CTSO

EO 05-1-3/16

ROYAL CANADIAN AIR FORCE

HEAT EXCHANGE EQUIPMENT REPAIR

(This EO replaces Part 16 of EO 05-1-3)

ISSUED ON AUTHORITY OF THE CHIEF OF THE AIR STAFF

16 NOV 60

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HEAT EXCHANGER EQUIPMENT REPAIR

General

1 Heat exchangers are of three general types; air-to-air, air-to-liquid, and liquid-to-liquid. Repairs to the air to air type of heat exchanger are usually limited to those shown in Figure 1.

AIR CONDITIONING HEAT EXCHANGER

General

2 The air conditioning heat exchanger assembly is designed to cool pressurized air from the compressor prior to delivery to the refrigeration unit of the air conditioning system.

Description

3 The heat exchanger usually consists of dimpled aluminum alloy tubes held in position by a support plate and brazed header plate at each end. Side cover plates between the header and support plates form the unit into a rigid assembly. Inlet and outlet ducts are brazed and welded to the header plates.

Operation

4 Hot pressurized air from the turbo-engine compressor or an independent compressor unit is ducted to the heat exchanger assembly, where it passes through the tubes to the heat exchanger outlet. Air coolant from a ram air source passes across the tubes. Heat from the pressurized air is transferred through the walls of the tubes to the flow of ram air coolant. (See Figure 1).

Overhaul

5 Cleanliness and care in handling are of first importance when working on the refrigeration unit. Personnel performing the work must be skilled mechanics, thoroughly familiar with the use of precision tools, gauges and micrometers. Close attention to tolerances and limits must be observed, especially during inspection and reassembly.

6 Disassembly, inspection and reassembly must be accomplished in a clean, dry, dust-free room. Clean all parts thoroughly as soon as disassembled. Oil and wrap steel parts or place under bell jars until inspection and reassembly.

7 Maintenance and overhaul on a typical air-to-air heat exchanger (AiResearch No. 80031) is given here. The following points should be noted.

(a) The work should be undertaken only in emergencies.

(b) The permissible number of damaged tubes is valid for this model only. A comparable number for other designs must be obtained from the manufacturer.

Removal of Turbine from Refrigeration Unit

8 To remove the turbine, proceed as follows:

(a) Remove the attaching bolts and lift the turbine off the heat exchanger. (See Figure 2).

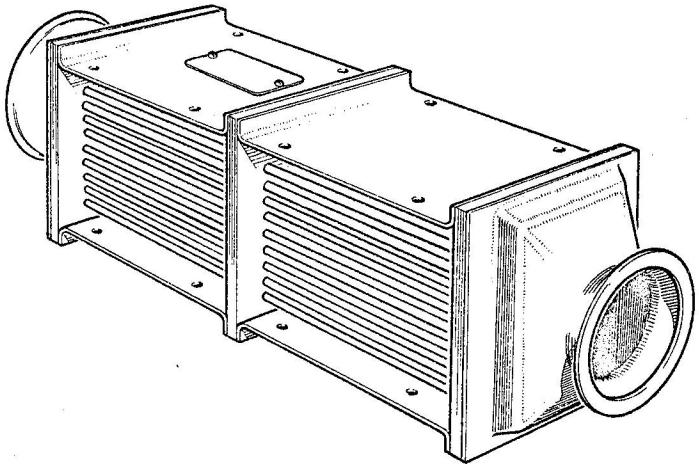
(b) Remove the spacer assemblies (5) and gasket (6) from the turbine assembly.

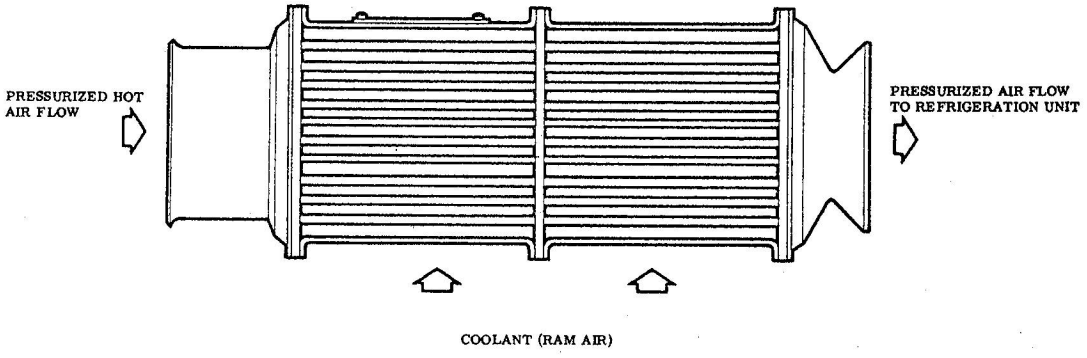
Disassembly of Heat Exchanger

9 Dissassemble the heat exchanger in accordance with the exploded view, (see Figure 2), following the numbering sequence.

Cleaning of Heat Exchanger

10 To clean the heat exchanger, proceed as follows:





TROUBLE	PROBABLE CAUSE	REMEDY
Failure to cool cabin air.	Clogged or damaged tubes.	Replace heat exchanger assembly.
Excessive leakage in system traced to heat exchanger.	Broken or damaged tubes.	Replace heat exchanger assembly.
	Loose duct connections.	Tighten duct connections.
Excessive pressure drop in the heat exchanger.	Clogged tubes.	Clean assembly with Stoddard solvent, and dry with compressed air.

Figure 1 Primary Heat Exchanger - Ram Air Type

(a) Remove all sealing compound from the heat exchanger flanges with methyl ethyl ketone (Item 9) or a suitable non-corrosive solvent.

WARNING

Use the solvent only under a forced draft hood or in a well-ventilated place. Do not inhale the fumes. Take adequate precautions to prevent igniting the fumes.

(b) Thoroughly clean the heat exchanger externally and internally with solvent (Item 10) or equivalent.

Inspection

11 Test the heat exchanger for leakage. Tube leaks may be detected by checking the heat exchanger in a suitable test bell, which must be approximately the size of the heat exchanger and constructed to withstand 30 psi internal air pressure. The heat exchanger must fit into the bell so that both ends of all tubes are exposed to atmosphere, with the header plates resting on neoprene gaskets. The bell must have a fitting for connection to an air pressure source. Test as follows:

(a) With the heat exchanger installed in the test bell, apply 20 psi air pressure to the out-

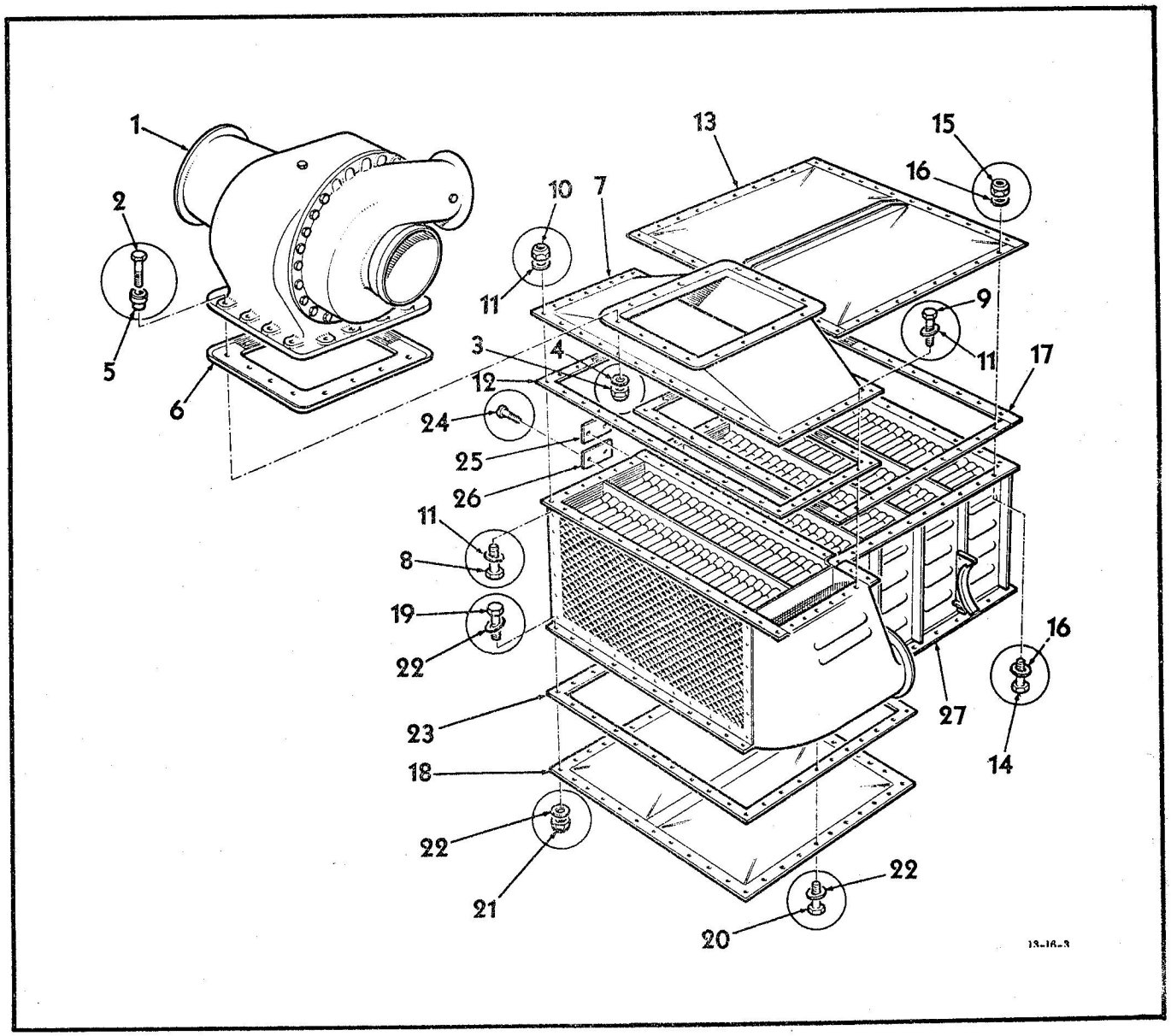


Figure 2 Aircraft Refrigeration Unit - Turbine Type

side of the tubes. Shut off pressure source and note that pressure does not drop to 15 psi in less than 45 seconds.

NOTE

Refer to applicable EO for inspection, test dimensions and specifications required for specific heat exchangers.

(b) Leakage may be detected by submerging the test bell under water with the heat exchanger installed in it and applying air pressure to the test bell. Leakage from ruptured or broken tubes is shown by large geyser-like bubbles at the header plates. Leakage between the tubes and header plates is shown by small bubbles around the tubes.

Repairs

12 The following repairs may be made:

(a) Ruptured or broken tubes may be plugged with blind ferrules, provided a total of not more than 64 tubes are plugged. Replace the heat exchanger if more than 64 tubes must be plugged.

(b) Leaks between the tubes and header plates may be stopped by lightly swaging the tube in the header plate with a polished drift punch.

Reassembly of Heat Exchanger

13 Assemble the heat exchanger in accordance with the exploded view, (see Figure 2). Tighten bolts evenly to avoid damaging gaskets.

Assembled Heat Exchanger Test

14 The assembled heat exchanger must be checked for leakage as follows:

(a) Install a block plate on the outlet duct assembly, another on the cooling air inlet flange and a third on the air inlet from the oil cooler. The plate on the duct assembly flange must have a fitting installed to provide for the attachment of a vacuum line.

(b) Attach the fitting in the block plate on the duct assembly flange to a vacuum source, with a mercury manometer between the vacuum shut-off valve and the fitting in the block plate.

(c) Draw a vacuum of 11.0 inches of mercury on the heat exchanger and close the shut-off valve. The maximum pressure drop allowable is 2.0 inches of mercury in a period of 30 seconds. If the leakage is greater than this, stop the leaks by applying compound (Item 1) at the seams.

Installation of Turbine on Heat Exchanger

15 Assemble the turbine (1) to the heat exchanger assembly with the bolts (2), nuts (3), washers (4), gasket (6) and spacer assemblies (5) as shown in Figures 2 and 3.

NOTE

Replace the spacer assemblies (5) and gasket (6), each time the turbine is removed from the heat exchanger.

LIQUID-TO-AIR HEAT EXCHANGERS

General

16 This type of heat exchanger includes oil coolers and coolant radiators.

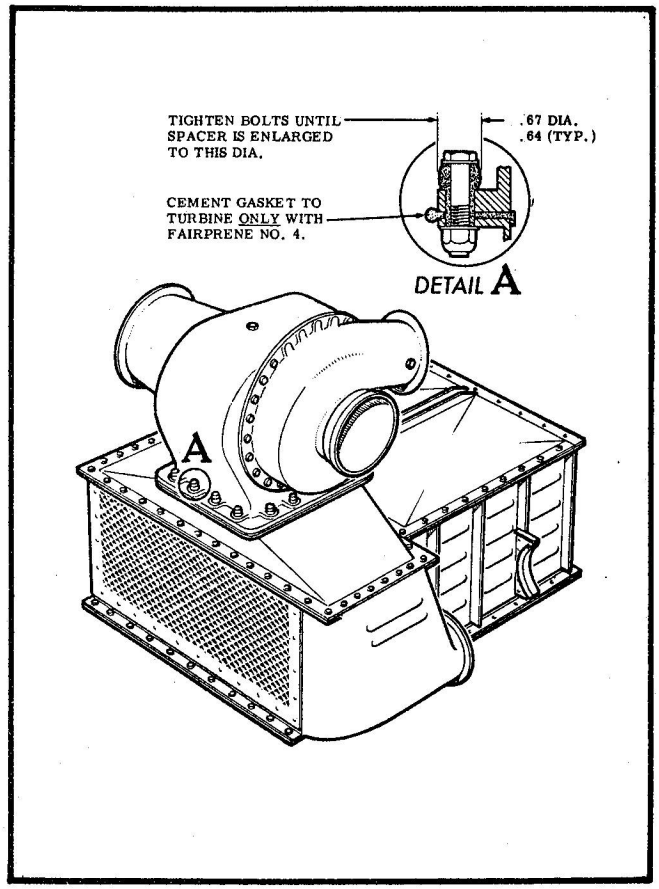


Figure 3 Refrigeration Unit Assembly

Testing

17 If it is necessary to locate leaks in oil coolers or coolant radiators, seal all openings except one, connect a pressure line and apply an air pressure not exceeding 75 psi for oil coolers or 15 psi for coolant radiators. Slowly submerge the unit in warm water. Where bubbles appear, mark the location with a wire clip. Continue the examination until the entire unit has been covered. Remove the unit, disconnect the pressure line and allow the unit to drain.

NOTE

Before testing an oil cooler for leaks, it must be cleaned in a hot soda bath, (Item 2).

Repairs to Oil Coolers

18 To repair or rebuild an oil cooler, proceed as follows:

(a) Dip cooler in hydrochloric acid (Item 3) diluted for cleaning and soldering purposes.

(b) Loosen solder, remove tubes (see Figure 4 of EO 05-1-3/6, and blow out with maximum air pressure of 75 psi, if possible.

(c) After the jacket is cleaned and ready for reassembly, repack the tubes and baffle plates in the jacket. Pack tubes tight enough to keep them from slipping out when they are put in position for soldering.

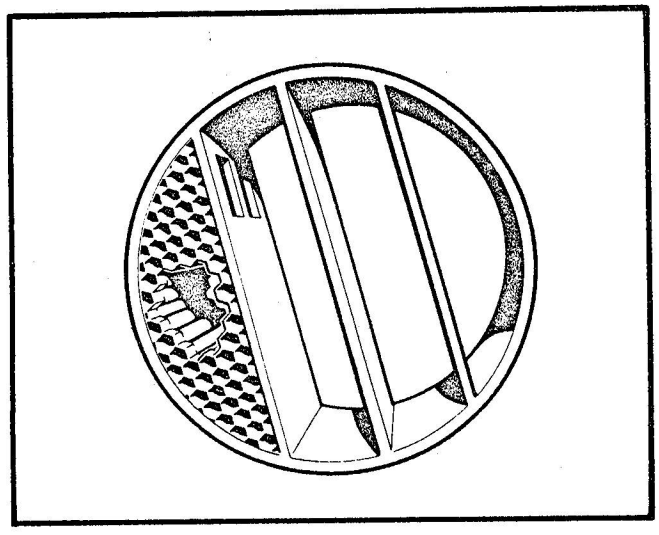


Figure 4 Oil Cooler with Damaged Tubes Removed

(d) Dip the oil cooler in diluted hydrochloric acid, tube end down, so as to clean the tubes 1/2 to 3/4 inch from the end of the tubes. This operation takes from two to three minutes.

(e) Dip the tube end of the oil cooler in hot solder to a depth of 1/4 to 3/8 inch and cool by air.

(f) Wash in hot water to remove acid from the core and jacket.

NOTE

The solder (Item 4) used in repairing oil coolers is a high melting point solder, (refer to EO 05-1-3/20). See Figure 5 for details of a typical oil cooler tube repair.

Repairs to Coolant Radiators

19 Use similar methods in cleaning and removing tubes. Hand solder rather than dip the unit in solder.

Repairs to Oil Cooler and Coolant Radiator Shells

20 The following repairs are used for both units:

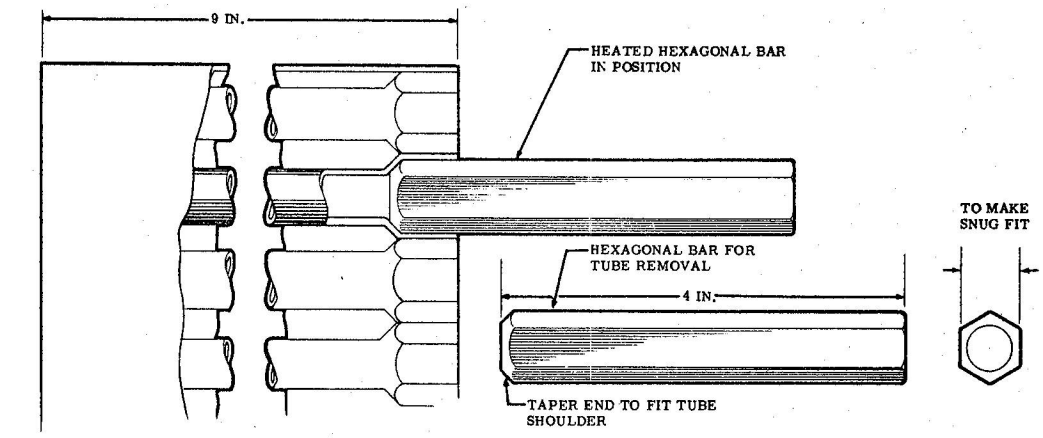
(a) Dents in Shell - Large dents in the shell not indicating sharp radii may be corrected by the following procedure:

(1) Apply an air pressure of 30 to 40 psi to the inside of the cooler or a pressure of 15 psi to the radiator.

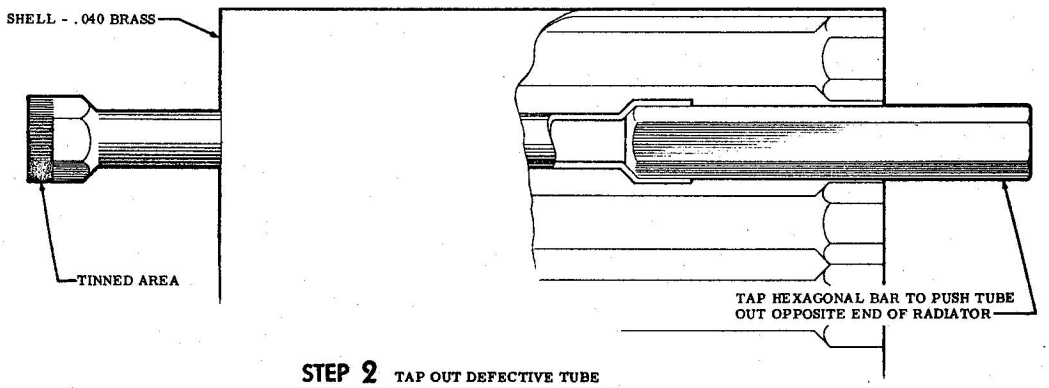
(2) Using an acetylene flame, carefully heat the area affected by the dent. Under the air pressure from within, the material should return to its normal contour.

(3) Sharp dents sometimes may be corrected by soldering the end of the silver solder wire to the centre of the dent. After this is done, gradually pull the shell back into position.

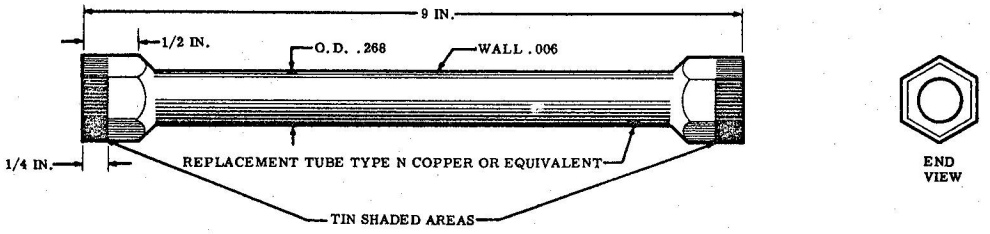
(b) Holes in Shell - Small holes not exceeding one-quarter inch in diameter may be patched by thoroughly cleaning the area with steel wool (Item 5) and soft soldering (Item 7) a patch over the hole using a piece of .040 or



STEP 1 MELT SOLDER ON DEFECTIVE TUBE



STEP 2 TAP OUT DEFECTIVE TUBE



STEP 3 REPLACE TUBE

Figure 5 Typical Oil Cooler Tube Replacement

.050 inch brass. Repair large holes in the shell by silver soldering (Item 4), provided the core is properly protected from excessive heat by utilizing wet cloths. For silver soldering procedure, refer to EO 05-1-3/20. Holes in the inside shell are extremely difficult to repair and the cooler should be replaced rather than repaired.

(c) Shell casing - To repair external leaks on outer shell or casing, proceed as follows:

(1) Ascertain the exact location of the leak by testing as previously described.

(2) Thoroughly clean the defective area and apply flux.

(3) Fit a patch of brass over the damage, tin and solder in place with high melting point solder (Item 4). Perform this operation quickly to prevent annealing tubes in core or melting soft solder.

(4) Cracks around the damaged solder seams of casings may also be repaired by high melting point soldering.

(5) Test the oil coolers and radiators prior to installation on the aircraft.

Intercoolers

21 Supercharger intercoolers are made of aluminum tubes and cannot be soldered, but must be aluminum welded.

Testing of Oil Coolers, Coolant Radiator and Intercoolers

22 Test as follows:

(a) After repairs, seal all openings except one. Apply air pressure to this opening not to exceed 15 psi for coolant radiators and 75 psi for oil coolers or intercoolers.

(b) Slowly submerge the unit in warm water and, where bubbles appear, mark the location with a wire clip. Continue the examination until the entire unit has been covered.

(c) Remove the unit, disconnect the pressure line and allow the unit to drain.

NOTE

Pipes annealed by excessive heat during the soldering operation will collapse under pressure. Replace where necessary.

23 If test shows that the repair is satisfactory, thoroughly flush the oil cooler with light oil (Item 8) at 127°C (260°F) or the coolant radiator with kerosene (Item 6). Reassemble and re-install the unit.

Material Specifications

24 For table showing item numbers, materials, specifications and manufacturers, see Figure 6.

Item No.	Material	RCAF Ref.	Spec.
*1	Compound	33G/, Type as required	MIL-S-7502
2	Soda	33C/680	2-GP-25
3	Acid, Hydrochloric	33C/1	
4	Solder, High Melting Point 6% Silver	30B/NIC	
5	Steel Wool	29/1880 to 1884	
6	Kerosene	34A/217	3-GP-3
7	Solder, Soft	30B/400	QQ-S-571 comp Sn50
8	Oil, Light	34A/35	3-GP-45
9	Methyl Ethyl Ketone	33C/520	TT-M-261
10	Cleaner	33C/182	3-GP-8
*Manufacturer: Minnesota Mining and Mfr. London, Ontario.			

Figure 6 Table of Material Specifications