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CONTENTS

COVER: A Lockheed Flight Test crew boards a Canadian Armed Forces Hercules for an early morning takeoff.

Troubleshooting the Hercules Fuel Quantity INDICATING SYSTEM

by HAROLD COOK, ***Senior Functional Test Engineer and***
ELBERT FIELDS, ***Service Analyst***

WE’RE GOING to look at, specifically, the fuel quantity indicating system installed on C-130B and subsequent Hercules aircraft. But the general information is applicable to all capacitance-type indicating systems, such as those on the C-130A and the JetStar.

Troubleshooting a fuel quantity indicating system requires strict adherence to all of the safety precautions concerning such matters as fueling and defueling, open fuel tanks and proper test equipment. As a supplement to these safety precautions, the following procedures are recommended for troubleshooting the Hercules fuel quantity indicating system:

Do not use electrical equipment capable of producing more than 200 milliamperes in fuel tank measurements. Use only the MD-2A (FSN/4920-509-1508) automatic capacitance bridge and low-voltage megohmmeter (megger) or TF-20 (FSN/4920-962-3027) automatic capacitance bridge, low-voltage megger, and precision capacitors for all capacitance and resistance measurements.

With system or test equipment power applied to the fuel quantity indicating system (tanks not drained and purged), do not make or break any electrical connections in, or close to, the fuel tanks. Any connections required for continuity checks should be made with or TF-20 test equipment de-energized. Energize test equipment only after all connections are completed to verify continuity. De-energize test equipment prior to disconnecting.

CAUTION: ***Do not apply power to the aircraft while fuel tank is open.***

Any equipment used in testing or measuring fuel quantity indicating system components should be grounded to the aircraft and/or static ground prior to applying power to the equipment. Ground connections should not be assumed, they should be checked.

The Hercules fuel quantity indicating system is a single-point ground system. On some aircraft the shield of the coaxial cable is grounded only through the indicator, while on production aircraft LAC 4454 and subsequent and in-service aircraft modified in accordance with Service Bulletin 82-308 or 382-144 the ground is through the aircraft structure near the indicator. The system is not grounded in the tank. Depending on configuration, the shield may be above ground when the indicator is disconnected. In addition, the case of the MD-2A or TF-20 has the same ground potential as the shield. This means that when one of these testers is being used to check the system, either in the cockpit or at the tank boundary (the point at which the wiring enters the tank) and the ground wire for the MD-2A or TF-20 is not connected, any voltage on the case of the tester (internal short in MD-2A or TF-20, voltage on stand contacting case of the test equipment,etc.) may be applied directly to the shield of the coaxial cable inside the tank. Always ground the MD-2A or TF-20 to the aircraft structure prior to applying power to the test equipment.

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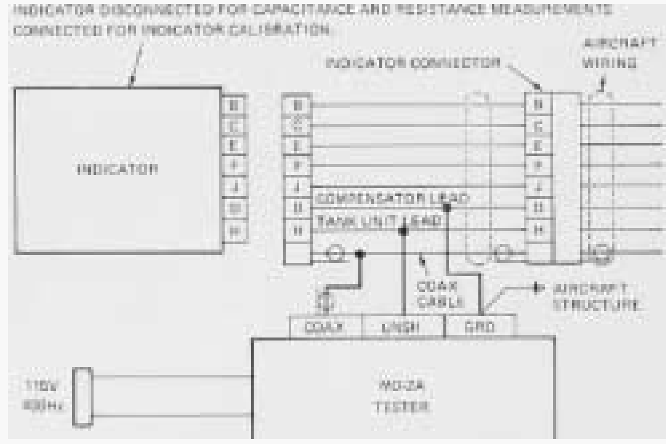
FRONT PANEL, MD-2A TESTER

FIGURE 1



CONNECTION OF MD-2A

Check **power source** for proper voltage (specified in handbook or on test equipment) before connecting test equipment to power source.

Any equipment in contact with the MD-2A or TF-20, such as the stand, should also be grounded to the aircraft and/or static ground.

Do not use ohmmeters with unknown current capabilities for resistance checks on the fuel quantity indicating system. Use only MD-2A or TF-20.

Do not use high-potential tester or megger. Use only MD-2A or TF-20.

Operations such as soldering should not be performed around the fuel tanks before draining and purging has been accomplished.

Static-producing clothing should not be worn when working around fueling and defueling operations.

TROUBLESHOOTING . Reports of malfunctions in the fuel quantity indicating system will usually be expressed in terms of indicator performance. Examples: indicator drives to below zero indicator shifts up scale or down scale in error (1000 lb., 2000 lb., etc.) indicator is inoperative .

Although a troubleshooting chart is included, let's look at the more common malfunctions as an aid in using the chart.

MALFUNCTION: INDICATOR IS AGAINST THE STOP BELOW ZERO WITH FUEL IN THE TANK

The most common causes, and tbeir remedies are:

Center conductor **of coaxial cable shorted to shield anywhere in the system, or internally shorted tank unit.**

Open the circuit breaker for the system being tested, disconnect the cockpit indicator, and connect the calibration harness and MD-2A or TF-20 per Figure 1 or Figure 2.

CAUTION: Connect *ground wire from MD-2A or TF-20 per Figure 1 or Figure 2 before connecting to power source.*

NOTE: Only the MD-2A will be referred to in the following tests. See "How to Use the TF-20" appearing later if this tester is to be employed.

Connect the MD-2A to 115V, 400 Hz power, and position power switch to ON. Allow approximately five minutes for warm-up.

Calibrate the megohmmeter with the Megohmmeter Range Selector in both CAL positions then position the Megohmmeter Range Selector to Xl.

Using the Capacitance-Megohms Selector (MD-2A), check the resistance for the A TO CRD (coaxial cable center conductor to GRD) position. The total system resistance should be within the limits of Table 1.

If the resistance reading is not less than the value shown in Table 1 (Approximate total sytem resistance before indicator accuracy is affected), the cause is neither the center conductor shorted to the shield nor an internally

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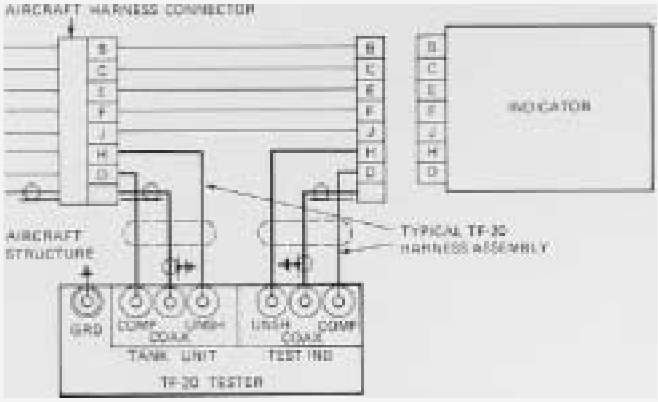
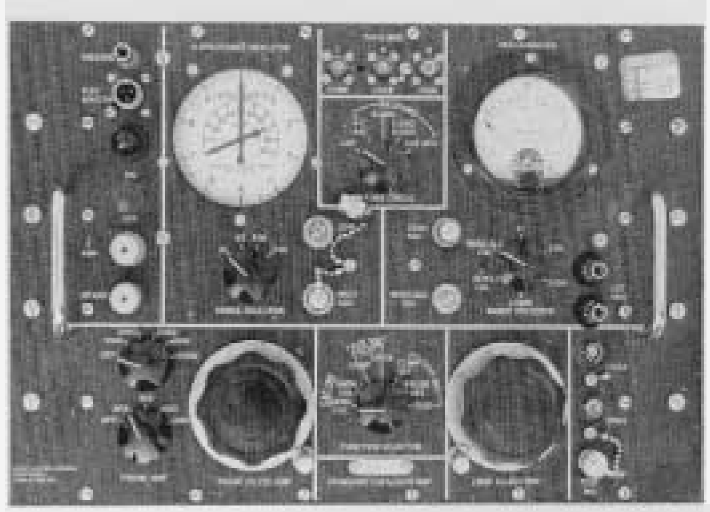
FIGURE 2



CONNECTION OF TF-20



FRONT PANEL, TF-20 TESTER

shorted tank unit. If the resistance reading indicates that the center conductor is shorted (approximately zero resistance) to the shield (ground), this is the cause of the indicator malfunction.

TABLE 1

MD-2A switch position	Minimum resistance in Megohms [1]	Approx. resistance before indicator error (Single malfunction only)
Tank Unit		
A TO B	60	25M
A TO GRD	40	5M
B TO GRD	20	1M
compensator[2]		
A TO B	60	30M
B TO GRD	20	1M

[1] Ref. T.O.'s 5L14-3-21-43 and 5L14-3-21-13

[2] Interchange tank unit and-compensator leads (Figure 1) for compensator circuit check.

With the MD-2A still connected to the indicator connector and the power switch (MD-2A) to OFF, disconnect the connector(s) at the tank boundary for the tank system under test. Position MD-2A power switch to ON and repeat A TO GRD resistance check.

If the short has cleared, the trouble is probably in the tank. (Recheck at the tank before opening.) In this case, drain and purge the tank per the recommended procedure before trying to locate the fault. The short will most likely be in one of the individual probe-harness coaxial-cable connectors, or the tank boundary connector.

The short can be isolated to a wire segment and/or probe by using the MD-2A (A TO GRD switch position) and disconnecting segments of probe wiring, beginning with the probe which is farthest from the tank boundary connector(s) until the fault is cleared or only one wire segment is left. (NOTE: Reconnect each segment as the test progresses.)

If the short has not cleared, the trouble is in the wiring outside the tank. While monitoring with the MD-2A (A TO GRD switch position), disconnect wire segments until the fault is cleared, or only one wire segment remains. You now have the fault isolated to two connectors and one length of wire. The fault will probably be in one of the connectors, and disassembly and recheck is the only way to determine which one. Disassemble and remove shield cup on only one connector at a time. Check from the remaining connector to determine if fault is cleared. If this one is not the connector with the short, you now have an excellent chance to create one when you reassemble. So, during reassembly, be sure that none of the individual shield strands protrude into the shield cap, where they can contact the center conductor; avoid excessive heating of the dielectric in the connector (this causes the dielectric to have an affinity for water); and remove any bits of solder or wire before installing the snap ring and strain relief. Repeat for the other connector if fault is not cleared.

If neither connector is at fault, replace the wire segment. There have been instances where the center conductor has migrated through the dielectric and contacted the shield after exposure to excessively high temperatures (hot air leaks). Crushing the coaxial cable could also cause the same fault. (Text continued on Page 8)

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HERCULES (Except C-130A & D Series)

TANK		ORIGINAL			MOD I		
		Lockheed P/N	Vendor P/N	FSN	Lockheed P/N	Vendor P/N	FSN
Bladder (Auxiliary)	1st Unit	695799-1	FG220A-97	6680-585-9354	695799-63	FG220A-194	6680-05 I-6693
	2nd Unit	-3	-96	-9363	-65	-193	-6694
	3rd Unit	-5	4 5	-9352	-67	-192	-6691
	Compensator	-7	FG260A-6	-0827	-69	FG250A-42	-089-5300
Inboard	1st Unit	695799-9	FG220A-108	6680-585-9350	695799-71	FG220A-205	6680-051-6702
	2nd Unit	-11	-109	-0811	-73	-206	-6690
	3rd Unit	-13	-110	-0820	-75	-207	-6700
	4th Unit	-15	-111	-082 1	-77	-208	-6687
	5th Unit	-17	-112	-0822	-79	-209	-6686
	6th Unit	-19	-113	-0823	-81	-210	-6686
	7th Unit	-21	-114	-0824	-83	-211	-6684
	8th Unit	-23	-1 16	-9351	-85	-212	-6699
	Compensator	-25	FG205A-7	-0828	-87	FG250A-43	-089-529s
Outboard	1st Unit	695799-27	FG220A-98	6680-585-0825	69579989	FG220A-195	6680-051-6683
	2nd Unit	-29	-99	-0826	-91	-196	-8849
	3rd Unit	-31	-100	-0817	-93	-197	-6688
	4th Unit	-33	-101	-1038	-95	-198	-6692
	5th Unit	-35	-102	-0816	-97	-199	-6698
	6th Unit	-37	-103	-9349	-99	-200	-6697
	7th Unit	-39	-104	-0815	-101	-201	-6696
	8th Unit	-41	-105	-08 14	-103	-202	-6689
	9th Unit	-43	-106	-0813	-105	-203	-6695
	10th Unit	-45	-107	-0812	-107	-204	-6701
	Compensator	-47	FG250A-8	-0810	-109	FG250A-44	-089-5298
Lock heed Pylon (External)	1st Unit Center	695799-49	FG220A-178	6680-899-8663	695799-I 11	FG220A-215	6680-056-9542
	2nd Unit Center	-51	-179	8664	-113	-216	-9543
	Aft Section	-53	-177	-8662	-115	-214	-9541
	Fwd Section	-55	-176	8661	-117	-213	-9540
	Compensator	-57	FG6B-1	-853-1233	-119	FG6B-2	-071-3968
American Electric Pylon (External)	1 st Unit Center	None	EA772-2856	6680-869-9811			
	2nd Unit Center	None	-2867	-9812			
	Aft Section	None	-2858	-9613			
	Fwd Section	None	-2859	-9814			
	compensator	None	6 1115.2860	-9810			

[1] Same as ORIGINAL except inner electrodes and compensators have a coating to resist the effects of contaminants in the fuel.

‘Same as MOD I except equipped with new connectors per MIL-C-255166 and internal wiring improvements. This configuration installed as a part of TCTO 741, and is the preferred replacement.

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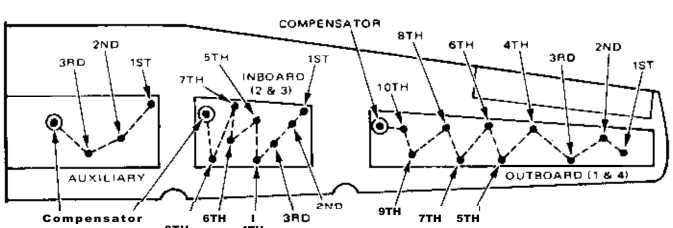
Fuel Quantity System Tank Units

MOD II[2]

Lockheed P/N	Vendor P/N	FSN		DRY CAPACITANCE IN MMF Tank Unit	Compensator
695799-I 21	FG220A-239	6680-968-3227		50.8-52.8	
-123	-238	-3226		27.3-28.9	
-125	-237	-3225		57.7-60.1	
-127	FG25OA-51	-3277		30.2-31.8	29.5-31.1
			Empty	169.8 (166.4-173.5)	30.3
			Added	188.0 *	31.7
			Full	357.8 *	62.0
695799-1 29	FG220A-250	6680-968-3260		27.0-28.6	
-131	-251	-3261		3 1.2-32.8	
-133	-252	-3263		33.0-34.6	
-135	-253	-3266		32.1-33.7	
-137	-254	-3269		33.6-35.2	
-139	-255	-3270		31 .O-32.6	
-141	-256	-327 1		26.4-28.0	
-143	-257	-3273		28.2-29.8	
-145	FG250A -52	-3278		6.7-8.3	29.5-31.1
			Empty	256.4 (251.3-261.5)	30.3
			Added	291.2*	31.7
			Full	547.6 *	62.0
695799-147	FG220A-240	6680-968 -3228		10.2-I 1.8	
-149	-241	-3229		18.2-19.8	
-151	-242	-3230		24.7-26.3	
-153	-243	-3242		19.7-21.3	
-155	-244	-3243		14.7-16.3	
-157	-245	-3247		13.2-14.8	
-159	-246	-3251		13.7-15.3	
-161	-247	-3252		26.7-28.3	
-163	-248	-3255		3 1.6-33.2	
-165	-249	-3258		27.2-28.8	
-167	FG25OA-53	-328 1		5.0-6.6	29.5-31.1
			Empty	213.7 (209.4-218.0)	30.3
			Added	241.6 *	31.7
			Full	455.3 *	62.0
695799-169	FG22OA-260	6680-968 -32 13		84.2-85.8	
-171	-261	-3223		81.7-83.3	
-173	-259	-3212		80.2-81.8	
-175	-258	-3197		8 1.4-83.0	29.5-31 .I
-177	FG6B-3	-3224	Empty	330.7 (324.1-337.3)	30.3
			Added	391.2 *	31.7
			Full	721.9 *	62.0
				84.2-85.8	
				8 1.7-83.3	
				80.2-8 1.8	
				8 1.4-83.0	29.5-3 1.1
			Empty	330.7 (324.1-337.3)	30.3
			Added	391.2 *	31.7
			Full	721.9 *	62.0



FUEL TANK UNIT AND COMPENSATOR LOCATIONS

* Increase value shown by 5% for tanks with foam installed.

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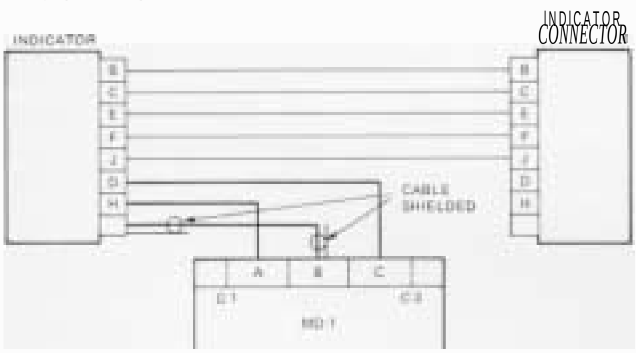
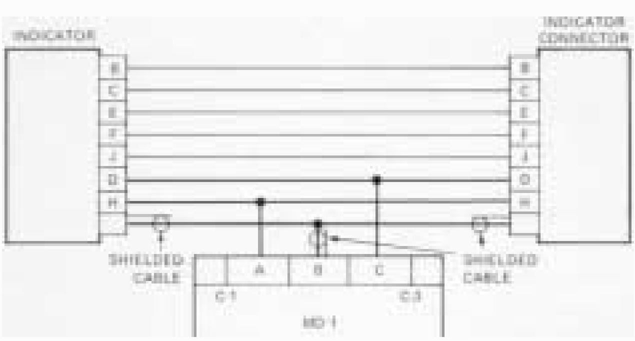
FRONT PANEL, MO-1 TESTER

FIGURE 3



CONNECTION OF MD-1 (ALTERNATE CALIBRATION)

FIGURE 4



CONNECTION OF MD-1 (PREFERRED CALIBRATION)

Open coaxial cable (center conductor) or unshielded tank unit wire, outside or inside the tank.

With the MD-2A connected to the indicator harness connector, check the capacitance of the tank units.

NOTE: Ground the compensator lead when checking the tank units.

If the capacitance is approximately zero, the break is in, or between, the tank boundary connector and the two closest probes. This fault is generally the result of pushed-back pin, cold solder, or broken wire in the probe or harness connectors. This type fault may appear intermittently as a result of altitude (temperature), descent, flap operation, etc. Although not as common as the above, the open circuit can occur in the probe wiring in the head of the probe with the same results.

NOTE: When checking wiring in the tank, make sure that all the wire harnesses have sufficient slack, the nuts on the rear of the coaxial cable connections are tight, and the pin is not pushed back in the dielectric.

If the capacitance reading is greater than the probe closest to the tank boundary, add the values of the individual probes in sequence from the tank boundary until the sum is approximately equal to the capacitance reading. You now have the break isolated to one length of wire and two probes.

NOTE: See Table 2 for probe capacitance values.

Indicator improperly calibrated.

If the tank contains fuel, disconnect the indicator and connect calibration harness and MD-l (FSN/6625-302-4802) as shown in Figure 3. The MD-1 Tester supplies equivalent capacitance for testing and calibrating fuel quantity indicators. Adjust the C-3 section of the MD-l to 62.0 MMF and the C-l section to the nominal empty value of capacitance for the tank being checked. (See Table 2).

NOTE: When calibrating or checking the indicator at empty, the compensator may be either the dry or wet value of capacitance without affecting the accuracy of the indicator calibration.

Adjust the C-l section of the MD-1 to position the indicator pointer to the empty graduation. The capacitance should be within +4 percent of the nominal empty capacitance.

Now, for the full check, adjust the C-l section of the MD-l to the sum of the nominal empty capacitance, plus the added capacitance (full capacitance). Continue to adjust (if required) until the indicator pointer coincides

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with the full (last scale) graduation. The capacitance should be within +4 percent of the full capacitance.

If the check demonstrates that the indicator is improperly calibrated, it is preferable to drain the tank and calibrate the indicator to a dry tank (preferred method Figure 4). If time will not permit the preferred method of calibration, the indicator can be calibrated for “empty”, using the nominal empty capacitance, and for “full”, using the nominal full capacitance (“empty” plus added capacitance). When using this alternate method, you are assuming the integrity of the tank wiring and probes. Some degree of confidence in this method of calibration can be had by using a dipstick if the aircraft is in a level attitude (0 roll and 0 pitch).

NOTE: Do not calibrate the indicator to the dipstick. Your calibration will be much more accurate if the dipstick is used only to show that the calibration is approximately correct.

Agreement between the dipstick and indicator within 500 to 600 pounds (especially if the aircraft is not perfectly level) is generally an indication that the empty capacitance limits (100 to 200 pounds) is the only added error.

MALFUNCTION: INDICATOR AGAINST THE STOP ABOVE THE LAST SCALE GRADUATION

The most common causes, and their remedies, are:

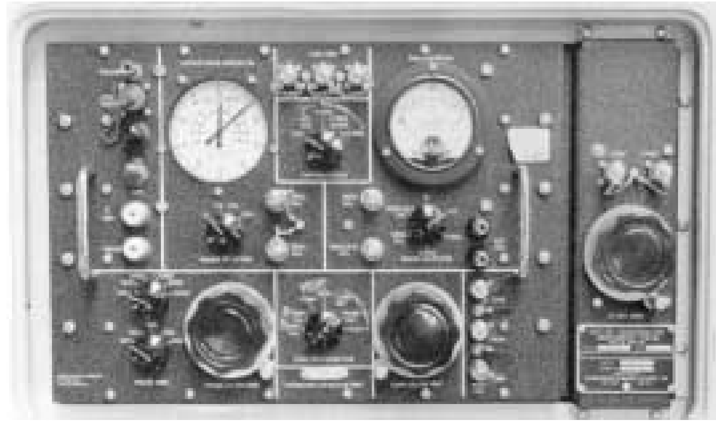
Open **circuit in shield between individual indicator and tank boundary connector.**

With the MD-2A connected per Figure 5, disconnect the connector(s) at the tank boundary. With MD-2A Megohmmeter Range Selector at Xl, position the Capacitance-Megohms Selector to A TO GRD. Megohmmeter should read infinite resistance (full CCW). Connect a jumper from the coaxial cable center conductor to the shield at the tank boundary connector and observe megohmmeter for continuity (no change: open shield- full CW: continuity).

If open, isolate to a connector and repair as necessary.

Open **circuit in shield between individual probes within the tank.**

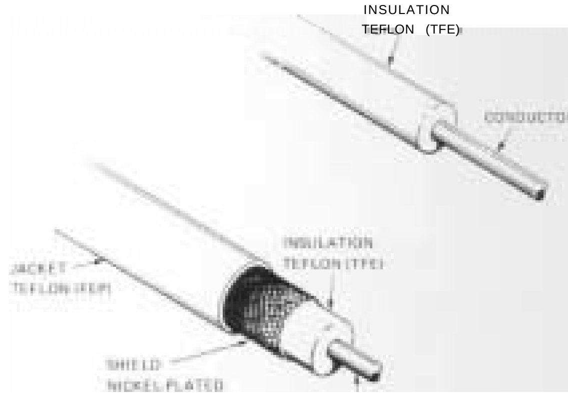
If continuity exists with the MD-2A connected and operated as described above, the open circuit is in the tank. With the tank drained and purged and the MD-2A connected per Figure 5, use the megohmmeter section of the MD-2A to isolate open shield. **(Text continued on Page 12)**



FRONT PANEL, TF-20-1 TESTER

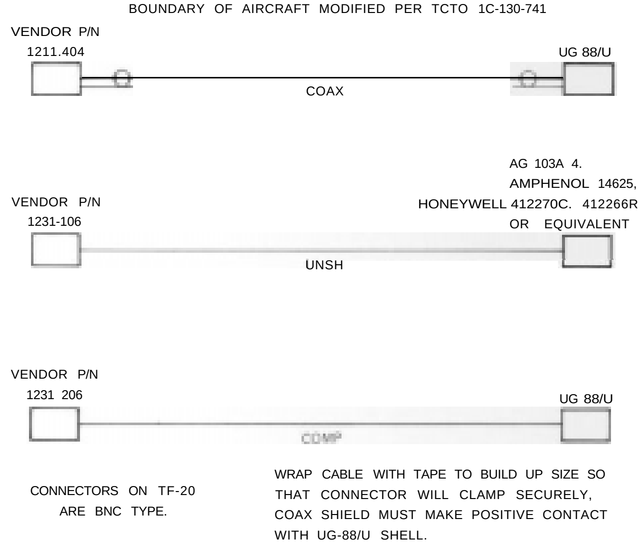
Front panel of TF-20-I tester (FSN/4920-962-3097) which is version of TF-20 in waterproof case with added Capacitance Simulator CV-86-1 mounted on right side of panel. The extra capacitance simulator is independent of the TF-20 portion and is included for specific applications such as the KC/LC-130F fuselage gauge system.

FUEL RESISTANT UNSHIELDED LEAD WIRE



FUEL RESISTANT COAXIAL (SHIELDED) CABLE

TF-20 ADAPTER CABLES FOR TESTING TANK UNITS AND COMPENSATORS OUT OF TANK OR AT TANK BOUNDARY OF AIRCRAFT MODIFIED PER TCTO 1C-130-741



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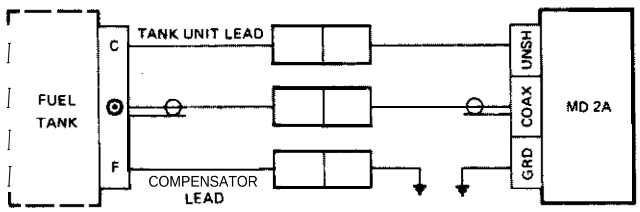
HERCULES

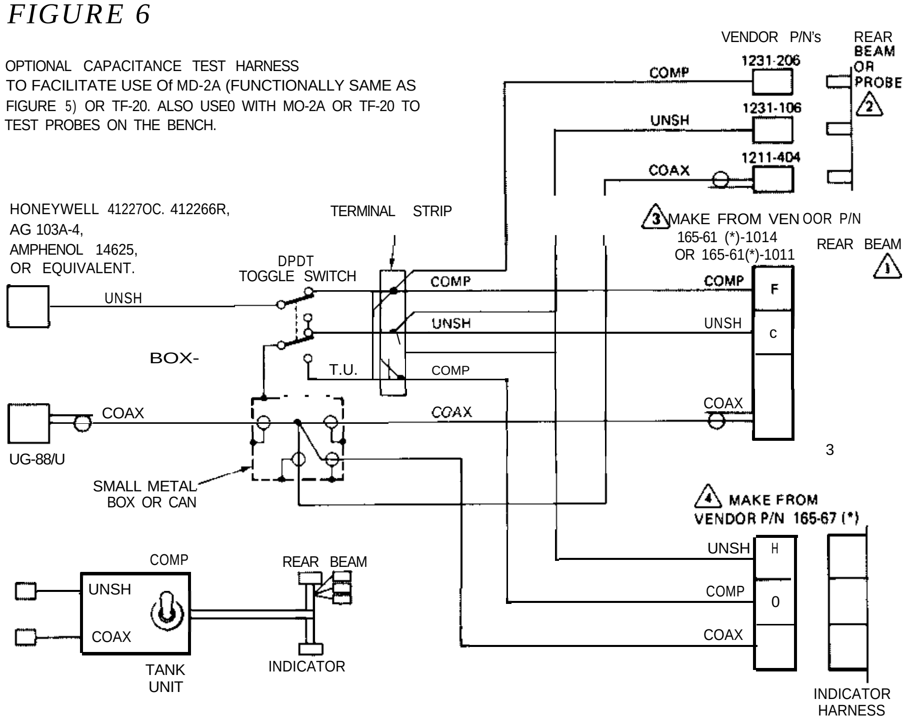
FIGURE 5



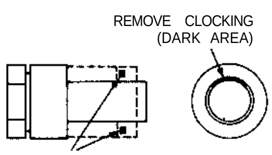
CONNECTION OF MD-2A AT TANK BOUNDARY (CAPACITANCE CHECK)

FIGURE 6

OPTIONAL CAPACITANCE TEST HARNESS TO FACILITATE USE Of MD-2A (FUNCTIONALLY SAME AS FIGURE 5) OR TF-20. ALSO USE0 WITH MO-2A OR TF-20 TO TEST PROBES ON THE BENCH.



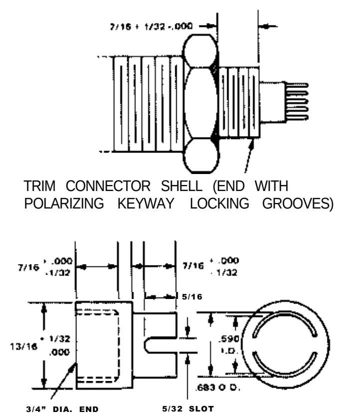
DETAIL A



REMOVE LOCKING PINS (DARK AREA) BY DRILLING (I/8 DIA.) HOLE (2 PLACES) IN NUT.

TYP FOR ALL VENOOR P/N 165-61(*) SERIES CONNECTORS

DETAIL B



TRIM CONNECTOR SHELL (END WITH POLARIZING KEYWAY LOCKING GROOVES)

THREADS TO MATE TRIMMED PORTION OF VENDOR P/N 165-67(*)

MADE FROM STAINLESS STEEL TO PROTECT CONNECTOR PINS AFTER SHELL IS TRIMMED.

ALTERATION TO VENDOR P/N 165-67(*) SERIES CONNECTOR

(1) BEFORE TCTO 1C-130-741

(2) AFTER TCTO 1C-130-741

(3) REMOVE POLARIZING TAB & DRILL OUT LOCKING PINS PER DETAIL A.

(4) REMOVE POLARIZING RING OR ALTER PER DETAIL B.

(*) SINCE CONNECTOR IS TO BE DEPOLARIZED, YOU MAY USE A CONNECTOR OF ANY POLARIZATION LETTER.

MALFUNCTION SYMPTOM

Indicator against stop below zero with fuel in the tank

Intermittent counterclockwise rotation of indicator

Indicator shifts downscale in error or drives to stop below zero when fuel level is below a specific value

Indicator against stop above full

Indicator shift upscale in error or drives to stop above full when fuel level is above approximately one-half tank

Intermittent clockwise rotation of indicator

Totalizer indicator reads incorrectly continuously or fluctuates between two fuel quantities

Indicator drifts slowly upscale or downscale (usually upscale).

Interaction (more than one indicator moving) between indicators when only one test button is pressed.

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Fuel Quantity System TROUBLESHOOTING CHART

CAUSE	REMEDY
Compensator in water NOTE: Water causes capacitance of compensator to be extremely high, thereby causing indicator to go downscale	Remove water from tank.
Open circuit in either unshielded or coaxial lead between individual tank indicator and rear beam harnessconnector	Check continuity of unshielded and coaxial leads.
Open circuit in either unshielded or coaxial lead between individual probes within tank boundary	Check continuity of unshielded and coaxial leads. Repair as necessary. NOTE: Open circuit can exist within coaxial connector inside tank as described below.
Short between coaxial lead center conductor and shield	Check continuity of coaxial center conductor (high lead) and shield. (Short may exist within coaxial connectors.)
Indicator defective or improperly calibrated	Recalibrate or replace indicator as required.
Intermittent open circuit in either unshielded or coaxial lead between individual tank indicator and rear beam harness	Check continuity of unshielded and coaxial lead. Repair as necessary.
Intermittent open circuit in either unshielded or coaxial lead between individual probes within tank boundary	Check continuity of unshielded and coaxial lead. Repair as necessary. NOTE: Open circuit can exist within coaxial connector inside tank as described above.
Intermittent short between coaxial lead center conductor and shield	Check continuity of coaxial center conductor (high lead) and shield. (Short may exist within coaxial connectors.)
Compensator in water	Remove water from tank.
Low resistance path between electrodes of compensator and/or probe	Replace compensator.
Open coaxial lead between probes within tank boundary or open unshielded lead between individual probe and connector within tank boundary	Isolate fault to a connector or probe and replace or repair as necessary.
Open circuit in shield between individual tank indicator and rear beam coaxial connector	Check continuity of shield. Repair as necessary.
Open circuit in shield between individual probes within tank boundary	Check continuity of shield. Repair as necessary.
Defective indicator or improperly calibrated	Recalibrate or replace indicator as required.
Probes in water. NOTE: Water causes capacitance of probes to be extremely high, thereby causing indicator to go upscale.	Remove water from tank.
Open compensator wiring, either internal or external	Repair wiring as necessary or replace compensator.
Intermittent discontinuity of shield components of coaxial connectors	Disassemble coaxial connector and verify shield connections. Check shield connections at all other terminating points.
Intermittent open circuit in shield between individual tank indicator and rear beam coaxial connector	Check continuity of shield. Repair as necessary.
Intermittent open circuit in shield between individual probes within tank boundary	Check continuity of shield. Repair as necessary.
Incorrectly calibrated	Recalibrate totalizer.
Individual tank indicator malfunctioning	Correct indicator malfunctions as described above and recheck totalizer.
Short or open in totalizer circuit	Continuity check for malfunction and repair as necessary.
Malfunctioning totalizer indicator	Replace indicator.
Ineffective indicator (Pin J) power and/or coax shield ground. (Should be less than one milliohm)	Clean and/or tighten ground stud. (See Figure 7)
Ineffective indicator (Pin J) power and/or coax shield ground. (Should be less than one milliohm)	Clean and/or tighten ground stud. (See Figure 7)

Position MD-2A selector to A TO GRD, with Megohmmeter Range Selector to Xl. The meter should indicate full CCW. Now disconnect the coaxial cable connector at the probe closest to tank boundary, and connect a jumper from the shield section of the connector to the center conductor. Observe megohmmeter for continuity (full CW). Continue in sequence, reconnecting each segment after testing, until continuity fails to exist and you have located the open shield.

Probes in water or water contaminated probes.

With the MD-2A connected per Figure 1, check resistance for Capacitance-Megohms Selector positions A TO B, A TO GRD, and B TO GRD. Interchange compensator and tank cables and repeat checks. Resistance values for all positions of the selector will be lower than the values presented in Table 1, indicating that probes are in water or are contaminated.

Position selector to CAP UUF and check capacitance of probes and compensator. Capacitance will be extremely high, usually driving the Capacitance Indicator full CW, even on the X50 position, if a probe is in water.

HOW TO USE THE TF-20 . . . The TF-20 is an automatic capacitance bridge (like the MD-2A) and two variable capacitor circuits (like the MD-l) related in the same manner as the compensator and the tank units of a fuel quantity indicating system.

Connect TF-20 per Figure 2, except leave the aircraft harness connector disconnected, and proceed as follows:

- Position Function Selector to ZERO CAL, Cap-Res Check Selector to CAP, and Range Selector to Xl.
- Adjust the Zero Adj until the Capacitance Indicator Pointer coincides with the zero graduation.
- Position Function Selector to HIGH CAL and set Range Selector as required.
- Adjust High Adj until Capacitance Indicator coincides with the value of capacitance stamped on the plate below the Function Selector.
- Repeat these four steps until no further adjustment is required (just like a fuel gage calibration).

  NOTE: Do not adjust High Adj to position indicator to last scale division. Adjust only to the value on the plate.
- Position the Function Selector to TANK UNIT- COMP and verify that Capacitance Indicator indicates the same as for ZERO CAL position. Disconnect COMP, COAX, and UNSH cables from TF-20. The indicator should read the same as for ZERO CAL.

  NOTE: This checks the integrity of the TF-20 and associated cables.
- Reconnect COMP,. COAX, UNSH cables to Tank Unit Section of TF-20.

Now we are ready to check and/or calibrate a fuel quantity indicating system. Using the TF-20 harness shown in Figure 2 (the type normally furnished with the TF-20) let's check and calibrate a typical system.

Connect the TF-20 to a source of 1 15V, 400Hz (no attention to polarity is required because of the isolation transformer in the TF-20).

Position TF-20 power switch to OFF and connect to indicator and aircraft harness per Figure 2.

NOTE: When using Capacitance Indicator, set Range Selector to the lowest multiplier possible for greatest accuracy. Set Megohmmeter 'Range Selector to the multiplier that causes indicator to read nearest mid-scale.

CAPACITANCE CHECK

Set Cap-Res Check to CAP.

Set Function Selector to TANK UNIT TEST-COMP and read capacitance of compensator. UNSH lead is grounded internally.

Set Function Selector to TANK UNIT TEST-UNSH and read capacitance of tank units (probes). Compensator lead is grounded internally.

RESISTANCE CHECK

Check megohmmeter at zero and mid-scale settings of Range Selector; adjust if required.

Cap-Res Check Switch Position	Function Selector Position	Read Resistance Between
A-C, A-B	TANK UNIT TEST-COMP	COAX and COMP
A-C, A-0	TANK UNIT TEST-UNSH	COAX and UNSH
A-GRD	TAN K UN IT TEST-UNSH or COMP	COAX and GRD
B-GRD, C-GRD,	TANK UN IT TEST-COMP	COMP and GRD
B-GRD, C-GRD	TANK UNIT TEST-UNSH	UNSH and GRD

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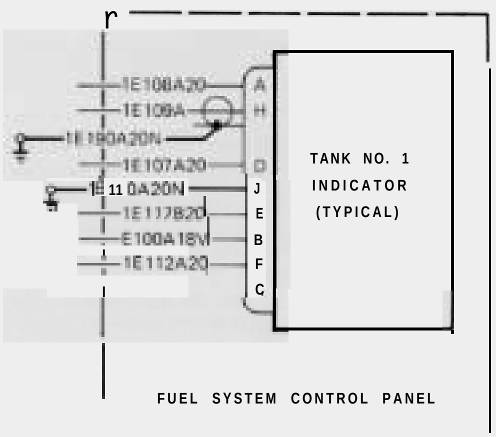
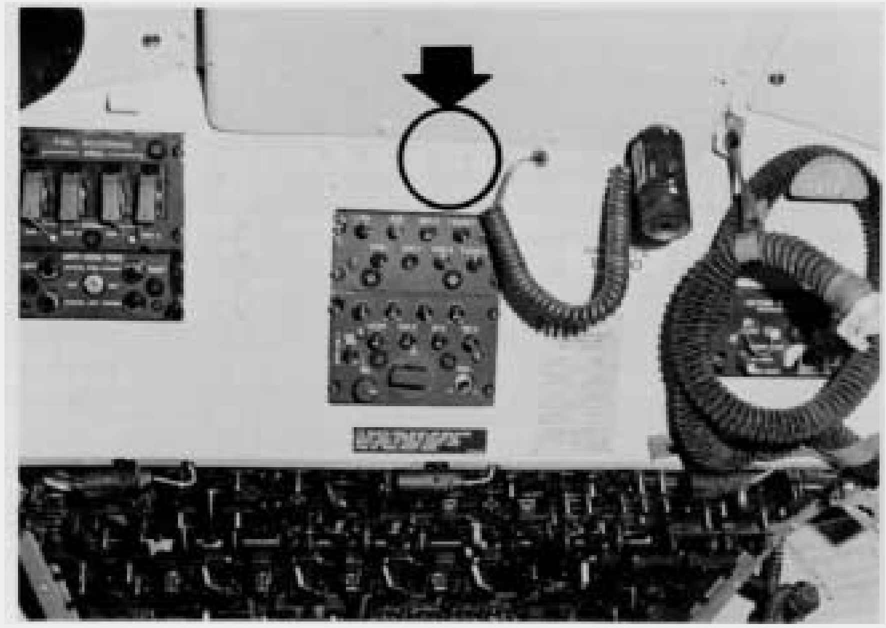
FIGURE 7



GROUND STUDS



CALIBRATION

Set Cap-Res Check to CAP and Function Selector to COMP SET.

NOTE: The fuel quantity indicator will drive to the stop below zero while Function Selector is in either COMP SET or PROBE SET. The TF-20 Capacitance Indicator only is connected to the capacitors when Function Selector is in either of the SET positions.

Now add the value of the dry compensator (reading obtained during capacitance check) to the added capacitance value for the compensator.

A wet compensator during empty calibration does not change the calibration accuracy. In other words, you can use the dry or wet value for empty calibration; but a wet compensator value must be used for full calibration.

Adjust Comp Capacitance Control to position the Capacitance Indicator to the wet compensator value (dry reading plus added capacitance).

Position Function Selector to PROBE SET.

Set Probe MMF Fixed Capacitor Selectors to a capacitance value as near desired capacitance as possible, but not exceeding this value.

Make trimming adjustment to obtain exact value with Probe Variable Control.

Now adjust controls per above to position Capacitance Indicator to dry capacitance value of probes obtained during capacitance check.

Position Function Selector to TEST.

NOTE: This switches the values of capacitance set in COMP SET and PROBE SET from the TF-20 Capacitance Indicator to the aircraft indicator. The TF-20 pointer will drive to zero.

Adjust fuel quantity indicator to position the pointer at zero.

Position Function Selector back to PROBE SET.

NOTE: The fuel quantity indicator will now drive to the stop below zero.

Add the added capacitance value to the dry probe value. This will be the full calibration value.

Set Probe MMF Fixed Selector and Variable Probe MMF control to position the TF-20 Capacitance Indicator to this value. Position Function Selector to TEST.

Adjust fuel quantity indicator until the pointer coincides with the last scale graduation.

Repeat empty and full calibration until no further adjustment is required.

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NOTE: Remember, when the TF-20 Capacitance Indicator is reading capacitance, the aircraft fuel quantity indicator capacitance leads are open.

INDEPENDENT USE. .. Each section of the TF-20 can be used independently of the other section. If MD-2A capability only is required, connect the coaxial cable to the TANK UNIT section COAX connector, and unshielded lead to either COMP or UNSH connector. Function Selector must be positioned to coincide with connections (TANK UNIT TEST-COMP or PROBE).

If MD-1 capability only is required, use the TEST IND connections.

TO CHECK A PROBE FOR CONTAMINATION.. After completion of the dry capacitance check of the individual tank unit or tank unit and compensator, as detailed in T.O.'s 5L14-3-21-13 and 5L14-3-21-43, immerse the end of the tank unit or tank unit and compensator in approximately six inches of clear tap water (with the probe still connected to MD-2A or TF-20). The capacitance will increase and the bridge (MD-2A or TF-20) will not balance if the probe is allowed to remain in the water.

Remove the probe from the water and thoroughly shake off the residual water.

Continue to monitor capacitance with an MD-2A or TF-20. If the unit is not contaminated, the capacitance should, within 20 seconds after removal of the residual water, return to within +2 MMF of the value noted during the dry capacitance check before water immersion. The length of time required for the probe to return to its normal capacitance is proportional to, and an indication of, the extent of contamination.

Failure to pass this test is not justification to discard the probe. It does indicate, however, that the probe should be washed, as described later under the quick reference troubleshooting tips.

Repeat these tests. If the probe passes, it should be ready for further service.

For Quick Reference, here are a few Hercules fuel quantity indicating system troubleshooting tips....

A positive error in the compensator causes a negative error in the indicator reading.

A negative error in the compensator causes a positive error in the indicator reading.

An open shield always causes high capacitance readings for both the compensator and the tank units (probes).

A water-contaminated probe and compensator can cause either a positive or negative error in the indicator.

Contaminated probes can generally be restored by carefully washing in water and a mild detergent, thoroughly rinsing in clear warm water, and baking dry. Drying temperature should be approximately 150°F, as mentioned above, and shop air must not be used to blow moisture out of probes, since it can recontaminate the probe with oil mist and dirty water.

Intermittent malfunctions that will not repeat on the ground can usually be located by monitoring the capacitance of the tank units with the MD-2A or TF-20, while lightly pulling and flexing the wiring and connectors in the tank. Any change in the capacitance reading is cause to disassemble and inspect a suspect connector. Capacitance decrease indicates an open coaxial cable center conductor, an open unshielded lead, or the coaxial cable center conductor shorted to its shield. Capacitance increase indicates open coaxial shield.

Excessive moisture in the coaxial cable connectors can cause the indicator to read in error.

If you calibrate an indicator by the preferred method (added capacitance to a dry tank) with the compensator partially immersed in fuel, the indicator will have a positive error. EXPLANATION: Added capacitance plus dry compensator equals a wet compensator. Added capacitance plus a partially wet compensator equals abnormally high compensator capacitance. When MD-l is removed and aircraft wiring reconnected, the compensator capacitance presented to the indicator is now lower in value, and the indicator will move upscale in error, except at empty. Monitor the compensator capacitance with the MD-2A or TF-20 just prior to calibration to determine that residual fuel has not drained back on the compensator.

Sluggish, slow moving indicators can be caused by contaminated probes and compensators (low resistance paths between the electrodes), moisture in connectors, and shorts in system wiring.

You can check the coaxial cable from the cockpit to the tank boundary for stray capacitance by simply disconnecting the connector(s) at the tank boundary and reading capacitance on the MD-2A or TF-20 in the cockpit. Capacitance should be nearly zero.

Intermittent faults in test cables can cause you to draw conclusions that are misleading, resulting in time-consuming unnecessary replacement of serviceable components.

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The compensator is the greatest offender with respect to water contamination.

Hercules Fuel Quantity Indicator Linearity
Except C-130A & D Series
(Fuel Weight to Capacitance)

Major Dial Calibration In Pounds	Capacitance In mmf *
Outboard Tank Indicators 2.57mmf/100 lbs	
0	213.5
1000	239.2 +/-5
2000	264.9 +/-5
3000	290.6 +/-5
4000	316.3+/- 5
5000	342.0 +/-5
6000	367.7 +/- 5
7000	393.4 +/-5
8000	419.1 +/-5
9000	444.8 +/-5
9400	455.1
Inboard Tank Indicators 3.31 mmf/100 lbs	
0	256.4
1000	289.5 +/-7
2000	322.6 +/-7
3000	355.7 +/-7
4000	388.8 +/-7
5000	421.8 +/-7
6000	454.9 +/-7
7000	488.0+/- 7
8000	521.1 +/-7
8800	547.6
Auxiliary Tank Indicators 2.85mmf/100 lbs	
0	169.8
1000	198.3 +/-6
2000	226.8 +/-6
3000	255.3 +/-6
4000	283.7 +/- 6
5000	312.2+/-6
6000	340.1 +/-6
6600	357.8
Pylon (External) Tank Indicators 3.99mmf/100 lbs	
0	330.7
1000	370.6 +/-8
2000	410.5+/-8
3000	450.5 +/-8
4000	490.4 +/-8
5000	530.3 +/- 8
6000	570.2 +/- 8
7000	610.1 +/- 8
8000	650.0+/- 8
9000	690.0 +/- 8
9800	721.9

* Increase value shown by 5% for tanks with foam installed.

Use this table to check **the validity of any calibration you suspect may have been made using a dipstick. Chances are you will decide to recalibrate using the preferred or alternate method.**

StarTips

TWO DIFFERENT HERCULES ENGINE DRIVEN HYDRAULIC PUMPS

Two manufacturers are now supplying engine driven hydraulic pumps for our Hercules airplanes. Most of the commercial and foreign military configurations are equipped with pumps manufactured by Vickers Aerospace Division, Sperry Rand Corporation. U.S. Military configurations have the pump manufactured by New York Air Brake Company installed as original equipment. For resupply purposes the U.S. Military has procured some Vickers pumps and we understand these are being installed on C-130A models only.

The StarTips item on "How to Bleed a Hercules Hydraulic Pump – and Keep it Clean" in our April – June 1974 issue *Service News* applies only to the New York Air Brake pump installation. Fluid under pressure from the suction boost pump can pass through the NYAB pump by opening the check valves at the ends of the cylinders, although this engine driven pump is not rotating. This installation includes a "run around" loop of tubing (C-130B model and up) to cool and recirculate fluid to prevent the pump from overheating when the pump is in "isolation"; i.e., pump switched off with engine turning. Part numbers for these NYAB pumps are 66WBD300, 66WBD300-1, 66WBD300-4 and 66W U300-2.

The newer Vickers pump, part number PV3-075-4, does not require the external loop for cooling. Also, the Vickers pump must rotate for fluid to flow through it. In both installations, rotation of the engine rotates the pump.

The suction boost pumps located near the reservoirs are used to provide a positive hydraulic pressure of 70-l 10 PSI to the suction side of each engine driven pump when turned on. This pressure prevents cavitation and helps to "prime" an engine driven pump should air get into the suction line. If the reservoir fluid level is kept within limits and correct maintenance procedures are followed, air will not enter the system.

When a hydraulic component is replaced, the cavities of the new unit should be filled with system fluid (MI L-H-5606) just before installation to minimize entrapment of air. This is especially true when replacing engine driven pumps, Always fill the pump case to overflowing through the case drain port. Also, retain as much fluid as possible in disconnected tubing during component changes. Become familiar with all the instructions in your maintenance manuals to avoid extra expense – and work.

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Hercules
Fuel Quantity Indicating System

by ELBERT FIELDS, *Service Analyst*

Correct assembly of the Cinch NuLine fuel quantity indicating system connectors is very important. Assembly instructions for coaxial (shielded) cable connectors (NuLine Part Numbers 12 1 l-404 and 122 l-404) are shown in Figure 2 and instructions for unshielded lead connectors (NuLine Part Numbers 1231-106, 1231-206, 1244-106, 1244-206, 1246-106 and 1246-206) are shown in Figure 3. It is important to torque correctly the hex back-end nut to insure that the V-gasket is cut, providing metal-to-metal locking of the shielding to the shell, maximum environmental protection (moisture sealing), and effective locking of the back-end nut. The .042 inch maximum gap between the nut and body assembly is a good indication the nut has been properly torqued.

If for any reason a connector is disassembled, a new V-gasket (also called a chevron washer) must be installed. (See Figure 1 for part number.) All pieces of the old V-gasket must be removed. If the braid clamp collar is missing, check inside the shell. Be sure the braid is not broken and is smoothly combed in place before reassembly. Also, make sure the groove in the V-gasket is pointing forward and the internal taper of the braid clamp collar conforms to the brushed-back braid on the braid clamp. Assembly of the connector with the internal taper of the braid clamp collar backwards will shear the shield braid, resulting in an intermittent connection.

On **the rear wing beam,** at the outer wing break and at the pylon tank disconnect, three new connectors replace one earlier multipin connector, bringing each lead through a separate connector. A new adapter fits the existing multipin connector hole, and new holes are drilled for the remaining connectors.

Information regarding fuel quantity wire and cable used with the new connectors is detailed in an article, "Hercules Wire Identification", Page 9 of the April - June 1974 issue of *Service News.*

Here is a table listing the NuLine connectors:

FIGURE 1 FUEL QUANTITY INDICATING SYSTEM CONNECTORS USED ON C-l 30 HERCULES AIRCRAFT

Item No.	NuLine P/N	Federal Stock No.	Description	Type Contact	V-Gasket P/N*	Front Gasket P/N*	Replaces P/N*
P-870	1211-404	5935-071-7329	Shielded Cable Plug	Pin	B 138009	A 138007	5329-1
J-502	122 l-404	5935-071-7330	Shielded Cable Jack	Socket	B 138009	None	5166-l
P-67 1	1231-106	5935-909.2358	Unshielded Cable Plug	Socket	B 138014	A 138006	1-906-l
P.872	1231-206	5935-946-Q 194	Unshielded Cable Plug	Pin	B 138014	A 138007	1-728-1
J-514	1244-l 06	5935-071-7331	Glass Seal Bulkhead Feed Thru Unshielded Cable Jack	Pin	B 138014	None	Combinations of these connectors replace Vendor P/N's 165-67, 165-67W, and 165-67X
J-512	1244-206	5935-07 1-7332	Glass Seal Bulkhead Feed Thru Unshielded Cable Jack	Socket	B 138014	None	
J-517	1246-l 06	5935-07 I-7333	Bulkhead Feed Thru Unshielded Cable Jack	Pin	B 138014	None	
J-516	1246-206	5936-947-9275	Bulkhead Feed Thru Unshielded Cable Jack	Socket	B 138014	None	
J-513	1284-451	NSL	Isolated Ground Bulkhead Feed Thru Adapter	Socket	None	None	

*Federal Stock Numbers have not been assigned to the gaskets.

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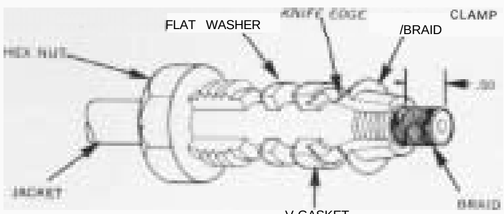
CONNECTORS

FIGURE 2

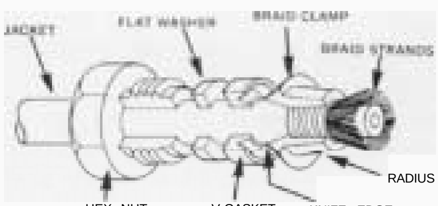
STEP 1.

SLIDE THE HEX NUT, FLAT WASHER AND V-GASKET OVER THE JACKET. SCREW THE THREADED BRAID CLAMP OVER THE JACKET, NOTE: TAKE CARE NOT TO DAMAGE KNIFE EDGE OF BRAID CLAMP. STRIP THE JACKET UNTIL 1/2 INCH OF BRAID IS EXPOSED. SCREW THE BRAID CLAMP BACK UNTIL IT IS FLUSH WITH EDGE OF JACKET.



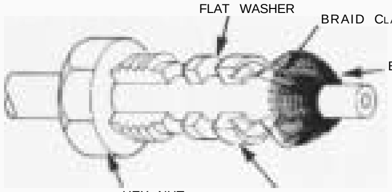
STEP 2

USE A THIN PROD TO UNBRAID AND STRAIGHTEN THE BRAID STRANDS.



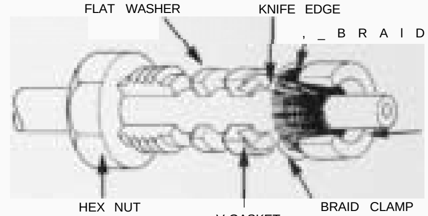
STEP 3.

USE A NYLON BRUSH TO COMB THE BRAID BACK OVER THE RADIUS EDGE OF THE BRAID CLAMP. AN IDEAL BRUSH FOR THIS PURPOSE CAN BE MADE BY TRIMMING THE BRISTLES OF A HARD NYLON TOOTHBRUSH. THE STRANDS SHOULD LIE APPROXIMATELY PAR. ALLEL TO EACH OTHER.



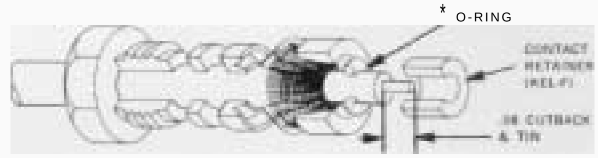
STEP 4

PRESS ON THE BRAID CLAMP COLLAR HALF WAY ON TO BRAID CLAMP WITH LARGEST INSIDE DIA. OF BRAID CLAMP COLLAR AWAY FROM CONTACT. NOTE IT IS MOST IMPORTANT AT THIS STEP TO ASSEMBLE BRAID CLAMP CORRECTLY TO PREVENT SHEARING OF BRAID STRANDS. TRIM THE BRAID WITH THE RAZOR BLADE OR SHARP KNIFE TO +.OOO – 025 WITHIN SHOULDER OF BRAID CLAMP. DO NOT USE "DYKES" FOR TRIMMING. NO CRIMPING OR SQUEEZING TOOLS ARE TO BE USED TO INSTALL OR SEAT BRAID CLAMP COLLAR. THIS IS TO PREVENT DAMAGE TO KNIFE EDGE OF BRAID CLAMP,



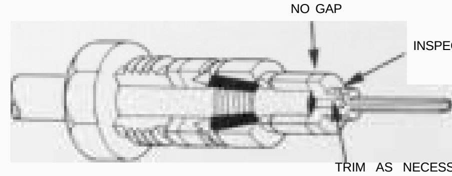
STEP 5

ADD THE 0- RING AND CONTACT RETAINER. CUT OFF THE PRIMARY INSULATION FLUSH WITH THE KEL-F CONTACT RETAINER. CUT THE CENTER CONDUCTOR APPROXIMATELY 08 INCH BEYOND THE INSULATION. TIN THE CENTER CONDUCTOR WITH QQ-W-571C COMP SN50 OR 60 SOLDER. SUPERIOR NO .30 FLUX MAY BE USED DURING TINNING OF WIRE.



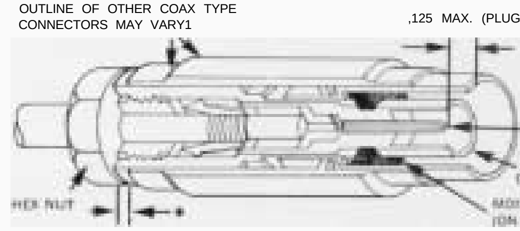
STEP 6.

PRESOLDER CONTACT, PLACE THE CONTACT ON THE WIRE AND APPLY HEAT UNTIL SOLDER FLOWS. OBSERVE THE FLOW OF SOLDER THROUGH THE INSPECTION HOLE. THE PROPER TEMPERATURE EXISTS WHEN SOLDER APPEARS IN THE HOLE. CAREFULLY REMOVE ANY EXCESS SOLDER ON OUTER SURFACE OF CONTACT.



STEP 7.

PLACE CONTACT INSULATOR ON CONTACT. APPLY APPROX. 1 DROP OF MIL-S-22473C GRADE A OR AA SEALANT TO HEX NUT THREADS. INSERT CABLE ASSEMBLY INTO SHELL AND TORQUE DOWN TO 8 TO 10 IN -LBS USING CALIBRATED OR DIAL TYPE TORQUE WRENCH. THE 8 TO 10 IN-LBS APPLIED WILL SEAT THE BRAID CLAMP SHOULDER AND CUT THROUGH THE V-GASKET*ON PLUGS, PLACE MOISTURE SEAL IN CONNECTOR SHELL CHECK THE CONTACT ON PLUGS TO A ,125 MAXIMUM DIMENSION AND ON JACKS OR RECEPTACLES TO A ,050 MAXIMUM DIMENSION.



***When** properly torqued, gap between nut and body assembly should not exceed 042.

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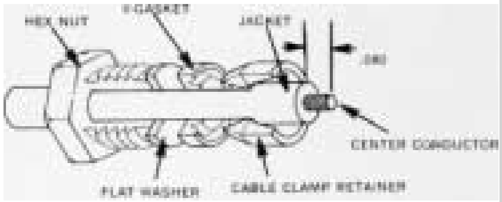
FIGURE 3

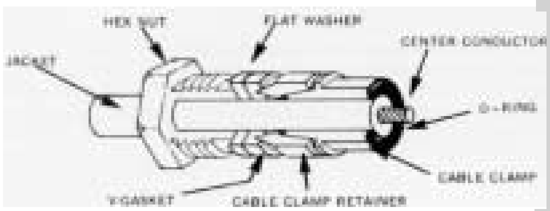
STEP 1.

SLIDE HEX NUT, FLAT WASHER, "-GASKET, AND CABLE CLAMP RETAINER OVER JACKET AS SHOWN. STRIP JACKET OFF CENTER CONDUCTOR TO EXPOSE 0.080 INCH OF CONDUCTOR.



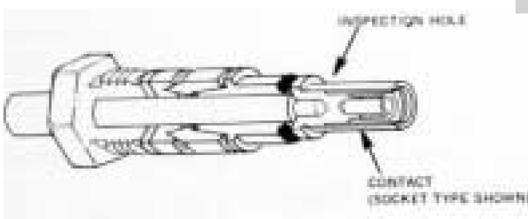
STEP 2.

SCREW CABLE CLAMP IN PLACE ON JACKET AS SHOWN PROVIDING SPACE ON JACKET FOR 0 -RING. NOTE CABLE CLAMP RETAINER'S POSITION MAY VARY BUT WILL TIGHTEN DOWN WHEN THE ASSY IS INSERTED INTO SHELL, PLACE O-RING AS SHOWN.



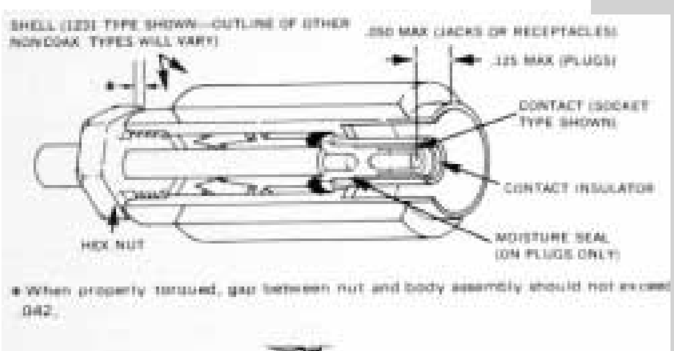
STEP 3

TIN THE CENTER CONDUCTOR WITH 00-W-571C COMP SN50 OR 60 SOLDER. PRESOLQER CONTACT, PLACE THE CONTACT ON THE WIRE AND APPLY HEAT UNTIL SOLDER FLOWS. OBSERVE THE FLOW OF SOLDER THROUGH THE INSPECTION HOLE. THE PROPER TEMPERA. TURE EXISTS WHEN SOLDER APPEARS IN THE HOLE. CAREFULLY REMOVE ANY EXCESS SOLDER ON OUTER SURFACE OF CONTACT.



STEP 4

PLACE CONTACT INSULATOR ON CONTACT, APPLY APPROX. 1 DROP OF MIL-S-22473C GRADE A OR AA SEALANT TO HEX NUT THREADS. INSERT CABLE ASSEMBLY INTO SHELL AND TORQUE DOWN TO 8T0 10 INCH-LBS. USING CALIBRATED OR DIAL TYPE TORQUE WRENCH* ON PLUGS, PLACE MOISTURE SEAL IN CONNECTOR SHELL. CHECK THE CONTACT ON PLUGS TO A ,125 MAXIMUM DIMENSION AND ON JACKS OR RECEPTACLES TO A ,050 MAXIMUM DIMENSION. 00 NOT CHECK CONTACT DIMENSIONS ON GLASS SEAL BULKHEAD FEED THRU JACKS (1244 SERIES) SINCE THE EXTERNAL CONTACT IS POSITIONED DURING MANUFACTURE OF SHELL.



Delayed Maintenance

by TED FABER, ***Aerospace Safety Engineer, Senior***

The companion article entitled, "Troubleshooting the Hercules Fuel Quantity Indicating System" points out that troubleshooting the fuel quantity indicating system requires strict adherence to all safety precautions when checking the system. This is also true when repairs are required and is especially important when repair involves the Amphenol 16.5 series fuel quantity indicator harness connector plugs.

The fuel quantity indicating system is designed as an electrically inert capacitance system, specifically designed to eliminate any possibility of arcing from electrically charged components within the system. However, when careful attention is not observed during repair or reinstallation of these connectors, it is possible to route 11.5 volts to the fuel tank through the shielded coaxial cable. This can be accomplished through misalignment of the connector pins or otherwise causing the wire shielding to contact the 1 15-volt AC pin. On one occasion, an explosion occurred when electrical power was restored after maintenance had been performed on the Number Four tank fuel quantity system. Investigation revealed that an instrument specialist was troubleshooting the indicating system as a result of a fuel quantity write up. External power was disconnected and then reconnected after the MD-2A fuel tester was used. The specialist was in the process of visually checking the fuel quantity gage wiring, with the gage removed from the overhead panel mounting socket, and with the plug connected, when the explosion occurred. The explosion ruptured the fuel tank and caused extensive structural wing damage.

In this mishap it was found that during assembly of the Amphenol connector, the retainer ring was not used. The absence of the retainer ring allowed the plug socket to move outward from the plug shell, disengaging the socket keyway and permitting the socket to rotate approximately 120 degrees before mating. This allowed pin "J"

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..Can Give You A BLAST

in the connector to contact receptacle "B" in the socket, allowing 115 volts to pass from pin "J", which is common ground, to the coaxial cable shield. When 1 15 volts was applied to the system, a ground, through a fault in the outer covering of the coaxial cable, was obtained, and arced to aircraft structure, igniting fuel fumes in the tank.

In a similar manner an explosion occurred in the Number One tank of a Hercules as the aircraft was climbing to altitude for an extended over water mission, The explosion resulted in an extensive wing fire and the crew was forced to land the aircraft in a nearby corn field with the landing gear retracted. After landing, the crew evacuated the aircraft safely and the local Fire Department extinguished the fir-e.

In this accident, delayed maintenance to correct repeated write ups against the Number One tank fuel quantity indication played a vital role. Over a period of two months the indicator was reported for reading "off scale" a number of times. Each time the discrepancy was corrected by resoldering the plug connections but the corrective action taken did not eliminate the problem. The last time, maintenance action to correct the malfunction was interrupted by an operational commitment to use the aircraft. The plug was hastily reassembled and connected to the indicator. The fuel quantity circuit breaker was pulled and the flight engineer was verbally advised to keep the circuit breaker pulled. This advice was passed on from one flight engineer to another for a time but this communications system finally broke down and the circuit breaker was pushed in prior to the last flight. When this occurred 11 5-volt current was directed to the Number One fuel tank. When sufficient fuel had been consumed from the tank to create an explosive atmosphere, arcing between a fault in the coaxial cable and internal wing structure resulted in the subsequent explosion. Later examination of the connector plug revealed the 11 5-volt wire was in contact with the coaxial shield and the shield was not grounded to the case.

Both mishaps could have been avoided by carefully following procedures contained in service manuals and having a better understanding of the fuel quantity indicating system. Failure of the indicator to self test or failure of the indicator to display proper fuel quantity should have alerted the flight crew and maintenance personnel to the possibility of a faulty connector plug.

LOCKHEED RECOMMENDS the following safety precautions be adhered to during operation of the fuel quantity indicating system:

> Failure of the indicator to test is indicative of a malfunction in the fuel quantity indicating system. Maintenance action should be taken. If maintenance is not complete, pull and pin the circuit breaker for that indicator. Failure to comply may result in high voltage being routed to the fuel tank which could cause an explosion.
>
> Fuel quantity indicators should not be removed or changed in flight. If a fuel quantity indicator malfunctions or fails the press to test check, pull the respective circuit breaker and leave it out. If a fuel quantity indicator circuit breaker pops, do not attempt to reset it. Failure to comply may result in high voltage being routed to the fuel tank which could cause an explosion.

After landing write up the discrepancy and have maintenance correct the problem, NOW! Tomorrow may be too late!

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How JetStars Keep Their cool

by J. S. RENO, ***Service Engineer, Hamilton Standard***

SOURCE OF COOLING for the JetStar air conditioning system is the refrigeration package designed and manufactured by Hamilton Standard, a division of United Aircraft Corporation.

Two refrigeration packages, employed in parallel, convert high temperature, high pressure engine bleed air to conditions providing a comfortable environment in the JetStar's cabin and flight deck.

Each refrigeration package is a two-stage cooling device consisting of a heat exchanger and a turbine-fan unit, sometimes referred to as an air cycle machine. The heat exchanger provides initial cooling by transferring heat from the bleed air to ambient ram air which passes through the heat exchanger and is then dumped overboard. The second stage of cooling is accomplished with the turbine-fan. Cooling is obtained as the air expands through the turbine where heat is converted into mechanical energy. This energy is dissipated through the fan as it helps to move the ram air through the heat exchanger. Acting primarily as a load for the turbine, the fan serves a dual purpose in that it also induces air flow through the ambient side of the heat exchanger when the aircraft is moving too slowly to generate ram flow.

The shaft on which the turbine and fan are mounted is supported by two ball bearings, spaced on one end of the shaft and contained within the bearing cartridge. The cartridge extends into the cold air of the turbine discharge, providing ideal bearing operating temperatures. The bearings are lubricated by means of capillary wicks which draw oil from a small reservoir. The wicks wipe the oil onto tapered sections of the shaft which, through centrifugal action, sling the oil as a fine mist into the bearings.

Here are inspection, maintenance, and overhaul recommendations for the JetStar refrigeration unit.

INSPECTION OF OIL SUMP

At the end of each 500 hours of flying time, the turbine-fan oil sump should be inspected for oil level. (See editor's notes following article.) Look at the translucent plastic oil sump while it is installed on the package. Don't add oil if its addition would result in its overflowing the sump's spouts; any level less than full will require addition of MILL-6085A oil.

If oil is added, the filler plug preformed packing, P/N MS28778-2 should be replaced.

The sump should also be inspected for the accumulation of water (considered normal when high humidity ambient conditions prevail). Any water present should be removed with a suction syringe. Since atmospheric and operating conditions determine the rate of water accumulation, the period for sump inspection for the presence of water must be established by each operator.

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REPLACEMENT OF THE TURBINE-FAN ASSEMBLY

Replacement of the turbine-fan assembly may be accomplished as follows:

1. Remove the oil through the filler port of the sump of the turbine-fan with a suction-type syringe.

2. Remove the two bolts and washers at the turbine inlet/bleed air duct junction.

3. Decouple the Marmon clamp between the turbine-fan and the heat exchanger and remove the turbine-fan.

4. When installing the new turbine-fan, replace the two preformed packings, P/N 69490B218 at the turbine inlet/bleed air duct and P/N 69490B247 between turbine-fan and heat exchanger. Attach the Marmon clamp loosely, line up the bleed air duct to turbine inlet, install the two bolts, secure the Marmon clamp and lockwire as required.

5. Service the oil sump with MIL-L-6085A oil after the package is installed in the aircraft.

REPLACEMENT ON OVERHAUL INTERVAL

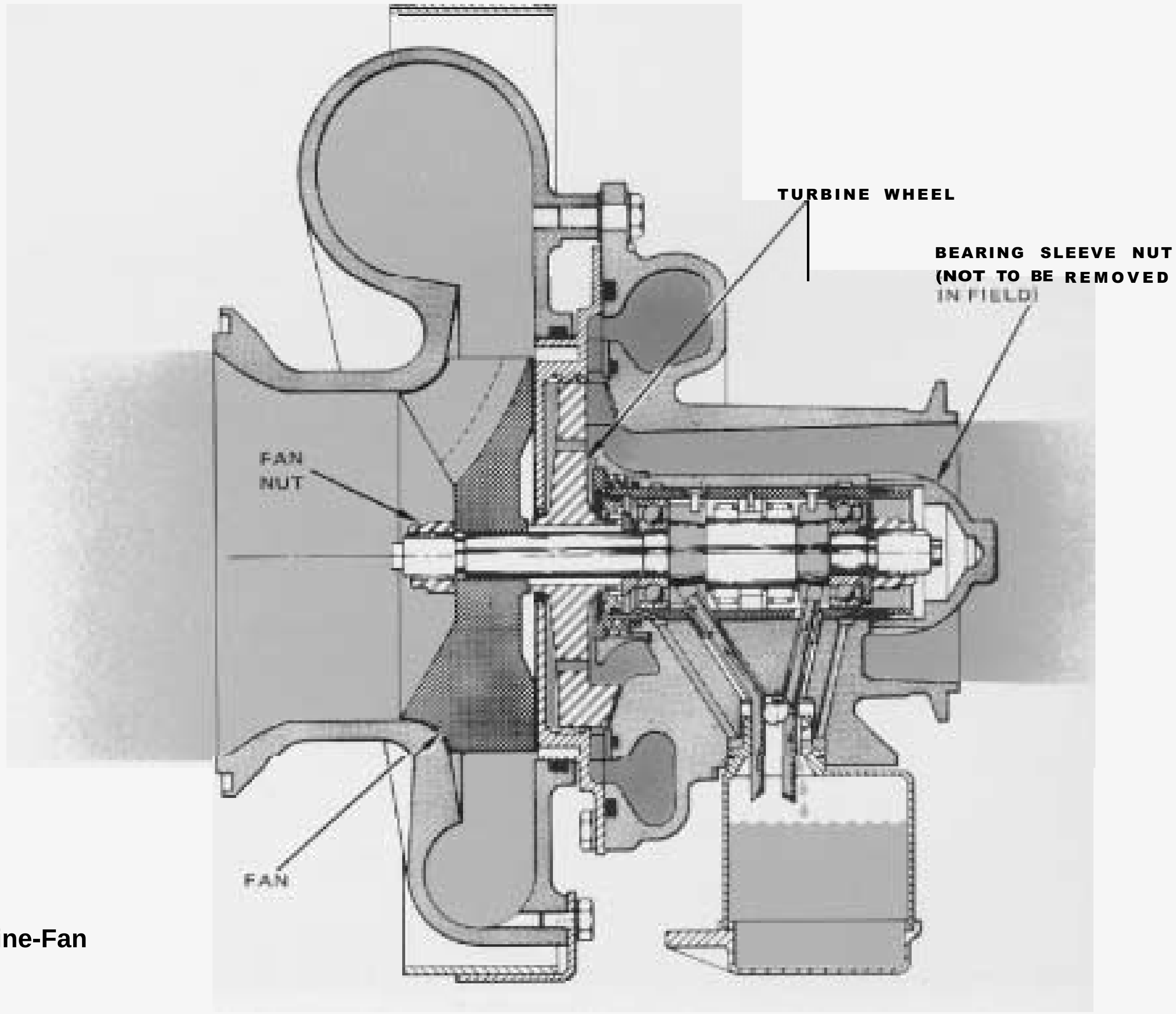
The turbine-fan should be overhauled each 1500 hours of flying time. (See editor's notes following article.) The heat exchanger may continue in service.

CAUTIONARY CONSIDERATION

Handling of the package with oil in the sump should be held to a minimum, and only with the sump in down position. It is preferred that the sump be serviced after the package is installed in the aircraft, and the oil be removed with a syringe prior to removal of the package from the aircraft. The package should never be shipped with oil in the sump.

Should the package be inverted with oil in the sump, the oil could be introduced into the air passageways, which will result in smoke or fumes in the conditioned air. This would require removal of the turbine-fan assembly and return to an overhaul facility for thorough cleaning.

When installing a turbine-fan assembly or refrigeration package in the aircraft, make sure that the oil sump is



Cutaway of JetStar Turbine-Fan Assembly

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filled for at least three hours prior to running the package. The lubrication wicks must be saturated with oil for this minimum time period before they will provide adequate lubrication to the bearings.

Hamilton Standard provides a turbine-fan exchange service for the repair and overhaul needs of all JetStar operators. Participation in this Exchange Program enables an operator to obtain a zero time turbine-fan in advance of removal of a unit in need of repair or overhaul. This ability to secure replacement turbine-fans in anticipation of scheduled removals minimizes maintenance down time.

Reprint From AirLifters Vol. 1, No. 4

EDITOR'S NOTES

The JetStar Handbook of Operating and Maintenance Instructions (HOMI) published by Lockheed specifies that the lubricating oil be changed every 500 hours. Any oil available that conforms to MIL-L-6085A can be used. This precautionary maintenance against contamination contributes to more hours between overhaul. Other factors have helped to increase the TBO to 5,000 hours as specified in the JetStar Operator's Maintenance Report. However, the manufacturer recommends a TBO of 1,500 hours or $2\frac{1}{2}$ years, whichever occurs first.

We wish to elaborate on the approach to the problem of a "frozen" turbine wheel. Lockheed has also heard field reports that indicate attempts were made to unstick turbine rotors by pushing on the fan blades. Damage to these elements, although not apparent, can be destructive at operating speeds near 60,000 RPM. If the rotor sticks on a high time refrigeration turbine, the unit should be replaced.

On rare occasions, it has happened that, during the "wear in" period of earlier model refrigeration units, the rim of the turbine wheel stuck in the cadmium seal in the nozzle plate. Rubbing here may occur for as long as 500 hours of operation before the wheel "seats in" to the seal. If attempts to start the refrigeration unit fail with the engines at full RPM, and there is reason to believe that non-rotation is due to seal drag, you can try a method of applying mechanical torque that has been approved.

The unit must be removed from the airplane, the turbine-fan separated from the heat exchanger, and torque up to 100 inch-pounds applied to the fan nut in the direction of normal rotation. The oil level in the reservoir should be adequate during any run attempts; and, remember to keep the reservoir positioned down at all times when the unit is removed, as pointed out in your Maintenance Manual.

After freeing the rotor, a bench run can be made with bleed air, if available, or with a drill motor and a flexible coupling such as a hose clamped to the fan nut.

While the earlier configuration turbine fans, P/N 584395, were susceptible to turbine wheel/cadmium seal binding, the later configuration turbine fans, P/N 726638-1, contain an improved seal arrangement which is not susceptible to binding. Thus, if a later configuration unit does not rotate while being subjected to full engine bleed pressures, it should be removed from service and returned to an overhaul facility for investigation.

service news

StarTips

HOW THE 1867TH FCS LICKED A TURBINE PROBLEM

by E. P. CARY, JR., *Field Service Representative*

THE 1867th FACILITY CHECKING SQUADRON at Clark Air Base in the Philippines flies JetStars low and slow in hot and humid environments.

These hard-flying pilots have to fly low and slow to perform their mission, checking navigational facilities in Southeast Asia – such as Precision Approach Radar and Tacan – to make sure they are functioning properly for the safety of other aircrews.

Sustained low altitude flight causes heavy water condensation in the cooling turbine oil reservoir, ultimately causing turbine bearing failure.

To lick this special problem, the 1867th FCS instituted a special maintenance procedure – removing and replacing reservoir oil every 25 flight hours. As a result, turbine bearing life was materially improved.

Reprint From AirLifters Vol. 1, No. 4

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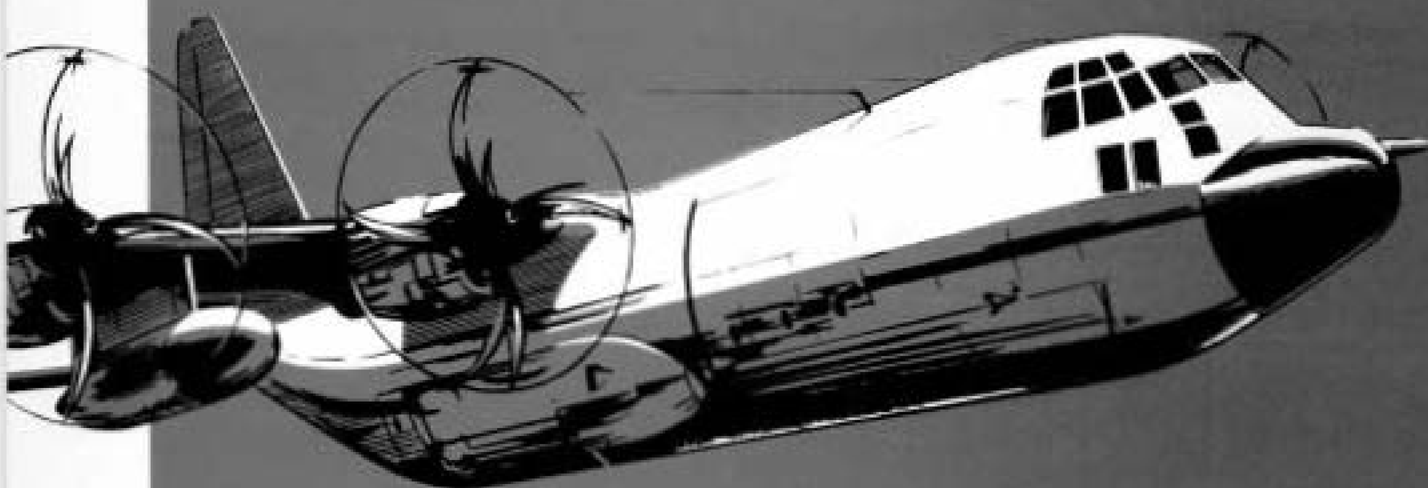
CUSTOMER SERVICE DIVISION
LOCKHEED-GEORGIA COMPANY
A DIVISION OF LOCKHEED AIRCRAFT CORPORATION
MARIETTA, GEORGIA, 30063



In most areas of the world today the **LOCKHEED HERCULES** is recognized immediately on sight, or by the sound of its constant speed turboprop power plants. In any language, the Hercules has meant relief for troubled people through its ability to deliver much needed cargo to areas difficult to reach by conventional means.

The unique Hercules design for its basic airlift mission, gives this reasonably large airplane its distinct appearance. Tandem landing gear, cradling a low cargo floor, a high wing, and an empennage high above the straight-in cargo entrance provide clearance around the airplane.

From its original mission of military airlift, the Hercules naturally grew into a commercial freight carrier. As the cargo volume "cubed out" the fuselage was "stretched". Not only does the longer Hercules hold more cubic feet of cargo but a greater variety of long pieces, like pipe, can be accommodated.

Many other improvements have been made in the basic airplane that are not as obvious in appearance as the longer fuselage. Today's Hercules engines are more powerful. The structural components of the airframe were improved to extend service life, and to accommodate the increased performance. Aircraft systems have been updated along with the other improvements. The economy of the original production Hercules remains with the added capability and efficiency of today's product.

While the Hercules is basically a cargo airplane, it has proved to be very versatile. Currently, there are five basic models operating. Thirty-four different nations including the U.S. utilize the Hercules.

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