume industrial use. The current control is step-lessly adjustable between 400 and 2400 amperes. These features enable the welding of studs between 5/16″ and 1″ in diameter with preciseness and repeatability when used with Nelson and other brands of DC stud welding equipment.