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MINIATURE INTERCONNECTION DEVELOPMENT

PDO 6984843, Final Report

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Published September 1976

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MINIATURE INTERCONNECTION DEVELOPMENT

BDX-613-1651 (Rev.), UNCLASSIFIED Final Report, Published
September 1976

Prepared by D. L. Hollar, D/862, under PDO 6984843

Several specialized miniature interconnection methods were established and tested to minimize development hardware lead times and lower the cost of small special design assemblies. A joining technique was developed for attaching a 33 AWG aluminum wire to a copper flexcircuit. Two miniature connector prototypes were designed--a multi-conductor low voltage connector and a two-conductor high voltage connector. A precision X-Y-Z mechanical positioner using a closed circuit television system was developed to allow electrode alignment for welding miniature parts.

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SUMMARY

As new systems become miniaturized, the need for small interconnection systems increases. The ability to interconnect subassemblies and modules within a weapon becomes quite important with respect to cost, ease of assembly, and reworkability.

The purpose of this project was to develop interconnection systems for flexcircuits and discrete wire cables which, by using miniature interconnection technology, minimized development costs and hardware lead times. The scope of the project included developing prototype interconnecting hardware, testing the hardware, and developing processes to assemble the interconnection systems.

An AWG 33 solid aluminum wire was joined to a copper flexcircuit by establishing a suitable insulation removal method using Iso-Verre cream insulation stripper and by developing an aluminum soldering technique using Force 55 aluminum solder alloy and flux. Two miniature connector concepts were developed. A thin 1.52 mm (0.06 in.) multiconductor connector was designed using a modified strip connector and special molding technique. This connector was used on a low voltage multiconductor flexcircuit. The other connector concept was designed for use on a high voltage two conductor flexcircuit and was fabricated using commercial spring contacts and special epoxy molding methods.

A closed circuit television (CCTV) alignment system was developed to allow precise positioning of the pulse-arc welding electrode on miniature electromechanical assemblies. The system consisted of a three axis (XYZ) positioning system and an optical relay lens system connected to a CCTV. This system provides approximately 100X magnification of the part to be welded and a precise reticle type of electrode alignment.

DISCUSSION

SCOPE AND PURPOSE

The purpose of this project was to develop special miniature interconnection methods on small flexcircuit cables to allow miniature electromechanical assemblies to be welded. This work included developing two miniature low voltage multicontact connectors and one high voltage flexcircuit connector as well as precision alignment equipment utilizing optics and XYZ mechanical positioners.

PRIOR WORK

Prior work on this project was recorded in a series of Bendix reports, all of which are listed in the References section of this report.

ACTIVITY

Joining of a Small Aluminum Conductor

Interest in using an AWG 33 solid aluminum conductor for a 90-wire woven tape established a requirement for connecting the small aluminum conductor and the tape. The wire tape consists of 90 strands of AWG 33 aluminum interwoven with a multifilament nylon thread.

Several different chemical, mechanical, and laser insulation removal methods were evaluated with consideration given to effectiveness of removal, damage to remaining insulation, damage to the basic wire, and convenience of stripping method. A thorough investigation of these methods was required since the insulation, a polyester with an amide-imide overcoat, has exceptional adhesion to the aluminum wire.

Chemical stripping processes proved to be the most successful. Chemicals containing methylene chloride provided acceptable results with Iso-Verre cream producing the best results. Acceptable stripping is defined as an even stripline across the wire tape and no insulation presence indicated by microscopic examination.

Solder alloys and pretinning techniques necessary to satisfactorily terminate the aluminum wires of a 90-strand woven-wire tape to a copper conductor flexcircuit were evaluated next.

Single- and two-wire-twisted AWG 33 bare aluminum wires were used to determine the best solder alloy and the best method of pre-tinning the aluminum. Several solders were evaluated with the activated fluoride flux necessary to tin the aluminum. Ultrasonic tinning was compared to the conventional soldering-iron tinning method and these same solders were used to hand solder the aluminum wires to the copper conductors.

Of the several alloys evaluated, Force 55 and 63Sn-37Pb provided the best, and essentially the same, tinning capabilities. Force 55 is preferred, however, because of slightly improved joint quality and compatibility with the physical properties of the aluminum. For these same reasons, Force 55 is preferred for soldering the pretinned wires to the copper conductors. However, 63Sn-37Pb produced visually equal joint quality.

Controlled temperature and humidity tests revealed a tendency for the solder to flake away from the aluminum after repeated flexing but this problem did not appear to affect the quality of the joints under anticipated operating conditions. Visual examination revealed a particulate residue on the aluminum and the solder of these joints but the residue did not appear on the copper. The residue was not completely removed by the water rinse recommended by the manufacturer of the activated fluoride flux.

Miniature Connector Development

Two significant accomplishments in this area were the development of an exceptionally thin [1.54 mm (0.06 in.)] connector and a small molded high voltage flexcircuit connector. A design requirement existed for a multiconductor flexcircuit termination consisting of a 1.54 mm thick ten-conductor assembly. Molding a connector with this thickness requirement required some very difficult mold designs. However, a commercially available strip connector 1.78 mm (0.07 in.) thick and available in a 100-contact length (Figure 1A) was machined down to 1.54 mm (0.06 in.) at Bendix and then cut into 10 contact segments. The modified connector was soldered to the flexcircuit and encapsulated as illustrated in Figure 1B.

High-Voltage Flexcircuit Connector Design

Previously described designs were to be used on low voltage systems (under 100 Vdc). Next, an interconnection was required to provide an electrical connection on a two-conductor high voltage (9 kVdc) flexcircuit within a minimum space. A survey of commercial flexcircuit connectors revealed that only low voltage connectors were available.

A

B

Figure 1. Strip Connectors (Top Shows Commercial 100-Pin Contact; Bottom Shows Modified 10-Contact Segment and Completed Interconnection)

Figure 2. High Voltage Flexcircuit Connector Assembly

A design was established using an existing gold-plated beryllium copper spring contact and an epoxy molded connector. The beryllium copper contact as well as the previously mentioned strip connector are available commercially. Using existing hardware reduces procurement lead time and costs. From the drawing of this concept (Figure 2) RTV mold masters were designed and fabricated. Figure 3 illustrates prototype parts molded from Epon 815/Versamid using the RTV molds. The high voltage capability was obtained by placing the contacts on opposite sides of the plug insulator. The plug is secured in the receptacle by detents on opposite sides of the plug and receptacle, providing a snapaction locking of the plug in the receptacle.

Several of these connector assemblies were fabricated and tested. The connector assembly consistently withstood 10 kVdc in a laboratory environment of normal room temperature, humidity, and

Figure 3. Connector Concept for the High Voltage Flexcircuit

atmospheric pressure. The high voltage connector was designed only to determine the characteristics of small, high voltage flexcircuit connectors. Various configurations using this concept could be designed to meet specific requirements.

Epoxy Molded Connector Housings

Following the successful molding of connector housings on high voltage connectors, additional evaluations using Epon 815/Versamid and RTV molds were made. A 19-pin miniature rack and panel connector configuration was selected to evaluate connector housing molding methods. RTV molds were designed and fabricated and connector housings were designed to accept small inexpensive commercially available gold plated pin and socket contacts. Some difficulty was encountered in producing a connector assembly with close dimensional control. Better dimensional control could be obtained with more expensive steel molds but this would negate the economic advantages of the RTV molds and the commercial contact approach. The RTV mold and commercial contact method of producing connectors is quick and economical; however, it is practical only for a short run prototype application.

Closed Circuit Television Alignment System

Electronic arc-welding processes require accurate and repeatable positioning of welding electrodes with respect to the parts being joined. As the size of the welded parts decreases and accurate positioning becomes more important, the use of conventional microscope viewing for electrode alignment becomes inadequate. Alignment errors can be caused by microscope viewing angles and eye fatigue can result from long term microscope use. A closed circuit television (CCTV) alignment system was developed to alleviate these problems.

A complete CCTV alignment system has been developed for use with a motor driven weld positioning system. A telephoto camera system with a cross hair reticle is positioned to view straight down. The parts to be welded are aligned while in view on the monitor and are subsequently automatically indexed into position under the welding electrode by using the precision slide motor controls of the positioning system. The system provides accurate, controlled, multi-weld configuration alignment.

A previously developed motorized weld positioning system was used to design a complete CCTV welding alignment system for precision weld targeting (Figure 4). The motorized fixturing consists of a three-axis motorized slide arrangement. Each slide is driven by a stepping motor controlled by a stepping-pulse-generating presettable indexer. The indexers allow a pre-determined number of stepping pulses to be supplied to the slide motors and provide for precision position control of the slide. The indexers also provide free running and one-step jogging modes. In addition to standard operating features, the indexers were modified to provide two speed operation.

The CCTV telephoto lens system and a 1:1 optical relay lens which superimposes a cross hair onto the televised image were mounted on the side of the vertical axis slide member. Slide adjustments are included for final camera positioning. The camera assembly is aligned to view directly downward a calibrated distance away from the welding electrode along the lateral x-axis. Parts are positioned while being viewed on the CCTV monitor. When the cross hair is aligned on the desired weld target, the part to be welded is indexed automatically into position under the welding electrode.

This alignment system provides accurate positioning capabilities with none of the previously encountered limitations. In addition to accurate single target alignment, this system provides the potential for manual or computer controlled multi-weld configuration alignment.

Figure 4. Motorized Alignment System

ACCOMPLISHMENTS

Insulation stripping and soldering methods were developed to join a 33 AWG aluminum wire to a copper flexcircuit. Of all the stripping methods and materials investigated, chemical strippers of the methylene chloride system are the most successful because they provide a repeatable insulation removal method. Iso-Verre cream provided the best stripping process.

All of the soldering alloys visually indicated some degree of wetting and adherence to the aluminum wires. The Force 55 and the 63Sn-37Pb solders produced nearly equal results in these tests, but Force 55 is preferred because of slightly better wetting and material compatibility. Since the Force 55 was formulated specifically for soldering aluminum, aluminum-to-solder compatibility can be ensured by using Force 55 for both pretinning and final soldering.

An exceptionally thin (1.54 mm or 0.06 in.) 10-contact connector was developed using a modified commercially-available strip connector. The Bendix modifications reduced tooling costs associated with this type of interconnection. In addition, the modified strip connector is easily altered if more or less contacts are required.

A high-voltage flexcircuit connector was developed and tested. Development of this interconnection concept was required since this type of connector is non-existent commercially. Test results proved that the connector could consistently withstand 10 kVdc.

An evaluation was performed to determine if miniature rack and panel connectors could be fabricated using RTV molds, epoxy molding compounds, and commercially available contacts. Results indicated that this technique would be satisfactory only for short run prototype applications.

A weld electrode alignment system was developed which uses closed circuit television optics and motorized slides. This system uses three-axis motorized positioning by preset indexers and provides accurate positioning capabilities as well as potential multiweld position programming.

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