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ENGINEERING OPERATIONS REPORT

DRA

NERVA TURBOPUMP BEARING RETAINER FABRICATION NON-METALLIC RETAINER

PROJECT 121

4 APRIL 1972

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ABSTRACT

The need for a low-wear, lightweight, high strength bearing retainer material with a radiation degradation threshold of 10^9 rads (C) prompted development of non-metallic reinforced polymers of the following types:

a. Polybenzimidazole

b. Polyimide

c. Polyquinoxaline

Retainers were machined from tubular laminates (billets) of the above polymers, including reinforcement by either glass or graphite fabric or filament. Fabrication of billets involves hot preimpregnation of the reinforcement fabric or filament with polymer followed by wrapping this "prepreg" over a heated mandrel to form a tube with the required thickness and length.

The PBI/Graphite fabric laminates appeared to be the most desirable provided a repeatable hoop strength of greater than 15,000 psi could be achieved.

Additional process development effort will be required with the PBI/Graphite fabric reinforced material to obtain higher and repeatable hoop strength.

1.0 INTRODUCTION

This report constitutes an addendum to Section 4.4.0, "Bearing Retainer Materials, Design and Testing", Reference 1. The purpose here is to document the status of the fabrication process primarily with the polybenzimidazole (PBI) polymer reinforced with graphite and glass cloth. Also discussed is the polyquinoxaline polymer reinforced with high strength graphite filament. The principal problems appear to be associated with the definition and classification of pertinent polymer quality, polymer preimpregnation process of the reinforcing material, and the fabrication process of the raw tubular laminate (billet) from which bearing retainers are machined.

2.0 SUMMARY AND CONCLUSIONS

a. The need for a non-galling, lightweight, structurally strong bearing retainer having a radiation resistance to 10^9 rads (C) required the use of a non-metallic reinforced polymer material of the polyimide type.

b. Three polymers fit the desired requirements, Polybenzimidazole, Polyimide, and Polyquinoxaline, each reinforced with graphite cloth, graphite filament or glass cloth.

c. Retainers are machined from tubular laminates (billets) of the reinforced polymer. The process starts with hot preimpregnation of the cloth or filament with the polymer followed by wrapping the "prepreg" to a tubular configuration on a heated mandrel to the required wall thickness and tube length.

2.0 (Continued)

d. Billet (laminated tube) quality is determined by hoop tension tests and x-ray inspection of test rings machined from each end of the cured billet. A hoop strength of 15000 psi appears to be the minimum acceptable. PBI/graphite cloth laminates have been in this range and three PQ/graphite filament laminates (PQ/MODMOR I) were in the range from 21000 to 44000 psi. The highest strength is obtained with the glass cloth reinforcing (> 50000 psi).

e. Gamma radiation dose to 4 x 10^9 Rads (C) did not affect hoop strength of these reinforced polymer laminates.

f. Considerable process development effort is required with the PBI/graphite reinforced material to obtain higher and repeatable hoop strength. The problems seems to be associated with classification of polymer quality, the preimpregnation process of the reinforcing material, and the procedure for wrapping the laminate tube.

3.0 TECHNICAL DISCUSSION

3.1 PROCUREMENT OF RAW MATERIALS

The most promising retainer materials to meet the requirements of radiation resistance to gamma dose of 10^9 rads (C), high structural strength and lightweight were the polybenzimidazole (PBI), and the polyquinoxaline (PQ) polymers reinforced with glass fabric, graphite fabric or high strength graphite filaments. These polymers are produced and sold by the Whittaker Corp. of San Diego, California. The Type S994 Style 181 glass fabric is available from the J. P. Stevens Co. (glass yarn from Owens-Corning), the WCL (harness weave) graphite fabric from Union Carbide Corporation and the high

3.1 (Continued)

strength graphite filament, Modmor Type I, from the Whittaker-Morgan Inc. of Costa Mesa, California. Typical physical properties of these reinforcing materials are shown in Table I:

TABLE I - TYPICAL PHYSICAL STRENGTH PROPERTIES OF REINFORCING MATERIALS

	TENSILE STRENGTH, PSI	TENSILE MODULUS, PSI
S994 Glass Fabric Laminate	65,000	3.0×10^6
WCL Graphite Fabric Laminate	15,000	1.9×10^6
Modmor Type I, Graphite Filament Only	275,000	55×10^6

Of the three materials of interest, the most promising material system is the PBI/Graphite Fabric System. The graphite laminate, although structurally weaker, has several advantages over the glass fabric laminate as follows:

Light Weight

Good Thermal Conduction

Non-abrasive

The polyquinoxaline/graphite filament (PQ/Modmor I) system also has these advantages and additionally appears to be structurally stronger. The disadvantages are that this resin is still experimental and thus considerably more costly ($1000/lb versus $150/lb) and appears to be more brittle than the graphite fabric laminate. At this time, it appears that the primary effort should be concentrated on the development of a process for optimizing the structural strength of the PBI/graphite fabric laminate.

3.2 RETAINER BILLET PROCUREMENT

The bearing retainers are machined from tubular billets fabricated by laminating layers of polymer and reinforcing material under heat and pressure. Billet tube wall thickness is determined by the final retainer thickness with allowance for machining of the I.D. and O.D. to cut away undesirable porous material. Billet tube length is generally not more than 8 inches although better control of material is achieved if billet is not more than 6 inches. After due consideration of the background technical experience, general cooperative attitude, and understanding of final product requirements, the San Rafael Plastics Company of San Rafael, California was chosen to fabricate the PBI/glass cloth and PBI/graphite cloth billets and the final bearing retainers from each. Because of the experimental nature of the polymer, the PQ/Modmor I billets were fabricated by the Whittaker Corp. Three experimental billets were made using a slightly different processing procedure for each resulting in average hoop strength of 21400, 31600 and 36300 psi, respectively. Details of the processes are not known at this time and no additional billets were ordered pending evaluation of the three on hand. The final retainers from these Whittaker PQ/Modmor I billets were machined by the San Rafael Plastics Co. of San Rafael, California.

3.2.1 Billet Drawings

To obtain some degree of quality control and consistency in the fabrication process, two drawings were issued showing dimensions of retainer blanks and test blanks (rings) to be machined from the billet tube. ANSC Drawing 1138220 was set up for the PBI/glass and PBI/graphite billets and ANSC Drawing 1138288 was for the PQ/Modmor I billets. These drawings are

3.2.1 (Continued)

shown in Figures 1 and 2. General and specific notes on each drawing indicate material specifications, general process method, curing, inspection and acceptance criteria. For the PQ/Modmor I material, process and material specifications were requested rather than specified since this experimental material was unknown with respect to optimum process and some material specifications.

3.2.2 Billet Fabrication Process

San Rafael Plastics Co. (SRPCo) was contracted to fabricate the PBI/glass and PBI/graphite retainers. In the early effort with 50mm ball and roller bearing retainers, SRPCo procured the polymer (PBI) preimpregnated reinforcing material (called "prepreg"), glass or graphite cloth, from Whittaker Corp. Some of the PBI/graphite retainers produced were of good or acceptable quality as judged by hoop strength values (about 15000 psi) on test rings from the billet tubes, while others, for no apparent reason, were low in strength (as low as 2000 psi). The PBI/glass retainer also had hoop strength variations but were well above minimum values. It was felt that the PBI/glass billets could be repeatedly processed to acceptable quality while the PBI/graphite billets could not. However, since the PBI polymer is not a very good lubricant and the glass fabric reinforcement presents a metal wear problem because of its abrasive characteristics, the structurally very strong PBI/glass cloth was considered a secondary retainer candidate. In discussions with SRPCo, it was revealed that the lack of consistency in quality with the PBI/graphite laminate was probably associated with the quality of the "prepreg" of the PBI/graphite system which, in turn, could be affected by the quality of the polymer.

3.2.2 (Continued)

A decision was made to concentrate effort on fabricating at least 20 PBI/graphite billets (100 retainers) and testing each billet for hoop strength in an effort to develop a repeatable process to produce billets having hoop strength above 15000 psi and to simultaneously identify and define the desirable polymer characteristics. Whittaker was not enthusiastic about making the necessary PBI/graphite "prepreg" to SRPCo purchase specifications, and SRPCo and Whittaker agreed to an arrangement whereby Whittaker would sell the required quantity of PBI polymer and lease or sell their "prepreg" machine to SRPCo. SRPCo would now have the full responsibility of making the "prepreg", the billets, and the retainers.

In the purchase order to Whittaker Corp. for the PBI polymer, SRPCo asked for melting temperature, viscosity, volatile loss and carbon assay, but was able to get only melting point, volatiles and mesh (particle size). Because the polymer is not in regular production, Whittaker made the required 35 lbs in their research laboratory. The polymer was produced in seven lots of approximately 5 lbs each and each lot was checked only for the properties listed in Table II.

3.2.2 (Continued)

TABLE II - PBI POLYMER PROPERTIES AS REPORTED BY WHITTAKER TO SRPCo
(Certification dated October 19, 1971)

LOT NO.	MELTING POINT, °C	VOLATILES, %	MESH
4338-I	105-118	26.0	100
4338-II	99-123	26.2	100
4338-III	95-118	25.6	100
4338-IV	97-120	25.3	100
4338-V	98-120	26.6	100
4338-VI	100-124	25.6	100
4338-VII	102-118	27.0	100

SRPCo checked the melting point of each of the seven samples by running small samples of each lot (simultaneously) through progressive series of oven-maintained temperature steps of half hour duration with intermediate weighings. The lowest test temperature (initial) was at 250°F (121°C) and progressed in 25-30°F increments to 510°F (266°C). Only two batches melted fully and two not at all. Others had only portions melted. Not all discolored the same. The two that melted, did so quickly at 250°F. Others did so at 350°F or 375°F. These melting points were considerably different than those reported by Whittaker and shown in Table II. Discussions with Whittaker indicated that the SRPCo melting process was "staging" the resins so severely in the half hour at 250°F (presumably a high, sub-melting range) causing the reaction to proceed so far that it never would melt. Therefore, Whittaker suggested a simultaneous exposure of all samples to 375°F. SRPCo did this and found that all but 2 resins melted in 6 minutes, and they melted almost completely in 20 minutes. Weight losses were 3.4 to 4.7%.

3.2.2 (Continued)

When these results were reported to Whittaker, they felt that with a good apparatus, SRPCo would get a true melt of all resins at the temperatures reported by Whittaker and that the melt condition proved the ability of the resin to make a good prepreg. SRPCo felt it proved they could not keep the resin soft enough and long enough to make the parts as Whittaker itself had originally recommended: namely, to heat prepreg to 300-350°F forward of nip and keep soft and above 300°F all during wrap and pressure application which had to be within 2 hours of wrap. Whittaker felt the resin lots were normally uniform; SRPCo thought they were demonstrably non-uniform and do not consider that making a well-fused, calendared prepreg is an adequate demonstration that the resin is usable. Whittaker felt the IR (infrared) curves all to be normal, and SRPCo are quite certain Whittaker's melt point data was accurate (low number was first sign of softening; high number was full melt). SRPCo felt 2 and 3 of the resins exhibited the behavior we had seen in 2 previous lots of resin and the successful prepregs. SRPCo decided to prepare to test the 7 lots in a Thiele-Dennis tube in a batch preset to 265° to 270°F, which is higher than each of Whittaker's reported fully melt points, (but still well below the 375°F demonstrated-but-of-no-practical-use). SRPCo acquired the Thiele-Dennis tube apparatus and tested all lots at 280°F. The following comments quoted below were reported by SRPCo regarding the test results in the Thiele-Dennis tube apparatus:

3.2.2 (Continued)

"From all the testing done to date, it is quite apparent that this "melting point" test is misleading in the extreme. All the resins seem to "melt" more or less near the top temperature reported by Whittaker, but with widely different viscosities and with vastly different times to soften (3 seconds to 15 seconds) and vastly different period of continued softness at temperature (4 minutes to 34 minutes at 380°F). The lab test we originally requested, (but Whittaker was unable to provide) the temperature at which a resin would reach a certain viscosity, would have rated these lots in a meaningful practical way. An additional or alternate test of hardening time at 325°F would have provided another meaningful practical test since our "frozen" manufacturing process involves about 20 minutes of holding at 300°-320°F while wrapping and pressurization is complete.

Although we feel we can "prepreg" this material in the sense of calendaring the properly metered amount of resin into the cloth, and fusing it there, we can already see there is insufficient "life" in 4-5 of the 7 resin lots to fabricate in our usual way, especially when this "life" is further reduced by the heat input of the hot-melt prepreg system. This input can be minimized in time by using a 350°-375°F temperature followed by pressure, but the reaction rate is so rapid at this temperature that the "prepreg" of 4 lots is almost certain to require different fabrication approaches if there is <u>any</u> chance of getting good billets from it.

3.2.2 (Continued)

<u>In summary</u>: Resin lots do seem to reflect only "state of the art" variations which will recur unless resin supplier can be brought to produce under new and hither to undeveloped inspection test criteria, such as gel time, viscosity index, stepped oven cycles or the like. Whittaker's criterion of whether you can "prepreg" resin is inadequate for our actual fabrication process.

It does seem that the stepped oven cycle SRPCo originally used provides a practical rating means that all the subsequent tests support, to the extent they actually distinquish between the resins. Nevertheless, the resins can be said to "melt" in a fairly uniform temperature range (variations appearing in the melted condition rather than the temperature of melt). There is no apparent basis for rejecting any of these questionable lots, and some to believe that they might work well with changed fabrication.

<u>Suggestions:</u> We think prepreg should be produced from at least the "juiciest" (quite fluid) lot and from a "medium-dry" (quite dry) lot. These should be evaluated <u>as prepregs</u> by some simple <u>lap shear test</u>, and visually, and then committed to the basic or some modification of the basic billet wrapping and curing process, and finally machining into test rings. This leaves at least one "juicy" lot and 2 medium and 2 dry lots to be handled as then seems best: curing during wrap, increasing wrap heat or pressure, blending lots, or wrapping and curing directly "in-line" with prepregging are all options which might save the resins."

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3.2.2 (Continued)

In following-up on their suggestion to evaluate in a simple lap shear test prepregs made from the "quite fluid" and "quite dry" resin lot, SRPCo reported the following results and quoted comments:

LAP SHEAR STRENGTH

Lot VI (Quite Fluid)	Lot V (Quite Dry)
323 psi Ave.	408 psi Ave.

"We think it premature to presume the differences relate solely to resin differences, since there were many and broad fabrication variables: we could prepreg VI much more easily than V. Nevertheless, we conclude:

(1) Both resins are, in fact, true resins worthy of investigation.

(2) Original anxiety about prepreg technique requiring wide modification because melting of "dry" resins is not distinct, is justified and constitutes a major problem.

(3) As already indicated and shown to you, we do not believe the value reported by Whittaker is actually a liquids temperature.

At present, then, we feel the problems remain as before, but we now have definite reason to pursue the dry resins in a separate manner from the wet resins. This is because prepreg technique is quite different and end properties might be quite different, but primarily because the fabrication "working life" of each prepreg will definitely demand large changes in our billet fabrication approach if the heat input to the prepreg is to be uniformly controlled."

3.2.2 (Continued)

Based on the above findings and SRPCo conclusions, it was decided that SRPCo attack the problem as follows:

a. Select second lowest melting resin lot and prepare WCL graphite cloth prepreg for a single billet.

b. Fabricate billet per best process from prepreg prepared in item a. above and provide hoop strength results.

c. Select third highest melting resin lot and prepare prepreg WCL graphite cloth for a single billet.

d. Fabricate billet per best process from prepreg prepared in item c. above and provide hoop strength results.

e. Prepare fabrication plan for all remaining billets with necessary process adjustments to provide for individual resin lot characteristics and submit for approval by ANSC Engineering and Quality Assurance.

f. Upon ANSC Engineering and QA approval, complete fabrication of billets and testing in accordance with ANSC P. O. No. 1364, Change 1.

Before the above plan could be implemented, termination of the NERVA Engine Program at ANSC resulted in cancellation of all effort under P. O. 1364-01. It is believed that the development work outlined would have resulted in PBI/graphite retainer billets of significantly improved quality, as well as identification of the effect of resin characteristics on prepregging and billet fabrication.

3.2.3 Retainer Billet Testing

Billet quality presently has been determined by testing blanks from each end of the billet tubes after machining to remove porous materials from ends, I.D. and O.D. the test blanks are first inspected by x-ray to reveal delaminations, cracks, porosity, inclusions, and waviness (wrinkling) of laminations. ANSC Drawing 1138220 gives applicable acceptance criteria for these discrepancies. Figure 3 shows a print of a typical x-ray of an acceptable PBI/graphite test ring. For reference, a print of an x-ray of test ring showing badly wrinkled laminations is shown in Figure 4.

Hoop strength tensile tests on test rings are performed on tensile machine at 0.1 inches/min. cross-head speed until ring is ruptured. The test ring holding fixture consists of two half cylinders which fit the ID of the test ring. The sketch in Figure 5 shows the set up for the hoop strength tensile tests.

3.2.3 (Continued)

Typical room temperature hoop strength tensile test values for the various materials for which retainers were fabricated are shown in Table III below:

TABLE III

SUMMARY OF HOOP STRENGTH RESULTS FROM TEST BLANKS (RINGS) FROM THREE RETAINER MATERIALS

RETAINER MATERIAL	HOOP STRENGTH VALUES, KSI		
	TYPICAL RANGE	NON-IRRADIATED	IRRADIATED, GAMMA DOSE 4.9×10^9 RAD (C)
PBI/Glass	30-55	48.2	52.6
PBI/Graphite	2-20	4.8*	5.1 @ 4.2×10^9 Rads (C)
PQ/Modmor I	21-44	36.3	41.9

*Only samples of this material tested both non-irradiated and irradiated.

It is encouraging to note that in all cases exposure to gamma radiation in the range to 4.9×10^9 Rad (C) increased the hoop strength. The PBI/Graphite material has shown the lowest strength value, well below the minimum acceptable. However, the low values of the PBI/graphite test rings are from early processing attempts. Since this early experience, the lower end of the hoop strength range has been increased to about 12 ksi and it is believed additional development of the type outlined will bring the minimum value well above the 15 ksi now specified.

3.3 RETAINER FABRICATION

3.3.1 Drawings

The final 65mm ball bearing retainer configurations are fabricated in accordance with ANSC Drawings 1139961, 1139963, and 1139964 (Figures 6, 7, and 8). Early 65mm ball bearing retainers were fabricated per ANSC Drawing 1138192 (Figure 9). Drawings 1139961, 1139963 and 1139964 are primarily updated versions of Drawing 1138192 with additional configurations, including application of MoS_2 dry film lubricant, if desired.

3.3.2 Tooling Requirements

The retainers are machined using a conventional machine lathe and are made from the retainer blanks of Drawings 1138220-1 (PBI/Glass), -2 (PBI/Graphite), and 1138288-1 (PQ/Modmor I). The ball pockets are bored on a milling machine using a hardened steel machining fixture. The steel fixture holds the machined retainer blank firmly and provides proper indexing of the pockets.

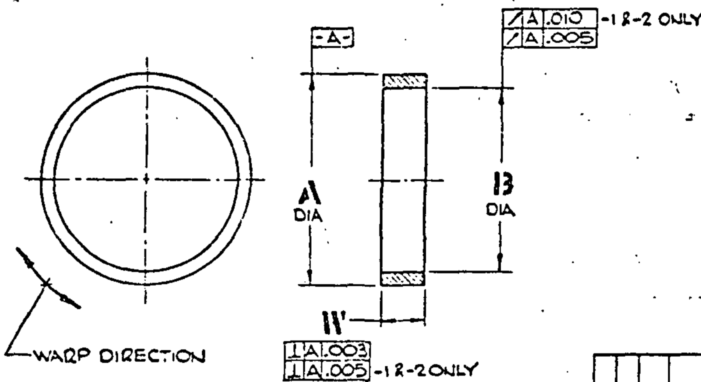
REFERENCES

1. "Design and Development of LH_2 Cooled Rolling Element Radial Bearings for the NERVA Engine Turbopump", N8300R:72-096 - Phase I - January 1969 - December 1971, Volume I

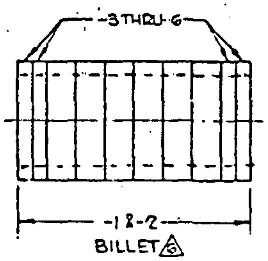
THIS DOCUMENT AND THE DATA DISCLOSED HEREIN OR HEREWITH IS NOT TO BE REPRODUCED, USED OR DISCLOSED IN WHOLE OR IN PART TO ANYONE WITHOUT THE PERMISSION OF AEROJET-GENERAL CORPORATION

NOTES:

1. INTERPRET DRAWING PER MIL-D-1000 FORM 9 AND USASI Y14.5.
2. REMOVE ALL BURRS AND SHARP EDGES EQUIVALENT TO .005-.015 R UNLESS OTHERWISE NOTED.
3. MATERIAL TO BE MANDREL WOUND. PBI PORTION TO BE 35-40% BY WEIGHT. GLASS CLOTH TO HAVE A 112 HEAT CLEANED FINISH. HOOP STRENGTH TO BE 30,000 PSI MINIMUM AND SPECIFIC GRAVITY OF BILLET AND BLANK TO BE 1.6 MINIMUM.
4. MATERIAL TO BE MANDREL WOUND. PBI PORTION TO BE 36-40% BY WEIGHT. HOOP STRENGTH TO BE 15,000 PSI MINIMUM AND SPECIFIC GRAVITY OF BILLET AND BLANK TO BE 1.2 MINIMUM.
5. GENERAL MATERIAL SPECIFICATIONS:
   A. SUPPLIER OF BLANKS SHALL RUN INDIVIDUAL DRY RESIN SOLIDS CONTENT ANALYSIS ON "PREPREG" PRIOR TO FABRICATION OF BILLETS. A REPORT SHALL BE FURNISHED WITH EACH BILLET.
   B. ALL BLANKS SHALL BE POST CURED IN A FREE POSITION AFTER PARTING FROM BILLET AND PRIOR TO FINAL MACHINING AT 600°F± 20°F FOR 3 HOURS ± 1 HOUR UNDER A GASEOUS NITROGEN BLANKET. HEATING AND COOLING RATE SHALL NOT EXCEED 50°F PER HOUR ABOVE 250°F. AT NO STAGE IN THE PROCESSING SHALL THESE PARTS BE EXPOSED TO AIR AT TEMPERATURES IN EXCESS OF 450°F.
6. NO MORE THAN 8 BLANKS OF -1 OR -2 SHALL BE CUT FROM ONE BILLET. FOR TEST PURPOSES, -3 THRU -6 SHALL BE MADE FROM EACH END BLANK. ASSIGN A LOT NUMBER TO EACH BILLET. MAINTAIN TRACEABILITY AS TO LOCATION OF ALL BLANKS.
7. MARK PER ASD5215M WITH: "05824-1138220" AND APPLICABLE DASH NUMBER AND WHEN MANUFACTURED OUTSIDE OF AEROJET-GENERAL CORP, THE MANUFACTURER'S CODE IDENTIFICATION NUMBER, TRADEMARK OR NAME PREFIXED WITH "MFG" & ASSIGNED CONSECTIVE SERIAL NUMBERS FROM ONE END OF BILLET AND RETAIN LOT NUMBER.
8. SURFACE ROUGHNESS 125/ UNLESS OTHERWISE NOTED.
9. VISUALLY INSPECT PARTS USING 5X MAGNIFICATION. THE FOLLOWING ACCEPTANCE CRITERIA IS APPLICABLE:
   A. NO CRACKS ALLOWED. A CRACK IS DEFINED AS A BREAK ACROSS A PLY OF FABRIC.
   B. NO DELAMINATIONS ALLOWED. A DELAMINATION IS DEFINED AS A DISCONTINUITY IN THE RESIN PHASE LYING BETWEEN ADJACENT PLIES WHICH IS AT LEAST .25 LONG AND ESSENTIALLY FREE OF RESIN.
   C. THERE SHALL BE NO CONTINUOUS POROSITY OR FROTH EXCEEDING .25 IN LENGTH ALONG THE PLYS. OBSERVED BUBBLES SHALL NOT EXCEED .035 IN A RADIAL PLANE NOR SHALL ANY ONE BUBBLE EXCEED .025 WHEN MEASURED DIAMETRICALLY. POROSITY IS DEFINED AS AN INFUSION OF BUBBLES IN THE RESIN PHASE.
   D. NO VOIDS ALLOWED. A VOID IS DEFINED AS ANY BUBBLE WHICH EXCEEDS .025 IN DIAMETER.
10. RADIOGRAPHIC INSPECT USING EASTMAN R FILM OR EQUIVALENT AND NO SCREENS. THE KV SHALL NOT EXCEED 50. TARGET TO BE LOCATED ON AXIS OF RING AT DISTANCE OF 60 INCHES. DENSITY IN READING AREA TO BE 2.3 TO 2.5 HURTER AND DRIFFIELD. THE FOLLOWING ACCEPTANCE CRITERIA IS APPLICABLE:
    A. INCLUSIONS OF HIGH DENSITY INDICATIONS - .015 MAXIMUM AND 3 MAXIMUM PER PART ALLOWED.
    B. INCLUSIONS OF LOW DENSITY INDICATIONS - .030 MAXIMUM AND 3 MAXIMUM PER PART ALLOWED.
    C. WRINKLES OR WAVES OF A HEIGHT IN EXCESS OF THREE REINFORCEMENT LAYERS AND OVER A CIRCUMFERENTIAL DISTANCE OF LESS THAN 20° SHALL BE CAUSE FOR REJECTION. A MINIMUM OF 75% OF REINFORCEMENT LAYERS SHALL BE CONTINUOUS.
11. RECORD ALL OTHER DISCONTINUITIES FOR RECORD ONLY.
12. CLEANLINESS PER AGC-STD-9037 LEVEL I.
13. PACKAGE PER FABRICATION ORDER INSTRUCTIONS.



TABULATION BLOCK			
DASH NO.	W	A DIA	B DIA
-1 & -2	.723 .718	3.550 3.545	3.145 3.150
-3 & -4	.200 .190	3.490 3.485	3.205 3.210
-5 & -6	.232 .222	3.472 3.467	3.205 3.210



QTY REQD		SYM	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL/SPECIFICATION	ITEM NO.
				-6	TEST BLANK	-2	
				-5		-1	
				-4		-2	
				-3	TEST BLANK	-1	
				-2		PBI IMIDITE 1850 RESIN SYSTEM CODE IDENT NO 83472, REINFORCED WITH WCL GRAPHITE FABRIC, CODE IDENT NO 42451.	
				-1		PBI IMIDITE 1850 RESIN SYSTEM CODE IDENT NO 83472, REINFORCED WITH TYPE 5994 STYLE 181 GLASS CLOTH CODE IDENT NO 12760.	

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS ANGULAR .XX ± .03 ± 1° .XXX ± .010 DO NOT SCALE DRAWING

AEROJET-GENERAL CORPORATION SACRAMENTO, CALIFORNIA

TITLE: BLANK, RETAINER-GEMM, BALL BEARING

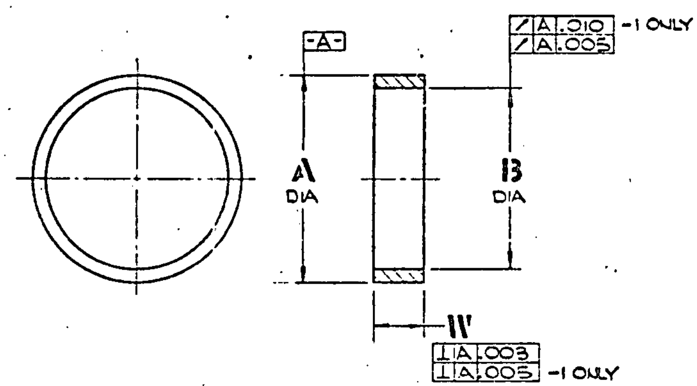
SIZE D | CODE IDENT NO 05824 | DWG NO. 1138220

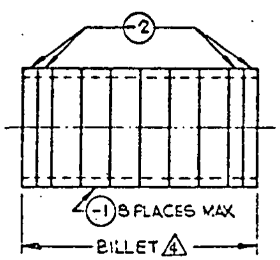
SCALE 1/1

FIGURE 1

NOTES:

1 INTERPRET DRAWING PER MIL-D-1000 FORM 3 AND USASI Y14.5.
2 REMOVE ALL BURRS AND SHARP EDGES EQUIVALENT TO .005-.015 R UNLESS OTHERWISE NOTED.
3 GENERAL MATERIAL SPECIFICATIONS:
   A. DOCUMENT THE FOLLOWING:
      1. FILAMENT
         A. IDENTIFICATION OF BASE MATERIAL AND SPECIFICATION.
         B. PHYSICAL AND CHEMICAL PROPERTIES.
      2. RESIN
         A. SPECIFIC GRAVITY.
         B. RESIN SOLID CONTENT.
         C. FILLER CONTENT - IF APPLICABLE.
         D. GEL TIME AND TEMPERATURE.
         E. RESIN IDENTIFICATION NUMBER.
      3. PREPREG FILAMENT
         A. RESIN CONTENT.
         B. VOLATILE CONTENT.
         C. FLOW - IF APPLICABLE
         D. INFRARED POLYMERIZATION INDEX (IRPI).
      4. BLANK
         A. CURE CYCLE.
         B. DENSITY.
4 NO MORE THAN 8 DASH ONES (-1) SHALL BE CUT FROM ONE BILLET. FOR TEST PURPOSES, -2 (TEST BLANK) SHALL BE MADE FROM EACH END BLANK. ASSIGN A LOT NUMBER TO EACH BILLET. ASSIGN CONTROL NUMBERS TO BLANKS FROM ONE END OF BILLET.
5 MARK PER AS35215M WITH:
   "05824-1138265" AND APPLICABLE DASH NUMBER AND WHEN MANUFACTURED OUTSIDE OF AEROJET-GENERAL CORP, THE MANUFACTURER'S CODE IDENTIFICATION NUMBER, TRADEMARK OR NAME PREFIXED WITH "MFG", ASSIGNED SERIAL NUMBERS AND RETAIN LOT NUMBER.
6 SURFACE ROUGHNESS 125√ UNLESS OTHERWISE NOTED.
7 VISUALLY INSPECT PARTS USING 5X MAGNIFICATION. THE FOLLOWING ACCEPTANCE CRITERIA IS APPLICABLE:
   A. NO CRACKS ALLOWED. A CRACK IS DEFINED AS A BREAK ACROSS A PLY OF FILAMENT.
   B. NO DELAMINATIONS ALLOWED. A DELAMINATION IS DEFINED AS A DISCONTINUITY IN THE RESIN PHASE LYING BETWEEN ADJACENT FILAMENTS AND ESSENTIALLY FREE OF RESIN. NO MORE THAN 5 AREAS OF UP TO .25 LONG. NO TWO AREAS IN ONE RADIAL PLANE.
   C. NO VOIDS ALLOWED. A VOID IS DEFINED AS ANY BUBBLE WHICH EXCEEDS .025 IN DIAMETER.
8 RADIOGRAPHIC INSPECT FOR INFORMATION ONLY USING EASTMAN R FILM OR EQUIVALENT AND NO SCREENS. THE KV SHALL NOT EXCEED 50. TARGET TO BE LOCATED ON AXIS OF RING AT DISTANCE OF 60 INCHES. DENSITY IN READING AREA TO BE 2.0 TO 2.5 HURTER AND DRIFFIELD. THE FOLLOWING CRITERIA IS APPLICABLE FOR RECORD ONLY.
   A. INCLUSIONS OF HIGH DENSITY INDICATIONS - .015 MAXIMUM AND 3 MAXIMUM PER PART ALLOWED.
   B. INCLUSIONS OF LOW DENSITY INDICATIONS - .030 MAXIMUM AND 3 MAXIMUM PER PART ALLOWED.
   C. WRINKLES OR WAVES OF AN AMPLITUDE IN EXCESS OF THREE REINFORCEMENT LAYERS AND OVER A CIRCUMFERENTIAL DISTANCE OF LESS THAN 20° SHALL BE CAUSE FOR REJECTION.
9 RECORD ALL OTHER DISCONTINUITIES FOR RECORD ONLY.
10 CLEANLINESS PER AGC-STD-9007 LEVEL I.
11 PACKAGE PER FABRICATION ORDER INSTRUCTIONS.





TABULATION BLOCK

DASH NO.	W	A DIA	B DIA
-1	.861 .856	3.550 3.545	3.035 3.030
-2	.200 .190	3.490 3.485	3.205 3.210

QTY REQD	STM	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL/SPECIFICATION	ITEM NO
			-2	TEST BLANK	-1	
			-1		POLYQUINOXALINE (PQ), REINFORCED WITH MODMOR TYPE I GRAPHITE FILAMENT CODE IDENT NO 83472. 3	

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON DECIMALS .XX ± .03 .XXX ± .010 ANGULAR ± 2° DO NOT SCALE DRAWING

AEROJET-GENERAL CORPORATION SACRAMENTO, CALIFORNIA

TITLE: BLANK, RETAINER - 35 MM, BALL & ROLLER BEARING

SIZE D | CODE IDENT NO 05824 | DWG NO 1138265

SCALE 1/1

7-6-70

CC-70 PC-1

FIGURE 2

FIGURE 3. TYPICAL X-RAY OF ACCEPTABLE BEARING RETAINER TEST RING. PBI / GRAPHITE

FIGURE 4. TYPICAL X-RAY OF BEARING RETAINER TEST RING. SHOWS BADLY WRINKLED LAMINATIONS.

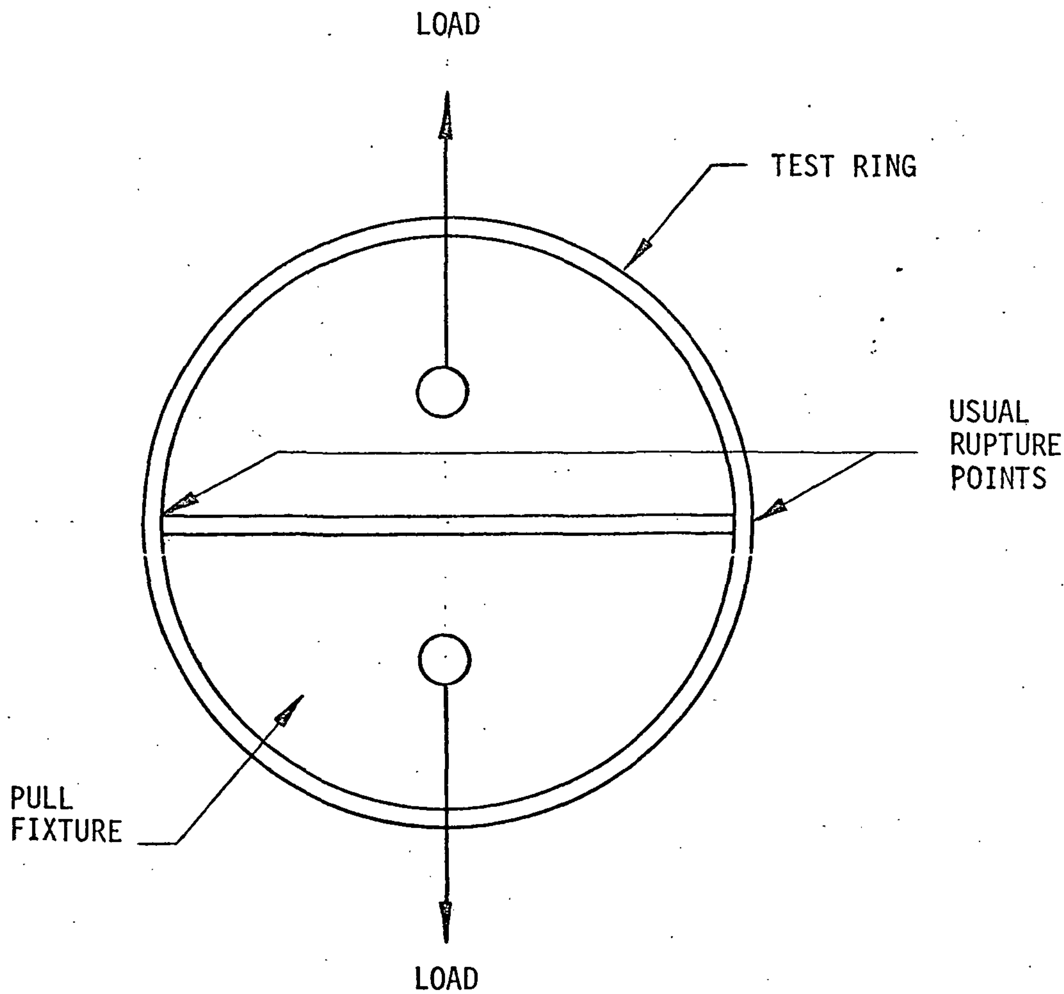
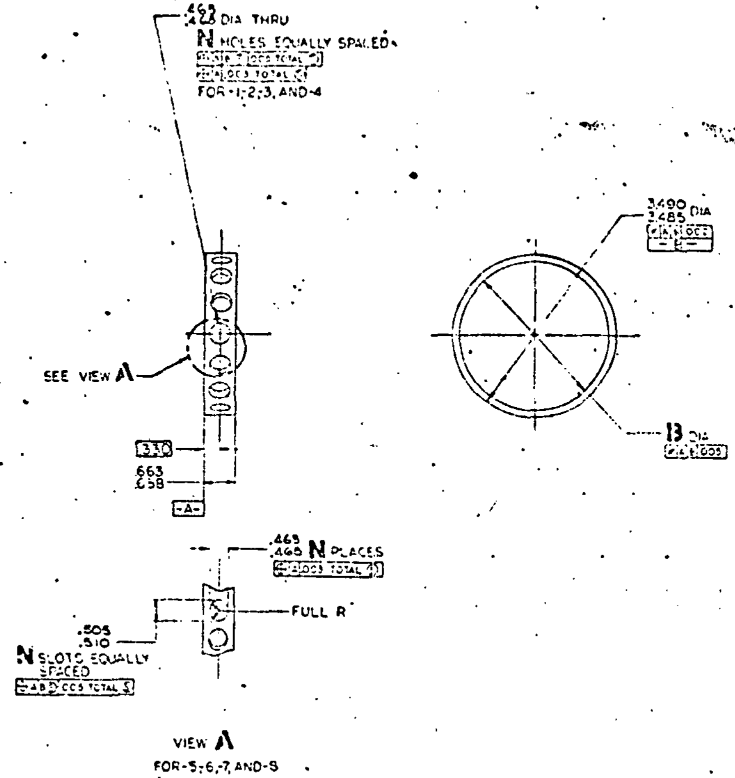


FIGURE 5 - SET-UP FOR HOOP STRENGTH TENSILE TESTS ON BEARING RETAINER TEST RING.

NOTES:

1. INTERPRET DRAWING PER MIL-D-1000 FORM 2, MIL-STD-100 AND USAS Y14.5.
2. REMOVE ALL BURRS AND SHARP EDGES EQUIVALENT TO .005-.015 R UNLESS OTHERWISE NOTED.
3. SURFACE ROUGHNESS 125/ UNLESS OTHERWISE NOTED.
4. MARK PER ASC-STD WITH:
   A. 34632- 1139961 AND APPLICABLE DASH NUMBER.
   B. ASSIGNED SERIAL NUMBER
   C. THE MANUFACTURERS CODE IDENTIFICATION NUMBER, TRADE MARK, OR NAME PREFIXED WITH "MFR" WHEN MANUFACTURED OUTSIDE OF AEROJET NUCLEAR SYSTEMS CO.
   D. QUALITY ACCEPTANCE STAMPS FOR NONDESTRUCTIVE TESTING
5. NONDESTRUCTIVE TESTING:
   A. VISUALLY INSPECT USING 5X MAGNIFICATION
   B. X-RAY INSPECT PER MIL-STD-453. X-RAY PROCEDURE SHALL BE APPROVED BY ANSC PRIOR TO USE.
   C. ACCEPTANCE CRITERIA FOR VISUAL AND X-RAY INSPECTION AS FOLLOWS
      1. NO CRACKS ALLOWED. A CRACK IS DEFINED AS A BREAK LONGER THAN .125 ACROSS A PLY OF FABRIC.
      2. NO DELAMINATIONS ALLOWED. A DELAMINATION IS DEFINED AS A DISCONTINUITY IN THE RESIN BOND BETWEEN ADJACENT PLIES WHICH IS LONGER THAN .25.
      3. NO VOIDS ALLOWED. A VOID IS DEFINED AS ANY BUBBLE LARGER THAN .025 IN DIAMETER.
      4. NO POROSITY ALLOWED. POROSITY IS DEFINED AS A CONCENTRATION OF BUBBLES LESS THAN .025 IN DIAMETER THAT EXCEED .035 RADIALLY OR .25 ALONG THE PLIES
6. WHERE REQUIRED BY PARTS LIST CALLOUT, COAT ALL AREAS OF RETAINER PER THE FOLLOWING PROCEDURE.
   A. PRIOR TO SPRAYING THE PART, THE OPERATOR SHALL ESTABLISH THE DISTANCE FROM NOZZLE TO WORK BY SPRAYING A SHEET OF BOND PAPER. ADJUST DISTANCE FROM WORK TO NOZZLE SO THAT THE RESIN ARRIVES STILL WET ON THE SURFACE WITHOUT RUNNING OR RIPPLING. DISTANCE SHALL NOT BE SO GREAT THAT RESIN ARRIVES PARTIALLY DRY. THE DISTANCE LIMITS, AS ESTABLISHED BY SPRAYING THE PAPER, SHALL BE USED WHEN SPRAYING THE PART.
   B. OBTAIN LIQUID SOLUTION OF LUBRICANT BY DISCHARGING SPRAY CAN INTO SUITABLE CONTAINER (SPRAY CAN TOP).
   C. USING A BRISTLE BRUSH, THOROUGHLY APPLY LUBRICANT FROM STEP B TO RETAINER O.D., I.D., AND POCKETS. ALLOW TO AIR DRY FOR 30 MINUTES.
   D. POLISH BY HAND WITH KIM WIPES BY APPLYING LIGHT WEIGHT OF HAND PRESSURE. USE CLEAN COTTON TIP SWAB FOR POLISHING POCKETS.
   E. SPRAY ENTIRE RETAINER (O.D., I.D., EDGES, AND POCKETS) AND ALLOW TO AIR DRY FOR 15 MINUTES.
   F. REPEAT POLISHING PROCEDURE PER (D) ABOVE
   G. SPRAY RETAINER WITH SECOND COAT OF LUBRICANT AND ALLOW TO AIR DRY FOR 30 MINUTES.
   H. REPEAT POLISHING PROCEDURE PER (D) ABOVE.
7. CLEANLINESS PER ASC-STD-9007, LEVEL II.
8. PACKAGE PER FABRICATION ORDER INSTRUCTIONS



TABULATION BLOCK		
DASH NO.	B DIA	N NO.
-1	3.205 3.210	17
-2	3.205 3.210	16
-3	3.275 3.280	17
-4	3.275 3.280	16
-5	3.205 3.210	17
-6	3.205 3.210	16
-7	3.275 3.280	17
-8	3.275 3.280	16

321-X	LUBRICANT DRY FILM	
-8		MAKE FROM 1138220-1
-7		
-6		
-5		
-4		
-3		
-2		
-1		MAKE FROM 1138220-1

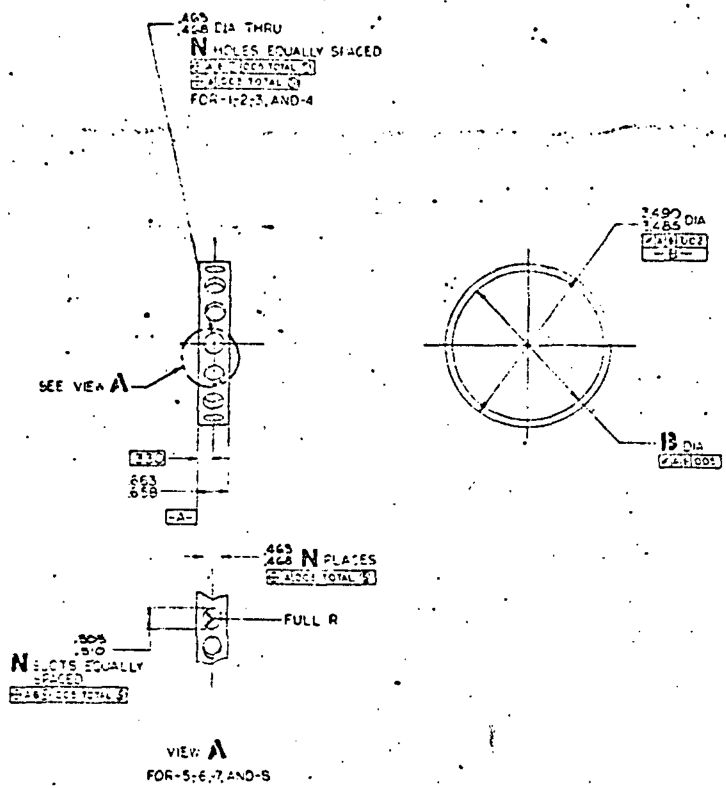
RETAINER, BALL BEARING-65MM (¾ DIA BALL)

E 34632 1139961

FIGURE 6

NOTES:

1. INTERPRET DRAWING PER MIL-D-1000 FORM 3, MIL-STD-100 AND USAS Y14.5.
2. REMOVE ALL BURRS AND SHARP EDGES EQUIVALENT TO .005-.015 R UNLESS OTHERWISE NOTED.
3. SURFACE ROUGHNESS 125/ UNLESS OTHERWISE NOTED.
4. MARK PER AS0521594 WITH:
   A. 34632-1139963 AND APPLICABLE DASH NUMBER.
   B. ASSIGNED SERIAL NUMBER
   C. THE MANUFACTURERS CODE IDENTIFICATION NUMBER, TRADE MARK, OR NAME PREFIXED WITH "SVT" WHEN MANUFACTURED OUTSIDE OF AEROJET NUCLEAR SYSTEMS CO.
   D. QUALITY ACCEPTANCE STAMPS FOR NONDESTRUCTIVE TESTING
5. NONDESTRUCTIVE TESTING:
   A. VISUALLY INSPECT USING 5X MAGNIFICATION.
   B. X-RAY INSPECT PER MIL-STD-453. X-RAY PROCEDURE SHALL BE APPROVED BY ANSC PRIOR TO USE.
   ACCEPTANCE CRITERIA FOR VISUAL AND X-RAY INSPECTION AS FOLLOWS
   1. NO CRACKS ALLOWED. A CRACK IS DEFINED AS A BREAK LONGER THAN .125 ACROSS A PLY OF FABRIC.
   2. NO DELAMINATIONS ALLOWED. A DELAMINATION IS DEFINED AS A DISCONTINUITY IN THE RESIN LYING BETWEEN ADJACENT PLIES WHICH IS LONGER THAN .25.
   3. NO VOIDS ALLOWED. A VOID IS DEFINED AS ANY BUBBLE LARGER THAN .025 IN DIAMETER.
   4. NO POROSITY ALLOWED. POROSITY IS DEFINED AS A CONCENTRATION OF BUBBLES LESS THAN .025 IN DIAMETER THAT EXCEED .035 RADIALLY OR .25 ALONG THE PLIES
6. WHERE REQUIRED BY PARTS LIST CALLOUT, COAT ALL AREAS OF RETAINER PER THE FOLLOWING PROCEDURE.
   A. PRIOR TO SPRAYING THE PART, THE OPERATOR SHALL ESTABLISH THE DISTANCE FROM NOZZLE TO WORK BY SPRAYING A SHEET OF BOND PAPER. ADJUST DISTANCE FROM WORK TO NOZZLE SO THAT THE RESIN ARRIVES STILL WET ON THE SURFACE WITHOUT RUNNING OR RIPPLING. DISTANCE SHALL NOT BE SO GREAT THAT RESIN ARRIVES PARTIALLY DRY. THE DISTANCE LIMITS, AS ESTABLISHED BY SPRAYING THE PAPER, SHALL BE USED WHEN SPRAYING THE PART.
   B. OBTAIN LIQUID SOLUTION OF LUBRICANT (MS-5) BY DISCHARGING SPRAY CAN INTO SUITABLE CONTAINER (SPRAY CAN TOP).
   C. USING A BRISTLE BRUSH, THOROUGHLY APPLY LUBRICANT FROM STEP B TO RETAINER O.D., I.D., AND POCKETS. ALLOW TO AIR DRY FOR 30 MINUTES.
   D. POLISH BY HAND WITH KIM WIPES (T.M.) APPLYING LIGHT WEIGHT OF HAND PRESSURE. USE CLEAN COTTON TIP SWAB FOR POLISHING POCKETS.
   E. SPRAY ENTIRE RETAINER (O.D., I.D., EDGES, AND POCKETS) AND ALLOW TO AIR DRY FOR 15 MINUTES
   F. REPEAT POLISHING PROCEDURE PER (D) ABOVE.
   G. SPRAY RETAINER WITH SECOND COAT OF LUBRICANT AND ALLOW TO AIR DRY FOR 30 MINUTES.
   H. REPEAT POLISHING PROCEDURE PER (D) ABOVE.
7. CLEANLINESS PER ASC-STD-9007, LEVEL VI.
8. PACKAGE PER FABRICATION ORDER INSTRUCTIONS.



TABULATION BLOCK		
DASH NO.	B	N
-1	3205 / 3210	17
-2	3205 / 3210	16
-3	3.275 / 3.260	17
-4	3275 / 3260	16
-5	3205 / 3210	17
-6	3205 / 3210	16
-7	3275 / 3260	17
-8	3275 / 3260	16

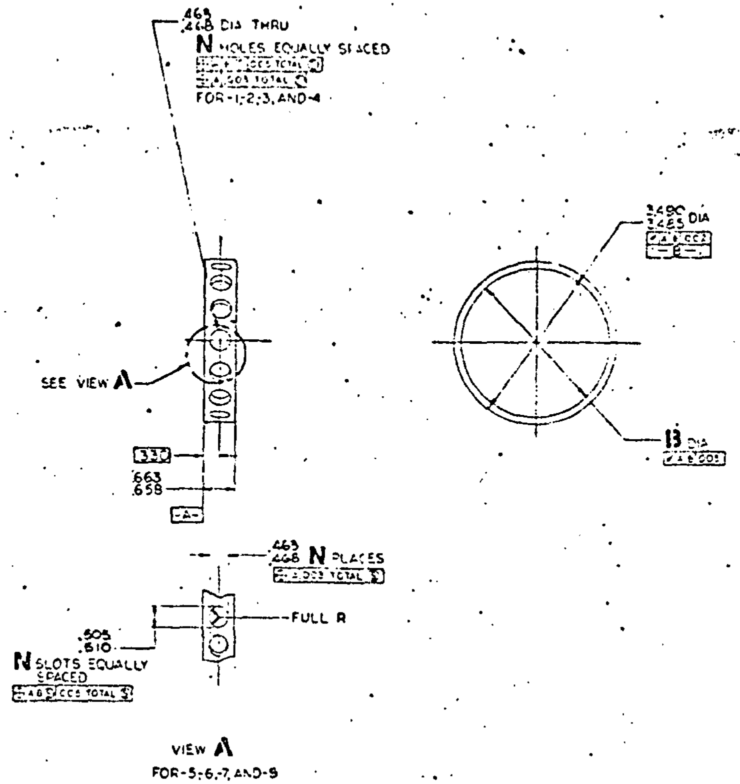
321-X
LUBRICANT DRY FILM, MoS2
-8 MAKE FROM 1136288-1
-7
-6
-5
-4
-3
-2
-1 MAKE FROM 1136288-1

AEROJET NUCLEAR SYSTEMS COMPANY
RETAINER, BALL BEARING-65mm(1/2 DIA BALL)
E 34632 1139963

FIGURE 7

NOTES

1. INTERPRET DRAWING PER MIL-D-1000 FORM 2, MIL-STD-100 AND USAS Y14.5.
2. REMOVE ALL BURRS AND SHARP EDGES EQUIVALENT TO .005-.015 R UNLESS OTHERWISE NOTED.
3. SURFACE ROUGHNESS 125/ UNLESS OTHERWISE NOTED.
4. MARK PER AGC-STD-... WITH:
   A. 34632-1139964- AND APPLICABLE DASH NUMBER.
   B. ASSIGNED SERIAL NUMBER
   C. THE MANUFACTURERS CODE IDENTIFICATION NUMBER, TRADE MARK, OR NAME PREFIXED WITH "MFR" WHEN MANUFACTURED OUTSIDE OF AEROJET NUCLEAR SYSTEMS CO.
   D. QUALITY ACCEPTANCE STAMPS FOR NONDESTRUCTIVE TESTING
5. NONDESTRUCTIVE TESTING:
   A. VISUALLY INSPECT USING 5X MAGNIFICATION
   B. X-RAY INSPECT PER MIL-STD-453. X-RAY PROCEDURE SHALL BE APPROVED BY ANSC PRIOR TO USE.
   ACCEPTANCE CRITERIA FOR VISUAL AND X-RAY INSPECTION AS FOLLOWS
   1. NO CRACKS ALLOWED. A CRACK IS DEFINED AS A BREAK LONGER THAN .125 ACROSS A PLY OF FABRIC.
   2. NO DELAMINATIONS ALLOWED. A DELAMINATION IS DEFINED AS A DISCONTINUITY IN THE RESIN LYING BETWEEN ADJACENT PLIES WHICH IS LONGER THAN .25.
   3. NO VOIDS ALLOWED. A VOID IS DEFINED AS ANY BUBBLE LARGER THAN .025 IN DIAMETER.
   4. NO POROSITY ALLOWED. POROSITY IS DEFINED AS A CONCENTRATION OF BUBBLES LESS THAN .025 IN DIAMETER THAT EXCEED .035 RADIALLY OR .25 ALONG THE PLIES.
6. WHERE REQUIRED BY PARTS LIST CALLOUT, COAT ALL AREAS OF RETAINER PER THE FOLLOWING PROCEDURE.
   A. PRIOR TO SPRAYING THE PART, THE OPERATOR SHALL ESTABLISH THE DISTANCE FROM NOZZLE TO WORK BY SPRAYING A SHEET OF BOND PAPER. ADJUST DISTANCE FROM WORK TO NOZZLE SO THAT THE RESIN ARRIVES STILL WET ON THE SURFACE WITHOUT RUNNING OR RIPPLING. DISTANCE SHALL NOT BE SO GREAT THAT RESIN ARRIVES PARTIALLY DRY. THE DISTANCE LIMITS, AS ESTABLISHED BY SPRAYING THE PAPER, SHALL BE USED WHEN SPRAYING THE PART.
   B. OBTAIN LIQUID SOLUTION OF LUBRICANT (MLS-2) BY DISCHARGING SPRAY CAN INTO SUITABLE CONTAINER (SPRAY CAN TOP).
   C. USING A BRISTLE BRUSH, THOROUGHLY APPLY LUBRICANT FROM STEP B TO RETAINER O.D., I.D., AND POCKETS. ALLOW TO AIR DRY FOR 30 MINUTES.
   D. POLISH BY HAND WITH KIM WIPES (T.M.) APPLYING LIGHT WEIGHT OF HAND PRESSURE. USE CLEAN COTTON TIP SWAB FOR POLISHING POCKETS
   E. SPRAY ENTIRE RETAINER (O.D., I.D., EDGES, AND POCKETS) AND ALLOW TO AIR DRY FOR 15 MINUTES.
   F. REPEAT POLISHING PROCEDURE PER (D) ABOVE.
   G. SPRAY RETAINER WITH SECOND COAT OF LUBRICANT AND ALLOW TO AIR DRY FOR 30 MINUTES.
   H. REPEAT POLISHING PROCEDURE PER (D) ABOVE.
7. CLEANLINESS PER AGC-STD-9037, LEVEL II.
8. PACKAGE PER FABRICATION ORDER INSTRUCTIONS.



TABULATION BLOCK		
DASH NO.	B DIA	N NO.
-1	3205 3210	17
-2	3205 3210	16
-3	3275 3280	17
-4	3275 3280	16
-5	3205 3210	17
-6	3205 3210	16
-7	3275 3280	17
-8	3275 3280	16

DASH NO.	NOMENCLATURE OR DESCRIPTION
-8	MAKE FROM 1138220-2
-7	
-6	
-5	
-4	
-3	
-2	
-1	MAKE FROM 1138220-2

FIGURE 8

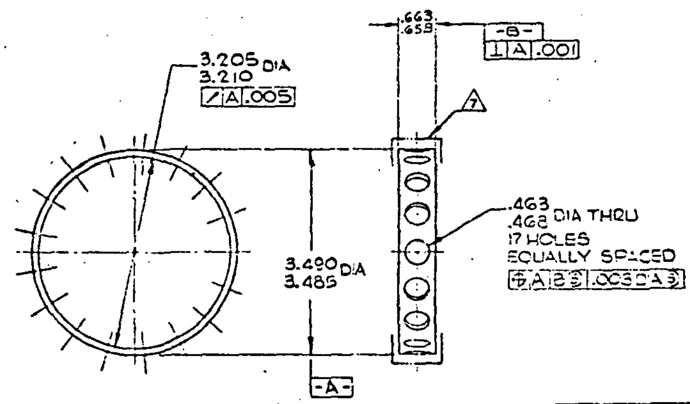
RETAINER, BALL BEARING-65mm (¾ DIA BALL)

E 34632 1139964

NOTES:

1 INTERPRET DRAWING PER MIL-D-1000 FORM 3 AND USASI Y14.5.
2 REMOVE ALL BURRS AND SHARP EDGES EQUIVALENT TO .005-.015 R UNLESS OTHERWISE NOTED.
3 SURFACE ROUGHNESS 125/ UNLESS OTHERWISE NOTED.
4 VISUALLY INSPECT FOR CRACKS USING 5X MAGNIFICATION. NO CRACKS OR DELAMINATIONS ALLOWED AS DEFINED ON 1138220 & 1138288.
5 MARK PER ASD5215-1 WITH: "05824-1138192" AND APPLICABLE DASH NUMBER AND WHEN MANUFACTURED OUTSIDE OF AEROJET-GENERAL CORP, THE MANUFACTURERS CODE IDENTIFICATION NUMBER, TRADEMARK OR NAME PREFIXED WITH "MFG" & ASSIGNED SERIAL NUMBER.
6 CLEANLINESS PER AGC-STD-9207 LEVEL I.
7 PACKAGE PER FABRICATION ORDER INSTRUCTIONS, INCLUDE PROTECTIVE CONTAINER.
8 REMOVED
9 REMOVED
10 REMOVED
11 RADIOGRAPHIC INSPECT USING EASTMAN R FILM OR EQUIVALENT AND NO SCREENS. THE KV SHALL NOT EXCEED 50. DISTANCE TO 60 INCHES WITH TARGET LOCATED ON AXIS OF RING. DENSITY IN READING AREA TO BE 2.0 TO 2.5 HURTER AND DRIFFIELD. ACCEPTANCE CRITERIA: NO DELAMINATION OR CRACKS AS DEFINED ON 1138220 & 1138288.
12 WHERE REQUIRED BY PARTS LIST CALLOUT, COAT ALL AREAS OF RETAINER PER THE FOLLOWING PROCEDURE.
   (A) PRIOR TO SPRAYING THE PART, THE OPERATOR SHALL ESTABLISH THE DISTANCE FROM NOZZLE TO WORK BY SPRAYING A SHEET OF BOND PAPER, ADJUST DISTANCE FROM WORK TO NOZZLE SO THAT THE RESIN ARRIVES STILL WET ON THE SURFACE WITHOUT RUNNING OR RIPPLING. DISTANCE SHALL NOT BE SO GREAT THAT RESIN ARRIVES PARTIALLY DRY. THE DISTANCE LIMITS AS ESTABLISHED BY SPRAYING THE PAPER SHALL BE USED WHEN SPRAYING THE PART.
   (B) SPRAY PART AND ALLOW TO AIR DRY FOR 10 (TEN) MINUTES.
   (C) POLISH BY HAND WITH SCOT-WIPE (TM) APPLYING LIGHT, WEIGHT OF HAND, PRESSURE.
   (D) REMOVE ANY SCOT-WIPE (TM) FIBERS WITH CLEAN DRY 50 PSIG GASEOUS NITROGEN.
   (E) SPRAY PART WITH A SECOND COAT OF LUBRICANT AND ALLOW TO AIR DRY FOR 30 (THIRTY) MINUTES.
   (F) REPEAT (C) AND (D) ABOVE.
   (G) AFTER (B) THRU (F) ABOVE, VISUALLY INSPECT USING 5X MAGNIFICATION FOR COMPLETE COATING CONTINUITY, ANY SURFACE DISCONTINUITIES AS EVIDENCED BY THE ABSENCE OF A GLOSS IN A LOCALIZED LINE EXTENDING ACROSS ANY ONE DIRECTION OF THE PART SHALL BE CAUSE FOR REJECTION. PERMISSIBLE TO REPEAT B THRU F.

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	SEE A DCN		
	B	SEE B DCN		



-G	-4	-3	SYM	CODE IDENT	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	MATERIAL/SPECIFICATION	ITEM NO.
1					-5		MAKE FROM 1138288-1	
AR	AR	A2		94459	321-X	LUBRICANT DRY FILM MoS2		
	1				-2		MAKE FROM 1138220-2	
		1			-1		MAKE FROM 1138220-1	

PARTS LIST

AEROJET-GENERAL CORPORATION
SACRAMENTO, CALIFORNIA

TITLE: RETAINER, BALL BEARING - 65MM

SIZE D | CODE IDENT NO. 05824 | DWG NO. 1138192

1137904

FIGURE 9