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# INVESTIGATION OF ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS

July 1963

Prepared under Navy Bureau of Naval Weapons  
Contract No. N0w 63-0125-c

Bimonthly Progress Report No. 5  
16 April 1963 thorough 15 June 1963

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OF REFRACTORY METALS AND ALLOYS

ABSTRACT

The necessity for moving the experimental welder and instruments into a new area precluded continuation of actual welding studies during this period. The interruption of the experimental work provided time for the incorporation of modifications and improvements to the existing welding array, the necessity for which has become increasingly apparent during the course of the work.

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INVESTIGATION OF ULTRASONIC WELDING  
OF REFRACTORY METALS AND ALLOYS

The power-force programming study of the welding behavior of 2024-T3 aluminum, AISI 304 stainless steel, and Inconel X, described in Progress Report No. 4, revealed several minor difficulties with the welding array and instrumentation which required correction prior to continuation of the program. The necessity of moving the welder and instruments into a new location provided a convenient time for these corrective measures to be taken.

A. Power Programming

The initial studies had indicated that the variation in power delivered to the transducer had not always followed the linear variation set out on the program pegboard. The incremental steps of power over the effective range of the program control have been made uniform by modification of the circuit of the program controller. The power input to the transducers may thus be divided into ten steps of equal magnitude throughout the power range used in the welding studies.

B. Force Programming

Two difficulties were observed in the force-measuring instrumentation. Information for recording the actual changing clamping force is provided by the signal from SR-4 strain gages mounted on the body of each hydraulic cylinder. A decrease in sensitivity of the output from the strain gages was observed during continued operation. Inspection of the gages revealed inadequate bonding to the cylinders. These gages were removed and replaced with securely bonded gages.

Pick-up of stray magnetic fields by the strain gage cables had disturbed the strain gage signals, necessitating a power-dependent correction factor. Cables have been shielded for use in magnetic fields to reduce magnetic pick-up.

C. Equipment Integration

The large number of recording and measuring instruments, with associated power supplies and interconnecting wiring, has made operation inconvenient. This unwieldy array of instrumentation has been integrated to provide greater accessibility and convenience of operation.

Weldment Materials

During this report period the following materials were received:

| Material        | Gage,<br>Inch | Source       |
|-----------------|---------------|--------------|
| C-105 Columbium | 0.015         | Wah Chang    |
| B-66 Columbium  | 0.005         | Westinghouse |
| B-66 Columbium  | 0.015         | Westinghouse |
| Tungsten        | 0.010         | Fansteel     |
| Tungsten        | 0.020         | Fansteel     |
| Tungsten        | 0.060         | Fansteel     |
| Tungsten        | 0.100         | Fansteel     |

The powder metallurgy tungsten was produced under the Bureau of Naval Weapons Refractory Metal Sheet Program, Contract NOW 60-0621-c. This material was supplied to us by Fansteel Metallurgical Corporation at the request of the Bureau of Naval Weapons, for use in connection with the performance of Contract NOW 63-0125-c and AF 33(600)-43026\*.

Identity of all test specimens shall be subject to control with regard to sheet number, position on sheet, final rolling direction, etc.

The material received is identified as follows:

Powder Metallurgy Tungsten

(Received from Fansteel Metallurgical Corporation)

| Nominal Gage,<br>(Inch) | Sheet Size (measured),<br>(Inches) | Identification             |
|-------------------------|------------------------------------|----------------------------|
| 0.010                   | 17-11/16 x 25-3/4                  | Lot A 5467 Sheet Plate 3   |
| 0.010                   | 18-3/16 x 26                       | Lot A 5467 Sheet Plate 2   |
| 0.020                   | 18-1/2 x 30-1/8                    | Lot A 5467 Sheet Plate 3-1 |
| 0.060                   | 21-1/2 x 29                        | Lot A 5467 Sheet Plate 19  |
| 0.100                   | 18-15/16 x 33-1/2                  | Lot A 5467 Sheet Plate 101 |

\* Letter (T. F. Kearns, Head, Metals Branch, Materials Division, Department of the Navy, Bureau of Naval Weapons to H. L. McKaig, Vice President, Aeroprojects Incorporated) dated 29 April 1963.

Additional tungsten and Mo-0.5 Ti alloy sheets are on order.

The materials received to date are adequate to start the next phase of investigative work involving the application of power-force programming techniques to the ultrasonic welding of refractory metals and alloys.

#### Future Work

Power-force programming will be applied to the welding of refractory metals. Experiments will be designed with the view of establishing PFP patterns for the production of high-quality ultrasonic welds.

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