For Training Purposes Only
Maintenance Manual

CHAPTER

72

ENGINE

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Maintenance Manual

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ENGINE - DESCRIPTION AND OPERATION

General

These instructions are based on the assumption that the reader is already familiar with the fundamentals and theory of a turbofan engine. In the description of the JT3D engine, frequent reference may be made to fundamental and theoretical principles as an aid to discussing the relationships of the parts. If the reader is not yet familiar with turbofan fundamentals and theory, it is recommended that reference be made to publications which supply this information.

The engine operates similarly to all turbofan versions of a gas turbine engine. The first two front compressor stages of vanes and blades are considerably larger than the other stages and are commonly referred to as the "fan". This "fan" provides two separate air streams. The primary (or inner) air stream travels through the engine and internal devices operate to generate pressures and gases in the exhaust nozzle and thereby provide the propulsive force. The secondary (or outer) air stream is mechanically compressed by the "fan" as it enters the engine and is ducted to outside the engine a short distance from the "fan". This secondary air stream adds to the propulsive force similar to a propeller. Although the "fan" has the effect of a geared propeller, it is driven at engine speed. The efficiency of the engine is increased by the dual air streams, and since a smaller percent of available energy is diverted to the "fan", the thrust specific fuel consumption is lower than that of a comparable turboprop engine.

The JT3D is an axial flow turbofan engine having a fifteen stage split compressor, an eight can combustion chamber, and a four stage split turbine. See Figure 1.

Model Differences

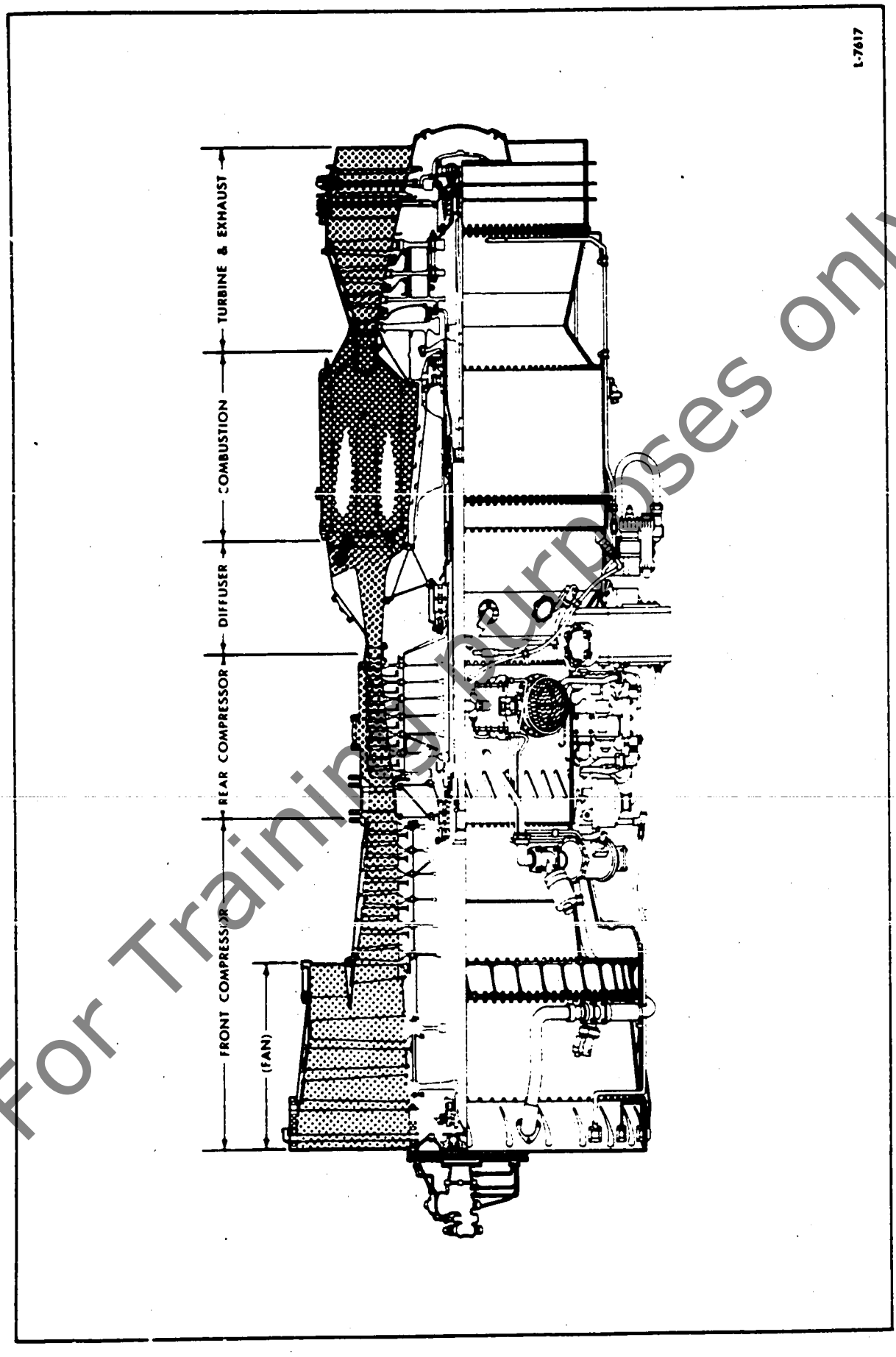
This publication covers JT3D-1 (Boeing and Douglas), JT3D-3 (Boeing and Douglas), JT3D-3B (Boeing, Douglas, and Douglas Long Duct), JT3D-1-MC6 (Boeing and QANTAS) and JT3D-1-MC7 engines.

NOTE: SAUDI uses the JT3D-3B Boeing configuration. References to other models should be disregarded by SAUDI manual readers.

The JT3D-3 and JT3D-3B engines are mechanically identical except for minor internal differences. Operationally, the standard day dry TAKE-OFF thrust rating for JT3D-3B has been extended to include ambient temperature up to 80°F.

The JT3D engine, without airframe installations, is approximately 136 inches long and 53 inches in diameter at the "fan" section. With all engine provided accessory components installed (aircraft component mounting brackets excepted), the JT3D-1 engine weights approximately 4130 pounds, the JT3D-3 weighs approximately 4170 pounds, the JT3D-3B approximately 4340 pounds, the JT3D-1-MC6 approximately 4540 pounds, and the JT3D-1-MC7 approximately 4165 pounds. The aircraft equipment brackets weigh 10 pounds and the fuel de-icing system weighs 45 pounds.

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Typical JT3D Turbofan Engine (Gas Flow)
Figure 1

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Operation

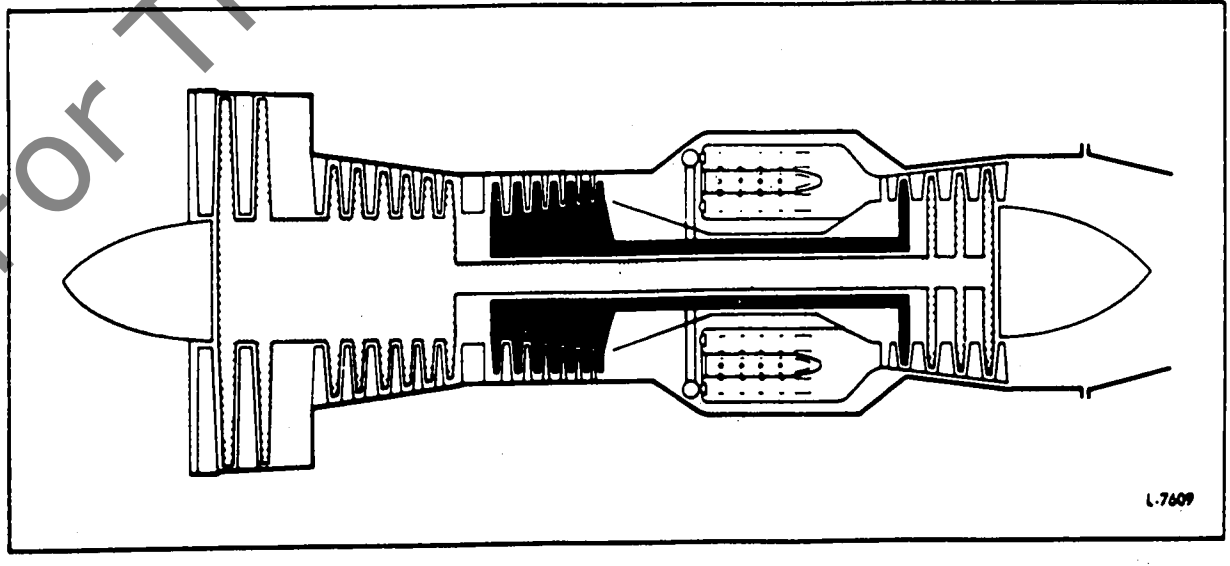
The outline which follows functionally traces the continuous gas flow through the engine in terms of the parts which direct and activate this gas flow. See Figure 1.

The air enters the engine through the compressor inlet case assembly. The airframe inlet duct is attached to the front of the inlet case. This inlet case assembly is provided with vane-type multi-purpose struts which transmit No. 1 Bearing loads to the outer case structure, conduct anti-icing air, and lubricating oil to the inner diameter of the engine and direct the air to the front compressor section.

The compressor section is of the split-type and consists of two rotor assemblies. Each rotor assembly is driven by an independent turbine, and each rotor is free to rotate at its best speed. See Figure 2. Since it is necessary to rotate only one of these units during the starting operation, the selection of the small (rear compressor) permits the use of a smaller starter.

Air from the inlet guide vane and shroud assembly enters the front compressor, which consists of eight rotor stages and seven vane stages. The gas path of this compressor has a constant inside diameter and a decreasing outside diameter. This compressor is the larger of the two, and provides the initial compression of air. The rotating parts are connected by a drive shaft which passes through the inside of the rear compressor rotor and drive shaft to the second third and fourth stage turbines.

Between the front and rear compressor is the intermediate case. It has an automatic arrangement for bleeding front compressor air. This is to improve the acceleration characteristics of the engine. The inlet vanes (9th stage) transmit No. 2 and No. 3 Bearing loads to the outer case, conduct supply and return oil to bearings, and direct the compressed air from the front compressor to the rear compressor.



Split Compressor and Turbine Arrangement
Figure 2

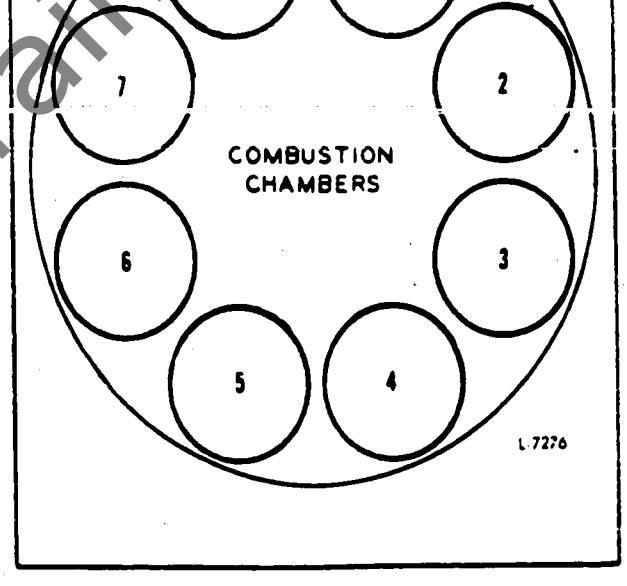
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ENGINE - DESCRIPTION AND OPERATION

The rear compressor has seven rotor stages and six vane stages. It has a constant outside diameter and an increasing inside diameter, and is driven by the first stage turbine through an independent shaft concentric with the front compressor drive shaft. Just aft of the rear compressor is the diffuser case.

Compressor exit guide vanes at the front of the diffuser case straighten the air which is then expanded for entry into the combustion chambers. Struts in the case transmit the No. 4 Bearing and No. 5 Bearing loads to the outer portion of the case. In addition, these struts conduct bearing oil pressure and suction lines and provide high pressure air for such engine functions as anti-icing. They also provide a source of clean air for aircraft pressure needs. The water injection manifold is mounted on the front flange. The coolant is dispersed through sixteen curled tubes mounted on the periphery of the diffuser case, through mating holes in the case and injected into the air stream. The outside contours of the compressor and diffuser sections give the engine its "wasp waist" and at the same time provide a convenient location for the accessory section.

The fuel manifold, which consists of eight circular clusters of six fuel nozzles, is located in the diffuser case annulus and injects the fuel into the air stream in governed proportions. At this point, the air is channeled into eight portions for burning with the fuel in the eight combustion chambers.



Combustion Chamber Positions
Figure 3

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ENGINE - DESCRIPTION AND OPERATION

The combustion section consists of eight separate cans arranged annularly (hence the name "can-annular" or "cannular burners"). The chambers, as viewed from the rear of the engine, are numbered in a clockwise direction starting with the uppermost chamber as No. 1. See Figure 3. These chambers are connected by cross-over tubes. The compressed air, its velocity decreased, and now with fuel particles injected, is lighted initially by sparkigniters installed in the No. 4 and No. 5 combustion chambers. After "light-up" the flame is perpetuated by the construction of the combustion chamber and the heat generated by previous combustion. The exhaust gases pass through the combustion chamber outlet duct into the turbine nozzle case.

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The turbine nozzle case houses the first stages of the four stage turbine and is aft of the combustion section. The first stage drives the rear compressor, and the second, third, and fourth stages drive the front compressor. The turbine nozzle case also contains the four turbine exhaust nozzles. The nozzles are made up of a series of stationary vanes which direct the exhaust gases through the turbine blades and into the turbine exhaust case.

To the rear of the turbine nozzle case is the turbine exhaust case which houses the fourth stage turbine disk and blades and through which the exhaust gases are ejected from the engine. The turbine exhaust case also supports the No. 6 Bearing and the No. 6 Bearing oil sump.

Description

General

Right and left, clockwise and counterclockwise, upper and lower, and similar directional references, apply to the engine as viewed from the rear (exhaust duct) with the main accessory housing at the bottom of the engine. The directional rotation of the rotor assemblies is clockwise.

It is anticipated that the appearance of certain parts and procedures as they are described herein continue to be affected by design changes materializing too late for consideration in this publication. The latest available information concerning parts and procedures so affected will be included in subsequent revisions.

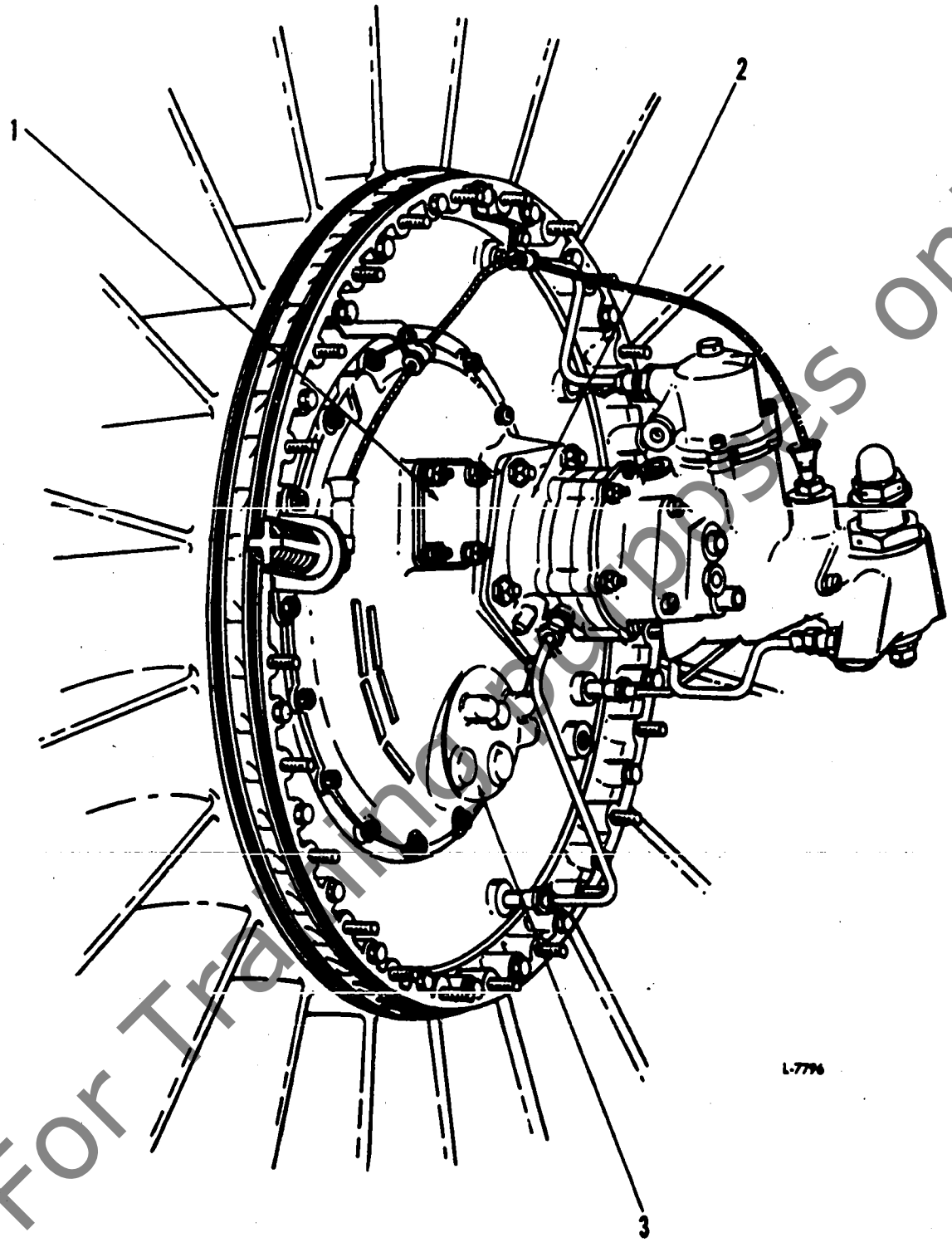
Front Accessory Section

See Figure 4.

The front accessory section consists of one assembly, the front accessory drive support. The case of this assembly is made of magnesium. Sixteen bolts secure the front accessory support to the number 1 Bearing support. The front accessory support has two mount pads on its front face. Later D-3 and D-3B engines have only one mount pad. Only one is used. This is the mounting and drive for the compressor bleed valve control (JT3D-1-MC6 and JT3D-1-MC7 - Temperature Biased). The other opening has provisions for mounting and driving a tachometer.

The No. 1 Bearing scavenge pump is mounted on its lower rear face of the support. Air and oil for the bleed control are brought out of the No. 1 Bearing support and tubed to the control. The front accessory drive gear which is externally splined, is inserted, with an "O" ring seal around it, into the front compressor front hub engaging the internal spline in the hub. In some engines the drivegear is retained by the No. 1 bearing inner race retaining nut; in other engines the drivegear is retained in the hub by a snapring and may be removed to permit internal rotor inspection without disturbing the bearing inner race retaining nut. The front accessory drive gear meshes with and drives the tachometer drivegear, the No. 1 Bearing scavenge pump drive gear, and the compressor bleed control drive gear.

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1. TACHOMETER DRIVE PAD
2. COMPRESSOR BLEED CONTROL MOUNTING PAD
3. OIL SCAVENGE PUMP AREA

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ENGINE - DESCRIPTION AND OPERATION

Front Compressor Section

Front Compressor Assembly

See Figure 5.

The front compressor, which is housed in the front compressor front and rear cases, consists of a rotor composed of eight rows of blades and a stator assembly containing eight rows of vane and shroud assemblies located between successive stages of blades. The first two rows of blades are considerably larger than the rest and are referred to as the "fan" blades.

There is no second stage stator, numbered as such, and also, there is no third row of blades. It is at this point that the air stream is separated into primary and secondary streams. The separation is achieved by the use of a spacer between the second and fourth stage blades. The primary air stream is directed internally by the third stage stator while the secondary air stream is exhausted through the exit struts. The numbering of the blade stage from front to rear is 1, 2, and 4 through 9, and the numbering of the stator stages is 1 and 3 through 8. The ninth stage stator vanes are incorporated in the intermediate case and will be discussed later.

The third stage vane and shroud assembly is of single piece construction, whereas the fourth through the eighth stage are of the split type. The spacers of the fourth through eighth stage are integral. The inner shrouds form a seal ring for the two air seals on the outer diameter of each rotor disk spacer.

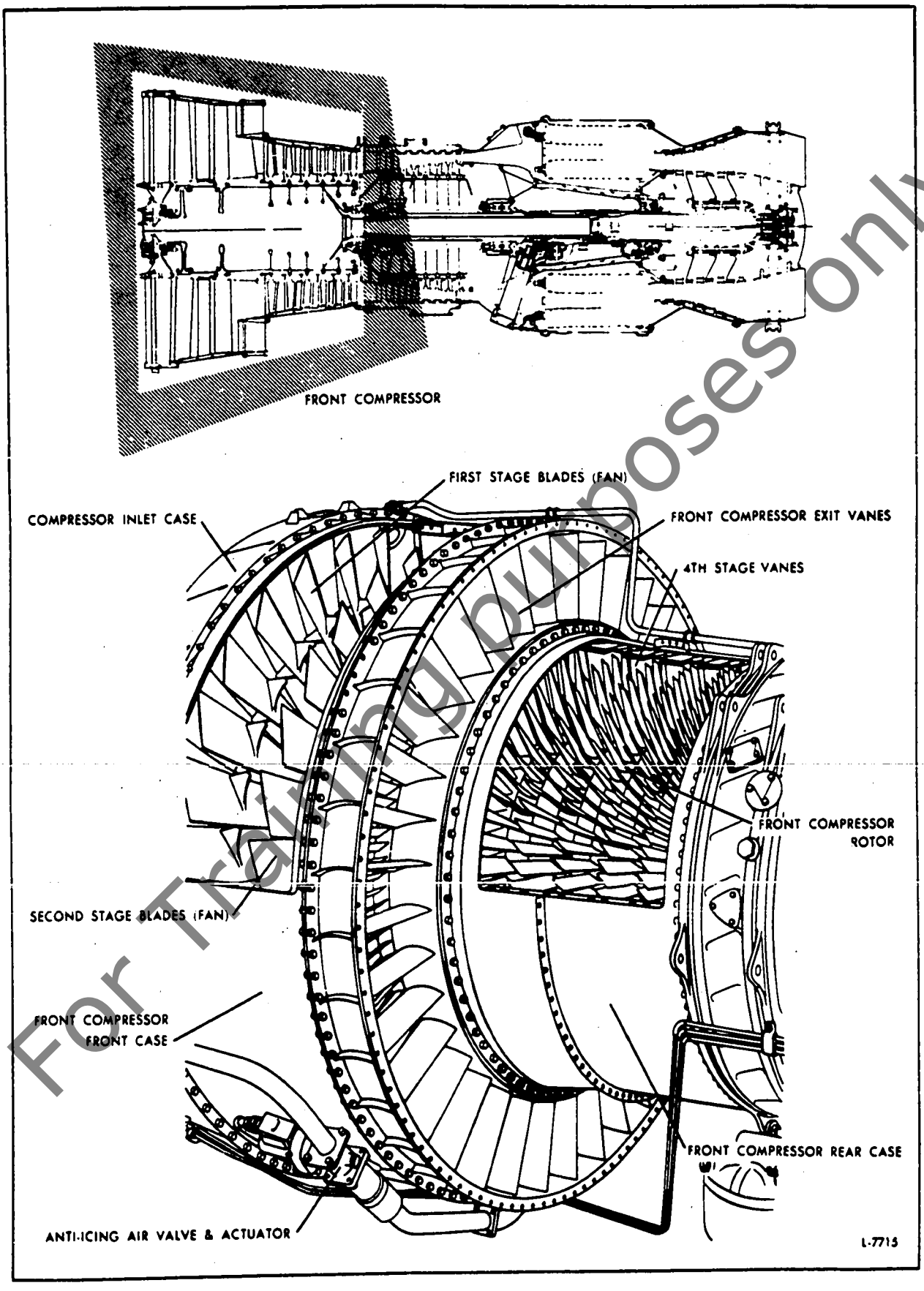
The compressor is driven by a shaft from the second, third, and fourth stage turbines. Its rotational speed is roughly two thirds the speed of the rear or high speed compressor. Its function is to provide the initial compression to the air that passes through the engine and transmit this air to the rear or high speed compressor. The stator vanes and rotor blades diminish in size and increase in quantity from the front to the rear of the compressor. This matches the decreasing volume of the air as the pressure of the air rises.

The front accessories are driven by a gear attached to the front hub of the front compressor rotor. The rear hub of the front compressor contains the front compressor drive turbine shaft coupling.

The rear hub of the front compressor rotor is supported by a double ball bearing (No. 2). The two halves of the No. 2 bearing (front compressor rear) are separated by an oil baffle in which drilled holes direct oil to the forward and aft sections of the double bearing. The No. 3 bearing (rear compressor front) inner race and rollers are mounted on the end of the rear hub. An oil seal on the rear end seals the bearing compartment from the engine air stream.

On the front hub, the rotor is supported by a roller bearing (No. 1), the liner of which is in the No. 1 bearing housing. An oil seal on the front end seals the bearing compartment from the engine air stream. The bearing support is secured to the inlet case assembly and forms the assembly which is discussed below.

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Front Compressor Section
Figure 5

ENGINE - DESCRIPTION AND OPERATION

No. 1 Bearing Supports and Inlet Case Assembly

These assemblies are discussed together since the supports are mounted in the inner diameter of the inlet case assembly, the vanes of which, carry the structural load of the No. 1 bearing (front compressor front) from the inner shroud to the outer shroud.

The inlet case assembly consists of hollow titanium vanes, incorporating foam rubber stiffeners in the center bays, that are inserted between hollow, double walled titanium inner and outer shrouds. Each vane extends from the inner wall of the inner shroud to the outer wall of the outer shroud. Also, the vanes are welded to the outer wall of each shroud. There are holes in the side walls of the vanes that are between the shroud walls and this forms a passage for the flow of anti-icing air. The left and right anti-icing tubes feed heated air, when desired, into the outer rim of the shroud assembly opposite the eight and four o'clock struts.

Some of the vanes have tubes inside. These are for oil, breather and bleed valve control air lines. The No. 1 bearing oil pressure and oil return tubes are located in the seven o'clock and five o'clock struts respectively. The purpose of these vanes is to cause the air to enter the compressor rotor blades at the best angle for best compressor operation and to transport the structural load as discussed above.

The inner shroud, being of double-wall construction, provides for the passage of anti-icing air that has flowed inward through the guide vanes. The oil and air tubes that pass through the vanes have fittings mounted on the inner wall of the inner shroud.

On the front edge of the inner shroud, holes are drilled and tapped to hold the bolts that secure the No. 1 bearing housing and the compressor inlet air seal assembly. The No. 1 bearing housing holds the No. 1 bearing outer race and rollers in its ID. The front accessory front support is bolted to its forward face. Anti-icing air outlet holes are also on the front edge of the shrouds. The No. 1 bearing rear support, the inner section of which houses the No. 1 bearing oil seal, is bolted at its outer diameter to the compressor inlet vane inner shroud rear flange.

The outer shroud, being also of double-wall construction, provides for the passage of anti-icing air. The outer wall of the outer shroud forms the support for the outer fittings of the tubes that pass through some of the vanes. The anti-icing air inlet fitting is also in the shroud outer wall. A pressure probe fitting passes through both walls of the shroud to protrude into the air stream between the vanes. They are bolted to the outer walls.

The front rim of the outer shroud is drilled and tapped to receive the bolts which will hold the airframe air inlet duct. The rear rim of the outer shroud is drilled and tapped to receive the bolts that hold the shroud to the front compressor case.

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ENGINE - DESCRIPTION AND OPERATION

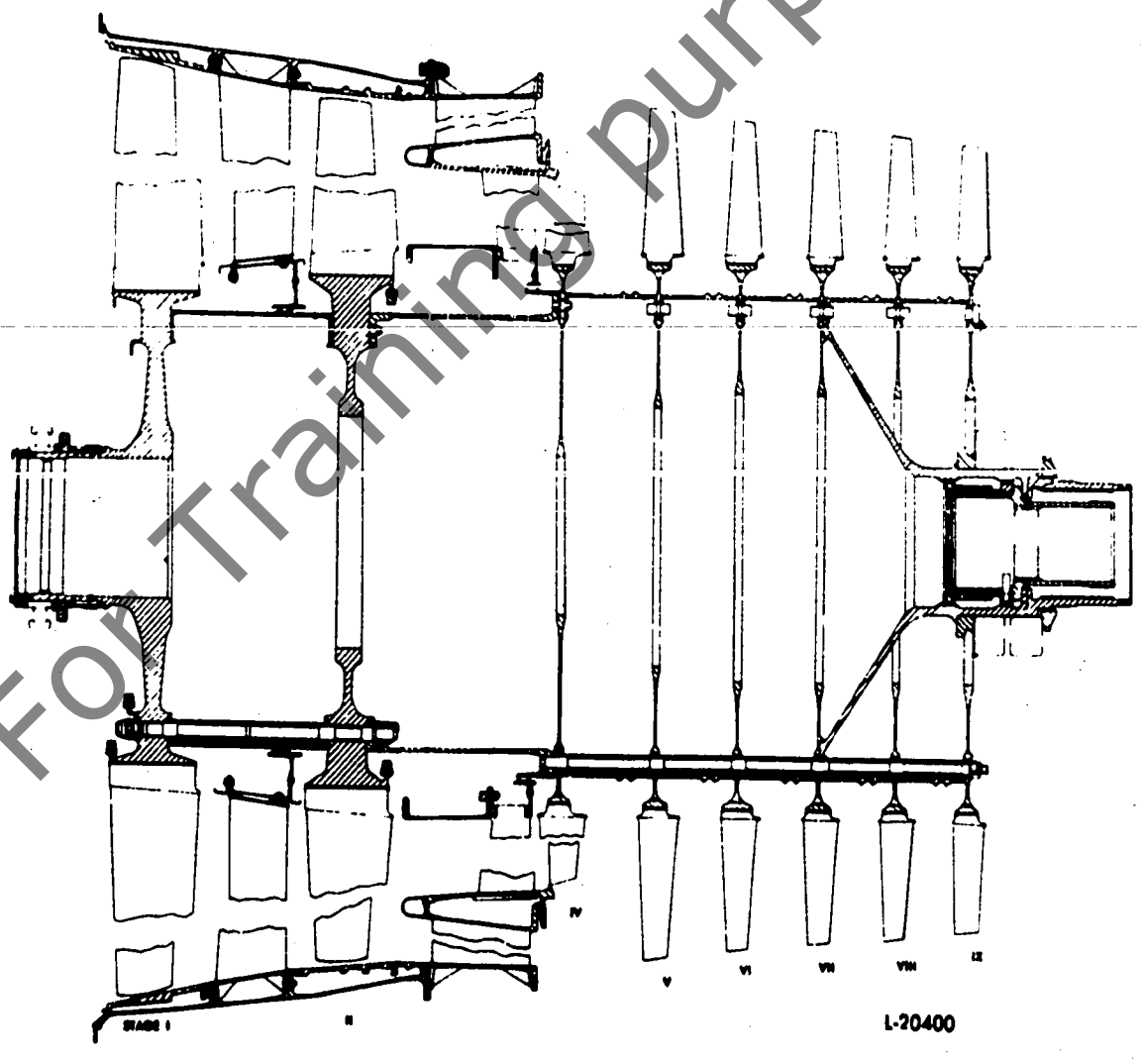
Front Compressor Cases

There are three front compressor cases namely: the front compressor case and vane assembly, the fan discharge case assembly, and the front compressor rear case assembly. These will be discussed individually below. The front compressor cases carry the structural load of the front of the engine. These cases decrease in diameter from front to rear to match the decreasing diameters of the stator rings.

Front Compressor Case and Vane Assembly

See Figure 6.

The front compressor case and vane assembly attaches to the rear flange of the compressor inlet case and the front flange of the fan discharge case. In the approximate center of the case, riveted to internal flanges, are the titanium first stage stator vanes. At the inner shroud of the vanes, a steel first stage air sealing ring is riveted. The inner shroud is constructed of titanium. From the forward internal flange to the inlet case, a front airflow duct is inserted. From the rearward internal flange to the fan discharge case forward flange, a rear airflow duct is inserted.



Front Compressor Rotor and Case Assembly
Figure 6

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ENGINE - DESCRIPTION AND OPERATION

Fan Discharge Case Assembly

Attached to the rear flange of the front compressor case and vane assembly by bolts and pinned to the rear airflow duct, previously discussed, is the fan discharge case. This case is constructed of stainless steel and consists of an outer shroud and an inner case with thirty-eight steel ducts between them. The struts are secured in the inner case by a riveted locking plate at the rearward end and wired to the fairing retaining screws at the forward end.

Front Compressor Rear Case Assembly

Attached to the rear innermost flange of the fan discharge case and to the forward flange of the intermediate case is the front compressor rear case assembly. The front compressor rear case assembly is welded steel in construction. Welded to it internally are the supports for the vane and shroud assemblies. A center external flange serves as a reinforcement and is also used to support the brackets that carry external items.

Front Compressor Stator Vanes and Shrouds

The first stage stator vanes were discussed above under the front compressor case and vane assembly. There is no second stage stator. The third and fourth stage rows or stators are made of aluminum except fourth stage on MC-6 which is made of steel. These vanes are riveted into aluminum shroud rings. The fifth through eighth stator vanes are made of stainless steel and are welded into steel shroud rings. All the shroud rings are wide enough to form spacers which permit the compressor blades to rotate. The stators are pinned to inner shrouds to which are riveted inner air seal platforms. The third stage stator vanes and shroud are built into a single circular assembly which is held stationary by a flange inserted between the fan discharge case and front compressor rear flanges. The fourth through eighth stage stator vanes and shrouds are split and are prevented from rotating by being pinned to each other and to the third stage vane and shroud. When assembled, the rings are held in the engine by shoulders on the inside of the front compressor rear case.

The angle at which the vanes are mounted in the shrouds is set to feed air into the following row of rotor blades to give the best compressor efficiency at operating speed. Stator vanes decrease in size from front to rear to match the decreasing volume air and the decreasing size of the rotor blades.

Front Compressor Rotor

See Figure 6.

The front compressor rotor consists of two hubs, seven disks, seven spacer assemblies, eight rows of blades, two sets (sixteen each) of tierods and associated hardware. Each row of blades is inserted into undercut slots in its disk. They are held in place by locks inserted under the blades and bent to secure. The blades do not have a tight fit, but rather are seated by centrifugal force during engine operation. The front hub forms the disk for the first row of blades, but the rear hub is a separate unit that is held fast to the forward face of the seventh stage disk by the tiebolts. The spacers between the disks

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are internally reinforced with tubes. The tiebolts run through these tubes and through the disks. These spacers have two knife-edges on their O.D. These run against the seal platforms on the stator vane inner shroud which was previously described. The exception to the above is the large spacer between the second and fourth stage compressor blades. This serves as a means of joining the "fan" section to the remainder of the compressor and in so doing, provides the needed space in that area. Each disk has twenty-four holes in its flange. Sixteen are for tierods and eight are for balancing weights when needed. The front hub has a lip on its forward face and the second stage disk has a similar lip on its rearward face to which balance weights can be added when the assembly is complete. The entire assembly is held together by the two sets of tiebolts. The smaller set holds the first two stages of blades together while the longer set holds the third through eighth stages together. Both sections are joined together by the spacer, as previously mentioned. The rotor blades decrease in size from front to rear. The first two stages of blades (fan) are considerably larger than the rest. The angle of each row of blades is set to give the best efficiency at operating speed. The rear hub flange has large holes to allow some ninth stage air into the compressor rotor. This air serves a dual purpose of providing bearing seal pressurizing and cooling. The front compressor rotor of the JT3D-1, and D-3 engines consists of hubs (front and rear) disks, and blades, all of which are made from titanium. On later JT3D-1, D-3, and D-3B engines, No. 2 Hub is made of steel. The first two stages of blades on the conversion engines (JT3D-1-MC6 and JT3D-1-MC7) are made from titanium. The fourth, fifth, and sixth stage blades (JT3D-1-MC7 only) and the seventh stage blades (JT3D-1-MC6 only) of the conversion engines are also made from titanium. The other stages of the conversion engines are made from stainless steel. There are two configurations of steel disk and blades used in the conversion engines; the difference being that the heavier design (JT3D-1-MC6) has thicker webs on the disks and hubs.

Compressor Intermediate Section

See Figure 7.

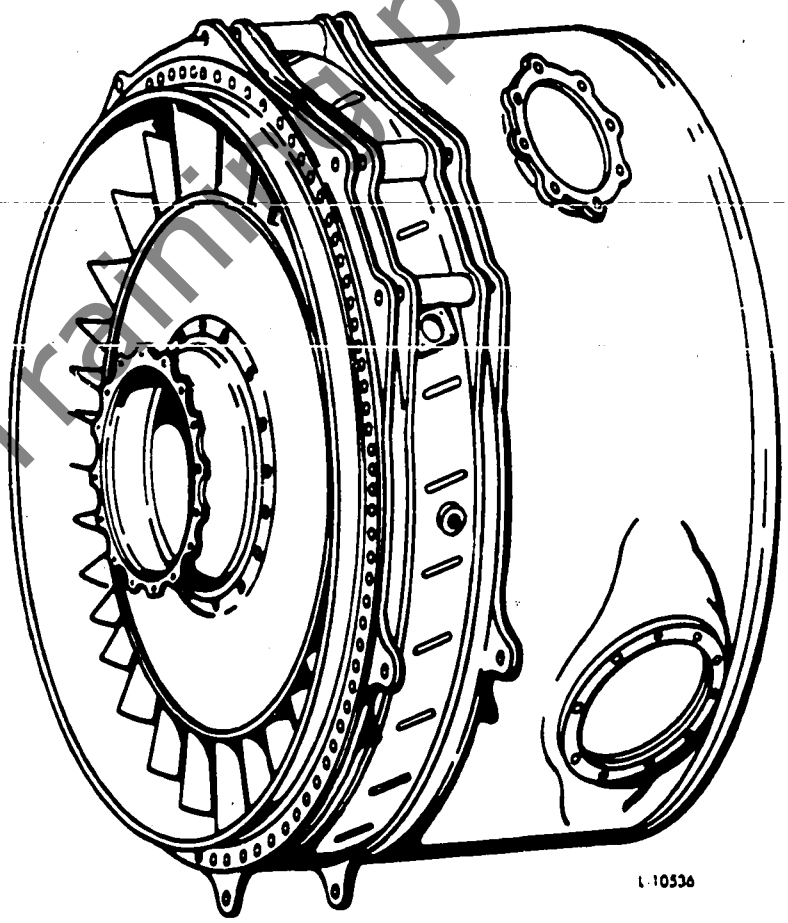
The forward mounting points are on the intermediate case which is attached to the rear flange of the front compressor case. A locating pin is used at top center between the two flanges. The intermediate case surrounds the rear compressor, but is not considered as part of it. It serves to separate the low pressure front compressor from the high pressure rear compressor and serves a structural function of joining the external cases. The intermediate case is of steel construction and has a double wall on the forward end. Guide vanes are welded from the outer wall, through the inner wall and extend into a shroud ring. The double mounting lugs are machined from rings. The case is welded to the rings. The front flange of the case is drilled and tapped for bolts that attach it to the front compressor case, and the rear flange is drilled. Nuts are spun into the holes for bolting the diffuser case and intermediate case together.

An oil breather pad is located between the mounting flanges at approximately the two o'clock position. An oil tube fitting is at the six o'clock position between the mounting flanges. Toward the rear of the case a hole is provided for air

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bleeding and the air bleed valve mounting. On JT3D-1, D-3 and D-3B (Douglas) engines this is located in the upper left quadrant. On JT3D-1, D-3 and D-3B (Boeing), JT3D-1-MC6 and JT3D-1-MC7 engine, it is located in the lower left quadrant.

The thirty vanes that are on the inside front of the case serve as air inlet guide vanes to the rear compressor. They are hollow steel vanes with openings in their side walls at the outer end. These openings together with the double wall of the case, form the breather passage from the upper breather connections on the case to the lower opening. The lower opening connects directly to the main accessory case. Breather and oil tubes for the bearings located in the center of the case are through the hollow guide vanes. The inlet vanes are welded to the No. 3 Bearing support whose outer configuration is shaped to form an inner shroud ring for these vanes. At the front (inner) and rear (outer) ends of this support, bolt circles are provided to receive bolts to hold the diagonal and rear bearing supports. A hollow tubular seal is used at the rear (outer) bolt circle. The integral support described above, two round plates and the No. 2 Bearing housing hold the No. 2 1/2 Bearing. One of the round plates is flat and forms a diagonal brace between the front and rear support. The tapered plate has large holes at the top and bottom to allow air breather and passages for oil tubes. The extensions of the front and rear supports form the seal housings.



Compressor Intermediate Case (Typical)
Figure 7

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ENGINE - DESCRIPTION AND OPERATION

The bearing housing is integral with the center support. A stepped edge seal ring is bolted to the support at the outer diameter of the rear support plate. This ring, together with its mating knife-edge seal minimizes air leakage out of the front end of the rear compressor. The area inside the ring and behind the rear support plate is exposed to high pressure air extracted from the twelfth stage of compression. The air pressure outside the seal ring is from the ninth stage.

Rear Compressor Section

See Figure 8.

The rear, or high, compressor is driven by a hollow shaft from the front stage turbine. Its function is to compress further the air delivered by the front compressor and then feed this air into the diffuser case and burners.

The rear compressor consists of a stator having six rows of vanes and a rotor having seven rows of blades. The exit guide vanes are mounted in the diffuser section. In function, these are part of the compressor, but because of their structural location, we will discuss them under the diffuser.

Vane and Shroud Assemblies

See Figure 9.

There are six vane and shroud assemblies in the rear compressor. The vanes reduce in height from front to rear of the compressor. The outer side diameter of the air passage formed by these assemblies is constant, the decreasing size of the vanes is accomplished by increasing the diameter of the inner shroud rings. The vanes are steel and are brazed to the inner shroud and pieced through the outer shrouds on the first five vane and shroud assemblies, the spacers separating the assemblies are integral. The sixth stage does not provide spacing. However this is furnished by the seventh stage located in the diffuser case. Between each shroud, dowel pins are used to lock the series of shrouds together. The rear shroud, (seventh) is pinned to the seventh stage outer shroud to prevent rotation. An edge of each spacer rests against a case shoulder to center the assembly.

Air Seals

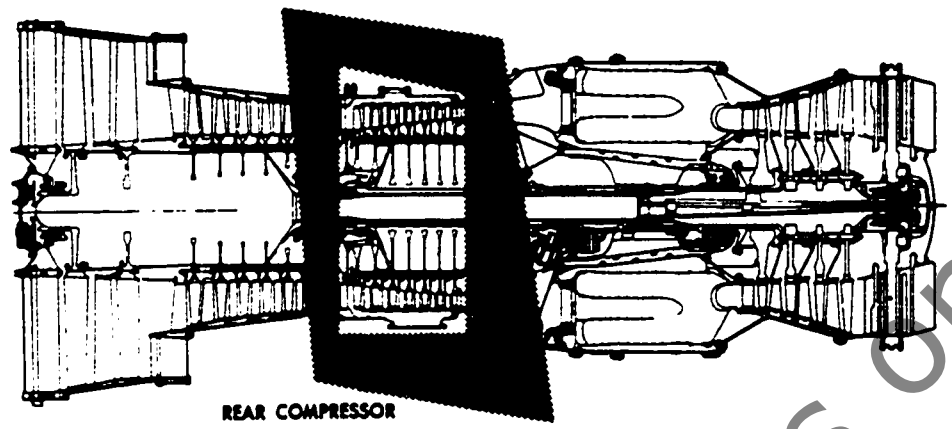
The inside shroud of each row of vanes has a steel ring, with a small step on its inside face, riveted to it. Two knife-edge seals on each rotor spacer rides free of the steps forming an air seal between the compressor stages.

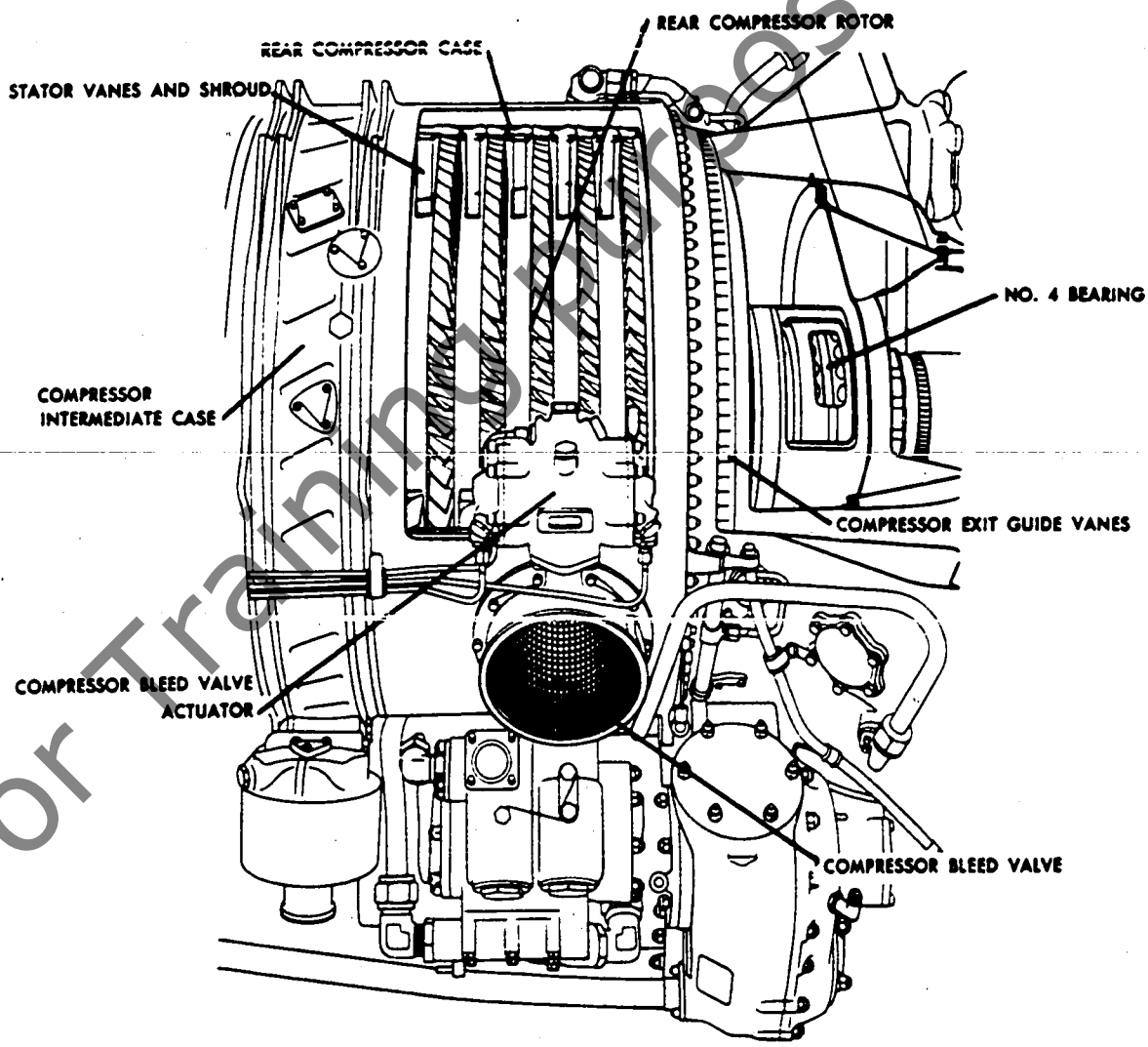
Rear Compressor Rotor

See Figure 10.

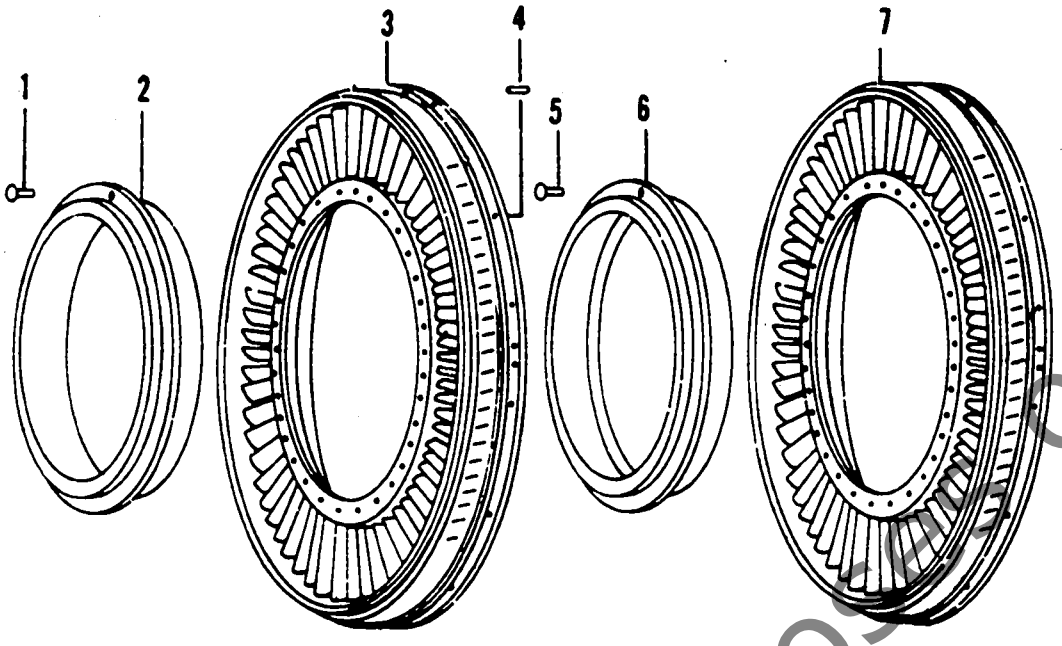
The rotor consists of seven rows of blades on disks; two hubs, six spacer assemblies, sixteen tierod bolts with nuts and washers. A knife-edge seal ring is

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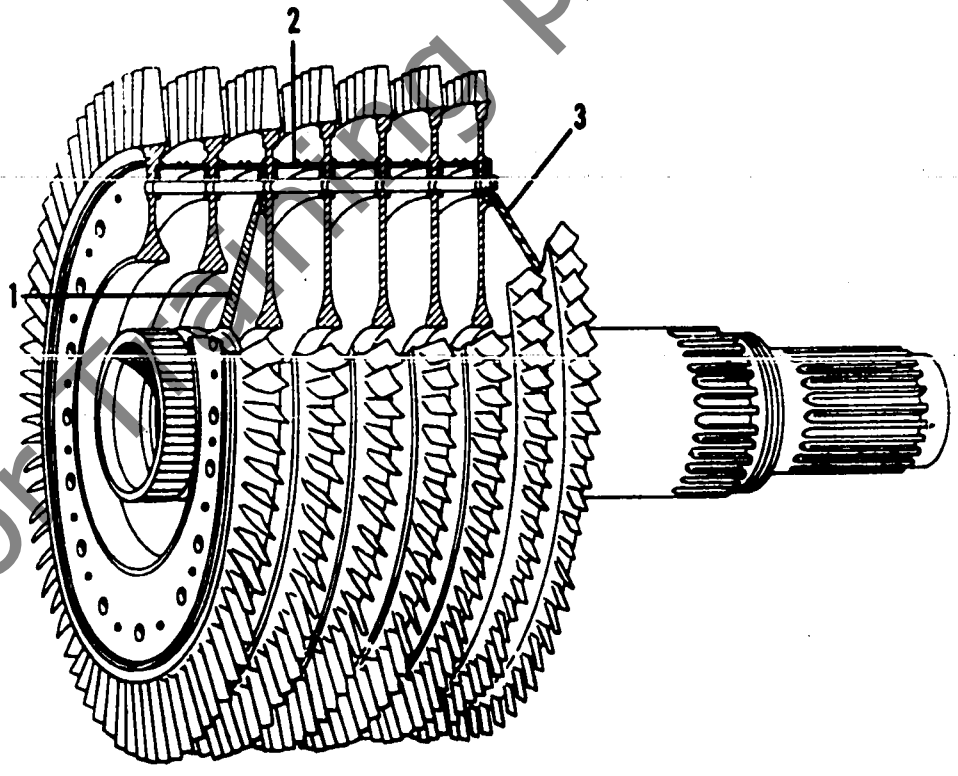
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1. RIVET
2. AIR SEAL RING
3. 10th STAGE VANE & SHROUD ASSEMBLY
4. PIN
5. RIVET
6. AIR SEAL RING
7. 11th STAGE VANE & SHROUD ASSEMBLY

L-7275

Rear Compressor Vanes and Shrouds
Figure 9



1. FRONT HUB
2. SPACER ASSEMBLY
3. REAR HUB

L-7082

Rear Compressor Rotor
Figure 10

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riveted to a lip on the forward face of the tenth stage disk. This seal ring rides free of the platformed seal which was referred to in the compressor intermediate case discussion.

Each row of blades is inserted into undercut slots in its disk. (See Figure 11). They are held in place by locks inserted under the blades and bent to secure. The blades do not have a tight fit, but rather are seated by centrifugal force during engine operation.

Every disk has thirty-two holes in its flange. Sixteen are for tiebolts, and sixteen are for balancing weights when needed. The entire assembly is held together by tiebolt heads on one end and a nut and washer on the other end.

The spacers between the disks are internally reinforced with tubes (See Figure 12). The tiebolts run through the tubes and the spacer internal flanges as well as the disk flanges.

Neither the front nor rear hub is integral with a disk. The front hub is attached to the front face of the third disk and the rear hub to the rear face of the last disk. The hubs are secured to the rotor assembly by the steel tiebolts mentioned above. A steel tube runs from one hub to the other inside the rotor.

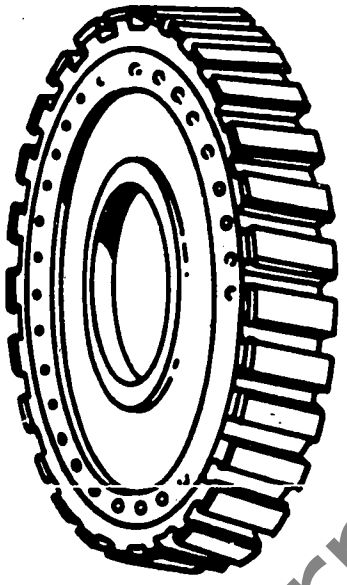
The tube is a force fit into the inside diameter of both hubs and permits breathing within its inside and keeps twelfth stage pressure air from the No. 3 and No. 4 1/2 Bearings.

The front seal was discussed previously. If required, a balance weight may be riveted to it.

The third spacer from the front has holes drilled in it. Through these holes twelfth stage air is bled into the rotor center where it is bled through holes in the front hub. The air is directed forward to the space just behind the No. 3 Bearing rear support plate and pressurizes the No. 3 Bearing oil seal. Since there are no holes in the rear hub disk the pressure of the air against this disk counteracts part of the rotor forward thrust.

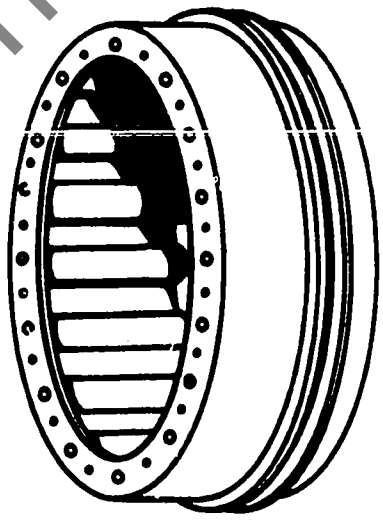
The rear compressor case carries no structural bearing loads and is thus made of relatively thin sheet metal. Its purpose is to hold the stator parts of the compressor and act as an air separator. The air pressure increases from front to rear and finally becomes sixteenth stage pressure. Between this case and the intermediate case which envelopes it, the pressure is ninth stage air. The case has a flange at its rear end to which the screws that attach the case to the diffuser section are secured. Also, bolt holes are provided to hold the intermediate case to the diffuser section.

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1-5204

Rotor Disk
Figure 11



1-5205

Rotor Disk Spacer
Figure 12

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Diffuser Section

See Figure 13.

General

The velocity of the air as it leaves the rear compressor is very high. This motion is both rearward and tangential around the ending. Exit guide vanes at the forward end of the diffuser case convert the tangential whirl into pressure energy. After the vanes, the high pressure air will have a large rearward velocity. The gradual increasing area of the air flow passages provided by the diffuser case configuration decreases the air flow velocity to a suitable burning speed and increases the pressure.

Diffuser Case

See Figure 14.

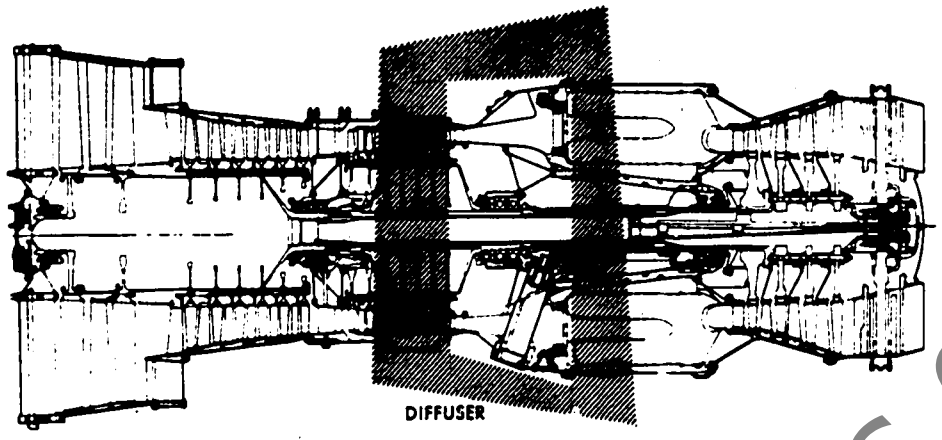
The diffuser case is of welded corrosion and heat resistant steel construction with drilled flanges at both ends for bolting to the rear compressor and intermediate cases in the front and the combustion chamber case in the rear.

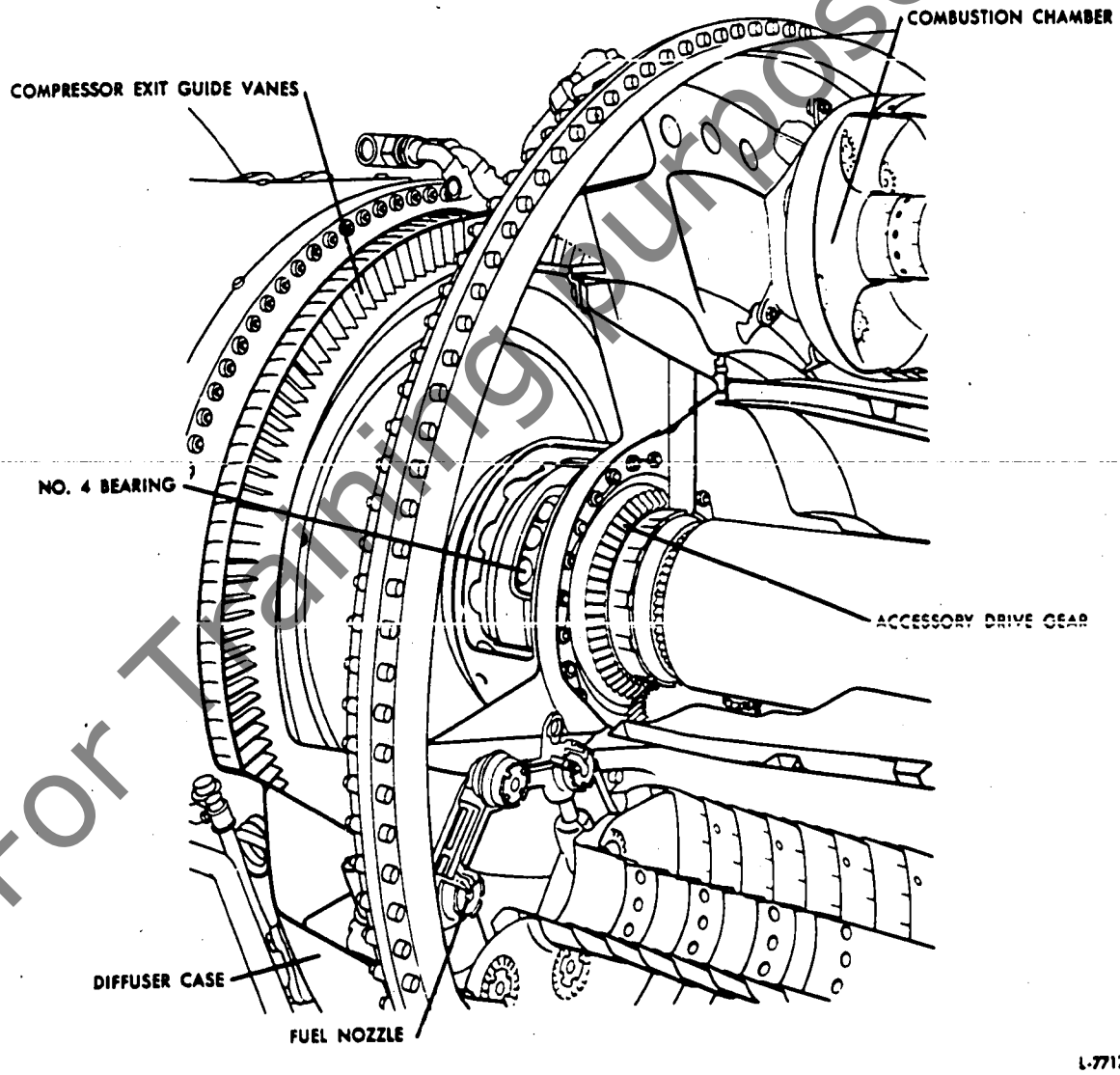
The pad at the top center of the case is used for a breather connection. This leads to the bearing area through a strut. Air bleed outlet pads are on the outside of the case. An opening with mounting bosses at the bottom of the case provides for the angled accessory drives system and the accessory drive adapter which transmits high rotor motivation to the accessory drives gearbox assembly. The rearmost pad at the bottom center of the diffuser case is for mounting the fuel pressurizing and dump valve which is attached outside the case. The fuel manifolds attach to the inside of the case at this pad. The fuel manifold inlet distributor which connects to the fuel pressurizing and dump valve passes through a hole in the case at this location.

Two forward facing and one rear facing bolt rings are mounted on the struts from the outer case. Sheet metal between these bolt rings and on the inside and outer case add to strength and form the gradually increasing cross section of the diffuser. A slightly tapered diffuser inner inlet duct is bolted between an inside flange on the inlet guide vane inner shroud and the outer, forward facing, bolt circle inside the diffuser case. This piece forms a part of the diffuser ducting. The rivet circle that holds the diffuser inner inlet duct to the inlet vane ring extends forward to ride over two knife-edges that are on the rear disk of the rear compressor. This forms the air seal between the rear compressor and the bearing housing area at the center of the diffuser case. The outer shroud flange is clamped between the diffuser case and the rear compressor case when these units are assembled.

The water injection nozzles (JT3D-1, D-3 and D-3B Boeing, and JT3D-1-MC6) are mounted around the periphery of the diffuser case. The nozzles permit the entry of water into the highly compressed air stream, thereby increasing its

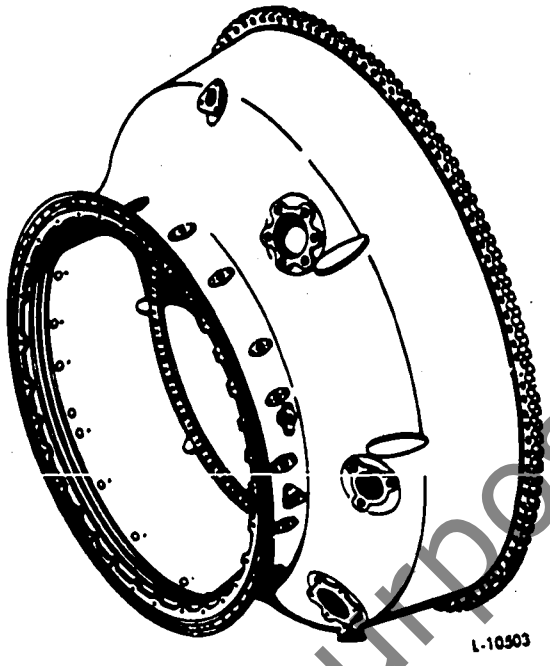
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Diffuser Section
Figure 13



Diffuser Case
Figure 14

density and lowering its temperature prior to injection of the fuel from the fuel nozzles.

Water Injection Manifold (Optional JT3D-1, D-3 and D-3B Boeing, and JT3D-1MC6)

The water injection manifold is the split type which is mounted on the diffuser case front flange. The water is dispersed through the sixteen curled tubes mounted on the periphery of the diffuser case. The elbows of the tubes are aligned to the sixteen holes in the diffuser case. Water is metered from the water injection control through a supply tube to the tee fitting on the diffuser case front flange. Water then flows through the manifold into the air stream in the diffuser case.

No. 4 Bearing Housing

The No. 4 Bearing is in the diffuser section. This supports the rear compressor rear hub. The bearing housing and its seal are fastened to the forward facing inner bolt ring with studs and nuts. A synthetic rubber gasket is used just inside of the stud circle.

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ENGINE - DESCRIPTION AND OPERATION

Oil Pump and Gearing

See Figure 15.

The No. 4 and No. 5 Bearing scavenge pump and the accessory drive gears are in the lower rear of the diffuser case.

Brackets

A quantity of brackets are attached to the external bolt circles for mounting external tubing and units.

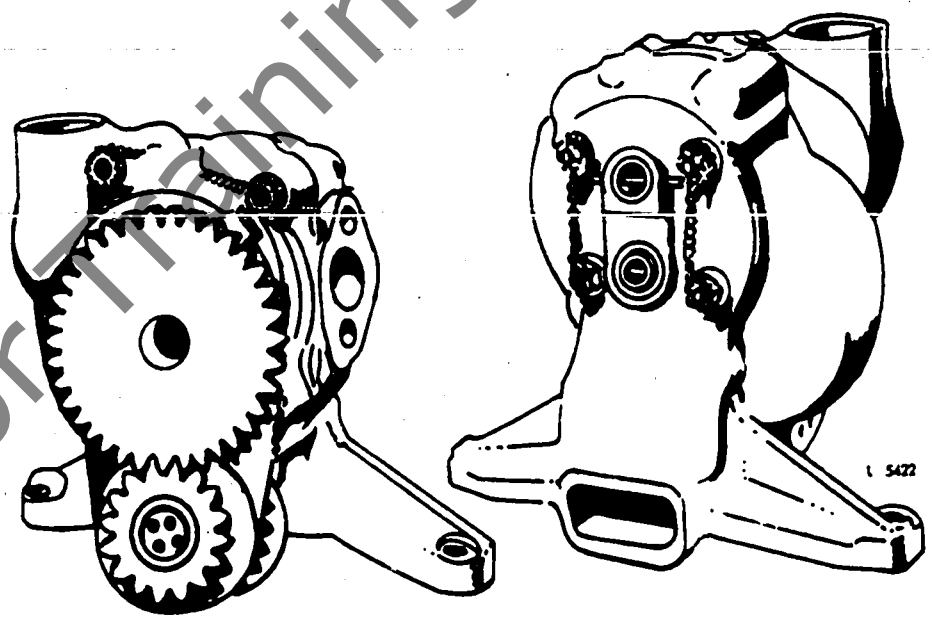
Fuel Manifold Attachment

As viewed from the rear, sixteen brackets are welded to the inner structure of the diffuser. These brackets, and brackets that are welded to the inside rear of the diffuser outer case, support the fuel manifold.

Fuel Manifold

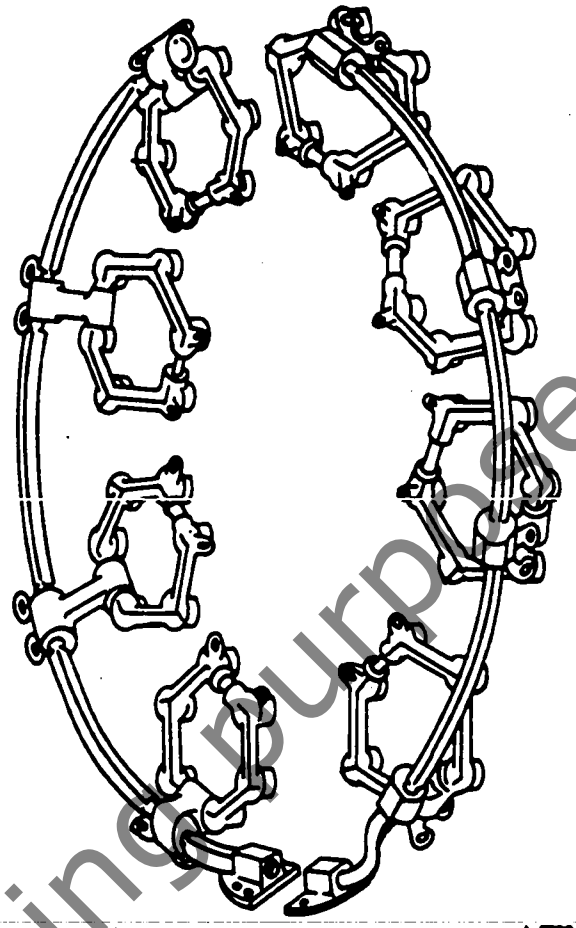
See Figure 16.

The fuel manifold is split at the inner flange and between the number one and eight clusters. The manifold assembly consists of a primary and a secondary fuel manifold and eight clusters of fuel nozzles. There are six fuel nozzles



No. 4 and No. 5 Bearings Oil Scavenge Pump
Figure 15

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Fuel Manifold
Figure 16

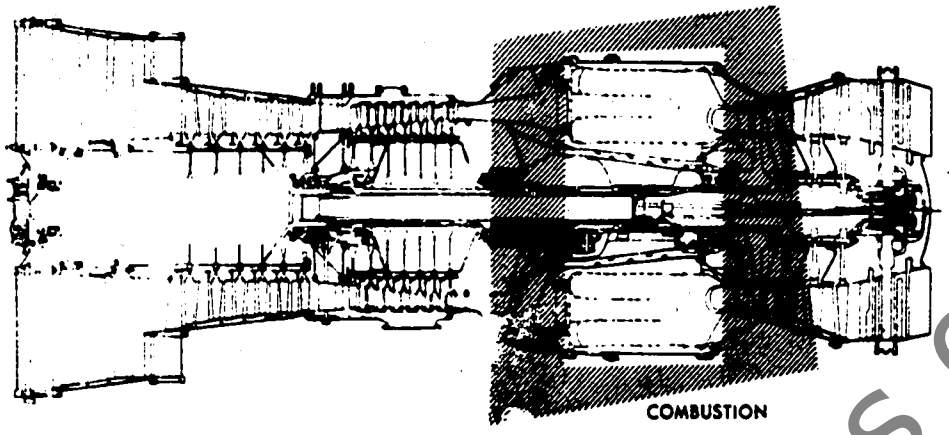
in each cluster. The fuel manifold incorporates mounting lugs in the inner and outer diameter which are secured to the rear face of the diffuser case. Eight combustion chamber positioning brackets are mounted on the outer diameter mounting lug locations. See Chapter 73.

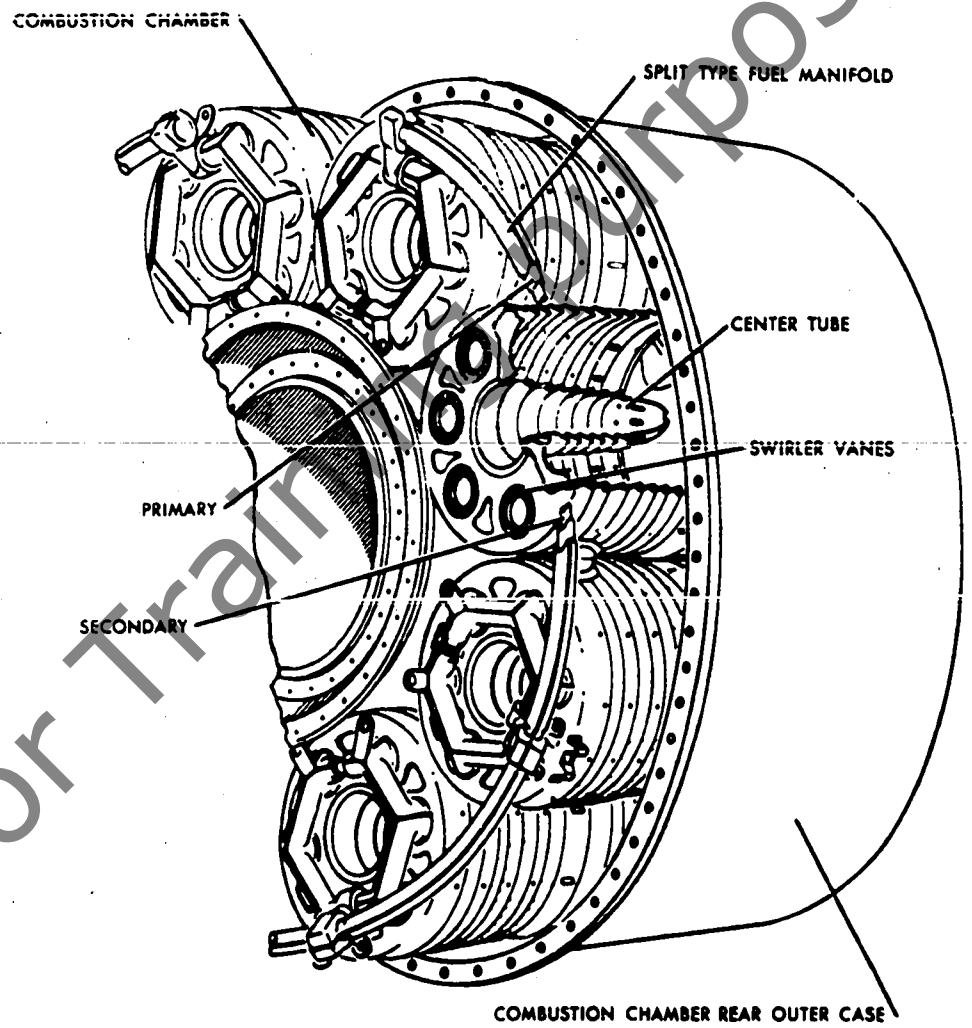
Combustion Section

See Figure 17.

The combustion chamber outer case is secured at the front flange to the rear flange of the diffuser case and at the rear flange to the turbine nozzle case. Eight combustion chambers, often called burner cans, the combustion chamber inner case, the No. 5 bearing support, and the No. 5 bearing housing are located inside the combustion chamber outer front case.

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ENGINE - DESCRIPTION AND OPERATION

Combustion Chamber Outer Cases

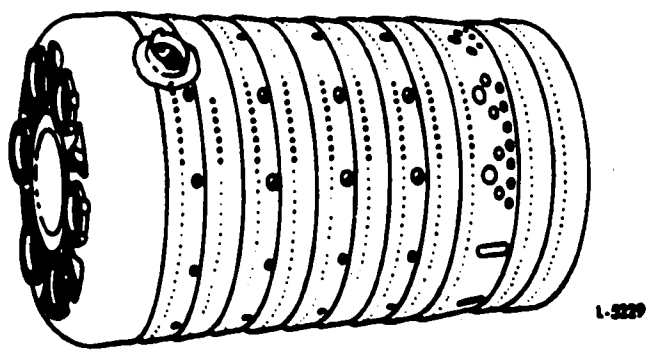
There are two combustion chamber outer cases, the front and the rear. They are constructed of corrosion and heat resistant steel. The front flange of the combustion chamber outer front case is bolted to the rear flange of the diffuser case. The front flange of the combustion chamber outer rear case is bolted to the rear flange of the outer front case and rear flange to the front flange of the turbine nozzle case. The outer rear case rear flange is internal. It lies behind the forward external flange of the turbine nozzle case and bolts to it. Thus, the outer cases (if bolted together) or the rear outer case can be slid rearward over the turbine nozzle case to give access to the combustion chambers. The outer front case has interlocking lips on its flanges to provide sealing when joined.

Combustion Chambers

See Figure 18.

The combustion chambers are radially housed inside the combustion chamber outer case. The forward face of each combustion chamber presents six apertures which align the six nozzle of the corresponding fuel nozzle cluster.

There are three basic types of combustion chambers in service. Combustion chambers Type I and Type II are interchangeable. However, Type I and Type II chambers are not functionally interchangeable with Type III chambers. Within combustion chambers Type I and II, chambers number 1, 3, and 7 are interchangeable and numbers 2, 6, and 8, are interchangeable. In Type III, chambers number 2 and 3 are interchangeable and numbers 6, 7, and 8 are interchangeable. Numbering is clockwise, as viewed from the rear, and starts with the one o'clock position chamber. Chambers number 4 and 5 have sparkigniter sleeves and guides, and chamber number 4 has an air pressure transfer tube in it. Interconnecting flame tubes join all the chambers around the circle. The tubes on the odd numbered Type I and II chambers are female and have an air shield on the upstream side that overlaps the mating male flame tube. In Type III chambers, the number one chamber has female interconnecting flame tubes; the number five chamber has male tubes and chambers number 2, 3, 4, 6, 7, and 8 have one male and one female flame tube. When removing Type I and II chambers, the even numbered chambers must be removed first. The removal sequence for Type III chambers is number 5, 6, 4, 3, 7, 2, 8, and 1.



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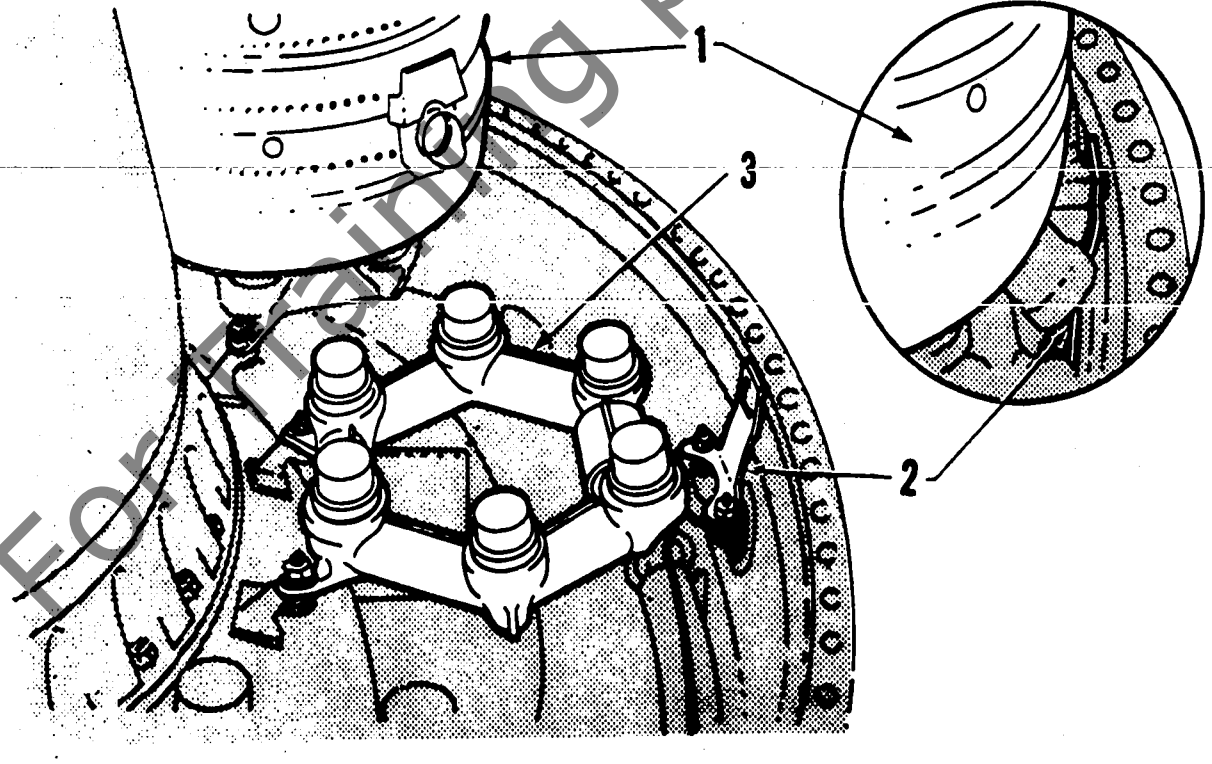
ENGINE - DESCRIPTION AND OPERATION

The combustion chambers are a welded assembly. At the head of each chamber are six air swirl fuel nozzle guides through which six fuel nozzles fit. These guides are fitted with cast toroidal deflectors which reduce carbon buildup on fuel nozzles and thus reduce subsequent turbine air seal wear. The holes in the walls of the chamber meter the entering air. Near the head of the chamber most of the air is used as combustion air. Further down the chamber the entering air is used to cool the hot gases to safe temperature for the chambers. The rows of smaller holes admit air that cools the can itself.

Each chamber is held in place by a positioning bracket (see Figure 19) and a clamp (see Figure 20). The clamp holds the open end of the chambers to an outlet duct assembly which is fastened to the turbine case. Each positioning bracket is secured by two outer fuel manifold retaining bolts. The bracket hooks onto a retaining lug on the combustion chamber. The fuel nozzle inside the air swirl guide holds the chamber from lateral movement.

Fireseal

The fireseal is held by the bolts that join the front and rear combustion chamber outer cases. The outer rim of the fireseal fits tightly against the engine pod. The JT3D-1, D-3 and D-3B (Boeing), the JT3D-1-MC6, and JT3D-1-MC7 engines use the narrow band type (see Figure 21) fireseal, while the JT3D-1, D-3 and D-3B (Douglas) uses the offset lip type.

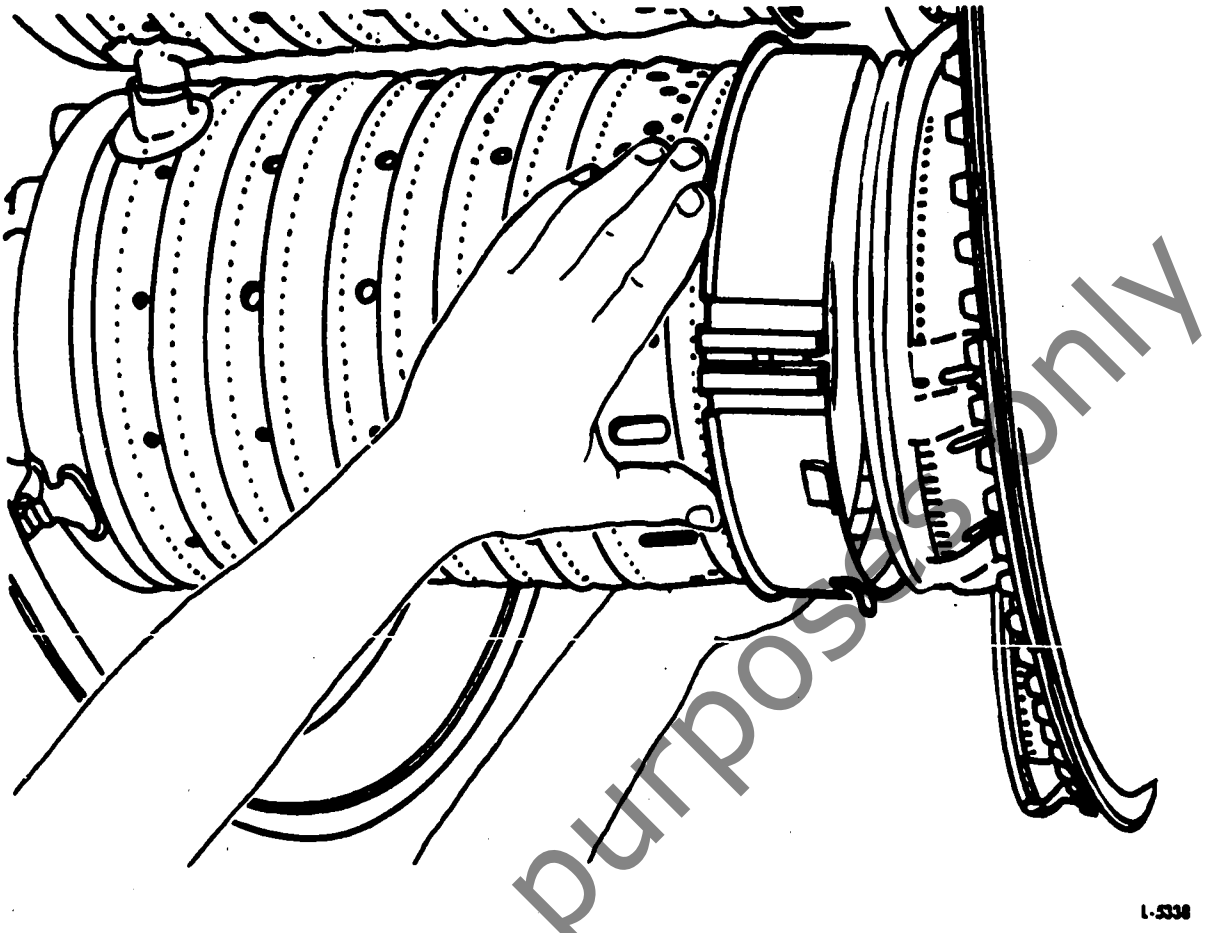


1. COMBUSTION CHAMBER
2. COMBUSTION CHAMBER POSITIONING BRACKET
3. FUEL MANIFOLD CLUSTER

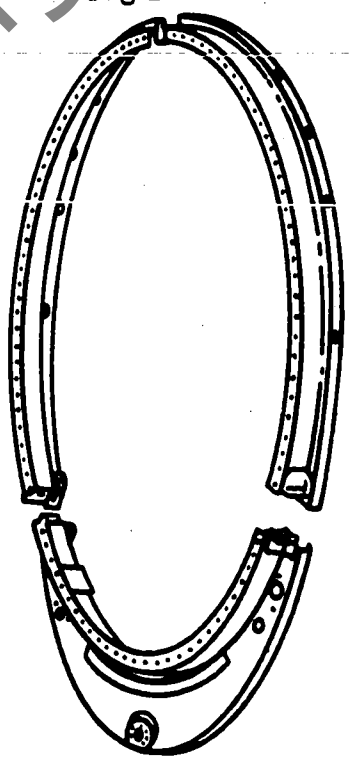
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Combustion Chamber Positioning Bracket
Figure 19

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Combustion Chamber Clamp
Figure 20



Fireseal (Narrow Band Type)
Figure 21

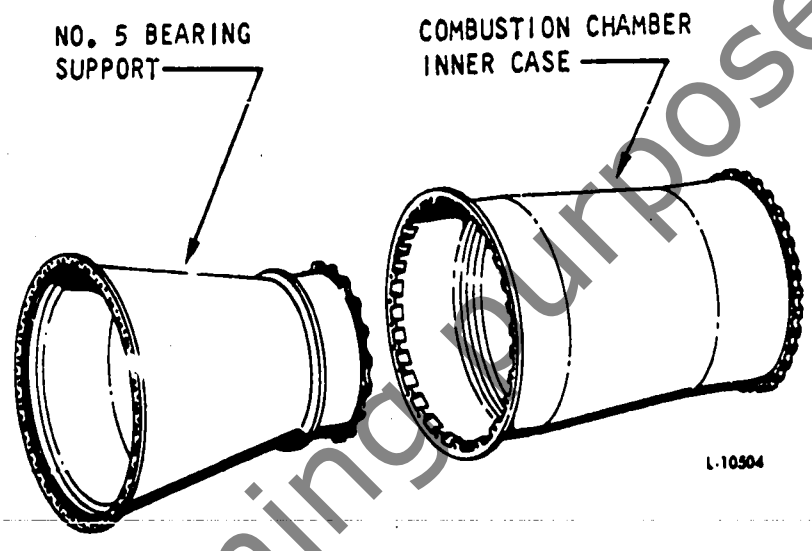
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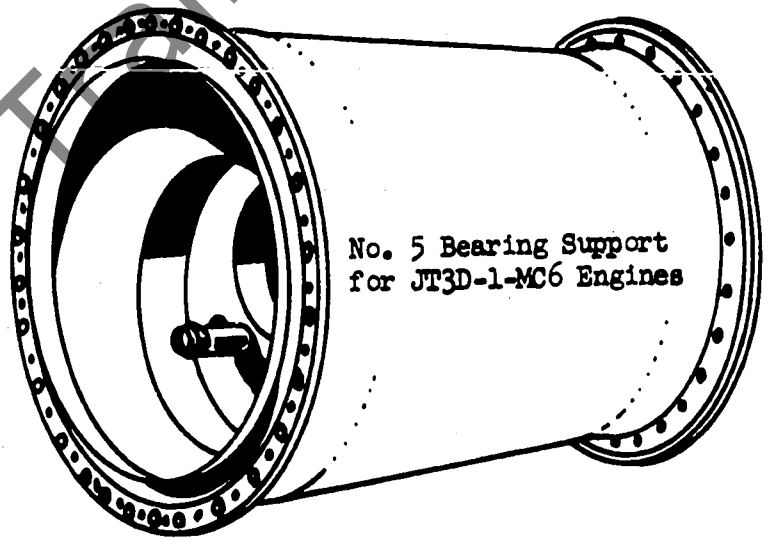
ENGINE - DESCRIPTION AND OPERATION

The Combustion Chamber Inner Case

See Figure 22.

The combustion chamber inner case is made of corrosion and heat resistant sheet steel with reinforcements welded to its inside surface. Its prime function is to form the inner surface of the combustion section, but together with the No. 5 Bearing support, it provides an inner passage for the sixteenth stage air which will help cool the radiant heat from the combustion chambers. Holes in its forward flange, the diffuser, and the No. 5 Bearing support permit this air to flow. A flange on the rear end attaches to the turbine nozzle inner case.





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No. 5 Bearing Support and Combustion/Chamber Inner Case
Figure 22

No. 5 Bearing Support

See Figure 22.

The No. 5 Bearing support is made of corrosion and heat resistant sheet steel with reinforcements welded to its inside surface. An inner wall is also welded to it. Its prime function is to support the No. 5 Bearing and its seal and provide an inner passage for the No. 5 Bearing pressure and scavenge tubes and the turbine shafts. The forward flange of the support bolts to the inner rear facing bolt circle of the diffuser. Together with the combustion chamber inner case, it forms the cooling air passage described above. Space is provided in the bottom of the support for the No. 4 and No. 5 Bearing scavenge pump. Between the inner and outer wall, the pressure and scavenge tubes for the No. 5 Bearing are located.

No. 5 Bearing Support (JT3D-1-MC6 - Prior to S.B. 765)

See Figure 22.

This single piece unit is of dual wall construction since it serves the double function of acting as the combustion chamber inner case (its outer wall) as well as supporting the No. 5 Bearing and its seal. A heatshield on its inner surface separates the sixteenth stage air from the radiant heat of the combustion chambers. It contains passages for the No. 5 Bearing oil scavenge and pressure tubes. The No. 5 Bearing is secured to the rear face of the diffuser case. The No. 5 Bearing housing is attached to the rear of the support.

Turbine Section

See Figure 23.

The turbine section consists of a four stage gas turbine. The first stage rotor, also called the high speed turbine, drives the rear compressor. The second third, and fourth stage rotors, also called the low speed turbine, are mounted on a single shaft which drives the front compressor.

Turbine Nozzle Outer Case

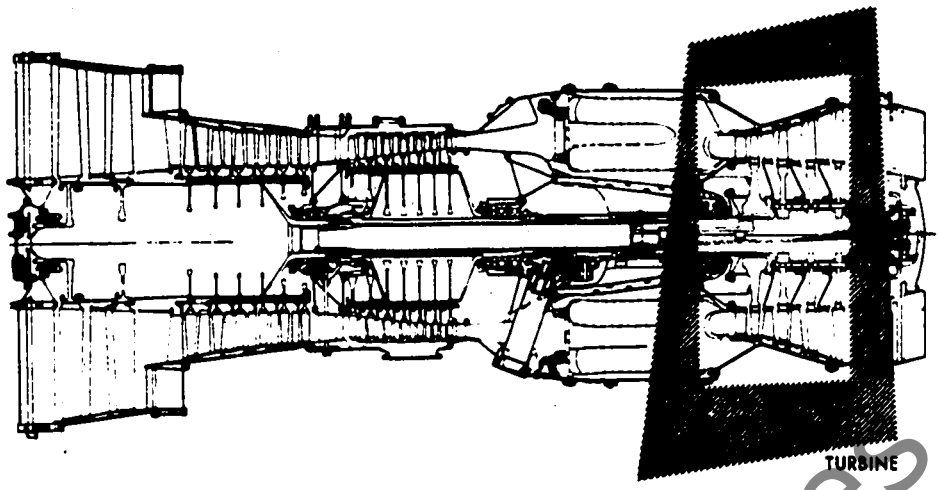
See Figure 24.

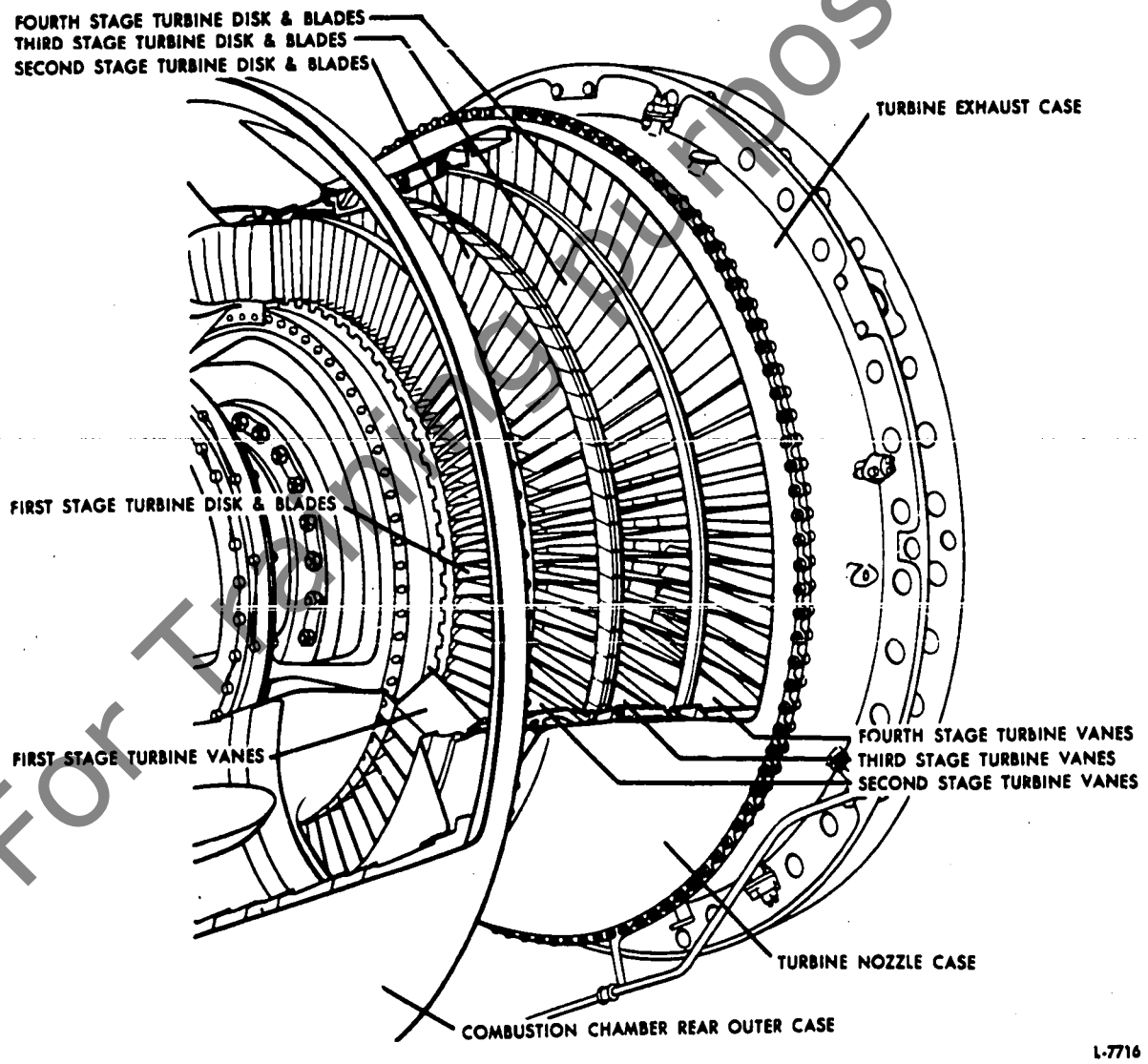
The turbine nozzle case is constructed of corrosion and heat resistant steel for single piece construction or for welded construction. On its front flange, gang bolt assembles are attached, and this flange bolts to the combustion chamber outer case. The rear flange bolts to the turbine exhaust case using a spacer ring. Inside the turbine case, slots and ridges are machined and stator vanes and seals are inserted in these locations.

Turbine Nozzle Inner Case

The turbine nozzle inner case is constructed of nickel alloy steel. On the JT3D-1 and JT3D-1MC7 engines, the front end of the case is attached to

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the rear flange of the combustion chamber inner case. On the JT3D-1-MC6 engine, the front end is attached to the rear flange of the No. 5 Bearing support. At the outer rear end, two shoulders hold the inner end of the first stage turbine vanes. The front (largest) shoulder has pins for securing the vanes. On the ID of the inner case, there are two knife-edged air seals. The innermost seal is riveted to a support welded to the approximate middle of the inner case. It rides free of an inner platform on the first stage turbine disk. The outer air seal is riveted to the rear of the inner case. It rides free of an outer platform on the first stage turbine disk.

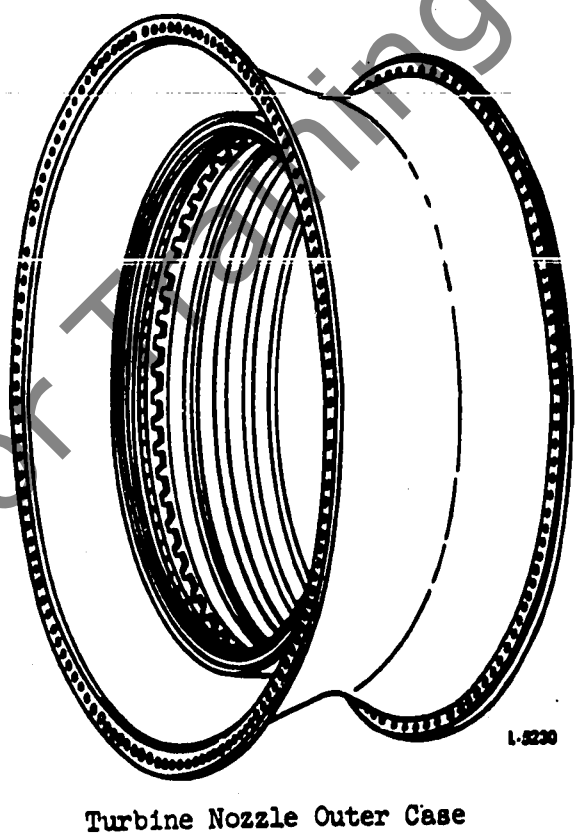
Combustion Chamber Outlet Duct

See Figure 25.

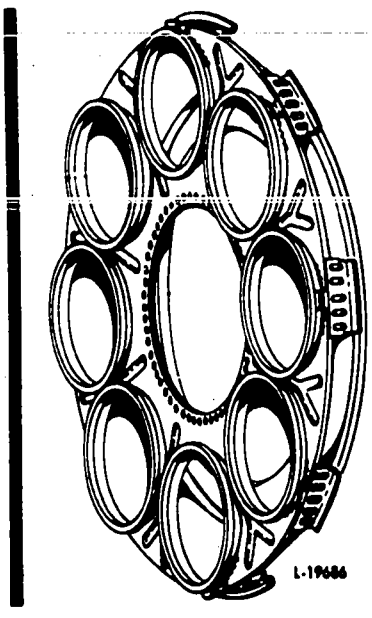
This duct guides the hot gases to the first stage nozzle. It is retained to the No. 5 Bearing support. The duct is a welded assembly that is held in place by the combustion chamber outer case-to-turbine nozzle case bolt circle. The forward flanges of the duct ports carry the rear edge of the clamps that hold the combustion chambers in place.

Turbine Vanes, Shrouds, and Seals

First Stage Vanes are cast from corrosion and heat resistant alloy with chromalize protective coating on all internal and external cast surfaces. Second, third, and fourth stage turbine vanes are cast from corrosion and heat resistant alloy. First Stage Vanes are held by pins between the recesses



Turbine Nozzle Outer Case
Figure 24



Combustion Chamber Outlet Duct
Figure 25

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in the outer turbine case and are snapped onto their pins in the turbine nozzle inner case assembly to seat on the shoulders of the case. A later configuration of first stage nozzle vane is bolted to the turbine stator support assembly.

A seal and a spacer are placed in the outer case just to the rear of the first stage vanes. One knife-edge on the first stage turbine blade shroud runs between the seal's two knife edges.

Second stage turbine vanes fit into the outer case just behind the first seal spacer. Extensions on the root platform of each vane hold them in place on their forward edges and a lockring is used at the outer rear edge. The inner end of these vanes slip into slots in the shroud ring. The inside edge of the shroud ring has a turbine inner seal riveted to it. The seal ring carries four knife-edges on its inside flange. One of these knife-edges run free against the shoulder on the rear compressor drive turbine disk and the remaining three (rear-most) against flange face of the front compressor drive turbine hub. This forms a seal between the front and second stage rotors to force the working gases to pass through the second stage vanes. A lockring, a stepped seal, and a seal spacer are in the outer case following the second stage vanes. The two knife edges of the second stage blade run free against the stepped seal. Mounting of the third stage turbine vanes is the same as the second stage. The inner seal ring, however, instead of having knife-edges has a stepped platform. The knife-edges are on the spacer between the second and third stage turbine disks. There are six of them set in pairs. Mounting of the fourth stage turbine vanes is identical to the third stage. The outer seal is stepped and extends into the turbine exhaust case. There is no locking ring, but the fourth stage vanes are held in the rear by the stepped seal which is held by its flange that fits between the turbine nozzle case and the turbine exhaust case flanges.

Rear Compressor Drive Turbine Rotor

See Figure 26.

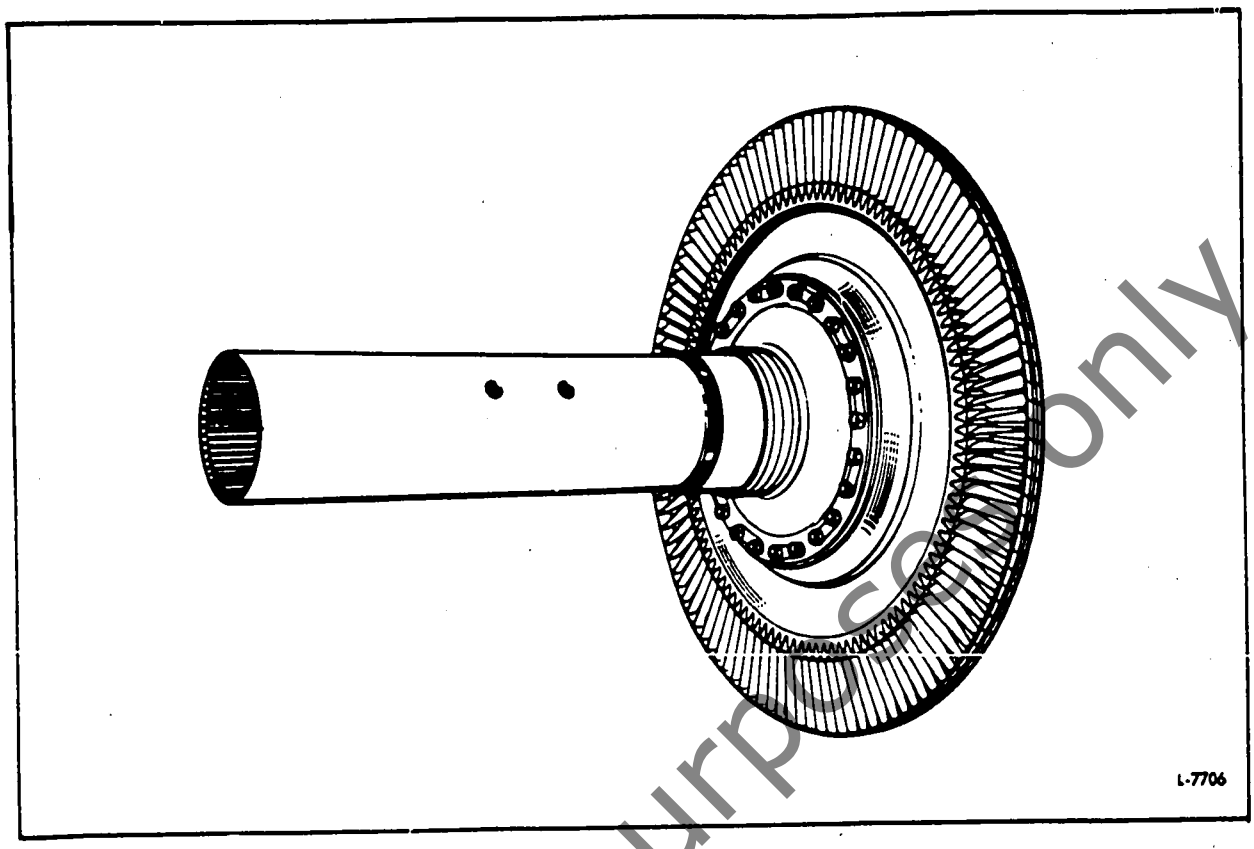
The rear compressor drive turbine rotor consists of a disk, blades and a shaft. The No. 5 Bearing inner race and seal assembly are located forward of the disk and secured on the shaft by a nut, a tabwasher, and a lockring at assembly. The turbine shaft splines into the rear compressor rotor and is secured to the rotor hub by the rear compressor drive turbine shaft coupling. The outer race of the No. 4-1/2 Bearing is located inside the turbine shaft.

Turbine Blades

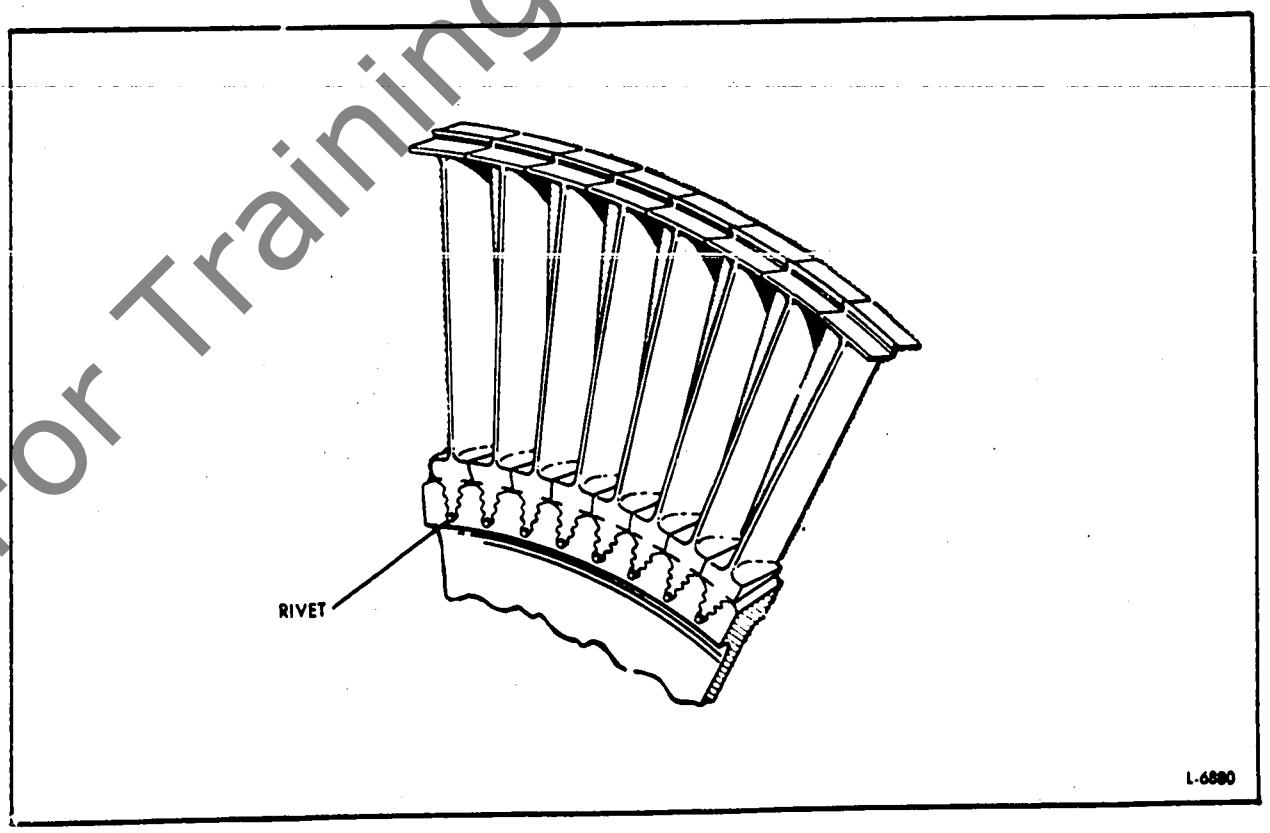
See Figure 27.

The blades are made of forged nickel alloy. The blades have "fir tree" serrations as their roots. The blades can only be inserted by a forward and rear movement and are held in place by a rivet at the bottom of the "fir tree". The working part of the blade is a curved surface that changes the direction of the swiftly moving gases that pass over it. The reaction of these gases to change in direction of travel produces the force that turns the turbine rotor.

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Rear Compressor Drive Turbine Rotor
Figure 26



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At the outward end of each blade is a wide flat section called a shroud. This shroud prevents gas leakage at the blade ends. Each blade has a stepped arrangement by which they lock to each other, and this forms a complete shroud ring when assembled. This ring gives the rotor greater strength as well as making up a gas seal. Because of the particular construction, it is impossible to remove one turbine blade only, and at least half of the blades at 90 degrees on either side must be removed. A staggered movement of all these blades must be made before the center blade "fir tree" will clear the disk. There are 130 blades in the first stage turbine rotor.

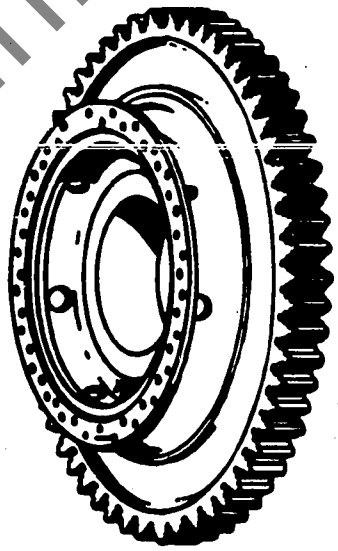
Turbine Disk

See Figure 28.

The disk is made of corrosion and heat resistant steel. A drilled flange on the front face of the disk is bolted to the rear end of the rear compressor drive turbine shaft. Balance holes in the disk flange are also provided. "Fir tree" serrations are cut in the rim matching the serrations in the turbine blades.

Turbine Shaft

The shaft is hollow with internal splines at its front end which mate with external splines of the rear compressor rear hub. Turbine position in the turbine nozzle case is determined by a spacer ring that is between the end of the compressor hub shaft and an internal shoulder in the turbine shaft.



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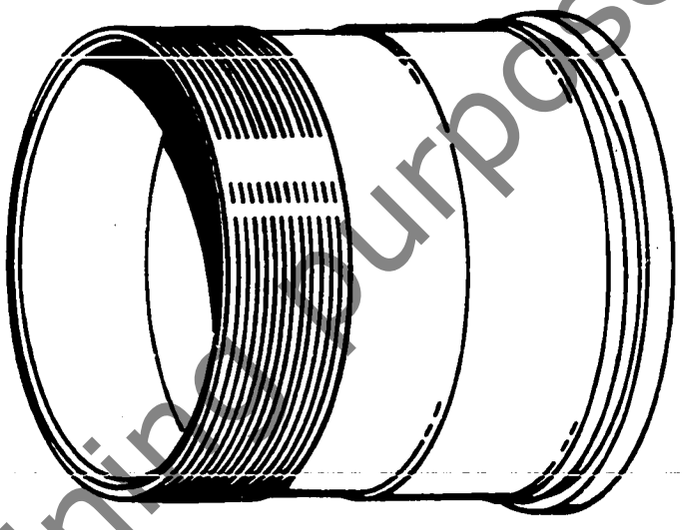
Turbine Disk
Figure 28

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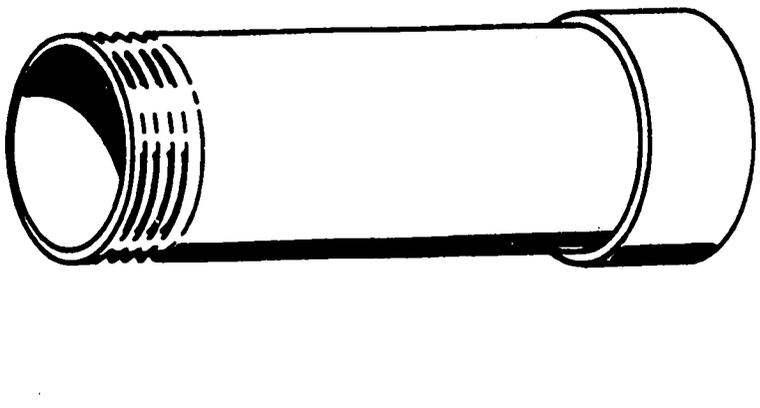
Coupling

See Figures 29 and 30.

A coupling holds the turbine shaft and the compressor rear hub together. Outside threads on the forward end of the coupling mate with threads on the inside of the compressor hub shaft, and a shoulder on the outside of the coupling butts against an internal shoulder in the turbine drive shaft. An internal spline at the rear of the coupling is used for wrenching. On the JT3D-1 and JT3D-1-MC7 engine, the coupling is locked in with a jamnut having a left hand thread. On the JT3D-1-MC6 engine, the coupling is locked by the No. 4 1/2 Bearing outer race and liner.



Coupling (JT3D-1, D-3, D-3B, and JT3D-1-MC7)
Figure 29



Coupling (JT3D-1-MC6)
Figure 30

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Front Compressor Drive Turbine Rotor

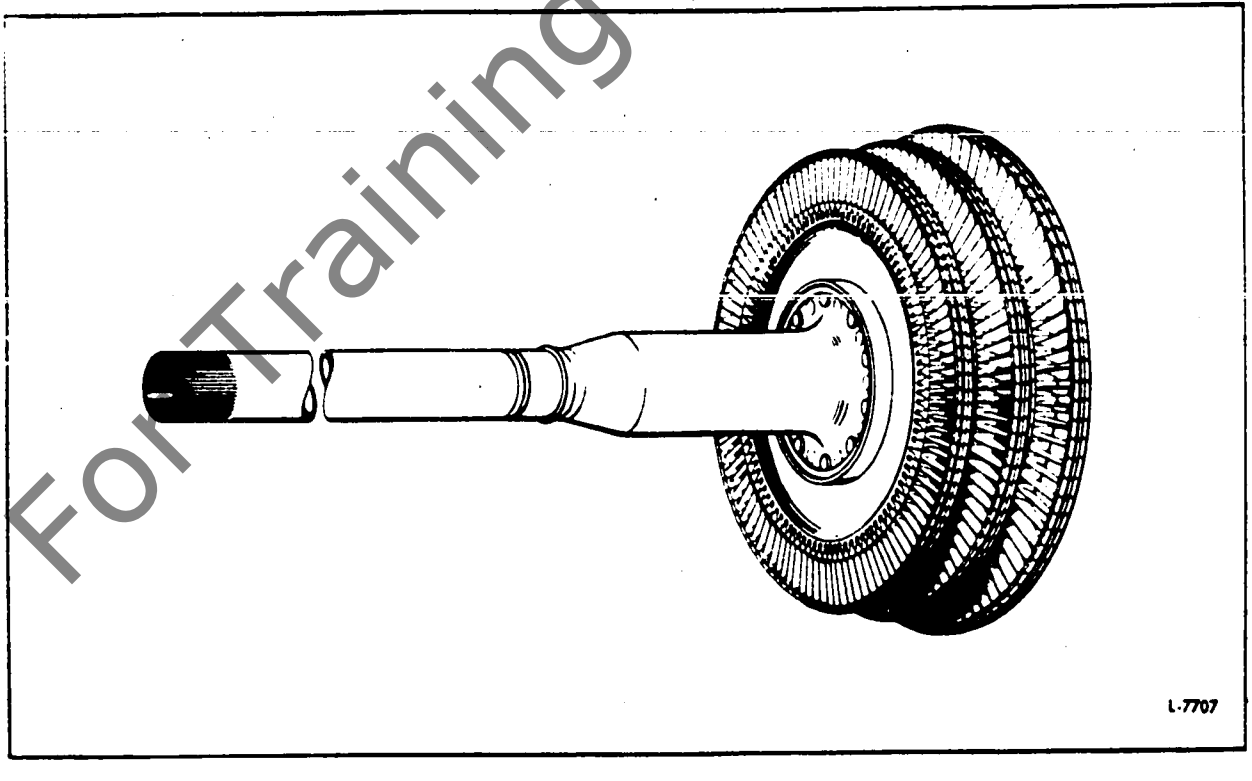
See Figure 31.

Three disks with turbine blades, a rear hub, a spacer, and a drive shaft make up the rotor. The second stage disk is bolted to the driveshaft and the rear hub. The third and fourth stage disks are held together and to the second stage disks by ten tierods.

Turbine Blades

See Figure 27.

The second stage turbine blades are cast from stainless steel. Third stage blades are cast from stainless steel, while fourth stage blades are forged from nickel alloy. They are assembled in the manner previously described under the Rear Compressor Drive Turbine Rotor - Turbine Blades. The second stage blades are larger in height than those of the first stage, the third stage blades are even larger, and the fourth stage blades are the largest. The reason for this is to match the blade size to the increase in volume of gas as it expands while passing through the turbine. There are 114 blades in the second stage disk and blade assembly, 108 blades in the third stage, and 80 blades in the fourth stage.



Front Compressor Drive Turbine Rotor
Figure 31

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Turbine Disks

The second stage turbine disk is made from corrosion and heat resistant steel. The third and fourth stage disks are made from corrosion and heat resistant steel. They are spearated from each other by spacers and are attached to the front compressor drive turbine shaft and the turbine rear hub by tierods as mentioned above.

Front Compressor Drive Turbine Shaft

The front compressor drive turbine shaft is made from low chrome steel alloy. It is a long thin shaft as it must pass through the first stage turbine rotor shaft and must reach from the front of the second stage turbine disk to the rear hub of the front compressor. Its front end is supported inside the front compressor hub, its middle by a bearing inside the rear compressor turbine rotor shaft, and its rear end by the turbine assembly which in turn is supported by a bearing at the turbine rear hub.

The shaft is hollow and provides a passage for 9th stage cooling air which passes through holes in the rear hub to cool the rear bearing seals, oil pump and the rear face of the fourth stage turbine disk. Oil is also piped through the shaft to its middle bearing. The forward end of the shaft is externally splined and internally threaded. The shaft external splines mate with the internal splines on the front compressor rear hub, and the shaft internal threads mate with the external threads on the front compressor drive turbine coupling.

A spacer is used between the compressor rear hub shaft and the front edge of the drive shaft to position the shaft correctly.

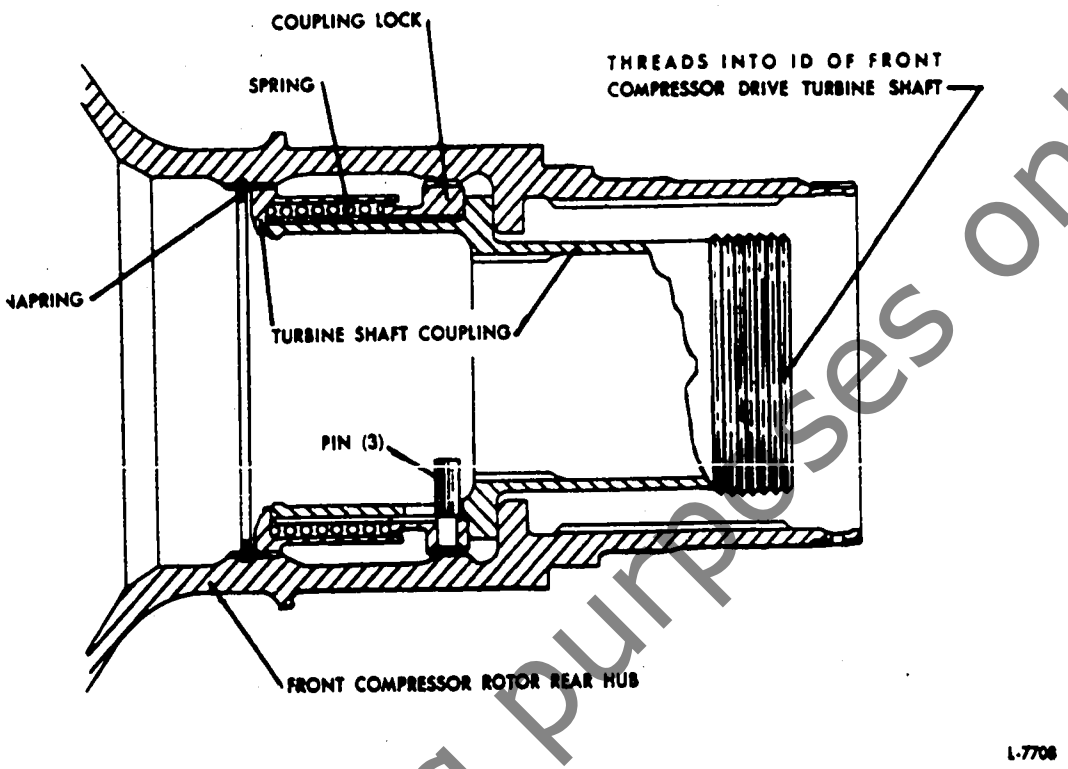
Coupling

See Figure 32.

The coupling's external shoulder butts against an internal shoulder in the front compressor hub. The internal splines in the coupling are for the wrench. The coupling front end has external splines with three short slots. A ring having external and internal splines and three inward projecting pins, fit over the forward end of the coupling, the pins projecting through the slots. A compression spring is located just forward of the spline pinned ring and is held in place by an internal shoulder of a collar. The collar is held in the coupling by splines and a snapring. The spring keeps a rearward pressure on the ring which will lock the ring's external splines to the internal splines in the compressor hub. These splines are just forward of the shoulder and as long as the ring is locked, the coupling cannot be unscrewed.

In order to unscrew the coupling from the drive shaft, the ring must first be moved forward against the spring pressure until its external splines disengage the small internal spline that is inside of the compressor hub ahead of the internal shoulder. The pins that project through the slots in the coupling are used to move the ring forward. A special wrench is used that can pull the pins forward and then engage wrenching splines to turn the coupling.

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Front Compressor Drive Turbine Coupling
Figure 32

Exhaust Section

See Figure 33.

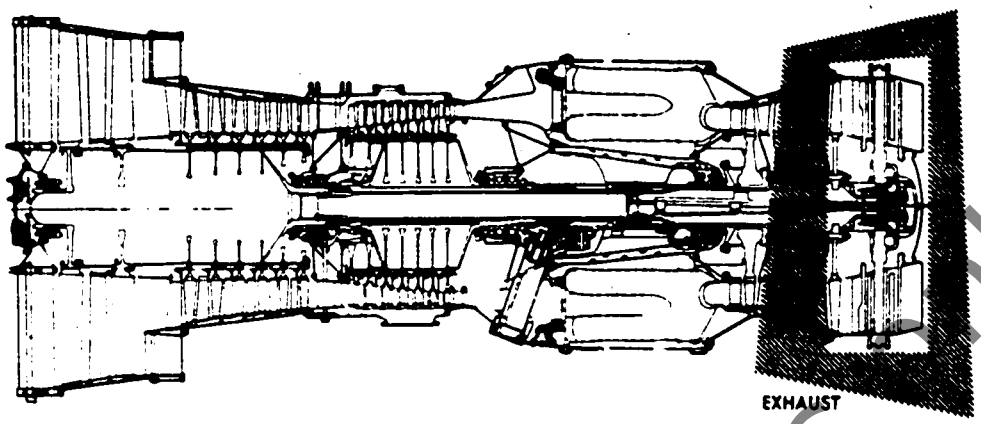
The exhaust section of the engine includes all items following the turbine except the tailpipe and other rearward attachments which are furnished by the airframe manufacturer.

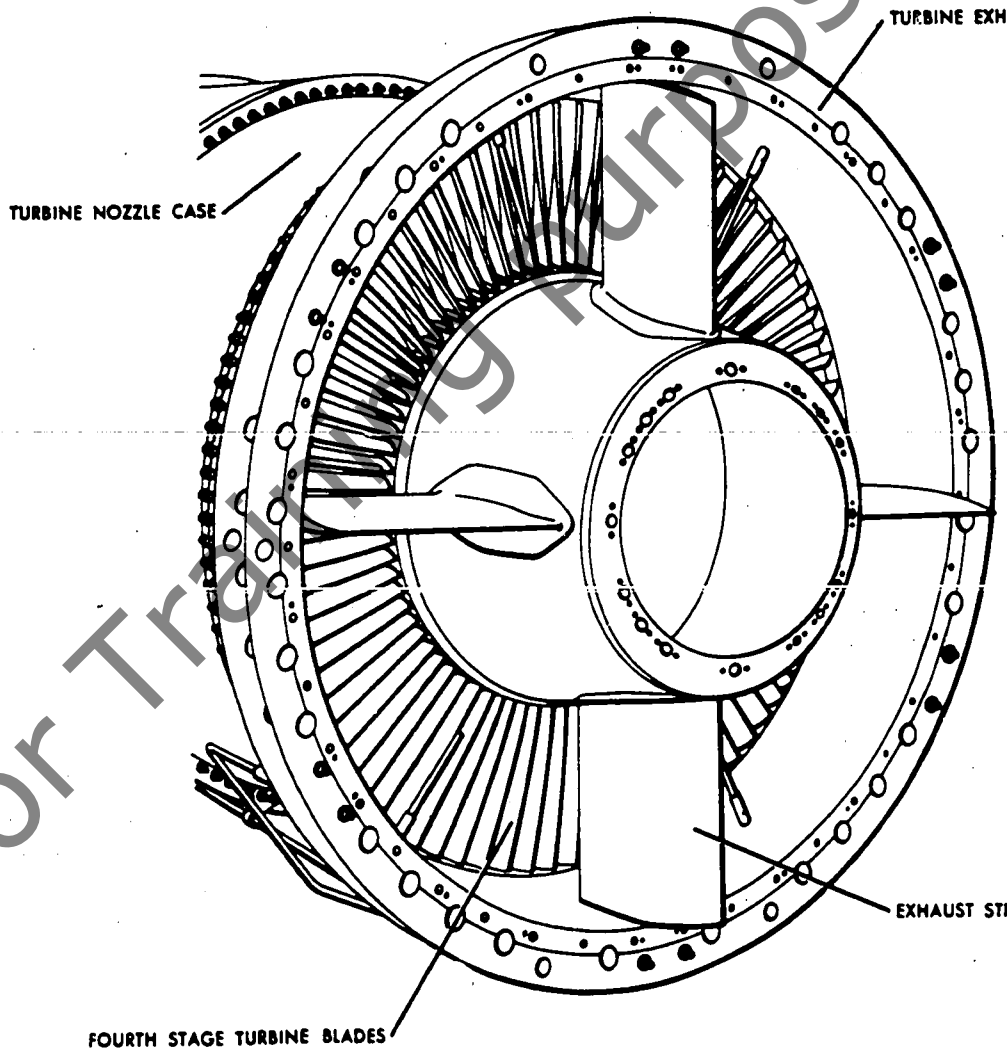
Turbine Exhaust Case

See Figure 33.

The outer case is constructed of chrome-nickel steel. It bolts to the rear of the turbine case at its front flange and its rear flange bolts to the tailpipe. Two heavy external flanges near the center of the case are used for engine mounting.

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ENGINE - DESCRIPTION AND OPERATION

The outer case supports all the parts used in the inner case. A few parts are mounted directly on the outer case. The fourth stage turbine outer seal is located in the front of the outer case, the flange of which is positioned between the rear flange of the turbine nozzle case and the forward flange on the exhaust case.

A turbine exhaust fairing assembly, consisting of an inner duct and four turbine exhaust struts, is positioned in the exhaust case. Four No. 6 Bearing support rods pass through the struts and through the holes in the outer case and are secured in strut supports between the engine mounting flanges mentioned above at the 12, 3, 6, and 9 o'clock positions. These rods are secured and positioned by a dual nut locking arrangement in the strut supports. At the inner end, the rods are bolted to lugs on the No. 6 Bearing housing. When assembled, the struts envelope the rods and the oil tubes (to be discussed) for streamlining. At the 3 o'clock position and to the rear of the support rod, the No. 6 Bearing pressure oil tube passes from outside the exhaust case to the No. 6 Bearing support. At the 6 o'clock position, the No. 6 Bearing scavenge oil tube is installed in the same manner.

A flange attached to the No. 6 Bearing support holds the sump adapter to which the No. 6 Bearing sump is attached. The entire sump area is enveloped by a heatshield. The fairing assembly area, internal to the struts, is also covered by a heatshield. An average pressure rake manifold is mounted around the case forward of the engine mounting flange. Just forward of the rear flange, the temperature thermocouples are installed. Attached to each are leads from a thermocouple harness which circles the case at this point.

No. 6 Bearing Support and Shields

The No. 6 Bearing seals buildup and No. 6 Bearing inner race and rollers are mounted on the rear hub. The outer race is held in a housing which also serves as the seals housing. This housing is attached to and is held by the No. 6 Bearing support. Four support rods from the outer case thread into the rear of the support. Attached to the rear of the support is the sump adapter to which the sump is bolted. The rear heatshield is bolted to the rear heatshield flange which is retained in the support by the adapter. Bolted to the front of the No. 6 Bearing support is the No. 6 Bearing air seal support. A knife-edge is riveted to its forward extremity to ride on a shoulder which is riveted to the rear hub thus forming a gas seal.

No. 6 Bearing Oil Sump

The sump contains the No. 6 Bearing oil scavenge pump which is driven by a pinion gear attached to the rear hub. Inserted through the pinion is the oil nozzle which provided lubrication for the No. 4 1/2 Bearing inside the turbine shaft. The sump bolts to the rear of the adapter and has a cover plate bolted to its rear side. "O" ring seals are used between the sump adapter and the support and between the sump and the rear cover. The rear heatshield is bolted to the front heatshield at external flanges. The two heatshields cover all components inside the inner duct. All the metal parts are steel.

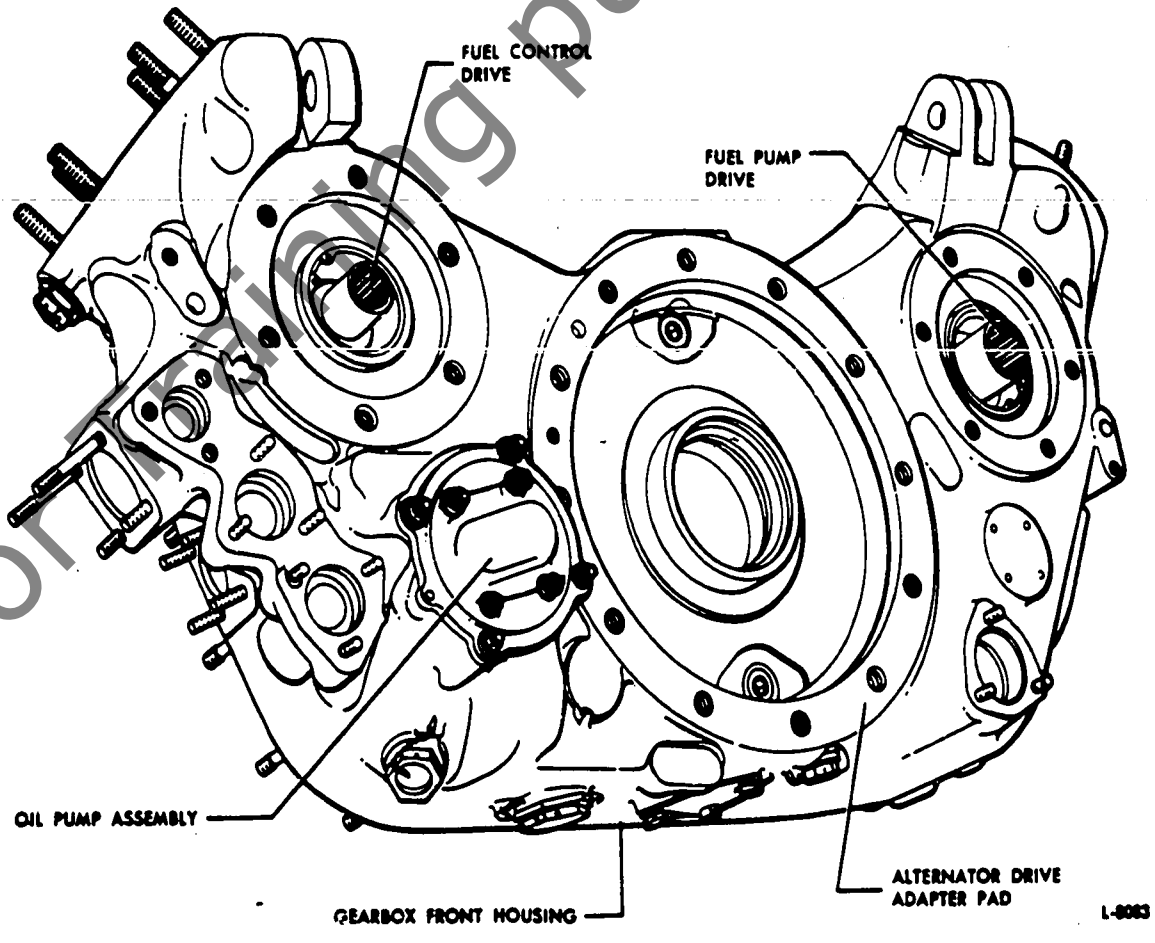
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MAIN ACCESSORY SECTION.

Accessory Component Drive Gearbox Assembly

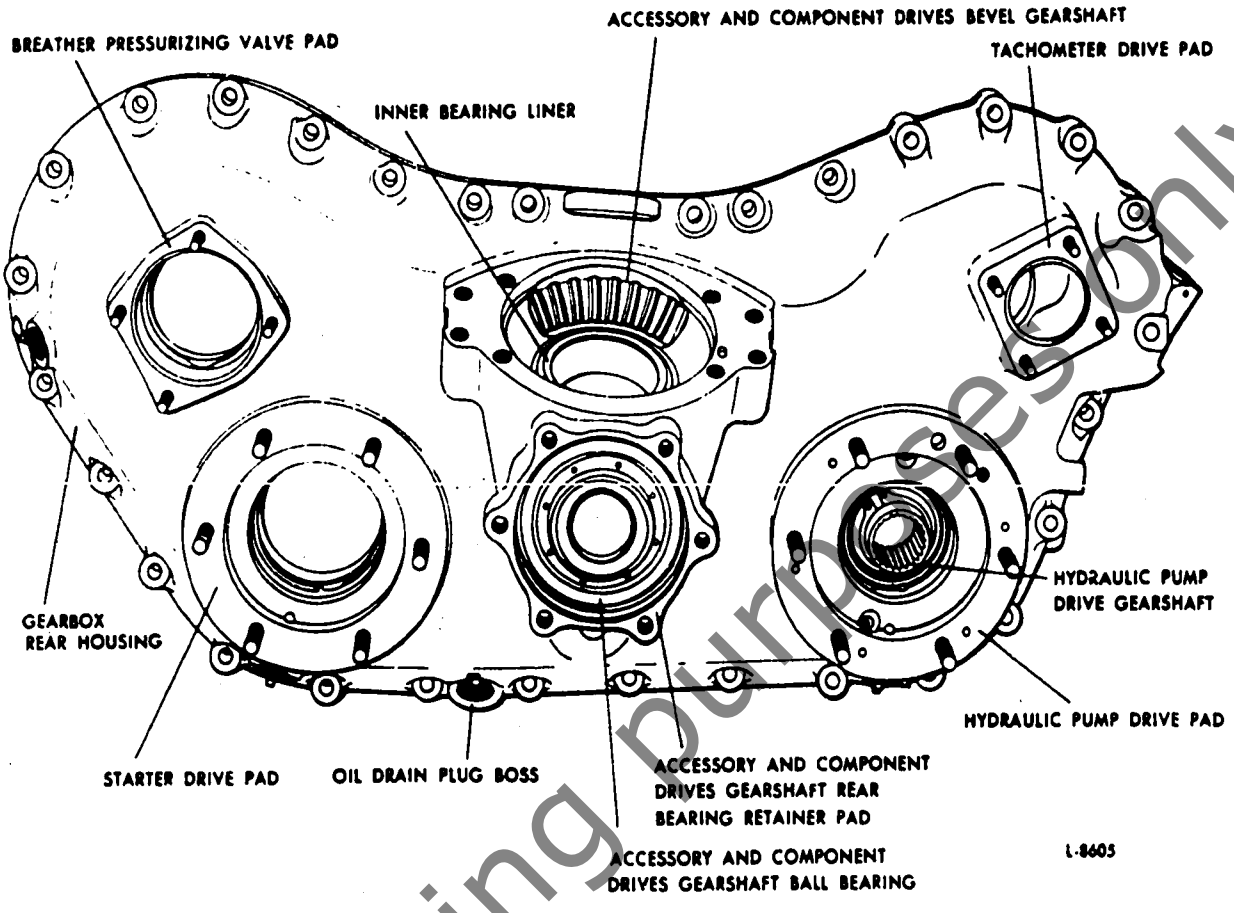
The accessory component drive gearbox consists of a front housing and a rear housing. See Figures 34 and 35. The gearbox assembly is mounted beneath the engine and secured to the diffuser case front flange. Power is supplied to the gearbox assembly from the rear compressor rotor shaft through an integral elbow on the rear housing. The main oil pump is located at the lower right front of the gearbox assembly.

The engine fuel control mounts to a six studded circular pad on the upper right front of the gearbox housing, and the fuel pump mounts on a similar pad on the upper left front. Gearing is provided to drive the fuel control, the fuel pump, high compressor tachometer, and a fluid pump drive. On the JT3D-1, D-3 and D-3B (Boeing), the JT3D-1-MC6, and JT3D-1-MC7 engines, a water pump drive is incorporated in the left side vertical drive. On the JT3D-1, D-3 and D-3B (Douglas), a fuel boost pump drive is incorporated in the right side vertical drive. The other vertical housings (right Boeing and left Douglas) are unused. Provisions are made for mounting a constant speed drive (Boeing) or with an adapter, a generator (Douglas) on the large alternator center front pad. At the left rear of the gearbox a six studded pad is provided for a starter. The starter rotates the high compressor rotor through gearing and shafts. A six studded fluid pump drive pad is positioned on an angle near the top on each side of the gearbox and another at the right rear of the gearbox.



Accessory Component Drive Gearbox/Front Housing Assembly
Figure 34

For Training purposes only



Accessory Component Drive Gearbox Rear Housing Assembly
Figure 35

Accessory Component Drive Gearbox Front Housing Assembly

See Figure 36.

The oil pump assembly, the fuel control, fuel pump and starter drive shaftgears, and the tachometer drive gear are located in the front housing. The duplex oil pump is mounted at the lower right front of the front housing. The pump is composed of two sections. The rear section is the pressure section; while the front section scavenges the gearbox assembly. The pump is a positive displacement, gear type pump. The pressure pump section receives oil from the tank, pumps it through the strainer and to all main bearings of the engine. The scavenge pump section clears the gearbox of scavenge oil and sends it to the oil tank. The scavenge pump assembly is provided with an inlet strainer which is positioned upstream of the pump and located in the bottom of the accessory drives gearbox front housing. The right vertical fluid drive (if incorporated) is driven by a gear

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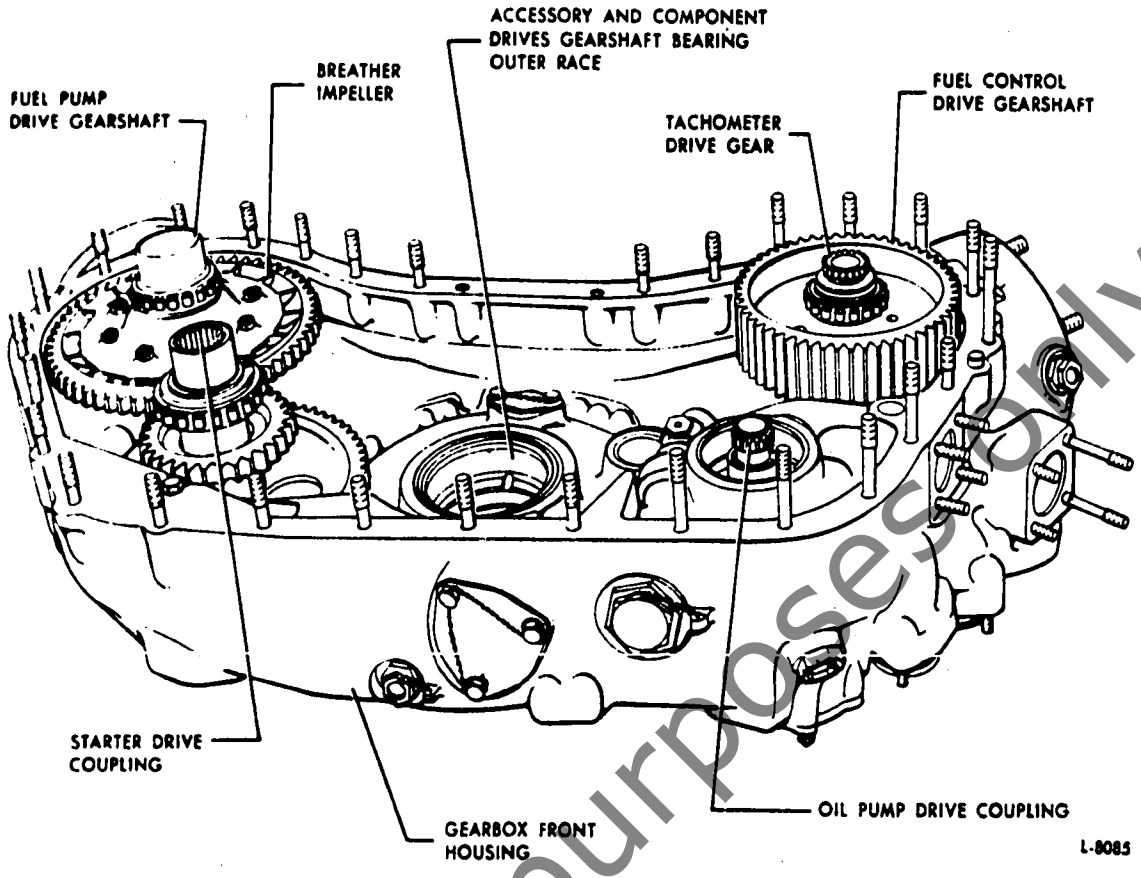
bolted to the fuel control drive gear shaft and the left vertical fluid drive (if incorporated) is driven by a gear bolted to the fuel pump drive gear shaft. An oil impeller which is a centrifugal device used to separate oil from air is also attached to the fuel pump drive gear. Later configurations incorporate an oil pressure tube assembly connected to the oil pressure relief valve which supplies a continuous flow of oil to the fuel pump drive splines by means of a nozzle staked in the bearing bushing.

Accessory Component Drive Gearbox Rear Housing Assembly

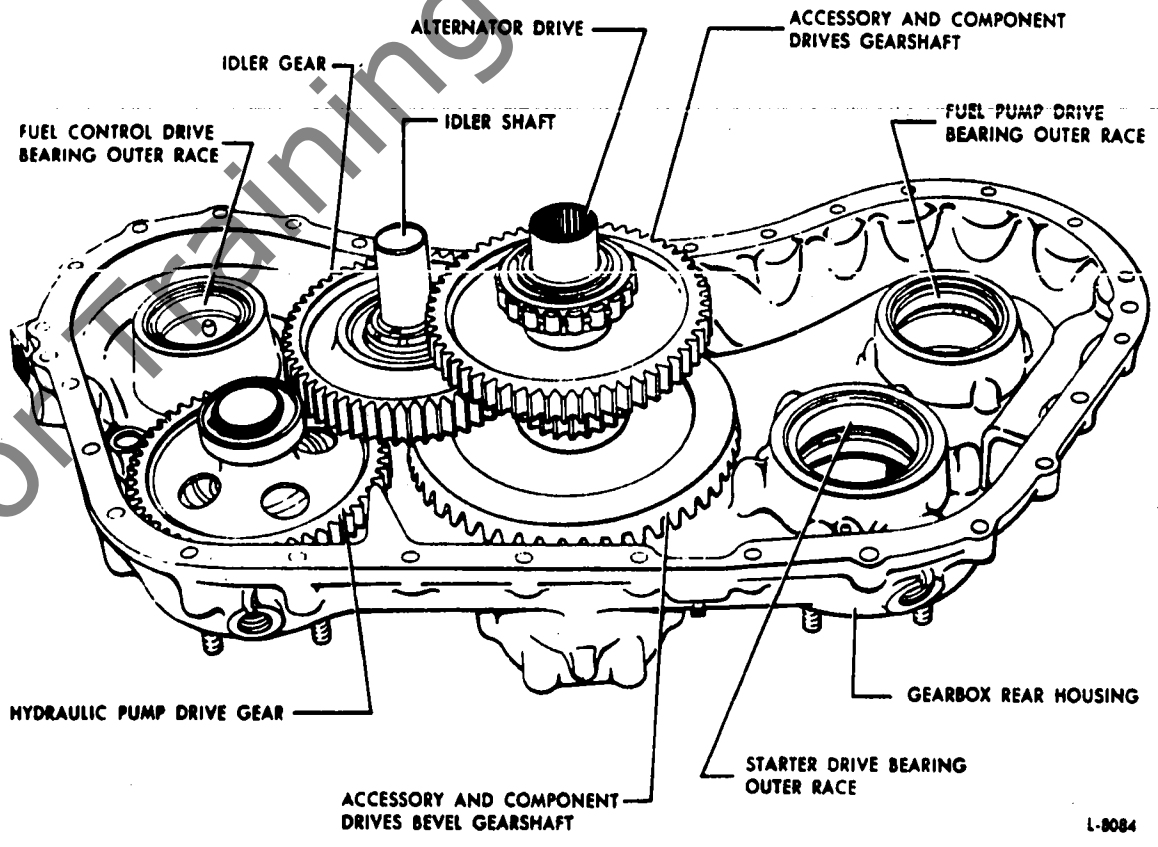
See Figure 37.

The rear housing contains the main accessory drive and idler gears, the tachometer drive, and the rear bearings for the horizontal gear trains. Between the main accessory drive gear and the fuel control drive gear is the idler gear through which power is transmitted to the right side of the gearbox. Splined to the alternator drive shaftgear is the main accessory drive gear which mates with the angled accessory drive gear in the elbow section of the housing. The angled accessory drive gear transmits power from the high compressor to the gearbox. The alternator drive shaftgear transmits power to the left side of the gearbox assembly through the starter drive shaftgear and the fuel pump drive gear. The tachometer drive is run by a tachometer drive gear internally splined to the fuel control drive gear.

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Accessory Component Drive Gearbox Front Housing and Gears
Figure 36



Accessory Component Drive Gearbox/Rear Housing and Gears
Figure 37

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Bearings

See Figure 38.

The bearings in the engine are of either the ball or roller type. Eight bearings are used on the principal rotating masses of the engine although in two instances, which we will discuss below, two bearings act as one. Twenty-five bearings are also used in fuel, oil, and accessory systems.

No. 1 Bearing

See Figure 39.

The No. 1 bearing is of the roller type and is located at the front hub of the front compressor. Its outer race is held in a housing by means of a spanner nut and nut locking rivet. The housing is supported by the No. 1 bearing front support and No. 1 bearing seal and support assembly at the center of the inlet guide vane circle. Its inner race has a pinch fit on the front compressor front hub and is further held in place by a spacer, a seal plate, a spanner nut and a nut locking rivet. The inner race is larger than its rollers to allow for engine dimension changes with temperature. An oil seal assembly is used on the rear side of the bearing.

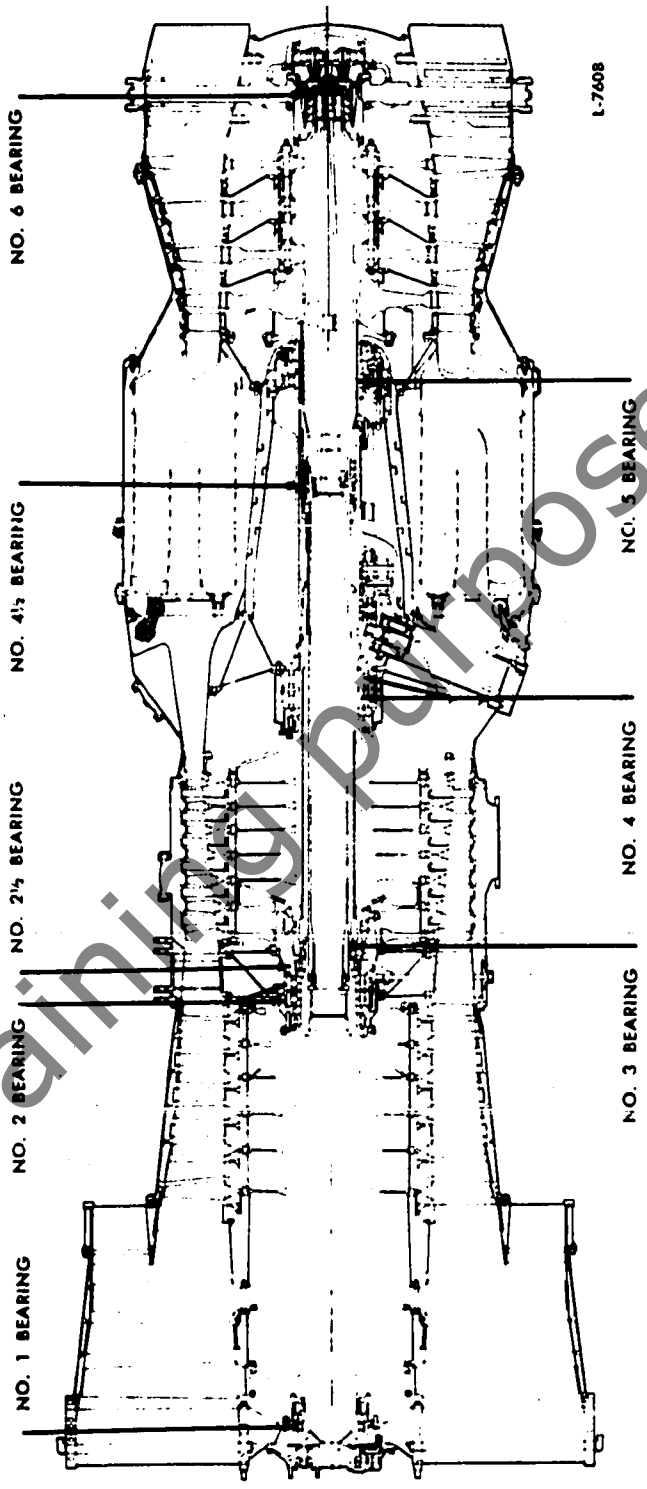
No. 2 Bearing

See Figure 40.

The No. 2 bearing is of the ball type. It is a duplex bearing with two bearings acting as one. They are a matched pair. Their outer races are carried in a steel housing. This housing is supported by three steel pieces that make up the bearing support at the rear compressor inlet vanes. These races are separated by an oil baffle and are held in place by an external shoulder in the housing and a spanner nut and tabwasher. The inner races of both these are split to aid installation. They are a pinch fit on the rear compressor rear hub and are held in place by a hub shoulder, seal plate, oil baffle, and retaining nut. An oil seal assembly is used on the front side of the bearing. Bearings No. 1 and No. 2 are the front compressor rotor supports.

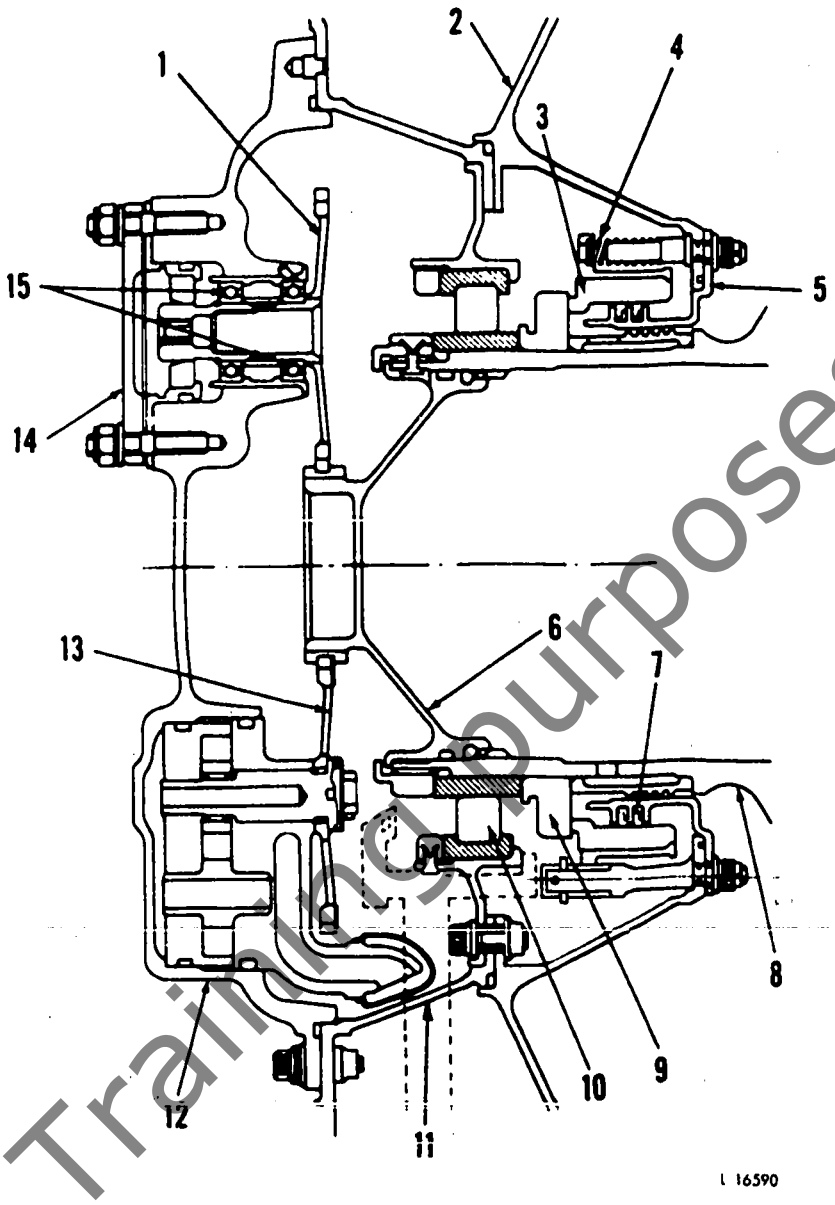
In order to reduce absorption of heat by engine oil. heatshielding and thermal blanket insulation is provided for the No. 2 bearing compartment on the JT3D-3. Bolts that secure the compressor intermediate front bearing housing to the rear face of the front bearing inner support also secure the compressor intermediate front bearing front heatshield to the front face of the support.

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Main Bearing Numbering
Figure 38



1. Tachometer Drive Gear
2. No. 1 Bearing Rear Support
3. No. 1 Bearing Seal
4. No. 1 Bearing Seal Spring
5. No. 1 Bearing Seal Support
6. Front Accessory Drive Main Spur Gear
7. No. 1 Bearing Seal Rings
8. No. 1 Hub
9. No. 1 Bearing Seal Spacer
10. No. 1 Bearing
11. No. 1 Bearing Front Support
12. Front Accessory Drive Front Support
13. Scavenge Pump Drive Gear
14. Accessory Drive Cover
15. Tachometer Drive Gear Bearings

No. 1 Bearing and No. 1 Bearing Seal Assembly
Figure 39

For Training purposes only

ENGINE - DESCRIPTION AND OPERATION

The compressor intermediate rear bearing heatshield consists of a front and rear heatshield both of which are secured together and in turn are secured as a unit to the rear face of the compressor intermediate bearing rear support.

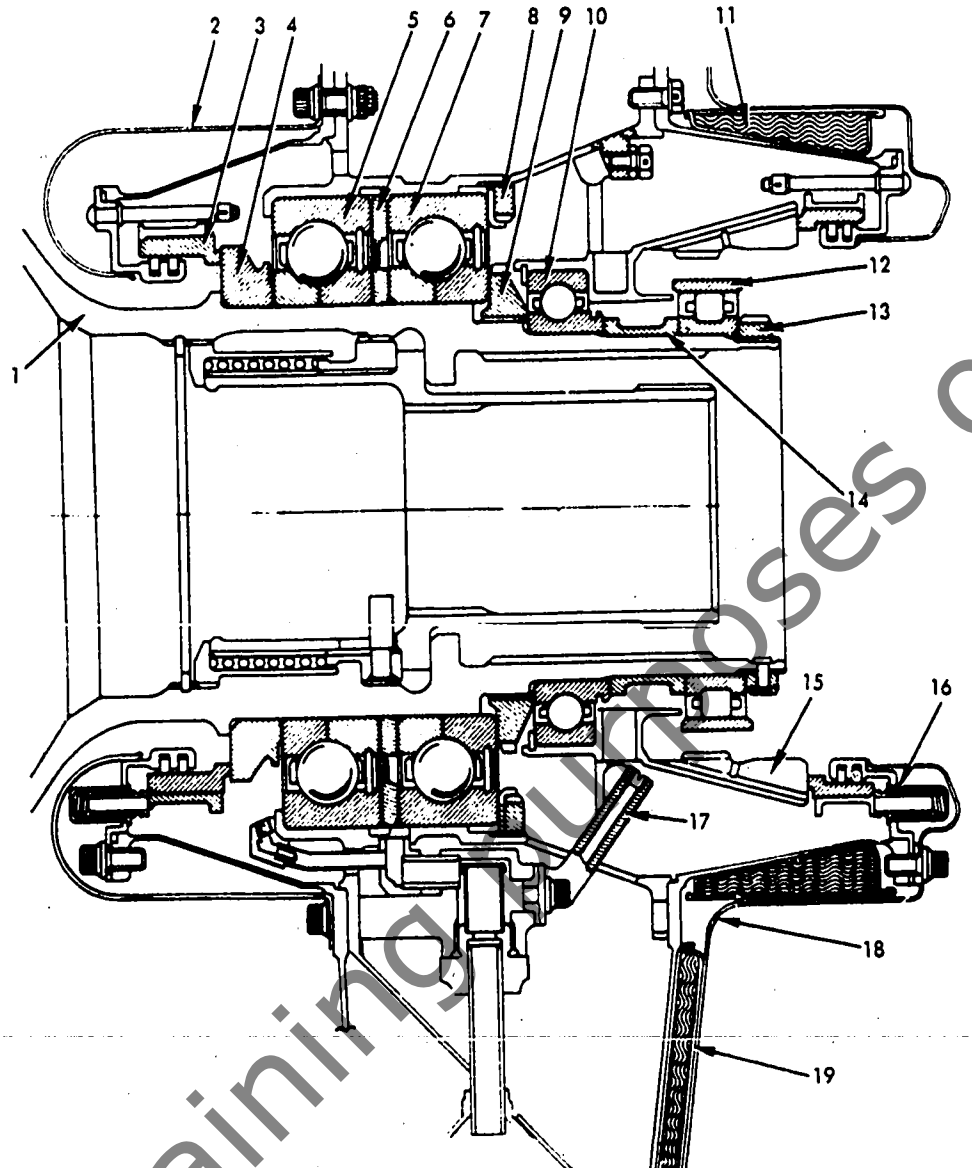
The thermal blanket insulation is contained within the heatshield.

No. 2 1/2 Bearing

See Figure 40.

The No. 2 1/2 Bearing is a small single row ball bearing and serves as part of the support for the No. 2 1/2 Bearing housing. This housing is part of the seal system for the aft end of No. 2, 2 1/2, and No. 3 Bearings. The outer race is held in the No. 2 1/2 Bearing housing by a snapring. Its inner race is on the front compressor rear hub and is held in place between No. 2 Bearing inner race retaining nut and a spacer. This spacer in turn is held in place by the No. 3 Bearing inner race.

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1. No. 2 Hub
2. Front Bearing (No. 2) Front Heatshield
3. No. 2 Bearing Seal Assembly
4. No. 2 Bearing Seal Plate
5. No. 2 Bearing (Front)
6. No. 2 Bearing Oil Baffle
7. No. 2 Bearing (Rear)
8. No. 2 Bearing Outer Race Retaining Nut
9. No. 2 Bearing Inner Race Retaining Nut
10. No. 2 1/2 Bearing
11. Heatshield Insulation Blankets (2)
12. No. 3 Bearing
13. No. 3 Bearing Inner Race Retaining Nut
14. No. 3 Bearing Spacer
15. No. 2 1/2 Bearing Housing
16. No. 3 Bearing Seal Assembly
17. Oil Pressure Manifold
18. No. 2 Rear Bearing Heatshield
19. No. 2 Rear Bearing Front Heatshield

No. 2, No. 2 1/2, and No. 3 Bearings and Seals Buildup
Figure 40

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For Training Purposes Only
Maintenance Manual

For Training purposes only

No. 3 Bearing

See Figure 40.

The No. 3 Bearing is of the roller type and forms the front hub support for the rear compressor. Its outer race is a force fit into the inside diameter of the rear compressor front hub. A shoulder and a snapring hold the race in place. The inner race and rollers are shrunk onto the OD of the front compressor rear hub. A retaining nut, secured by a rivet, jams this inner race against the spacer just in the rear of the No. 2 1/2 Bearing inner race.

No. 4 Bearing

See Figure 41.

The No. 4 Bearing is of the ball type. It is a duplex bearing with two bearings acting as one. It forms the support for the rear hub of the rear compressor. The outer races are mounted in a housing which is supported inside of the engine diffuser case. They are held in place by a shoulder and a spacer under the diffuser case bolt ring. There is an oil baffle between the outer races. The inner races are the split type, a pinch fit to the OD of the rear compressor rear hub. These races are positioned by a shoulder on the shaft, a seal plate, an oil baffle between the races, a spacer ring, a bevel gear and a retaining nut with a lock and snapring. There is an oil seal housing on the forward side of this bearing.

To reduce swirl and heat rejection a compressor rear bearing oil scavenge baffle assembly is provided in the JT3D-3. The baffle assembly is mounted on the longer studs of the compressor rear bearing support.

To reduce absorption of heat by the engine oil, heatshielding and thermal blanket insulation is provided for the No. 4 Bearing compartment. The compressor rear bearing heatshield assembly consists of several individual heatshields welded together. The complete unit is bolted to the compressor rear bearing housing and extends over the bearing housing, the breather tube, the oil pressure and scavenge tubes and along the tower shaft.

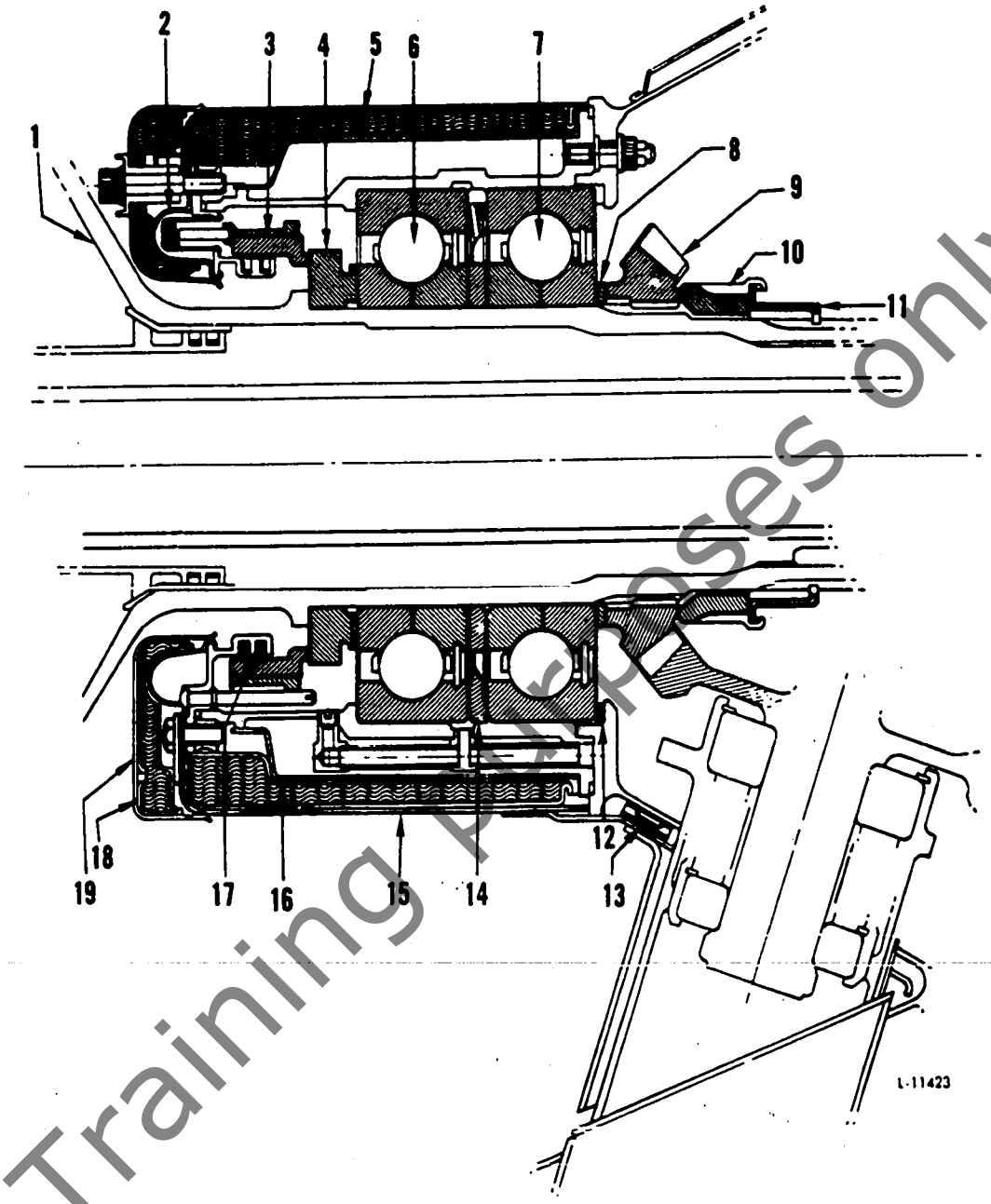
The thermal blanket insulation is contained within the heatshield.

No. 4 1/2 Bearing

See Figure 42.

The No. 4 1/2 Bearing is a small roller bearing which is located between the front and rear compressor turbine drive shafts to minimize the whip of the long (front) shaft. Its outer race is in the ID of the rear compressor drive turbine shaft. The race is held between a spacer on the shoulder on the ID of the shaft

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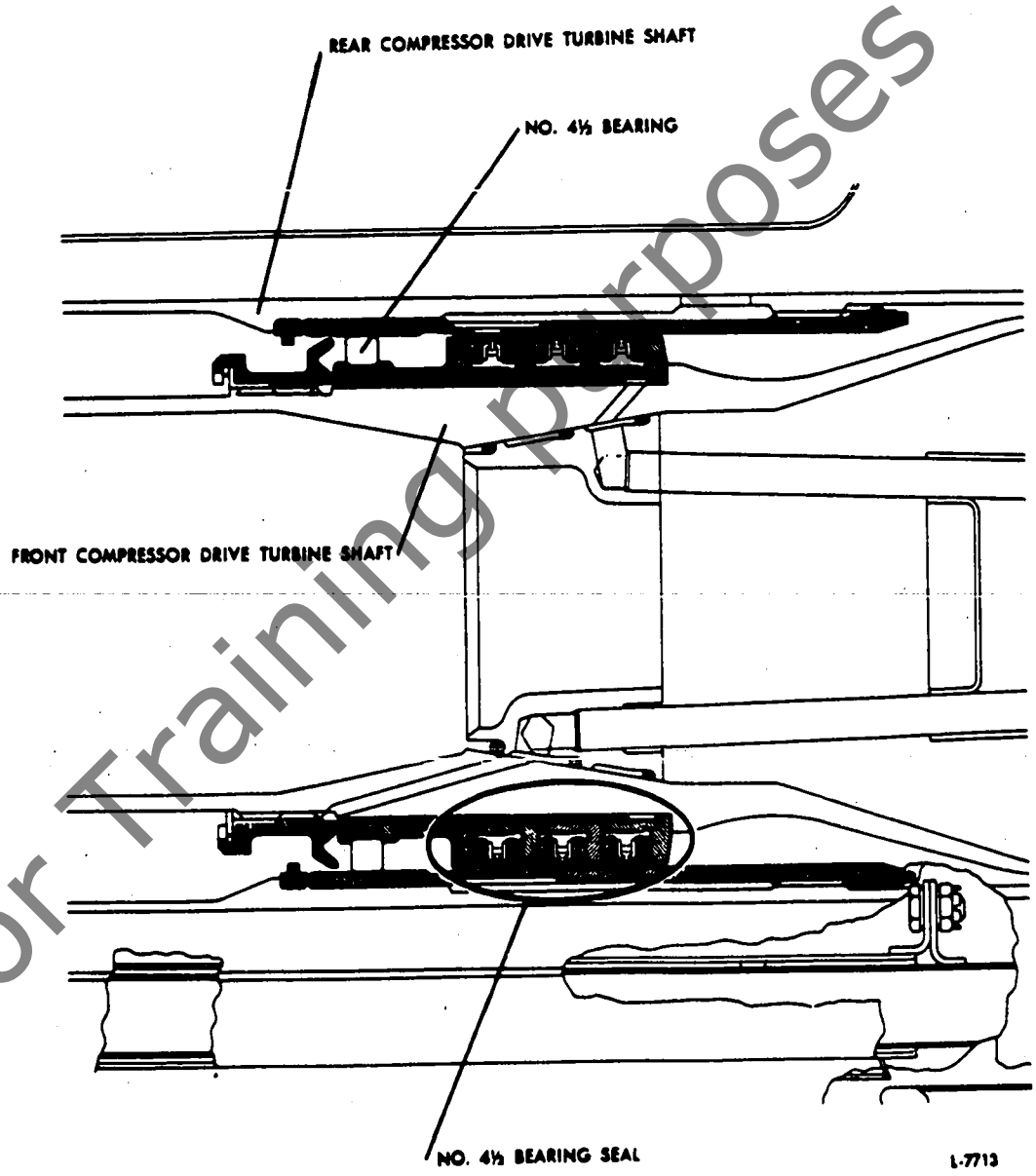


1. No. 4 Hub
2. No. 4 Bearing Seal Housing Assembly
3. No. 4 Bearing Carbon Seal Assembly
4. No. 4 Bearing Seal Plate
5. No. 4 Bearing Inner Thermal Blanket Heatshield (2)
6. No. 4 Bearing (Front)
7. No. 4 Bearing (Rear)
8. No. 4 Bearing Inner Race Spacer (Classified)
9. Accessory Drive Gear
10. Accessory Drive Gear Retaining Nut
11. Accessory Drive Gear Retaining Nut Lock
12. No. 4 Bearing Outer Race Spacer (Classified)
13. No. 4 Bearing Rear Heatshield (Not for MC-6)
14. No. 4 Bearing Oil Baffle Assembly
15. No. 4 Bearing Center Heatshield
16. No. 4 Bearing Housing
17. No. 4 Bearing Seal Assembly Oil Seal Rings
18. No. 4 Bearing Thermal Blanket Heatshield
19. No. 4 Bearing Front Heatshield

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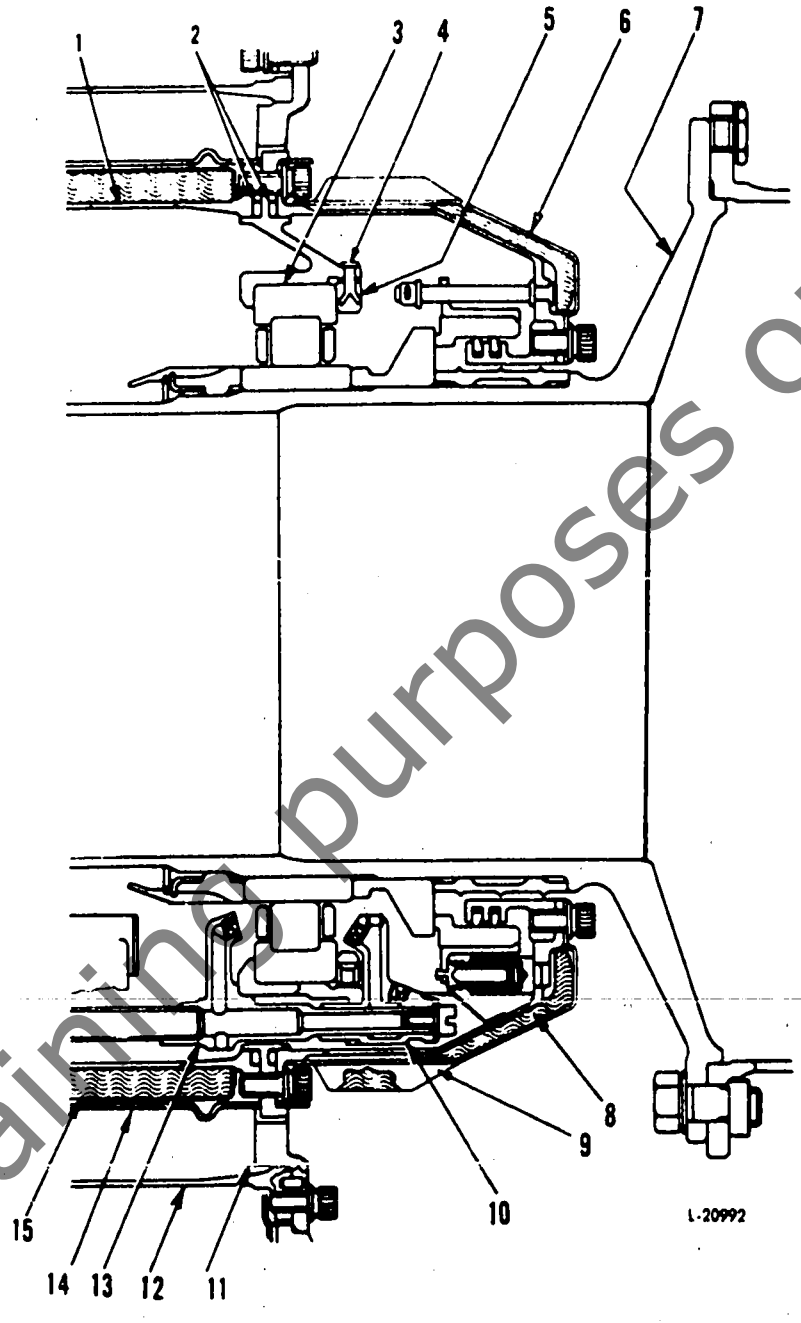
No. 4 Bearing and Seal Buildup
Figure 41

and the turbine shafts bearing seals liner. The liner is torqued to specification. The bearing inner race and cage are shrunk onto the front compressor drive turbine shaft. This race is held on the shaft by a shoulder on the shaft, the bearing seal assembly, a spacer and a retaining nut, a tabwasher, and a snapring assembly.



No. 4 1/2 Bearing and Seals Buildup/(JT3D-1, D-3, D-3B, MC7)
Figure 42

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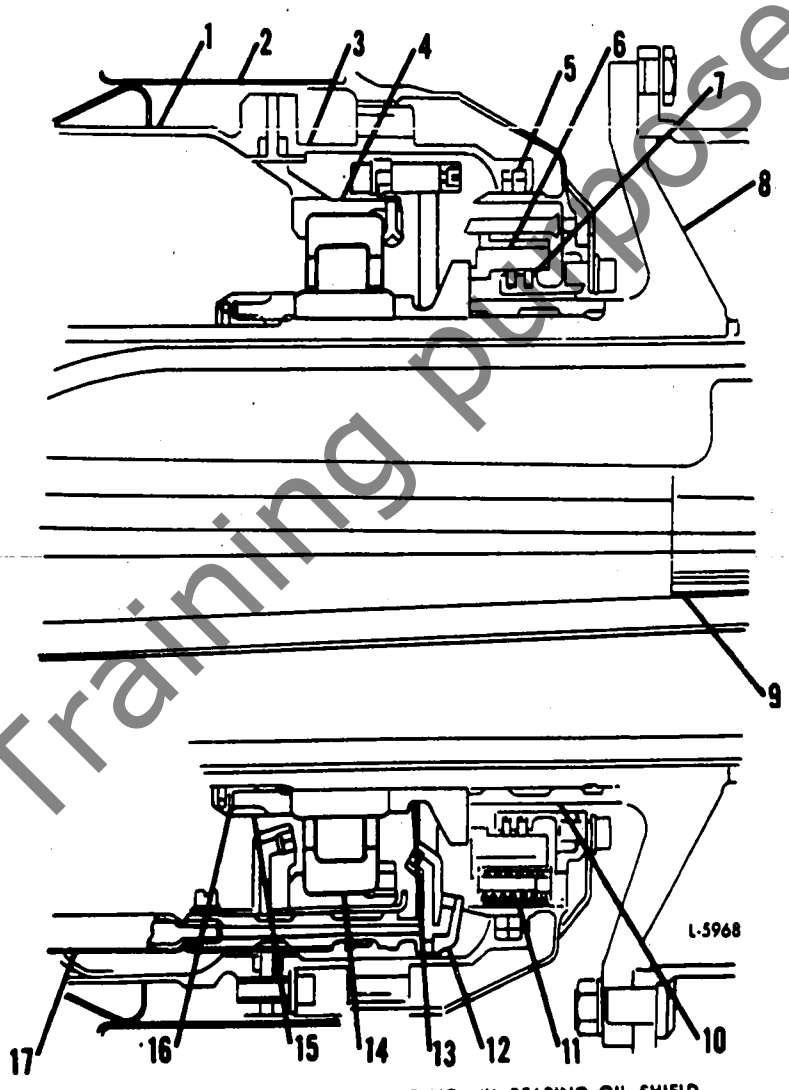
1. No. 5 Bearing Support
2. Gaskets
3. No. 5 Bearing
4. Rivet
5. Outer Race Retaining Nut
6. No. 5 Bearing Seal Assembly
7. Turbine Rotor Shaft (Typical)
8. Turbine Front Bearing Heatshield (2)
9. Turbine Front Bearing Heatshield Assembly
10. No. 5 Bearing Oil Pressure Manifold
11. No. 5 Bearing Housing Support
12. Combustion Chamber Case
13. No. 5 Bearing Oil Pressure Tube
14. Heatshield
15. Turbine Front Bearing Front Heatshield

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No. 5 Bearing

See Figures 43 and 44.

The No. 5 Bearing is a roller type bearing, located just forward of the rear compressor turbine. It forms the support for the rear compressor drive turbine shaft. The bearing outer race housing and its seal housing are carried by the turbine front bearing support and the nozzle case and outlet duct assembly. The outer race carries the bearing cage and rollers. It is held in its housing by a retaining nut which is torqued and riveted. The bearing inner race is shrunk onto the outside diameter of the rear compressor turbine shaft. This race is slightly wide to allow for engine temperature growth. The race is held in place by a shaft shoulder, air seal spacer, seal plate, retaining nut and a retaining nut tablock-snap ring assembly.



1 NO. 5 BEARING SUPPORT
2 NO. 5 BEARING SEAL HOUSING
3 NO. 5 BEARING SEAL SUPPORT
4 NO. 5 BEARING SUPPORT
5 RING OIL SEALS
6 NO. 5 BEARING SEAL
7 RING OIL SEALS
8 TURBINE ROTOR HUB
9 NO. 4½ BEARING OIL SHIELD
10 NO. 5 BEARING SPACER
11 NO. 5 BEARING SEAL SPRING
12 NO. 5 BEARING OIL METERING PLUG
13 NO. 5 BEARING SPACER
14 NO. 5 BEARING
15 NO. 5 BEARING NUT
16 NO. 5 BEARING NUT TABLOCK
17 NO. 5 BEARING OIL PRESSURE TUBE

No. 5 Bearing and Seal Buildup (JT3D-1-MC6)
Figure 44

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No. 6 Bearing

See Figures 45 and 46.

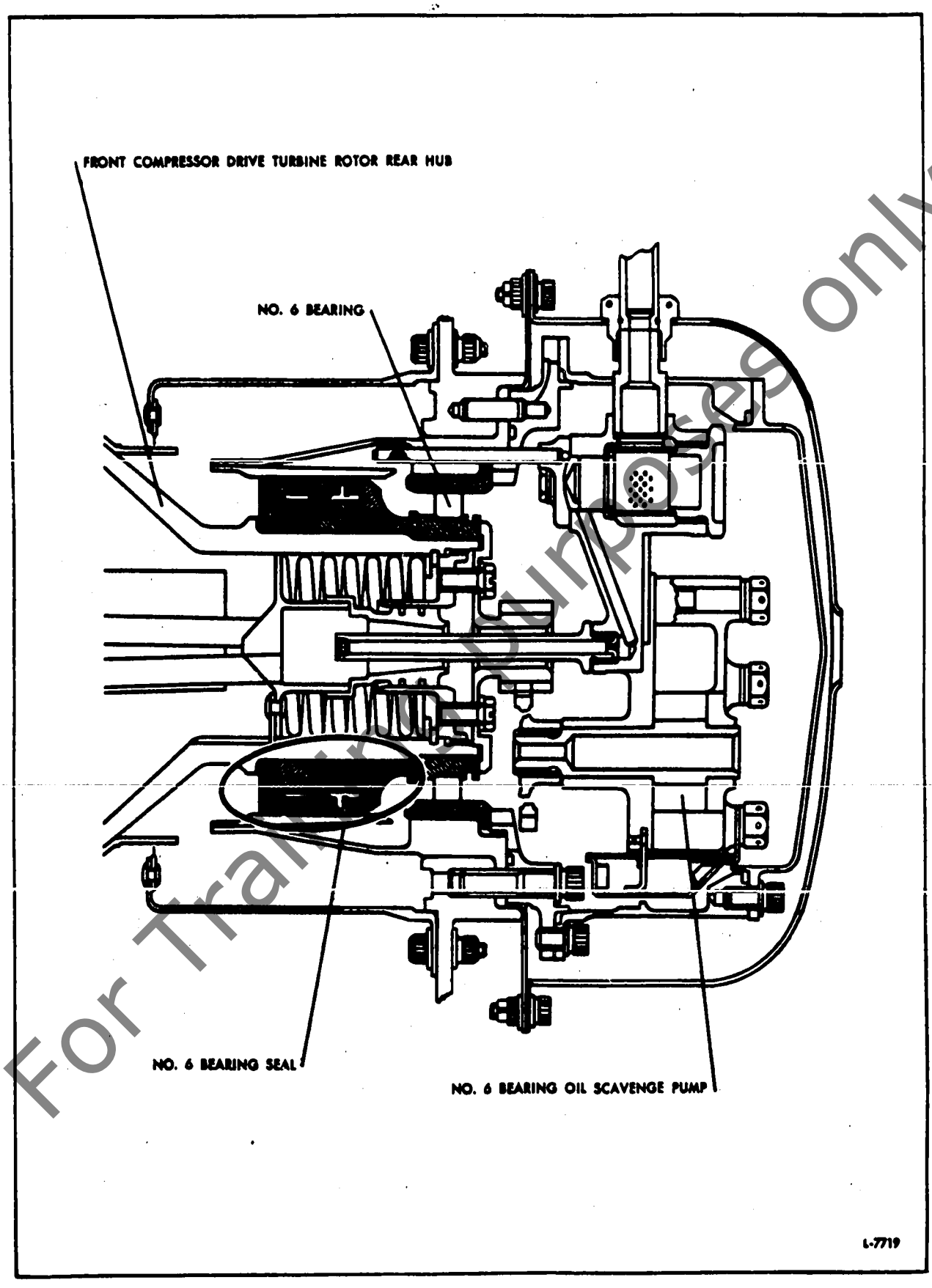
The No. 6 Bearing is a roller type bearing which forms the support for the compressor turbine rear hub. The outer race is held in a housing which is bolted to the assembly. The support assembly is held by support rods which carry the load to the structure of the turbine exhaust case. The inner race, which holds the roller and cage, has a force fit on the front compressor drive turbine rear hub. The inner race is located and held fast by the hub shoulder, two seal spacers, a seal plate, and the rear oil scavenge pump pinion flange. This flange is in turn bolted to a carrier sleeve which is threaded into the hub shaft.

Miscellaneous Bearings

Listed below are the locations, quantity, and type of bearing used in addition to the main bearings discussed above.

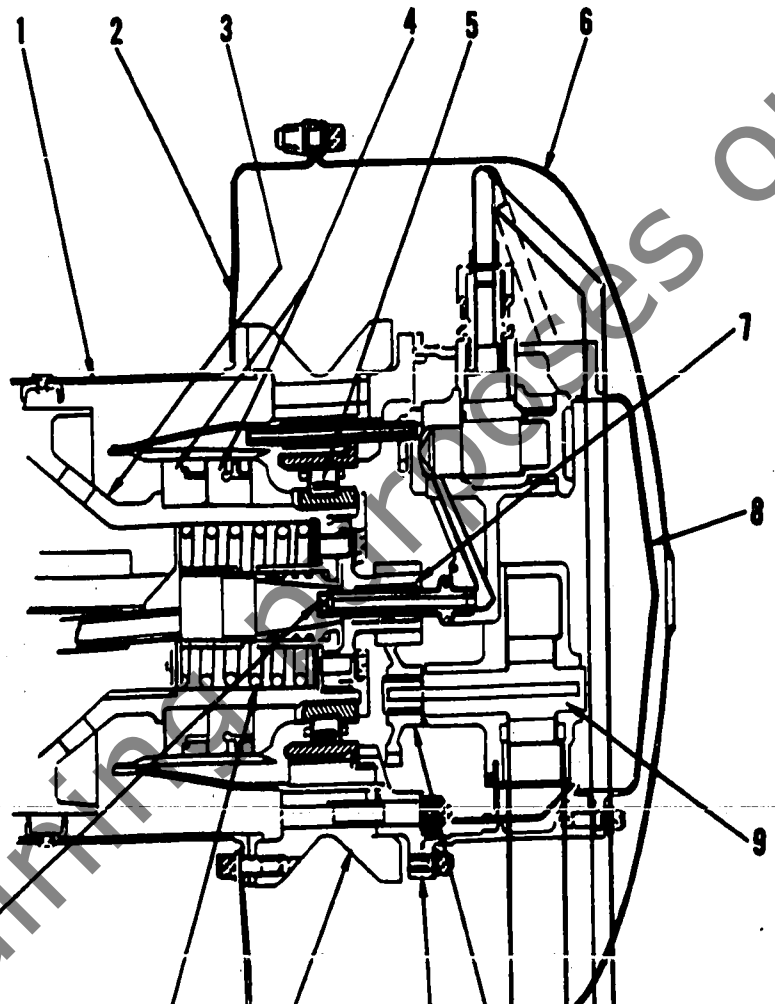
Where Used	Type	Quantity	General Location
Tachometer Drive Shaftgear	Ball	2	Front Accessory
Scavenge Pump Internal Shaftgear	Ball	2	No. 4 & No. 5 Bearing Oil Pump Area
Main Accessory Component Drives Shaftgear	Ball	1	Diffuser Case
	Roller	1	Diffuser Case
Hydraulic Pump Shaftgear	Ball	1	Main Accessory
	Roller	1	Main Accessory
Hydraulic Pump Shaftgear (Vertical right-if used)	Ball	1	Main Accessory
	Roller	1	Main Accessory
Fuel Control Shaftgear	Ball	1	Main Accessory
	Roller	1	Main Accessory
Tachometer Drive Shaftgear	Ball	2	Main Accessory
Idler Gear	Roller	1	Main Accessory
Accessory Drive Gear (bevel)	Ball	1	Main Accessory
	Roller	1	Main Accessory
Accessory Drive Shaftgear	Ball	1	Main Accessory
	Roller	1	Main Accessory
Starter Drive Shaftgear	Ball	1	Main Accessory
	Roller	1	Main Accessory
Fuel Pump Shaftgear	Ball	1	Main Accessory
	Roller	1	Main Accessory
Hydraulic Pump Shaftgear (Vertical left-if used)	Ball	1	Main Accessory
	Roller	1	Main Accessory

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No. 6 Bearing and Seal Buildup
(JT3D-1, JT3D-1-MC7, JT3D-3, and JT3D-3B)
Figure 45



1 NO. 6 BEARING GAS SEAL
2 NO. 6 BEARING FRONT HEATSHIELD
3 TURBINE ROTOR HUB
4 NO. 6 BEARING OIL SEALS
5 NO. 6 BEARING
6 NO. 6 BEARING REAR HEATSHIELD
7 NO. 4½ BEARING OIL NOZZLE
8 NO. 6 BEARING OIL COVER
9 NO. 6 BEARING OIL SUCTION PUMP
10 NO. 6 BEARING PUMP DRIVE GEAR
11 NO. 6 BEARING SUMP ADAPTER
12 NO. 6 BEARING SUPPORT
13 NO. 4½ BEARING SHIELD SPRING
14 NO. 4½ BEARING OIL NOZZLE

No. 6 Bearing and Seal Buildup (JT3D-1-MC6)
Figure 46

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ENGINE - DESCRIPTION AND OPERATION

Oil Seals

Carbon face seals are used at starter and alternator drives; synthetic rubber lip seals are used at all other accessory drive locations. See Figure 46A. "O" ring seals are used between most non-moving parts where sealing is necessary and are also used to prevent fuel leakage into a bearing.

Oil sealing is very important in a jet engine because any wetting of the blades or vanes by oil vapor will encourage the accumulation of dust and dirt. A dirty blade or vane represents high friction to air flow, thus decreasing engine efficiency. This will result in a noticeable decrease in thrust or increase in fuel consumption.

The main engine seals are found in three configurations. The seals behind No. 1 Bearing, ahead of No. 2 Bearing, behind No. 3 Bearing, ahead of No. 4 Bearing, and behind No. 5 Bearing are all the same type, differing only in minor details. These seals are both spring loaded and air pressurized. The seal behind No. 4 1/2 Bearing obtains pressure from wedging action of spring washer between the seals. The seal in front of the No. 6 Bearing is a double unit, one seal being pressurized, the other seal being spring loaded.

Pressurized Spring Loaded Seal Assembly

The seal support carries two cast iron rings in grooves around its OD. A carbon seal, with its metal shield around it, slips over these rings. The flange on the metal shield is loosely held to the seal support by lockpins, stops, and cotter keys. This flange also rides on guide pins and against springs. The guide pins are held fast to the seal support and the springs are around the guide pins. These springs push the carbon seal and its shield away from the seal support against the lockpin stops. When the seal assembly is bolted into place in the engine the edge of the carbon seal will press against the chrome plated steel seal plate. The seal plate is held fast to the rotating shaft. The seal assembly is bolted to the bearing support.

No. 1 Seal

See Figure 39.

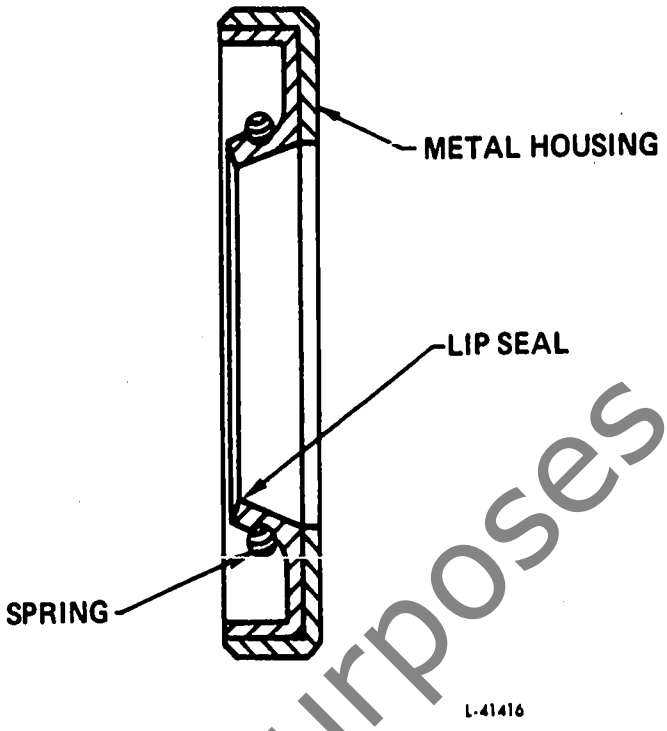
This seal support is bolted to the No. 1 Bearing support. Ninth stage air, at approximately 50 psi, is used to pressurize this seal. The air reaches the seal through a hole in the front hub of the front compressor. Air pressure is introduced in the space formed by the seal plate, the carbon seal, the seal rings and seal support assembly, and the hub spacer. Should there be any leakage between the seal plate face and the edge of the carbon seal, or seal and rings, the air flow will be toward the rear of the No. 1 Bearing. This will prevent oil from this bearing from entering the compressor.

No. 2 Seal

See Figure 40.

This seal support is bolted to the No. 2 Bearing front support. The seal plate

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Synthetic Rubber Lip - Type Seal
Figure 46A

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is on the rear hub of the front compressor. Ninth stage air, which surrounds the seal housing, pressurizes the seal. Operation is the same as described for No. 1 Bearing seal.

No. 3 Seal

See Figure 40.

The No. 2 Bearing rear support carries this seal's support. A heatshield is bolted to the rear of the seal support. The seal is pressurized by twelfth stage air which surrounds the housing. The seal plate is formed by the rear face of the compressor intermediate rear bearing housing.

No. 4 Seal

See Figure 41.

The diffuser section internal structure supports the No. 4 Bearing housing which in turn holds this seal support. The seal face plate is on the rear hub of the rear compressor. A cover is bolted to the front face of the support. The seal is pressurized by 16th stage air, which surrounds the seal support and bearing housing. Air pressure is about 150 psi.

No. 5 Seal

See Figures 43 and 44.

This seal assembly is mounted on the No. 5 Bearing support. Since it is necessary to use a heatshield in this location, there are some construction changes over those discussed above. The seal rings are carried on a separate housing which is bolted into a deep seal housing. The seal housing carries the lockpins, guides and springs. The carbon seal, with its metal shield is attached to these in the conventional manner. A separate seal support is used in this system. The support has internal oil seal rings backed by expander rings. This support is carried on the same bolt circle that carries the No. 5 Bearing support. This inner support is used to make the seal housing more rigid. A heatshield bolts to the rear end of the seal housing. Sixteenth stage air pressurizes this seal.

No. 6 Seal

See Figures 45 and 46.

The construction of this seal is entirely different from those discussed above. The assembly is made up of two carbon seals, two spacers, a seal plate, a spring washer, and a spring retaining nut. The seal system rotates with the turbine rotor hub inside of the turbine rear shaft gas seal support. This support is bolted to the No. 6 Bearing support. The forward carbon seal is pressurized by 9th stage air. This air is fed to the outside and forward faces of the carbon seal ring through a passage from inside of the hollow front compressor turbine shaft. The rear carbon seal is forced rearward against the seal plate by a

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spring washer. This washer is held in place by a retaining ring. Sealing action is outward against the turbine rear shaft gas seal support, and rearward against the spacer and face plate.

No. 4 1/2 Seal

See Figure 42.

The No. 4 1/2 Bearing Seals Assembly is located between the front compressor drive and rear compressor drive shafts just to the rear of the 4 1/2 bearing. The seal keeps oil from the No. 4 1/2 bearing from traveling rearward and seals compressor discharge cooling air from the No. 4 1/2 bearing area. This seal consists of four spacers, six carbon graphite seals, six thrust rings and three spring washers mounted on the front compressor drive turbine shaft and is contained radially with a seals liner mounted in the rear compressor drive shaft. Radial force is provided by the diametrical spring pressure of the carbons, centrifugal force of the carbons and a radial pressure differential which locks the seals liner so that the seals turn with the rear compressor drive shaft. Lateral force of the seals against the seal plates is provided by the spring washers which exert pressure forward and aft through the thrust rings with the forward force augmented by a differential pressure. Sealing therefore, is provided by the diametrical spring pressure of the carbons, the centrifugal force of the carbons and a radially and lateral acting pressure differential. The seals and spacers are cooled by pressure oil from the No. 6 bearing area furnished by the tubes and heatshield assembly. The oil is discharged to a tapered space between the rear two of three seals. Drilled holes through the shaft allows the oil to flow to a radial slot on the ID of the rearmost spacer. The four spacers have eight equally spaced forward tapered slots on their internal diameter forming oil channels for the cooling oil mentioned above. An alignment pin positions the spacers and turbine shaft correctly. The No. 4 1/2 bearing inner race and seal spacers are held on the shaft by a bearing retaining nut.

Auxiliary Drive Seals

See Figure 47.

There are seven of these seals in the engine. One is in the front accessory front support and six in the main gearbox assembly. Carbon face seals are used at starter alternator drives; synthetic rubber lip seals are used at all other accessory drive locations. At most locations seals and seal housings are retained by snaprings. There is an "O" seal ring between each housing and the case.

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ENGINE - DESCRIPTION AND OPERATION

Lubrication System

General

The lubrication system is of a high pressure design consisting of a pressure system, scavenge system, and a breather system. The pressure system supplies oil to the main engine bearings and to the accessory drives. The scavenge system scavenges the bearing compartments and accessory drives. The breather system interconnects the bearing compartments. The engine oil system is shown schematically in Figure 48.

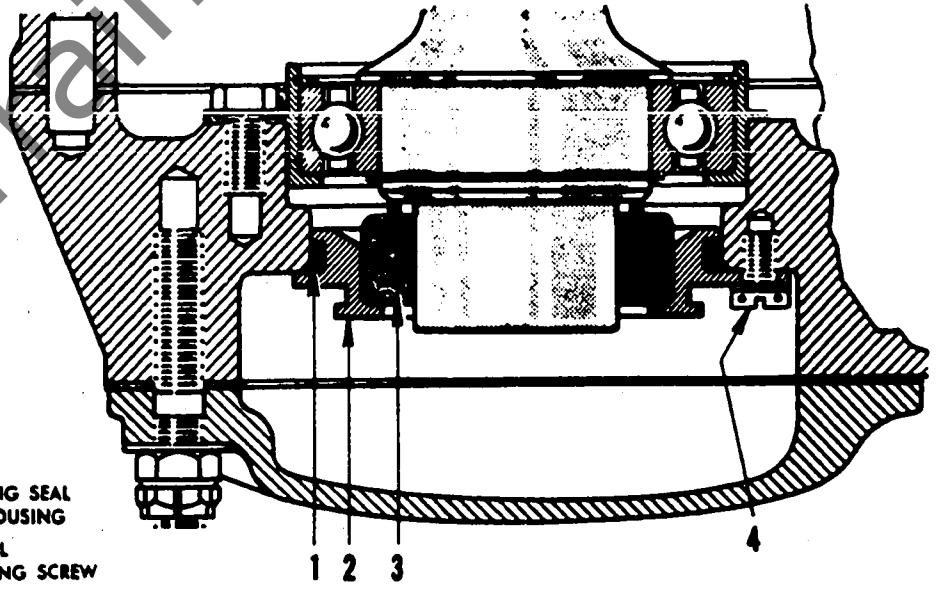
The engine is lubricated by a synthetic chemical base oil which must conform to PWA Specification 521. The system circulates seventy to eighty pounds of oil per minute.

The lubricant changes its viscosity only slightly over a wide temperature range, thus engine warm-up time is very short. It is toxic, will attack most paints, and will soften both natural and synthetic rubber seals. It will cake at 450°F (232°C). It weighs 7.7 pounds per gallon at 60°F (16°C).

Pressure System

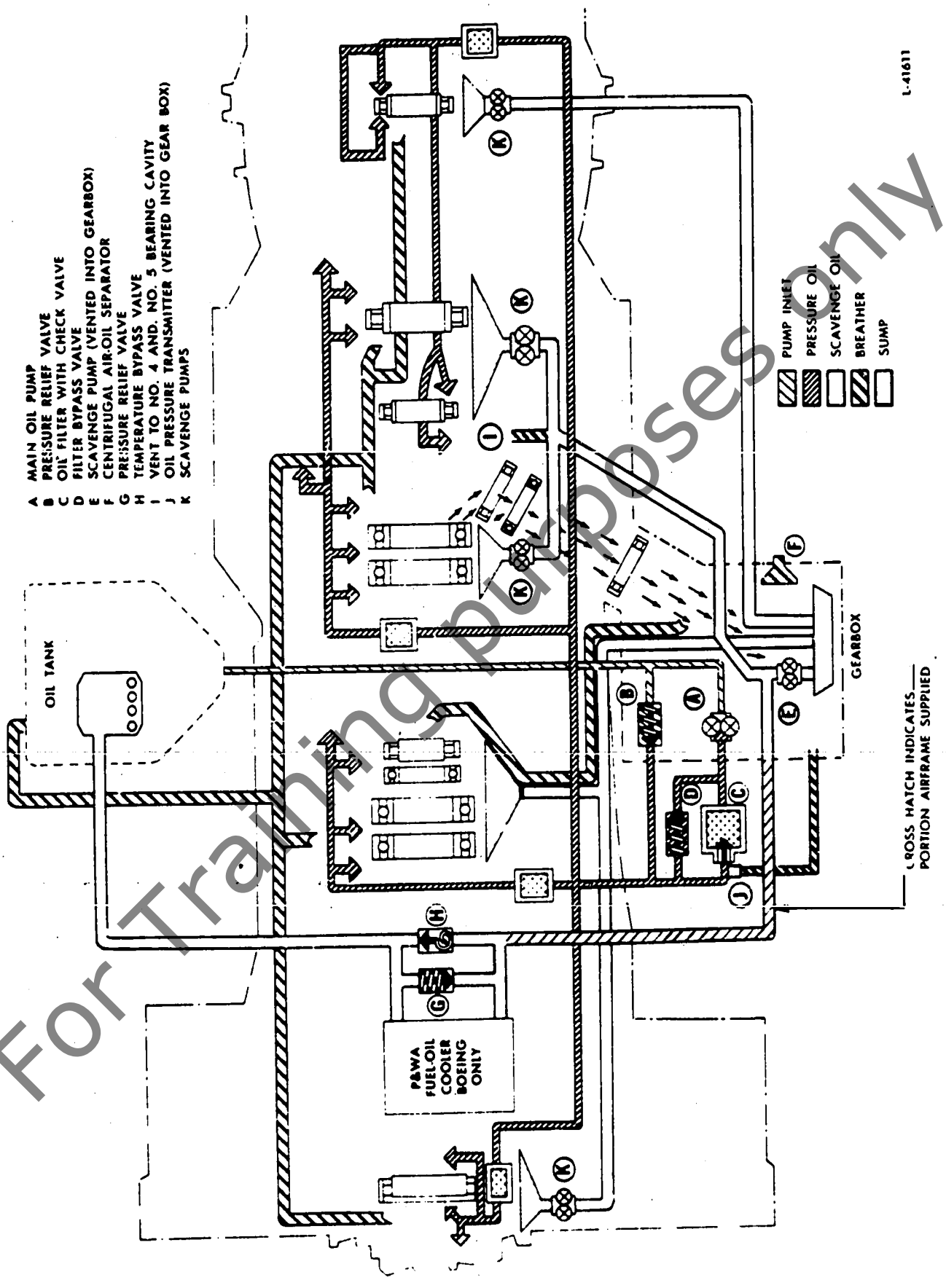
General

This system consists of a pressure pump, a pressure relief valve assembly, an oil strainer, an oil pressure (by-pass) valve, strainers, external tubing, internal passages and jets.



Typical Face Type Oil Seal
Figure 47

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Lubrication System Schematic
Figure 48

ENGINE - DESCRIPTION AND OPERATION

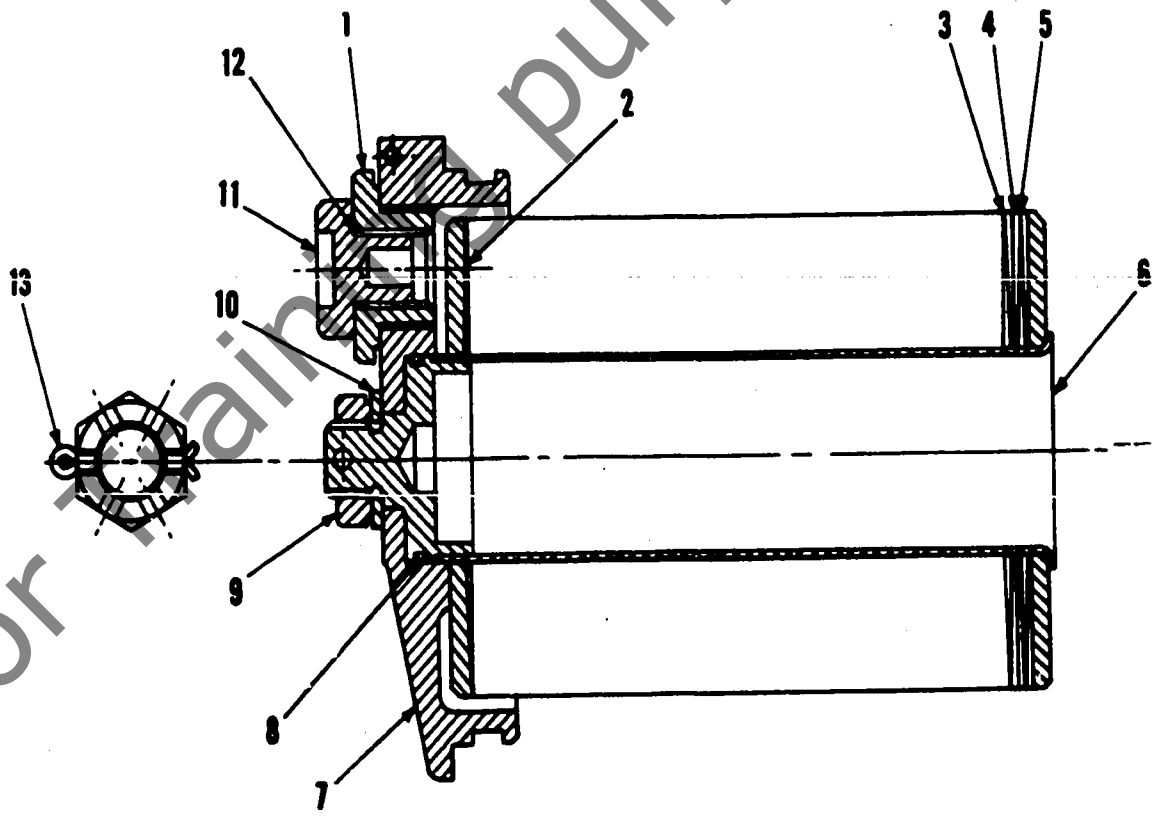
Oil Pump

Oil from the tank enters at the bottom part of three ports on the right side of the accessory component gearbox assembly. It travels through internal passages in the casting to the rear section of the duplex pump. The pump is duplex in construction since it has individual separated sections. The rear half is the pressure section while the front half is the scavenge section. The pump is the gear-type and is splined into the hydraulic pump gearshaft. The pump is located at the right front of the gearbox assembly.

Main Oil Filter

See Figure 49.

Oil from the pump travels through passages in the gearbox assembly casting to a filter housing assembly. See Figure 50. This filter housing assembly is located forward on the intermediate case flange. It consists of a housing, valves, and a main oil filter element. The main oil filter element is made up of alternate screens and spacers around an inner filter element assembly. Oil



1. BUSHING
2. SPACER END PLATE
3. INLET SPACER
4. SCREEN
5. OUTLET SPACER
6. INNER FILTER ELEMENT
7. COVER
8. PREFORMED PACKING
9. SLOTTED SHEAR NUT
10. SHANK WASHER
11. PLUG
12. PREFORMED PACKING
13. COTTER PIN

L-7450

Main Oil Filter Element
Figure 49

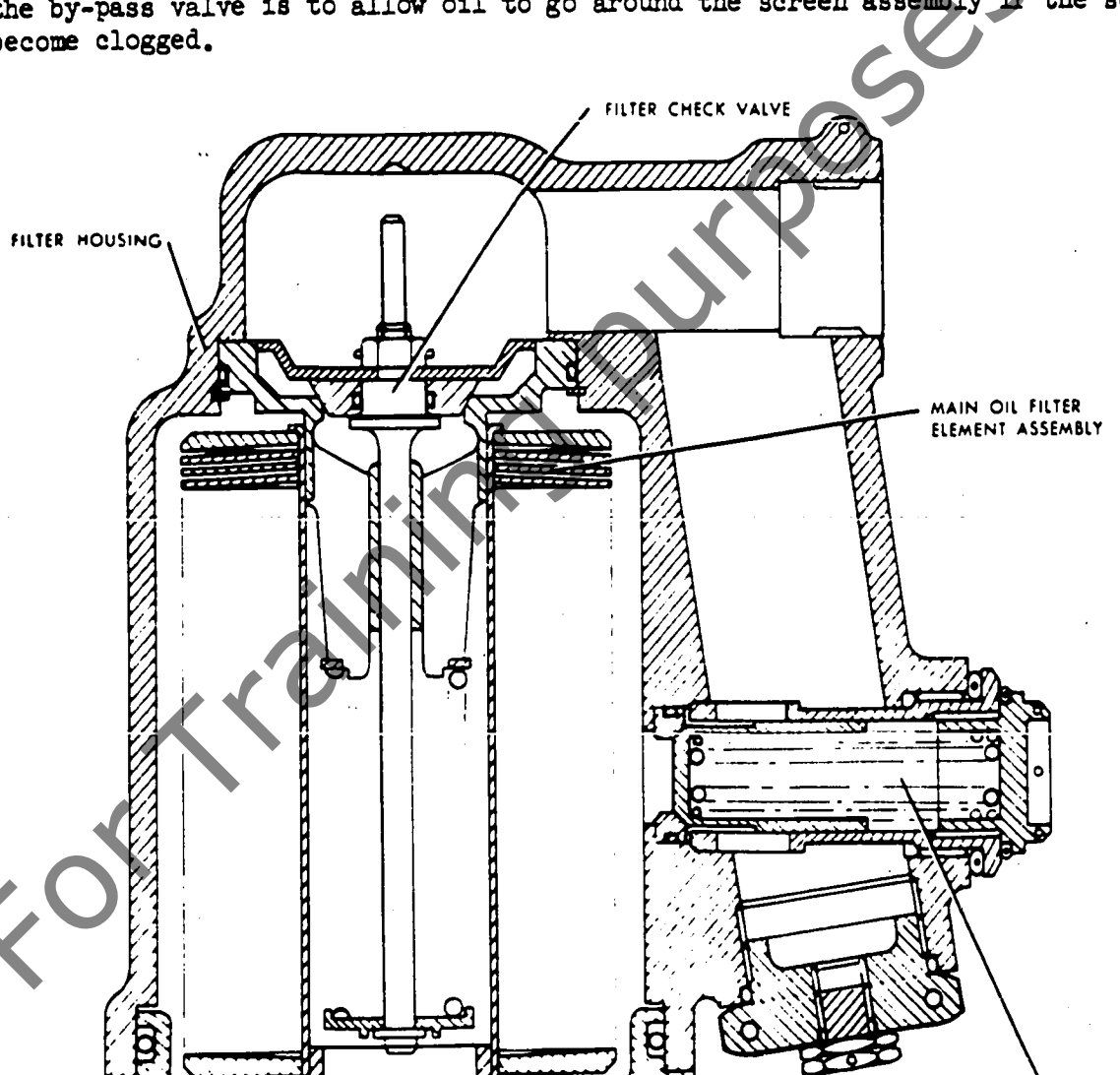
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flow is from outside the disks toward the center of the perforated baffle.

A spring-loaded return filter valve is mounted in the filter housing at the baffle outlet to prevent any leakage of oil into the engine during periods of inactivity. Also included in the filter housing is an oil pressure relief valve assembly (by-pass) which we will discuss below.

Oil Pressure Relief Valve Assembly (By-Pass)

A spring-loaded by-pass valve is mounted in the filter housing casting. Its inlet is from the chamber surrounding the main oil strainer. Its outlet is to a chamber downstream of the screen assembly and filter valve. The purpose of the by-pass valve is to allow oil to go around the screen assembly if the screens become clogged.



Filter Housing Assembly
Figure 50

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ENGINE - DESCRIPTION AND OPERATION

Main Oil Filter and By-Pass Warning System

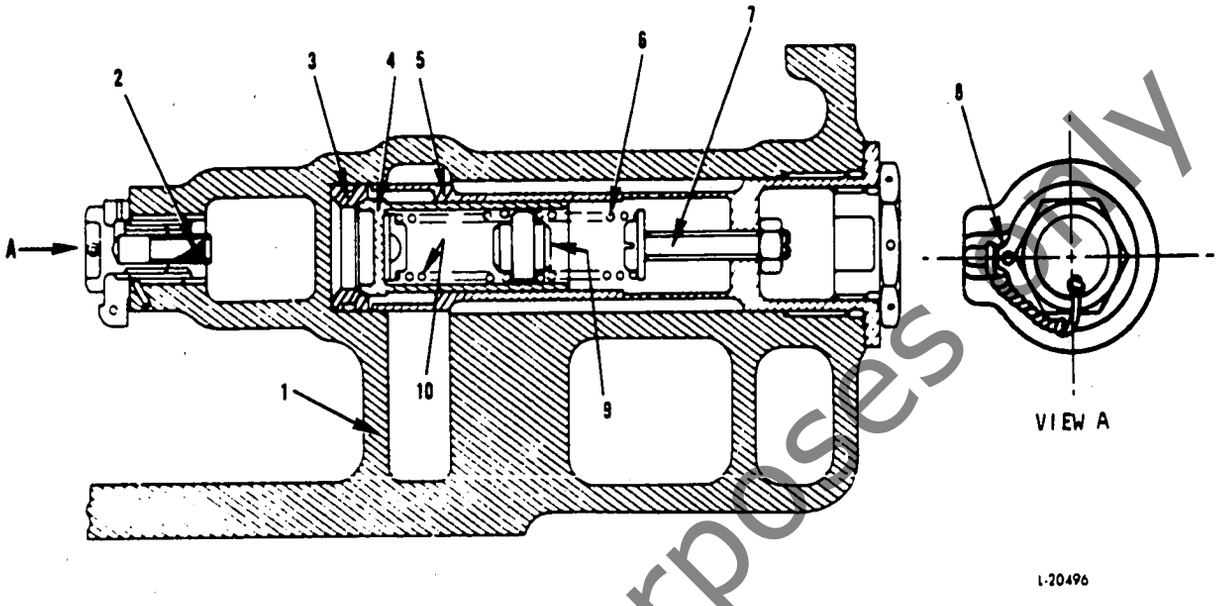
To prevent the engine from operating with a contaminated oil system and as a maintenance aid, an airframe supplied differential pressure switch (Delta P) connects with two ports on the bottom of the filter housing assembly. This differential pressure switch is actuated when the pressure differential of the oil entering the filter housing and the oil leaving the filter housing reaches 50 ± 1.5 psi as indicated by a warning light. When the pressure differential reaches this point, it is highly probable that the filter is becoming clogged but is still providing filtered oil since the oil does not by-pass the filter until the differential pressure reaches 67 ± 2.5 psi. Therefore this system warns the maintenance personnel and/or pilot that the oil filter is becoming clogged.

Pressure Relief Valve Assembly

See Figure 51.

Mounted in the accessory component gearbox assembly is the pressure relief valve assembly. This is a conventional relief valve which when open, permits oil to flow from the chamber downstream of the strainer valve to the pump inlet passage.

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1. Gearbox
2. Strainer
3. Valve Seat
4. Valve
5. Valve Body
6. Outer Spring
7. Adjusting Screw
8. Do Not Lockwire Over Jet Port
9. Intermediate Spring Seat
10. Inner Spring

Pressure Relief Valve
Figure 51

External Tubes

A tube attached to the middle of three outlets on the lower right front of the gearbox assembly carries the oil forward to the lower connection on the oil strainer housing. From the topmost filter housing connection on the oil strainer housing, a large tube carries the oil rearward to the adapter on the gearbox. At this point, the oil is influenced by the pressure relief valve as outlined in the above paragraph. From the adapter on the gearbox, a tube carries oil to an adapter on the diffuser case. This adapter permits oil to flow internally to the No. 4 and No. 5 bearings through internal tubing, and also permits oil

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to flow rearward through a tube to an elbow on the 3 o'clock position of the exhaust case. Internal tubing carries the oil internally to the No. 6 Bearing. A small tube connected to the strainer assembly carries oil to the center of the oil adapter located at the 6 o'clock position at the intermediate case front flange location. From here, it flows internally to the No. 2, No. 2 1/2 and No. 3 Bearings. Another tube from the strainer housing runs underneath the engine forward to an elbow at the 4 o'clock position in the inlet case and from there, internal tubing carries the oil to the No. 1 Bearing.

Internal Tubes and Passages

No. 1 Bearing

See Figure 52.

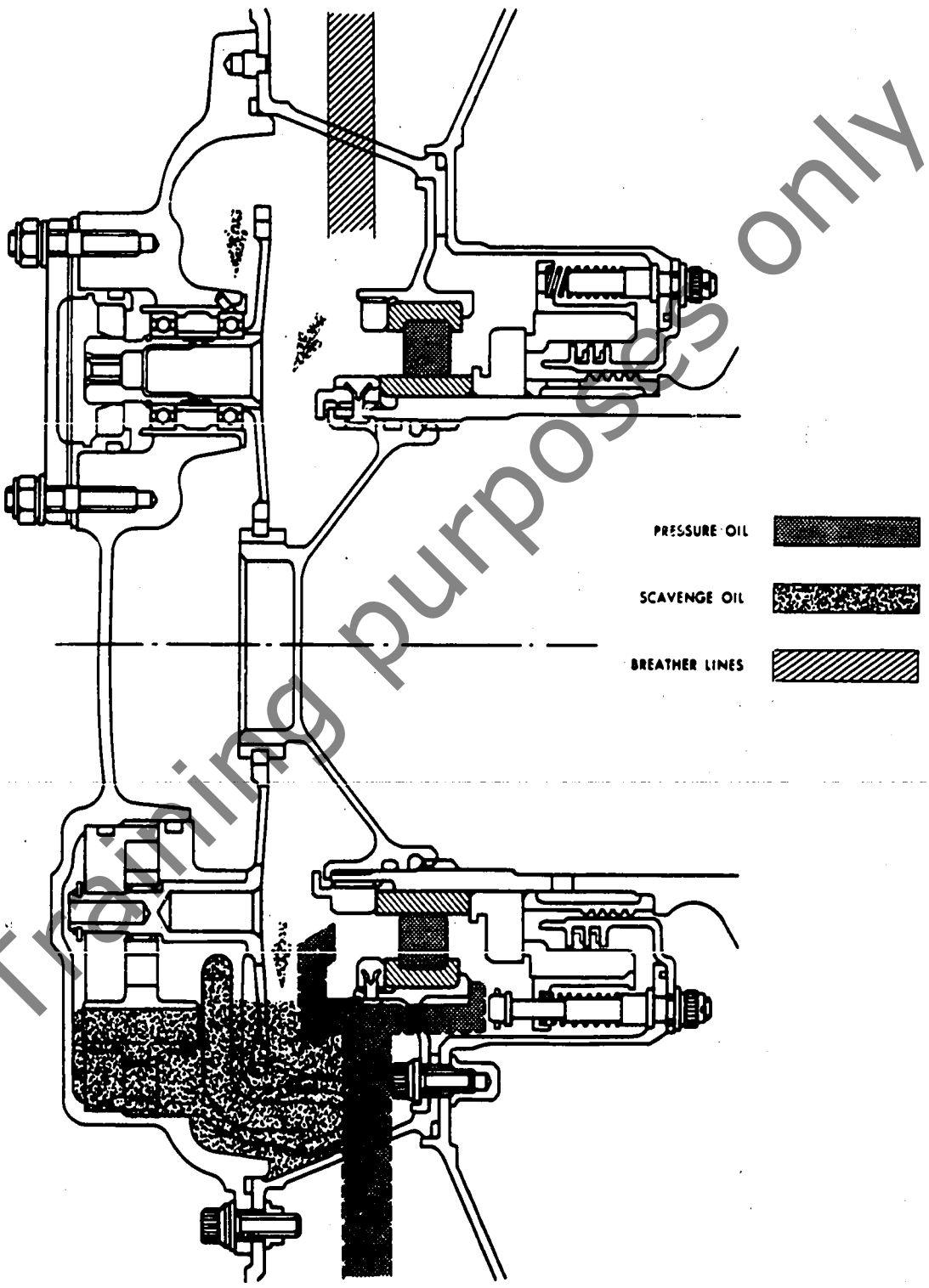
Oil from the front pressure tube enters the inlet case assembly through a fitting at the outer end of the 4 o'clock strut. A tube inside the strut carries the oil to a fitting on the inside diameter of the inner shroud. An oil transfer tube with "O" ring seals on the ends, carries the oil to the No. 1 Bearing oil nozzle assembly. Oil that flows to the nozzle assembly passes through a screen inside the assembly and then to two metering plugs. These plugs jet oil into the No. 1 Bearing rollers and the No. 1 Bearing seal assembly.

No. 2, No. 2 1/2, No. 3 Bearings

See Figure 53.

Oil from the pressure and scavenge oil adapter at the 6 o'clock front flange location of the intermediate case is passed inward via a transfer tube. The upper end of the transfer tube fits into the lower end of the compressor intermediate bearing oil pressure tube. This latter tube has a perforated flange welded to its lower end. The rim of this flange fits into the adapter liner, with an "O" ring for sealing. The top of the oil pressure tube fits into the compressor intermediate bearing oil pressure adapter. This adapter is to change the contour of the flat tube to a round tube. The oil pressure tube is flat because it travels through the six o'clock intermediate compressor vane. From the top of the adapter, a round tube carries the oil to a strainer assembly. This strainer is threaded into an adapter, with an "O" ring for sealing. The adapter is held fast to the bottom center outside of the No. 2 Bearing housing with studs and nuts. From the oil adapter, a forward-facing passage joins a tube. The front end of the passage is plugged, and oil is delivered through an opening to the baffles of the No. 2 Bearing. An oil manifold is attached to the rear of the adapter and bolted to the bearing housing. This manifold is semi-circular and mounted on the right side of the bearing housing. From the bottom of the manifold, a jet plug delivers oil to both the No. 2 1/2 and No. 3 Bearings. Oil reaches these bearings through openings in the No. 2 1/2 Bearing housing. At the 12 o'clock position of the manifold, a jet delivers oil to the forward section of the No. 3 Bearing seal.

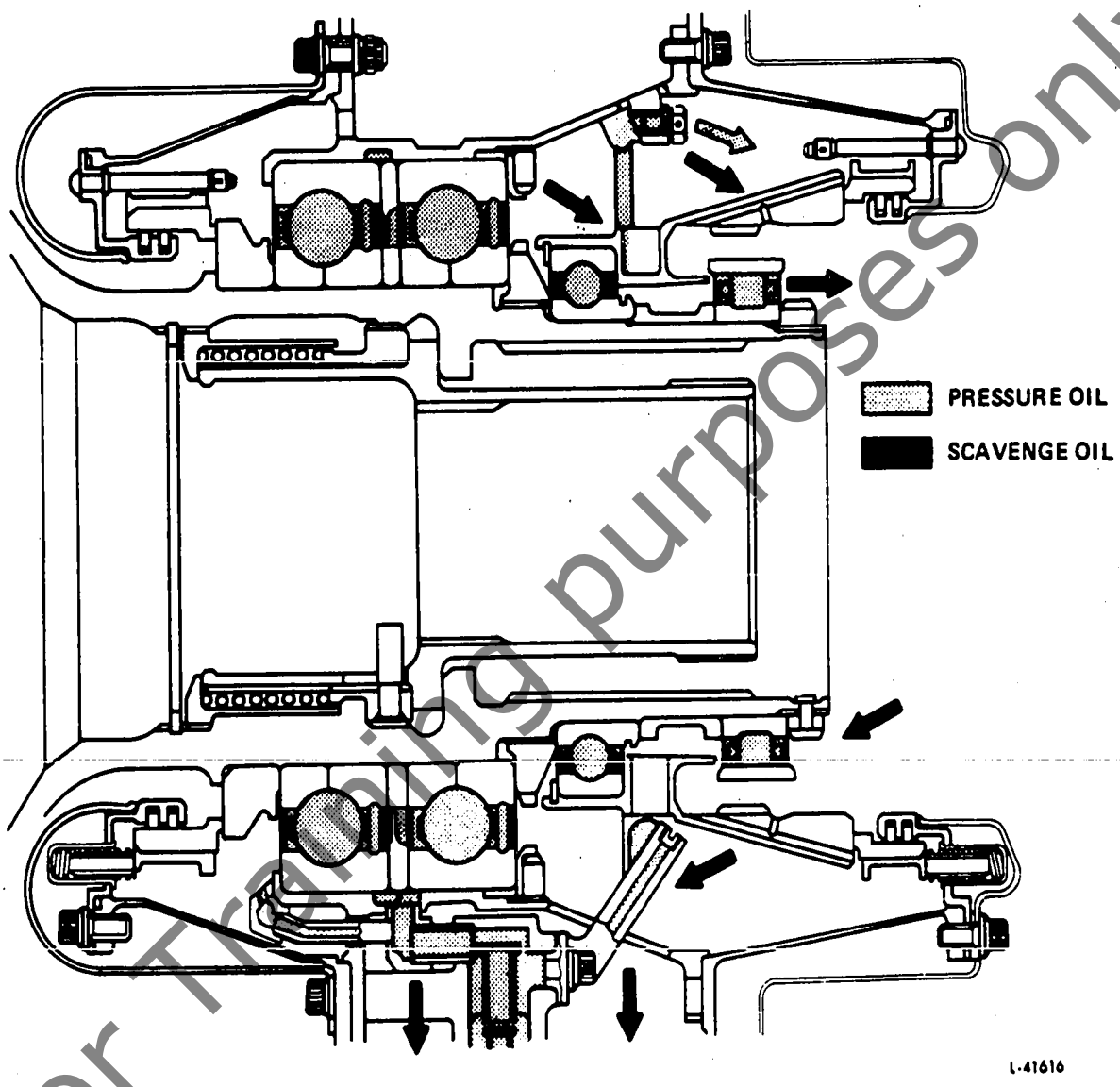
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No. 1 Bearing Oil Schematic
Figure 52

ENGINE - DESCRIPTION AND OPERATION



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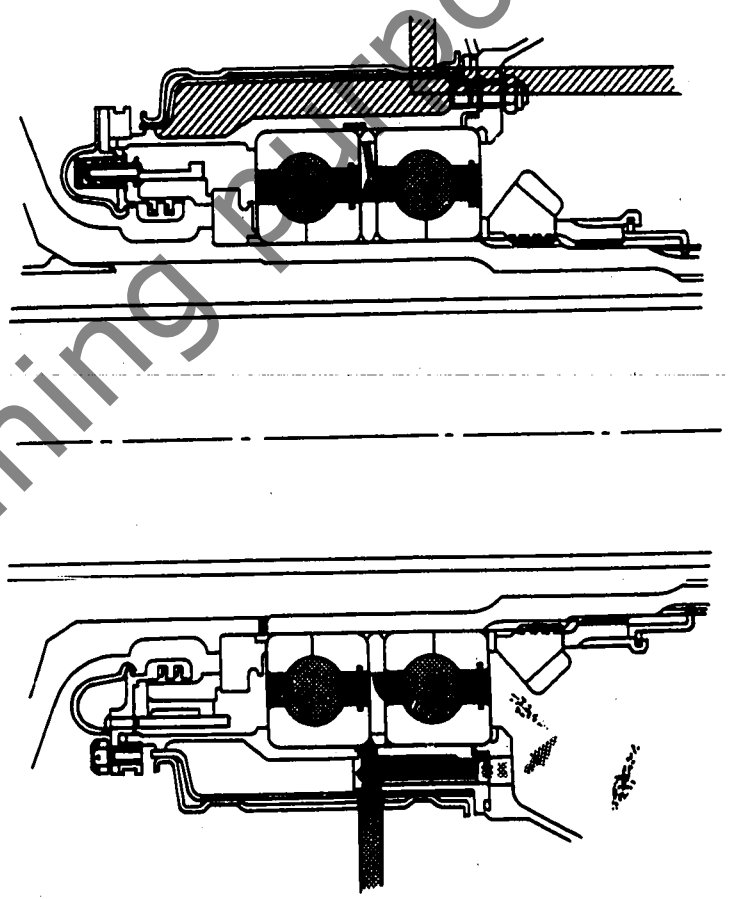
Typical No. 2, No. 2 1/2, and No. 3
Bearing Oil Schematic
Figure 53

ENGINE - DESCRIPTION AND OPERATION

No. 4 and No. 5 Bearings

See Figures 54, 55, and 56.

Oil from the external tube is brought through the tube in the four o'clock strut of the diffuser assembly to the rear area inside of the inner bolt circle. A ferrule joins the strut tube and oil pressure tube adapters. A strainer is located inside of the adapter. The adapter and a No. 4 Bearing oil transfer tube assembly are bolted together to a pad inside the diffuser case. The transfer tube rear bolt flange fits between the adapter bolt flange and the case pad.



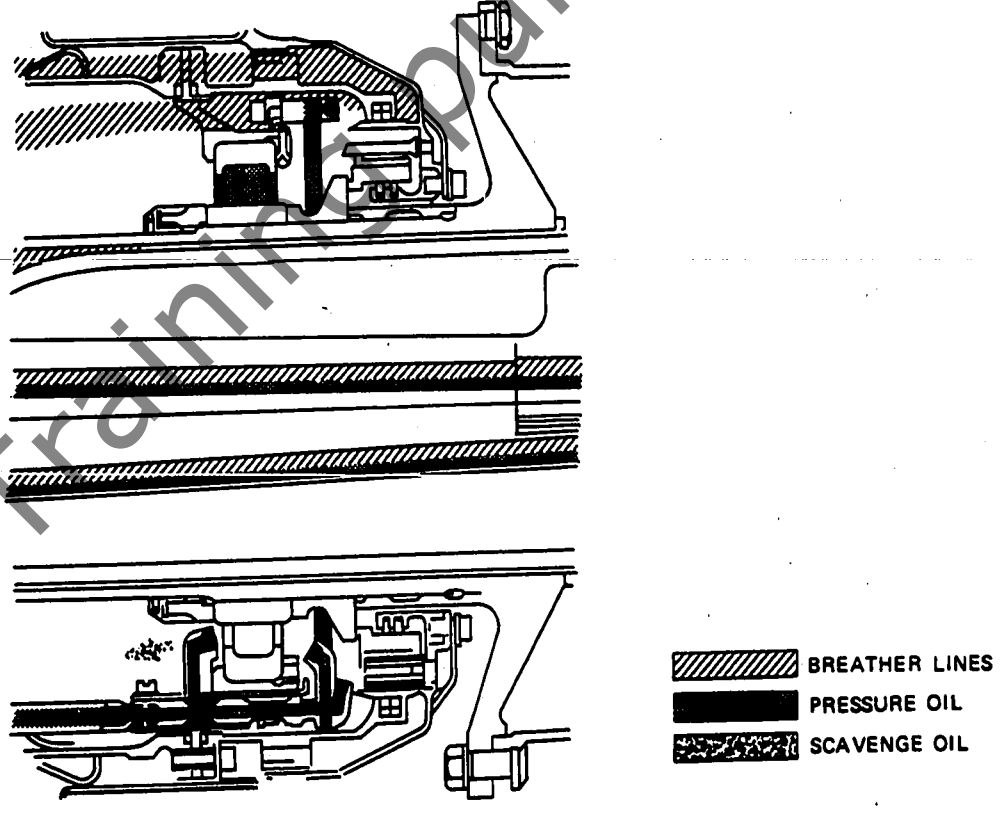
Typical No. 4 Bearing Oil Schematic
(JT3D-1-MC6 Shown)
Figure 54

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ENGINE - DESCRIPTION AND OPERATION

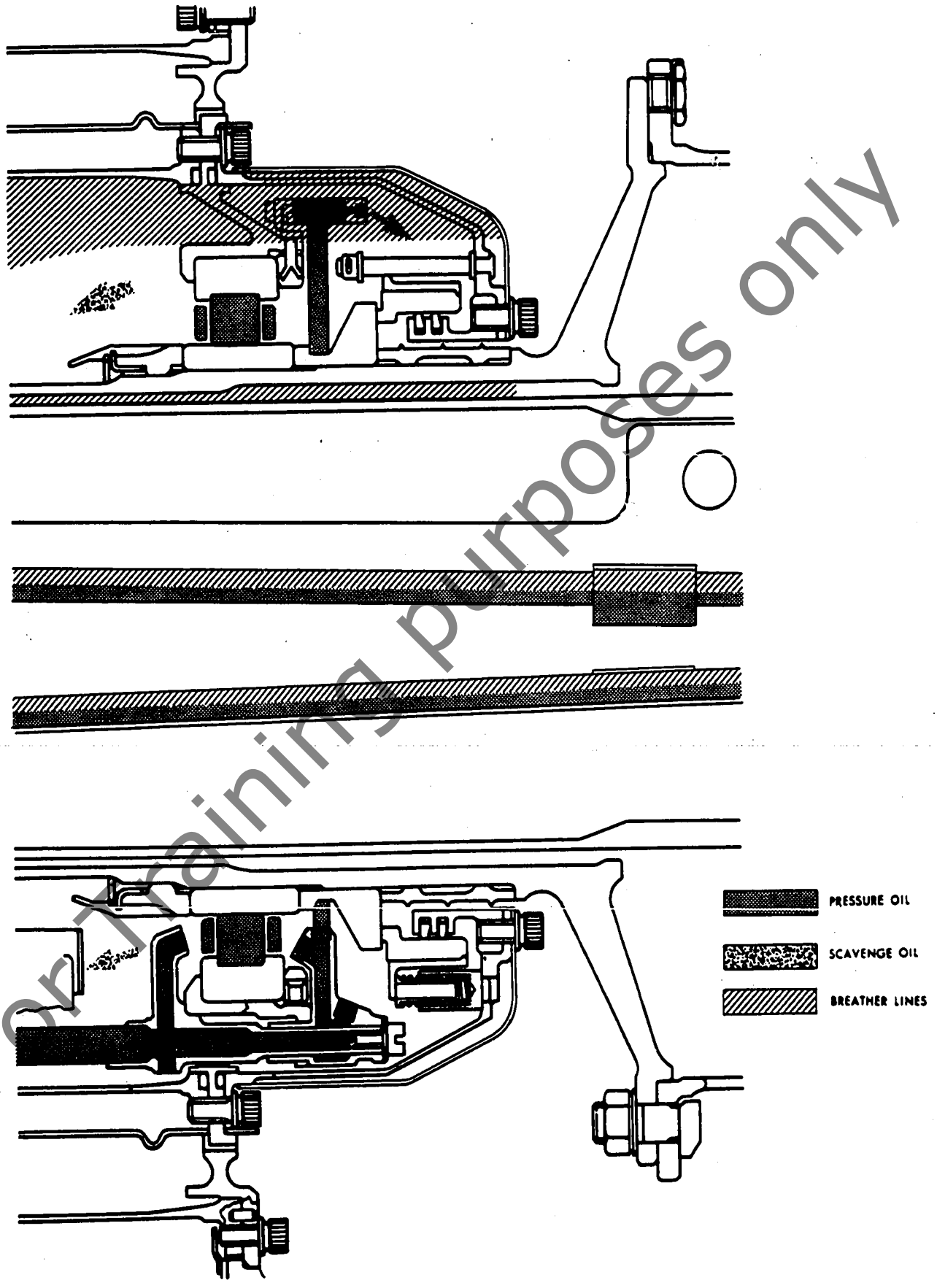
The transfer tube leads oil from the adapter forward to the oil baffle between the two ball bearings that together made up the No. 4 Bearing. A small oil tube leads oil from the left side of the adapter to the angled accessory drive shaftgear bearing. The housing for this bearing carries this tube by a bolt flange. The tube is a slip fit into the oil pressure tubes adapter. From an opening in the rear of the adapter, the No. 5 Bearing oil pressure tube carries oil rearward through the No. 5 Bearing support weldment. A nozzle assembly, containing a jet, is clamped over the holes in the tube in front of the No. 5 Bearing. The tube passes through the No. 5 Bearing housing and ends in a manifold that carries two jets, and delivers the oil to the top and bottom of the rear side of the bearing. This manifold is bolted to the No. 5 Bearing housing.

These two jets feed oil to the rear of the No. 5 Bearing and to the carbon seal and seal plate. The jet from the nozzle assembly just ahead of the bearing feeds oil to the front of the rollers.



No. 5 Bearing Oil Schematic (JT3D-1-MC6)
Figure 55

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No. 5 Bearing Oil Schematic
(JT3D-1 and JT3D-1-MC7)
Figure 56

ENGINE - DESCRIPTION AND OPERATION

No. 4 1/2 and No. 6 Bearings

See Figures 57, 58, and 59.

Oil from the rearmost external tube is brought through a strainer into the engine. The oil passes through the center of a rod in the three o'clock strut of the turbine exhaust case. The tube that carries the oil is the inside of the No. 6 Bearing support rod. The inner end of the support rod is fastened to the No. 6 Bearing internal oil pressure tube by a through bolt fitting. The other end of the tube connects to the No. 6 Bearing oil sump assembly. A strainer is located at this point. Inside of the sump assembly, the oil flow is divided, part flowing to the No. 6 Bearing nozzle assembly, which is bolted to a flange near the inside upper rim of the sump. The No. 6 Bearing gets its oil from this nozzle. The other flow inside of the sump tubes is to an outlet at the sump center. From this point, the oil is led forward into a nozzle assembly. This nozzle assembly is threaded into the center outlet of the sump assembly, and carries a metering jet inside the nozzle tube. The nozzle assembly passes through the center of the No. 6 Bearing oil suction pump pinion, and discharges the oil into the center of the No. 6 Bearing oil seal sleeve. The No. 4 1/2 Bearing shield assembly fits into the forward end of the sleeve using two bronze rings for seals. Four oil tubes in this assembly carry the pressure oil forward from the sleeve and discharge it to a tapered space between the front two of three seals. These seals fit tightly to the internal taper of the inside of the front compressor turbine shaft. Drilled holes through the shaft allow oil to run out into a space just ahead of the No. 4 1/2 Bearing. This bearing forms the rear wall of this space and in this way receives its lubrication.

Front Accessory Section

See Figure 52.

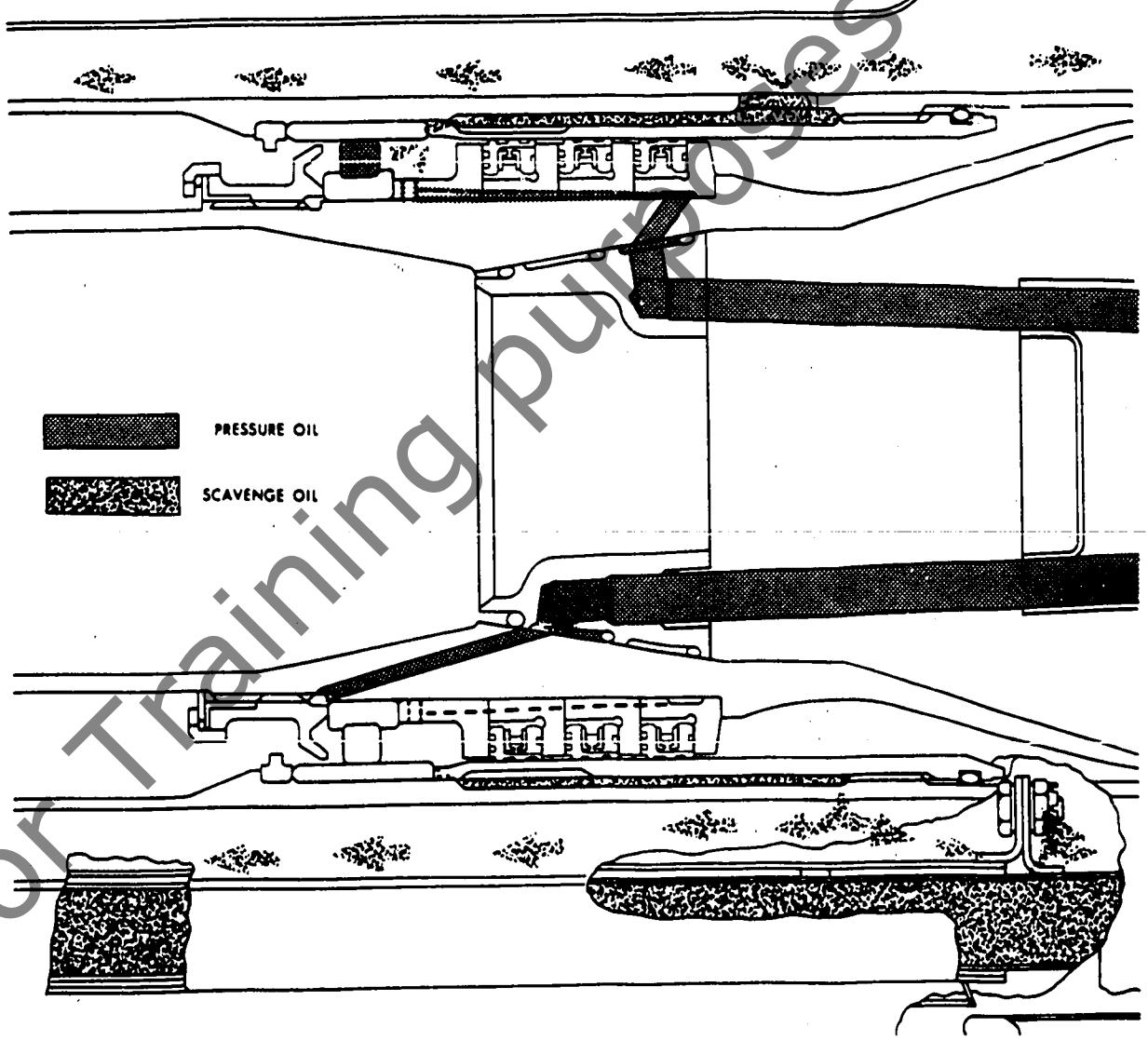
No. 1 Bearing oil, previously discussed, provides the lubrication for the front accessory section gears and bearings. This is accomplished by splash and gravitation in the annulus formed by the front accessory support and the No. 1 Bearing support.

Accessory Component Drive Gearbox Assembly

See Figure 48.

Lubrication for the front bearings of the fuel pump and the fuel control shaft bearings in the gearbox assembly is delivered by passages in the casting and jets. Splash and spray from the above and from return oil of the No. 4 and No. 5 Bearing area provide the remainder of the lubrication in this section.

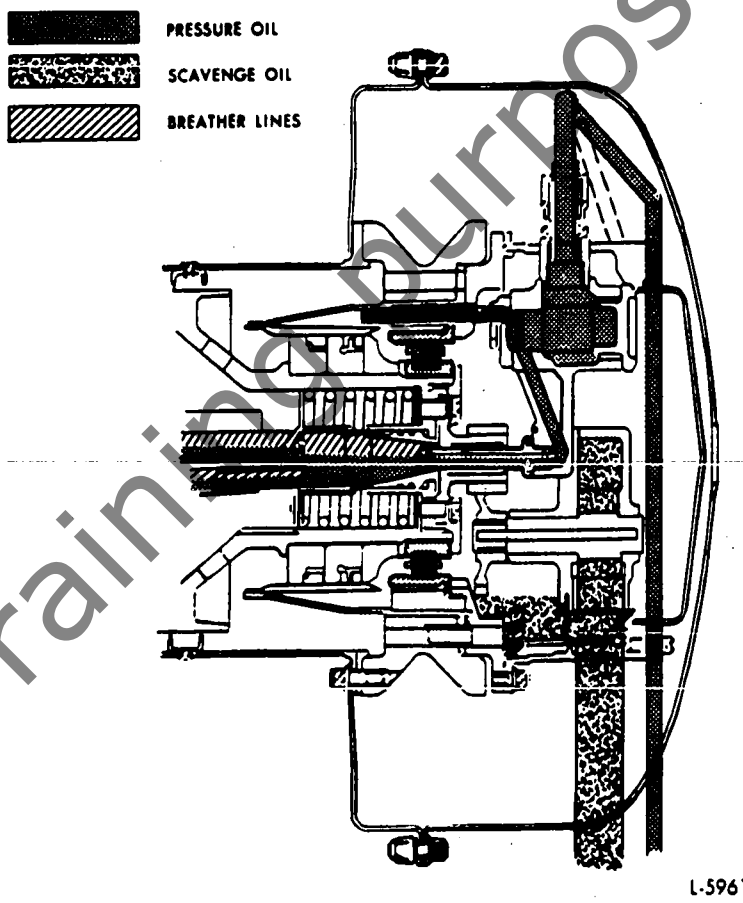
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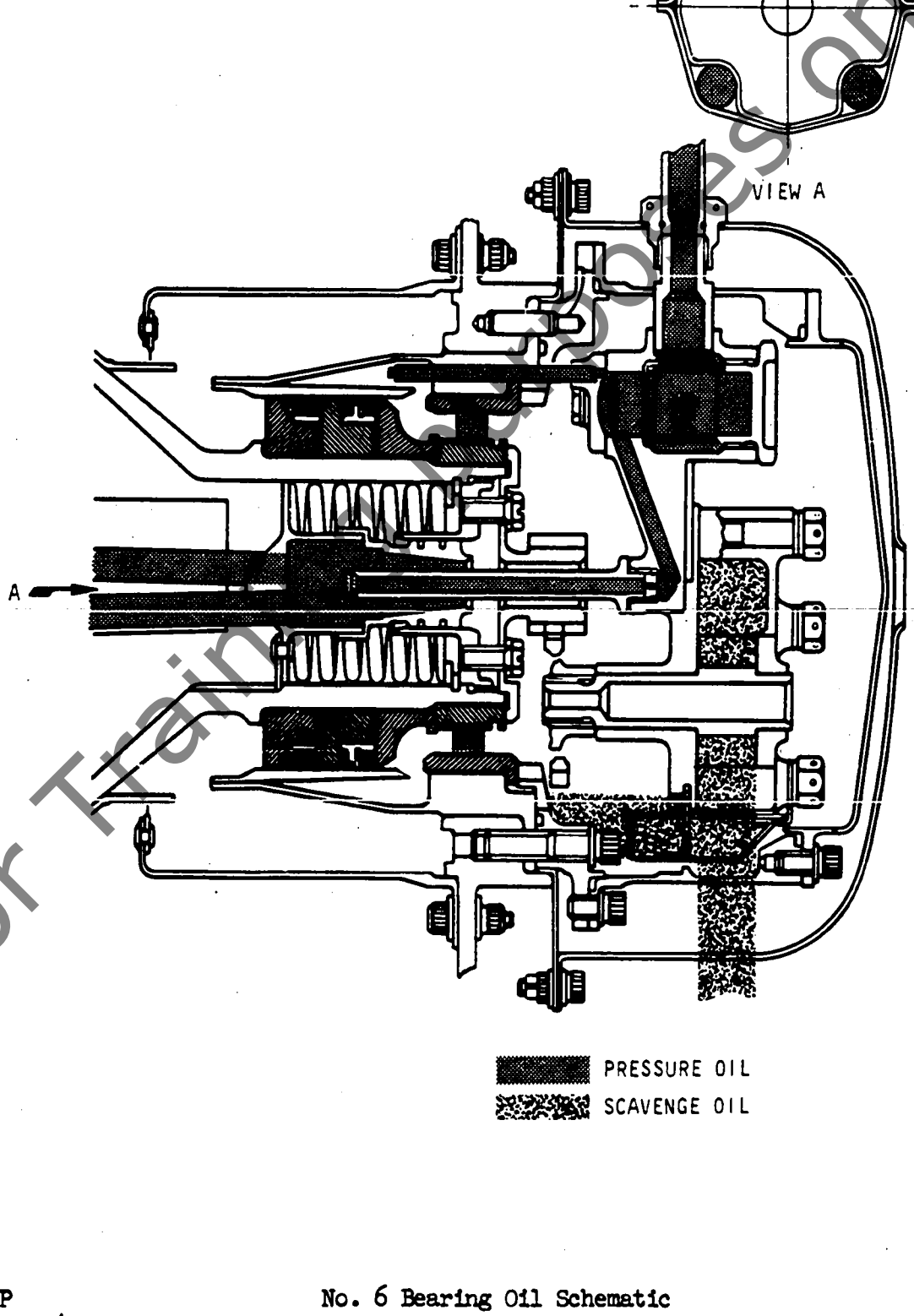
No. 4 1/2 Bearing Oil Schematic
Figure 57

ENGINE - DESCRIPTION AND OPERATION



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No. 6 Bearing Oil Schematic (JT3D-1-MC6)
Figure 58



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No. 6 Bearing Oil Schematic
Figure 59

ENGINE - DESCRIPTION AND OPERATION

Angled Accessory Drive Shaftgear Bearings

See Figure 48.

The angled accessory drive shaftgear bearing oil tube carries oil to the upper bearing, roller type, of the accessory drive shaftgear. The discharged oil from this roller bearing that falls downward in the bearing housing is used to lubricate the lower shaftgear ball bearing.

Scavenge System

See Figure 48.

General

The engine uses the dry sump system. The four scavenge pumps with five scavenge sections (one is dual sectioned) are capable of pumping about three times the quantity of oil that the pressure pump can handle. Each scavenge pump draws oil from a sump. The oil is routed to the cooler and tank through internal passages and external tubing.

No. 1 Bearing and Front Accessory Section

See Figure 52.

Oil from the No. 1 Bearing drains to the low point between the No. 1 Bearing front support and the front accessory drives support which forms a sump for this oil. Oil from all of the front accessory gears and bearings drains down between these supports to the same sump.

A conventional gear type pump is supported on a boss on the rear face of the front accessory drive support. The pump is driven by the front accessory drive gear. This pump is located in the sump with a strainer inlet in the bottom of the pump. Scavenge oil from the pump travels through a drilled passage in the front accessory drive support to an "O" ring sealed transfer tube; then to a tube inside the eight o'clock inlet vane. An external tube connected to a fitting on the outside of the outer shroud at the eight o'clock position, carries the oil to the rear underneath the engine to the approximate front flange location of the intermediate case where it connects to an elbow on a tube from the No. 2, No. 2 1/2 and No. 3 Bearing oil manifold.

No. 2, No. 2 1/2, No. 3 Bearings and Main Accessory System

See Figure 53.

Scavenge oil from the No. 2, No. 2 1/2 and No. 3 Bearings drains into the No. 2 Bearing support assembly. Oil first drains to the rear of the center support of this assembly. This oil passes through holes in the bottom of the center support to the space formed by the bearing assembly's front support, the rear support, and the inner shroud of the compressor intermediate case assembly. Oil

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then runs down through the lower vanes of the intermediate case assembly to the 6 o'clock vane. The No. 2 Bearing oil pressure tube does not fully fill this vane. There is room around it to allow drainage of scavenge oil. There are holes through the support ring at the lower end of the tube. Scavenge oil drops through these holes and through the No. 2 Bearing oil drain adapter into the pressure and scavenge oil adapter assembly. This adapter assembly is mounted under the compressor intermediate case assembly. A sump at the bottom center of the gearbox assembly case collects the oil. All scavenge oil from the gearbox accessory gears and bearings also drains to this same sump. The scavenge section of the duplex pump scavenges the sump of oil.

No. 4 Bearing

See Figure 54.

Scavenge oil is discharged from the front of the forward bearing and the rear of the rear bearing. Space in the seal housing allows oil from the front to drain back to the rear of the No. 4 Bearing support structure in the diffuser case. Oil from the rear bearing drains directly to the same place. The splash from this rear bearing scavenge oil forms the lubrication for the gears and scavenge pump idler bearings in this area. All scavenge oil then drains to a sump formed where the No. 5 Bearing support weldment joins the No. 4 Bearing support structure.

The lower section of the dual scavenge pump, draws oil from the sump. The oil scavenge tube for this pump is a passage in the pump housing casting. There is an inlet strainer located in the pump housing. The pump shafts are vertically mounted and driven by a gear train from the accessory drive gear ("bull gear"). The pump housing is bolted to the bearing support structure in the diffuser case. The pump outlet tube assembly is flange bolted to the left side of the strut. A tube through this strut carries the oil to a pad outside of the diffuser case. An elbow, a tube, and a connector carry the oil forward into the right front face of the gearbox assembly. Internal passages in the gearbox assembly casting carry the oil to the outlet pad.

No. 4 1/2 and No. 5 Bearings

See Figures 57, 55, and 56.

Scavenge oil from the No. 4 1/2 Bearing is discharged from the rear side of the rollers into a space formed by the No. 4 1/2 Bearing spacer and the No. 4 1/2 Bearing seal liner.

Through slots in front of this liner and in the rear compressor drive turbine shaft, the oil drains into the No. 5 Bearing support weldment. Some of this oil may run forward to the sump at the No. 4 Bearing. The remainder runs aft to a sump formed by the junction of the No. 5 Bearing support weldment and the No. 5 Bearing housing. Scavenge oil from the No. 5 Bearing drains into this same sump.

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The No. 5 Bearing oil scavenge tube dips its rear end into this sump. The tube is bolted into place in the lower part of the No. 5 Bearing support weldment. The forward end of this tube fits into the inlet of the upper scavenge pump. The tube is sealed with "O" rings and a strainer is held inside the pump inlet with a snapring. The scavenge pump is the second section of the dual unit discussed under the No. 4 Bearing scavenge system. The outlet of both sections is common and the oil travel from this outlet was discussed under the No. 4 Bearing scavenge system.

No. 6 Bearing

See Figures 58 and 59.

Scavenge oil is discharged from both sides of the No. 6 Bearing. Oil that is discharged forward can run back through holes in the rear of the seal housing. Oil that is discharged rearward falls into the sump, lubricating the scavenge pump gears as it goes. The sump is a horizontally mounted, cylindrical unit, with a scavenge pump at its bottom. The gear-type pump is driven by a gear which meshes with a pinion. This pinion is at the rear end of the front compressor drive turbine. The pump inlet is at the bottom of the sump, and is covered by a strainer. The pump outlet is at the six o'clock position of the sump assembly. A tube connects this point to a tube assembly passing through the six o'clock exit strut to the rear of the No. 6 Bearing support rod. Tubes carry the oil forward along the left side of the engine and discharge it into a fitting at the left rear of the rear gearbox housing.

Angled Accessory Drive Shaftgear Bearings

Scavenge oil from the accessory drive shaftgear bearings, inside of the diffuser case, falls through a tube to the rear gearbox housing. This tube is located just forward of the accessory drive shaft. Through internal passages in the rear gearbox housing the oil reaches the sump. Oil from the accessory drive gears and bearings also falls into this same sump.

Oil Cooling System

From the oil outlet pad on the gearbox housing assembly, the oil is piped to the fuel-oil cooler, then to the air-oil cooler and from the air-oil cooler to the oil tank. These units are airframe supplied parts.

Fuel-Oil Cooler

This is a cylindrical unit mounted in the front lower right quadrant of the diffuser case. Fuel flows through tubes in the core of the cooler, and oil circulates within the housing and around the outside of the core tubes. Engine oil which has not been heated sufficiently by engine operation to require cooling is prevented from entering the cooler by a thermostatic valve located in the inlet connection of the cooler. This unit will be discussed further in the oil chapter. See Chapter 79.

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ENGINE - DESCRIPTION AND OPERATION

Breather System

General

All breathing is done through the gearbox assembly. Inside this assembly and attached to the fuel pump drive shaft is an impeller which serves as a centrifugal device to remove oil from the air. Internal passages and external tubing are used to connect all breathing points to the gearbox assembly. An overboard breather tube furnished by the airframe manufacturer is attached to an adapter on the upper left side of the gearbox assembly.

No. 1 Bearing and Front Accessory Breathing

See Figure 52.

The space behind the front accessory drive support and the No. 1 Bearing is vented by means of an "O" ring sealed transfer tube, to a tube through the 12:30 o'clock vane than to a fitting on the outside of the outer shroud of the compressor inlet guide vane and shroud assembly. A connector and a flexible tube carry breathing air from the outer shroud fitting to the external breather tee. On outboard engines, this flexible tube is connected to the oil tank. This tee is bolted to the compressor intermediate case at the two o'clock position between the mounting rings. A tube from the tee leads inward through a vane to the No. 2 Bearing area.

No. 2, No. 2 1/2, and No. 3 Bearings Breathing

See Figure 53.

This space is formed by the No. 2 Bearing front support and the No. 2 Bearing seal on the forward side. The No. 2 Bearing rear support and the No. 3 Bearing seal form the rear wall. The inner shroud of the compressor intermediate case forms the outside wall of the space. This space breathes through the six o'clock vane and the No. 2 Bearing oil drain adapter. The No. 2 1/2 and No. 3 Bearings use this same breathing space and passages.

No. 4, No. 4 1/2 and No. 5 Bearings Breathing

See Figures 54, through 57.

The forward wall of the compressor-to-turbine space is formed by the No. 5 Bearing support structure in the diffuser case and the seal just ahead of the No. 4 Bearing. The rear wall is the No. 5 Bearing seal system. The inner wall is the structure of the No. 5 Bearing support system. The No. 4, No. 4 1/2 and No. 5 Bearings, the accessory drive gearing, the accessory drive adapter (elbow) assembly and the No. 4 and No. 5 Bearings oil scavenge pump are all vented to this space. The accessory drive adapter vents through the strut that carries the accessory drive shaft. The twelve o'clock diffuser case strut is open from this

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space to a pad on the top of the diffuser case. An elbow bolted to this pad connects to a tube. The forward end of this tube is connected to the tee that was mentioned in connection with the No. 1 Bearing and front accessory case breather.

No. 6 Bearing Sump

See Figures 58 and 59.

This area has two possible breathing passages. One is through its scavenge system. The other is through the No. 4 1/2 Bearing lubrication system. The tubes in the No. 4 1/2 Bearing oil tube shield assembly do not run full of oil. The jet tube that feeds oil into the sleeve that is their common rear termination is not tight on this sleeve. Air from the No. 6 Bearing area can enter these tubes along with the No. 4 1/2 Bearing oil. Because the tubes taper outward as they go forward, centrifugal force is used to make the oil move forward to the No. 4 1/2 Bearing. These tubes, therefore, do not have to run full of oil under pressure. The No. 6 Bearing area breathing air follows the same path as the No. 4 1/2 Bearing oil supply and eventually breathes through the same passages used by the No. 4 1/2 Bearing oil supply. Air flow will always be in the same direction as oil flow in these tubes. This is because of the slight pressure that is created in the No. 6 Bearing area by leakage of 9th stage air through the No. 6 Bearing carbon seals.

Accessory Component Drive Gearbox Assembly

In the foregoing it was shown how all breathing is to the gearbox assembly. Also as has been mentioned, inside of this case and mounted on the fuel pump drive shaft is a centrifugal device to remove oil from the air. It resembles a pump impeller with its vanes enclosed on both sides. The inside diameter of the breather assembly is vented to inside the front end of the fuel pump drive shaft The forward end of this shaft is open to a passage in the cover of the gearbox assembly. An internal passage in the cover casting leads to an outlet at the top right hand corner of the casting. The breather adapter is mounted on the gearbox rear housing in this area.

Cooling Air System

Cooling air for the third and fourth stage disk and seals is furnished by the front compressor. Leakage at the rear of the ninth stage blade platform enters the front compressor rotor assembly through holes in the front compressor rear hub. The air then enters the front end of the front compressor drive turbine shaft and passes rearward through the hollow shaft. The cooling air leaves the shaft through holes in the turbine disk spacer between the third and fourth disk and in the turbine rotor hub. It flows outward through a hole in the air seal and past a knife-edge seal in the hub to cool the rear face of the third stage turbine and the rear face of the fourth stage turbine. Leakage past a triple seal between the third and fourth stage turbine cools the front face of the fourth stage turbine. A hole in the extruded flange of the second stage turbine permits this cooling air to be static in the area above the seal between the second and third stage turbine.

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ENGINE - DESCRIPTION AND OPERATION

Rear compressor air from the sixteenth stage leaks by the air seal of the rotor and enters the diffuser case inner cavity forward of the No. 4 Bearing heatshield. It then passes through holesin the inner periphery of the case to a chamber formed by the diffuser case inner and outer walls. From here it passes through holes in the diffuser case rear flange to the air space between the No. 5 Bearing support to enter the area between the turbine nozzle inner case and the first stage turbine seal support. The air then leaks past the air seals at the front of the first stage turbine disk to mix with the exhaust gases cooling the front of the turbine as it goes or enters larger holes in the extended inner flange of the disk and then past knife-edge seals to cool the rear face of the first stage turbine and the front face of the second stage turbine.

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ENGINE - TROUBLESHOOTING

1. Troubleshooting

A. General

(1) To find and correct engine troubles first study the symptoms carefully, then check each possible cause beginning with the most probable, until the exact cause of the trouble is determined. Thorough acquaintance with the engine will result in a minimum of running defects, but these may occur as a result of inadvertently exceeding operational limitations under adverse conditions. Before attempting to diagnose the trouble or to work on an engine which has been reported malfunctioning during flight, consult the pilot's flight report and all other pertinent data for information which might help in diagnosing the trouble.

(2) Due to inherent differences in individual engines and/or engine aircraft installations, it has not been found feasible to establish specific drainage limits for the JT3D overboard breather. Each case should be evaluated on the basis of experience and engine history. An engine should be rejected for further investigation only when the following conditions exits:

(a) Discharge from the overboard breather is substantially greater than that of other engines of the same model or where a definite increase in the amount of discharge is noted for an individual engine.

(b) Oil consumption shows a rapid increase and/or the oil consumption exceeds four pints per hour (0.5 gallon per hour). If any of the above conditions are noted, an attempt should be made to isolate the section of the engine involved to assist in troubleshooting.

(3) If, during operation, engine oil temperature exceeds maximum steady state temperature limit of 270°F (132°C) for more than 15 minutes, see Oil Temperature Over Limit chart in this section.

NOTE: If oil temperature should exceed 290°F (143°C) for more than 15 minutes but does not "peg-out" to 302°F (150°C) a "fly-back" period of ten hours is permissible. "Fly-back" limit is valid only on compliance with normal corrective action (oil drained, external oil screens inspected, and cause of overtemperature corrected). Ground action as attached below will still be required following return of engine to nearest maintenance base.

B. Chart

Refer to Figure 101.

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ENGINE - TROUBLESHOOTING

2. Oil Temperature Over Limit

A. Corrective Action

Main Oil Temperature More Than	Main Oil Temperature But Not Exceeding	Time Interval	Malfunction	Ground Action
270°F (132°C)	290°F (143°C)	More Than 15 Min.	P&WA Thermostat Other	(1) (1)
290°F (143°C)	302°F Gage (150°C) Pegged	Less Than 15 Min.	P&WA Thermostat Other	(2) (3)
290°F (143°C)	302°F Gage (150°C) Pegged	More Than 15 Min.	P&WA Thermostat Other	(3) (3)
290°F (143°C)	320°F or the 302°F (150°C)* Gage Does Not Peg-Out (160°C)	Less Than 15 Min.	P&WA Thermostat Other	(1) (1)
290°F (143°C)	320°F (160°C)	More Than 15 Min.	P&WA Thermostat Other	(3) (3)

*150°C Reading is acceptable providing needle is not pegged.

Ground Action

B. Ground Action

(1) Correct cause and continue, providing no engine damage is indicated.

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(2) Check thermostat and bypass valve (See Note).

(a) If one is bad-the engine oil shall be drained, all external oil elements shall be inspected for foreign matter and corrective action taken for cause of overtemperature. Engine may continue in service providing no engine damage is indicated. For those engines incorporating a bypass valve only, per SB 3571, and this unit is failed, then ground action (2) applies.

(b) If both elements of thermostat valve are defective - ground action (3) applies.

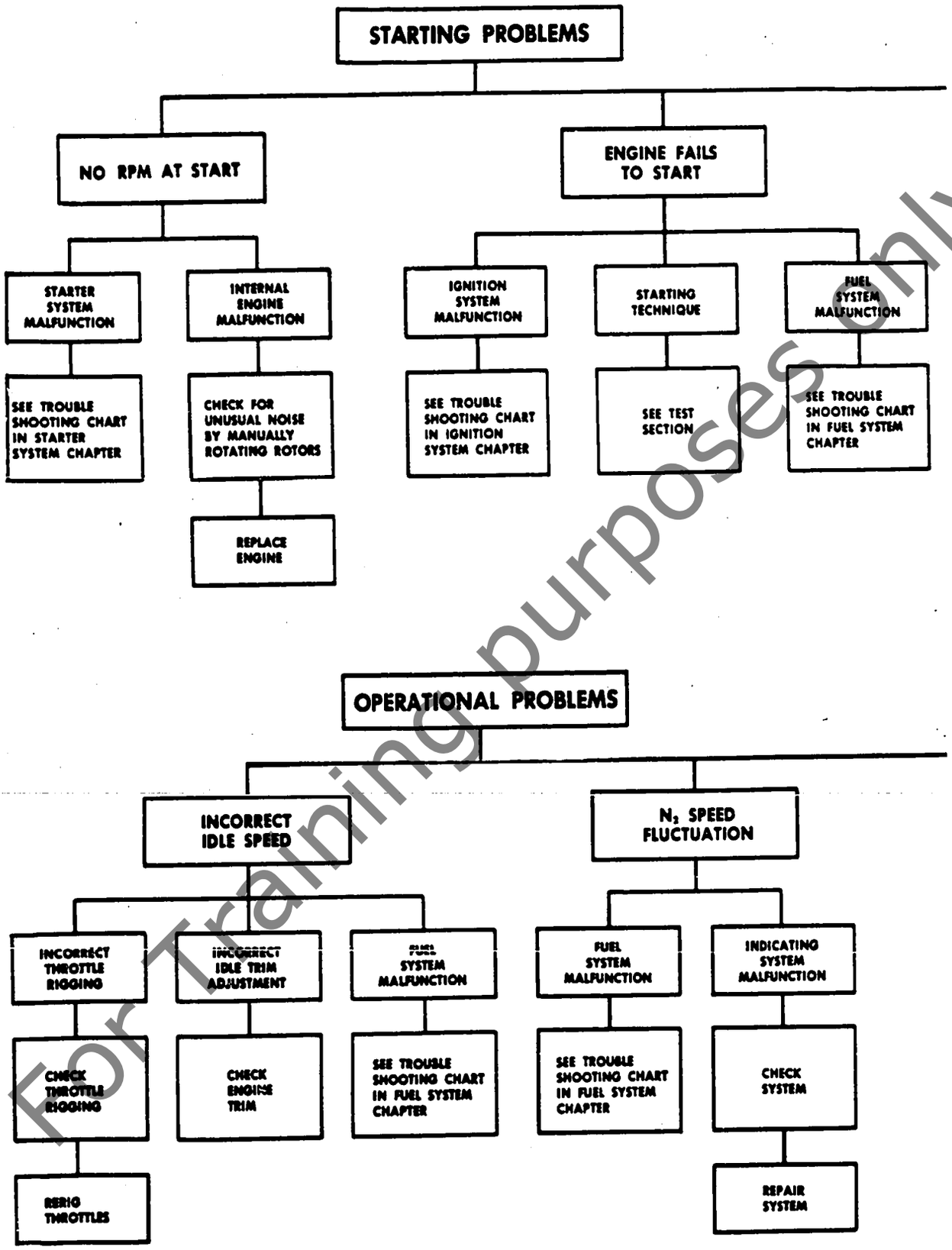
(3) Comply with (2) (a) oil drain and screen inspection. Additionally the gearbox accessory drive bearings will be checked for heat discoloration. If heat discoloration exists, all main bearings and seals must be removed for overhaul inspection. If no discoloration exists, a hardness check must be performed. If any bearing is found to have a hardness below the minimum limit, all main bearings must be removed for overhaul inspection. If neither heat discoloration or below Rockwell hardness is found, all main bearings and seals may be considered serviceable.

NOTE: It is permissible to check the thermostat flow valve assembly as follows.

(a) Ascertain that pressure relief spring housing is snug against retaining ring in the cap. Then check spring by exerting approximately 65 psig on cone which should permit bottoming.

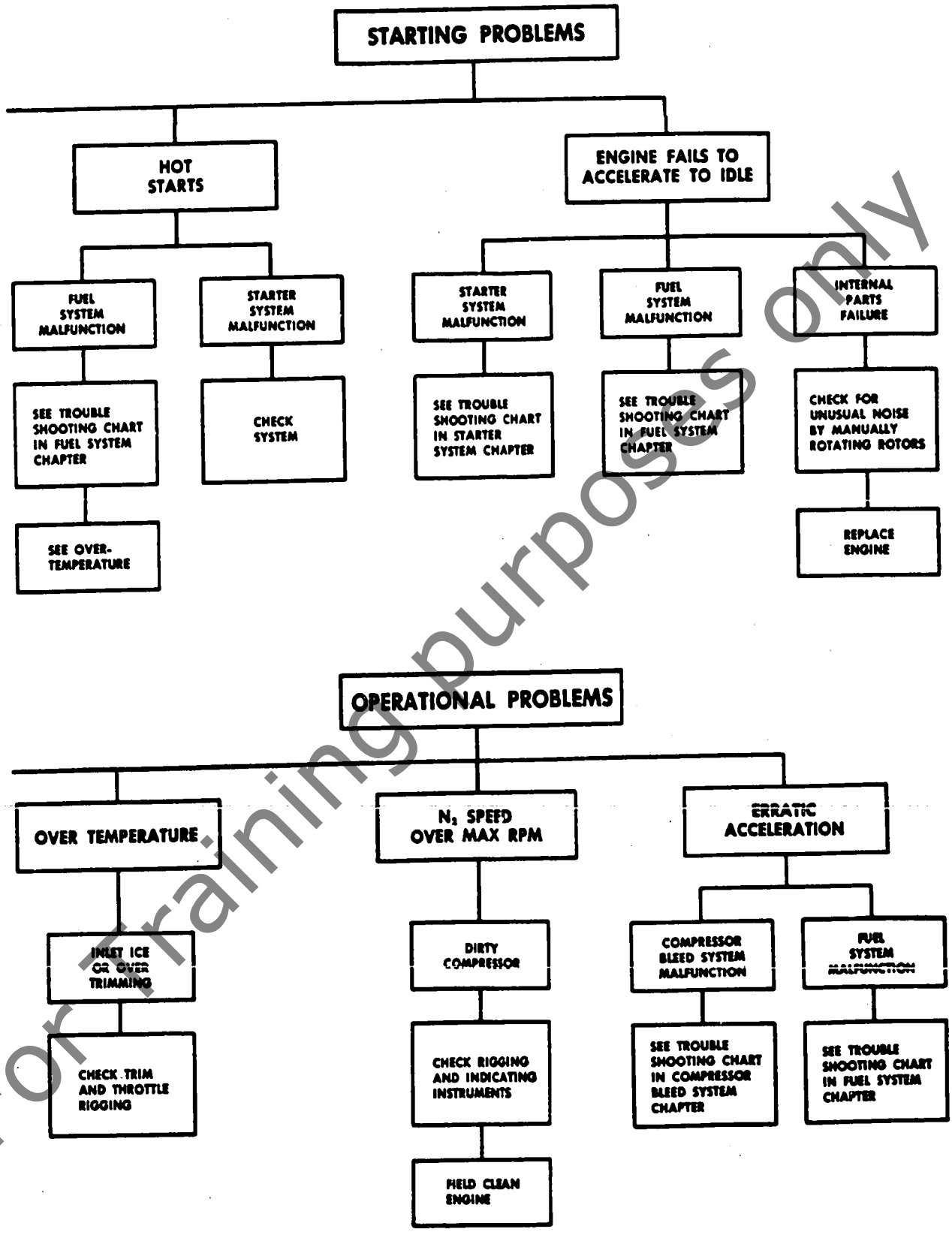
(b) The thermostatic section of the valve may be checked by dipping in 185°F (85°C) oil. The valve should lengthen at least 0.285 inch between ambient temperature 100°F (37.38°C) and below and 185°F (85°C).

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Engine Troubleshooting Chart
Figure 101 (Sheet 1)



For Training purposes only

ENGINE - SERVICING

1. Periodic Inspection

(1) The life of the engine and its associated equipment is determined by operational conditions. The inspection system must anticipate these conditions. See Inspection/Check for periodic inspection procedures.

2. Repair

(1) The permissible repair procedures for line maintenance are listed in Approved Repairs. These repairs can be made at any airport.

3. Fuel

A. General

(1) The fuel for the engine shall conform to PWA-522 Specifications.

(2) Fuel contamination may occur in shipment, during transfer from one container to another, or in the aircraft fuel system from scale, lint from packings and seals, and deterioration of fuel lines and hoses. Serious malfunction of the engine will occur, even to the extent of engine stoppage, as a result of contaminants in the fuel reaching the engine fuel system. It is important, that the mesh screen in the aircraft fuel system upstream of the engine fuel pump be inspected periodically for removal of all foreign particles.

B. Fuel Drainage

See Section 71-5, Adjustment/Test

4. Fuel Tanks

See Chapter 28.

5. Oil

A. General

(1) The synthetic oil for the engine shall conform to PWA-521 Specifications.

(2) The engine internal oil system is shown schematically in Figure 48.

B. Oil Connections and Servicing Drains

(1) The oil connections are separated into two groups; overboard drains and operational connections. The servicing drains are not aircraft oil connections but are used to drain oil from engine low points.

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6. Storage of the Shipping Container

A. Remove the humidity indicator from the observation port and remove the dehydrating agent from the bottom of the sealing cover. Place all the internal components, bolts, nuts, side rails, and brackets in the container. Secure these units and then secure the container side sections and cover for storage.

7. Preservation/Depreservation of the Engine

CAUTION: UNDER NO CIRCUMSTANCES SHALL PRESERVATIVE OIL BE SPRAYED INTO THE COMPRESSOR OR TURBINE END OF THE ENGINE. DIRT PARTICLES DEPOSITING ON THE BLADES AND VANES DURING OPERATION WILL ALTER THE AIRFOIL SHAPE AND ADVERSELY AFFECT COMPRESSOR EFFICIENCY.

A. Engine Oil System Preservation

(1) The following procedures shall be followed for the preservation of engines which are to be inactive, when engine motoring and periodic maintenance will not be performed.

(a) Rotate the engine with the starter or auxiliary power unit at the starter pad until oil pressure and high compressor (N2) speed is indicated. Disengage starter.

(b) Open the drain on the bottom of the oil tank and remove the drain plug from the bottom of the N2 gearbox. Drain all oil into suitable containers.

(c) With the drains open, motor the engine over to 1200 ±100 rpm with the starter, allowing the scavenge pumps to clear the engine, indicated by a cessation of a steady stream of oil from the drains. To prevent excessive operation with limited lubrication, limit the rotation to the shortest possible time to fulfill the above requirement. Starter operating time limits should not be exceeded.

(d) Remove the main oil strainer and rinse the assembly in petroleum solvent.

(e) Allow the engine oil to drain to a slow drip for approximately 1/2 hour.

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(f) Install the oil strainer and close the previously opened drains.

(g) Fill oil tank with new engine oil.

(h) Motor the engine over with the starter until oil pressure indication is observed.

(i) Start and operate the engine for five minutes at 75 percent normal rated and shut down engine. Specific engine operating instructions should be observed during the preservation run.

(j) Drain the oil tank and accessory case by opening the oil tank drain and removing the drain plug from the bottom of the N_2 gearbox. Drain the oil into suitable containers.

(k) Close the oil tank drain and reinstall the N_2 gearbox drain plug.

(l) Remove tne cover plates from the pads of accessory drives upon which accessories are not installed and spray the exposed surfaces with engine oil. Reinstall the cover plates.

(m) Plugs, caps, covers, or screens should be installed over all openings to prohibit the entrance of foreign material and accumulation of moisture.

(n) If the engine is to remain in the aircraft, install 52 pounds of dehydrating agent, distributing 26 pounds in the compartment. The balance should be distributed equally in aircraft inlet and exhaust section.

(o) Oil filler caps should be tagged as to the preservative used and date of preservation. Using an air tight moisture barrier or other suitable covers, cover the air inlet and exhaust end of the engine compartment, installing a humidity indicator at each end. Inspection windows at each end should be provided through which the indicators will be visible.

(p) Inspection of the preserved unit should be made every two weeks if the aircraft is stored outside or every 30 days if the aircraft is stored inside. If the relative humidity as indicated on the humidity cards is 40 percent or less, no further action is required. If humidity indications are 40 percent or higher, the unit should be depreserved, then represerved.

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B. Fuel System Preservation

NOTE: On engines modified by SB 3721, dump valve overboard drain and signal lines have been removed and the ports plugged. To perform fuel system preservation on these engines, remove plugs from dump valve overboard drain and signal ports and disregard step (2).

(1) Place suitable container, having minimum capacity of 5 gallons, under pressurizing and dump valve overboard drain.

(2) Disconnect dump signal line from pressurizing and dump valve to fuel control on either end. Install pressure tight closure on passage leading to fuel control, leaving passage to dump valve open at atmosphere.

(3) Disconnect fuel-in supply at inlet pad of fuel pump and connect supply of filtered flushing oil at pressure of 5 to 25 psi and minimum temperature of 60°F (15°C). Extreme care should be taken to prevent foreign material from being drawn into engine fuel system. Equipment should be provided with suitable filters and/or strainers of no coarser mesh than used in engine. 10-micron filter is recommended for this purpose.

(4) With ignition switch off and stand fuel shutoff valve closed, move fuel control lever to full OPEN position. Motor engine at a speed of 1700 ±100 rpm with starter until at least 2 gallons of oil have discharged out overboard dump line. During motoring period control lever should be moved from open to closed to open.

(5) Remove closure from dump signal passage leading to fuel control and reinstall line to pressurizing and dump valve fitting.

NOTE: On engines modified by SB 3721, reinstall plugs in dump valve overboard drain and signal ports.

(6) Fuel control power lever should be tagged as to preservative used and date of preservation.

(7) Using an airtight moisture barrier or other suitable covers, cover the air inlet and exhaust end of the engine compartment.

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C. Engine Depreservation

NOTE: On engines modified by SB 3721, dump valve overboard drain and signal lines have been removed and the ports plugged. In order to perform fuel system depreservation on these engines, remove plugs from dump valve overboard drain and signal ports and disregard step (5).

Check all oil passages for obstructions before installing accessories which are dependent on engine oil.

(1) Remove all moisture barriers, humidity indicators, and dehydrating agent.

(2) Fill the oil tank with engine lubricating oil.

(3) Connect the fuel supply line to the fuel inlet pad.

(4) Place a suitable container, having a minimum capacity of 5 gallons, under the pressurizing and dump valve overboard drain.

(5) Disconnect either end of the dump signal line-to-fuel control tube. Leave the dump valve connection open to atmosphere. Plug the fuel control connection with a suitable plugged fitting to prevent dumping of fuel.

(6) With the ignition OFF, the fuel shutoff valve OPEN, the fuel control lever in the full open position, motor the engine over with the starter on external power source to a high rotor (N2) speed of 1200 ±100 rpm. During the motoring period, the shutoff lever should be moved from open to closed to open.

(7) When at least 2 gallons of fluid have been obtained from the overboard dump line, close the fuel control lever and disengage the starter.

CAUTION: ROTATION OF THE ENGINE SHOULD BE LIMITED TO THE SHORTEST POSSIBLE TIME IN ORDER NOT TO EXCEED THE STARTER OPERATING LIMIT.

(8) Remove the plugged fitting from the dump signal line and reconnect the signal line to the pressurizing and dump valve.

(9) Remove the preservation tags and make proper entry in the engine records.

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ENGINE SERVICING

8. Inspection of Engine During Storage

A. High Relative Humidity Indication of Engines in Storage

(1) If the humidity indicator shows the relative humidity within the container to exceed 40 percent, proceed as follows:

(a) Position the container under a suitable hoist. A free overhead space of approximately eight feet minimum, exclusive of the distance from the top of the container to the hoist hook, is required.

(b) After removing the straps, install a suitable sling to the rings in the top section of the container.

(c) Unfasten the four hooks securing the side sections of the container.

(d) Raise the top section straight up until free and clear of the engine and draw it to one side; then remove the four side sections.

(e) Using a knife, open the covering and check it for tears or holes.

(f) Check the engine for evidence of corrosion.

(g) Remove the old humidity indicator from the observation port and the dehydrating containers from the bottom of the covering.

NOTE: Care must be exercised to assure that the dehydrating agent and humidity indicator which have been removed are properly disposed of and cannot possibly be reinstalled in the container.

(h) Check the interior of the container to be sure that it is free of all dirt, oil, water, or other foreign matter.

(i) Install a new humidity indicator in the place provided (observation port). Fasten the indicator securely with the tape as required so that the transparent side is visible from the exterior of the container.

(j) Place the dehydrating agent containers loosely in the bottom of the engine covering.

(k) Close the covering and seal it with a sealing iron or equivalent.

(l) Using the guide pins, install the four sides in their position on the box and fasten the four hooks. Lower the top on the container.

NOTE: If the engine is to be shipped, install the side straps.

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ENGINE - SERVICING

9. Preservation of Non-Operable Engines

(A) Engines which cannot be operated or cannot use the methods described in Preservation/Depreservation shall be preserved by practices and procedures compatable with preservation principles of this manual.

10. Protection of Non-Running Engines

(A) Engines in aircraft left standing outside or exposed to the wind must have the inlet and exhaust duct openings covered, to prevent dirt, dust, and foreign materials from entering the engine, and to prevent reverse rotation of the low rotor due to wind blowing through the inlet or exhaust ducts.

11. Spare Engine Transportation and Storage

(A) A spare engine may be transported in an external pod or in a cargo compartment of an aircraft. In either case protect engine from corrosion, especially if humid conditions are expected to be encountered enroute to destination.

(B) Preserve engine, fuel and oil system, as directed in Preservation/Depreservation of Engine.

NOTE: In addition to following regular preservation procedures the following may be done for engines which are enroute to overhaul.

CAUTION: ENGINES WHICH HAVE BEEN SPRAYED WITH OIL INTERNALLY ARE NOT TO BE RUN UNTIL COMPLETELY DISASSEMBLED AND CLEANED.

(1) While rotating both compressor and turbine rotors with the starter, use a fine spray to apply a thin film of oil on internal parts of the engine.

(2) Direct the spray into the inlet at the start and spray the exhaust area just before the rotors stop.

(C) Install fifty-two pounds of desiccant or dehydrating agent, half in the inlet and half in the exhaust section of the engine. Be sure desiccant is properly packaged and secured.

(D) Install and secure a humidity indicator in the inlet and exhaust ends of engine.

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(5) Install appropriate external pod fairings and covers to act as moisture barriers and prevent air circulation through engine.

(6) Engines shipped in cargo compartments shall be wrapped in a nearly air tight suitable plastic type envelope or sealed by covers at the inlet and exhaust openings.

(7) Upon arrival at destination and removal of engine from aircraft remove fairings, covers, humidity indicators and dehydrating agent. Check humidity indicators before removal.

(8) Blow hot dry air through engine to remove moisture before continued storage. Hot air velocity shall not be great enough to cause engine rotations.

NOTE: If engine is to be installed in an aircraft and run immediately the drying process is not required.

(9) Continued storage shall follow established procedures.

12. Transporting Engine Using "Three-Engine Ferry" Method

A. Front and rear compressor sections, of engines being transported by "three-engine ferry", must be immobilized to prevent rotation due to air passing through engine.

NOTE: Special preparation of thrust reverser or other engine related equipment may be necessary on some installations. See applicable aircraft manual.

(1) Secure front compressor rotor using three PWA-30233 Locking Straps.

(a) Feed one end of strap into engine inboard of mid-span shroud, around trailing edge of a first stage fan blade and back outside of engine.

(b) Position strap so one end extends past leading edge of inlet guide vane approximately one inch (not including velero tape detail).

(c) Pass other (long) end of strap over leading edge of next inlet guide vane in direction of engine rotation and around trailing edge of closest first stage fan blade, causing strap to pull on blade in direction of rotation.

(d) Continue weaving strap alternately between blades and vanes keeping strap tight and always pulling compressor rotor in direction of engine rotation.

NOTE: Some blades will be skipped because there are more blades than vanes. Each strap should pass around approximately one third of the vanes.

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(e) When end of strap is reached, bring end out of engine, pull tight and overlap velero tape at each end of strap.

(f) Secure velero tape by tightly rolling overlap and whipping with nylon cord for 3 to 4 inches at each end. Wrap nylon cord and velero tape with adhesive tape and tape overlaid strap span to nearest inlet guide vanes.

(g) Continue to secure remaining portions of front compressor rotor by repeating above procedure with remaining two straps.

(2) Secure rear compressor rotor using PWA-30251 Lock.

(a) Remove starter from engine (see appropriate section in airframe manual).

(b) Place PWA-30251 Lock over studs on starter drive pad engaging lock with starter drivegear splines.

(c) Secure lock to starter drive pad studs with nuts.

13. Identification of Metal Particles

A. When unidentified particles of metal are found, they may be either steel, tin, aluminum, magnesium, silver, bronze, or cadmium. In some cases the type of metal may be determined by the color and hardness of the pieces. However, when the particles cannot be positively identified by visual inspection and knowledge of the exact character of the metal is desired as an aid to troubleshooting, a few simple tests will determine the kind of metal present.

B. The following equipment and chemicals are required to make these tests: A source of open flame, a permanent magnet, two ounces of aqueous solution containing ten percent ammonium nitrate, an electric soldering iron, two ounces each of 50 percent by volume hydrochloric acid, and concentrated nitric acid, sodium hydroxide pellets, a watch glass, a white porcelain spot plate, ammonium bifluoride crystals, 5 to 10% hydrofluoric acid or concentrated sulfuric acid, 3 to 10% hydrogen peroxide, and concentrated phosphoric acid.

WARNING: USE EXTREME CARE IN HANDLING THE ACIDS.

14. Test Procedure for Identification of Metal Particles

NOTE: The following test procedure is recommended for determining the character of unknown metal particles. For best results, follow the steps as outlined:

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A. Steel - The particles can be isolated by means of the permanent magnet. Steel or iron is attracted by the magnet.

B. Magnesium - A simple test for these particles is burning. Magnesium will burn with a bright white flash.

WARNING: NEVER ATTEMPT TO BURN MORE THAN A FEW PARTICLES OF METAL SUSPECTED TO BE MAGNESIUM. MAGNESIUM POWDER OR DUST IS EXPLOSIVE.

C. Cadmium - Place the remaining particles in the aqueous (water) solution of ammonium nitrate. If all or any of the particles dissolve in this solution, they are cadmium. After this test, rinse and dry any remaining particles.

D. Tin - The tin particles can be distinguished by their low melting point. With a clean soldering iron, heated to 500°F (260°C) and tinned with 50-50 solder (50 percent tin - 50 percent lead), a tin particle dropped on the iron will melt and fuse with the solder.

E. Aluminum - When a particle of aluminum is placed in hydrochloric acid 50 percent by volume, it will fizz with rapid emission of gas bubbles and gradually disintegrate and form a black residue (aluminum chloride). Silver and bronze do not noticeably react with hydrochloric acid.

F. Aluminum Paint - Use this procedure to determine whether or not the material is aluminum silicone paint, aluminum chips, or silver particles.

WARNING: HYDROCHLORIC ACID IS DANGEROUS AND REQUIRES SPECIAL HANDLING.

(1) Make a sodium hydroxide solution by adding one pellet of sodium hydroxide to three cubic centimeters of water.

(2) Place several drops of this solution in a watch glass and drop in the suspected particles.

(a) If the particles are aluminum silicone paint, there will be a mild reaction in the form of gas bubbles and some visible gas as the particles change to sodium aluminate.

(b) If the particles are aluminum chips, the reaction will be much more active with many more gas bubbles forming and more visible gas.

(c) If the particles are silver, there will be no reaction.

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G. Silver - When a silver particle is placed in nitric acid, it reacts rather slowly, producing a whitish fog in the acid.

H. Bronze - When a bronze (or copper) particle is placed in nitric acid, a bright green cloud is produced.

15. Test Procedure for Identification of Titanium Particles

A. Place a piece or pieces of the metal to be identified on a white porcelain spot plate. A piece of titanium or titanium bearing metal should be placed on another spot plate to observe and verify the results obtained.

B. Add several crystals of ammonium bifluoride and 5-10 drops of water to the metal particles. (2-3 drops of a 5-10% hydrofluoric acid solution can be used instead.)

C. Let stand 20 to 30 minutes, or until the solution becomes slightly discolored.

D. Add 2-3 drops of 1:1 sulfuric acid (1 part water to 1 part concentrated acid).

E. Let stand 20-30 minutes, or until solution becomes more discolored.

F. Add 3-4 drops of 3-10% hydrogen peroxide. Solution must not be too old.

G. If titanium is present a yellowish color will develop. This yellow color will become progressively darker with time, if allowed to set.

H. Add 2-3 drops of concentrated phosphoric acid, and stir to discharge any yellow color due to the possible presence of iron.

I. Any light yellow to orange coloration indicates the presence of titanium.

NOTE: Above chemicals are hazardous and require special handling. Solid ammonium bifluoride is crystalline and can be conveniently stored in a dry place and used as needed.

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ENGINE - DISMANTLING/ASSEMBLY

1. Air Frame Parts

A. Refer to Chapter 71, as required, for information concerning removal of airframe installed parts.

B. Alternator Drive Adapter Pad

CAUTION: THIS MOUNT PAD MAY INCORPORATE MID-GRIP TYPE HELICAL INSERTS IDENTIFIED BY THE HEXAGONAL APPEARANCE OF ONE THREAD AND BY RESISTANCE WHEN TURNING BOLT BY HAND WITH UNIFORM THREAD DRAG, WHICH LOCKS THE BOLT IN PLACE, WHEN TURNED WITH A WRENCH. GASKET MUST BE INSTALLED SO AS NOT TO OBSTRUCT OIL PASSAGE HOLES. REMOVE THE TEST PLUGS FROM THE OIL PASSAGES IN THE ALTERNATOR DRIVE ADAPTER PAD BEFORE INSTALLING THE ALTERNATOR DRIVE ADAPTER.

C. Accessory Housing Breather

CAUTION: ON BOEING ENGINES ONLY THE ROTARY BREATHER SEAL CARRIER MUST EXTEND TO THE FACE OF THE BREATHER MOUNT PAD OR INCLUDE A SPACER P/N 446978.

2. General Maintenance Procedures

NOTE: PWA 9156-51 Engine Air Inlet Cover And PWA 9156-52 Engine Turbine Exhaust Cover have been provided to prevent foreign objects from entering engine. Use these tools as required during engine maintenance.

A. To ensure proper reinstallation, tag and mark all parts, clips, and brackets as to their location.

CAUTION: IT IS POSSIBLE TO ASSEMBLE CERTAIN ENGINE PARTS IN A LOCATION OR IN OTHER MODELS OF ENGINES FOR WHICH THESE PARTS WERE NOT INTENDED. BECAUSE SUCH MIS-ASSEMBLY CAN POSSIBLY RESULT IN A FAILURE, CHECK EACH PART TO BE SURE CORRECT PART IS USED.

B. During removal of tubes or engine parts look for indications of scoring, burning or other undesirable conditions. To facilitate reinstallation observe the location of each part during removal. Tag unserviceable parts and units for investigation and possible repair.

C. Extreme care shall be taken to prevent dust, dirt, lockwire, nuts, washers, or other foreign matter from entering the engine. If at any time such items are dropped, the assembly process must stop until the dropped articles are located, even though this may require a considerable amount of time and labor. Before assembling or installing any part, be sure it is thoroughly clean. Suitable plugs, caps, and other covering shall be used to protect all openings as they are exposed.

NOTE: Dust caps used to protect open lines against contamination shall always be installed over the tube ends and not in the tube ends. Flow through the lines may be blocked off if lines are inadvertently installed with dust caps in the tube ends.

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D. Lockwire, lockwashers, tablocks, tabwashers, or cotterpins shall never be reused. All lockwire and cotterpins must fit snugly in their holes. Install a cotterpin so that the head fits into the castellation of the nut, and unless otherwise specified, bend one end of the pin back over the stud or bolt and the other end down flat against the nut. Only lockwire and cotterpins made of corrosion resistant steel shall be used. Bushing plugs shall be lockwired to the assembly boss or case. Do not lockwire the plug to the bushing.

E. Replace all gaskets, packings, and rubber parts at every removal/installation. Make sure that new nonmetallic parts to be installed (such as an oil seal) show no sign of having deteriorated in storage. If necessary, coat gasket surfaces with Gredag Lubricant to reduce the possibility of the gasket adhering to the surfaces of mating parts.

F. In order to protect critical areas of engine parts (such as compressor and turbine disks) against scratches and nicks, tool surfaces contacting these areas must be covered with a protective material.

CAUTION: BEFORE USING TOOLS SO COVERED, MAKE CERTAIN THAT THERE IS SUFFICIENT PROTECTIVE MATERIAL PRESENT TO PRECLUDE THE POSSIBILITY OF DAMAGING ENGINE PARTS.

G. If any part were coated with corrosion preventive compounds, all traces of this compound and accumulated foreign matter must be removed.

H. Tubes which incorporate a fixed ferrule and a loose nut shall have the seal retaining nut at the fixed ferrule end of the tube tightened first.

3. Silicone Rubber "O" Rings

A. At all assembly operations, whenever silicone "O" rings of the materials listed below are being installed, use only petrolatum, Snow White Parmo No. 2F or equivalent, as the lubricant, applied sparingly, on the rings. The colors of the "O" rings which, in general, are affected are red and off-white.

B. Ester type oils (turbine oils) must not be used.

Silicone Rubber "O" Ring Materials Affected

AMS-3301	AMS-3305	AMS-3334	AMS-3345
AMS-3302	AMS-3315	AMS-3335	AMS-3346
AMS-3303	AMS-3320	AMS-3336	AMS-3356
AMS-3304	AMS-3332	AMS-3338	AMS-3357

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4. Installation of "O" Ring and Jamnut Type Connector (Universal Fittings)

A. Install jamnut type connectors in accordance with Figure 401.

B. Measure the thread protrusions as shown in Sheet 3 of Figure 401. The recommended torque limits and thread protrusion limits for various fittings are outlined in the table in Figure 401.

5. Assembly of Flexible Type Fittings

A. Assemble oil and fuel line flexible fittings in accordance with Figure 402.

6. Installation of Elbow Type Fittings

CAUTION: BEFORE TIGHTENING TUBE COUPLING NUTS, BE SURE THAT ELBOWS ARE PROPERLY ALIGNED. TUBE ENDS MUST BE CENTERED AT THE ELBOWS AND BE FREE TO MOVE. BINDING OF TUBE AND FITTING OR MISALIGNMENT MUST NOT BE PRESENT.

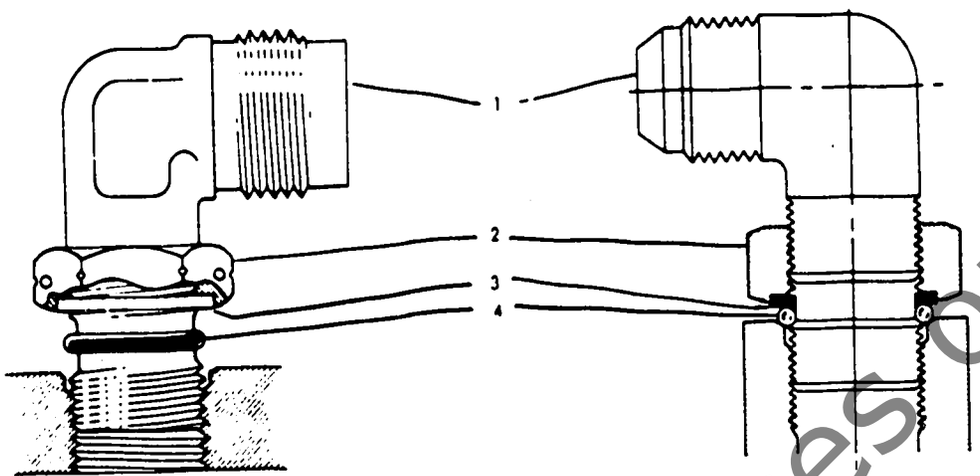
7. Antigalling Compounds

A. The following instructions cover the use of antigalling compounds.

(1) When splines of any kind are to be mated, they must be properly lubricated.

(2) All accessory splines which do not normally receive lubrication through engine systems must be lubricated with Plastilube No. 3 compound.

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1. CONNECTOR ELBOW
2. JAMNUT
3. PACKING
4. SEAL

(a)
INITIAL CONTACT BETWEEN SEAL AND HOUSING

a. Coat the male threads of the fitting, "O" ring seal and packing sparingly with petrolatum, Specification VV-P-236 (vaseline) or jet engine oil. Plastic packing requires no moistening.

b. Assemble the nut on the fitting with the counterbored face toward the engaging end.

c. Work the packing into the nut counterbore. Leather packings must be assembled with the smooth side toward the "O" ring seal.

d. Install the "O" ring seal on the non-threaded annulus of the fitting.

e. Turn the nut down until the "O" ring seal is positioned in the annulus firmly against the threads to be installed in the mating part

f Install the fitting into the mating part, turning the nut with the fitting until the "O" ring seal contacts the mating part boss This point can be determined by an increase in torque. With the fitting in this position and while now holding the nut to prevent its turning, screw the fitting into the mating part an additional one and one-half turns.

NOTE From this point the fitting can be further turned inward only to a maximum of one additional turn for alignment purposes If the fitting tightens in the nut before completing one and one-half turns or before the fitting can be aligned, it will be permissible for the nut to turn with the fitting for the remainder of the distance

g With the fitting held in its properly aligned position, tighten the jamnut to the recommended torque and lockwire

h. Metal to metal contact between the nut and the mating part boss must be obtained without exceeding the recommended torque values and no extrusion of the "O" ring seal or back-up packing is permitted It is essential that the proper values based on metal to metal contact mentioned above be observed when tightening the jamnut. This will minimize the possibility of the fitting loosening and resultant thread wear

L-7521

WARNING

Failure to accomplish installation in accordance with these instructions may result in subsequent failure, fire, extensive damage and loss of life.

"O" Ring and Jamnut Type Connector
Figure 401 (Sheet 1)

(3) Molybdenum disulfide, in either its powder form or suspended in some vehicle such as alcohol or engine oil, has been found satisfactory for certain assembly applications.

NOTE: Since molybdenum disulfide is not stable above 900°F (482°C), it must not be used in locations where operating temperatures are in excess of 900°F (482°C).

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THREAD PROTRUSION AND TORQUE LIMITS

THREAD SIZE	TORQUE LIMITS	FITTING PART NUMBERS	THREAD PROTRUSION LIMITS*
1.625-12	.600-900	196826, 215812, 222090, 254498	1-2
		405623	0.900 to 1.000 inch from mating face of nut to mating face of coupling mount flange when nut is tight against adjacent part.
		332627, 462254	0.166" Max from undercut
		390998	0.476" Max from undercut
1.3125-12	500-700	183649, 198420, 214163, 253424	0-1
		226110, 227470, 323462	1 1/2 - 2-1/2
		183653	3-4
		170987 (with thread undercut)	1 1/2 - 1-1/2
		170987 (without thread undercut)	2-3
		417813	2-3
1.0625-12	300-500	235157, 307450, 314431, 317408	0-1
		226112	1-2
		418842	5-8
0.875-14	200-350	224913	0-1
		321677	1-2
0.750-16	150-250	223923, 278121	0.100" Max from undercut
		218217, 331583	0.234" Max from undercut
		232179, 443519	0-1
		341231	1 1/2 - 1-1 1/2
		155974, 321675	1 1/2
		150697, 227456, 361593	2-3
		355812	5-6
0.5625-18	75-125	229161	1-2
0.500-20	60-80	222172, 265050	1 1/2 - 1-1 1/2
		303035, 315335, 363010	1-2
		282715	2-1 1/2 - 3-1 1/2
		431952	0.105" Max from undercut
0.4375-20	40-65	190682	0.209" Max from undercut
		210247, 233548, 234097, 268652	0.080" Max from undercut
		240875, 360691	1 1/2 thread max
		168974, 170493, 183630, 228640, 237346	0-1
		243308, 252790, 331097, 433116, 454210	0-1
		164433, 224877, 249600, 252785	1 1/2 - 1-1 1/2
		260962, 266284, 307064, 361589, 388207	1 1/2 - 1-1 1/2
		276754	2-3
		348650	4-6
0.375-24	30-50	258086, 274359	1-3

*Limits shown are "Full Threads" exposed on the fitting, beyond the jamnut. A full thread is defined here as a thread crest with a complete root radius on each side of it.

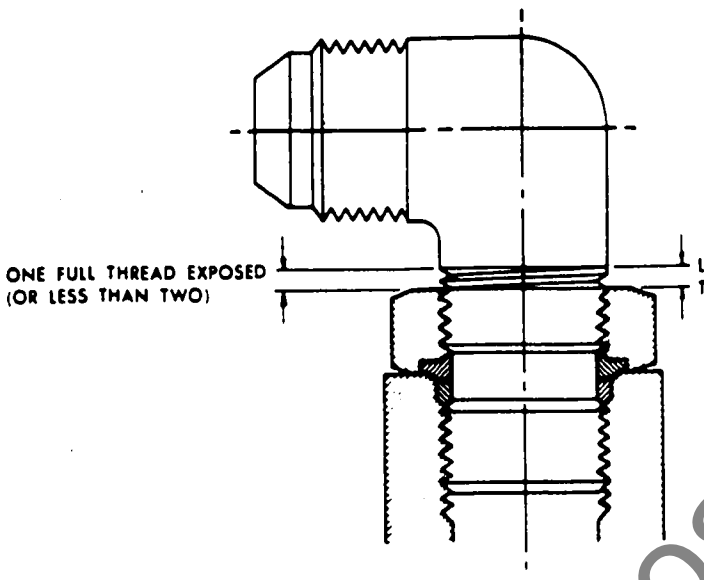
High limit on thread protrusion is set to be sure that at least three full lower threads of fitting are engaged under all tolerance conditions. Thread protrusions below low limit indicate possible connection faults associated with fittings installed too deep. Seal or packing omission or extrusion, very loose nut, or inadequate seal annulus. If fitting is found to have too many threads exposed upon periodic service check, fitting must be removed and reinstalled. If there are still too many threads exposed, fitting must have extreme tolerances and if installation procedure was followed correctly, proper thread engagement may be assumed

UNSATISFACTORY CONNECTION CONDITIONS AND METHODS OF PREVENTION

CONDITION	POSSIBLE RESULT	INSPECTION INDICATION
1. No Packing and/or seal	Leakage	Possibly beyond Thread Limits or Leakage Check
2. Inadequate Seal Groove - Fitting too deep	Leakage	Too few threads protruding or visible packing extrusion
3. Inadequate Seal Groove - Fitting too high	Leakage or See No. 4	Too many threads protruding
4. Insufficient lower thread engagement	Lower thread failure	Too many threads protruding
5. Loose Nut - Nut Undertorqued	Vibration failure of Lower threads	Test torque, or too few threads protruding or no metal to metal contact
6. Seal or Packing Extrusion	See No. 5 Torque lost due to re laxation of pinched packing	No metal to metal contact or visible extrusion
7. Re-use of seals, repositioning of fitting after tightening nut	Leakage	Leakage check

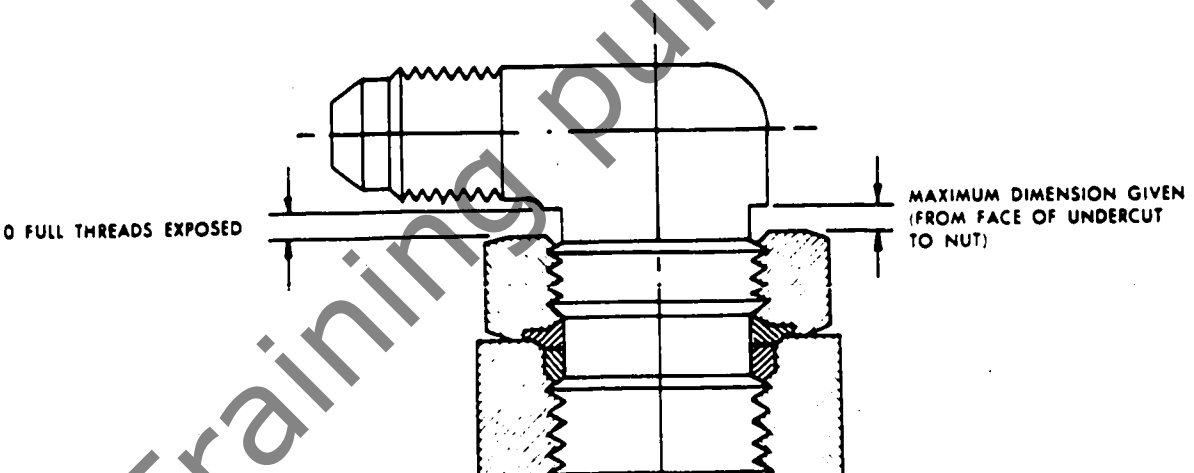
L-19071

For Training purposes only



(b)
TYPICAL POSITION AFTER
INSTALLATION (STANDARD FITTING)

$\left(\text{THREADS EXPOSED} = \frac{0+1}{2} = \frac{1}{2}\right)$



(c)
TYPICAL POSITION AFTER
INSTALLATION (UNDERCUT FITTING)

To check thread protrusion, count Whole Numbers of full threads exposed at each end of a diameter and use the average of these two readings. For example, one-half thread means that one (or less than two) full thread is visible on one side and zero or less than one full thread is visible 180 degrees away, as shown in (b). For limits other than zero, a reading error of one-half thread is expected. When there is a thread undercut at the upper end of the fitting thread, in some cases even a zero thread high limit would not ensure sufficient engagement. For these cases, maximum dimensions have been given, from the rear face of the undercut to the nut, as shown in (c).

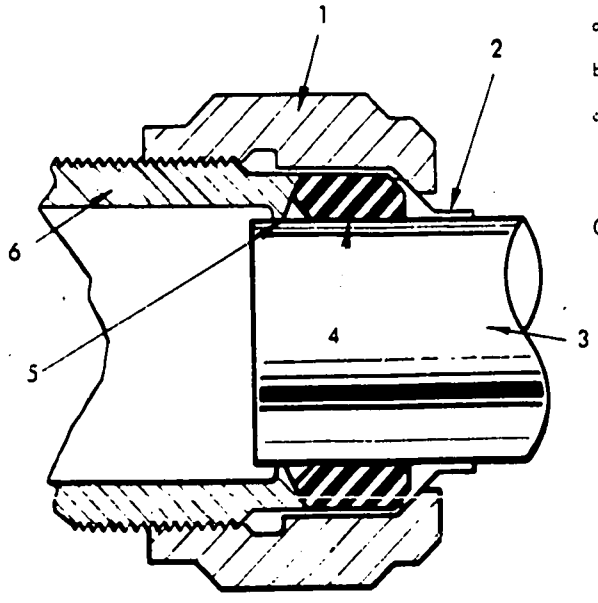
WARNING

L 7523

Failure to accomplish installation in accordance with these instructions may result in subsequent failure, fire, extensive damage and loss of life.

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"O" Ring and Jamnut Type Connector
Figure 401 (Sheet 3)



a Moisten the rubber seal with petrolatum and install it on the tube end against the ferrule.
b Install the retainer on the tube positioning it against the packing or seal. Minimize stretching of the retainer to insure a tight fit.
c Install tube to properly aligned connector and tighten nut to the recommended torque.

CAUTION: IF THE RETAINER IS NOT USED THE PACKING OR SEAL MAY PROTRUDE BETWEEN THE TUBE AND THE CONNECTOR AND PIECES OF THE RUBBER MAY ENTER THE SYSTEM.

1. Nut
2. Ferrule
3. Tube
4. Packing or Seal
5. Retainer
6. Connector

L-23237

Flexible Fittings
Figure 402

(4) An extreme pressure lubricant, Lubriplate No. 130A or equivalent has been found satisfactory for use on all tight press fit splines.

CAUTION: EXTREME CARE MUST BE EXERCISED TO SEE THAT ANTI-GALLING AND ANTISEIZE COMPOUNDS ARE APPLIED IN A THIN EVEN COAT AND THAT ALL EXCESS MATERIAL IS COMPLETELY REMOVED SO AS TO AVOID ITS GETTING INTO OR ONTO PARTS, PASSAGES, OR SURFACES WHERE IT MAY CAUSE MALFUNCTIONING OR EVEN FAILURE OF THE ENGINE.

8. Antiseize Compounds

A. In order to facilitate subsequent disassembly, apply Ease-Off 990 or Fel-Pro C200 antiseize compound to all threaded parts attached to the hot section except silver plated threaded parts, fuel fittings, and locations where another compound is specified.

9. Gasket Lubricant (Gredag)

A. Where necessary, coat gasket surfaces with Gredag Lubricant to reduce the possibility of the gaskets adhering to the surfaces of the mating parts.

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ENGINE - DISMANTLING/ASSEMBLY

10. Keywashers

A. Definition and Purpose

(1) A keywasher is a washer-like locking device which uses keys (tabs) to lock parts together.

(2) These instructions concern single or multiple hole keywashers with two or three unbent keys (or tabs) per hole.

(3) An unbent key is one which is bent, or locked, following installation of the part, but which may be partially bent or preformed during manufacture.

B. Locking Procedure

(1) Once removed a new keywasher must be used at assembly. Use a keywasher only one time.

(2) All keys on the keywasher are to be bent as a safeguard against reuse.

(3) When locking a single hole keywasher bend one key full against a flat face on the nut or bolt head to be locked. Other keys may be bent in any convenient manner.

(4) When locking a multiple hole keywasher bend one key for each hole full against a flat face of the nut or bolt head being locked. Other keys may be bent in any convenient manner.

(5) When installing keywashers which have ID tabs which mate with a slotted shaft proceed as follows.

(a) Use fine crocus cloth, stone, or file to remove spalled or rough surface from face of nut. Remove sharp edges from inside tool slots and around outside diameter of nut face.

(b) Using a new washer, apply a one to one mixture of molybdenum disulphide, Molykote Type Z, powder and engine oil to face of washer which contacts nut. Remove excess lubricant.

(c) Install washer aligning ID tab with slot in shaft and retaining nut fingertight.

(d) Install an alignment mark across exposed area of washer and shaft or part which mates with washer ID tab.

(e) Tighten nut to recommended torque.

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(f) Check alignment mark. Any misalignment indicates a sheared or weakened ID locking tab. Remove washer and repeat above procedure using a new washer, as necessary, to ensure proper locking of retaining nut.

(g) Bend external locking tabs of washer against nut. At least one tab shall be bent full against one flat of nut. Keywashers not having external tabs, crimp side into mating nut slot 180 degrees apart.

NOTE: If no special tool is provided for bending tabs use a brass drift.

C. Acceptable Standards

(1) Keywashers shall be considered properly locked when all keys for each hole have been bent against the nut or head to be locked.

(2) One of the keys must be full against a flat face of the nut or head with a gap which does not exceed 0.020 inch.

11. Identification of Hardware Material, Particularly Nuts and Bolts

A. A permanent type of material code designation has been adopted for use in these engines. Correct engine reassembly procedures require that particular attention be paid to the material requirements for nuts and bolts used in the hot section of the engine. In these areas, where parts must be of material which is resistant to high operating temperatures, special heat resistant alloys are employed. It is imperative that at reassembly of the engine or its components the properly coded part be reassembled in its original location, if serviceable.

B. The code system employs the use of a letter, "C", for corrosion resistant steel for normal application and "H" for heat resistant alloys in hot section application. The stamped or embossed letter will be followed by a number of one or more digits, such as C1, C8, H3, and H12. Bolt code identification will usually appear on the top of the head (see Figure 403) and nut identification on one side of the hex (see Figure 404). When the application is an AN or MS six digit part number, the code identification "C" or "H" will be preceded by the letter "E" as in EC3 or EH10.

NOTE: All AN and MS six digit part numbers, when manufactured of material in the common temperature range (such as cadmium plated, low alloy steel parts), are also coded "E" to indicate, in part, close material quality control.

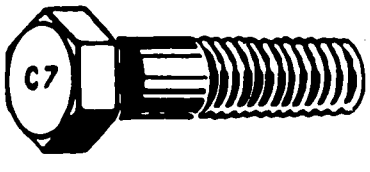
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C. Under step F is a complete list of specific material identification numbers. It is probable that new designations will be added from time to time. In the event that a material code number is preceded with the letter "P", it will be noted that this is a temporary PWA designation which will be used until such time as a "C" or "H" number is adopted.

D. The adoption of this program will make it possible for service activities to avoid the assembly of parts, with similar physical appearance, in locations which require high heat resistant parts. In this regard, it is required, at time of disassembly, that all similarly coded parts be segregated so that two or more physically, similar parts with different code numbers will not be scrambled; and so that, at subsequent reassembly, the properly coded parts are replaced in their proper locations.

CAUTION: NEVER ASSEMBLE A MATERIAL CODED PART WITH A "C" IDENTIFICATION IN A LOCATION WHICH REQUIRES AN "H" CODED PART AND VICE-VERSA. NEVER USE CADMIUM PLATED NUTS, BOLTS, OR ANY OTHER CADMIUM PLATED PART IN THE HOT SECTION OF THE ENGINE. REFER TO THE LIMITS AND EXTERNAL PARTS CHARTS FOR CORRECT LOCATION OF CODED PARTS.

E. Parts from several engines should not be scrambled at disassembly and cleaning, because, at the time of engine manufacture, production requirements may necessitate one or more material substitutions in a block of engines. Subsequent engine reassembly, in the field, with indiscriminate scrambling of hardware, may result in unnecessary confusion in sorting these parts for proper reassembly.



Bolt Code Identification
Figure 403



Nut Code Identification
Figure 404

For Training purposes only

F. Corrosion, Heat Resistant and Special Material List

CORROSION RESISTANT MATERIALS

Material Specification	Code	Material Specification	Code
AMS-5640	C1	AMS-5610	C7
AMS-5628	C2	AMS-5504 (Was C11) or AMS-5613	C8
AMS-5636 (Was C5) AMS-5637 or AMS-7472	C3	AMS-5624 AMS-5639	C9 C10
AMS-7228	C4	AMS-5738	C12
AMS-5616 or AMS-7470	C6	AMS-5625	C15 (Was P10)

HEAT RESISTANT MATERIALS

Material Specification	Code	Material Specification	Code
AMS-7229	H1	Chromel	H15
AMS-7232	H2	Alumel	H16
AMS-5720 (Was H13) AMS-5721, 5722 or 7476	H3	AMS-5649 AMS-5768	H17 H18
AMS-5642	H4	AMS-5525, AMS-5735 (Was P4) AMS-5763, 5737, or 7481	H19 or Knurl
AMS-5646	H5		
AMS-5733	H6	AMS-5647	H20
AMS-5645	H7	AMS-5754	H21 (Was P19)
AMS-5648	H8	AMS-5660, PWA-1003 (Was PWA-1002)	H25 (Was P11)
AMS-5665	H9		
AMS-5651	H11	AMS-5708, AMS-7471, PWA-686, (Was CF236, P18) or PWA-1004	H26 (Was P15)
AMS-5652	H12		
AMS-5667 (Was H10) or AMS-5668	H14		

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TITANIUM OR TITANIUM ALLOY

Material Specification	Code	Material Specification	Code
AMS-4921	T1 (Was P8)	AMS-4928 or AMS-7460	T5
AMS-4925	T3	AMS-4929	T6

SPECIAL MATERIAL

Material Specification	Code	Material Specification	Code
AMS-6304, 7454, 7455, or 7458	S37	AMS-6302 (Was P9)	Inactive
AMS-5620	P3		

G. Stainless Steel Bolts with Reduced Pitch Diameters

(1) At engine manufacture, it is the practice to provide bolts with reduced pitch diameter for use in the hot sections of the engines. This will minimize the possibility of bolt and nut seizure. This is standard practice for locations where the parts are subjected to temperatures in excess of 500°F (260°C).

12. Standard Torques

A. General

(1) Use standard torque values in locations where no specific torque is given in the text or clearance charts.

(2) Torque values for J-threads are identical to torques applied to standard threads.

(3) The torque limits listed in this section shall be interpreted as follows:

(a) Torque values in pound-inches.

(b) Angles of turn in degrees.

(c) Stretch values in inches.

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(4) Unless otherwise specified, thread lubricants shall be applied to parts which are to be torqued. Thread lubricant shall be engine oil unless otherwise specified.

(5) If the part to be tightened is hot, allow sufficient time to elapse to allow the temperature of the part to reach a temperature equilibrium with the surrounding area before final torquing.

(6) Extreme care should be exercised in joining of flanges or mating sections during assembly. When joining snap fits, it is essential that mating parts be properly seated prior to application of final torque. Unless specific procedures are provided in assembly instructions, parts should be seated by installing several bolts at regular intervals then applying uniform torque where required to seat mating surfaces. Once seating is assured, all bolts should be torqued to approximately 75 percent of final torque in a uniform stagger (180°, 90°, and 45° intervals, etc.) to preclude local overstressing of bolts or flange. Final torque should be applied in same sequence.

(7) Torque applications should be done slowly and evenly for consistency and best possible accuracy. There may be instances, other than specific torque limits, where it is obvious that the standard torque required should not be used due to the kind of material or the design of the engine part involved. Common sense and good judgment should of course be exercised in such cases.

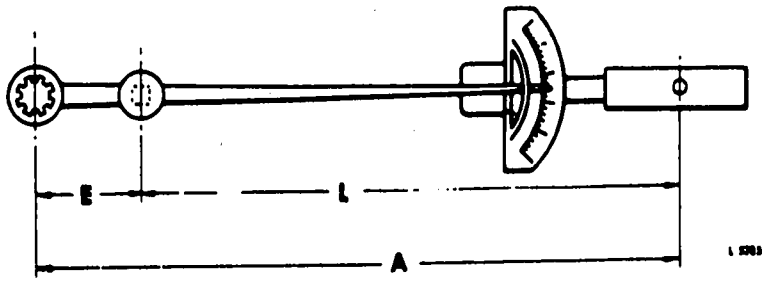
13. Torque Indicating Devices

See Figure 405.

A. Check torque indicating devices by schedule below and calibrate by means of weights and a measured lever arm to make sure that there are no inaccuracies. Checking one torque wrench against another is not sufficient. Some wrenches are quite sensitive to the way they are supported during a tightening operation, and every effort must be made to adhere to the instructions furnished by the respective manufacturers.

(1) Set-type torque wrenches: Check once a week.

(2) Non-set-type torque wrenches: Check every four weeks.



Torque Wrench and Extension
Figure 405

For Training purposes only

B. Torque Wrench and Extensions

(1) Occasionally, it is necessary to use a special extension, or adapter wrench together with a standard torque wrench. See Figure 405. In order to arrive at the resultant required torque limits, the following formula shall be used:

T = Desired torque on the part.

E = Effective length of special extension or adapter.

L = Effective length of torque wrench.

A = Distance through which force is applied to part.

R = Reading on scale or dial of torque wrench.

$$R = \frac{LT}{A} = \frac{LT}{L+E}$$

Example: A torque of 1440 pound-inches is desired on a part, using special extension having a length of three inches from center to center of its holes, and a torque wrench, measuring 15 inches from center of handle or handle swivel pin to center of its square adapter.

$$\text{Then: } R = \frac{LT}{L+E} = \frac{15 \times 1440}{15+3} = 1200$$

(2) With the axis of the extension or adapter and the torque wrench in a straight line, tightening to a wrench reading of 1200 pound-inches will provide the desired torque of 1440 pound-inches on the part.

NOTE: The effective length of P&WA special extensions, adapters, and wrenches is stamped on the tool.

14. General Torque Recommendations

A. Lubricants and Lubrication

(1) Oil Lubricated Parts

(a) Torque limits given in this section for oil lubricated parts apply specifically to the use of engine oil, or equivalent, on the parts.

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(2) Antiseize Lubricated Parts

(a) Torque limits given in this section for antiseize coated parts apply specifically to the use of antiseize compounds applied in accordance with SPOP 145, 146, 156, 160, or 161, or to wet applications of Fel-Pro C-200 and C-300, and Ease-Off 990. or to Kaylube 3.

B. Nuts, Bolts, and Screws.

(1) General

(a) Torque values listed in Table I for nuts, bolts, and screws have been established to provide sufficient pre-load without overstressing the parts and are based on materials having minimum ultimate tensile strengths of 125,000 pounds per square inch, equivalent to Rockwell C26 hardness for steel parts.

NOTE: The torque values specified in Table I apply to bolts in standard helical coil inserts as long as full thread engagement of insert is accomplished.

(2) Thin Nuts, Slotted Nuts

(a) The torque values in Table I shall appply to nuts where height of the nuts is greater than 75 percent of the major diameter of the thread. For thin nuts, where the height of the nuts is 40 to 75 percent of the size of the major diameter, reduce the torque values 50 percent. Slots in slotted nuts should be disregarded in figuring height of nut. Values do not apply to hollow bolts and screws.

(3) Safety Wire and Cotterpin Requirements

(a) After a castle nut, screw or bolt has been tightened to the proper torque, it should not be loosened to permit the insertion of safety wire or a cotterpin. If the slot in the nut or the safety wire hole in the bolt or screw is not properly aligned at the minimum torque limit, the nut, screw or bolt should be further tightened to the next aligning position, but the maximum torque limit must not be exceeded. If alignment cannot be accomplished without exceeding the maximum limit, back off the nut, screw or bolt half a turn, then retighten. It may be necessary to select a new part.

C. Self-Locking Nuts

(1) Free Spinning Locknuts.

(a) Free spinning locknuts are nuts that spin freely on the bolt or stud until it contacts the mating surface with activation of the locking feature produced with additional torque. Use the torque values listed in Table I.

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Thread** size	Torque, lb-in.					
	Oil lubricated			Anti-seize coated		
	Max.	Min.*		Max.	Min.*	
		Type I	Type II		Type I	Type II
.112 -40	6	4.5	5	4.5	3.5	4
.138 -32	11.5	8.5	10	8.5	6.5	7.5
.164 -32	22	16	20	16.5	12.5	15
.164 -36	24	18	22	18	13.5	16
.190 -24	30	23	27	21.5	16	19.5
.190 -32	36	24	32	26	19.5	23
.216 -24	48	35	43	35	26	31
.216 -28	50	35	45	38	28	34
.250 -20	70	50	65	50	37	45
.250 -28	85	65	75	60	45	54
.3125-18	150	110	135	105	80	95
.3125-24	170	125	150	120	90	110
.375 -16	270	200	250	185	140	170
.375 -24	300	225	275	215	160	190
.4375-14	425	325	375	300	225	270
.4375-20	475	350	425	340	255	310
.500 -13	650	500	600	450	340	400
.500 -20	750	550	675	515	390	460
.5625-12	950	700	850	675	500	600
.5625-18	1050	800	950	750	550	675
.625 -11	1300	1000	1200	900	675	800
.625 -18	1500	1150	1350	1025	775	925
.750 -10	2300	1700	2100	1600	1200	1450
.750 -16	2600	2000	2400	1800	1350	1600
.875 - 9	3700	2800	3400	2600	1950	2350
.875 -14	4200	3200	3800	2900	2200	2600
1.000 - 8	5600	4200	5100	3900	2900	3500
1.000 -12	6400	4800	5800	4300	3200	3850

* Use Type I minimum values where alignment of locking holes (cotterpins, lockwire, etc.) is required at assembly. Use Type II minimum values where alignment of locking holes is not required at assembly.

** For screws larger than .164 thread size, having screwdriver slots only (no external wrenching provisions):

1. For non-self-locking applications, 22 lb in. minimum is permissible.
2. For self-locking applications, the permissible minimum torque is 22 lb in. plus the torque required to turn the screw through the nut.

L-41653

Table I - Standard Nuts, Bolts, and Screws

For Training purposes only

(2) Prevailing Torque Type Locknut.

(a) Prevailing torque type locknuts are nuts that spin freely on a bolt or stud until the threads enter the locking portion of the nut. At this point the bolt interferes with the deformed section of the nut causing a tight frictional hold on the bolt thread flanks. Use torque values listed in Table II except when nut is on a stud, then use Table I.

NOTE: Helical coil self-locking inserts are categorized as prevailing torque type locknuts. The torques for bolts used in such inserts are listed in Table II.

(b) Effective locking of slotted steel locknuts on bolts or studs requires full engagement of all locknut threads. It is not necessary for the bolt or stud to protrude beyond the outer end of the locknuts because the chamfered part of the locknut ID does not exert a locking force on the bolt or stud.

D. Steel Pipe Plugs in Aluminum and Magnesium Cases

(1) The torque values for steel pipe plugs in aluminum and magnesium cases listed in Table III have been established to provide for tightening plugs sufficiently to prevent leakage without overstressing cases. If a pipe plug is found to leak after it has been tightened to these limits and sealing compound has been applied to the threads, it should not be tightened further, but should be removed and more sealing compound should be applied to threads; plug should then be reinstalled and retightened to the indicated limits.

Thread size	Torque, lb-in.		Thread size	Torque, lb-in.	
	Oil lubricated	Anti-seize coated		Oil lubricated	Anti-seize coated
.112 -40	6- 7	5- 6	.4375-20	450- 500	340- 380
.138 -32	12- 14	9- 11	.500 -13	630- 700	450- 500
.164 -32	23- 26	18- 20	.500 -20	720- 800	515- 575
.164 -36	25- 28	20- 22	.5625-12	950-1050	675- 750
.190 -24	32- 35	24 -27	.5625-18	1050-1150	750- 825
.190 -32	36- 40	27- 30	.625 -11	1250-1400	900-1000
.216 -24	48- 54	36- 40	.625 -18	1450-1600	1030-1150
.216 -28	50- 56	40- 44	.750 -10	2200-2450	1600-1750
.250 -20	74- 82	55- 62	.750 -16	2500-2750	1750-1950
.250 -28	85- 95	62- 72	.875 - 9	3600-4000	2500-2850
.3125-18	160-175	115-130	.875 -14	4000-4450	2800-3100
.3125-24	180-200	125-140	1.000 - 8	5400-6000	3800-4200
.375 -16	270-300	200-220	1.000 -12	6000-6700	4000-4500
.375 -24	290-325	225-250			
.4375-14	420-465	315-350			

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Table II - Torques for Self-Locking Nuts and Bolts, and for Bolts Used in Helical Coil Self-Locking Inserts

For Training purposes only

Thread size (ANPT or NPT)	Torque (lb-in.)	Thread size (ANPT or NPT)	Torque (lb-in.)
.062	30- 40	.500	140-160
.125	30- 40	.750	210-230
.250	70- 85	1.000	285-315
.375	95-110	1.250	355-385

L-41637

Table III - Steel Pipe Plugs in Aluminum or Magnesium Cases

(2) When plugs are tightened in a hot engine, torques should be reduced about 20 percent to allow for difference in expansion between steel plugs and aluminum or magnesium cases.

E. Hex-Head, Straight-Threaded Fittings and Plugs (MS9015, MS9193 or Similar)

CAUTION: EXCESSIVE TIGHTENING WILL RESULT IN DAMAGE TO THREADS OF MATING PARTS.

(1) The torques listed in Table IV are based on strength of thread in cast aluminum or magnesium; they may be used in stronger materials.

F. Flexible Tube Connections (such as Sealastic Type Fittings)

See Figure 405A.

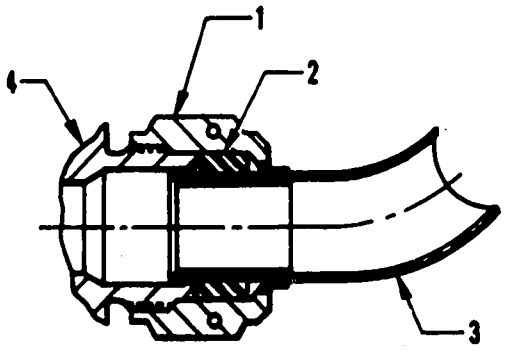
(1) When assembling flexible tube connections, the seal and fitting threads must be lubricated with a light film of engine oil or petrolatum. The seal must be bottomed and the tube aligned before applying the torque listed in Table IV.

Thread size	Torque (lb-in.)	Thread size	Torque (lb-in.)
.250 -28	15- 20	1.0625-12	375-425
.3125-24	35- 40	1.250 -12	500-600
.375 -24	40- 50	1.3125-12	525-625
.4375-20	65- 75	1.500 -12	600-700
.500 -20	90-100	1.625 -12	650-750
.5625-18	110-120	1.750 -12	650-750
.625 -18	150-170	1.875 -12	650-750
.750 -16	200-225	2.250 -12	650-750
.8125-16	225-250	2.500 -12	650-750
.875 -14	250-275		
1.000 -12, -14	275-300		

L-41629

Table IV - Hex-Head, Straight-Threaded Fittings and Plugs

For Training purposes only



1-29739
3-72

1. Nut; See Table V.
2. Packing
3. Tube
4. Fitting

PWA Flexible Fitting
Figure 405A

Tube dia.	Torque, lb-in.	
	For 75 durometer "A" packing; e.g. AMS 7260	For 77 durometer "C" (100 durometer "A") packing; e.g. PWA 401
.125	25- 30	55- 60
.1875	25- 30	55- 60
.250	25- 30	55- 60
.3125	30- 35	65- 70
.375	30- 35	65- 70
.500	55- 60	110-120
.625	65- 70	130-140
.750	70- 80	140-160
.875	75- 85	150-170
1.000	100-110	200-220
1.125	100-110	200-220
1.250	100-110	200-220
1.500	100-110	200-220

1-41621

Table V - PWA Flexible Fittings

For Training purposes only

(2) It is expected that these flexible tube connections will experience slight loss of torque over a period of time due to seating of rubber in mating parts. To minimize this condition, parts should be torqued to listed value, then loosened, and torqued again to listed value.

G. Cone Seat Connectors

See Figure 405B.

(1) For 37° cone seat connectors without gaskets, use torque values listed in Table VI.

(2) For 37° cone seat connectors with nickel gaskets, use torque values listed in Table VII.

(3) Do not attempt to correct any leakage of joint by overtorquing. Disassemble fitting and check for nicks, burrs, dirt, etc. If necessary, use new parts.

Hose size	Tubing O.D.	Thread size	Torque, lb-in.		
			Aluminum fittings**	Steel and titanium fittings*	
			All lubricants	Oil lubricated	Anti-seize coated
3	.1875	.375 -24	30- 50	70- 80	50- 60
4	.250	.4375-20	40- 65	90- 100	65- 75
5	.3125	.500- 20	60- 80	135- 150	100- 110
6	.375	.5625-18	75-125	270- 300	200- 225
7	.4375	.625 -18	100-175	320- 350	225- 250
-	.500	.6875-24	-	320- 350	225- 250
8	.500	.750 -16	150-250	450- 500	340- 375
9	.5625	.8125-16	175-300	550- 600	400- 450
10	.625	.875 -14	200-350	650- 700	475- 525
10	.625	.875 -16	200- 350	650- 700	475- 525
12	.750	1.000 -14	275-450	800- 900	600- 675
12	.750	1.000 -12	275-450	800- 900	600- 675
12	.750	1.0625-12	300-500	900-1000	675- 750
16	1.000	1.250 -12	400-650	1150-1300	900-1000
16	1.000	1.3125-12	500-700	1300-1400	950-1050
18	1.125	1.500 -12	600-900	1500-1600	1050-1200
20	1.250	1.625 -12	600-900	1700-1800	1150-1300
24	1.500	1.875 -12	600-900	2100-2200	1500-1600

* If the nut or either of the mating sealing surfaces is aluminum, the required torque limits for aluminum fittings apply.

** For thrust reverser airline fittings, use torques for aluminum fittings, regardless of material, unless otherwise specified.

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Thread size	Torque, lb-in.		Thread size	Torque, lb-in.	
	Oil lubricated	Anti-seize coated		Oil lubricated	Anti-seize coated
.375 -24	50- 60	40- 45	.875 -14	500- 550	360- 400
.4375-20	90-100	65- 75	1.0625-12	700- 800	540- 600
.500 -20	135-150	100-110	1.1875-12	800- 900	600- 675
.5625-18	200-220	150-165	1.3125-12	1000-1100	750- 825
.750 -16	350-400	270-300	1.625 -12	1400-1500	1000-1100
.8125-16	400-450	300-350			

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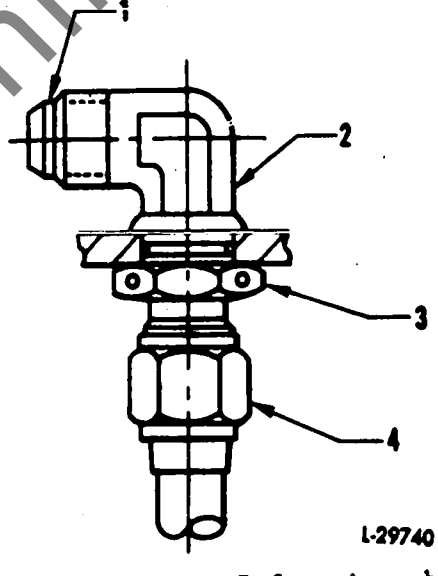
Table VII - 37 Degree Cone Seat Steel Connectors With Nickel Gaskets

H. Jam Nuts

See Figures 405B and 405C.

(1) The torques listed in Table VIIA are to be used for all steel and aluminum jam nuts (locknuts) of type used on fittings for tube and hose connections.

(2) On elbow fittings, jam nut shall be torqued after connecting tube or hose has been installed and properly aligned.

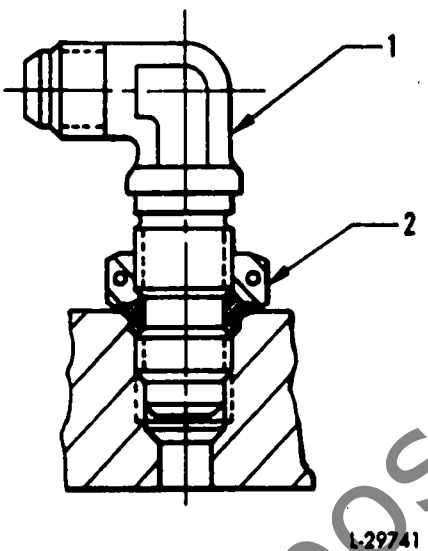


1. Cone Seat Connector, Before Assembling Mating Parts; See Table VI or VII.
2. Bulkhead Fitting
3. Jam Nut; See Table VIIA.
4. Cone Seat Connector Nut; See Table VI or VII.

Cone Seat Connector, and Bulkhead Fitting Jamnut
Figure 405B

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ENGINE - DISMANTLING/ASSEMBLY



1. Boss Fitting; See Text.
2. Jam Nut: See Table VIIA.

"O" Ring and Jammut Type Connector
Figure 405C

Thread size	Torque, lb-in.	Thread size	Torque, lb-in.
.250 -28	14- 16	1.1875-12	350-390
.3125-24	22- 24	1.250 -12	380-420
.375 -24	28- 32	1.3125-12	475-525
.4375-20	38- 42	1.500 -12	570-630
.500 -20	58- 62	1.625 -12	570-630
.5625-18	70- 80	1.875 -12	570-630
.625 -18	95-105	2.250 -12	570-630
.750 -16	145-155	2.500 -12	570-630
.8125-16	165-185		
.875 -14	190-210		
1.000 -12	260-290		
1.0625-12	285-315		

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Table VIIA - Jam Nuts

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ENGINE - DISMANTLING/ASSEMBLY

I. Installation of Crush Type, Asbestos Filled Gaskets

(1) Install all crush type gaskets except the self-centering type, with the unbroken surface against the flange of the plug or part being tightened against the seal. Turn mating part until sealing surfaces are in contact and tighten to the angle of turn shown in Table VIIB for the appropriate thread pitch.

J. Installing and/or Attaching Various Components of Ignition and Thermocouple Systems.

See Figure 405D.

(1) Torque all plug-in type threaded connections fingertight plus a 45° maximum turn. See Figure 405D.

(2) Igniter Plugs

(a) All igniter plugs except "slim line" igniter plugs should be installed in engines with a torque of 300 to 360 pound-inches.

(b) "Slim-line" igniter plugs are considered special. Specific installation instructions will be given in publications directing their use.

(3) All "cigarette" type electrical connections (intermediate voltage leads and high tension leads) shall be torqued until the connection is bottomed on its shoulder. This normally takes approximately 140 to 160 pound-inches of torque. See Figure 405D.

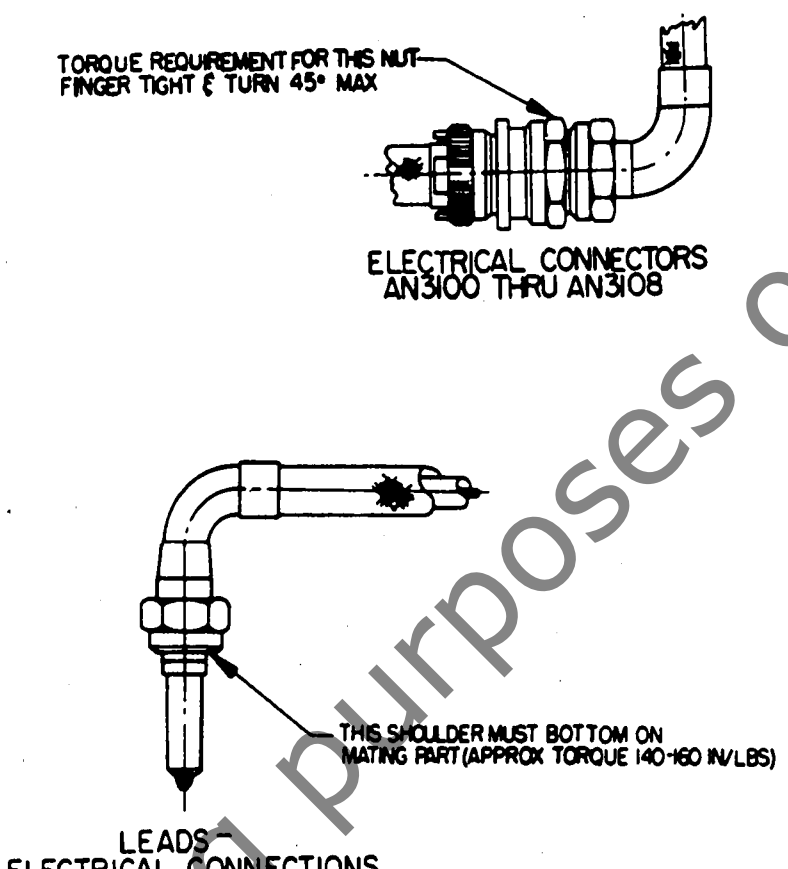
Thread pitch on part to be tightened	Angle of turn, tolerance ±5°	
	Aluminum asbestos	Copper asbestos Nickel asbestos Steel asbestos
8 threads per inch	135°	67°
10 threads per inch	135°	67°
12 threads per inch	180°	90°
14 threads per inch	180°	90°
16 threads per inch	270°	135°
18 threads per inch	270°	135°
20 threads per inch	270°	135°
24 threads per inch	360°	180°
28 threads per inch	360°	180°
These values provide for a compression of approximately 40% for aluminum-asbestos and 20% for copper-asbestos, nickel-asbestos, and steel-asbestos gaskets.		

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Table VIIB - Metal-Asbestos Gaskets

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ENGINE - DISMANTLING/ASSEMBLY



Installation of Plug-In and "Cigarette" Type
Electrical Connections
Figure 405D

For Training purposes only

(4) All exhaust temperature probe terminal attaching nuts and thermocouple harness-to-lead attaching screws shall be torqued as shown in Table VIIC unless otherwise specified.

(5) In exhaust gas temperature junction box, all harness terminal and bus bar attaching nuts should be torqued as shown in Table VIID.

15. Removal/Installation of the Engine From/In the Transportation Stand

See Figure 406.

A. Removal

(1) Attach the PWA-16220 Adapter to the 12 o'clock holes on the intermediate case.

(2) If not installed, pass the PWA-8663 Saddle under and around the turbine nozzle case so that the saddle contacts the necked-down surface of the case.

(3) Secure the PWA-10859 Lifting Sling to the lifting adapter on the compressor intermediate case and the saddle on the turbine nozzle case. Attach the sling to a chain hoist.

NOTE: The compression bar on the sling must be adjusted to agree with the engine being lifted.

Thread size	Torque, lb-in.
.138-32	8-10
.164-32	8-12
.190-32	10-15
.216-32	30-35
.250-32	35-40

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Table VIIC - Temperature Probe Nuts and Screws

Thread size	Torque, lb-in.
.190-32	25-30
.164-32	20-25

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Table VIID - Harness Terminal and Bus Bar Nuts

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(4) Unfasten the engine mount and adapters and lift the engine clear of the stand.

B. Installation

(1) Secure two PWA-8664 Adapters in the upright supports of the PWA-8740 Adapter Assembly at the turbine nozzle location on the stand. Secure PWA-10903 Support to the PWA-8740 Adapter Assembly at both ends.

NOTE: PWA-16375 Mounts may be used to support the engine at the exhaust case instead of the nozzle case.

(2) Secure two PWA-8665 Adapters in the upright supports of the PWA-8740 Adapter Assembly at the compressor intermediate case location on the stand.

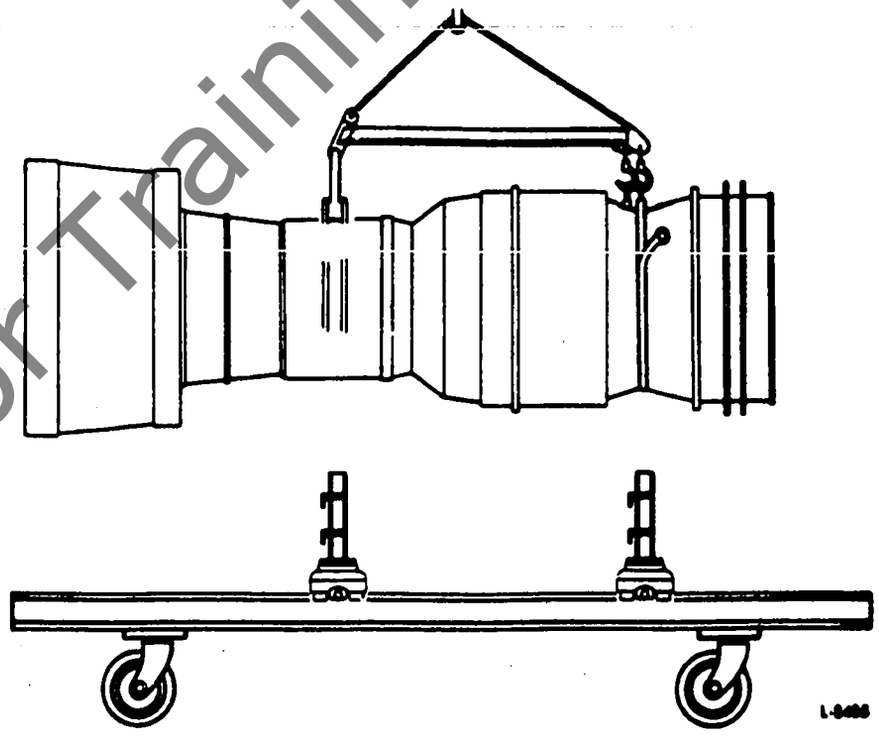
(3) Attach the PWA-16220 Adapter to the 12 o'clock holes on the intermediate case.

(4) Pass the PWA-8663 Saddle under and around the turbine nozzle case so that the saddle contacts the necked-down surface of the case.

(5) Attach the PWA-10859 Sling to the lifting adapter and the saddle. Using a chain hoist, lift the engine from the container.

(6) Lower the engine to the PWA-10860 Stand and secure the mounts and adapters.

CAUTION: BEFORE REMOVING THE PWA-10859 LIFTING SLING, THE ENGINE MUST BE ADEQUATELY SUPPORTED BY BOTH OF THE VERTICAL SUPPORTS.



Installing Engine in Horizontal Stand
Figure 406

For Training Purposes only

(7) Remove the PWA-10859 Lifting sling and the PWA-16220 adapter from the engine.

16. Main Oil Filter Housing and Oil Adapter - Removal/Installation

A. Oil Adapter and Filter-to-Adapter Oil Pressure Tube - Removal

(1) Loosen the nut securing the filter-to-adapter oil pressure tube at the oil filter housing; then loosen the nut at the oil adapter and remove the tube.

(2) Remove the bolts and locknuts securing the oil adapter to the intermediate case mount ring.

(3) Remove the two internal and two external spacers positioning the adapter in the intermediate case mount ring area.

NOTE: On the JT3D-3B the internal spacers are used on the adapter arm adjacent to the oil filter housing.

(4) Remove the oil adapter.

B. Main Oil Filter Housing - Removal

(1) If not already removed, remove the bolts and locknuts securing the oil filter housing legs to the intermediate case mount ring.

(2) Remove the two internal spacers positioning the legs of the oil adapter and the filter housing.

(3) Remove the bolts, washers, and spacers securing the filter housing outside leg to the clevis mounted on the bracket on the lower right front flange of the intermediate case. Remove the filter housing.

C. Oil Adapter and Filter-to-Adapter Oil Pressure Tube - Installation

(1) Install new seal on intermediate case oil pressure tube positioning flange.

(2) Install new seal on pressure line fitting of the oil adapter.

(3) Carefully position intermediate case oil tube to align with strainer assembly in the number two bearing housing.

(4) Install the two internal and two external spacers positioning the adapter in the intermediate case mount ring area.

(5) Install the bolts and locknuts securing the oil adapter to the intermediate case mount ring.

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D. Airflow check (assembled engine) to verify proper engagement of pressure tube adapter assembly to strainer assembly.

(1) Whenever the pressure tube adapter assembly (PWA 385716 or 494655) is disengaged from the strainer assembly (PWA 467009), the following check must be accomplished.

(a) Remove the tube assembly (PWA 393863) which connects oil filter to compressor intermediate bearing.

(b) Install special test fitting in place of the removed tube.

(c) Connect airflow checker.

(d) Regulate line air pressure to 60 ±2 psi.

(e) Read pressure differential between the two gages. Maximum $\triangle$ P is 47 psi. (1st gage at 60 ±2 psi and 2nd gage at 13 ±2 psi). If 2nd gage reads less than 10 psi, check adapter assembly (PWA 385176) for proper installation.

E. Main Oil Filter Housing Installation

(1) Position the oil filter housing to lower right location of the intermediate case mount ring area inserting the inner legs of the housing between the intermediate case mount rings and the legs of the oil adapter.

(2) Align the holes of the mount rings, filter housing, and oil adapter; then insert the internal spacers (small ID inward) from the inside through the legs of the oil adapter and then through the legs of the oil filter housing. Secure the buildup by inserting the bolts through the mount rings of the intermediate case and installing the nuts on the inside of the legs. Tighten the bolts and nuts to 50-60 pound inches torque.

NOTE: Install a bracket under the bolt head of the rear bolt to support a fuel tube clip.

NOTE: New design shoulder studs are installed in each filter housing at overhaul. Use only covers that are counterbored to accept the shoulder stud. Either the counterbored or non-counterbored cover can be used with the old style standard straight shank studs.

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17. Removal/Installation of the Main Oil Filter Element Assembly

See Figure 407.

A. Removal

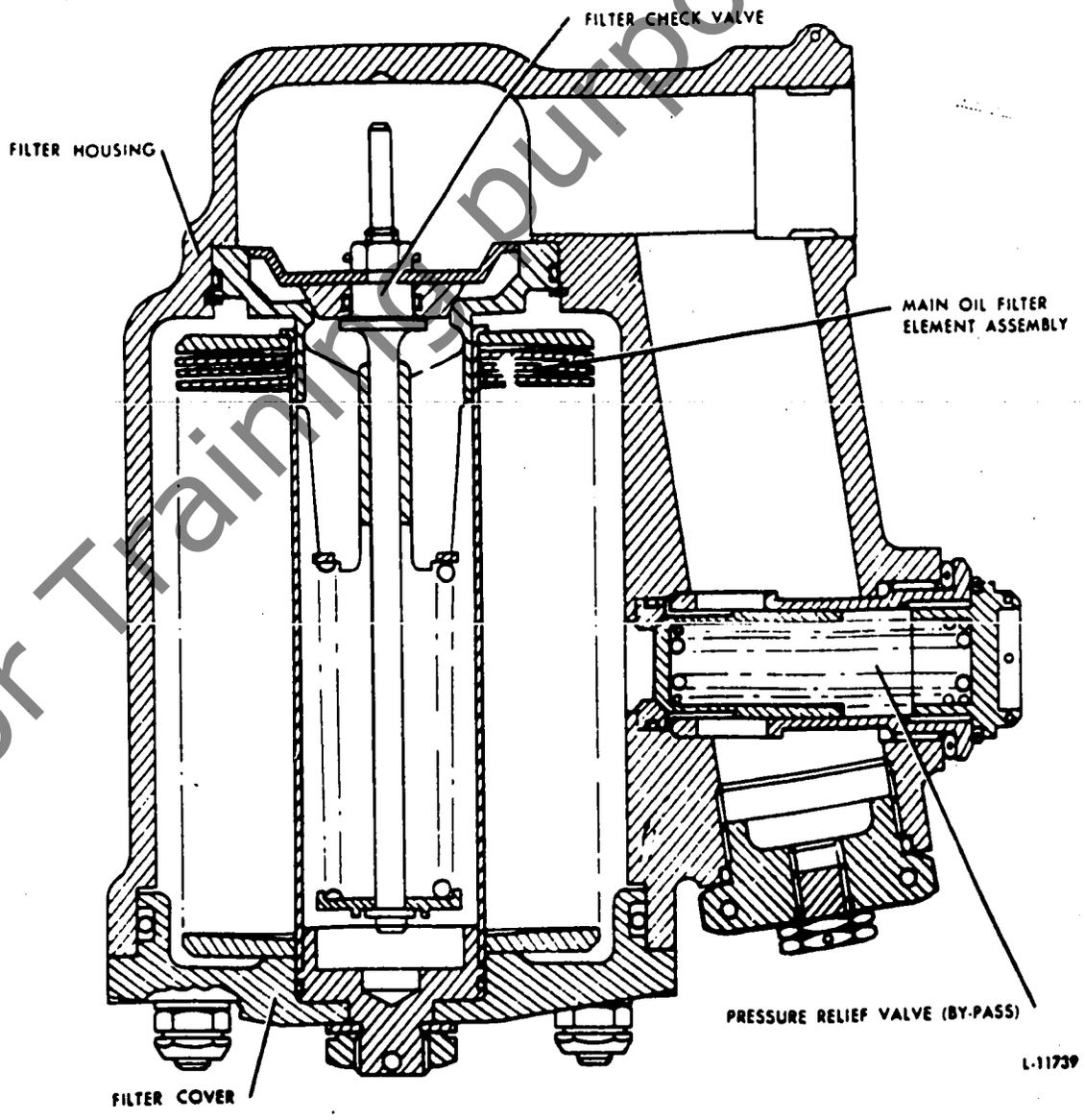
(1) Remove the nuts securing the main oil filter cover to the main oil filter housing assembly.

NOTE: On covers which incorporate puller grooves, engage PWA-30643 Puller in grooves and, using knocker action, remove cover.

(2) Remove the main oil filter element.

B. Installation

(1) Coat a new packing with engine oil and insert it on the groove of the cover.



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(2) Install the main oil filter element assembly into the main oil filter housing.

(3) Secure the element assembly with the washers and nuts. Tighten the nuts to the recommended torque.

18. Disassembly/Assembly of the Main Oil Filter Element Assembly

See Figure 408.

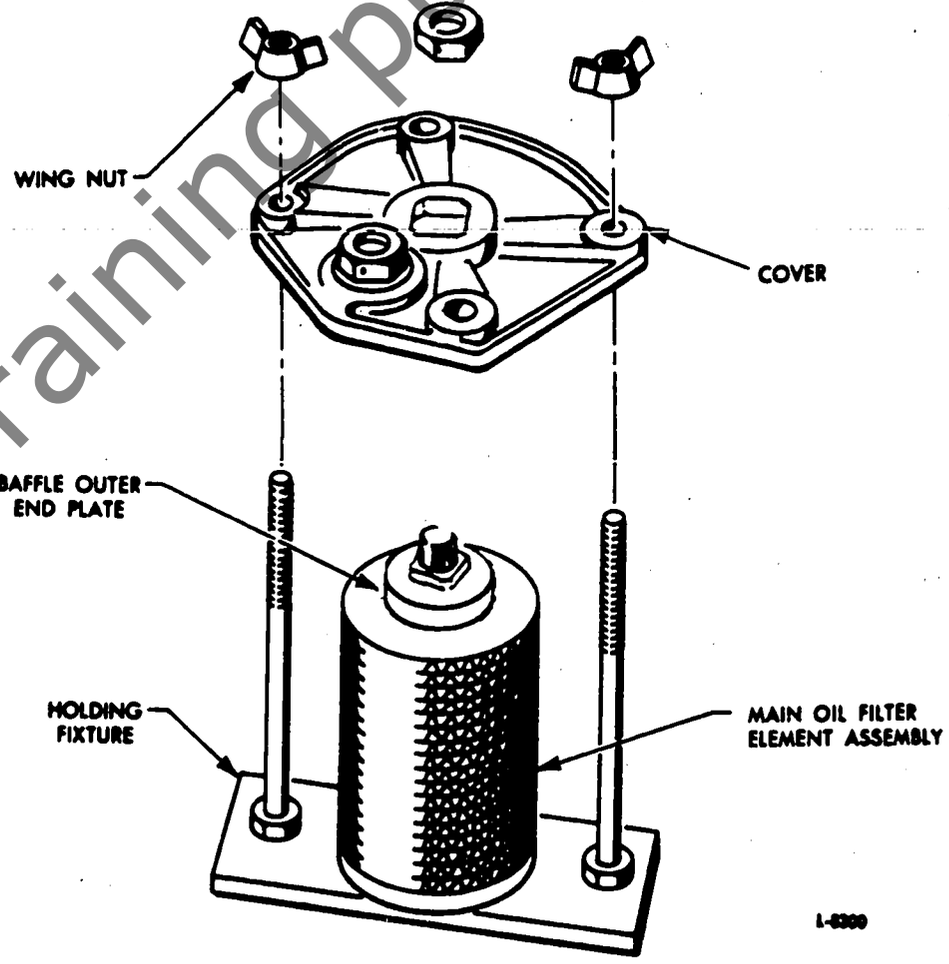
A. Disassembly

(1) Position the element in the PWA-7153 Fixture; then remove the off-center plug from the bushing in the oil filter cover.

(2) Remove the cotterpin and the slotted nut securing the cover to the inner element.

CAUTION: THE FILTER ELEMENT MUST BE INSTALLED IN THE FIXTURE PRIOR TO REMOVING THE COVER NUT TO PREVENT THE STACKED SCREENS AND SPACERS FROM FLYING OFF UNDER THEIR OWN SPRING PRESSURE.

(3) Carefully remove the filter cover from the fixture; then slide off the screens and spacers onto a suitable cleaning rod.



Aligning and Installing Main Oil Filter Element in Fixture
Figure 408

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

B. Assembly

(1) With the inner element installed in the PWA-7153 Fixture, install the outlet spacers, screens, and inlet spacers on the inner element so that an outlet spacer will be at both ends and each screen will be between an outlet spacer and an inlet spacer.

(2) Install the spacer end plate on the assembled spacers and screens.

(3) Place the main oil filter cover, slot over the shank, on the inner filter element.

(4) Install the washer and slotted shear nut securing the cover to the inner element and torque nut to 275 lb. in. minimum to 375 lb. in. maximum.

CAUTION: COMPLETE SETS OF PARTS CONSISTING OF TWO SCREENS AND ONE EACH OF THE INLET AND OUTLET SPACERS MUST BE ADDED OR REMOVED, IF REQUIRED, SO THAT THE SCREENS AND SPACERS CANNOT BE ROTATED BY HAND WHEN THE CENTER SHEAR NUT IS TIGHTENED WITH A TORQUE SUFFICIENT TO SEAT THE ELEMENT END SOLIDLY AGAINST THE COVER.

(5) Insert the cotter pin in the shear nut on the center shaft of the inner element.

(6) Place a packing on the bushing and install the bushing in the off-center hole in the cover. Tighten the bushing to the recommended torque. Place a packing on the plug and install the plug in the bushing. Tighten the plug to the recommended torque. Lockwire the plug to the cover.

(7) Check to be sure that the cover is seated against the end plate and the screens and spacers cannot be rotated by hand. If necessary, remove the cover and add or remove sets of screens and spacers as directed above until requirements are met. Remove the assembled element from the fixture.

19. Removal/Installation of the Oil Pressure Relief Valve (By-Pass).

See Figure 407.

A. Removal

(1) Remove the relief valve plug and spring from the relief valve liner.

(2) Remove the relief valve liner and valve from the filter housing.

B. Installation

(1) Install the relief valve, gasket and relief valve liner into the oil filter housing.

(2) Insert the spring into the well of the relief valve.

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(3) Place a gasket on the relief valve liner and install the plug. Tighten the plug to the recommended torque.

20. Removal/Installation of the Oil Pump

See Figure 34, Section 72-0, Description and Operation.

A. Removal

NOTE: The fuel control and CSD must be removed prior to removal of the oil pump.

(1) Unfasten the locknuts and washers securing the oil pump front body to the gearbox front housing.

(2) Remove the lockwire from the two nuts (adjacent to the fuel control drive pad) on the front face of the oil pump and remove the nut and washer closest to the pump cover positioning pin.

CAUTION: DO NOT REMOVE THE REMAINING THREE NUTS EXCEPT THE NUT DIAGONALLY OPPOSITE MAY BE REMOVED IN PLACE OF THE ONE ABOVE.

(3) Carefully attach the PWA-2536 Puller to the extended threads of the bolt from which the above nut was removed. Using knocker action remove the oil pump from its cavity in the gearbox front housing.

NOTE: The coupling may remain splined to the hydraulic pump drive gearshaft or stay splined to the end of the oil pump driveshaft when removing the oil pump assembly complete.

B. Installation

(1) Moisten the oil pump packings with engine oil and place them in the oil pump rear and front body grooves, and in the rear body spacer assembly groove.

(2) Insert the oil pump assembly in the gearbox front housing.

NOTE: Be careful that the oil pump coupling properly engages the matching splines of the hydraulic pump drive gearshaft in the gearbox housing, and those of the oil pump drive shaft.

(3) Align the oil pump cover with the positioning pin and bolt holes.

(4) Secure the oil pump to the gearbox front housing with the washers and locknuts. Tighten the locknuts to the recommended torque.

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ENGINE - DISMANTLING/ASSEMBLY

21. Disassembly/Assembly of the Oil Pump

See Figure 409.

A. Disassembly

(1) Unfasten the nuts securing the oil pump bodies together and remove the washers and bolts.

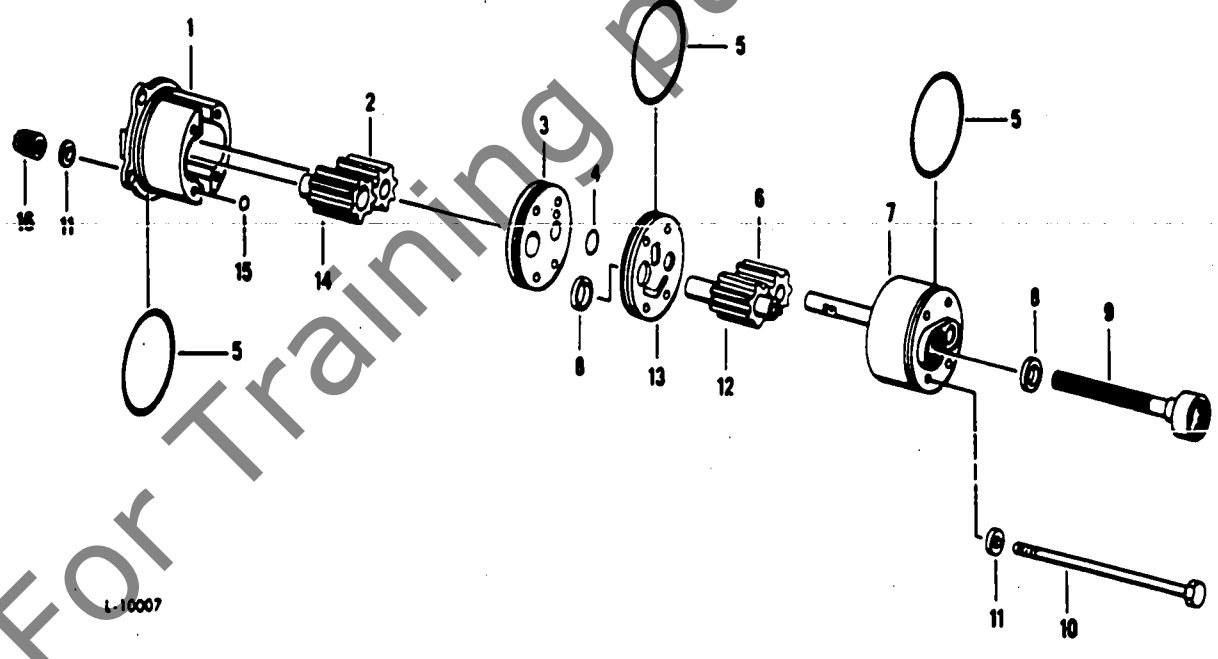
(2) Remove the front oil pump body and the four packings.

(3) Remove the oil pump gearshaft.

(4) Remove the oil pressure pump spur gear.

(5) Remove the front oil pump body spacer.

(6) Remove the rear oil pump body spacer assembly; then remove the seal and the packing from the spacer.



1. FRONT OIL PUMP BODY
2. OIL PUMP SPUR GEAR
3. OIL PUMP BODY FRONT SPACER
4. OIL PUMP BODY REAR SPACER PACKING
5. OIL PUMP PACKING
6. OIL PUMP SPUR GEAR
7. REAR OIL PUMP BODY ASSY OF
8. OIL PUMP BODY SEAL
9. OIL PUMP DRIVE SHAFT
10. OIL PUMP BODY BOLT
11. OIL PUMP BODY BOLT WASHER
12. OIL PUMP DRIVE SPUR GEARSHAFT
13. OIL PUMP BODY REAR SPACER ASSY
14. OIL PUMP GEARSHAFT
15. OIL PUMP FRONT BODY PACKING
16. OIL PUMP BODY BOLT NUT

NOTE: PARTS MUST BE ASSEMBLED SO THAT THE GEARS WILL ROTATE FREELY.

Main Oil Pump
Figure 409

For Training purposes only

(7) Remove the oil pump drive spur gearshaft.

(8) Remove the oil pump spur gear.

(9) Remove the oil pump drive shaft from the rear oil pump body assembly. Remove the seal from the rear body.

B. Assembly

See Figure 409.

(1) Position the oil pump rear body, oil pump drive shaft opening up, on a bench; then, place a new seal on the PWA-10381 Drift with the seal element up. Install the pilot of the drift into the bore of the oil pump rear body and push the seal into position to seat. Remove the drift. Lubricate the inside of the seal with engine oil.

(2) Position the oil pump rear body assembly (idler shaft end up) on a bench; then lubricate the inside of the seal with engine oil.

(3) Install the oil pump spur gear over the rear body idler shaft and the oil pump drive spur gearshaft in the seal (internal splines up) to seat in the oil pump rear body.

(4) Place the oil pump rear body spacer on a bench, seal opening up; then place a new seal on the PWA-10381 Drift with the seal element up. Install the pilot of the drift into the base of the spacer and push the seal into position to seat. Remove the drift. Lubricate the inside of the seal with engine oil.

(5) Place a packing in the ID of the idler shaft opening in the rear body spacer and install the spacer assembly over the idler shaft and oil pump drive spur gearshaft to seat on the oil pump rear body.

(6) Install the oil pump front body spacer over the idler shaft and gearshaft to seat on the oil pump rear body spacer assembly.

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(7) Install the oil pump spur gear over the idler shaft and the oil pump gearshaft over the installed oil pump drive spur gearshaft to seat on the oil pump front body spacer.

(8) Place the packings in the four bottom openings in the oil pump front body and install it over the idler shaft and the oil pump gearshaft to seat on the oil pump front body spacer.

(9) Install the four oil pump assembly bolts and washers through the assembled oil pump, boltheads in rear, and secure with the nuts. Tighten the nuts hand tight.

(10) Install the oil pump drive shaft through the oil pump rear body to seat the shaft shoulder on the gearshaft and to engage the internal splines of the oil suction and oil pressure gearshafts. Rotate the drive shaft to make certain the gears rotate freely inside the oil pump.

(11) Tighten the four nuts to the recommended torque and lockwire.

CAUTION: CHECK TO MAKE CERTAIN THAT THE GEARS CONTINUE TO ROTATE FREELY AFTER TIGHTENING THE NUTS.

22. Removal/Installation of the Oil Filter Check Valve

See Figure 407.

A. Removal

(1) Unfasten the retaining ring which secures the oil filter valve seat to the oil filter housing.

(2) Remove the oil filter valve seat (with disks and stem) from the filter housing.

(3) Remove the dowel pin from the end of the valve stem and slide off the seat, spring, and washer.

(4) Remove the cotterpin from the nut and remove the nut from the shouldered end of the valve stem.

(5) Remove the upper and lower disks from the stem.

B. Installation

(1) Coat a new packing with oil and install the oil filter valve lower disk onto the stem, conical side toward the shoulder of the stem.

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(2) Install the oil filter valve upper disk on the stem against the lower disk, concave side of the disk away from the lower disk.

(3) Install the nut on the stem and tighten to the recommended torque. Install the cotterpin in the nut and bend to secure.

(4) Slide the build-up stem down into the large ID end of the oil filter valve seat.

(5) Place the washer against the lower end of the valve seat; then install the spring against the washer on the stem.

(6) Install the spring seat over the stem and secure the spring and seat on the valve stem with the dowel.

(7) Coat a new packing with engine oil and position it in the groove of the filter valve seat.

(8) Install the assembled oil filter valve in the oil filter housing.

(9) Secure the valve in the housing by installing the retaining ring.

23. Removal/Installation of the Accessory and Component Drives Gearbox

A. Removal

(1) Remove both hydraulic pad covers from each end of the accessory and component drives gearbox; then install the PWA-16566 (Left) and PWA-16567 (Right) Brackets to each of the pads and secure with the cover's retaining nuts.

(2) Attach the PWA-6580 Sling to each of the bracket spools and take up the slack.

(3) Remove the bolts securing the locks retaining the pins in the diffuser case positioning bracket and the accessory and component drives bearing housing; then using a screwdriver or similar tool, remove the locks and the pins.

(4) Remove the two bolts securing the locks to the brackets attached to the diffuser case front flange.

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(5) Using the chain hoist, adjust the accessory and component drives gearbox to take its load off of the pins adjacent to the bolts removed from the diffuser case brackets.

(6) Using a screwdriver or similar tool, pry the pins and locks from the brackets attached to the diffuser case.

(7) Position a dolly having small casters under the gearbox and lower the gearbox to the dolly. Remove the sling from the spools of the brackets and withdraw the accessory and component drives gearbox under the horizontal stand.

CAUTION: BECAUSE THE ANGULAR ENGAGEMENT OF THE COUPLING TO THE MAIN ACCESSORY COMPONENT DRIVE SHAFT, THE GEARBOX DOES NOT DROP VERTICALLY UNTIL THE GUIDE IN THE COUPLING IS COMPLETELY OUT OF THE ID OF THE SHAFT. THEREFORE, EXERT PRESSURE ON THE REAR OF THE GEARBOX TOWARDS THE FRONT OF THE ENGINE, TO AID THE GUIDE IN THE COUPLING TO DISENGAGE FROM THE ID OF THE SHAFT DURING INITIAL LOWERING OF THE GEARBOX.

(8) Reinstall the sling to the bracket spools and raise the gearbox; then install the PWA-16177 Support to the alternator drive pad on the front of the gearbox using engine bolts.

(9) Install the gearbox in the PWA-16514 Stand and secure with the ball-lok pins.

(10) Remove the accessory and component drive shaft from inside the diffuser case six o'clock strut.

NOTE: Wrap the shaft in protective paper to prevent damage and contamination to the splines.

B. Installation

(1) Coat the splines with Lubriplate No. 130A or its equivalent; then install the component drive shaft inside the diffuser case six o'clock strut and into its mating spline in the main accessory component drive gearshaft.

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(2) With the hydraulic pad covers on each end of the accessory and component drives gearbox removed, install the PWA-16566 (Left) and PWA-16567 (Right) Brackets to each pad and secure them with the cover's retaining nuts.

(3) Using PWA-6580 Sling and a hoist, raise the gearbox from the PWA-16514 Stand and remove the PWA-16177 Support to the alternator drive pad on the front of the gearbox.

(4) Position the gearbox assembly in flight position on a dolly having casters; then remove the sling.

(5) Using the dolly, position the gearbox assembly under the six o'clock strut of the diffuser case and reinstall the sling to the bracket spools.

(6) Coat the splines of the coupling in the gearbox assembly with Lubriplate No. 130A or its equivalent, and with the hoist, raise the gearbox assembly from the dolly while positioning the guide of the coupling in the ID of the component drive shaft in the diffuser case strut, carefully install the gearbox, placing the lugs of the gearbox assembly bracket in the diffuser case positioning bracket.

CAUTION: BECAUSE OF THE ANGULAR ENGAGEMENT OF THE COUPLING TO THE MAIN ACCESSORY COMPONENT DRIVE SHAFT, THE GEARBOX ASSEMBLY CANNOT BE RAISED VERTICALLY AFTER THE COUPLING HAS ENTERED THE ID OF THE SHAFT. THEREFORE, EXERT PRESSURE ON THE FRONT OF THE GEARBOX TOWARD THE REAR OF THE ENGINE, TO AID THE GUIDE IN THE COUPLING TO ENGAGE IN THE ID OF THE SHAFT DURING INITIAL RAISING OF THE GEARBOX.

(7) Align the holes in the diffuser case brackets with those in the accessory and component drives bearing housing and insert the retaining pins. Install the locks on the pins; then secure the locks with the bolts. Tighten the bolts to the recommended torque.

(8) Using the chain hoist, align the holes of the gearbox links to those in the brackets on the diffuser case front flange and insert the retaining pins. Install the locks on the pins; then secure the locks with the bolts. Tighten the bolts to the recommended torque. Lockwire the bolts.

(9) Remove the brackets and the sling.

For Training Purposes only

ENGINE - DISMANTLING/ASSEMBLY

23A. Removal/Installation of Gearbox Components

A. Accessory and Component Drives Bearing Housing Assembly and Gearbox Positioning Adapter Removal.

NOTE: See 72-0 Engine Inspection/Check for inspection limits.

(1) Remove the bolts securing the accessory and component driver bearing housing to the rear housing of the gearbox.

(2) Remove the bearing housing from the gearbox rear housing pad. Discard the gasket.

(3) Remove the accessory and components drive housing assembly lower bearing outer race from the gearbox and secure it with the bearing housing assembly.

CAUTION: IT IS IMPERATIVE THAT ALL SERIALIZED BEARING DETAILS ARE KEPT TOGETHER AS AN ASSEMBLY.

(4) Remove the bolts securing the gearbox positioning adapter to the diffuser case.

(5) Remove the positioning adapter and discard seal and gasket.

B. Removal and Installation of Gearbox Angle Pad Bushing.

(1) Remove the four screws securing the angle pad bushing to the gearbox.

(2) Using a suitable tool carefully pry the bushing free of the gearbox.

NOTE: It may be necessary to work a thin blade under the bushing around the entire perimeter to break the seal bond before attempting to remove the bushing from the gearbox.

(3) Thoroughly clean all sealer from the gearbox angle pad mating surface and from the mating surface of the bushing.

(4) Thoroughly clean all surfaces to be sealed with MEK or equivalent.

(5) Coat the gearbox angle pad mating surfaces with a film of RTV silicone sealer compound of uniform thickness.

For Training purposes only

(6) Install a bead of RTV silicone sealer compound around the bushing at the angle formed by the flange and the flange lip.

(7) Install the bushing on the gearbox angle pad and secure with the four counter sunk screws.

C. Accessory and Component Drives Bearing Housing and Gearbox Positioning Adapter Installation

NOTE: See 72-0 Engine Inspection/Check for serviceability limits.

(1) Place a gasket on the diffuser case accessory and component drives mounting pad: then install accessory and component drives positioning adapter aligning pin with hole in diffuser case pad. Secure to diffuser case with bolts and nuts. Torque and lockwire bolt heads.

NOTE: On assemblies using spring gasket lip with smaller ID contacts diffuser case and lip with larger ID contacts adapter.

(2) For engines incorporating teflon seal P/N 629416, proceed as follows: (Fig. 409A).

(a) Stone down any sharp edges on groove corners of gearbox seat assembly to avoid seal damage.

(b) Partially install the seal in the groove. Approximately half of the seal will enter groove without application of pressure.

(c) Using uniform finger pressure expand the remainder of the seal until it falls into the groove. This will eliminate twisting or rolling of the seal and minimize stretching.

(d) Install the mating adapter. Using adapter, push in any stretched areas of the seal not feeding into the lead-in chamfer.

(e) Install the retainer.

NOTE: Retainer may be installed either before or after seal is installed. Do not attempt to install seal and retainer simultaneously.

(3) Place a gasket in the groove of the accessory and component drives bearing housing mounting flange.

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ENGINE - DISMANTLING/ASSEMBLY

(4) Install the lower bearing outer race into the gearbox liner with serial number facing installer.

CAUTION: IT IS IMPERATIVE THAT ALL SERIALIZED BEARING DETAILS ARE KEPT TOGETHER AS AN ASSEMBLY.

(5) Matching the locating pin in the gearbox rear housing carefully position the accessory and component drives bearing housing assembly on the rear housing meshing the gearshaft and positioning the bearing rollers as necessary.

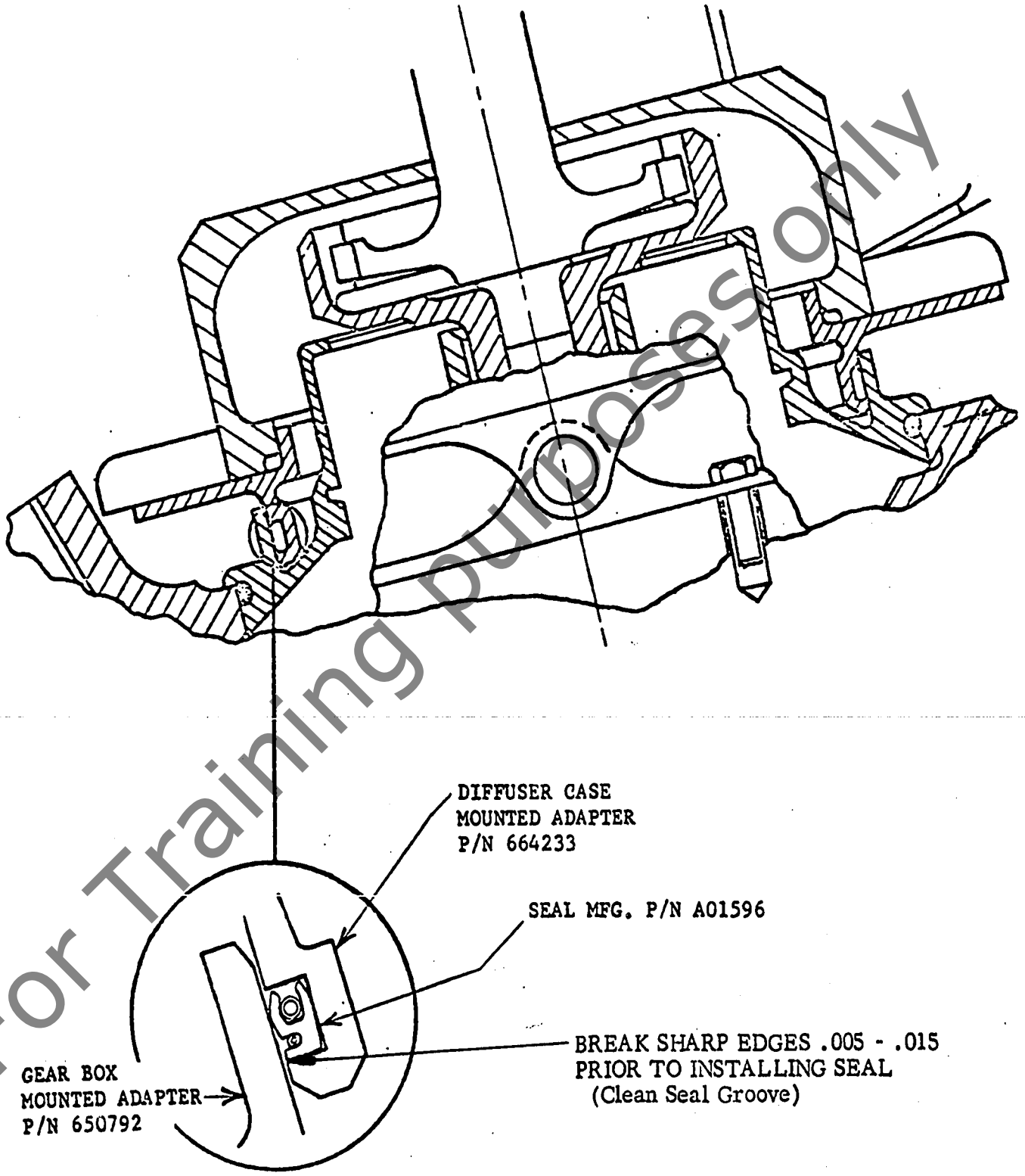
NOTE: The bearing rollers shall be coated with Esso Snow White 2F petrolatum prior to assembly.

(6) Secure the bearing housing to the gearbox angle drive pad with bolts. If four studs are present, use nuts and washers at that location. Torque bolts and nuts and lockwire.

NOTE: Gearbox assemblies incorporating the intent of S/B 1408 shall use longer bolts. The longer bolts can only be used with gearbox assemblies incorporating the longer inserts (MS 122242 at these locations). Gearbox assemblies incorporating four studs at the outside corner of the pad shall use 43-0134 flat washer and 42-0031 slotted nuts.

For Training Purposes Only

Engine - Seal, Gearbox Support Assembly, Main Accessory Drive - Replacement Of



JT3D N2 GEAR BOX ADAPTER SEAL INSTALLATION

Installation of Seal and Retainer in
Gearbox Support Assembly
Figure 409A

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

24. Removal/Installation of the Accessory and Component Drives Gearbox Breather Adapter (JT3D-1, D-3 and D-3B Boeing, JT3D-1-MC6 and JT3D-1-MC7) or Breather Elbow (JT3D-1, D-3 and D-3B Douglas)

A. Removal

(1) Remove the locknuts securing the accessory and component drives gearbox breather adapter (JT3D-1, D-3 and D-3B Boeing, JT3D-1-MC6, and JT3D-1-MC7) or breather elbow (JT3D-1, D-3 and D-3B Douglas) to the oil pump pad on the rear gearbox housing.

(2) Remove the breather adapter or breather elbow.

(3) Remove the plug and packing from the breather adapter or unfasten and remove the bolts, washers, and locknuts securing the cover to the elbow; then remove the cover and gasket.

B. Installation

(1) For the JT3D-1, D-3 and D-3B (Boeing), JT3D-1-MC6, and JT3D-1-MC7, using new packing, install the plug on the accessory and components drives gearbox adapter; then tighten the plug to the recommended torque and secure with lockwire or for the JT3D-1 (Douglas) using a new gasket, install the accessory and component drives gearbox elbow cover on the elbow and secure it with the bolts, washers, and locknuts and tighten to the recommended torque.

NOTE: Install washers under the bolt heads and under the nuts.

(2) Position the adapter or the elbow on the pad at the oil pump location on the rear gearbox housing and secure it using the washers and locknuts. Tighten the locknuts to the recommended torque.

25. Removal/Installation of the Oil Pressure Relief Valve

See Figure 409B.

A. Removal

(1) Using a wrench to prevent the pressure relief valve body from turning, remove the relief valve plug. Discard the packing.

(2) Remove the pressure relief valve assembly from the gearbox front housing using a standard wrench. Discard the packing.

B. Installation

(1) Place a new packing on the relief valve body flange and thread the relief valve body assembly into the threaded bore located on the lower right side of the accessory and components drives gearbox front housing. Tighten the housing to the recommended torque.

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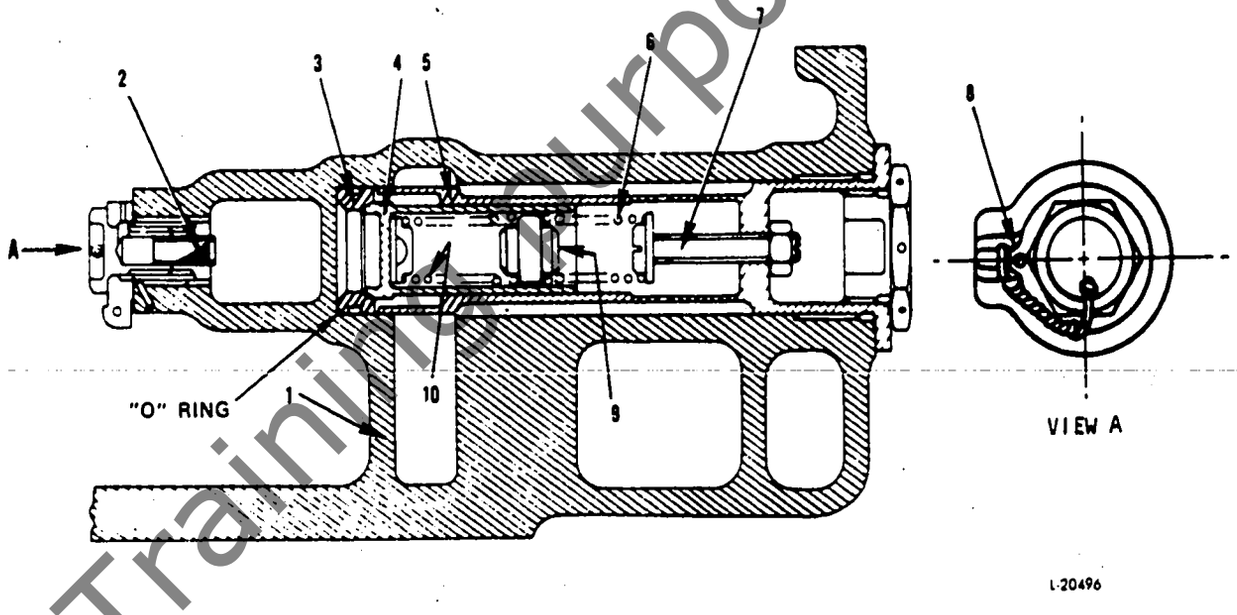
(2) Place a packing on the relief valve plug and thread it into the ID of the relief valve body. Tighten the plug to the recommended torque. Lockwire the plug.

26. Disassembly/Assembly of the Oil Pressure Relief Valve

A. Disassembly

(1) Remove the valve from the valve body; then remove the spring positioning plate, spring seat, and the spring.

(2) Remove the relief valve adjusting screw from the nut and remove them both from the valve body.



1. Gearbox
2. Strainer
3. Valve Seat
4. Valve
5. Valve Body
6. Outer Spring
7. Adjusting Screw
8. Do Not Lockwire Over Jet Port
9. Intermediate Spring Seat
10. Inner Spring

Oil Pressure Relief Valve
Figure 409B

For Training Purposes only

(3) Position the expander of PWA-16359 puller into the valve bore in the gearbox front housing to pass through the seat behind the valve seat; expand the puller securely in position and, holding the body of the puller in position, turn the jamnut and remove the valve seat from the housing bore. Remove the puller. Discard the gasket.

NOTE: If puller is not available, fabricate hook flattened on end and insert into cavity. Remove seat by hooking inner portion of seat and applying downward pressure. (This will require moving hook to several locations around the seal.)

B. Assembly

(1) Moisten the oil pressure relief valve seat packing with engine oil, and place it in the valve seat groove.

(2) Position the relief valve seat on the pilot of PWA-16358 drift and insert it into the bottom right side of the gearbox front housing. Drift the valve seat to bottom in the cavity. Remove the drift.

CAUTION: AFTER INSTALLING THE SEAT AND PACKING INTO THE HOUSING CAVITY, USE A STRONG LIGHT AND CHECK TO SEE THAT THE PACKING REMAINED IN THE GROOVE AND THAT NO ROLL-DOWN OF ANY PART OF THE PACKING HAS OCCURRED.

(3) Place relief valve positioning plate in relief valve and valve spring seat on plate. Position inner spring in valve to bottom on the spring seat; then install intermediate spring seat and the outer spring (Fig. 409B).

(4) Thread the adjusting screw to full depth in the body; then install the nut on the screw.

(5) Position the assembled relief valve into the relief valve body to seat the spring on the adjusting screw.

27. Removal/Installation of the Oil Scavenge Pump (Inlet) Strainer

A. Removal

(1) Provide a suitable container to catch the draining oil; then unfasten and remove the two bolts retaining the oil scavenge pump strainer at the bottom of the accessory drives housing and remove the strainer.

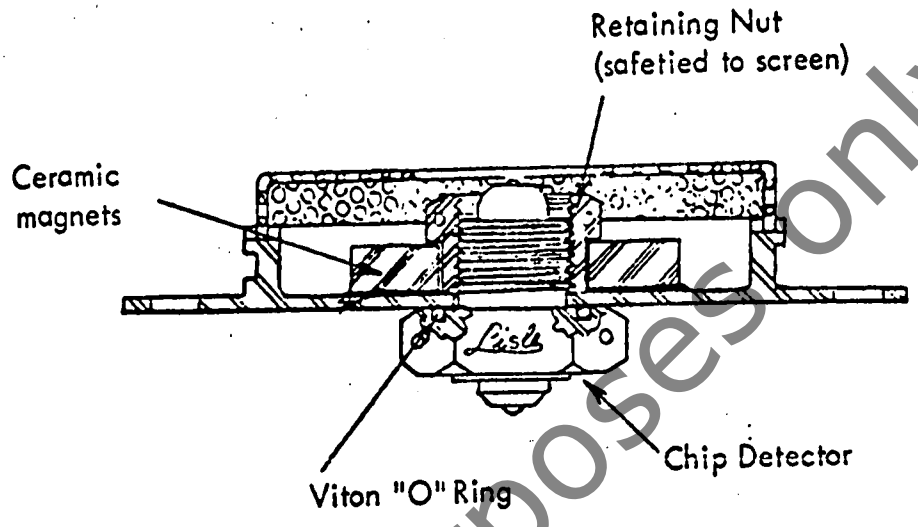
(2) Discard the oil strainer packing and clean the strainer.

B. Installation

(1) Install a new oil strainer packing on the strainer and install strainer in accessory drive housing.

CAUTION: DO NOT FORCE STRAINER INTO POSITION AS O-RING MAY BE EASILY CUT ON GEARBOX HOUSING.

For Training purposes only



Scavenge Screen
Chip Detector Installation
Figure 409C

27A. First Stage Compressor Blade and First Stage Spacer Replacement

A. Replacement of first stage compressor blades and first stage spacer on JT3D Engines are possible without removing engine from A/C. Any number of first stage fan blades may be replaced in the field. This will require special tools and must be accomplished with a qualified foreman.

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ENGINE - DISMANTLING/ASSEMBLY

(1) Removal

With the engine nose cowl removed replace damage first stage fan blades by the following procedure:

(a) Remove the turbo-compressor brackets and separate the anti-ice lines at the top of the inlet case.

(b) Detach reverser actuators at the inlet case and allow to hang on rear brackets.

(c) Remove all brackets at the "B" flange.

(d) Remove the front accessory case cover on the inlet case.

(e) Remove the No. 1 bearing inner race nut retaining rivet and remove the inner race nut.

(f) Remove the front accessory drive gear.

(g) Remove the screws retaining the No. 1 bearing housing.

NOTE: Do not remove outer nut retaining rivet, outer race nut or the No. 1 outer race from housing.

(h) Shim up under the second stage rotor blades.

(j) Remove the bearing housing.

(k) Pull the No. 1 bearing inner race and airseal.

(l) Remove remaining bolts securing the compressor inlet case to the front compressor case and vane assembly and remove the compressor inlet case.

NOTE: Prior to removing the bolts mark the location of all brackets so they may be installed in the correct position at assembly.

(m) Remove all nuts from the compressor front tie rod bolts. (Loosen each nut 1/4 turn until all nuts are removed.)

(n) Remove first stage rotor assembly. Mark the position before removal.

(o) Number the blades on the front side and mark the starting point and direction or rotation on the disk.

For Training purposes only

(p) Place the disk on a level surface with the hub down.

NOTE: A protective cover should be used on the surface to protect the disk.

(q) Using an aluminum or brass drift, straighten the blade locks and lightly tap each blade a small amount, moving around the disk, until all the blades are removed.

(r) Remove all old blade locks.

(2) Installation.

(a) Clean the disk and place disk on a level surface with the aft face down.

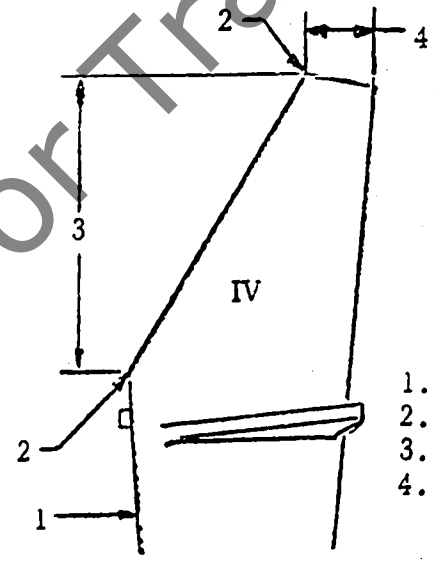
(b) Install new blade locks in the disk.

(c) Obtain new blade(s) to replace damaged blade(s) removed in Section 1.

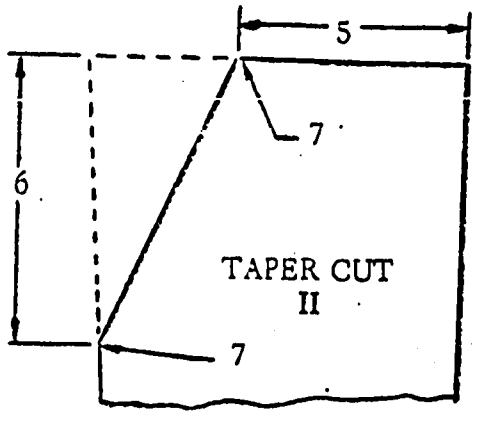
(d) Each replacement blade shall be weighted and compared with the weight of each respective damaged blade.

(1) The replacement blade weight shall be within plus or minus 2 gram weight of the damaged blade.

(2) If blade(s) replacement is required due to being dressed out to fly back limits cut II or IV the complete fan assembly must be replaced reference Fig.410.



1. Leading Edge
2. Smooth Blend
3. 4.500 Inch
4. 1.500 Inch



5. 2.500 Inches
6. 2.750 Inches
7. Smooth Blend

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

(e) Install blades in sequence. Start each blade in its respective slot in the disk and position the mid-span shroud on each blade as installed.

(f) Tap blades lightly around periphery of the disk until all blades are seated.

(g) Peen the blade lock tabs down over the blade root.

(h) Install the first stage rotor assembly over the front tie rods.

NOTE: Make certain the first to second stage spacer is seated on the second stage disk.

NOTE: Engines that incorporate the No. 1 bearing inner race anti-rotation slot and key modified as per M.O. 88532 and PWA Service Bulletin 2926 shall be handled as follows now that the M.O. and Service Bulletin has been cancelled.

1. Do not reuse or install a key.
2. Slotted bearing, seal plate and spacer may be reused.
3. Desirable to rotate bearing and seal spacer 180° from the slot in slot plate for unbalance.

(j) Seat the first stage disk on the spacer securely.

(k) Install the tab washers and nuts on the tie rods, using engine oil as a lubricant on the threads.

(l) Tighten the tie rods down to bottom in the spacer nuts, then back off 3/4 turn. Using special wrenches (PWA 16365) torque nuts.

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

28. Removal/Installation of Fuel Pump Drive Front Oil Seal/Engines Incorporating Fuel Pump Drive Spline Pressure Oil Lubrication

A. Removal

(1) Remove seal retaining ring (P/N 541170) from ID of retainer.

(2) Drill three one-eighth inch holes approximately 120° apart centered in the metal face of the seal.

(3) Install three self-tapping screws (No. 8 Blunt End recommended).

(4) Using suitable puller remove seal by pulling on the three screws.

CAUTION: LIMIT PENETRATION OF DRILL AND SCREWS TO 0.250 INCH OR LESS TO AVOID DAMAGE TO RETAINER.

B. Installation

(1) Place seal (P/N 436174) in retainer and over end of fuel pump shaftgear.

(2) Carefully seat seal in retainer.

(3) Replace seal retaining ring in retainer.

CAUTION: SEAL RETAINER (P/N 566070) CANNOT BE REMOVED BEFORE GEARBOX IS SPLIT AND FUEL PUMP DRIVE SPLINE LUBRICATION NOZZLE REMOVED.

28A. Starter Drive Oil Seal Replacement

A. Removal of Seal and Housing Assembly

(1) Remove starter, or drive pad cover from gearbox.

(2) Remove drain plug and drain gearbox.

(3) Remove snapring securing drive seal housing assembly in gearbox.

(4) Using PWA-16157 Puller, insert puller jaws into seal housing and remove housing. Remove packing from seal housing outer groove.

B. Seal Replacement

(1) Place seal housing assembly into PWA-16161 Base, large ID down, so housing engages locating diameter provided on base. Using PWA-7143 Drift, press seal out of housing.

For Training purposes only

(2) Place seal housing on bench, place seal onto housing and locate PWA-6676 Drift on face of seal. Drift oil seal into position.

C. Installation of Seal Housing Assembly

(1) Place a packing, lubricated with petrolatum, in starter drive oil seal housing outer groove.

(2) Position seal housing assembly over starter drive coupling and drift to seat on shoulder of counter-bore in gearbox rear housing.

(3) Install snapring securing oil seal housing assembly to gearbox rear housing.

(4) Place a gasket on starter drive cover and secure gasket and cover to starter drive pad with washers and locknuts. Tighten locknuts to recommended torque.

(5) Install drain plug with new seal into gearbox, tighten to recommended torque and lockwire.

23B. Alternator Drive Oil Seal Replacement

A. Removal of Seal and Housing Assembly

(1) Remove locknuts and washers securing alternator drive pad cover to gearbox and remove cover and gasket.

(2) Remove drain plug and drain gearbox.

(3) Remove snapring securing drive oil seal housing assembly in gearbox.

(4) Using PWA-16157 Puller, insert puller jaws into seal housing and remove housing. Remove packing from seal housing outer groove.

B. Seal Replacement

(1) Place seal housing assembly into PWA-16161 Base, large ID so housing engages locating diameter provided on base. Using PWA-7143 Drift, press seal out of housing.

(2) Place alternator drive housing on bench, place seal onto housing and locate PWA-6676 Drift on face seal. Drift oil seal into position.

C. Installation of Seal Housing Assembly

(1) Place a packing in alternator drive oil seal housing outer groove.

For Training purposes only

(2) Position seal housing assembly over alternator drive gearshaft and to seat on shoulder of counterbore in gearbox front housing.

(3) Install snapring securing oil seal housing to gearbox front housing.

(4) Place a gasket on alternator drive cover and secure gasket and cover to pad with washers and locknuts. Tighten locknuts to recommended torque.

(5) Install drain plug with new seal into gearbox, tighten to recommended torque and lockwire.

28C. Tachometer Drive Oil Seal Replacement

See Figures 410A and 410B.

A. Removal of Seal and Housing Assembly

(1) Remove tachometer drive pad cover from gearbox.

(2) Remove drain plug and drain gearbox.

(3) Insert PWA-3790-50 Puller into tachometer drive gearshaft ID. Tightening knurled collar, secure puller lips to gearshaft ID. Using knocker action, remove tachometer drive housing from gearbox rear housing cavity and place on bench housing flange down.

(4) Remove tachometer gearshaft bearing lockring from housing.

(5) Using a drift, remove gearshaft and bearings from housing.

(6) Remove retaining ring securing inner race of first bearing to gearshaft.

(7) Using PWA-16338 Puller, locate jaws between two bearings with puller jaws contacting under face of first bearing and pilot of jackscrew in ID of gearshaft. Turn jackscrew and remove first bearing from gearshaft. Remove puller.

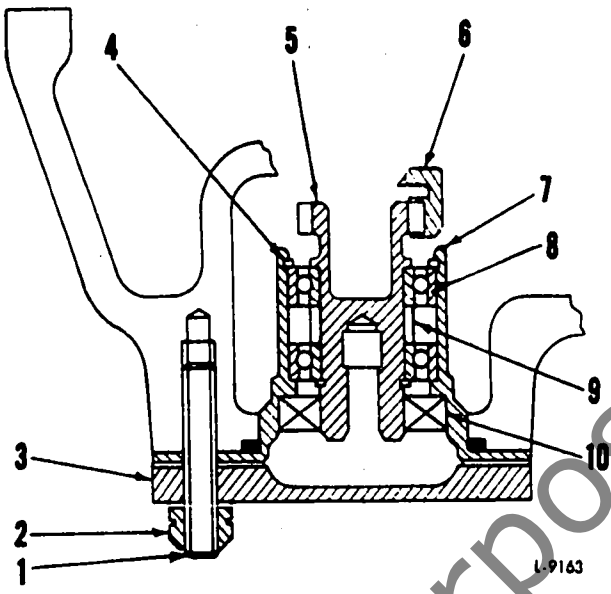
(8) Remove sleeve spacer from gearshaft.

(9) Position jaws of puller in cut-outs in shoulder of gearshaft to contact under side of inner race of second bearing. Turning jackscrew, with pilot in ID of gearshaft, remove bearing from gearshaft. Remove puller.

NOTE: Provide container to store bearings until reassembly.

(10) Place tachometer drive housing (flange face down) on bench. Using fiber drift, remove seal from housing.

For Training purposes only



1. Stud
2. Locknut
3. Cover
4. Lockring
5. Tachometer Drive Gearshaft
6. Tachometer Drivegear
7. Bearing Housing
8. Bearing (2)
9. Spacer
10. Seal

Tachometer Drive Gearshaft Assembly
Figure 410A

B. Installation of Gearshaft, Bearings and Oil Seal

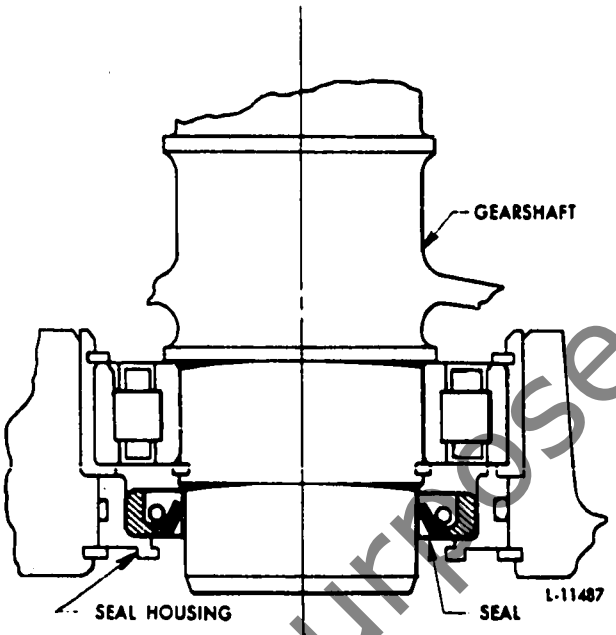
(1) Position tachometer drive gearshaft, gear end down, on an arbor press. Locate first bearing on end of gearshaft and, using PWA-16337 Drift, press bearing into position to seat on gearshaft shoulder. Remove drift. See Figure 410A.

(2) Install bearing spacer to seat on first bearing.

(3) Install second bearing in same manner as first bearing. Remove drift and assembly from arbor press.

(4) Secure bearings to gearshaft with retaining ring.

For Training purposes only



Typical Lip Type Oil Seal
Figure 410B

(5) Position tachometer drive gearshaft housing (flange down) on a bench. Drive gearshaft and bearings into housing to seat on housing shoulder.

(6) Install lockring in housing.

(7) Position tachometer drive housing on PWA-30017 Base then lubricate tachometer drive oil seal. Place PWA-14047 Guide into square hole in tachometer drive gearshaft; then place oil seal (element up) over guide and, using PWA-6841 or PWA-30016 Drift, seat seal on housing shoulder. See Figure 410B. Remove drift and guide.

(8) Place a packing in bottom side of tachometer drive gearshaft housing; then insert housing assembly into four sided pad cavity in gearbox rear housing, meshing tachometer drive gearshaft with tachometer drivegear. See Figure 410A.

(9) Position a gasket on tachometer pad and install cover. Secure cover with washers and locknuts. Tighten locknuts to recommended torque.

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

28D. Hydraulic Pump Drive Oil Seal Replacement

A. Removal of Seal and Housing Assembly

(1) Remove locknuts and washers securing hydraulic pump drive cover to gearbox rear housing; remove cover and gasket.

(2) Remove drain plug and drain gearbox.

(3) Remove retaining ring securing hydraulic pump drive oil seal housing in gearbox.

(4) Using PWA-16157 Puller, insert puller jaws into seal housing and remove housing. Remove packing from seal housing outer groove.

(5) Using drift, remove oil seal from oil seal housing.

B. Seal Replacement

(1) Place PWA-16295 Base on bench; then position seal housing on base (large ID up).

(2) Moisten new hydraulic pump drive lip type oil seal with engine oil and position it on PWA-16158 Drift with open face of seal up toward drift flange.

(3) Install drift and seal into seal housing with pilot on drift engaging hole in base.

(4) Using fiber mallet, seat seal in seal housing. Remove drift and housing from base.

C. Installation of Seal and Seal Housing Assembly

(1) Place PWA-16295 Base on a bench; then position hydraulic pump drive oil seal housing on base, large ID up.

(2) Lubricate hydraulic pump drive oil seal with petrolatum and position it on PWA-16158 Drift with open face of seal up towards drift flange.

(3) Install drift and seal into seal housing with pilot on drift engaging hole in base.

(4) Using a fiber mallet, seat seal in seal housing. Remove drift and housing from base.

(5) Place a packing in hydraulic pump drive oil seal housing outer groove.

For Training purposes only

(6) Position PWA-3095 Guide into splined ID of hydraulic pump drive gearshaft to seat on shoulder of guide. Position oil seal housing assembly into gearbox cavity and over guide to contact ID of oil seal. Drift housing assembly to seat on liner shoulder. Remove guide from gearshaft.

(7) Install snapring securing oil seal housing assembly to gearbox rear housing.

(8) Place a gasket on hydraulic pump drive cover and secure gasket and cover to hydraulic pump drive pad with washers and locknuts. Tighten locknuts to recommended torque.

28E. Fuel Pump Drive Front Oil Seal Replacement

A. Removal of Seal and Seal Housing Assembly

(1) With fuel pump removed from gearbox, remove snapring securing oil seal housing assembly in gearbox.

(2) Using PWA-16157 Puller, insert puller jaws into seal housing and remove housing assembly.

(3) Place seal housing assembly on bench and remove snapring securing oil seal. Using drift remove oil seal.

B. Seal Replacement

(1) Place PWA-16295 Base on bench; then position seal housing on base, large ID up.

(2) Moisten new fuel pump drive lip type oil seal with engine oil and position it on PWA-16158 Drift with open face of seal up toward drift flange.

(3) Install drift and seal into seal housing with pilot on drift engaging hole in base.

(4) Using fiber mallet, seat seal in seal housing. Remove drift and housing from base.

C. Installation

(1) Place packing in fuel pump drive oil seal housing outer groove.

2) Position PWA-3095 Guide into splined ID of fuel pump drive gearshaft to seat on shoulder of guide. Position oil seal housing assembly into liner and over guide to contact ID of oil seal. Drift housing assembly to seat on gearshaft ball bearing outer race. Remove guide from gearshaft ball bearing outer race. Remove guide from gearshaft.

For Training purposes only

(3) Install snapring securing oil seal housing assembly to liner.

(4) Install suitable protective cover over fuel pump opening of gearbox.

28F. Fuel Pump Drive Rear Oil Seal Replacement

A. Removal

(1) Remove locknuts and washers securing de-oiler pad cover. For Douglas engines, remove oil breather elbow.

(2) Using PWA-16157 Puller, engage puller lugs with puller groove in oil seal housing. Turn puller jackscrew to drive pilot into fuel pump drive gearshaft ID and jack oil seal housing assembly from accessory drive rear housing.

(3) Remove packing and drift oil seal from housing.

B. Seal Replacement

(1) Heat fuel pump drive rear oil seal housing in a hot oil bath. Position oil seal on pilot of PWA-16367 Drift with feather edge of seal facing drift. Place housing in an arbor press. Using press and drift, install and seat oil seal. Remove drift.

NOTE: For gearboxes incorporating fuel pump drive splined lubrication, use PWA-17078 Drift and PWA-10631 Base. After removing oil seal housing from hot oil bath, position it on PWA-10631 Base. Position oil seal on PWA-17078 Drift (feather edge of seal facing drift) and with aid of an arbor press, install and seat oil seal in housing.

C. Installation of Oil Seal Housing Assembly

(1) Install applicable Guide (PWA-16366 or PWA-16930 Guide) in end of fuel pump drive spur gearshaft.

(2) Install packing in recess on OD of oil seal housing.

(3) Slip OD of oil seal over OD of guide and onto OD of gearshaft. Remove guide.

(4) Use PWA-16768 Drift to seat housing and seal.

28G. Fuel Control Drive Oil Seal Replacement

A. Removal

(1) With fuel control removed from gearbox, remove snapring securing oil seal housing assembly in gearbox.

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(2) Using PWA-16157 Puller, insert puller jaws into seal housing and remove housing.

(3) Remove packing from seal housing outer groove.

(4) Using drift, remove oil seal from oil seal housing.

B. Seal Replacement

(1) Place fuel control drive oil seal housing (puller groove down) on a bench.

(2) Lubricate fuel control drive oil seal and position it on PWA-16162 Drift with open face of seal up towards drift flange. Place drift and seal on housing and press in until seal bottoms on shoulder in housing. Remove drift.

C. Installation of Oil Seal Housing

(1) Place a packing in fuel control drive oil seal housing outer groove.

(2) Position PWA-13030 Guide into splined ID of fuel control drive gearshaft to seat on shoulder of guide. Position oil seal housing assembly into liner and over guide to contact ID of oil seal. Drift housing assembly to seat on gearshaft ball bearing outer race. Remove guide from gearshaft.

(3) Install snapring securing oil seal housing assembly to liner.

(4) Install suitable protective cover over fuel control opening of gearbox.

28H. Water Injection Pump Drive (Boeing/Fuel Boost Pumps (Douglas) Oil Seal Replacement

A. Removal

(1) Remove locknuts and washers securing water injection pump drive cover from left end drive pad and remove cover.

(2) Remove retaining ring securing oil seal housing.

(3) Remove seal housing assembly using PWA-16463 Puller. Engage jaws of puller in groove in oil seal housing. Turn jackscrew of tool in so that pilot on end of jackscrew contacts end of water injection pump drive bevel gear. Continue to turn jackscrew in to jack oil seal housing out of bearing support.

(4) Place seal housing assembly on top of PWA-16454 Base with oil seal facing down.

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(5) Position shoulder of PWA-16453 Drift against rear face of oil seal. Using an arbor press, push oil seal out of oil seal housing assembly.

B. Seal Replacement

(1) Position oil seal on pilot of PWA-16455 Drift.

(2) Install oil seal in seal housing by using an arbor press on the drift.

C. Installation of Seal Housing

(1) Install pilot of PWA-16460 Guide in splined end of water injection pump drive bevel gearshaft.

(2) Install a new lubricated packing on seal housing.

(3) Push seal and housing over guide until seal bottoms in bearing support.

(4) Secure housing with retaining ring.

(5) Position a gasket on drive pad and install cover, making certain that largest hole in cover lines up with shouldered stud on drive pad. Secure cover with washers and locknuts. Tighten locknuts to recommended torque.

28I. Removal/Installation of Tachometer Drive Cover, Oil Seal Housing and Oil Seal (N1)

A. Removal

(1) Remove nuts and washers securing tachometer drive cover to four cornered pad on front accessory drive front support; then remove cover and gasket.

(2) Prior to removing oil seal housing, inspect housing area for oil leakage.

(3) Install PWA-7146 Puller jaws in oil seal housing puller groove; then using knocker action, remove tachometer drive oil seal housing and oil seal from front accessory drive front support.

(4) Remove oil seal ring from housing OD.

(5) Inspect carbon seal while it is still in housing. Remove seal from housing only if seal is to be replaced.

(6) Position tachometer drive oil seal housing (front face down) on bench.

(7) Using fiber drift, remove oil seal from housing.

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B. Installation

(1) Coat O-ring seal with engine oil and install seal in OD groove of tachometer drive shaftgear seal housing.

(2) Position seal housing on front accessory drive front support tachometer pad, aligning housing flange holes with studs. Using drift, seat housing to bottom of pad.

(3) Install PWA-14047 Guide in square drive of tachometer drive gearshaft; then moisten ID of lip type oil seal with engine oil and position seal on guide (spring toward ball bearings).

(4) Using PWA-6841 Drift, seat oil seal on inside shoulder of oil seal housing. Remove drift and guide.

(5) Place gaskets on tachometer and governor pads; then position covers over studs and install washers and locknuts. Torque locknuts.

28J. Removal/Installation of Inlet Cone Support Assembly

A. Removal

(1) Unfasten and remove bolts securing front accessory drive support assembly to No. 1 bearing front support.

(2) Using PWA-17412 Puller mounted on tachometer drive studs, remove front accessory drive support assembly from No. 1 bearing front support.

B. Installation

(1) Install a new lubricated packing in groove on OD of inlet cone support rear flange.

(2) Position inlet cone support assembly with its pin aligned with hole on front of inlet case against outer diameter of No. 1 bearing front support.

(3) Install washers, with depressions to fit grooves in support brackets in positions noted at disassembly, and bolts. Tighten bolts to recommended torque and bend tabs of tabwashers up to secure bolts.

(4) Install cap on compressor inlet vane air transfer tube.

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28K. Removal/Installation of No. 1 Bearing and Front Accessory Drives Main Gear

A. Removal

(1) Install front compressor locating supports (PWA-16935 Supports) on fan discharge case at approximately 5 and 7 o'clock positions. Adjust screw to engage second stage compressor disk between blades and support compressor rotor.

(2) Unfasten two oil nozzle bolts and remove No. 1 bearing oil nozzle assembly.

(3) Remove two bolts securing No. 1 bearing oil strainer support to No. 1 bearing housing. Remove strainer support and No. 1 bearing oil strainer housing.

(4) Remove "L" shaped oil suction tube from eight o'clock position of bearing front support.

(5) Remove bearing inner race retaining nut rivet.

(6) Position PWA-16031 Wrench on retaining nut. Install PWA-16249 Holder on studs of inlet cone support, engaging front accessory drivegear to prevent rotation of rotor.

(7) Loosen inner race retaining nut with PWA-16031 Wrench. Remove rotor holder and wrench.

(8) If front accessory drivegear is of type secured by snapring, compress snapring clear of bearing inner race retaining nut lip and pull drivegear from hub. Use PWA-16050 Puller to remove drivegear, if necessary.

(9) Remove inner race retaining nut.

(10) If front accessory drivegear is of type held in place by lip of No. 1 bearing retaining nut, not by snapring as in step (8), pull drivegear from hub using PWA-16050 Puller.

(11) Remove rivet, then remove No. 1 bearing outer race retaining nut (left-hand thread) with PWA-16040 Wrench by engaging slots of retaining nut.

NOTE: On JT3D-1MC6 engine, use six PWA-16282 Teeth to adapt wrench to nut.

(12) Remove bolts which secure No. 1 bearing housing to front and rear support.

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(13) Using PWA-16043 Puller, remove No. 1 bearing housing (with bearing outer race and rollers).

NOTE: On JT3D-1MC6 engine, use PWA-16281 Puller; for JT3D-1MC7, JT3D-1, and JT3D-3 engines, use PWA-16043 Puller.

(14) Install bearing housing front face down in PWA-30343 Base and drift out outer race and rollers, using PWA-30344 Drift.

CAUTION: DETAIL PARTS OF BEARING MUST BE KEPT IN THEIR ORIGINAL ASSEMBLIES. PROTECT BEARING BY STORING IN A SUITABLE CONTAINER.

(15) Place lips of PWA-8193 Puller in puller groove of No. 1 bearing seal plate and, by turning jackscrews, remove seal plate together with No 1 bearing inner race.

(16) Reinstall No. 1 bearing housing on No. 1 bearing support.

(17) Install PWA-16039 Spacer (dummy bearing) on front hub (and into housing).

NOTE: Use PWA-8192 Spacer on JT3D-1MC6 engine.

(18) Secure spacer and housing by installing inner race retaining nut handtight using PWA-16031 Wrench.

NOTE: For JT3D-1MC6 engine, use nine PWA-16572 Teeth to adapt PWA-16031 Wrench to nut.

(19) Remove two supports from fan discharge case.

B. Installation

(1) Install front compressor rotor PWA-16935 Locating Supports on fan discharge case at approximately 5 and 7 o'clock positions. Adjust screw to engage second stage compressor disk between blades to support compressor rotor.

(2) Using PWA-16040 Wrench, remove No. 1 bearing outer race retaining nut and, using PWA-3687 Puller, remove PWA-16039 Spacer (dummy bearing) from the No. 1 bearing housing and front compressor front hub.

(3) Remove bolts securing No. 1 bearing housing to front support and remove bearing housing, indexing housing and support for later reassembly in same location. Temporarily secure front and rear supports with short bolts.

(4) Heat bearing housing in hot oil and position housing front face up in PWA-30429 Base.

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(5) Install bearing outer race and rollers in housing as follows:

(a) Assemble inner and outer race and rollers of bearing assembly, mating serial numbers on both inner and outer races on same side of assembly.

(b) Install bearing assembly in PWA-30430 Drift with serail numbers on inner and outer races facing away from pilot detail of drift.

(c) Position drift and bearing assembly in heated housing and drift bearing into housing. Allow temperature of parts to equalize and then remove drift and inner race.

(6) Install outer race retaining nut using PWA-16040 Wrench, torque nut as follows:

(a) Tighten nut to 2000 lb. in.

(b) Mark location of nut with reference to mating part.

(c) Turn nut through angle of 9° minimum to 12° maximum.

(d) Loosen nut to 0 lb. in. and repeat step (a).

(e) If mark on nut is in line with or beyond mating part reference mark within 0.050 inch maximum, apply final angle of turn per step (c).

(f) If marks are not within limits, repeat steps (b), (c), and (d) in order, until marks are within limits. Then perform step (e).

(7) Install rivet in outer race retaining nut by inserting it from OD of bearing housing front flange. Flare rivet using PWA-16042 Riveter.

NOTE For engines incorporating No. 1 bearing anti-rotation key, key should not be reinstalled to prevent possible damage from mis-assembly. Slotted bearing, seal and seal seat may be used without key.

(8) Install No. 1 bearing spacer (knife-edge seals to rear) on front compressor front hub.

NOTE: To ensure a continuous seating contact of carbon seal plates and seal spacers, perform following blue check. This check must precede final build-up of bearing seal assembly.

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(a) Apply a bluing material to seating surfaces of carbon seal plates and seal spacers build-up.

NOTE: Inside diameters of seal plates and seal spacers do not have to be checked.

(b) Assemble seal plates and seal spacers on hubs and/or shafts, depending on which bearing is being installed.

(c) Wring build-up of seal plates and seal spacers together.

(d) Disassemble build-up and check seating surfaces for continuous contact.

(e) If necessary to obtain a continuous contact, lap the seating surfaces to a finish of RMS 16 or smoother; then recheck contact surfaces using bluing material.

(9) Coat No. 1 bearing seal plate with engine oil and install it (puller groove forward) on compressor front hub against No. 1 bearing spacer.

(10) Install PWA-16044 Compressor against front face of No. 1 bearing seal plate. Compress seal rearward by securing compressor in place with four of bearing housing holes.

NOTE: Before installing No. 1 bearing inner race, spray on a light coat of dgf-123 anti-galling lubricant on hub journal to eliminate scoring of hub at disassembly. Area to be lubricated must be clean and free of oil.

(11) Heat No. 1 bearing inner race in hot oil and, using PWA-7337 Drift, install No. 1 bearing inner race, serail numbers to front, on hub against seal plate.

(12) Lubricate new O-ring and install it in groove on OD of front accessory drivegear: If gear is not snapring-retained type, install gear in front hub, aligning rivet holes in gear with rivet hole in hub.

(13) Install No. 1 bearing inner race retaining nut on front compressor front hub. Tighten it up against bearing handtight, using PWA-16031 Wrench.

NOTE: If necessary, use following procedure to hold rotor. Position PWA-16031 Wrench for No. 1 bearing inner race retaining nut; then install PWA-16249 Holder on studs of inlet cone support, engaging front accessory drivegear to prevent rotor movement (snapring-retained drivegear must be installed as directed below). Wrench must be positioned before holder. Proceed as in step (13), then remove holder and wrench.

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(14) Remove PWA 16044 Compressor from No. 1 bearing seal plate.

(15) If front accessory drivegear is snapring-retained type, install it temporarily in hub ID to provide counterforce for torque wrench. Snapring may be temporarily removed from drivegear for convenience.

(16) Attach PWA 16041 Wrench to PWA 18872 Wrench using PWA 20333 Adapter and PWA 20334 Plate. Position assembled wrenches so that PWA 16041 Wrench engages inner race retaining nut and front accessory drivegear. Attach PWA 3755 Hydraulic Pump to ram of PWA 18872 Hydraulic Wrench and tighten inner race retaining nut using following procedure:

(a) Tighten nut to 2000 lb-in.; then turn through angle of 10 degrees minimum to 15 degrees maximum and then loosen to 0 lb-in.

(b) Tighten nut to 2000 lb-in.

(c) Mark location of nut with reference to mating part.

(d) Turn nut through angle of 10 degrees minimum to 15 degrees maximum.

(e) Loosen nut to 0 lb-in. and repeat step (b).

(f) If mark on nut is in line with or beyond mating part reference mark within 0.050 inch maximum, apply final angle of turn per step (d).

(g) If marks are not within limits, repeat steps (c), (d), and (e) in order, until marks are within limits. Then perform step (f).

NOTE: If front accessory drivegear is of type retained by bearing inner race retaining nut lip (see step (17), below), check clearance between drivegear and No. 1 bearing inner race retaining nut with a 0.001 inch feeler gage. There must be no contact between gear and nut. If there is contact, disassemble and inspect parts.

(17) Secure inner race retaining nut with one of following procedures:

(a) Front accessory drivegear held by retaining nut lip; install rivet in nut from hub ID side through holes in drivegear and hub. Flare rivet with PWA 31743 Riveter.

(b) Front accessory drivegear held by snapring. Compress snapring (if used during torquing procedure) and remove drivegear from hub. Install rivet from hub ID side, through hole in hub. Flare rivet with PWA 31743 Riveter. Reinstall drivegear, lining up any hole in drivegear rim with rivet location in hub, and engage snapring behind retaining nut lip.

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(18) Remove temporary bolts securing front and rear supports and install bearing housing and bearing outer race and rollers in front support, aligning indexing marks and boltholes. Install bolts. Tighten bolts to recommended torque and lockwire.

(19) Position two lubricated packings (larger one first) on longer section of "L" shaped oil suction tube. Install tube in opening at approximate eight o'clock position in No. 1 bearing front support. Position one lubricated packing on forward groove of oil suction tube.

(20) Make certain steel pin securing No. 1 bearing oil strainer assembly in oil strainer body is in place. Position a new packing on oil strainer body and install body and strainer assembly into No. 1 bearing oil transfer tube of front support.

(21) Secure body to No. 1 bearing housing with two bolts. Tighten bolts to recommended torque and lockwire.

(22) Place new packing over short tube between two boltholes of oil strainer body and install No. 1 bearing oil nozzle assembly on oil strainer body, long tube through hole in bearing housing. Install and tighten two bolts to recommended torque and lockwire.

NOTE: Prior to installation oil flow check nozzles in accordance with following procedure and Figure 410C.

(a) Lower two tubes and raise oil inlet adapter of PWA-16012 Fixture.

(b) Install new packing on oil strainer body. Position body to fixture and secure with bolts.

(c) Position No. 1 bearing oil nozzle assembly (jets pointing down) to body, installing new packing between parts, and secure with bolts.

(d) Position two oil tubes of fixture to nozzle jets and secure tubes.

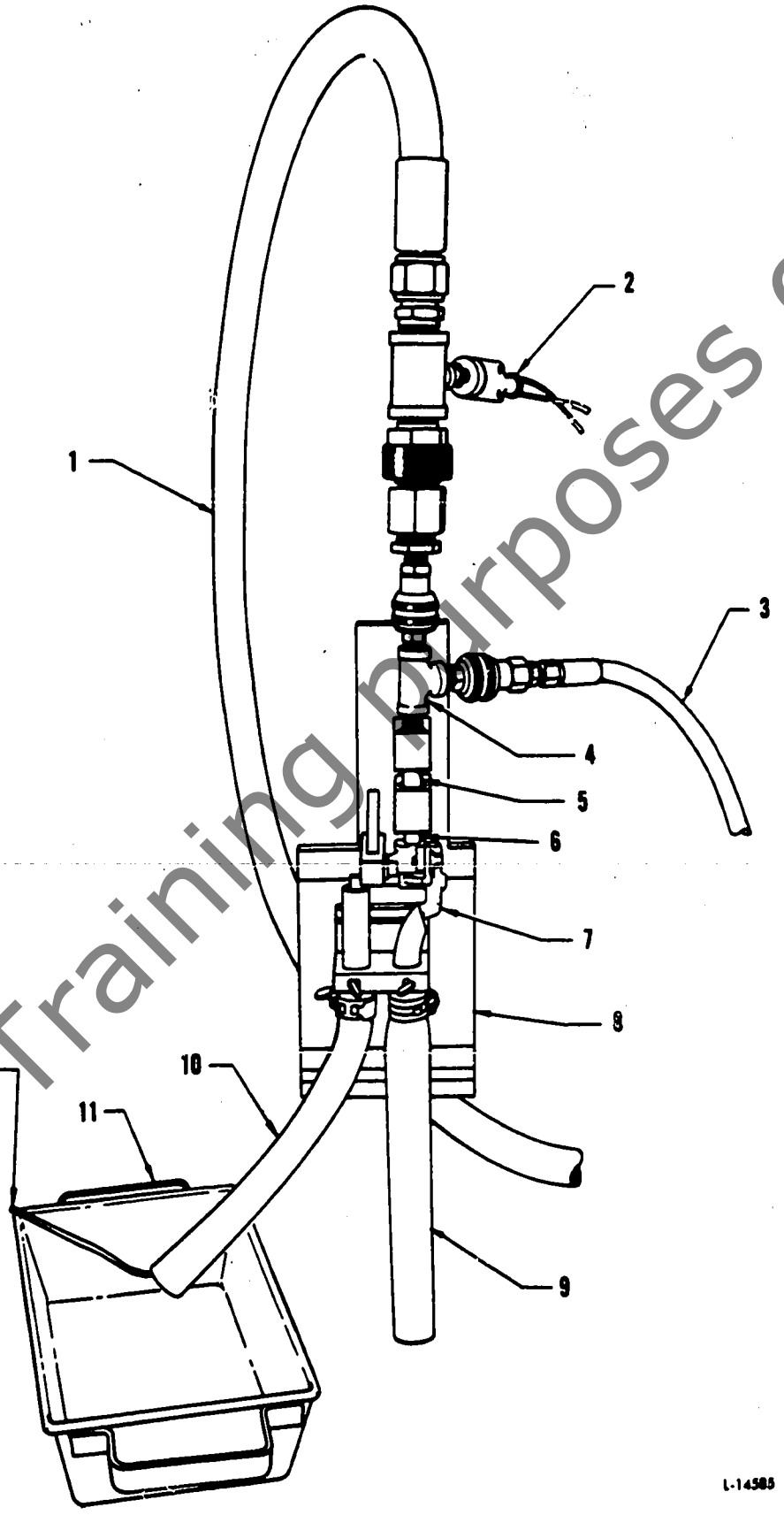
(e) Install packing on each end of strainer element assembly and install strainer into boss of fixture to seat against installed body.

(f) Secure oil inlet adapter of fixture over strainer element assembly on transfer tube.

(g) Attach oil supply line from suitable test stand to inlet adapter of fixture. Regulate oil pressure at 40 psig ±1 psi.

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No. 1 Bearing Oil Nozzle and Seal Jet
Oil Flow Check
Figure 410C

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1. Oil in Hose
2. Oil in Temperature Thermocouple (Typical)
3. Oil Pressure Gage Connection
4. Oil Inlet Adapter
5. Strainer Element
6. Oil Strainer Body
7. Nozzle Assembly
8. PWA-16012 Fixture
9. No. 1 Bearing Jet Oil Flow
10. No. 1 Bearing Seal Jet Oil Flow
11. Oil Flow Container (Typical)
12. Oil Out Temperature Thermocouple (Typical)

Key to Figure 410C

(h) Weigh oil flow from No. 1 bearing jet. Oil flow must be 2.5 to 3.0 lb/min.

(j) Weight oil flow from No. 1 bearing seal jet. Oil flow must be 2.5 to 3.0 lb/min.

(k) Remove engine parts from fixture.

(23) Remove supports from fan discharge case.

NOTE: Paragraph 28L must be complied with following above procedure.

28L. Front Accessory Drive Support Assembly and No. 1 Bearing Section Air Pressure Check

A. Procedure

(1) Place a new seal in groove on rear face of assembled front accessory drive support.

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(2) Align pin in front accessory drive support with hole in No. 1 bearing support, then bring front accessory drive support into position, making sure that scavenge pump and tachometer drivegears mesh properly with main accessory drivegear.

(3) Secure front accessory drive support to bearing support with washers and bolts. Tighten bolts to recommended torque and lockwire.

(4) Install PWA-10489 Connector to front compressor front bearing oil pressure fitting on compressor inlet case weldment.

(5) Connect air supply to connector.

(6) Regulate air supply to ten psi and check total airflow through flowmeter. Measured airflow must be within seven to twelve PPH.

(7) Disconnect air supply line and remove connector from No. 1 bearing pressure fitting.

NOTE: If this section is disassembled after airflow check, this air check must be repeated after assembly.

29. Removal/Installation of the Combustion Chambers

A. Removal

NOTE: All aircraft component tubing which interferes with this operation must be removed. Before removal of any part, mark the location of all clips and clamps to facilitate installation.

(1) With the engine in a horizontal position support it at the compressor intermediate case and the turbine exhaust case.

(2) Remove the high voltage leads from the sparkigniters; then remove the sparkigniters.

(3) Remove the exhaust temperature thermocouple lead, rear bearing pressure and scavenge oil lines and the combustion chamber drain line which extends rearward from the fireseal.

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(4) Remove all brackets and clips at the front flange of the turbine nozzle case (rear flange of the combustion chamber outer rear case). Note their locations.

CAUTION: WITH THE COMBUSTION CHAMBER OUTER REAR CASE MOVED BACK, THE LOAD ABOUT THE TURBINE REAR MOUNT PLANE MUST NOT EXCEED 2650 INCH-POUNDS. THIS RESTRICTION IS NECESSARY TO PREVENT A LOAD ON THE ENGINE THAT COULD DAMAGE THE SEALS OR BEARINGS. THEREFORE, REMOVE THE AIRFRAME SILENCER AND REVERSER OR MAKE PROVISIONS TO ADEQUATELY SUPPORT THEM DURING THIS PHASE OF MAINTENANCE.

(5) Remove the flange bolts and nuts securing the combustion chamber outer rear case to the shorter combustion chamber outer front case.

(6) Remove the screws which attach the sections of the fireseal and remove these sections.

NOTE: This step may be omitted but removing the top sections of the fireseal permits a slightly larger work area.

(7) Position the PWA-16210 Collar around the approximate center of the combustion chamber outer rear case and secure with the swing bolt and nut.

(8) Using a chain hoist, attach the PWA-6580 Sling to the collar spools and take up the slack.

(9) Remove the nuts which attach the combustion chamber outer rear case to the turbine nozzle case front flange.

(10) Slide the combustion chamber outer rear case rearward over the turbine nozzle case as far as it will go.

(11) Temporarily secure the lower section of the fireseal to the combustion chamber outer front case rear flange using engine bolts and nuts.

(12) Number the combustion chambers, using layout dye, from one to eight (clockwise) starting with the top right hand chamber as viewed from the rear.

(13) Remove all the bolts securing the combustion chamber clamps. If clamp incorporates spacer between bolt flanges, devise some method of keeping spacer with same clamp, such as lockwiring spacer to clamp, to ensure reinstallation with same clamp.

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(14) Slide the clamps forward on all of the even numbered chambers.

NOTE: The removal sequence steps (15) through (16) are for earlier configuration chambers. These combustion chambers with male crossover tubes (No. 2, 4, 6, and 8) must be disengaged first. No. 4 combustion chamber contains the opening for burner transfer tube, attached to right fuel manifold and must be removed directly rearward before lifting from fuel nozzles. On the newer Type III chambers, only the No. 5 chamber contains two male crossover tubes. The disengaging sequence with these chambers is No. 5, 6, 4, 3, 7, 2, 8, and 1. Disengage No. 4 chamber incorporating burner transfer tube directly rearward.

(15) Slide the even numbered (2, 4, 6, and 8) combustion chambers rearward moving the rear of the chamber outward to disengage the chamber lug from the positioning bracket, to clear the fuel nozzles; then rotate each chamber approximately ten degrees to disengage the cross-over tubes (See Figure 411). Lower to rest on adjacent parts.

CAUTION: AVOID BENDING OR DAMAGING THE POSITIONING BRACKETS AND BURNER TRANSFER TUBE WHICH IS IN THE NO. 4 COMBUSTION CHAMBER. IF NECESSARY LOOSEN OR REMOVE THE POSITIONING BRACKETS.

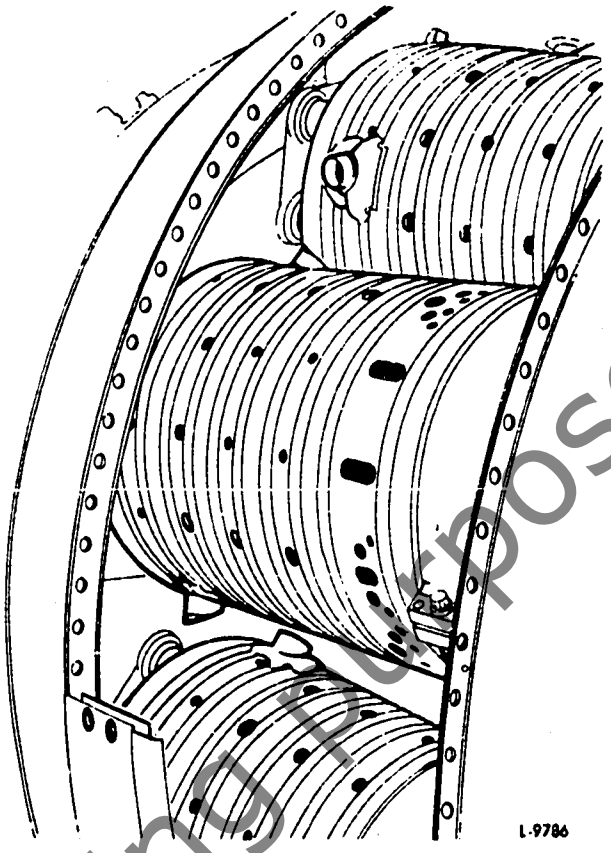
(16) Starting at the bottom repeat step (15) with the odd numbered (5, 3, 7, 1) chambers.

CAUTION: AS THE ODD NUMBERED CHAMBERS ARE MOVED REARWARD AND ROTATED, THE CHAMBERS ABOVE ARE FREE AND MUST BE HELD TO PREVENT DAMAGE TO THE FUEL NOZZLES. WORK PROGRESSIVELY UPWARD FROM THE BOTTOM WHEN ROTATING THE CHAMBERS AND CAREFULLY SHIFT THEM DOWNWARD.

(17) After all the combustion chambers are shifted downward, sufficient space is achieved at the top to remove either the No. 1 or No. 8 chamber. (See Figure 412.)

(18) Select either one and lift it slightly and swing the rearward end outward so that the combustion chamber inside edge will clear through the opening in the outlet duct. See Figure 413. Continue to swing the rear of the chamber outward and remove it from the engine.

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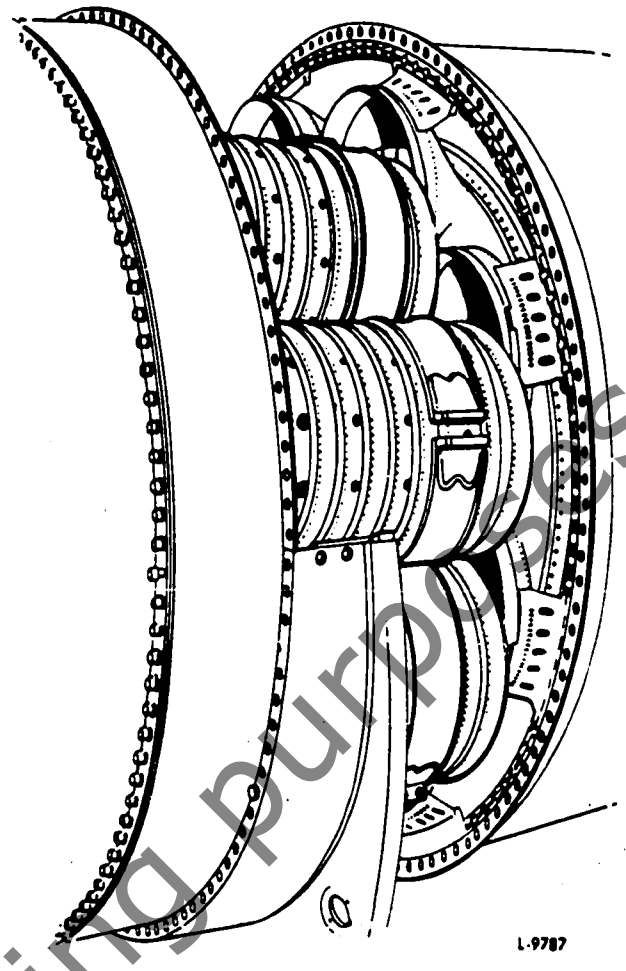


Preparing Combustion Chamber Liners for Removal
Figure 411

(19) Remove the rest of the combustion chambers in the same manner. The lower chambers must be raised upward to a position above the fireseal prior to removal.

(20) Install protective covers over the fuel nozzle clusters.

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Combustion Chambers Positioned for Removal
Figure 412

B. Installation

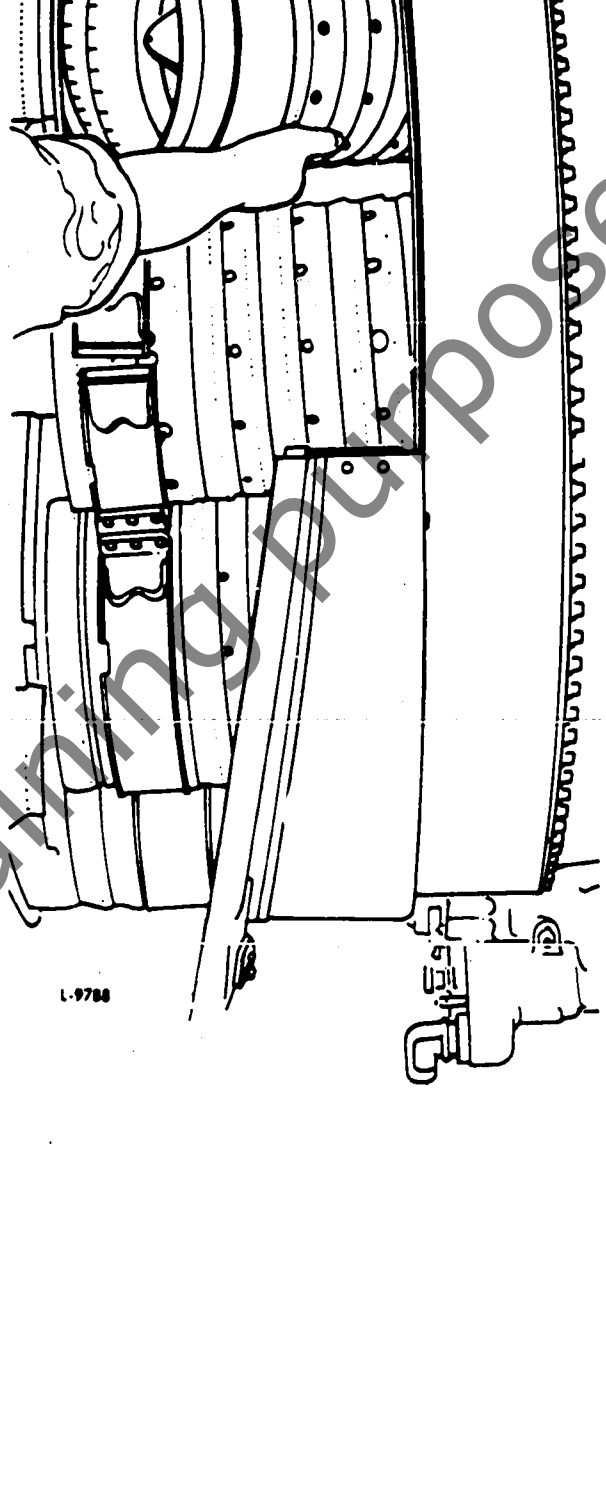
(1) The following precautions must be observed during chamber and chamber clamp installation.

(a) Do not mix chamber types within an engine set. See Section 72-0, Inspection/Check, for part number and type identification. Install only Type III chambers in JT3D-3B engines and other models incorporating SB 609 (JT3D-1, D-3, MC-7) or SB 765 (JT3D-1-MC6). Install only Type II chambers in JT3D-1, D-3, MC-6, and MC-7 engines not incorporating these bulletins.

(b) Chambers without hardfaced locating lugs are not acceptable for installation into engines.

(c) Chambers without hardfaced eleventh outer liners are not acceptable for installation into engines.

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Removing Top Combustion Chamber
Figure 413

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(d) Combustion chamber clamps which are not hardfaced in the forward ID which mates with the combustion chamber are not acceptable for installation into engines.

(e) Clamps, P/N 622382, incorporating loose heatshield, P/N 622379, installed (trapped) in center ID of clamp may not be operated without the heatshield.

(f) Interchangeability of clamps within an engine set of eight is as follows: loose (trapped) heatshield type clamps and welded-in heatshield type clamps can be used in complete engine sets respectively (preferred) or may be combined within an engine set if desired. Inter-mixing of Hastelloy and steel clamps of either heatshield design is also permissible. Combinations of heatshielded (all types) and non-heatshielded type clamps within an engine set are not recommended.

(2) Measure combustion chamber eleventh liner and record average OD.

(3) Measure both front and rear ID of clamp and record average ID and for clamps incorporating spacer, the spacer thickness required.

(4) Using the actual sizes of parts, as recorded on combustion chamber, outlet duct, and clamp, calculate the fit which will result when parts are assembled. For each of the eight combinations of chamber, outlet duct, and clamp, the fit must be as follows.

(a) Hastelloy material clamps (loose heatshield): P/N 622382 clamp (must have P/N 622379 heatshield assembled in place in center ID).

Clamp Front ID	9.783 - 9.789
Chamber Eleventh Liner OD	9.779 - 9.783
Fit 0.000 - 0.010L	
Clamp Rear ID	9.779 - 9.785
Outlet Duct Porthole OD	9.783 - 9.789
Fit 0.002L - 0.010T	
Clamp Center ID	9.898 - 9.902
Heatshield OD	9.902 - 9.908
Fit 0.000 - 0.010T	

(b) Hastelloy material clamps (welded-in heatshield): P/N 488124-SB1771, change letter E or later; P/N 500183-SB1771, change letter C or later; P/N 622378; and P/N 644546.

Clamp Front ID	9.783 - 9.789
Chamber Eleventh Liner OD	9.779 - 9.783
Fit 0.000 - 0.010L	
Clamp Rear ID	9.779 - 9.785
Outlet Duct Porthole OD	9.783 - 9.789
Fit 0.002L - 0.010T	

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(c) Hastelloy material clamps (non-heatshielded): P/N 488124, change letter E or later; P/N 500183, change letter C or later.

Clamp Front ID	9.778 - 9.784
Chamber Eleventh Liner OD	9.779 - 9.783
Fit 0.005L - 0.005T	
Clamp Rear ID	9.779 - 9.785
Outlet Duct Porthole OD	9.783 - 9.789
Fit 0.002L - 0.010T	

(d) Steel material clamps (welded-in heatshield): P/N 488124-SB1771, prior to change letter E; P/N 500183-SB1771, prior to change letter C; and P/N 647338.

Clamp Front ID	9.778 - 9.784
Chamber Eleventh Liner OD	9.779 - 9.783
Fit 0.005L - 0.005T	
Clamp Rear ID	9.775 - 9.781
Outlet Duct Porthole OD	9.783 - 9.789
Fit 0.002T - 0.014T	

(e) Steel material clamps (non-heatshielded): P/N 488124, prior to change letter E; P/N 500183, prior to change letter C.

Clamp Front ID	9.773 - 9.779
Chamber Eleventh Liner OD	9.779 - 9.783
Fit 0.000 - 0.010T	
Clamp Rear ID	9.775 - 9.781
Outlet Duct Porthole OD	9.783 - 9.789
Fit 0.002T - 0.014T	

(5) The most satisfactory condition is to mate chambers, clamps, and outlet duct portholes to achieve the mean of the fits limits at clamp to chamber and clamp to outlet duct porthole. However, clamp to chamber fit is more important than clamp to porthole fit.

CAUTION: UNDER NO CIRCUMSTANCES IS AN ENGINE TO BE ASSEMBLED WITH EITHER CLAMP TO CHAMBER OR CLAMP TO PORTHOLE FIT OUTSIDE LIMITS.

(6) The desired fit may be achieved as follows.

(a) For welded-in heatshield and loose (trapped) heatshield type clamps, which use spacers between bolt flanges of clamp, select spacer of proper thickness from Table VIII.

NOTE: Even though clamp may have been received with pre-selected spacer attached, it may be necessary to select a different spacer to obtain desired fit.

For Training purposes only

(b) For non-heatshielded type clamps, which do not use spacer, select chambers and clamps to make up an engine set which will meet fit requirements or rework clamp to welded-in heatshield type, with spacer.

Spacer, P/N 622383, is provided in the following thicknesses:

CL 7	0.045 - 0.047	CL 13	0.027 - 0.029
CL 8	0.042 - 0.044	CL 14	0.024 - 0.026
CL 9	0.039 - 0.041	CL 15	0.021 - 0.023
CL 10	0.036 - 0.038	CL 16	0.018 - 0.020
CL 11	0.033 - 0.035	CL 17	0.015 - 0.017
CL 12	0.030 - 0.032		

TABLE VIII

(7) When an engine set of chambers and clamps has been selected, mark chamber position on chamber, using non-permanent marking method, or some other system which will ensure that chamber/clamp combination will be installed in proper sequence, as follows:

Type II Chambers - 5-7-1-3-6-8-2-4
Type III Chambers - 1-8-2-7-3-4-6-5

(8) For loose (trapped) heatshield type clamps, select a heatshield which will give the desired clamp to heatshield fit. Mark position on heatshield, using non-permanent marking method. Do not install heatshield into clamp ID at this time.

(9) Spread ends of clamp and position clamp around chamber just forward of eleventh liner with split in clamp aligned axially with locating lug on chamber. Retain with clamp/chamber combination any circumferential shims and/or spacers which are associated with clamp. Do this for each of the eight clamp/chamber combinations in the engine set.

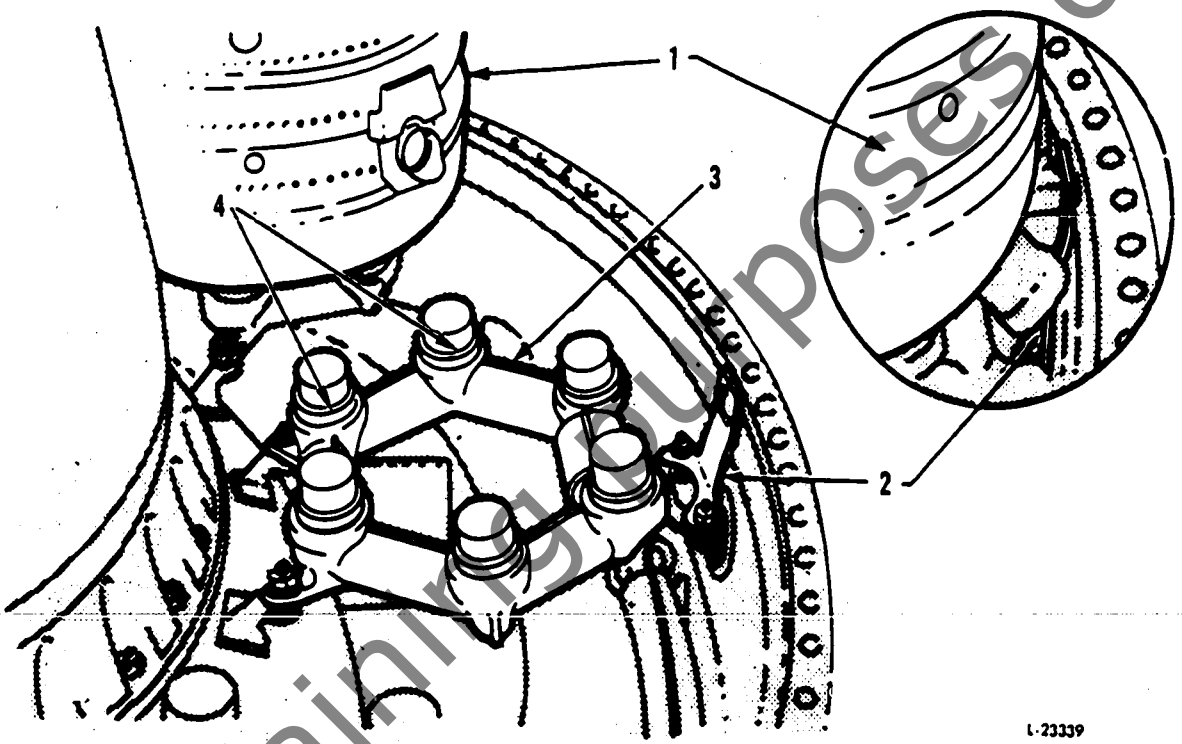
CAUTION: SPREAD CLAMP ONLY ENOUGH TO SLIP IT ONTO CHAMBER. EXCESSIVE SPREADING WILL PERMANENTLY DEFORM CLAMP. FOR WELDED-IN HEATSHIELD TYPE CLAMPS, DO NOT ALLOW CLAMP TO SPRING OR SNAP CLOSED ON CHAMBER SINCE THIS WILL BEND HEATSHIELD AND CLOSE GAP BETWEEN HEATSHIELD AND CLAMP BODY.

(10) Remove bolts securing combustion chamber outer front case to diffuser case. Raise case as far as it will go.

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(11) For loose (trapped) heatshield type clamps, install heatshield into outlet duct porthole.

(12) With combustion chamber outer front case moved rearward and with chamber positioning bracket (installed on manifold OD mount studs) loosened, install first chamber in sequence to seat on fuel nozzle cluster with chamber lug in position to engage positioning bracket. See Figure 414.



Index No.	Dimensions and Notes
1.	Combustion Chamber.
2.	Combustion Chamber Positioning Bracket. Nuts Securing This Bracket Must Be Installed Loosely Enough to Permit Bracket To Lean Toward OD of Engine During Chamber Installation.
3.	Fuel Nozzle Cluster.
4.	Shoulder On Fuel Nozzle. Install Chamber So hat Swirl Guides Seat On These Shoulders.

Combustion Chamber Installation
Figure 414

For Training Purposes Only

(13) While holding chamber seated against fuel nozzle cluster, spread ends of clamp only enough to permit slipping clamp toward outlet duct to engage around porthole.

NOTE: If circumferential shim is used in clamp rear ID to set fit, slide shim into place after clamp has been loosely engaged on outlet duct porthole.

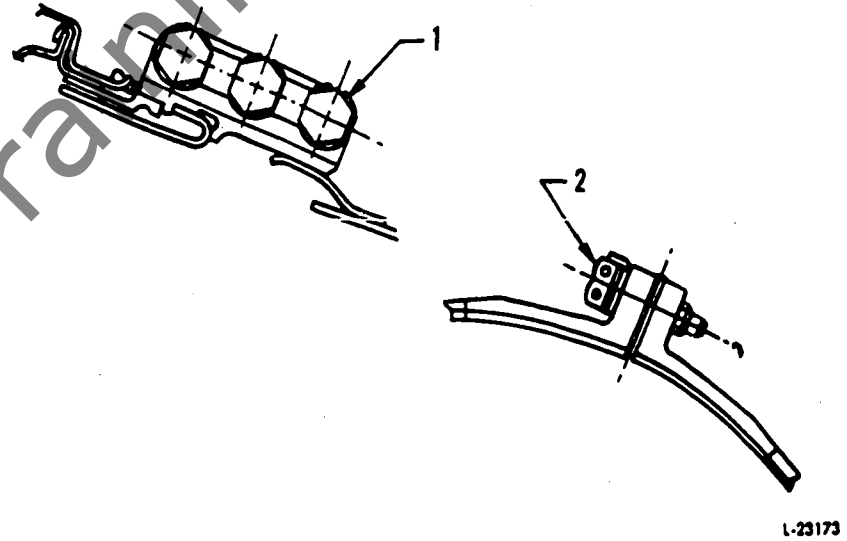
(14) For loose heatshield type clamps, move heatshield toward chamber and engage heatshield in clamp center ID as clamp is moved toward outlet duct porthole.

(15) Pull ends of clamp toward each other with finger pressure while inspecting to ensure that clamp is engaged 360 degrees around porthole and if circumferential shim is used, to ensure that shim is in place. Engage the notch at split in clamp over the anti-rotation lug on outlet duct porthole.

CAUTION: IF CLAMP HAS TWO NOTCHES, ENSURE THAT ONLY THE NOTCH AT SPLIT IN CLAMP IS USED.

(16) While holding ends of clamp as nearly together as possible, install tabwasher, three clamp bolts, and, if used, spacer between ends of clamp and run bolts down fingertight.

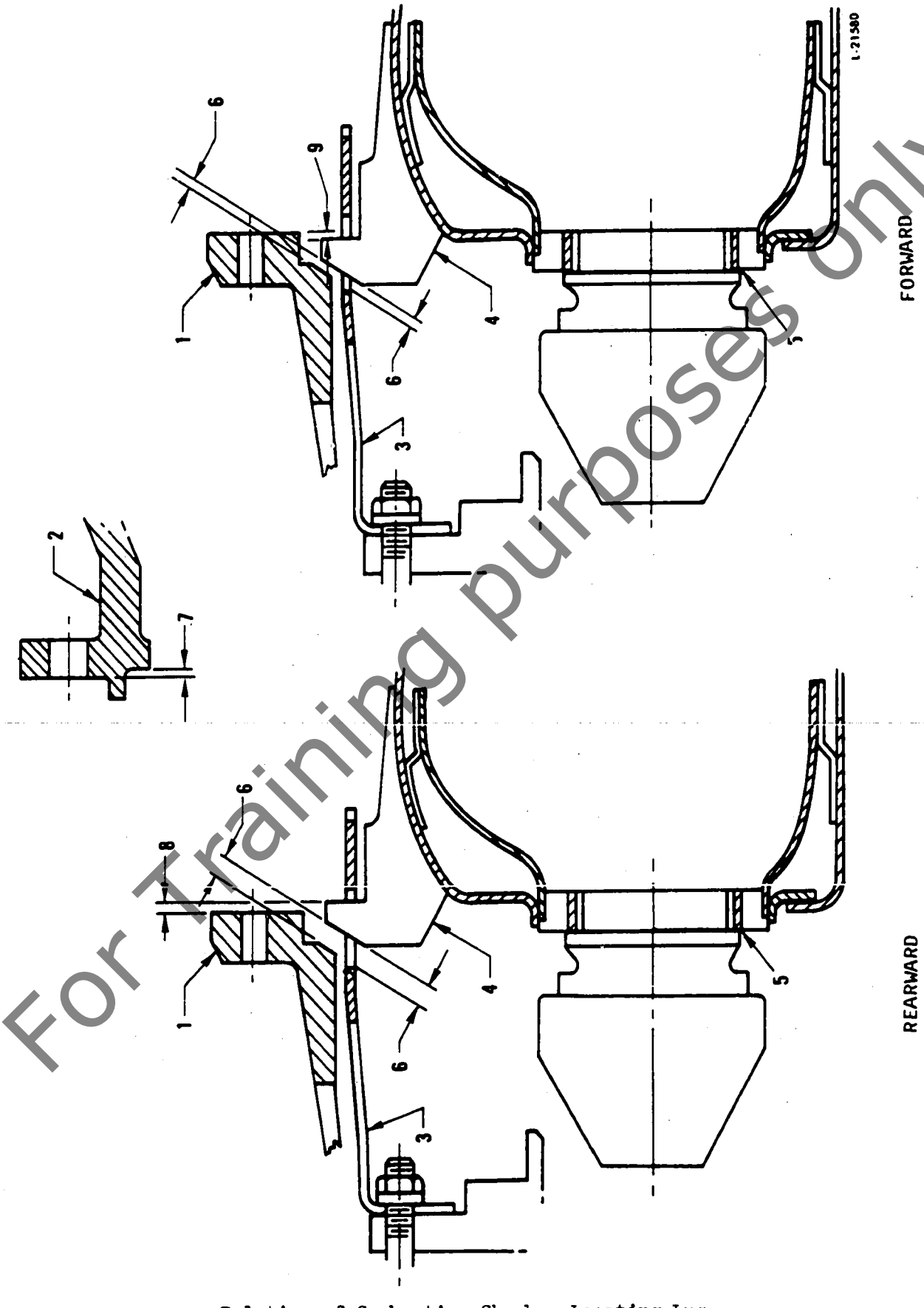
NOTE: See Figure 415 for clamp bolt arrangement. Do not use superseded type.



Index No.	Dimensions and Notes
1.	Single Hexhead Bolt Keywasher.
2.	Single Hexhead Bolt.

Combustion Chamber Clamp Bolting Arrangement
Figure 415

For Training purposes only



Relation of Combustion Chamber Locating Lug
to Diffuser Case
Figure 416

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

Index No.	Dimensions and Notes
1.	Diffuser Case, Rear OD Flange.
2.	Combustion Chamber Outer Front Case, Front Flange.
3.	Combustion Chamber Positioning Bracket.
4.	Combustion Chamber Locating Lug.
5.	Zero Clearance Between Chamber Swirl Guide And Shoulder On Fuel Nozzle Body During This Check.
6.	With Zero Clearance At Index No. 5, There Must Be Some Clearance Between Forward Angled Face Of Lug And Both Diffuser Case Flange and Positioning Bracket.
7.	Depth of Scallop In Front Flange of Outer Front Case. Begin Reading Table IX (Column I) At This Value.
8.	Face of Lug Rearward of Diffuser Case Flange. Table IX, Column III, Defines Maximum.
9.	Face of Lug Forward of Diffuser Case Flange. Table IX, Column II Defines Maximum.

Key to Figure 416

For Training Purposes only

(17) Tighten clamp screws to recommended torque. Do not bend tabwasher at this time.

CAUTION: CHECK FOR PROPER ENGAGEMENT OF CLAMP ALL AROUND (360 DEGREES) ON FLANGE OF COMBUSTION CHAMBER OUTLET DUCT PORTHOLE AS CLAMP BOLTS ARE TIGHTENED.

(18) With combustion chambers seated against their respective fuel nozzle clusters, check to determine that some clearance exists between forward face of chamber locating lug and both diffuser case and forward end of slot in chamber positioning bracket. See Figure 416, Index No. 6.

NOTE: If check does not indicate some clearance, it is probable that some major repair problem exists in manifold or diffuser case manifold mounting lugs, or chamber locating lug, which must be defined and necessary parts replaced before proceeding with engine assembly.

(19) With each combustion chamber seated against its fuel nozzle cluster, measure relationship between rear (hardfaced) face of chamber lug and rear face of diffuser case flange. See Figure 416. Check Table IX to determine that actual measurement is within limits specified for outer front case scallop depth, as marked on OD of front outer case near scallop. If all parts involved (manifold, manifold mount lugs in diffuser case chamber locating lug, outer front case scallop) individually meet limits defined in Section 72-0, Inspection/Check, then this measurement should fall between Column II and Column III of Table IX.

(20) Further tighten clamp bolts part of a turn as necessary to make possible bending tabwasher against a flat on bolthead. Bend tabwashers.

(21) Remove the lower fireseal section from the engine.

(22) Install the sparkigniters.

(23) Position PWA-16210 Collar around the combustion chamber rear outer case at the approximate center and secure with the swing bolt and nut; then attach the PWA-6580 Sling to the spools of the collar.

For Training purposes only

(24) Coat the snap diameter on the underside of the rear flange and the mating flange of the turbine case with molybdenum disulfide anti-seize compound.

Combustion Chamber Outer Front Case - Scallop Depth	Acceptable Range - Chamber Lug Measurement Forward Index No. 9, Figure 416 (Maximum)	Rearward Index No. 8, Figure 416 (Replace If Under)
Column I	Column II	Column III
0.075	0.019	0.050
0.074	0.020	0.049
0.073	0.021	0.048
0.072	0.022	0.047
0.071	0.023	0.046
0.070	0.024	0.045
0.069	0.025	0.044
0.068	0.026	0.043
0.067	0.027	0.042
0.066	0.028	0.041
0.065	0.029	0.040
0.064	0.030	0.039
0.063	0.031	0.038
0.062	0.032	0.037
0.061	0.033	0.036
0.060	0.034	0.035
0.059	0.035	0.034
0.058	0.036	0.033
0.057	0.037	0.032
0.056	0.038	0.031
0.055	0.039	0.030

NOTE: Begin reading table at Column I (scallop depth). Read horizontally to find maximum forward and rearward measurements of lug face, relative to diffuser case flange.

Table IX

For Training Purposes Only

ENGINE - DISMANTLING/ASSEMBLY

(25) Move the combustion chamber case forward into position.

CAUTION: DO NOT BUMP THE CASE AGAINST THE COMBUSTION CHAMBER LINERS SINCE MISALIGNMENT WITH THE FUEL NOZZLES MAY OCCUR. BEFORE CLOSING THE GAP BETWEEN THE FLANGES, VISUALLY CHECK EACH LINER FOR PROPER POSITIONING AND ALIGNMENT.

(26) Align the bolt holes of the combustion chamber rear outer case rear flange with the gangbolts in the turbine nozzle case front flange; then continue to move the outer case forward, aligning the offset hole, until the front and rear flanges are joined.

(27) Reinstall the three sections of the fireseal and temporarily secure the sections to the mating front flanges with a few bolts and locknuts (boltheads to rear).

(28) Install the rear of the bolts and locknuts securing the combustion chamber outer rear case front flange to the shorter combustion chamber outer front case (bolthead to rear). Tighten the locknuts to the recommended torque.

(29) Install the two screws on each side securing the fireseal section. Tighten the screws to the recommended torque.

(30) Install the brackets and clips, noted at disassembly, to the front flange of the turbine nozzle case (rear flange of the combustion chamber outer rear case). Secure the mating flanges, clips and brackets with the locknuts. Tighten the locknuts to the recommended torque.

(31) Reinstall the combustion chamber drain line, rear bearing pressure and scavenge oil lines and the exhaust temperature thermocouple lead.

(32) Using the chain hoist and sling loosen the collar swing bolt and nut and remove the collar.

(33) Connect the sparkigniter leads and the exhaust thermocouple lead. Replace all external parts to the locations from which they were removed.

For Training purposes only

30. Removal/Installation of First Stage Nozzle Guide Vanes

See Figure 417.

A. Removal

NOTE: The combustion chambers must be removed in the manner outlined in paragraph 2.

CAUTION: THE TURBINE NOZZLE CASE IS SUPPORTED BY THE FIRST STAGE TURBINE NOZZLE GUIDE VANES. MAKE CERTAIN THE NOZZLE CASE IS ADEQUATELY SUPPORTED IF A SIZABLE QUANTITY OF VANES ARE TO BE REMOVED. THIS MAY BE ACCOMPLISHED BY REPOSITIONING THE COMBUSTION CHAMBER OUTER FRONT CASE (ONLY) TO THE DIFFUSER CASE REAR FLANGE AND SECURING IT WITH SUFFICIENT BOLTS. INSTALL FOUR PWA-17205 SUPPORTS, 90 DEGREES APART BETWEEN THE COMBUSTION CHAMBER OUTER FRONT CASE AND THE TURBINE NOZZLE CASE OR POSITION A SADDLE ARRANGEMENT TO THE LOWER NECKED-DOWN SECTION OF THE TURBINE NOZZLE CASE. MAKE CERTAIN THE AIRFRAME SILENCER AND REVERSER ARE REMOVED OR ADEQUATELY SUPPORTED DURING THIS PHASE OF MAINTENANCE.

(1) Remove the bolts; then remove the clamp plates securing the outlet duct to the turbine nozzle inner case. Remove the clamp plates.

(2) Mark one of the fingers in the outlet duct and its position in the gangbolt assembly in the nozzle case; then remove the Allen screws securing the eight gangbolt assemblies, spacers, and the outlet duct to the nozzle case front flange. Remove the gangbolt assemblies while supporting the outlet duct.

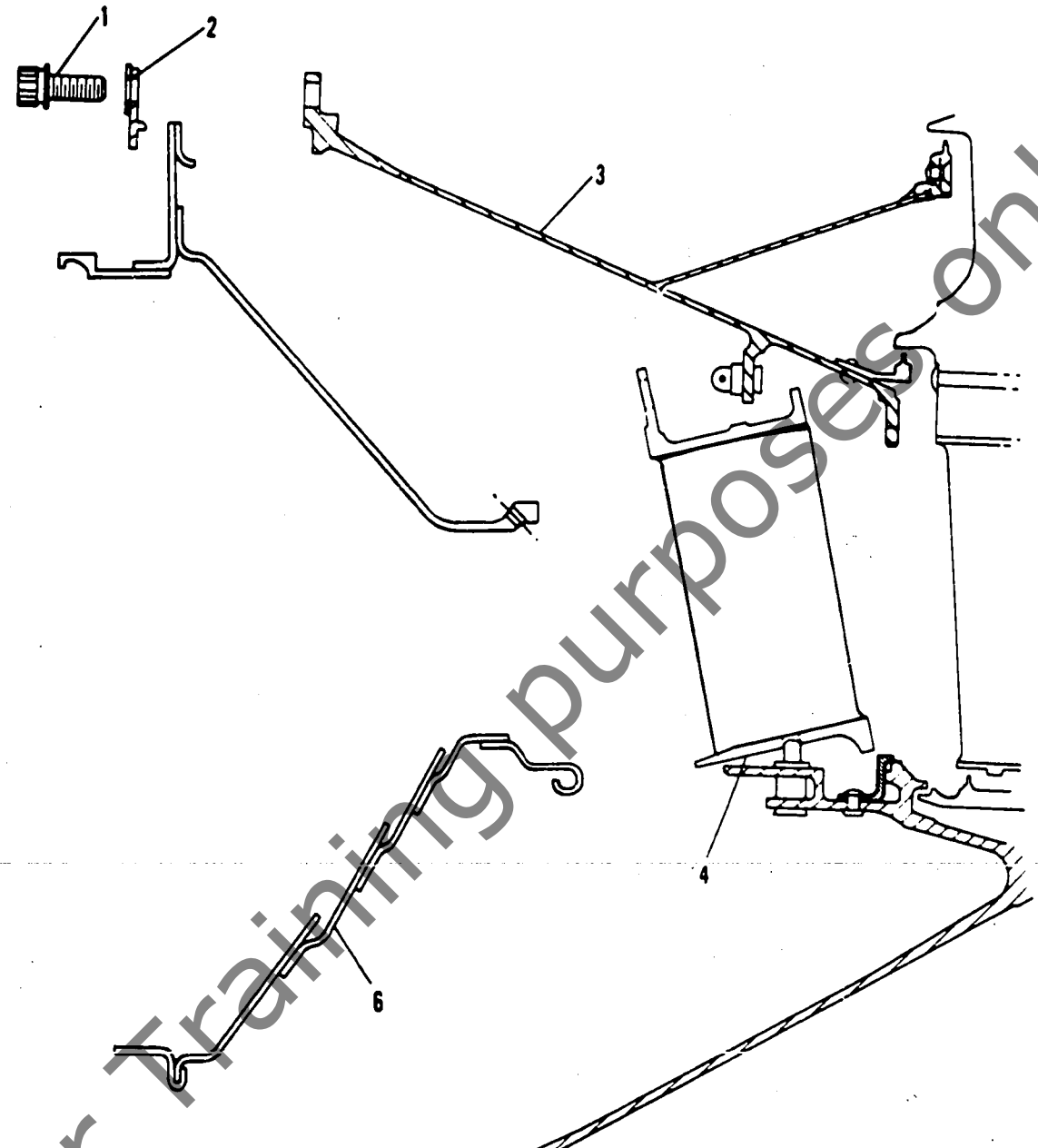
NOTE: Mark the gangbolt assemblies to assure their reinstallation in the proper location at assembly.

(3) Pull the outlet duct forward to expose the first stage nozzle vanes.

(4) Using an approved method, number the vanes and their location in order to assure their return to the same location.

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY



1. Retaining Nut
2. Outlet Duct Clamp Plate
3. Turbine Nozzle Inner Case
4. Turbine Vane
5. Turbine Nozzle Outer Case
6. Combustion Chamber Outlet Duct

First Stage Nozzle Guide Vane Assembly
Figure 417

For Training purposes only

(5) Remove the lockwire from a vane retaining pin, and using a rocking motion, pull the vane forward from its seat. Remove as many vanes as required in this manner.

NOTE: When it is necessary to remove all the vanes, 12 or more vanes should be left in (evenly dispersed) until after a sufficient number of new vanes are installed to prevent cocking of the turbine case. The number of vanes, up to 100 percent, may be replaced in a nozzle assembly as long as each replacement vane is the same class as the vane which it replaces. If replacement by exact class is not possible, the new average class should be determined to be within limits by recalculation.

B. Installation

(1) Insert the vanes into their seats and snap them into position aligning the vane retaining pins with their holes in the vanes. Lockwire the retaining pins in pairs, except, lockwire last three vanes together. See Figure 418.

NOTE: Make certain correct numbered vane or replacement (if required) is returned to its original position.

Engines incorporating turbine stator support assembly, P/N 622402 or 625948, must use vanes, P/N 536751. These vanes are installed with bolts, P/N 523514. Torque bolts and then lockwire as described in step (1).

(2) Position the outlet duct assembly to the turbine nozzle inner case and the turbine nozzle case front flange in the location marked at disassembly.

(3) Install a reinforcing plate between each outlet duct flange and turbine case front flange and an outlet duct positioning plate against front face of each flange so that each outlet duct flange is located between reinforcing plate and positioning plate.

NOTE: Hardfaced outlet duct flanges should be assembled between hardfaced reinforcing and positioning plates, (scuff plates) but may be assembled between non-hardfaced plates.

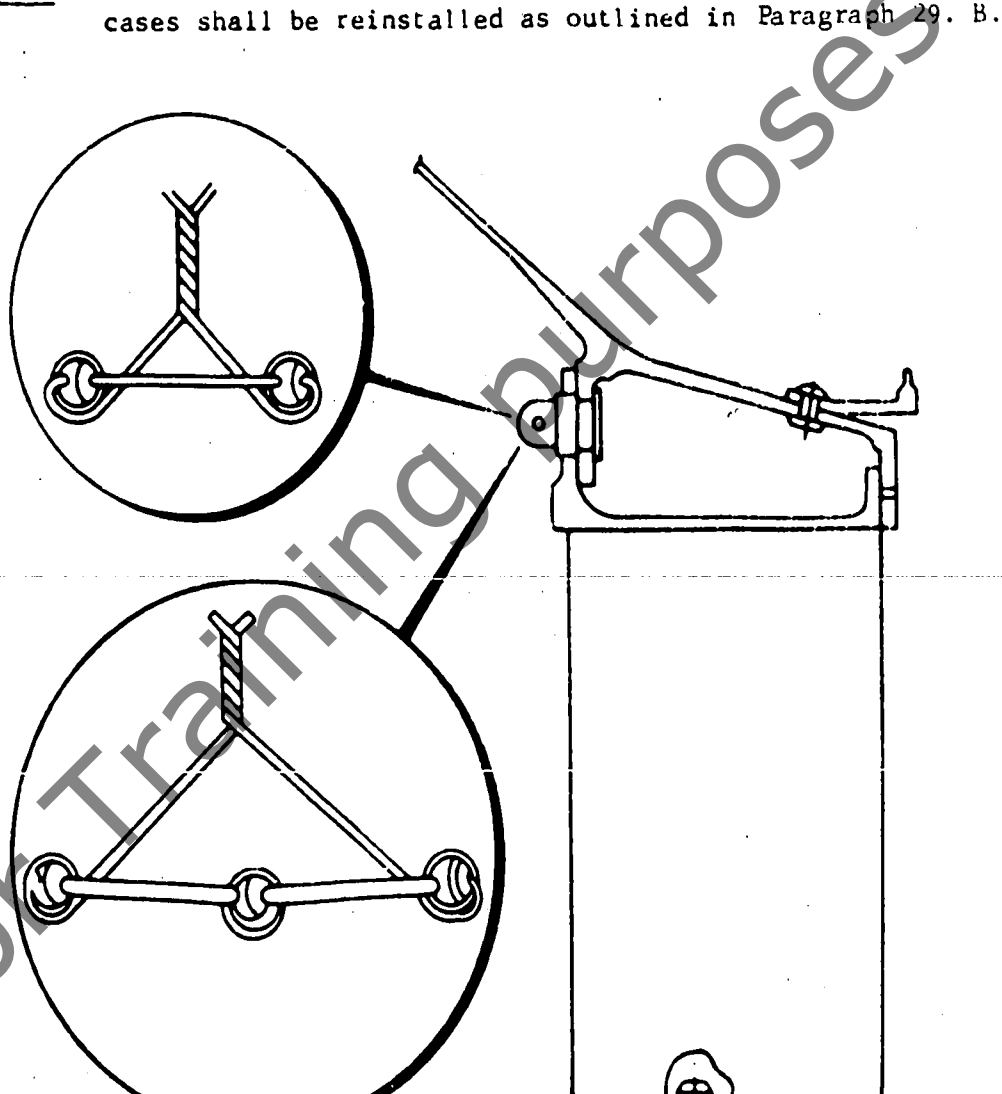
CAUTION: DO NOT ASSEMBLE NON-HARDFACED OUTLET DUCT FLANGES BETWEEN HARDFACED REINFORCING AND POSITIONING PLATES.

For Training purposes only

(4) Position the seven-bolt gangbolts to retain the reinforcing and positioning plates and the flanges of combustion chamber outlet duct against the turbine nozzle case front flange. Secure gangbolts to nozzle case flange with socket head screws.

(5) Install the outlet duct clamp plates and insert the bolts securing them to the turbine nozzle inner case. Tighten the bolts to the recommended torque.

NOTE: The combustion chambers and combustion chamber outer cases shall be reinstalled as outlined in Paragraph 29. B.



First Stage Turbine Vanes Lockwiring
Figure 418

For Training purposes only

REMOVAL/INSTALLATION OF #1 BEARING AND FRONT ACCESSORY DRIVE

30A. Removal/Installation of #1 Bearing and Front Accessory Drive

A. Front Accessory Drive Support Removal.

(1) Unfasten and remove the bolts securing the front accessory drive support assembly to the No. 1 bearing front support.

(2) Using the PWA 17412 Puller mounted on the tachometer drive studs if necessary remove the front accessory drive support assembly from the No. 1 bearing front support.

B. No. 1 Bearing and Front Accessory Drive Gear Removal

(1) Install front compressor shim supports in the fan case at approximately the 5 and 7 O'clock positions.

(2) Unfasten the two oil nozzle bolts and remove the No. 1 bearing oil nozzle assembly.

(3) Remove the two bolts securing the No. 1 bearing oil strainer support to the No. 1 bearing housing. Remove the strainer support and No. 1 bearing oil strainer housing.

(4) Remove the ell shaped oil suction tube from the eight O'clock position of the bearing front support.

(5) Remove the No. 1 bearing inner race retaining nut rivet.

(6) Position the PWA 16031 wrench on the No. 1 bearing inner race retaining nut. Install the PWA 16249 holder on the studs of the inlet cone support, engaging the front accessory drives main gear to prevent rotation of the rotor.

(7) Loosen the No. 1 bearing inner race retaining nut with the PWA 16031 wrench. Remove the holder and the wrench; then remove the retaining nut.

(8) Using PWA 16050-200 puller, remove the front accessory drives main gear.

(9) Remove the bolts which secure the No. 1 bearing housing to the front and rear support.

(10) Using the PWA 16043 puller, remove the No. 1 bearing housing (with the bearing outer race and rollers).

(11) Place the lips of the PWA 8193 puller in the puller groove of the No. 1 bearing seal plate and, by turning the jackscrews, remove the seal plate together with the No. 1 bearing inner race.

CAUTION: THE DETAIL PARTS OF THE BEARING MUST BE KEPT IN THEIR ORIGINAL ASSEMBLIES. PROTECT THE BEARING BY STORING IN A SUITABLE CONTAINER.

For Training purposes only

C. No. 1 Bearing and Front Accessory Drive Gear Installation

(1) Install anti rotation key engaging tang in one of the holes located in the fan hub.

NOTE: Step (1) applicable only if the No. 1 bearing inner race, carbon seal face plate, and knife edge air seal spacer have been reworked in accordance with M.O. 88532. (See Figure 418B).

(2) Position and install knife edge air seal spacer (knife edge seals to the rear) against hub with key through slot in seal.

CAUTION: CARE MUST BE TAKEN TO ENSURE PROPER ALIGNMENT OF NO. 1 BEARING INNER RACE, CARBON SEAL FACE PLATE AND KNIFE EDGE AIR SEAL SPACER ON ENGINES INCORPORATING ANTIROTATION KEY SLOTS. TEMPORARILY MARK 2 LINES ON HUB EXTENDING FROM INSTALLED KEY. TEMPORARILY MARK 2 LINES, EXTENDING FROM KEY SLOT, ON FACE OF INNER RACE. ALIGN KEY SLOT OF INNER RACE TO LINES ON HUB BEFORE DRIFTING INNER RACE ONTO HUB. LINES ON HUB AND INNER RACE MUST BE IN LINE AFTER BEARING INSTALLATION.

(3) Coat the No. 1 bearing seal plate with engine oil and install it (puller groove forward) on the compressor front hub against the No. 1 bearing spacer.

(4) Install the PWA 16044 seal compressor against the front face of the No. 1 bearing seal plate. Compress the seal rearward by securing the compressor in place with four screws in four of the bearing housing holes.

NOTE: Before installing the No. 1 bearing inner race, spray on a light coat of dgf-123 anti-galling lubricant on the hub journal to eliminate scoring of the hub at disassembly. Area to be lubricated must be clean and free of oil.

(5) Heat the No. 1 bearing inner race in hot oil and, using drift, install the No. 1 bearing inner race, serial numbers to the front, on the hub against the seal plate.

(6) Lubricate a new "O" ring seal and install it in the groove on the outer diameter of the front accessory drives main gear. Install the gear in the front hub, aligning the rivet hole in the gear with the rivet hole in the hub.

For Training purposes only

C. (7) Install the No. 1 bearing inner race retaining nut on the front compressor front hub. Tighten it up against the bearing hand tight,

NOTE: If necessary, use the following procedure to hold the rotor. Position the wrench for the No. 1 bearing inner race retaining nut; then install the holder on the studs of the inlet cone support, engaging the front accessory drives main gear to prevent rotation of the rotor. (The wrench must be positioned before the holder.) Proceed as in step (5), then remove the holder and wrench.

(8) Remove the seal compressor.

(9) Position the PWA 16031 and PWA 16249 wrenches so that wrench engages inner race retaining nut and the front accessory drives main gear. Attach wrench and tighten inner race retaining nut to torque and angle of turn using procedure given in Ref. No. 355 of Section 72-30, Clearance JT3D Overhaul.

(10) Install the rivet in the nut by inserting it from the ID of the front hub into the aligned rivet holes. Using the PWA 16042 riveter, flare the rivet.

NOTE: Check the clearance between the front accessory drives main gear and the No. 1 bearing inner race retaining nut with a 0.001 inch feeler gage. There must be no contact between the gear and the nut. If there is contact, disassemble and inspect parts.

(11) Install bearing housing and bearing outer race and rollers in front support, aligning bolt holes. Install bolts. Tighten bolts to recommended torque and lockwire.

(12) Position two lubricated packings (the larger one first) on the longer section of the ell shaped oil suction tube. Install the tube in the opening at the approximate eight O'clock position in the No. 1 bearing front support. Position one lubricated packing on the forward groove of the oil suction tube.

(13) Make certain the steel pin securing the No. 1 bearing oil strainer assembly in the oil strainer body is in place. Position a new packing on the oil strainer body and install the body and strainer assembly into the No. 1 bearing oil transfer tube of the front support.

For Training purposes only

C. (14) Secure the body to the No. 1 bearing housing with the two bolts. Tighten the bolts to the recommended torque and lockwire.

(15) Place a new packing over the short tube between the two bolt holes of the oil strainer body and install the No. 1 bearing oil nozzle assembly on the oil strainer body, the long tube through the hole in the bearing housing. Install and tighten the two bolts to the recommended torque and lockwire.

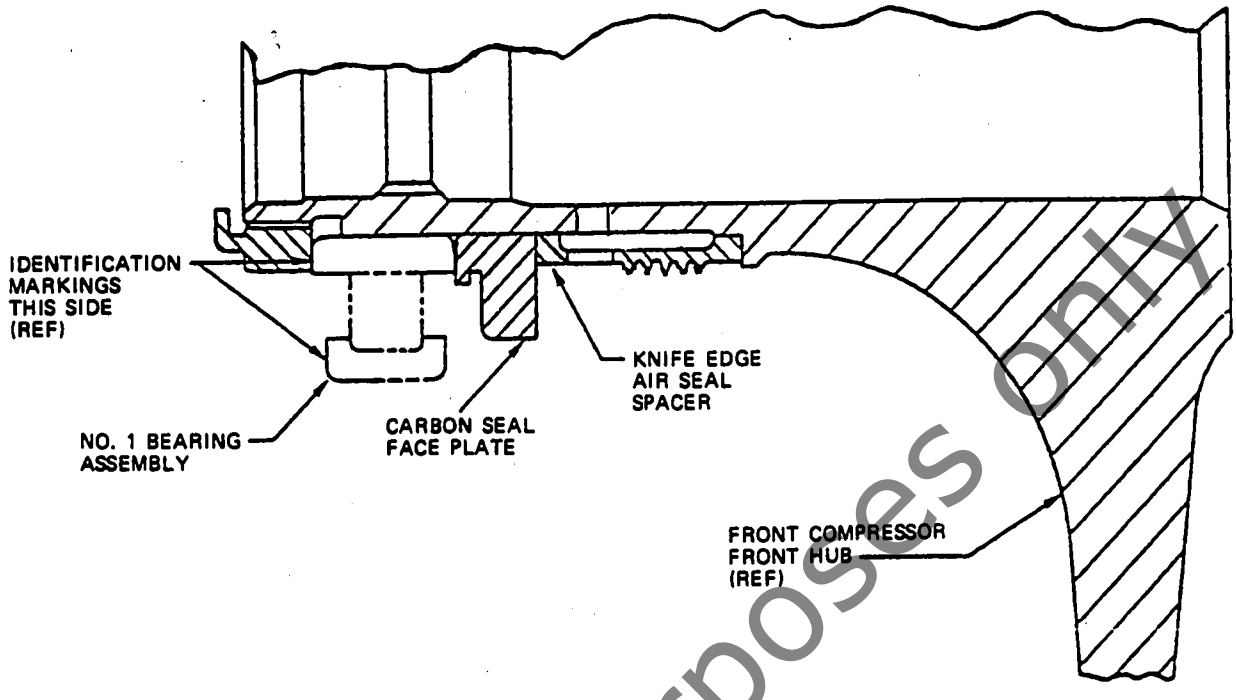
D. Front Accessory Drive Support Assembly Installation

(1) Place a new seal in the groove on the rear face of the assembled front accessory drive support.

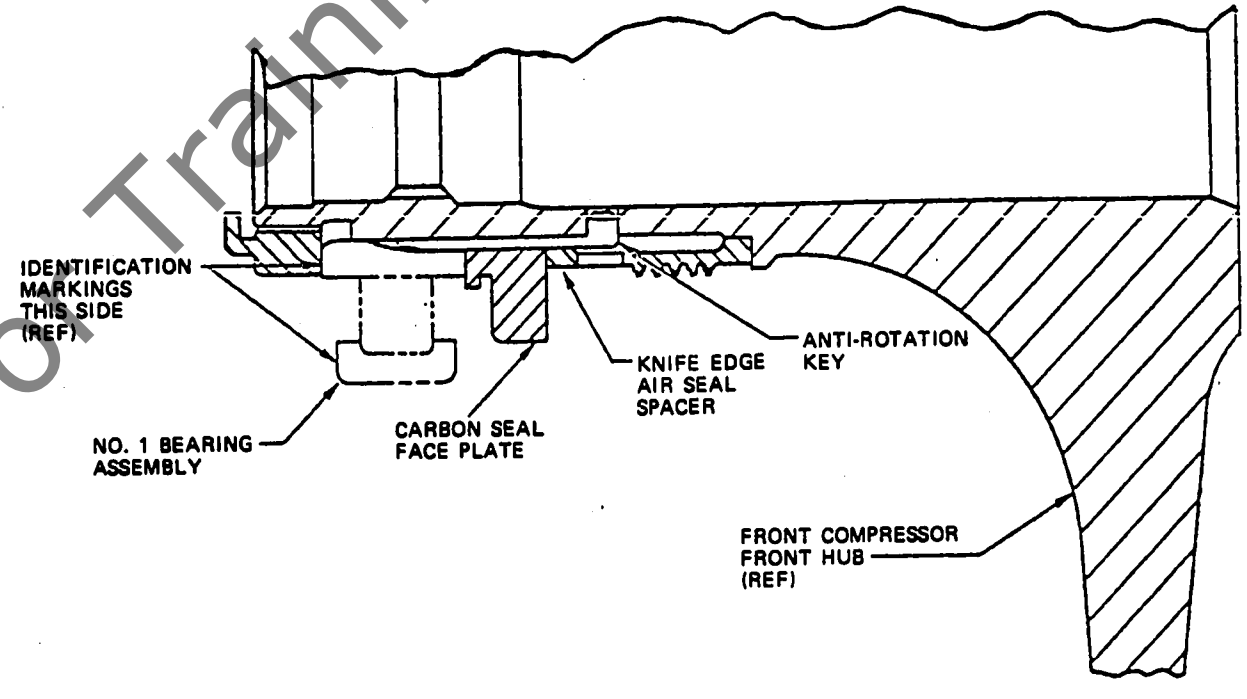
(2) Align the pin in the front accessory drive support with the hole in the No. 1 bearing support, then bring the front accessory drive support into position, making sure that the scavenge pump and tachometer drive gears mesh properly with the main accessory drive gear.

(3) Secure the front accessory drive support to the bearing support with the washers and bolts. Tighten the bolts to the recommended torque and lockwire.

For Training Purposes only



No. 1 Bearing Installation - No Antirotation Key
Figure 418A



No. 1 Bearing Installation - Antirotation Key Installed
Figure 418B

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

31. Numerical Tool List

PWA-2536 Puller
PWA-3095 Guide
PWA-3687 Puller
PWA-3755 Pump
PWA-3790-50 Puller
PWA-6580 Sling
PWA-6676 Drift
PWA-6841 Drift
PWA-7143 Drift
PWA-7146 Puller
PWA-7153 Fixture
PWA-7337 Drift
PWA-8050 Wrench
PWA-8192 Spacer
PWA-8193 Puller
PWA-8299-51 Seal Set
PWA-8299-52 Seal Set
PWA-8663 Saddle
PWA-8664 Adapter
PWA-8665 Adapter
PWA-8740 Adapter
PWA-9156-51 Protector
PWA-9156-52 Protector
PWA-10381 Drift
PWA-10489 Connector
PWA-10631 Base
PWA-10859 Sling
PWA-10860 Stand
PWA-10903 Support
PWA-13030 Guide
PWA-14047 Guide
PWA-16012 Fixture
PWA-16031 Wrench
PWA-16039 Spacer
PWA-16040 Wrench
PWA-16041 Wrench
PWA-16042 Riveter
PWA-16043 Puller
PWA-16044 Compressor
PWA-16050 Puller
PWA-16157 Puller
PWA-16158 Drift
PWA-16161 Base
PWA-16162 Drift
PWA-16177 Support
PWA-16210 Collar
PWA-16220 Adapter
PWA-16249 Holder

For Training purposes only

ENGINE - DISMANTLING/ASSEMBLY

PWA-16281 Puller
PWA-16282 Teeth
PWA-16295 Base
PWA-16337 Drift
PWA-16338 Puller
PWA-16358 Drift
PWA-16359 Puller
PWA-16366 Guide
PWA-16367 Drift
PWA-16375 Mount
PWA-16453 Drift
PWA-16454 Base
PWA-16455 Drift
PWA-16460 Guide
PWA-16463 Puller
PWA-16514 Stand
PWA-16566 Bracket
PWA-16567 Bracket
PWA-16572 Teeth
PWA-16768 Drift
PWA-16930 Guide
PWA-16935 Support
PWA-17078 Drift
PWA-17080 Adapter
PWA-17205 Support
PWA-17412 Puller
PWA-30016 Drift
PWA-30017 Base
PWA-30343 Base
PWA-30344 Drift
PWA-30429 Base
PWA-30430 Drift
PWA-30643 Puller
PWA-31469 Riveter

For Training purposes only

ENGINE - ADJUSTMENT TEST

1. General

A. This section provided by Pratt and Whitney for an uninstalled engine has been relocated as follows:

PRATT & WHITNEY SUBJECT		RELOCATED TO	
(1)	General Testing Information	71-5-0	500 Block
(2)	Testing After Major Engine Component Replacement	71-5-0	500 Block
(3)	Engine Operating Limitations	71-5-0	500 Block
(4)	Intercompressor Bleed Control Limitations	71-5-0	500 Block
(5)	Prestart Inspection Prior to Test	71-5-0	500 Block
(6)	Starting Procedure	71-5-0	500 Block
(7)	Satisfactory Start	71-5-0	500 Block
(8)	Unsatisfactory Start	71-5-0	500 Block
(9)	Clear Engine Procedure	71-5-0	500 Block
(10)	Shut Down Procedure	71-5-0	500 Block
(11)	Procedure for Determing Turbine Discharge Pressure (Pt 7) or Engine Pressure Rotor (Pt7/Pamb) Valves for Trimming and Thrust Checks	71-5-0	500 Block
(12)	Determination of Corrected N_2 Speed	71-5-0	500 Block
(13)	Engine Adjustments	71-5-0	500 Block
(14)	Ground Check at Idle	71-5-0	500 Block
(15)	All Ground Checks	71-5-0	500 Block
(16)	Engine Over Speed Limits and Inspection	71-5-0	500 Block
(17)	Overtemperature Limits and Inspections	71-5-0	500 Block

For Training purposes only

ENGINE - INSPECTION/CHECK

1. Periodic Inspection

A. General .

(1) These inspection procedures are a normal function of operating organizations. They consist of required inspections and minor adjustments necessary on the engine. The nature and conditions of engine operation determine the time interval between required inspections. For this reason, the intervals described in the Periodic Inspection Chart in this section are labeled Routine, Minor, and Major.

(2) Engine compartment cleanliness is important because the extensive mass air flow tends to draw foreign objects into the engine. Thoroughly clean the entire engine compartment with a vacuum cleaner after completion of any work. Keep the compartment free of dirt, oil and grease, and remove all unused parts, such as nuts, washers, and pieces of lockwire. Immediately cover all apertures resulting from the disconnection of tubing or parts. Use external caps on all tube openings, not internal plugs.

(3) Carefully inspect the exterior of the engine without dismantling to ensure that all connections are tight and free from leaks and that lines, tubing, and controls are secure and properly locked.

(4) Check all engine controls for proper operation. Make certain that the linkage from the cockpit controls to the engine units are connected in a manner that permits full and free movement with sufficient friction to hold the control in the required position. See that the controls are adjusted to permit overtravel of the control lever to ensure full operation of the engine unit.

(5) Suitable inlet cowl covers should be used during aircraft towing and at all times when not in service. As soon as the engine has cooled sufficiently after operation, a suitable exhaust nozzle cover should be installed.

(6) Service life of certain engine parts is limited by maximum number of hours or cycles. In addition to keeping track of operating hours an accurate record of cycles must be maintained. A cycle is defined as any flight, consisting of one take-off and one landing, regardless of length of flight and whether or not thrust reverser was used on landing. A touch and go landing and take-off is included in this definition.

NOTE: This definition of a cycle applies to engines in normal airline usage including a moderate amount of routine pilot training. Any extended special usage such as might be incurred by assignment of one aircraft to extensive pilot training use for several months or assignment of any engine to a flight test vehicle requires that any throttle changes equal to or greater than idle-to-maximum continuous, inflight or on the ground, be recorded as a cycle in obtaining the total cycles on an engine part.

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(7) Service life of disks is to be limited to maximum accumulated hours or cycles, whichever occurs first. Refer to Overhaul Manual for maximum time or cycles on front compressor front hubs and disks for each engine model. Refer to Section 70-30, Standard Practices Manual, for additional information on service life.

B. Periodic Inspection Chart

Component	Nature of Inspection	Inspection Time		
		Routine	Minor	Major
ENGINE GENERAL				
External Tubing, Hoses and Electrical Leads	a. Security of all accessible connections, clamps, and brackets.	X	X	X
	b. Evidence of chafing and wear.	X	X	X
	c. Evidence of fuel or oil leakage.	X	X	X
Engine Mounts	a. Security of installation.			X
COMPRESSOR				
Inlet Guide Vanes	a. Nicks, dents or other evidence of passage of foreign material.	X	X	X
Inlet Case Cracks	a. Check for cracks in these locations: (Refer to specific periodic inspection for crack limits).			
	1. Inner Shroud	X	X	X
	2. Outer Shroud	X	X	X
	3. Vane-to-shroud welds	X	X	X
	4. Check for stripped attaching bolt hole threads in rear outer flange.			
Compressor Blade Locks - First Stage Fan	a. Check for looseness. See specific periodic inspection for limits.	X	X	X
Compressor Blades See Figure 601.	a. Nicks, dents or other evidence of passage of foreign material.	X	X	X
Compressor Vanes, See Figure 602 and Fan Discharge Case Struts, See Figure 603.	a. Nicks, dents or other evidence of passage of foreign material.	X	X	X
	b. Case may be used with a maximum of 10 cracked struts without repair provided each crack is not over 1/2 inch long and does not extend into fillet area.	X	X	X

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ENGINE - INSPECTION/CHECK

Component	Nature of Inspection	Inspection Time		
		Routine	Minor	Major
COMPRESSOR (continued)				
Diffuser Case	a. Check for bulged and discolored areas which betray fuel nozzle or manifold discrepancies.	X	X	X
COMBUSTION CHAMBER, TURBINE AND EXHAUST SECTION				
Combustion Chamber Case	a. Cracks, dents, distortion and hot spots.	X	X	
Fuel Manifold and Nozzle Assembly	a. Remove assembly and replace with reconditioned unit.			X
Fireseal	a. Cracks	X	X	
Combustion Chambers	a. Cracks, warpage and localized overheating. b. Cracked, broken or worn locating flange lugs.			

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1. B. (1) Front Compressor Blades and Vanes Inspection Limits

NOTE: Compressor blade and vane limits, as specified in this section, are evaluated from the standpoint of structural integrity only and the use of a substantial number of blades or vanes reworked at or near the maximum limits or blades/vanes having many reworked areas may adversely affect compressor efficiency and engine performance.

(a) Repair of minor injuries to compressor blades can be made, provided injury can be removed without exceeding allowable limits (See Figure 601). Nicks in leading and trailing edges become increasingly critical the closer they are to the blade root. Any injury in inner half of air foil should be considered for repair only after most careful inspection and repaired with extreme caution.

(b) Portions of the blade which have sustained indentations (having the blade material compressed and the edges raised) and injuries with small radii or ragged edges, must be removed.

(c) Damage to the leading and trailing edge from the midspan outboard must meet the following requirements.

1) Dimension "Y" Figure 601 Detail A is the minimum amount of blade material which may remain after repair of a damaged area, provided the blade tip has not previously been radiused.

2) When the minimum blend ratio of length equal to 4 times depth (L/D=4) (See Figure 601 detail A) falls into the area enclosed by dimension "Y", the blend must be made continuous to the blade tip as shown by Area F2.

(d) When damage necessitates blending of both tip edge and leading or trailing edge as shown by Figure 601 Detail B, the new tip may be blended to a maximum depth as defined by Area F1.

(e) Repair of relatively smooth and round bottomed indentations can be accomplished by removing the edges of the injury only.

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(f) Well rounded injuries to leading and trailing edges which can be seen on the opposite side of the blade are acceptable without rework provided the injury is in the outer half of the blade and the indentation does not exceed 0.010 inch.

CAUTION: THE LIMITS REFERRED TO IN FIGURE 601 DETAILS A & B IN AREAS "C", "E", AND "F", PERTAIN TO LOCAL, ISOLATED, DAMAGED AREAS ONLY AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS THE TIP AND LEADING OR TRAILING EDGES AS MIGHT BE DONE IN A SINGLE MACHINING CUT OR BY ABRASIVE MEANS. LIMITS APPLY TO MAGNITUDE OF REPAIR AFTER BLENDING AND NOT TO DAMAGE MEASURED BEFORE BLENDING. DO NOT TRY TO REMOVE INJURY BY STRAIGHTENING.

(g) All surfaces must be smooth and all repairs well blended. The surface finish in the repaired areas must be as nearly comparable to a new blade as possible.

CAUTION: STONING AND LOCAL REWORK OF COMPRESSOR BLADES MUST BE DONE PARALLEL TO THE LENGTH OF THE BLADE AND NEVER ACROSS IT. THIS IS TO ENSURE THAT NO SCRATCHES, HOWEVER MINUTE, RUN ACROSS THE BLADE EDGES.

(h) Blending must be held to following limits;

1) Minimum length of blend must be at least four times the depth. (L/D=4.0) See Figure 601 Detail A.

2) Total blended length of any blade leading or trailing edge shall not exceed one-third the total edge length for stages one and two, and shall not exceed one-fourth the total edge length for stages four through nine.

3) Total blended length of blade tip shall not exceed one-fourth of the total tip edge length.

NOTE: Area A, Figure 601 represent minor blade tip damage and does not define maximum depth for repair.

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(i) Blends on both edges must not be directly opposite and must be separated diagonally by a minimum distance equal to the mean chordal length of blade. See Figure 600 Exception to this requirement is damage at the tip as shown in Figure 601 Detail A & B.

(j) Total number of blends permitted per blade, not including Area A.

1) A maximum of two edge blends to the maximum depth limit per blade edge is permitted on stages one and two. Additional blends up to one-half the maximum depth limit are permitted provided two-thirds of each edge length and three-fourths of blade tip edge length is unblended.

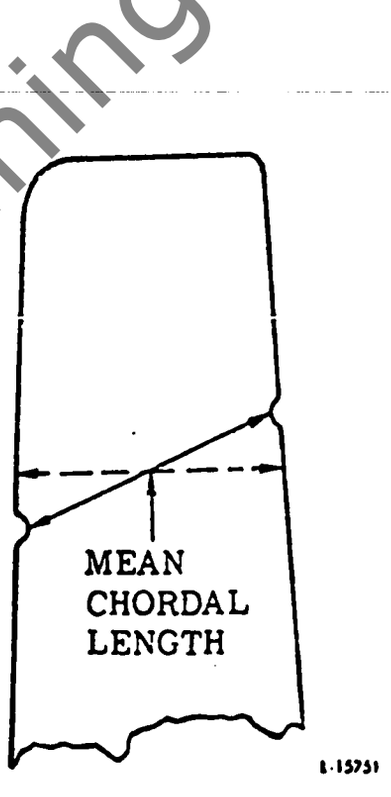
NOTE: For the additional blends, the diagonal separation limit of the mean chordal length does not apply.

(2) Fan Blade Bow Check

(a) Place a straight edge on convex surface of airfoil above midspan shroud approximately at center of airfoil chord and perpendicular to blade root center plane.

(b) Maximum bow is then defined as no more than 1/8 inch gap between blade surface and straight edge at any point.

(c) No appreciable bow is allowed for second stage fan blade.



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(3) Fan Blade Blend Repair

(a) General

1) All blend repair shall be made within the depth limits shown in Engine - Inspection/Check section of the Maintenance Manual.

2) Titanium blades should not be reworked with wheels that have been used on steel blades.

3) No attempt shall be made to repair bent blades by straighteing.

(b) Procedure

1) Remove damage by grinding with a C36-P-BFX2 carborundum wheel or equivalent using minimum pressure.

2) Minimum blend length shall be four times the depth.

3) Buff the blended area after grinding comparable to unrepaired surface finish. Buffing compound PMC-3061 or equivalent may be used to speed results.

4) Wipe part with soft cloth to remove residual compound and titanium powder.

5) Visually inspect repaired area dye penetrant inspection questionable findings.

(c) First Stage Fan Blade Root Radius Blending

1) Blend in accordance with the limits shown in the Engine-Inspection/Check section of the Maintenance Manual and the procedure outlined above except as follows:

a) Blend to provide a gradual cut back working outward from the blade platform. Use hand tools.

b) Provide full radius at airfoil to root junction.

c) Provide full radius on leading edge of repaired area.

2) Dye penetrant inspect repaired area. No crack indications permitted.

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(4) First Stage Fan Blade F.O.D. Fly Back Inspection and Repair

(a) General

NOTE: First stage fan blades which have foreign object damage in excess of inspection and repair limits shown in Figure 601 section may be continued in service by performing Fly Back Repair as indicated below.

Ref Fig 600A Sheet 1 and 2.

NOTE: Any time fan blades are reoperated to Fly Back Limits JEDMI must be notified by wire of A/C position and exact dimensions of material removed from each blade. Total number of blades re-operated.

(b) First Stage Fan Blade F.O.D. Fly Back Inspection Taper Cut IV (See Figure 600A Sheet 2)

NOTE: For instructions for removing material from blades, see paragraph (d).

1) Blades reoperated per Taper Cut IV dimensions are to be limited to twenty five (25) hours of operation.

2) This repair shall be limited to a total of six (6) blades per First Stage Fan assy.

3) A vibration check must be performed following this repair and existing vibration limits must not be exceeded.

(c) First Stage Fan Blade F.O.D. Fly Back Inspection Taper Cut I II III and Square Cut (See Figure 600A Sheet 1)

NOTE: For instructions for removing material from blades, see paragraph (d).

1) Blades reoperated per Taper Cut II are limited to 150 hours of operation and use of combination of cuts including Tpaer Cut II are also limited to 150 hours operation.

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2) All other cuts or combination of cuts will have no time limit i.e. square cut, taper cut I and III.

3) Do not reoperate more than five (5) blades to these limits. Blades may be adjacent or scattered throughout assembly and may be a combination of square cut and tapered cuts shown in Figure 600A Sheet 1

4) A vibration check must be performed following this repair and existing vibration limits must not be exceeded.

(d) Fly Back Repair Procedure

1) Repair leading edge outer end of blade within limits and cuts given in Figure 600A. Sheet 1 and 2. Remove damage with a hacksaw, or other suitable hand tool. Or in accordance with the following procedure:

a) Insert piece of scrap sheet stock between blade tip and fan case.

CAUTION: AREA TO BE REWORKED WITH CUT-OFF WHEEL MUST BE COMPLETELY MASKED TO ENSURE THAT NO METAL SPLATTER CAN STRIKE ANY OTHER BLADE OR DISK SURFACE.

b) Using a two inch diameter cut-off wheel. Remove major portion of material to be removed.

NOTE: A minimum of 0.060 inch material must remain for hand filing and polishing to assure removal of any heat affected area.

c) Use a Norton A601-OBNA2, Type I, Shape GWI (A) (2x1/32x1/4 inch) cut-off wheel or equivalent in an ARO air chuck, model 7015S which has an operating speed of 18,000 rpm maximum. A 3/16 inch rotary file may be used as an alternate tool to cut-off wheel.

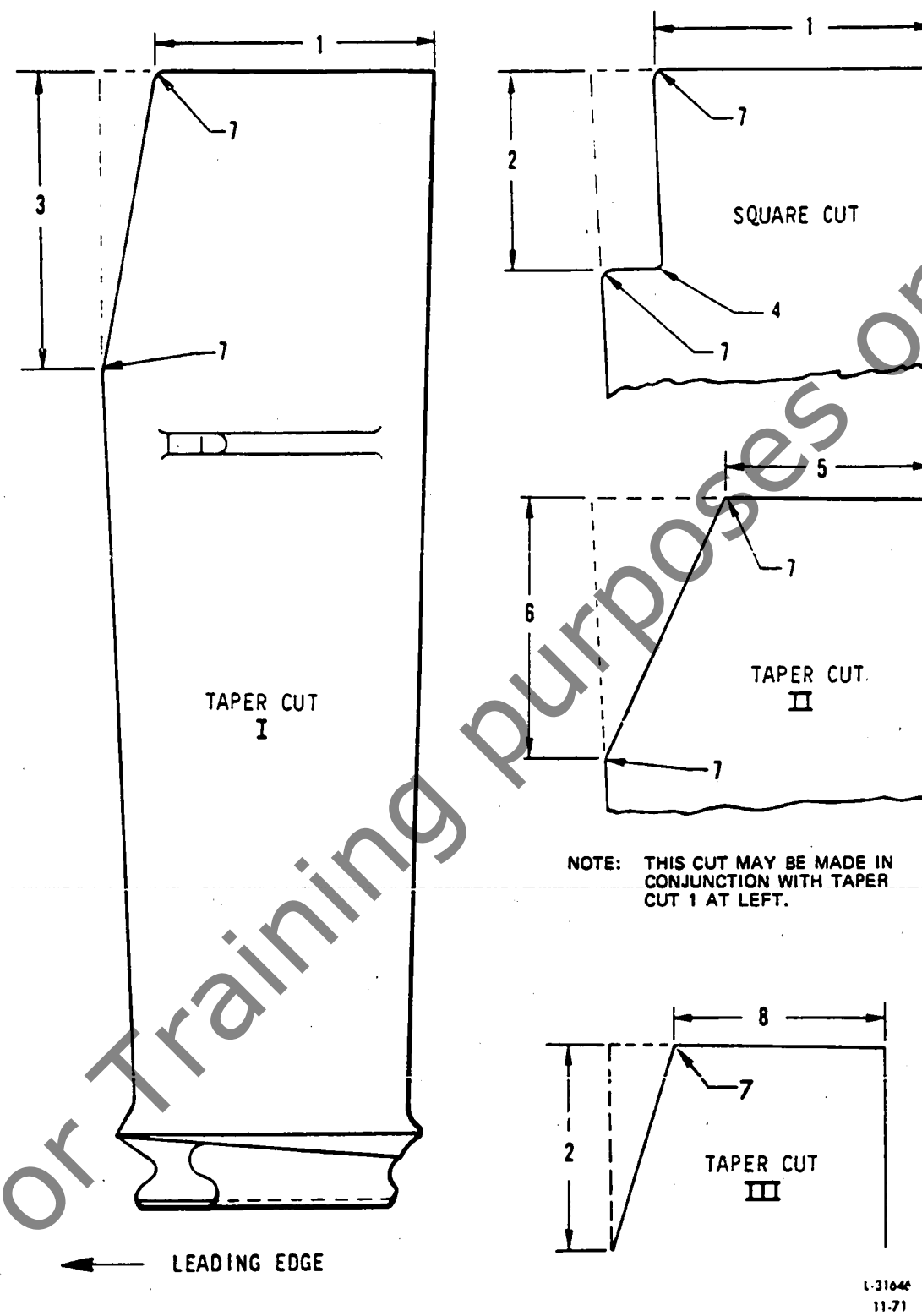
d) Hand file and polish leading edge where cut has been made.

e) Finish all edges of repair area to form a well rounded radius with a smooth surface.

f) Inspect repaired area with dye check or portable fluorescent penetrant. No cracks, tears, or sharp bottomed nicks are permitted after repair.

g) Perform a vibration check of repair using flight instrumentation. Vibration must not exceed existing flight limits.

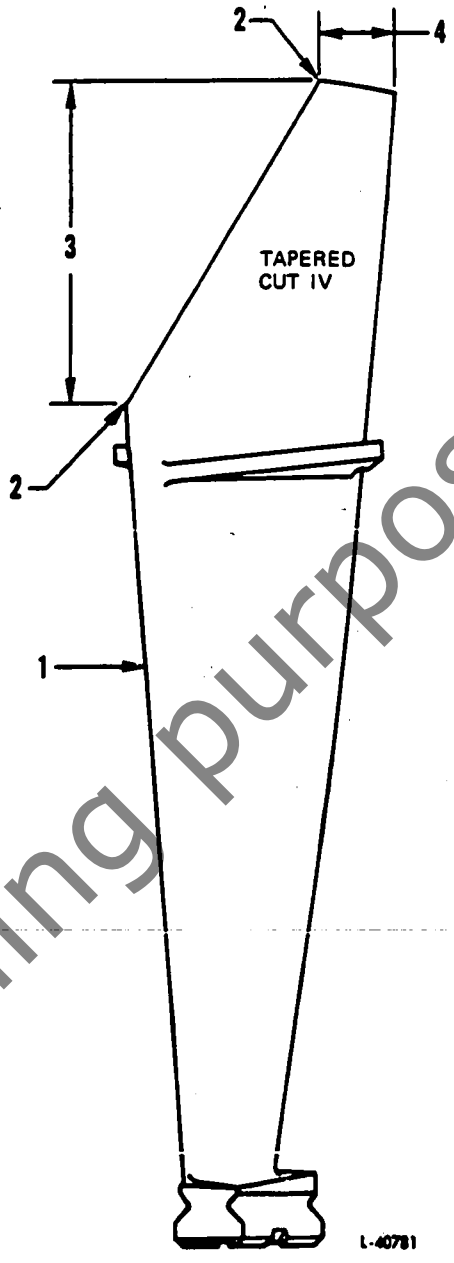
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1. 4.250 Inches
2. 2.000 Inches
3. 4.500 Inches
4. 0.375 Inch
5. 2.500 Inches
6. 2.750 Inches
7. Smooth Blend
8. 3.350 Inches

First Stage Fan Fly Back Repair Limits
Figure 600A (Sheet 1)

For Training purposes only



1. Leading Edge
2. Smooth Blend
3. 4.500 Inch
4. 1.500 Inch

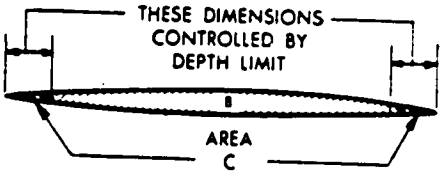
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MAXIMUM ALLOWABLE REPAIR LIMITS – INCHES

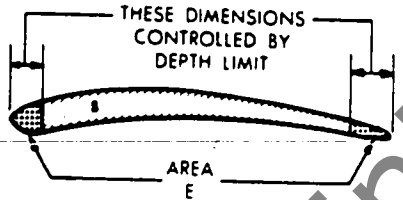
BLADE AREA	STAGES 1 AND 2
A	3 4 R
B	1 32 RB
C	3 8 D
D	NONE
E	1 4 D
F	1 16 D
G	.060 D

R RADIUS
D DEPTH
RB - ROUND BOTTOM

DAMAGE TO THE LEADING EDGE OF THE BLADES WITHIN TWO INCHES OF THE TIP MAY BE BLENDED TO A MAXIMUM DEPTH OF 5/8 INCH FOR A MAXIMUM OF SEVEN BLADES PER ENGINE. IN ADDITION TO RADIUS AREA "A" TIP DAMAGE MAY BE BLENDED TO LIMIT AREA "C".



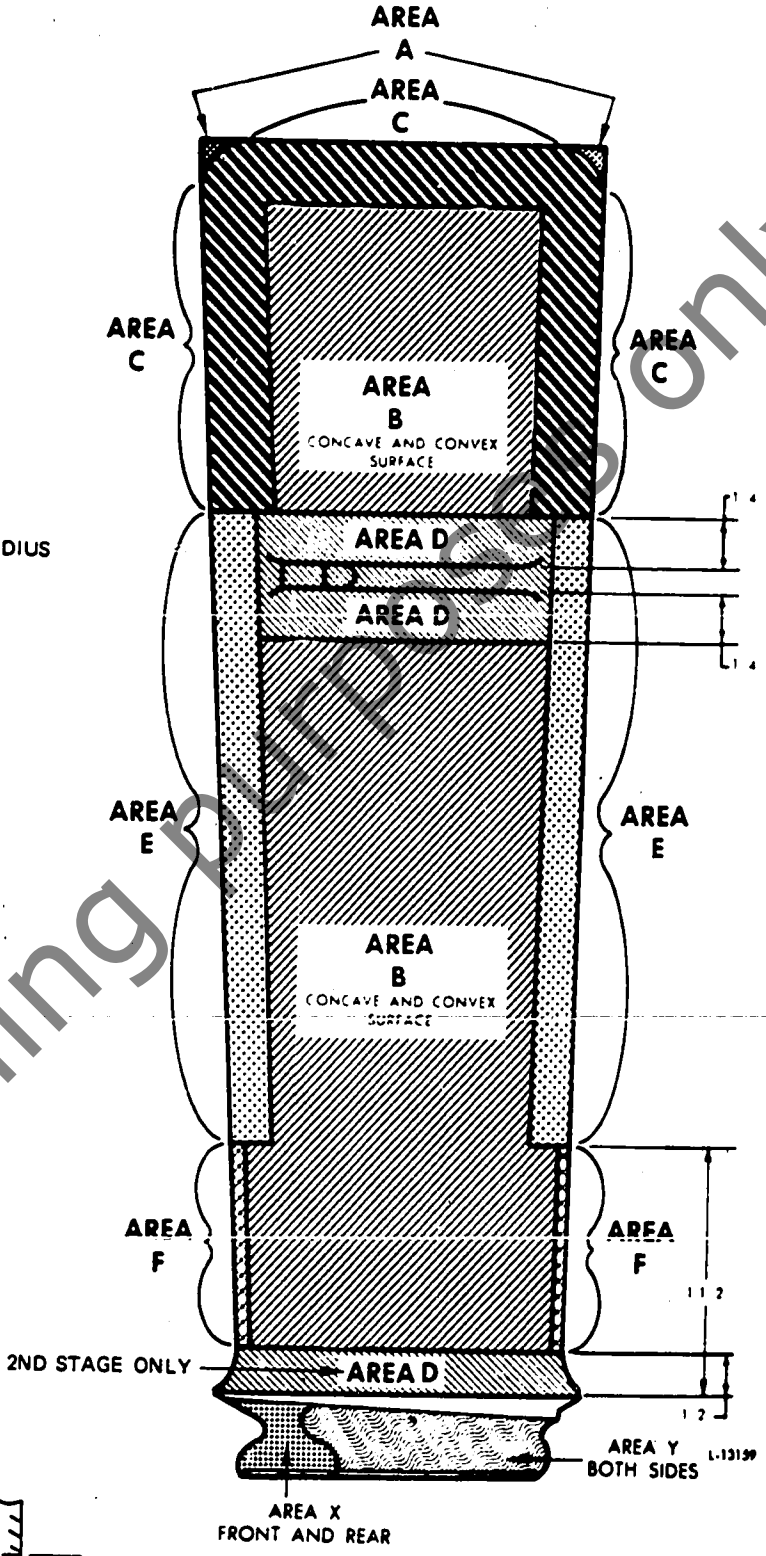
CROSS SECTION OF FAN BLADE ABOVE PART SPAN SHROUD

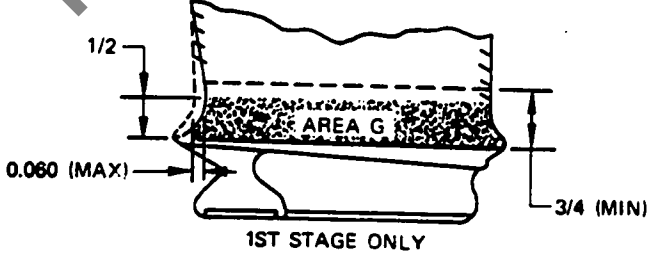


CROSS SECTION OF FAN BLADE BELOW PART SPAN SHROUD

CAUTION

THE LIMITS REFERRED TO IN THIS FIGURE IN AREAS "C", "E" AND "F" PERTAIN TO LOCAL, ISOLATED, DAMAGED AREAS ONLY AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS THE TIP AND LEADING OR TRAILING EDGES AS MIGHT BE DONE IN A SINGLE MACHINING CUT.



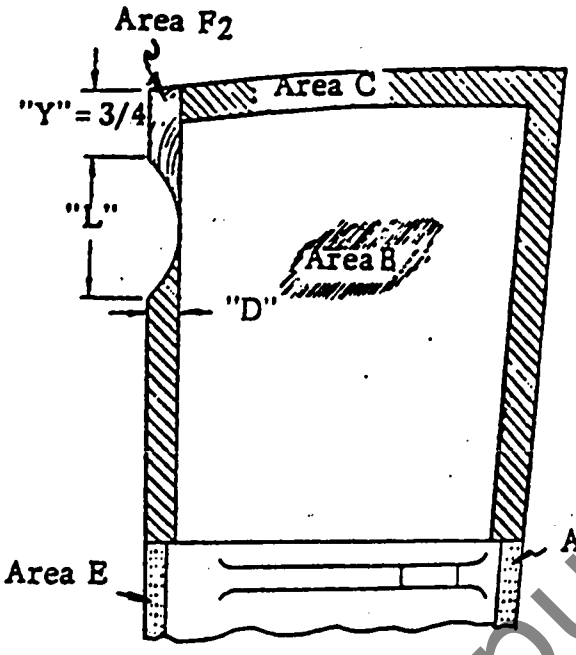


NOTE:

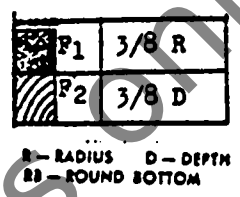
FAN BLADE DAMAGE MEASURING TOOL 27-8399 IS AVAILABLE AT ALL MAINTENANCE STATIONS. WHEN REPORTING FOD DAMAGE, REFER TO THE STATION NUMBERS ON THIS TOOL.

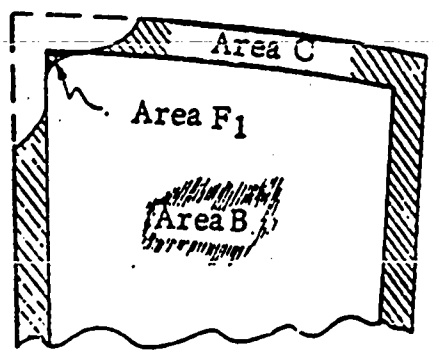
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Front Compressor Fan Blade Limits
(Stage One and Two)
Figure 601 (Sheet 1)



Front Compressor
Fan Blade Limits
(Stages 1 & 2)
DETAIL 1

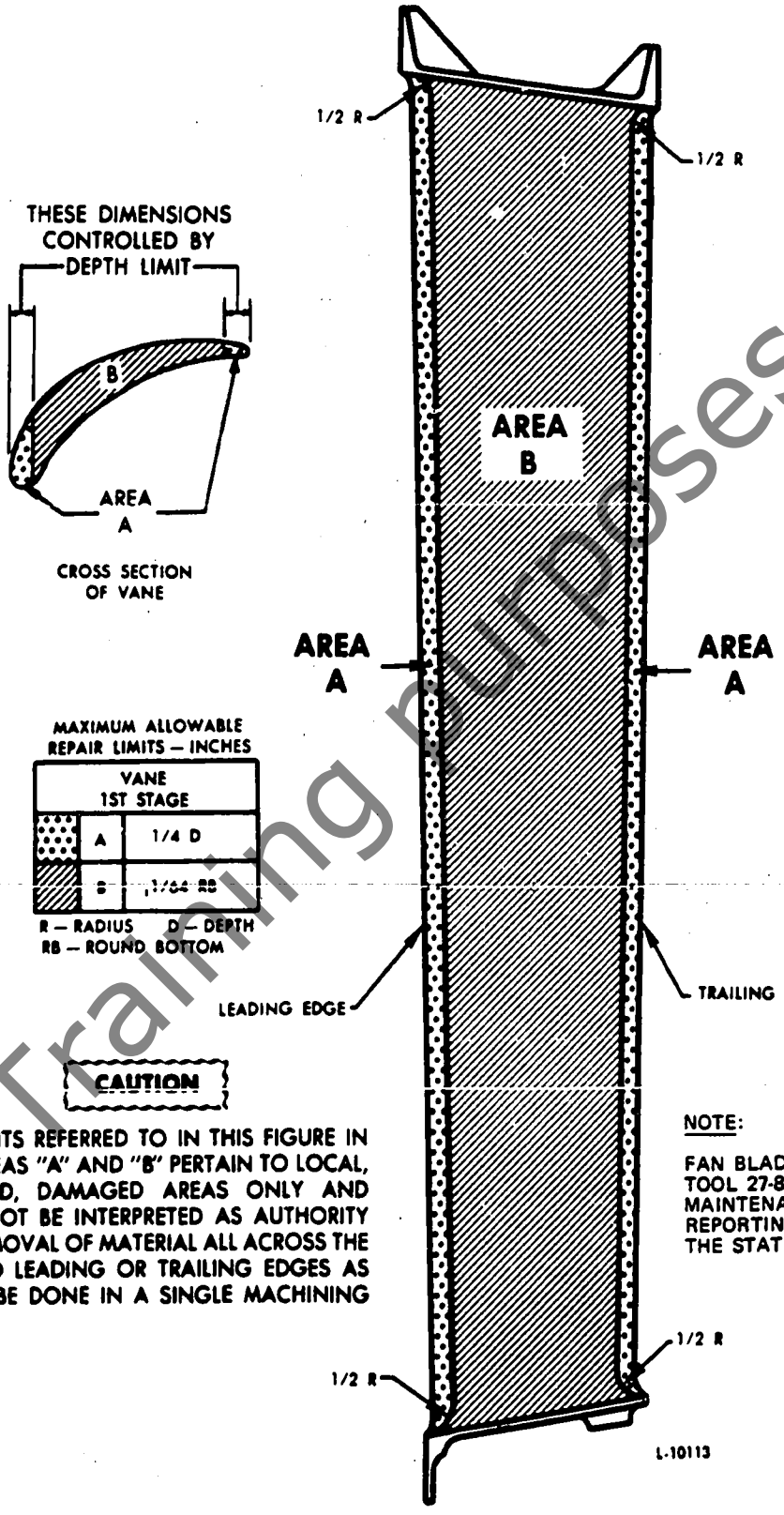




Front Compressor Fan
Blade Limits
(Stages 1 & 2)
DETAIL 2

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ENGINE - INSPECTION/CHECK



CAUTION

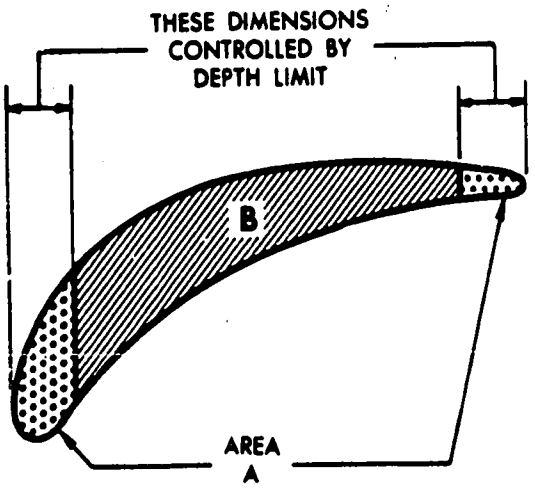
THE LIMITS REFERRED TO IN THIS FIGURE IN THE AREAS "A" AND "B" PERTAIN TO LOCAL, ISOLATED, DAMAGED AREAS ONLY AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS THE TIP AND LEADING OR TRAILING EDGES AS MIGHT BE DONE IN A SINGLE MACHINING CUT.

NOTE:

FAN BLADE DAMAGE MEASURING TOOL 27-8399 IS AVAILABLE AT ALL MAINTENANCE STATIONS. WHEN REPORTING FOD DAMAGE, REFER TO THE STATION NUMBERS ON THIS TOOL.

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First Stage Vane Inspection and Repair Limits
Figure 602



CROSS SECTION
FAN EXIT STRUT

MAXIMUM ALLOWABLE REPAIR LIMITS — INCHES

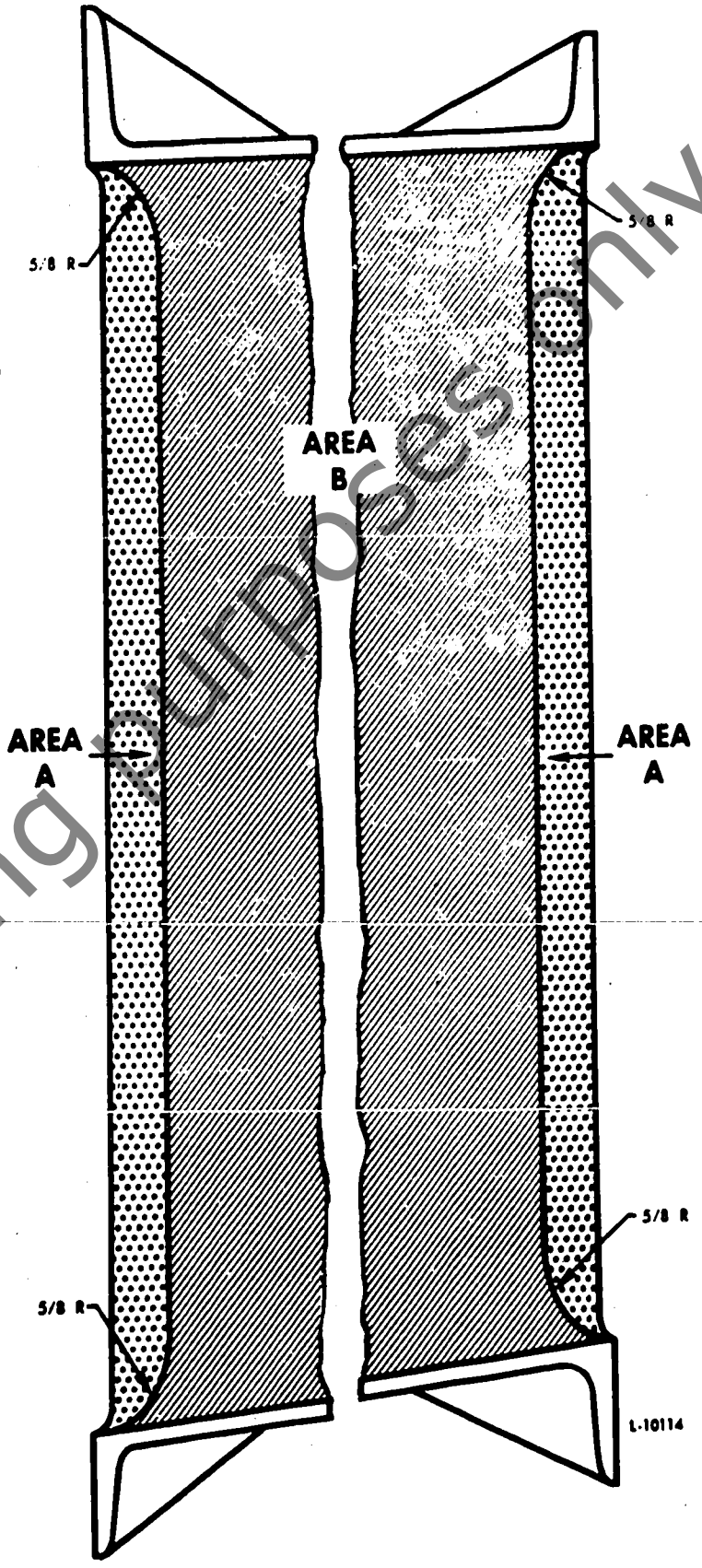
VANE FAN EXIT		
	A	5/16 D
	B	1/64 RB

R — RADIUS D — DEPTH
RB — ROUND BOTTOM

CAUTION

THE LIMITS REFERRED TO IN THIS FIGURE IN THE AREAS "A" AND "B" PERTAIN TO LOCAL, ISOLATED, DAMAGED AREAS ONLY AND MUST NOT BE INTERPRETED AS AUTHORITY FOR REMOVAL OF MATERIAL ALL ACROSS THE TIP AND LEADING OR TRAILING EDGES AS MIGHT BE DONE IN A SINGLE MACHINING CUT.

NOTE:
REFER TO APPROVED REPAIR SECTION FOR CRACKS IN VANE WELD AT INNER AND OUTER SHROUD.



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Fan Discharge Case Strut Inspection and Repair Limits
Figure 603

ENGINE - INSPECTION/CHECK

Component	Nature of Inspection	Inspection Time		
		Routine	Minor	Major
Combustion Chambers	c. Proper positioning of flame cross-over tubes.			
Combustion Chambers Outlet Duct	a. Cracks and deterioration.			
Turbine Case	a. Localized overheating and warpage.		X	
First Stage Turbine Nozzle Guide Vanes	a. Cracks, burning or impact damage.			
	b. Bowed vanes.			
First Stage Turbine Blades	a. Cracks or warpage.			
	b. Dents, nicks or other evidence of indicating passage of foreign material. Use a strong light.			
Fourth Stage Turbine Blades	a. Cracks or warpage.			
	b. Dents, nicks or other evidence indicating passage of foreign material.			
Fourth Stage Nozzle Vanes	a. Trailing edge for cracks and distortion. Rotate turbine and use a strong light.			
Turbine Exhaust Struts	a. Distortion, cracks, nicks, and erosion.			
	b. Evidence of broken strut retaining lugs.		X	

ACCESSORY SECTION

Accessory and Component Drives Gearbox	a. Check for oil leaks.	X	X	X

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ENGINE - INSPECTION/CHECK

Component	Nature of Inspection	Inspection Time		
		Routine	Minor	Major
CAUTION: DO NOT TURN OR ATTEMPT TO TURN THE FOUR CASTLE NUTS IN THE CENTER PORTION OF THE OIL PUMP ASSEMBLY. THESE NUTS ARE LOCKWIRED AND SECURE THE OIL PUMP THROUGH BOLTS. THESE NUTS MAY BE TIGHTENED ONLY WHEN THE PUMP IS OUT OF THE GEARBOX ASSEMBLY.				
OIL SYSTEM				
CAUTION: DO NOT MIX DIFFERENT BRANDS OF OIL WHEN CHANGING OIL OR ADDING OIL BETWEEN CHANGES, SINCE THE CHEMICAL STRUCTURE OF DIFFERENT BRANDS OF SYNTHETIC OIL MAY DIFFER SUFFICIENTLY TO MAKE THEM INCOMPATIBLE WITH EACH OTHER.				
Oil*	a. Check oil level.	X	X	X
NOTE: Oil should be checked and added as required within two hours after shutdown.				
*See paragraph C below.				
Oil Filter*	a. Metal particles and other foreign matter.		X	X
*See paragraph C below.	b. Damaged screens and spacers.		X	X
	c. Proper installation and leakage.		X	X
	d. Adequate assembly tension (cannot rotate screen elements by hand).		X	X
Oil Scavenge Pump Inlet Strainer See Paragraph C(3) below.	a. Metal Particles and other foreign matter.		X	X
Differential Pressure Switch (Delta P). See sub-paragraph C.	a. Actuation		X	X

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ENGINE - INSPECTION/CHECK

Component	Nature of Inspection	Inspection Time		
		Routine	Minor	Major
BREATHER SYSTEM Breather Line Connection (Top of Diffuser Case)	a. Remove, clean, and Reinstall.			X

C. Specific Periodic Inspection

(1) Oil Change

(a) Recommendations for oil drain intervals are based on the performance of specific brands of lubricating oil in specific engine models and are available, upon request. The oil change interval may be increased from time to time based on tests conducted on used oil samples. Approval for extended drain intervals will be granted for specific brands of oil by Pratt & Whitney Aircraft after it has been determined that the specific brand of oil is satisfactory for extended service.

NOTE: The engine must be operated for at least one minute at idle speed in order that any oil which may be in the scavenge section of the engine is returned to the tank. If drainage takes place immediately after shutdown, it is not necessary to drain any other part of the engine in addition to the oil tank during an oil change. Unlimited lapse of time between shutdown and an oil change is permitted, providing the oil is drained from the oil pumps, accessory and component drives gearbox housing and the accessory drive adapter in addition to the oil tank.

(2) Main Oil Strainer.

(a) Remove main oil strainer for inspection at every oil change and/or when any excessive vibration is experienced (over limits) or when any erractic change to oil pressure is noted (below 30 or above 55 PSIG).

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ENGINE - INSPECTION/CHECK

(b) Perform the following procedure if a few finely divided metal particles are found at the first strainer check after installation of a new or newly overhauled engine:

NOTE: Discovery of fine metal particles is not uncommon and is not normally cause for concern.

(c) Clean and reinstall the strainer.

(d) Operate the engine for at least ten minutes but not more than twenty minutes; then recheck the strainer.

(e) If there is no increase in the quantity of the metal particles the engine may be returned to service.

(f) When metal is found in oil strainer during routine inspection, strainer shall be cleaned or replaced and engine ground run at part power setting. Engine should be accelerated from idle to part power stop five times, then run at part power for approximately 20 minutes. Recheck strainer and, if clean, engine is ready for service. Check strainer after approximately 50 hours of operation.

NOTE: The 20 minute part power run may be reduced to 10 minutes, if desired, or to comply with airport noise regulations.

(g) Any engine not incorporating a main oil strainer by-pass warning system that has been partially disassembled to the extent of exposing any bearing compartment except No. 1 bearing must have the main oil screen disassembled, inspected and cleaned at periods not to exceed 12 hours. Screen checks will be continued until the screen is free of contamination for 2 successive inspections.

CAUTION: IF CONTAMINANTS INDICATE ENGINE PART FAILURE OR CONTAMINANTS IN SUFFICIENT QUANTITY TO PLUG THE OIL SCREEN ARE FOUND DURING ANY INSPECTION THE ENGINE MUST NOT BE OPERATED UNTIL THE CAUSE OF THE DIFFICULTY HAS BEEN DETERMINED AND SATISFACTORILY CORRECTED.

(3) Oil Scavenge Pump Inlet Strainer

(a) Check scavenge pump inlet strainer after installing a new, repaired or overhauled engine. If the strainer is clean, no further action is required. If the strainer is contaminated, clean it, replace and check as for main oil strainer. See preceding paragraph C.(2)(b).

(b) During subsequent operation of the engine there should be no further need to inspect this strainer unless the main oil strainer is found contaminated in which case, perform the above.

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(3A) Check the oil pressure relief valve (bypass) spring (outer) at the following length and weights:

(a) At 2.230 inches and 14.00-14.75 lbs.

(b) At 1.638 inches and 22.25-23.75 lbs.

(3B) Check the oil pressure relief valve (bypass) spring (inner) at the following lengths and weights:

(a) At 2.240 inches and 10.125-11.125 lbs.

(b) At 1.725 inches and 21.0-23.0 lbs.

(4) Check the differential pressure switch for actuation. The warning light should turn on at 50 ±1.5 psi and should remain on as long as the differential pressure is 50 ±1.5 psi or greater.

(5) Inlet Case Cracks - Limits of Acceptability.

NOTE: An inlet case with cracks exceeding limits of acceptability may be continued in operation for a period not to exceed 150 hours, provided the cracks are not of a converging nature or could possibly liberate pieces.

Identification of repairs or serviceable damage on engine inlet cases.

Failure to identify field repairs or serviceable engine damage on engine inlet components, case, vanes, shroud, compressor, etc., have resulted in delays at a later time. This is due to flight crews questioning engine serviceability and requiring additional inspections. Also, in many incidents, damage or repairs are noted and identified with yellow paint which peels off.

To prevent this from occurring, and thus remove future questions which might arise as to engine serviceability, any field repair or serviceable damage, cracks, dents, etc., in the engine inlet should be marked with blue steel dye marker P/N 50-0306 or its equivalent. By this method, flight crews will be alerted the area was inspected and found serviceable.

For Training purposes only

(a) If a crack in excess of 1 inch in the outer surface of the inner shroud is noted at inspection, it will be necessary to examine the welds at the inner end of the inlet vanes and the inner shroud flange to assure that the inner end of the vane is not breaking loose from the inner shroud. This examination of the inner surface of the inlet case inner shroud can be made by looking through the anti-icing holes in the No. 1 bearing support web.

NOTE: Multiple cracks which indicate possible joining in such a manner so as to permit a piece of shroud to enter the inlet air stream, are not acceptable.

(b) For cracks running adjacent to the weld bead and transversing the weld bead, the inlet case must be removed and the cracks weld repaired. See reference Number 1 in Fig. 604.

NOTE: If the type of crack noted above is found at a remote line station, periodic inspection must be made until the aircraft returns to a maintenance station capable of repairing the case.

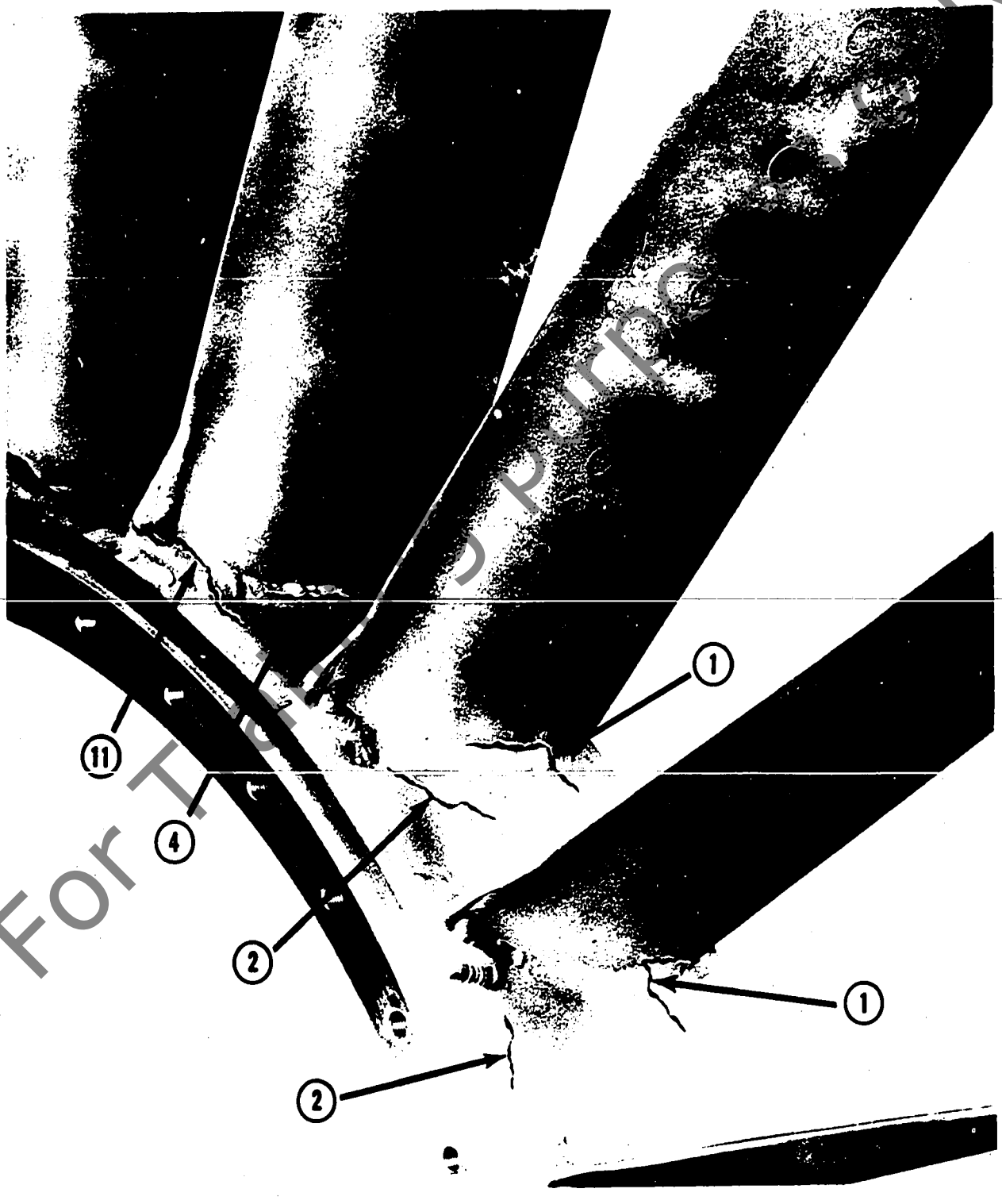
(c) Cracks in the outer shroud inner box and inner shroud outer box (reference Number 2, Fig. 604) are acceptable up to 3 inches in length if wholly contained in the shroud sheet and are not associated with cracks originating in the vane skin at the leading or trailing edges. These cracks are not to be of a converging nature. No more than three cracks not exceeding 3 inches of this nature are permitted in any 90 degree segment.

(d) Cracks in inner and outer vane end welds adjacent to vane skin (see 3, Fig. 605) are to be repaired when aircraft returns to a maintenance station capable of making such repairs.

(e) Cracks in vane to shroud welds proper (see No. 4 and 13, Fig. 604 and 605) are acceptable up to 3 inches maximum in 50% of the vanes.

(f) Cracks in inner box segment (see No. 5, Fig. 605) are acceptable up to 3 inches maximum. These cracks must not be of a converging nature.

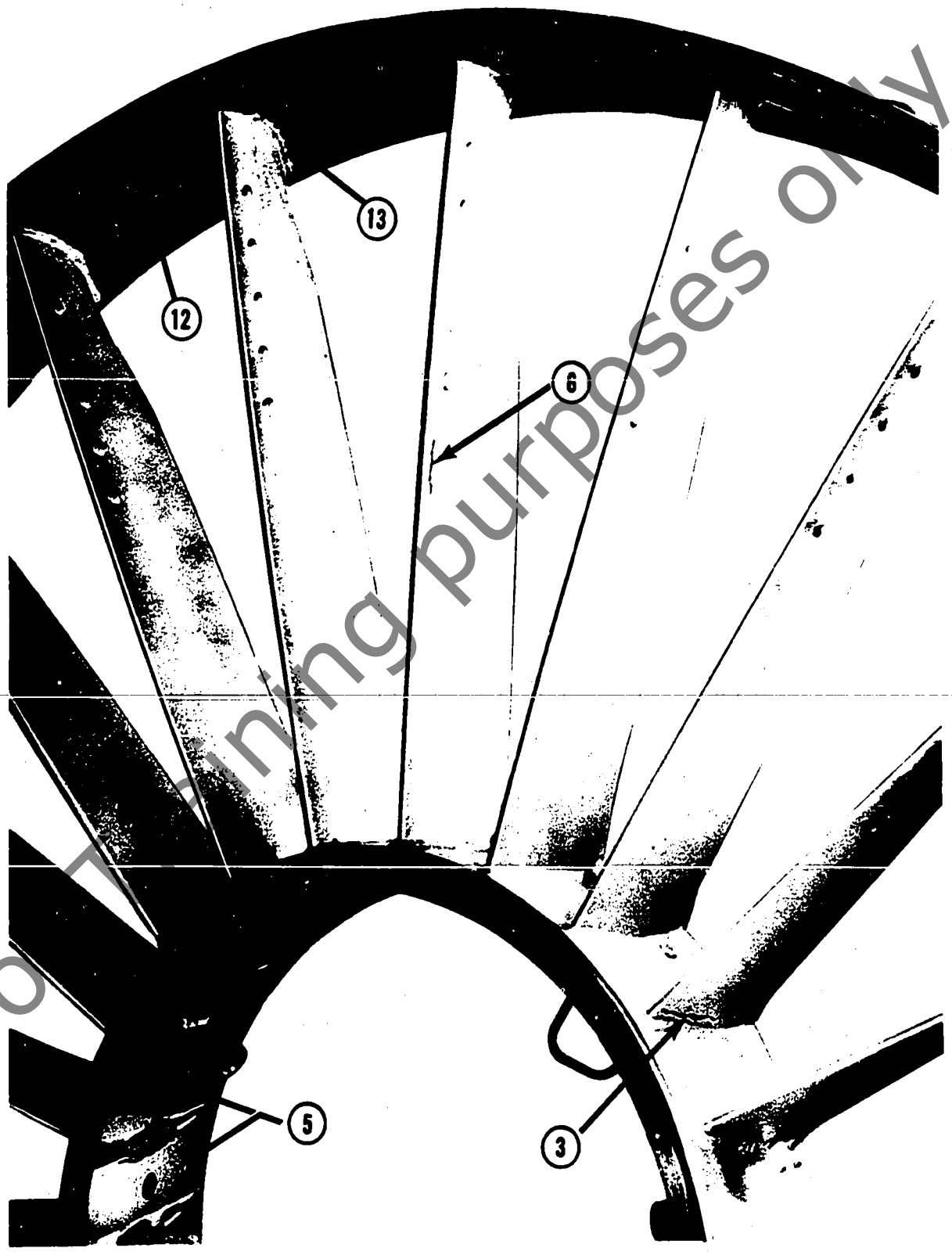
For Training purposes only



Inlet Case Crack Limits
Figure 504

For Training Purposes Only

ENGINE - INSPECTION/CHECK



For Training purposes only

Inlet Case Crack Limits
Figure 605

ENGINE - INSPECTION/CHECK

(g) Cracks are not permitted in the vane skin (reference No. 1, 3, and 6, Figures 604 and 605). If this condition is found at a remote line station, apply Mylar Tape as an expedient repair until the aircraft returns to a maintenance station capable of making permanent repairs. Clean the area to be taped by scrubbing with a stiff bristle brush using Acetone or Mythel Ethyl Ketone. Wipe dry with a clean cloth to remove all residue. Wrap area of crack but do not overlap tape.

NOTE: Mylar tape is manufactured by the Borden Chemical Co., Mystik Tape Division, Northfield, Illinois 60093, and Markem Machine Co., 150 Congress St., Keene, New Hampshire.

(h) Cracks in outer surface of outer shroud are acceptable up to three inches maximum. See reference No. 9, Figure 606. Cracks in weld around outer shroud brace (tea cup) are acceptable up to one inch maximum. See reference No. 7, Figure 606. A crack which extends from tea cup is acceptable if the total length is less than three inches and the length of crack around the tea cup is less than one inch. These cracks are not to be of a converging nature.

(i) Cracks in the outer shroud vane end covers may be stop drilled with a No. 40 drill following dye check, regardless of length. No further repair required.

(j) Cracks in the weld bead around various bosses in the outer shroud (reference No. 10, Figure 606) are acceptable up to 180 degrees around the boss leg.

(k) Cracks progressing into the fin (reference No. 11, Figure 604) are not acceptable. These cracks must be weld repaired.

(l) Cracks are acceptable up to three inches long if wholly contained in the shroud skin. See reference No. 12, Figure 605. A maximum of three cracks up to three inches long in any 90 degree sector are acceptable provided there is no converging of cracks.

(m) Check rear outer flange for stripped attaching bolt hole threads. Repair stripped threads in accordance with Engine Approved Repair Section 72-0.

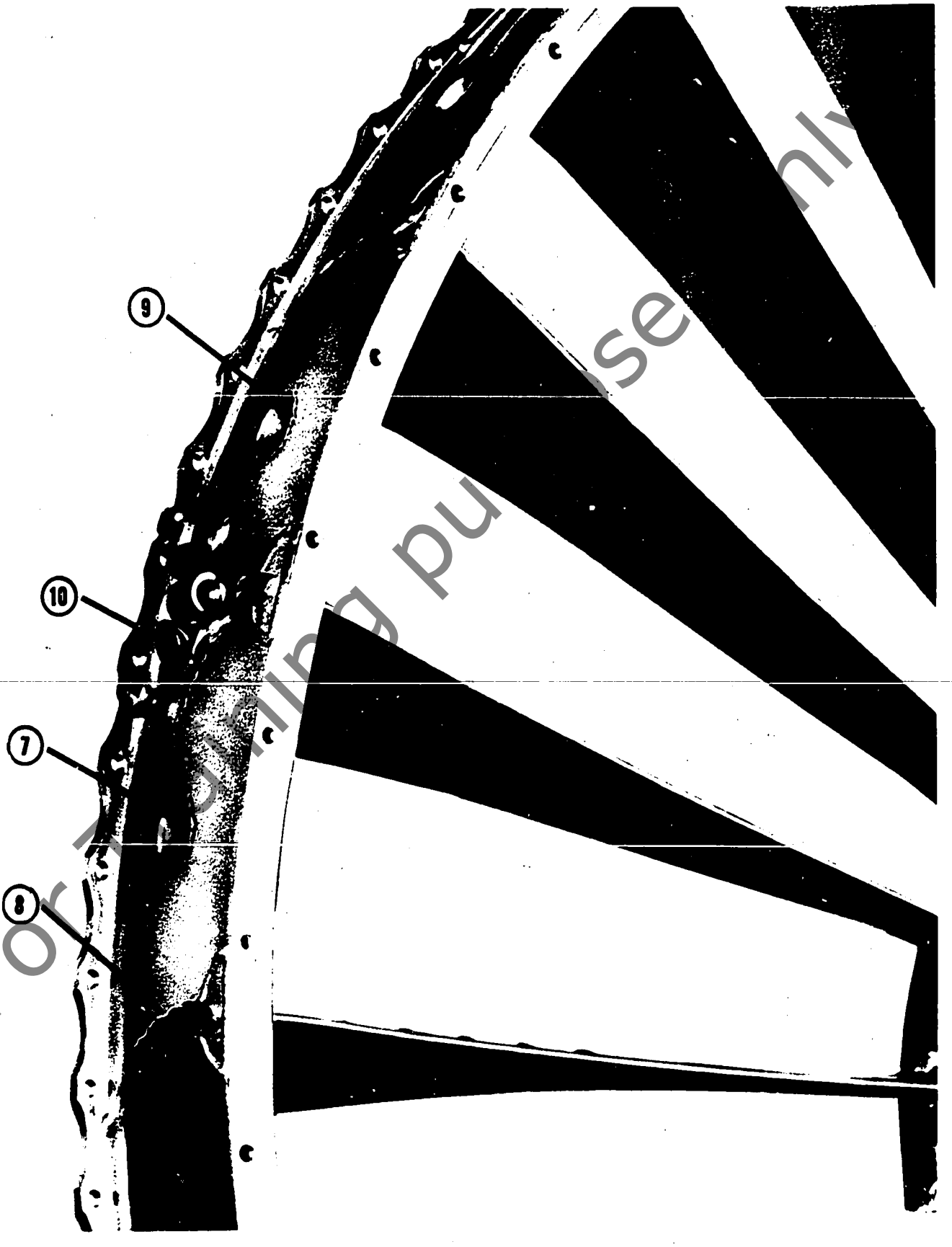
(n) Fan discharge case struts with cracks exceeding the limits specified in Periodic Inspection Chart may be continued in operation for a period not to exceed 150 hours provided the cracks are not of a converging nature or could possibly liberate pieces, and only one crack per strut.

(o) Cracks at the aft flange adjacent to the thrust reverser actuator mount bracket are acceptable after repair. Cracks up to three inches in length in the inlet case aft flange radius are acceptable after repair.

NOTE: See 72-0, Page 801 for repair procedure.

For Training purposes only

ENGINE - INSPECTION/CHECK



For Training purposes only

Inlet Case Crack Limits
Figure 606

(6) First Stage Fan Blade Shift (Loose Lock)

NOTE: Step (d) is not applicable to "Bat Wing" type blade locks such as P/N 512978.

(a) Shift due to a loose blade lock is permitted within the following limits.

(b) Unlimited number of blades are permitted with shift up to 0.030 inch without rebending blade lock.

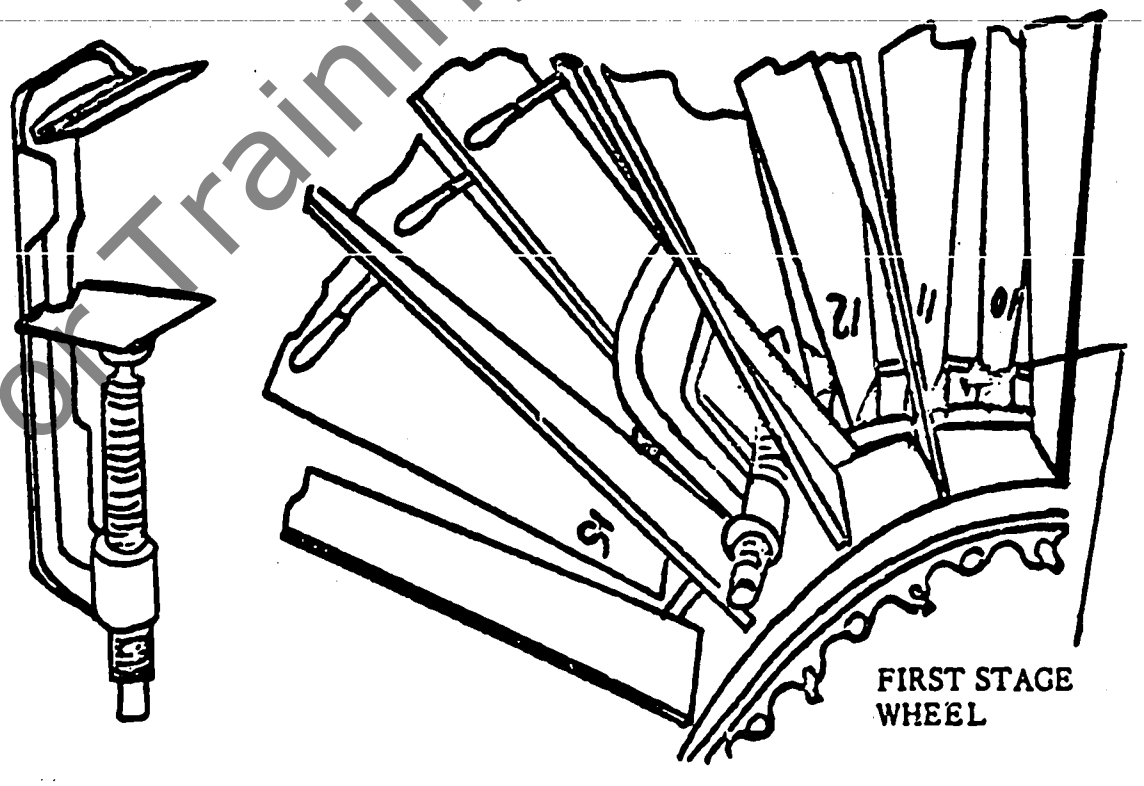
(c) A maximum of five blades, of which three may be adjacent, are permitted with shift up to 0.090 inch without rebending blade lock.

(d) P/N 430242 Lock may be rebent a maximum of five times. P/N 478174 Lock may be rebent a maximum of two times.

NOTE: Use a suitable system to keep accurate record of number of times each lock is rebent.

Each time blades are repositioned and lock tabs rebent, identify by painting a one inch circle between the blade tip and mid span area using blue steel dye marker.

Advise JEDMI by TWX, of Aircraft Number, engine position, and number of blades repositioned, also indicate previous blade shift by noticing the number of painted circles on blades.



GEN 1041 Tool - First Stage Fan Blade Tab Bending (JT3D)
Figure 606A

For Training purposes only

(7) First Stage Fan Blade F.O.D. "On Wing" Repair Limits

DELETED See Paragraph 1. B. (4)

"First Stage Fan Blade F. O. D. Fly Back Inspection and Repair"

This Section

(8) Turbine Blade Shroud Notch Wear Check (Broomstick Check).

NOTE: Inspection may be made by removing reverser cascade or entering tail pipe and feeling each blade for looseness by hand.

(a) Check for blade looseness at intervals compatible with periodic aircraft checks. Excessive shroud notch wear can result in blade looseness and failure.

(b) Attach short length of rubber hose to a wood pole or broomstick of sufficient length to reach fourth stage turbine blades through exhaust nozzle.

For Training purposes only

(8) (c) When engine is cold, press short length of hose lightly against turbine blades and rotate front compressor by hand in normal direction of rotation to produce strumming action of hose against blades.

CAUTION: TO REDUCE POSSIBILITY OF BLADE SHROUD NOTCH DISENGAGEMENT, DO NOT USE POLE OR HOSE ATTACHMENT TO ROTATE TURBINE.

(d) If blade looseness is evident the following action should be taken.

1) Local powerplant foreman must confirm and evaluate blade looseness.

2) Line foreman is to initiate a message to JEDMI indicating A/C engine position, number of loose blades, and amount of notch wear.

3) JEDMI will evaluate the problem and set up 4th stage wheel change.

CAUTION: SINCE P/N 434104 BLADES COULD BECOME DISENGAGED BY HANDLING AND LOOSENESS CHECK, VISUALLY INSPECT BLADES WITH STRONG LIGHT TO ENSURE ENGAGEMENT OF SHROUD NOTCHES. RE-ENGAGE BLADES.

(9) Inspect and recondition fuel manifolds and nozzles in accordance with Section 73-5-1, Accessory Component Overhaul Manual.

(10) First Stage Fan Blade Bow Check
(Relocated to 1.B. (2) This Section)

For Training Purposes Only

ENGINE - INSPECTION/CHECK

(11) First Stage Vane Spacers

(a) Inspection (Refer to Figure 607A)

1) Loose Spacers

a) Loose fan spacers are acceptable for service provided:

1 No more than twelve (12) spacers are loose.

2 Radial movement of spacer when depressed does not exceed 1/16 inch.

3 No cracks are found.

2) Cracked Spacers

a) Cracked spacers are acceptable provided:

1 Cracked spacers may be continued in use until the crack extends completely across the spacer.

2 Remove spacers which are cracked across entire spacers as follows:

a A maximum of six spacers may be removed.

b Do not remove two adjacent spacers or more than two spacers in same 90° quadrant.

3) Missing Spacers

Missing spacers are acceptable with out replacement with the following provisions:

a) The spacer flat is missing or removed back to each leg radius.

b) The engine is thoroughly inspected for damage to blades and vanes.

c) That not more than two spacers are missing in the same 90° quadrant.

d) That no two missing spacers are adjacent to each other.

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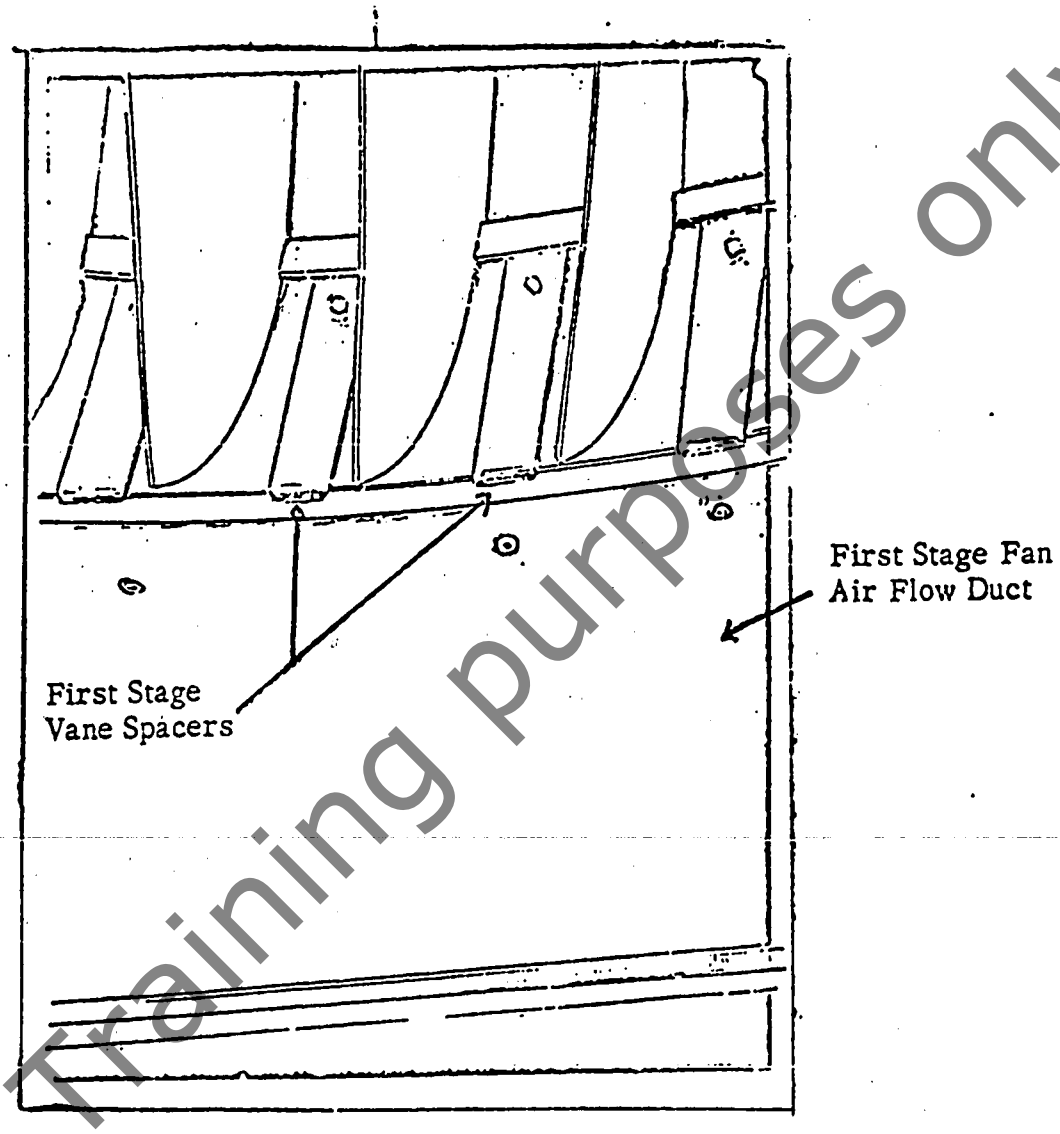


Figure 607A

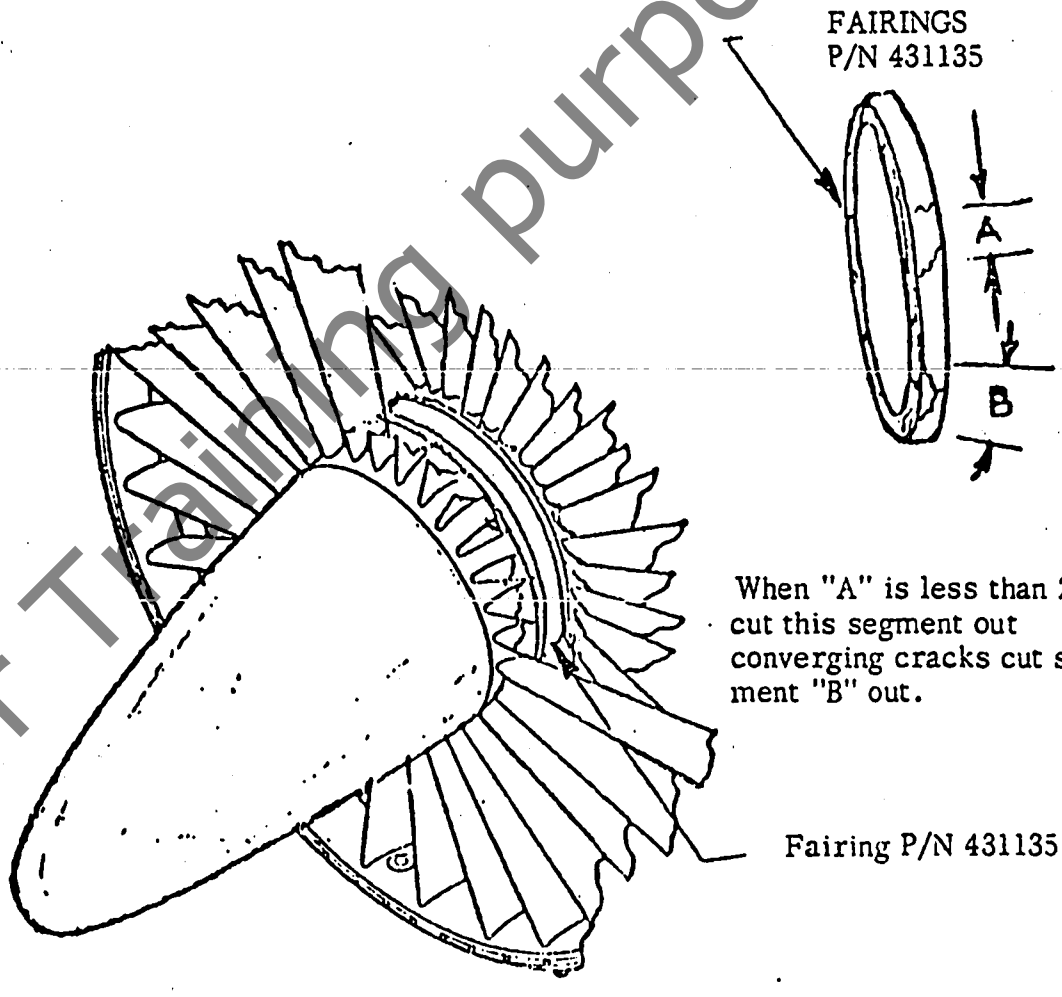
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ENGINE - INSPECTION/CHECK

1. C. (12) Inlet Case to Compressor Rotor Fairing Crack Limits (Refer Fig. 607B)

(a) There is no limit on the length or number of cracks allowed in this fairing. If cracks which run lengthwise, (parallel to the longitudinal axis of the engine) are less than two (2) inches apart, or there are converging cracks which present the possibility of a piece breaking out, the segment including such cracks should be cut or broken out. See Figure 607B for further details.

NOTE: The primary concern with regard to this fairing is to avoid pieces breaking out and going into the engine.



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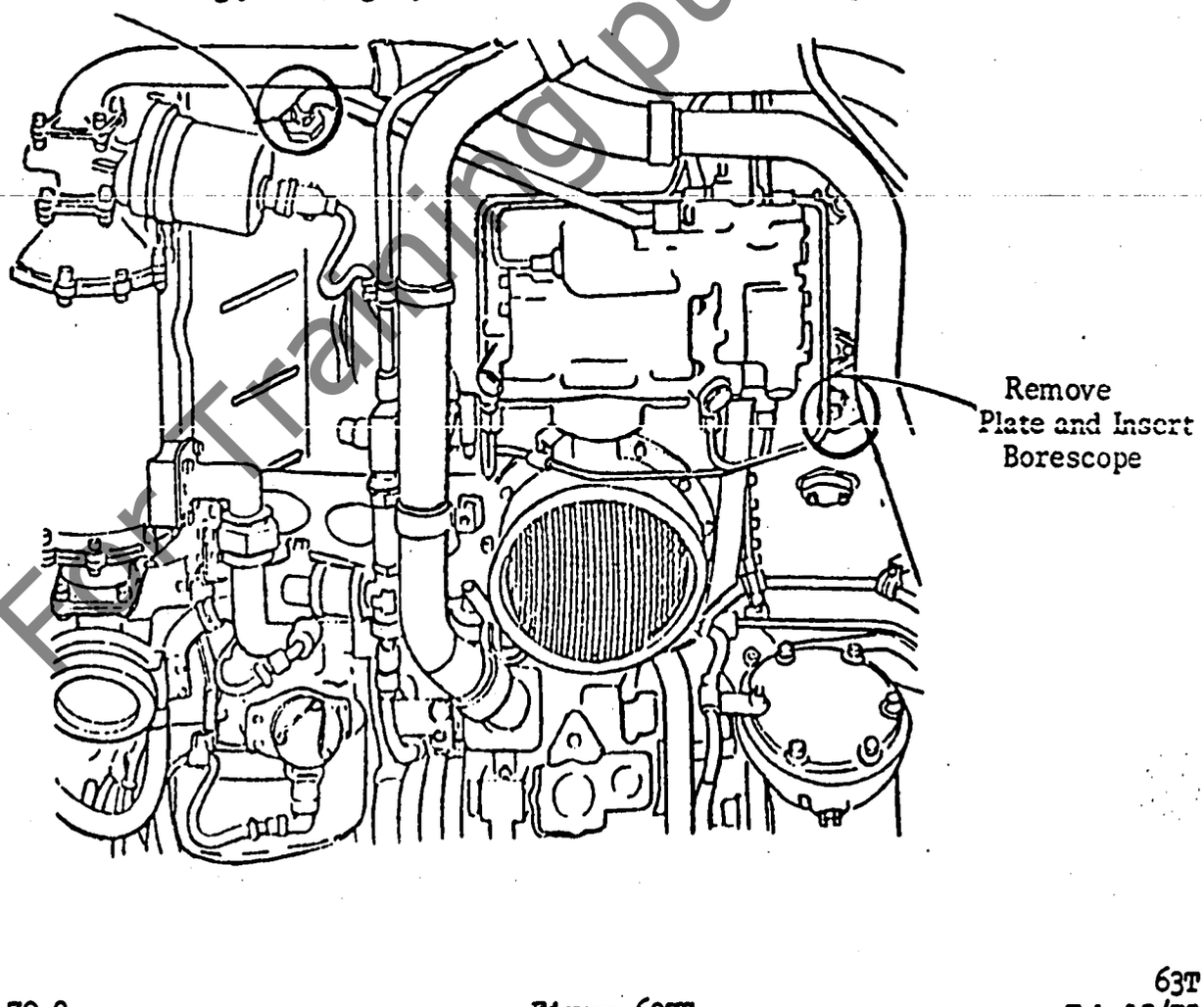
1. C. (13) Borescoping For Compressor Damage

(a) General

1) No means for inspecting the compressor were incorporated by the manufacturer, however, there are various plugs and plates located on the intermediate case and diffuser section which will afford an adequate view of the compressor when damage is suspected.

2) Compressor damage is normally associated with remarks in which stalling occurs at a "steady state" or fixed thrust lever position. In advance stages, metal is observed in the tail pipe caused by deflection of shroud vanes in the compressor section.

3) When compressor damage is suspected, a check of the trailing edges of the 9th and 16th stage compressor blades may be accomplished by inserting a borescope through the openings as shown in Figure 607C.



For Training purposes only

Figure 607C

(13) (b) Borescoping Procedure

1) Remove fitting 9:00 o'clock position on the intermediate case connecting PS3 to the air bleed actuator. Refer to Figure 607C for fitting location.

2) Slightly ream hole to afford entry of borescope.

3) Insert borescope and inspect aft stage of N1 compressor. Rotate compressor slowly by hand and inspect individual blades and surrounding area for damage.

4) Remove plate at the 7:00 o'clock position on the diffuser section. Refer to Figure 607C for plate location.

NOTE: Do not ream this hole as it is sufficient to permit borescope entry.

5) Insert borescope and check aft edges of 16th stage compressor and exit guide vanes for damage.

6) Remove air exit duct at the starter and rotate the starter impeller by hand, this will in turn rotate N2 compressor. With the borescope installed, slowly rotate N2 compressor and inspect the individual blades and surrounding area for damage.

CAUTION: ASSURE AIR START TRUCK IS NOT CONNECTED TO THE AIRCRAFT DURING THIS TIME.

NOTE: In applying the above procedure for inspecting compressor damage only a small partial view of each blade is possible. Thus it should be remembered damage might not be viewed as a large amount, or progressed to advanced stages of failure. Small nicks. dents in the blades or vane and shroud assembly are reason to suspect an mpending failure and might be sufficient reason for engine removal.

For Training purposes only

1. C. (14) Intermediate and Diffuser Case Cracks - Limits of Acceptability (crack in P&D Valve Pad and Fuel Manifold Excepted).

(a) The following shall be used as a guide for acceptability of cracks in welds of supports, vanes and bosses welded to the case.

1) Maximum length of serviceable cracks will be limited to one half (1/2") where no corrective action is required.

2) Cracks at the weld junction between struts and diffuser case outer skin may be repaired without disassembling engine provided following limits are met.

a) Cracks must not exceed three inches.

b) Not more than one crack is permitted at each of seven strut locations. No crack or repair is permitted at gearbox tower shaft strut.

c) Previously welded cracks may be rewelded as per instructions 72-0 Diffuser Case Repair provided old weld material is removed and parent metal is sound.

d) Deleted

e) A total of five vane welds may be cracked.

f) No indication of oil or fuel leakage from any crack is permitted.

(15) Anti-Icing Air Ports

(a) Cracks in the area of anti-icing air ports up to two inches may be continued in service to the nearest repair facility.

(b) Weld repair cracks as soon as possible. Refer Engine approved Repair Section.

For Training purposes only

2. 7th-Stage Disk - Front Compressor Rear Hub - Crack Inspection (JT3D-1,-3,-3B)

A. Inspection Requirements

NOTE: After rework in accordance with SB 1671 with bench rework and wink zyglo, on wing follow-on eddy current inspection interval for JT3D-1 engines is 8000 cycles for No. 2 hub and 7th-stage disk. Inspection intervals for JT3D-3, -3B engines, are 3000 cycles for No. 2 hub and 4000 cycles for 7th disk. These initial inspection intervals are good only once.

If parts are winked on bench at some later date, subsequent "On Wing" inspection of hub and disk must be performed every 2000 cycles for JT3D-1 engines and every 1000 cycles for JT3D-3, -3B engines per Tables I and II.

P/N 635498 No. 2 hubs do not require "On Wing" inspection.

(1) All engines should have 7th-stage compressor disk and front compressor rear hub inspected with specified equipment at first opportunity in accordance with procedures outlined in this section and with Tables I and II.

NOTE: 7th-stage compressor disks P/N 639307, P/N 719407 and No. 2 front compressor rear hub, P/N 635498, do not require eddy current inspection.

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ENGINE - INSPECTION/CHECK

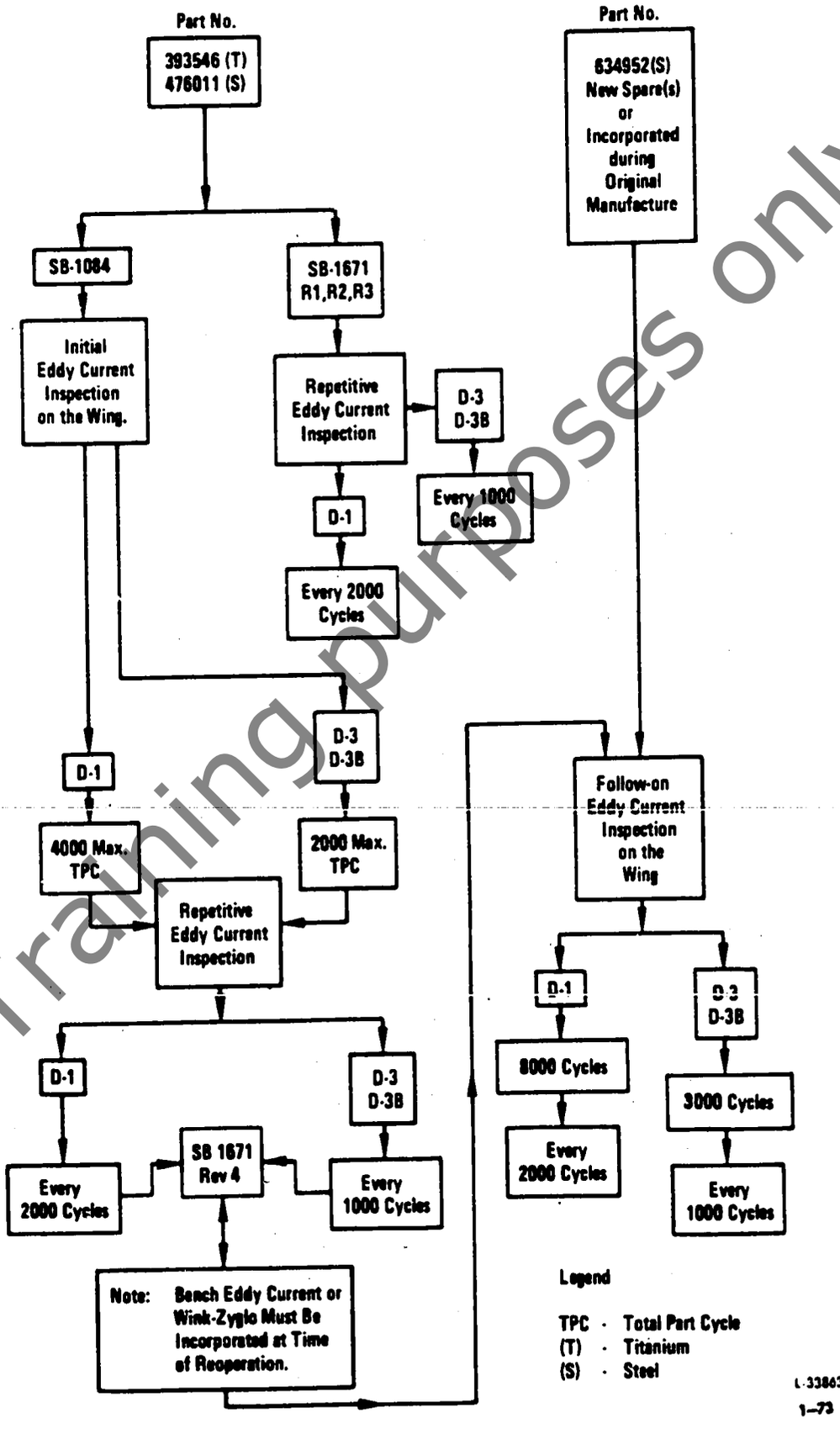
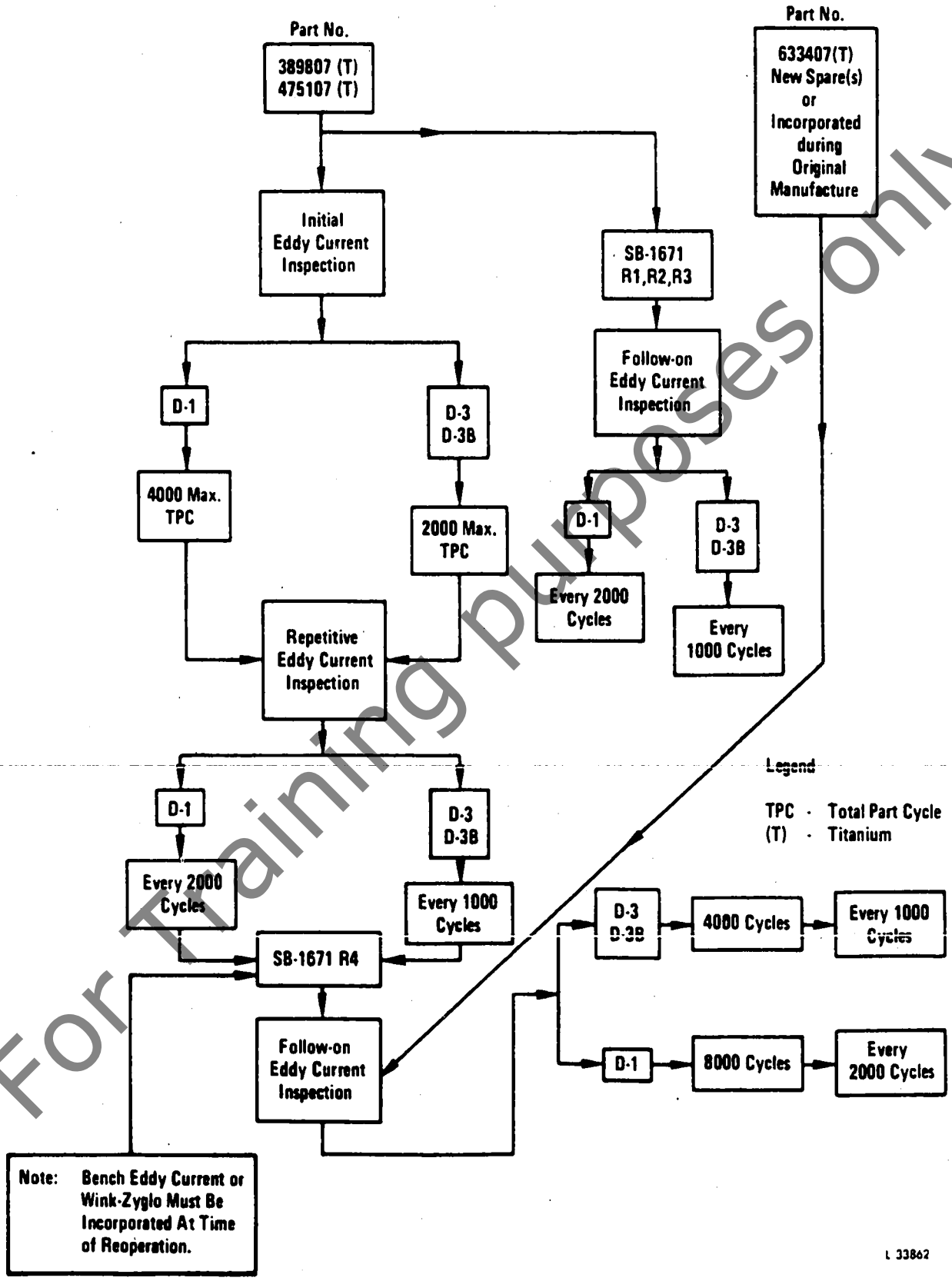


Table I

For Training purposes only



For Training purposes only

Table II

(2) Inspections will be accomplished with use of eddy current and access to areas to be inspected may be gained by removing front accessory case cover, number one inner race retaining nut (if necessary) and front accessory drivegear.

NOTE: Engines which incorporate front accessory drivegear held by retaining ring (Reference SB 3701) do not require removal of inner race retaining nut. Compress retaining ring and remove gear to gain access to inside of rotor.

B. Equipment Required

(1) Magnaflux ED 500 series instrument or equivalent.

(2) PWA 30458, seventh stage compressor disk inspection tool.

(3) PWA 30455, front compressor rear hub inspection tool.

C. Equipment Operation Procedures for No. 2 Hub.

(1) Connect PWA 30455 Inspection Tool to instrument. Turn instrument "ON" and allow 15 minutes minimum for warm up.

NOTE: Remove covering tape from end of probe prior to use in testing.

(2) Set "FREQUENCY" control to "0", the highest frequency. Turn "SENSITIVITY" control to medium. Turn "BALANCE" control as required to obtain on scale reading.

(3) Using a portable light, locate a lightening/counterweight hole (outer holes in conical section) of hub which is located near or at bottom of hub. See Figure 608.

(4) Insert inspection tool through bore of No. 1 hub and lightening/counterweight hole.

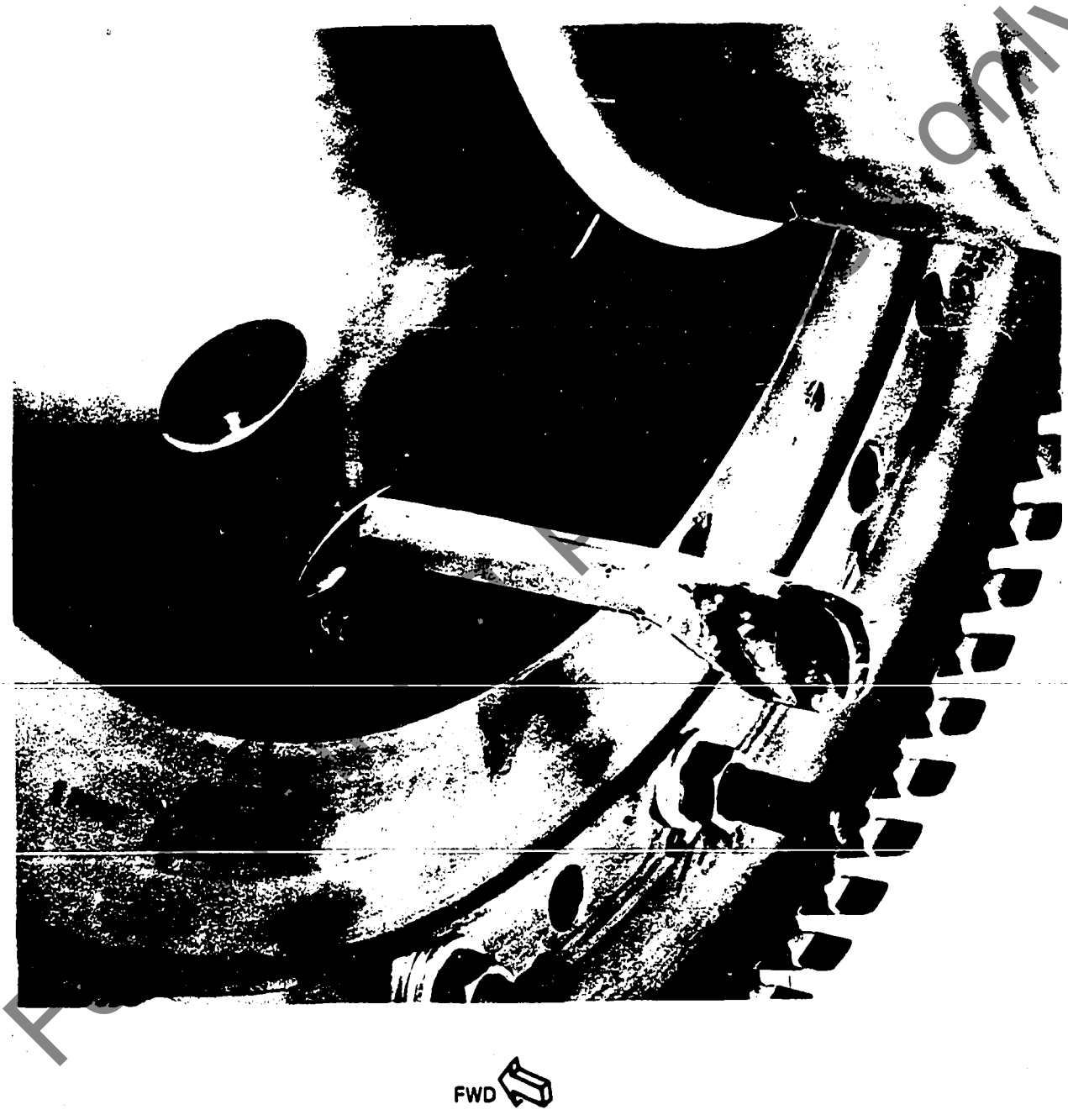
CAUTION: EXERCISE EXTREME CAUTION TO PRECLUDE DAMAGE TO INSPECTION EQUIPMENT.

(5) Pull trigger on tool handle to release eddy current probe head enough to rest probe head against conical section of rear side of hub. There should be no pressure on trigger once probe head has been positioned against hub.

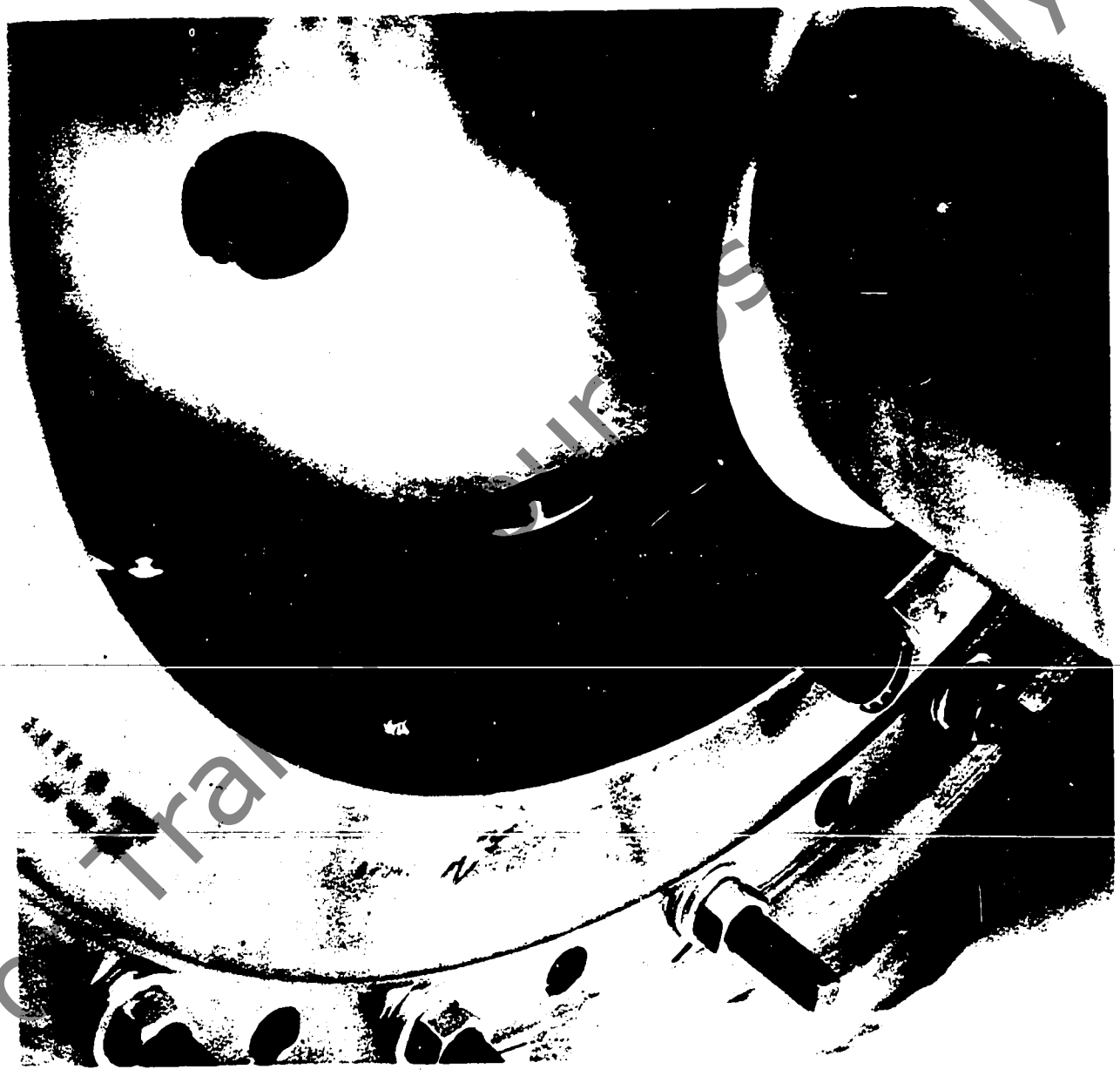
(6) Cautiously extract tool toward front of engine until probe head has positioned itself in hub flange-bell-blend radius which is inboard of No. 7 - No. 8 rotor spacer flange ID. See Figure 609.

(7) While observing micro-ampere meter, rotate tool and scan radius in both directions. Meter will indicate large deflections toward zero as probe passes tierod holes. These deflections may be standardized to -100 units by careful frequency selection.

For Training purposes only



Probe Head Following Conical Section of Hub (Rear Side)
Figure 608



For Training Purposes Only

Probe Head in Small Radius of Hub (Rear Side)
Figure 609

(8) Select proper frequency.

(a) Turn "LIFTOFF" control to 240 and repeat step (7).

(b) Continue adjusting "LIFTOFF" and "BALANCE" controls until a point is reached where tierod bolt proximity causes down scale meter deflection of 100 units.

(c) Release forward pressure on tool and carefully push toward rear of engine until probe head assumes a horizontal position, and extract from lightening/counterweight hole.

(d) Extract tool from inside of engine through bore of No. 1 hub.

(e) Crack deflection definition of +150 units may be observed using a simulated cracked test piece.

(f) Instrument is now ready for inspection of hub radius.

D. Inspection of Front Compressor Rear Hub.

(1) Repeat step C(3), except mark first hole that is being used for inspection with Magic Marker, to aid in determining starting point of inspection. Also repeat steps C(4), C(5) and C(6).

(2) Rotate probe slowly from one extreme to another and observe the meter for up scale deflection. Entire travel of probe head is approximately four inches. Indication of a crack will be noted on the meter up-scale when 100 micro-amperes or more are observed.

(3) Repeat steps C(8)(d) and C(8)(e).

(4) Repeat steps C(3), C(4), C(5), C(6) and C(8)(d) and inspect entire circumference of hub flange-bell-radius through remaining five lightening/counterweight holes.

(5) Crack indication(s) will require removal of engine from aircraft and disassembly to confirm indication(s).

E. Equipment Required (Alternate)

NOTE: Eddy Current Inspection of Front Compressor Rear Hub Incorporating Ideal Specialty Company P/N 6113 Probe Tip or P/N 6123 Arm and Head Assembly.

For Training purposes only

ENGINE - INSPECTION/CHECK

(1) Magnaflux ED 520 series instrument. (Preferred - but may use ED 500).

(2) PWA 30518 Inspection Tool or equivalent. (PWA 30518 is identical to PWA 30455 except probe tip is manufactured by Ideal Specialty Company.)

F. Equipment Operating Procedures

(1) Connect Inspection Tool to instrument. Turn the instrument "ON" and allow to warm up for a minimum of 15 minutes.

(2) Set "FREQUENCY CONTROL" to position 10, the lowest frequency. Turn "SENSITIVITY" control to Hi.

NOTE: Turn "Liftoff" to mid-position.

(3) Place probe on hub crack standard and rotate "Balance Control" to bring meter to mid-scale.

(4) Slowly pass probe over crack and note meter deflection.

(5) Turn "FREQUENCY CONTROL" to position 9 and repeat steps 3 and 4.

(6) Continue turning "FREQUENCY CONTROL" and checking hub crack standard until a position is found which gives maximum meter deflection in an up-scale direction. This should occur at frequency setting of approximately 5, 6 or 7. Meter deflection should be at least 100 micro-ampers in the up-scale direction.

NOTE: An ED 520 should peak out at about 150 micro-amperes. Readjust the deflection to read 125-150 micro-amperes.

(7) If no hub crack standard available,

(a) Starting at 1000 frequency setting, lift off compensate on hub to be inspected.

(b) Remove probe from engine and place on PWA crack standard. Meter deflection should be at least 100 micro-ampers in the up-scale direction.

(c) If standard crack does not produce 100 micro-amperes, a hub standard must be obtained for system calibration.

(8) Using external lighting (flashlight, drop-cord, etc.) locate a lightening/counterweight hole (outer holes in conical section) of hub which is located near or at the bottom of hub.

For Training purposes only

ENGINE - INSPECTION/CHECK

(9) Insert inspection tool through bore of number 1 hub and lightening/counterweight hole. Extreme caution should be exercised to preclude damage to inspection equipment. (See Figure 609A)

(10) Pull trigger on tool handle to release eddy current probe head enough to rest probe head against conical section of rear side of hub. There should be no pressure on trigger once probe head has been positioned against hub.

(11) Cautiously extract tool toward front of engine until probe head has positioned itself in the hub flange-bell-blend radius which is inboard of No. 7 - No. 8 rotor spacer flange ID. (See Figure 609B)

(12) Rotate "BALANCE CONTROL" to bring meter to mid-scale.

(13) The instrument is now ready for inspection of hub radius.

G. Accomplishment Instructions

(1) Repeat Step F8, except mark first hole that is being used for inspection with magic marker, to aid in determining starting point of inspection. Also repeat steps F9, F10 and F11.

(2) Rotate probe slowly from one extreme to another and observe the meter for up-scale deflection. Entire travel of probe head is approximately 4 inches. Indication of a crack will be noted on the meter up-scale when 50 micro-ampers or more are observed.

(3) Release forward pressure on tool and carefully push toward rear of engine until probe head assumes a horizontal position, and extract from lightening/counterweight hole.

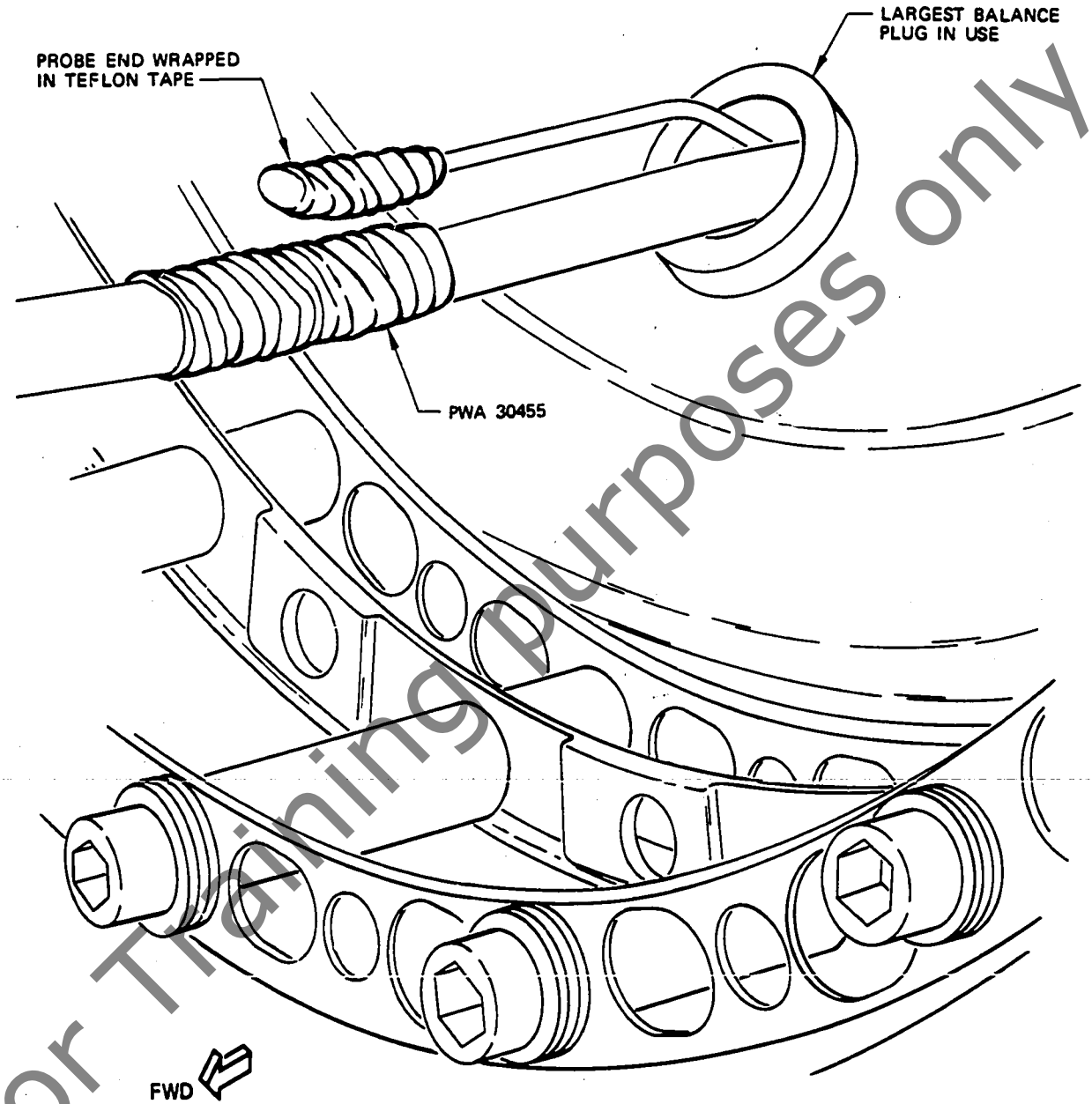
(4) Inspect entire circumference of hub flange-bell-radius through remaining five (5) lightening/counterweight holes.

(5) Crack indication(s) will require removal of engine from aircraft and disassembly to confirm indication(s).

H. Equipment Operating Procedures for Seventh Stage Disk

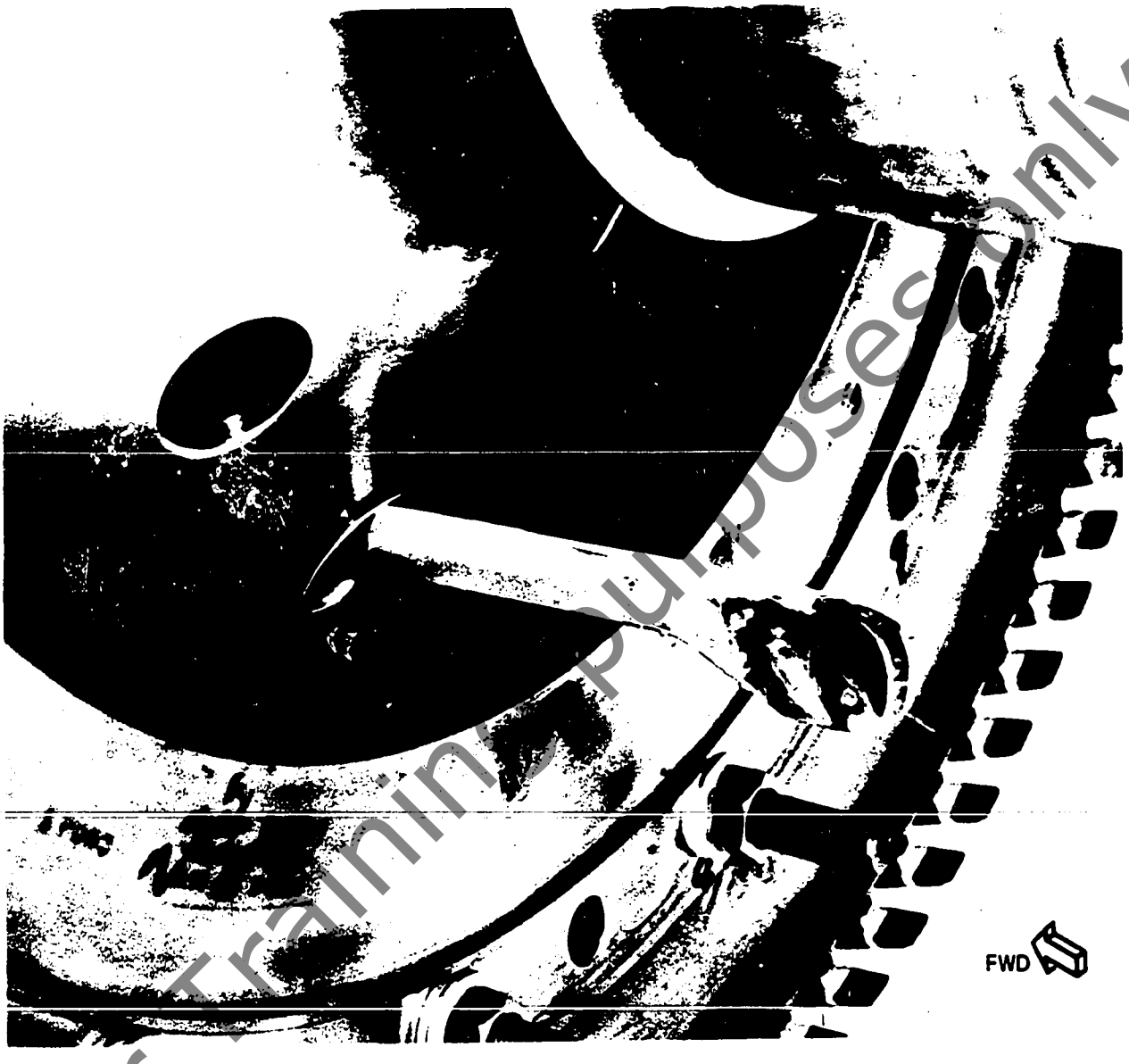
(1) Connect PWA 30458 Inspection Tool to instrument. Turn the instrument "ON" and allow minimum warm up of 15 minutes.

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For Training Purposes only

Insertion of Inspection Tool PWA 30455 into
Lightening/Counter weight Hole.
Front Side of Hub.



For Training Purposes Only

Inspection Tool PWA 30455 through Hole.
Rear Side of Hub.

(2) Follow instrument manufacturer's instructions for FREQUENCY and LIFTOFF adjustments.

(3) Crack deflection definition may be observed using simulated cracked test piece.

(4) Insert inspection tool through bore of No. 1 hub.

(5) Locate and place probe head on bore of disk and turn BALANCE control to give midscale meter indication.

(6) The instrument is ready for inspection of front face of 7th-stage disk.

I. Inspection of 7th-Stage Disk

(1) With probe head resting on bore of disk, slowly traverse web area with probe and observe meter. Engine may be rotated for this inspection. Caution should be exercised to preclude probe head jumping disk bore.

(2) Indication of a crack will be noted on meter scale when a deflection of meter form its midscale position is observed.

(3) Crack indication(s) will require removal of engine from airplane and disassembly to confirm indications.

J. Inspection Accomplishment Reporting

(1) Report eddy current inspection accomplishment as follows:

(a) If no cracks found, inspector shall sign off appropriate cards accordingly.

(b) If crack indication is found, report immediately to JEDMI by Telex prior to next flight.

K. Reassemble the Engine After Inspection.

(1) Reinstall the front accessory drive main spur gear.

(2) Install and torque the No. 1 bearing inner race retaining nut and rivet lock per JT3D Overhaul Manual 72-30 (Ref Index 355 Fits and Clearances Section).

(3) Check clearance between the front accessory main drive gear and the No. 1 bearing inner race retaining nut with 0.001-inch feeler gage. No contact is permitted between the gear and the nut.

(4) Reinstall the front accessory drive front support assembly cover.

(5) Reinstall the bullet.

For Training Purposes only

3. Combustion Chamber Lug Wear Pad - On The Wing Radiography Inspection.

NOTE: Inspection procedure for cases with wear pads. Following cases do not have wear pads unless they were reoperated to Service Bulletin 2384; P/N 433011, 488961, 617071.

A. Move aircraft to remote area that affords protection from radio activity.

WARNING: ISOTOPE RADIOGRAPHY MUST BE PERFORMED BY QUALIFIED PERSONNEL AND ALL APPROPRIATE SAFETY PRECAUTIONS MUST BE OBSERVED.

B. Remove front accessory drive support and front accessory drive main gear in accordance with Section 72-0, Dismantling/Assembly.

C. Locally fabricate a tube to accept Iridium-192, Type 100c Source. Insert a cap in inner end of tube to provide a locating stop for source when it is in position.

D. Locally fabricate tooling necessary to support tube in position.

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ENGINE - INSPECTION/CHECK

E. Insert source guide tube into shaft of engine such that in exposed position source will be 84.1875 inches from front face of compressor inlet cone support assembly. See Figure 610.

NOTE: Exact source positioning is needed to obtain adequate radiographs for accurate wear determination. See Figures 611 a, b.

To ensure that correct source positioning has been achieved, a test shot (800 curie - minute exposure) with a fast film such as Agfa Gaevert D-10 or equivalent is recommended. Source is correctly positioned if inner surface of radiographic image of "V" shaped contoured indenture, Figure 612, is between 0.216 inch and 0.256 inch (5.5 to 6.5 MM) from "H" flange, Figure 611 b.

F. Tape 4 inch by 7 inch Agfa Gaevert D-4 lead pack film onto the engine case at the eight positions shown in Figure 613. (Kodak "M" film may be used if D-4 is not available.)

NOTE: Equivalent type film may be used when exposures are adjusted to give same results.

(1) Number films one through eight clockwise from rear starting at twelve o'clock position. Mark engine number on No. 1 film.

G. Obtain following gamma-ray projector equipment or equivalent.

(1) Technical Operations Model 529 Gamma Ray Projector Control.

(2) Technical Operations Model 533 Shielded Container.

(3) Flexible Guide Tube.

NOTE: Technical Operations Inc., Burlington, Mass. have indicated they would be willing to furnish equipment required.

H. Expose film for 3000 curie-minutes (increase exposure by a factor of 1.33 if "M" film is used).

NOTE: Curie-minutes are determined from actual exposure in minutes multiplied by power source-type 100C power rated at time of exposure.

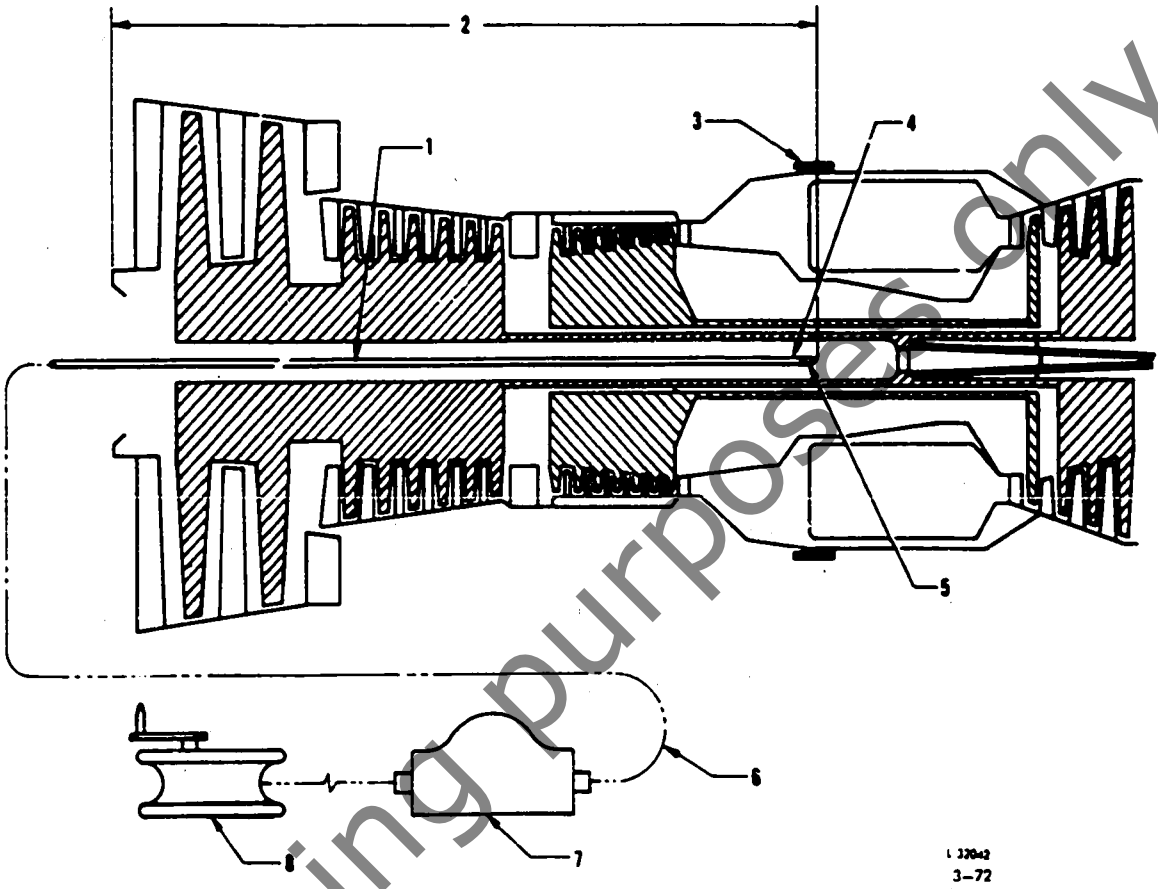
I. Develope film per manufacturers recommendations.

J. Interpret radiographs using a high intensity light box, film density approximately 4.0.

NOTE: Wear to a maximum depth of 0.015 inch will be allowed on pad at interim inspection periods with pad replacement required at next hot section.

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1. Capped Tube (Source Travels Inside).
2. 84.1875 Inches To Exposed Source.
3. Agfa Gaevert D-4 Lead Pack Film (4 x 7 Inches), 8 Sheets
4. Iridium-192 Source.
5. Cap
6. Flexible Guide Tube.
7. Shielded Container
8. Gamma Ray Projector Control.

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3A. Borescoping for Burner Can Lug and Scallop Wear

A. General

(1) To prevent burner can, locating lugs and scallop shims from excessive wear and subsequent burn thru due to the can sliding away from the fuel nozzles, the parts shall be borescoped at scheduled periods.

(2) The wear on the burner can lug and scallop shim can also be monitored at any time when suspected that accelerated wear is occurring.

B. Borescoping Procedure

(1) To gain excess to the borescope holes remove the hydraulic lines and heatshields from engines 2 and 3 positions and on engines 1, 2, 3 and 4 the start duct and brackets at the diffuser case "H" flange.

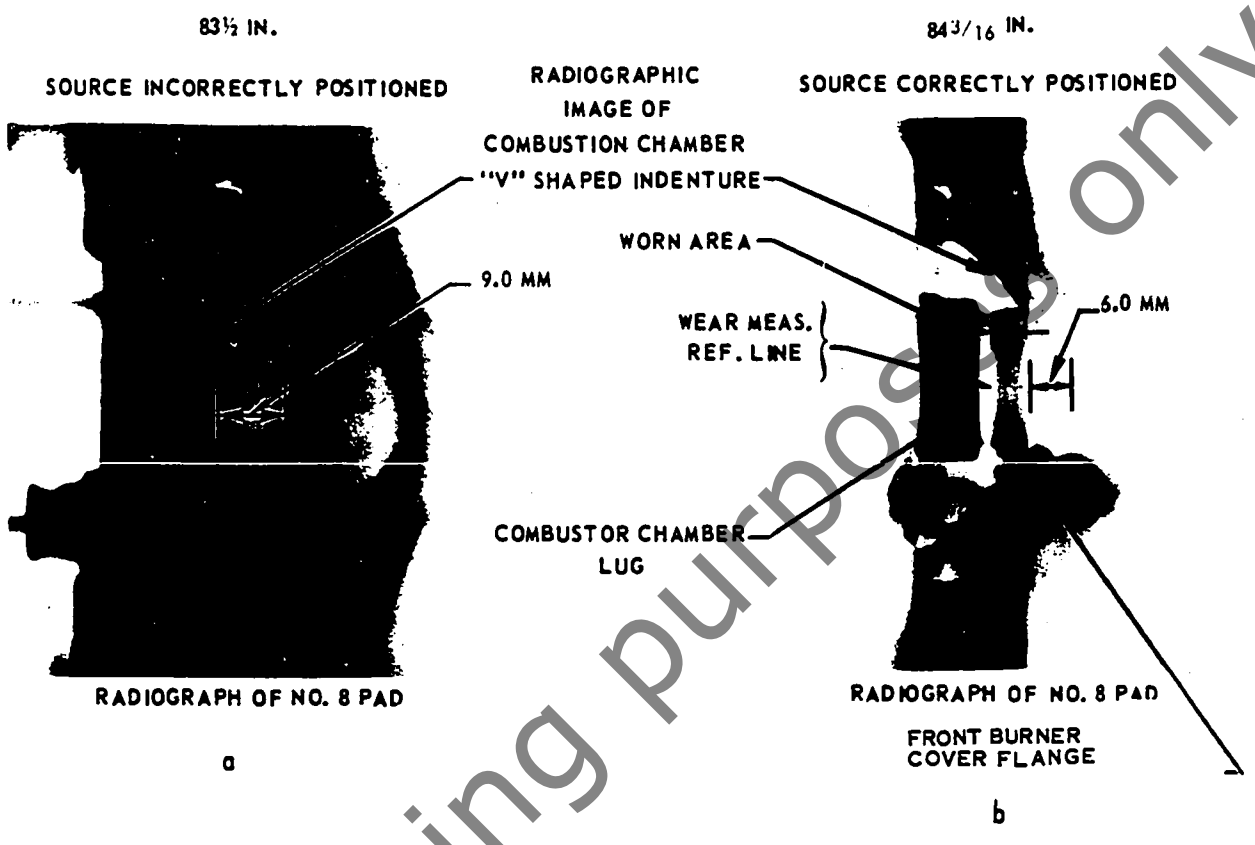
(2) Remove the bolts and sleeves in the diffuser case "H" flange at 6 burner can drilled hole location and the 2 ignitor plugs.

(3) Insert the borescope BFO - 1814 R, thru the diffuser case "H" flange just far enough to clear the inside edge of the flange with the light. This will permit a side or profile view of the lug and scallop shim.

C. Limits & Follow Up Action Requirements

Amount of wear	Re-inspection requirements	Correction requirements	Correction deferments
.000 To .010	Routine	None	None
.011 To .020	Within 1000 Hrs*	None	None
.021 To .030	NA	Prior to further service	May be deferred 550 Hrs* if necessary to maintain scheduled operation.
.031 To .040	NA	Prior to further service	May be deferred 50 Hrs* if necessary to maintain scheduled operations.
Over .040	NA	Prior to further service	None

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Radiographic Image Of Combustion Chamber
Figure 611

4. Combustion Chamber Weldments

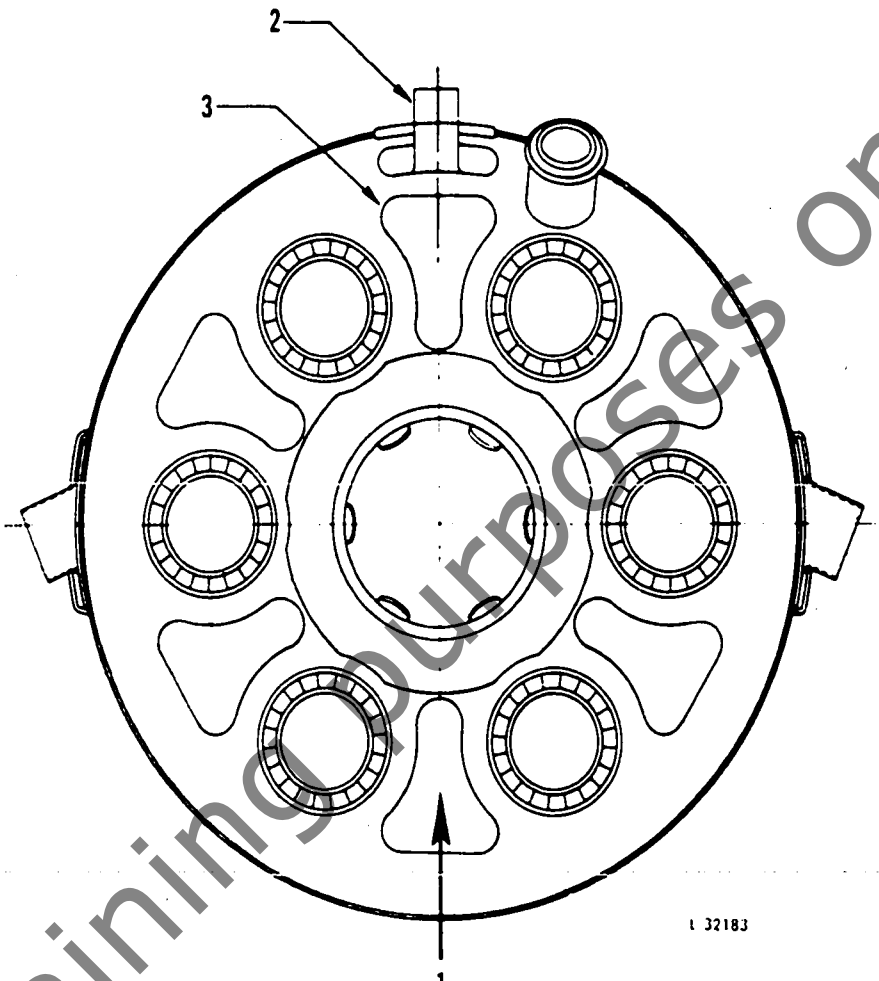
A. General

(1) Cracks in combustion chamber surfaces are usually of stress relieving nature and, as such, are not serious in that the rate of growth decreases as the crack lengthens. Thermal stresses, in effect, relieve original stress condition. It is usually normal to observe repetitive occurrence of a given type of deterioration from chamber to chamber in a given engine.

(2) To ensure consistency and to eliminate confusion in reports or inspection standards, use the established nomenclature for the various components of the combustion chambers as shown in Figures 614 and 615.

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ENGINE - INSPECTION/CHECK

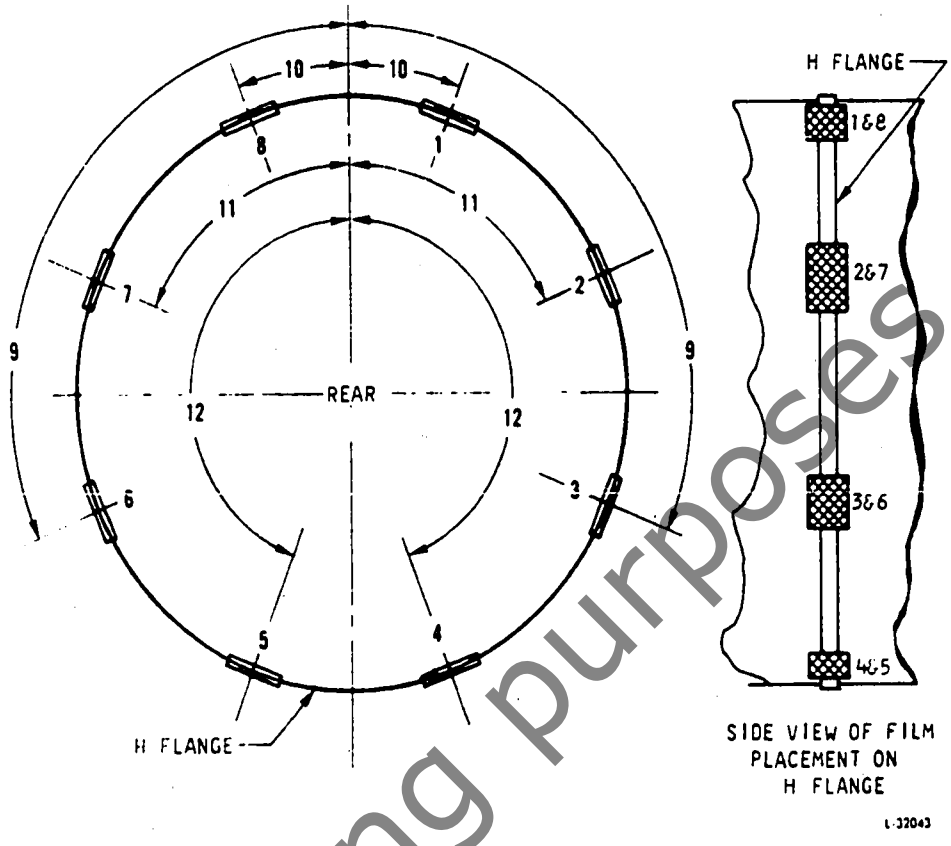


1. Source Projection
2. Combustion Chamber Lug
3. "V" Shaped Contoured Indenture.

Isotope Inspection Of Combustion Chamber Lug Wear Pad
Figure 612

For Training purposes only

ENGINE - INSPECTION/CHECK



1 Thru 8. Film Locations

9. 39.5 Inches

10. 7.9 Inches

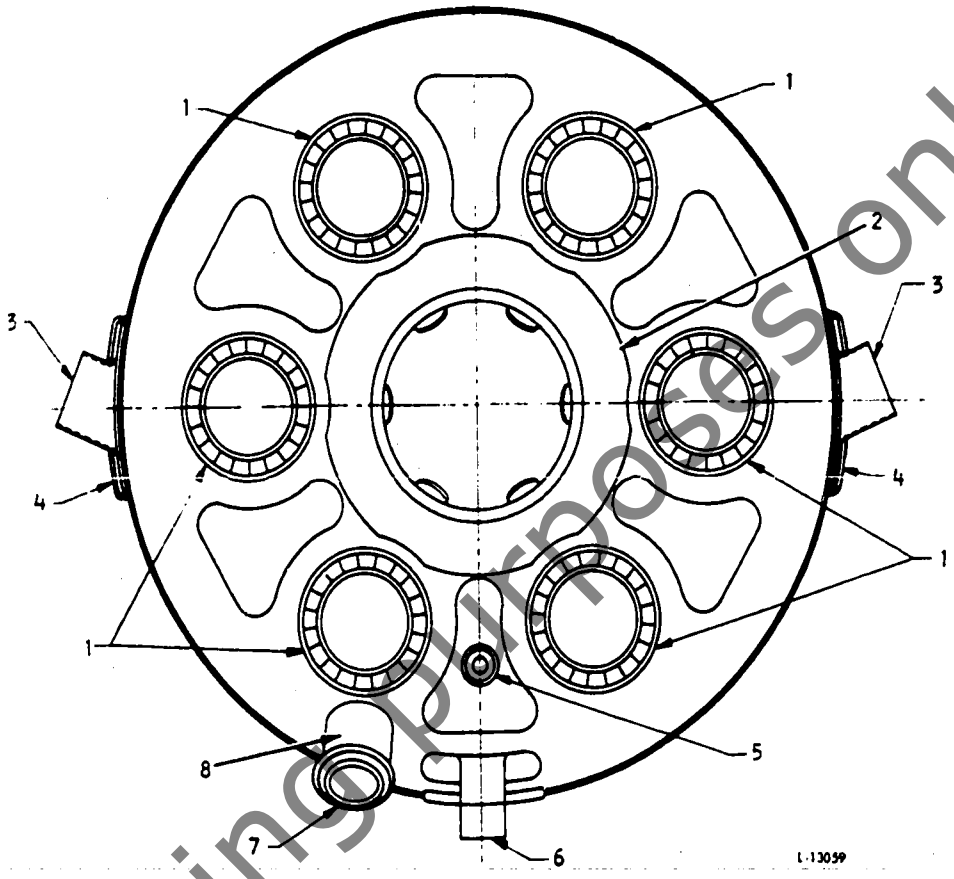
11. 23.7 Inches

12. 55.3 Inches

Film Locations For Isotope Inspection
Figure 613

For Training purposes only

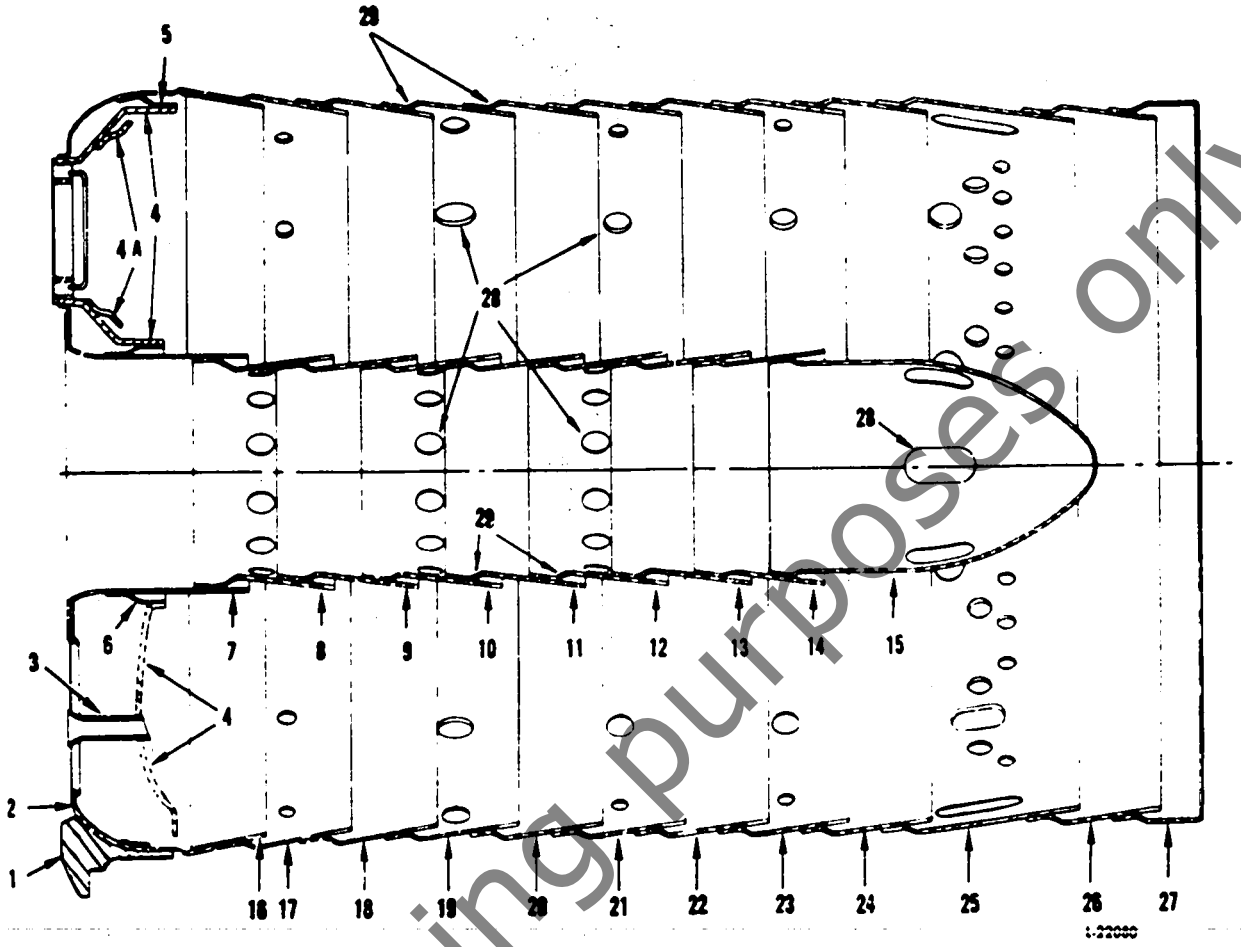
ENGINE - INSPECTION/CHECK



1. Air Swirl Guide
2. Front End Inner Liner
3. Cross Over Tube
4. Heatshield
5. Burner Transfer Tube
6. Locating Lug
7. Igniter Plug Bushing
8. Igniter Plug Sleeve

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ENGINE - INSPECTION/CHECK



1.	Locating Lug	15.	Rear End Inner Liner
2.	Cover	16.	Front Outer Liner
3.	Burner Transfer Tube	17.	No. 1 Outer Liner
4.	Swirl Cup	18.	No. 2 Outer Liner
4A.	Baffle	19.	No. 3 Outer Liner
5.	Outer Brace	20.	No. 4 Outer Liner
6.	Inner Brace	21.	No. 5 Outer Liner
7.	Front End Inner Liner	22.	No. 6 Outer Liner
8.	No. 1 Inner Liner	23.	No. 7 Outer Liner
9.	No. 2 Inner Liner	24.	No. 8 Outer Liner
10.	No. 3 Inner Liner	25.	No. 9 Outer Liner
11.	No. 4 Inner Liner	26.	No. 10 Outer Liner
12.	No. 5 Inner Liner	27.	No. 11 Outer Liner
13.	No. 6 Inner Liner	28.	Combustion Air Holes
14.	No. 7 Inner Liner	29.	Cooling Air Holes

NOTE: Head assembly includes Index Nos. 1 through 6. Inner liner assembly includes Index Nos. 7 through 15. Outer liner assembly includes Index Nos. 16 through 27.

Combustion Chamber Nomenclature
Figure 615

For Training purposes only

(3) Figures 616 through 621 show various types of combustion chamber deterioration which may be found in chambers at time of inspection. The following paragraphs will call out the deteriorated areas and tell whether or not they can be repaired or replaced.

(4) Fluorescent penetrant inspect combustion chambers in accordance with SPOP 62.

NOTE: Particular attention should be given to all the seam weld joints in the inner and outer liner segments on both the inside and outside liner surfaces.

(5) All cracks found in the seam weld joints must be weld repaired.

B. Acceptable Areas Without Repair

(1) Buckling on the OD of the fuel nozzle swirl cup is acceptable without repair provided that no cracks extend from the buckled areas. See reference number 1, Figure 616.

(2) Burning of the louver inside the wall to the extent shown in reference number 1, Figure 621 is acceptable.

(3) Burning of the inner liners to the degree shown in reference numbers 2 and 4, Figure 618, is acceptable. Straighten any bent louver to provide 0.070 to 0.120 inch clearance between louver and liner segment ID. If the head is replaced, rotate the inner liner 90 degrees with respect to the outer liner when reassembling.

(4) No unrepaired cracks permissible in inner liner assembly. See Paragraph C.

C. Acceptable Areas With Repair

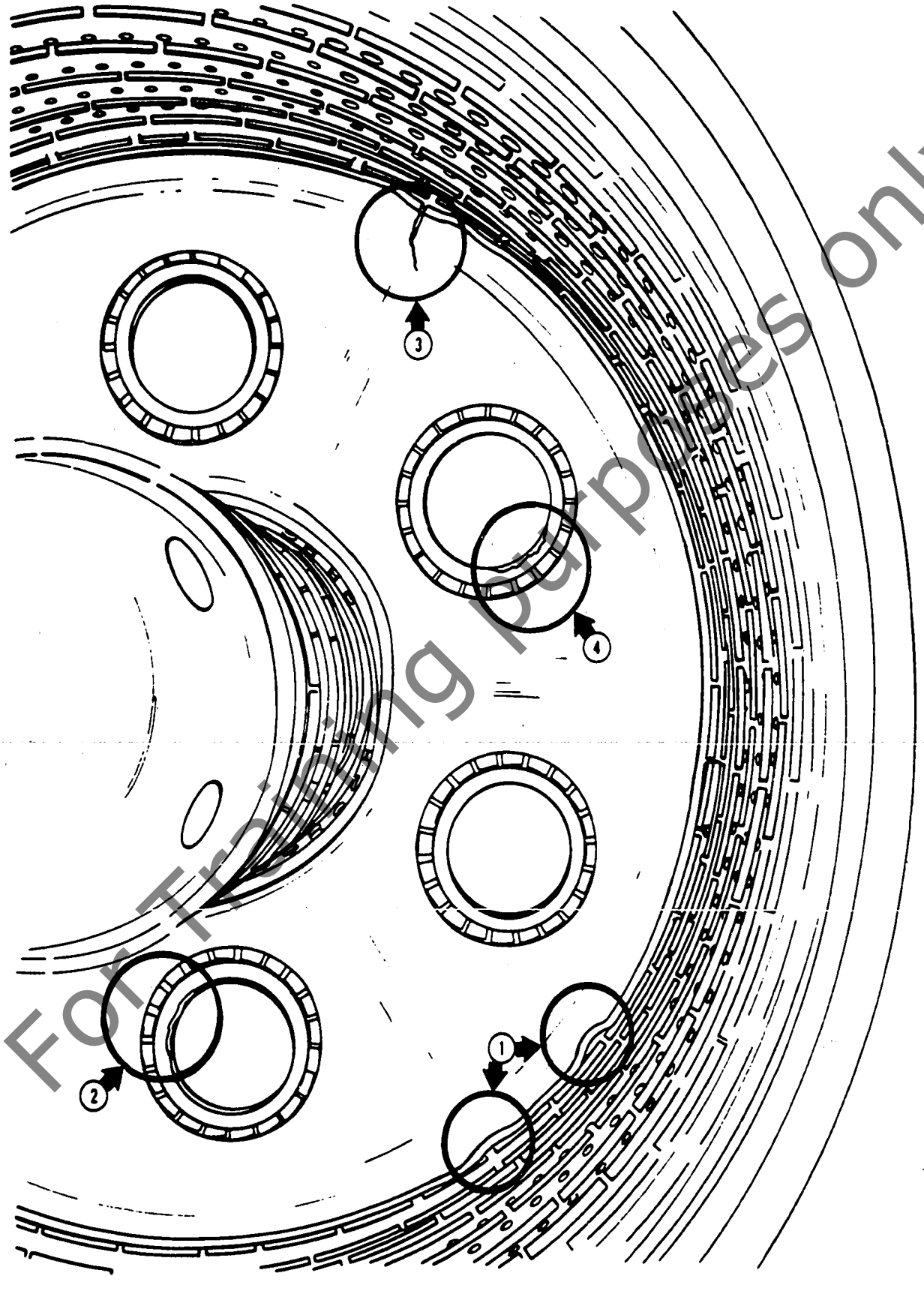
(1) Cracks underneath the flame tubes are not acceptable. See reference number 1, Figure 619. Repair this condition by replacing the flame tube.

(2) Burning on the inside of the liners directly underneath the flame tubes as shown in reference number 3, Figure 620, is not acceptable and must be repaired by patching the outer liners and replacing the flame tube.

(3) An example of cracking typical of that found in the hot streak area is illustrated in Figure 620, Nos. 1 and 2. Repair by patching.

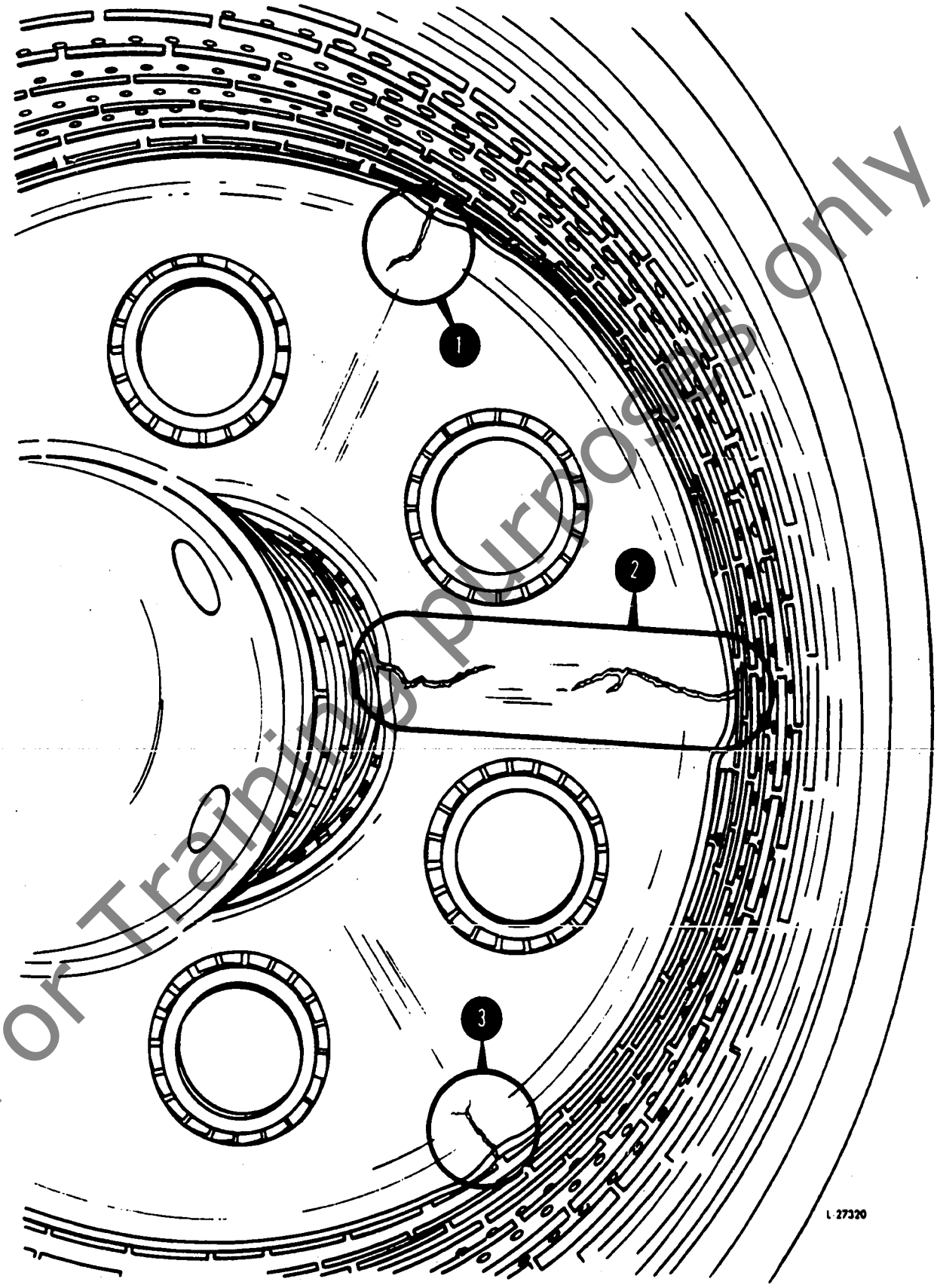
(4) Cracks in the outer liner as shown in reference number 2, Figure 619, are not acceptable. Repair this condition by patching the section.

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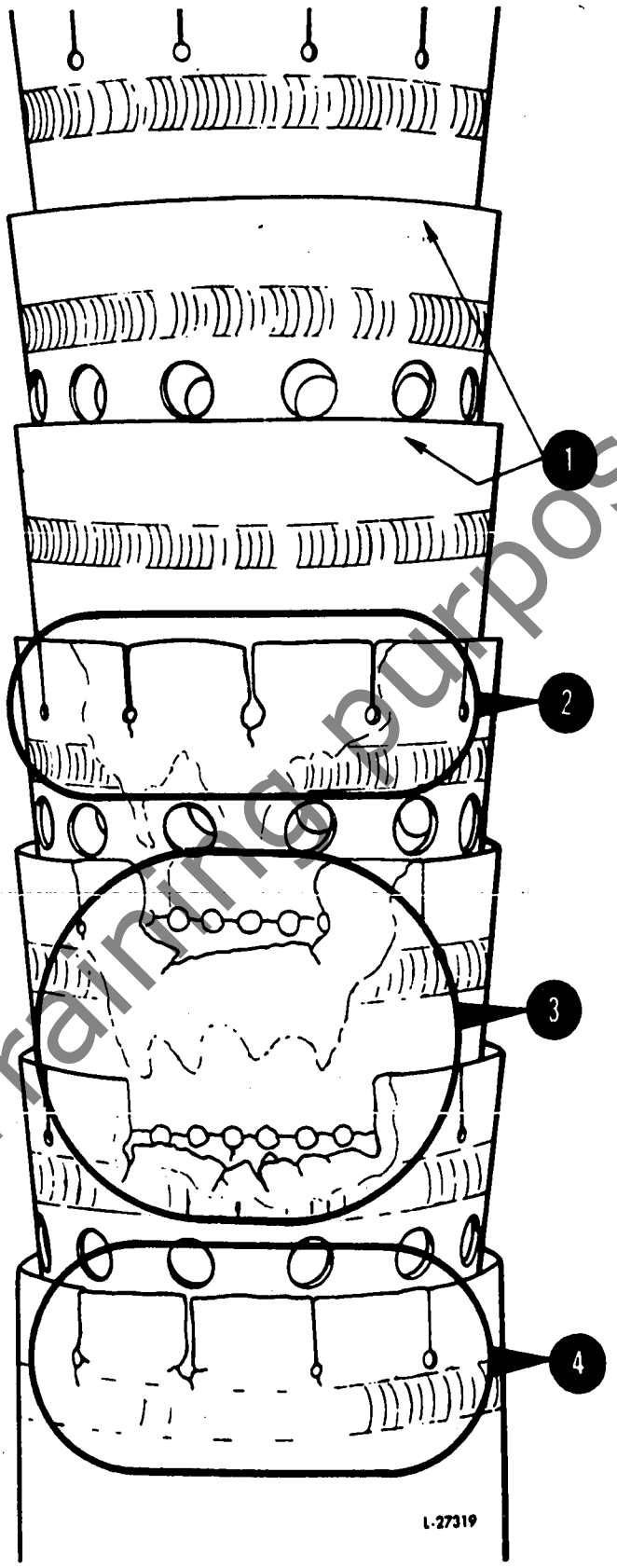
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Combustion Chamber Wear
Figure 616



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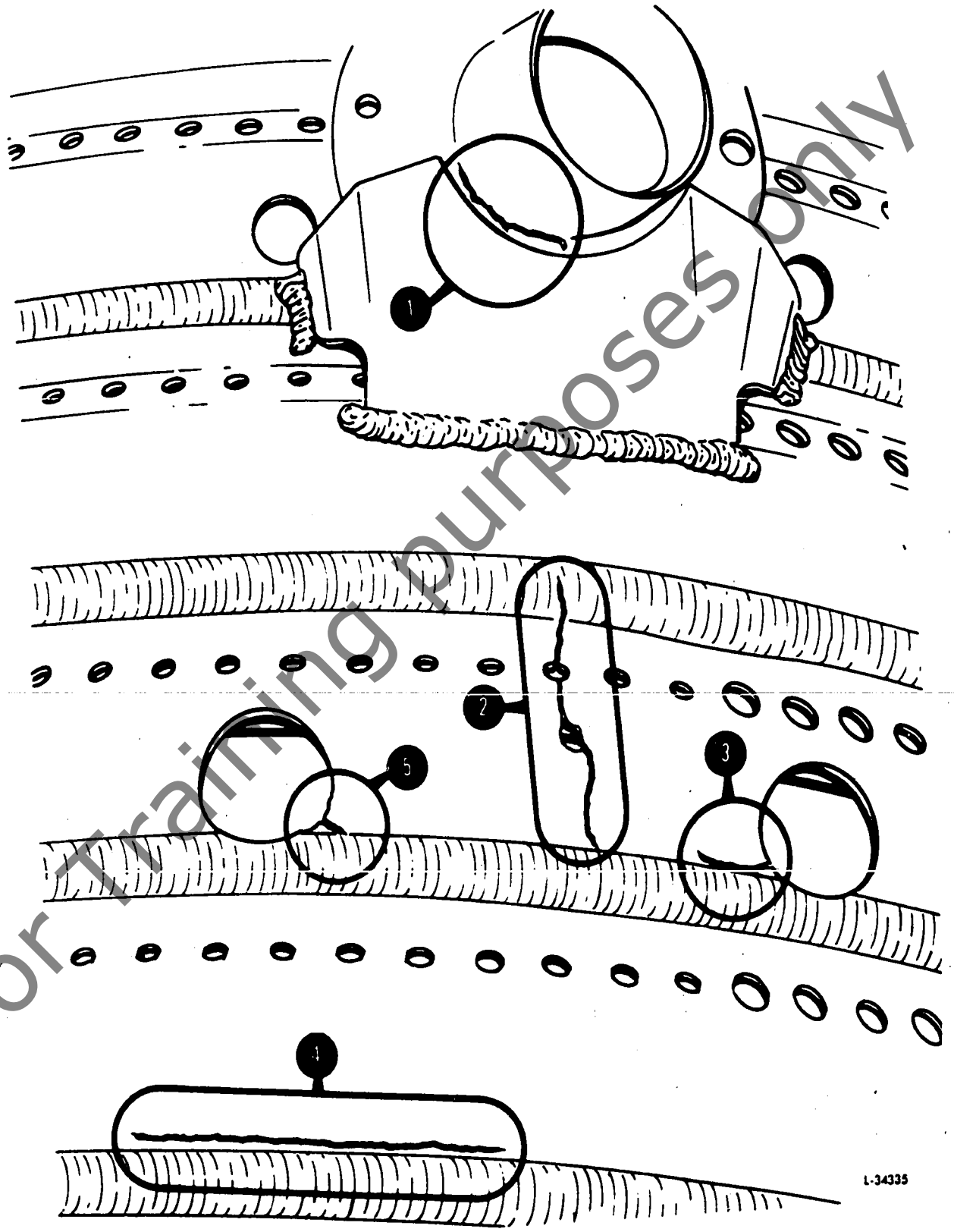
ENGINE - INSPECTION/CHECK



Combustion Chamber Liner Wear
Figure 618

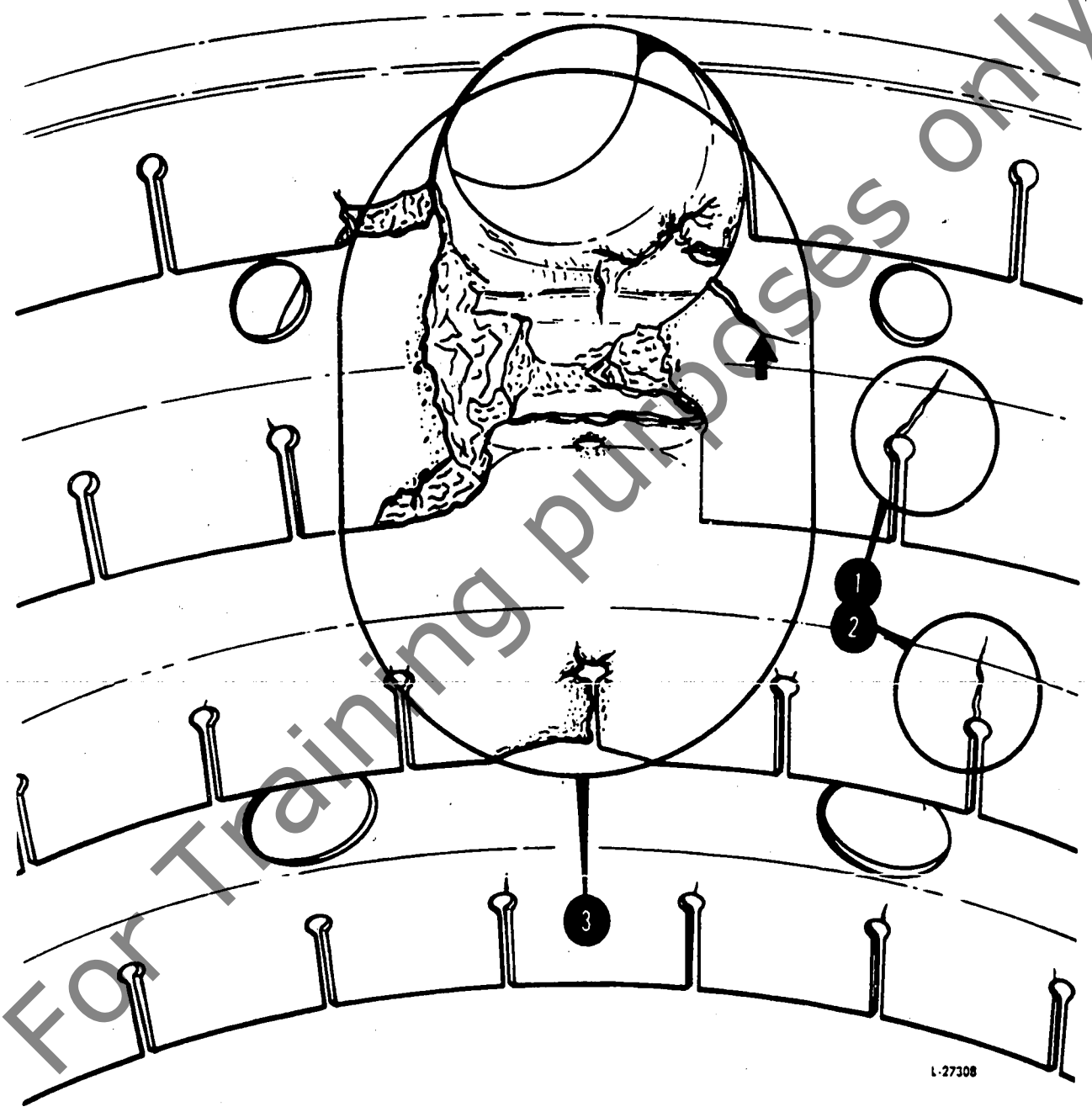
For Training purposes only

ENGINE - INSPECTION/CHECK



For Training purposes only

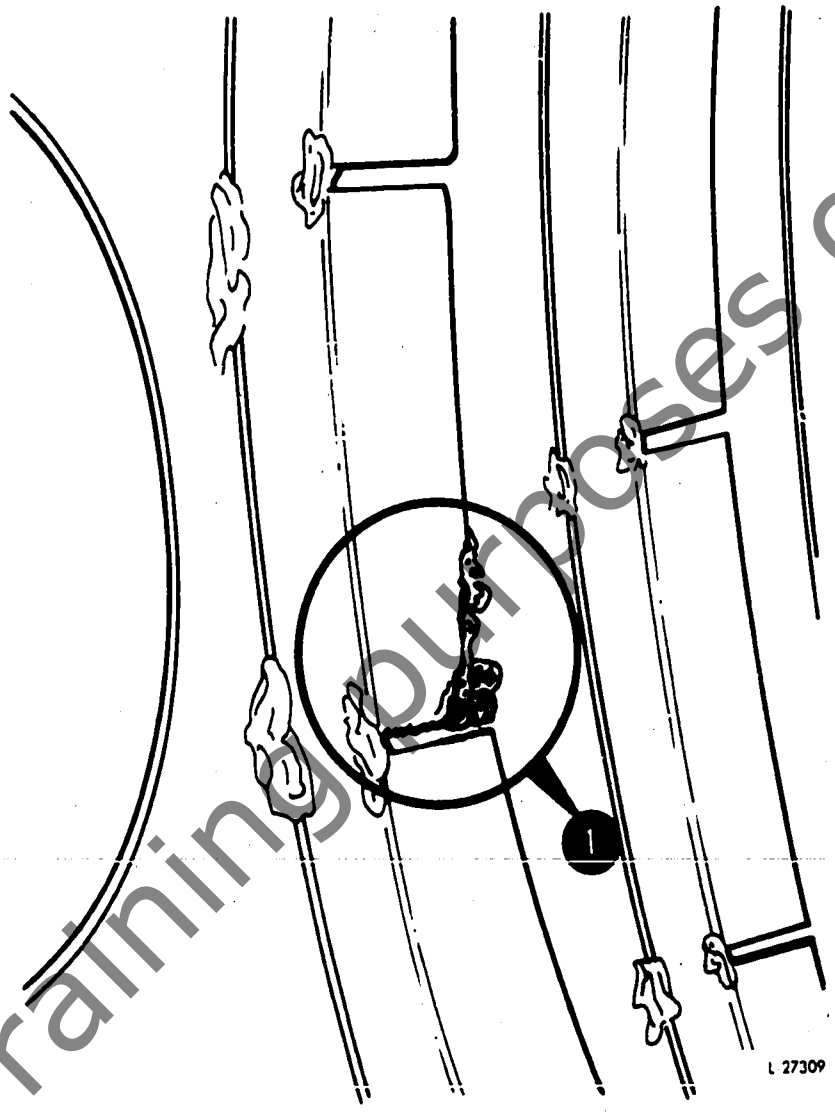
ENGINE - INSPECTION/CHECK



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Combustion Chamber Flame Tube and Liner Buring
Figure 620

ENGINE - INSPECTION/CHECK



Combustion Chamber Burning
Figure 621

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ENGINE - INSPECTION/CHECK

(5) Cracks extending from the large holes of the liners as shown in reference numbers 3 and 5, Figure 619, are not acceptable. Repair these cracks by welding.

(6) Circumferential cracks immediately above or below the seam weld in the outer liners as shown in reference number 4, Figure 619, must be weld repaired. Such crack openings in excess of 0.030 inch are not repairable. There is no restriction on the length of this type crack repair.

(7) Cracks extending over 1/4 inch in length in the fuel nozzle swirl cups as shown in reference numbers 3 (Figure 616) or 2 and 3 (Figure 617), are acceptable provided they are weld repaired. See step (10).

(8) Slight burning of the swirl guide deflectors, reference numbers 2 and 4, Figure 616 is acceptable provided they are blended to the following limits:

(a) No more than cumulative length of 1.30 inch of the ID of the deflector or a cumulative total of the length of six vanes (including six vane spaces) may be blended to one-half the lip height.

(b) The blend must produce sound metal of generally uniform thickness. Do not remove more material than is necessary to achieve this.

(c) Buckling of the lip of the deflector beyond the blended areas is acceptable provided the buckled area is not burned and the general contour of the ID circumference is uniform.

(d) Thinned and slightly buckled areas of the deflector's lip are acceptable without rework when burning has not occurred.

(9) Location of cracks in inner liner assembly which do not automatically reject assembly are as follows. All cracks must be weld repaired.

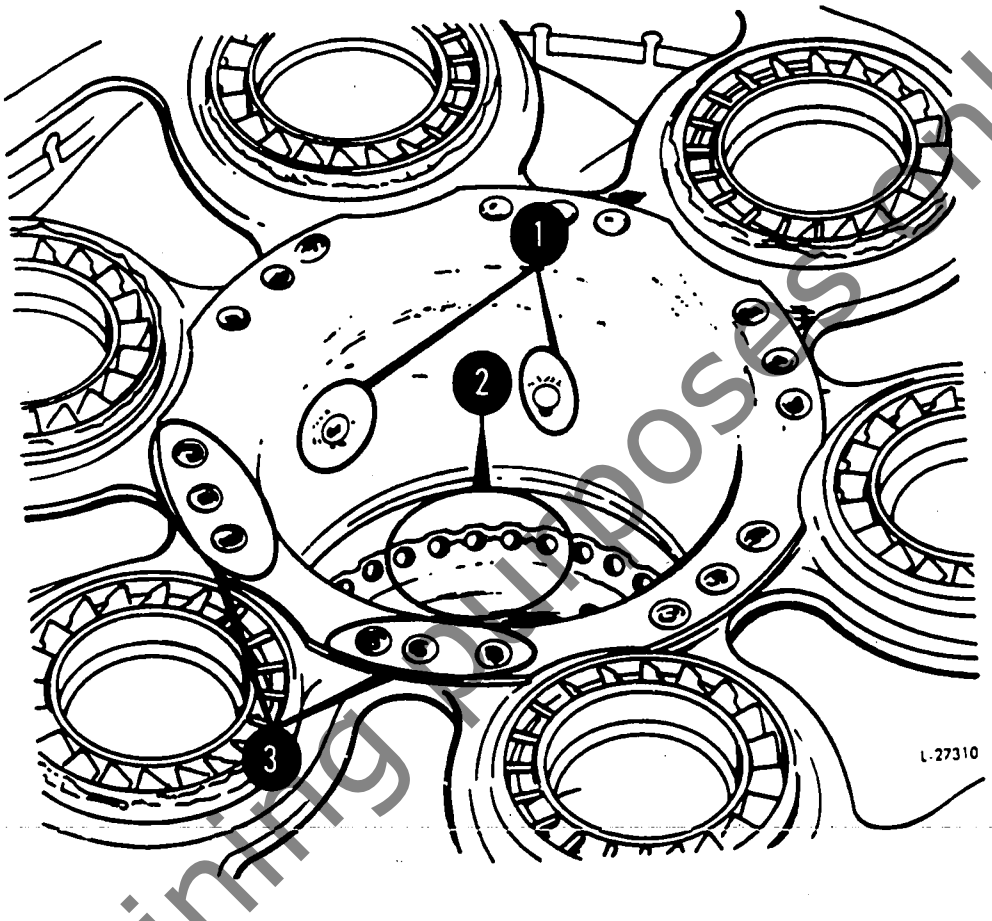
(a) In ID of front end of inner liner, around and emanating from six spot welds used, in early chambers only, to secure inner liner assembly to swirl cup inner brace. On Figure 622, Index No. 1, these spots have been sketched in.

(b) In flange of front end inner liner, around or emanating from spot welds or hand fusion welds used to secure inner liner assembly to cover. See Figure 622, Index No. 3, for location.

(c) In No. 1 inner liner only, circumferentially between small cooling air holes, between not more than four consecutive holes in any 120 degree sector (maximum of nine cracks per liner) provided groups are separated by a sector of sound material of at least 90 degrees. Examples are shown in Figure 622, Index No. 2.

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Combustion Chamber Inner Liner Cracking
Figure 622

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ENGINE - INSPECTION/CHECK

(10) Figure 623 show ventilated (louver cooled) swirl cup configuration. All inspection criteria for earlier, non-louver cooled swirl cup apply to new louver cooled configuration. In addition, following criteria are added applicable only to louver cooled configuration:

(a) Cracks in baffle must be repair welded. A copper shim or chill must be used in space between baffle and swirl cup to prevent burn through from restricting air flow.

(b) Cracks in baffle to swirl cup attaching weld must be routed and repair welded.

(c) Clearance between baffle and swirl cup must be within limits shown in Figure 624. If clearance is found below minimum, it is probably caused by distortion of swirl cup, not the baffle. Before bending baffle to restore clearance, inspect swirl cup for buckling and/or rolling inward of ID and correct these conditions if present. After bending baffle or swirl cup, inspect baffle attaching welds for cracks.

D. Unacceptable Conditions

(1) Cracks located in the fuel nozzle swirl cups as shown in reference number 2, Figure 617, are not acceptable. Repair of this type condition requires head replacement.

(2) Burning and cracking of inner liners as shown in Reference Number 3, Figure 618, are not acceptable. Replace the complete set of liners to repair this condition.

(3) Wall thickness of the No. 11 Outer Liner at any location must be 0.030 inch minimum. Below this minimum thickness combustion chamber liner must be replaced.

(4) Combustion chambers having locating lug hardface worn 0.010 inch or more are unacceptable for further service until repaired.

(5) Wear in swirl guide ID (bore) which increases ID to 1.263 inch diameter or over at any point is unacceptable (this wear is usually localized). Check ID with PWA-30018 Go-No-Go Gage.

E. Combustion Chamber Differences

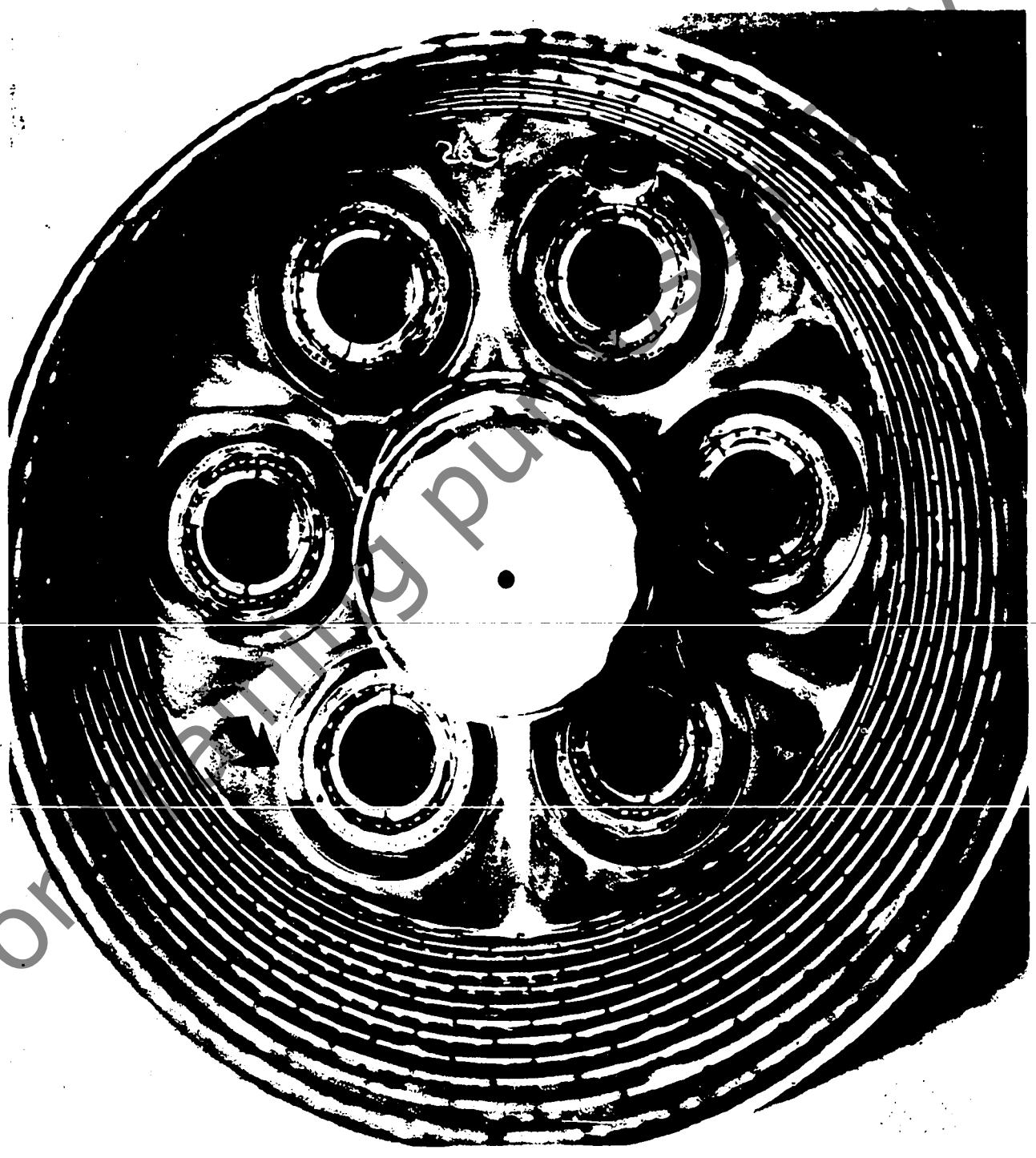
See Figure 625.

(1) There are three basic types of combustion chambers in service:

(a) Type I - Chambers in which all sheet metal parts are of Inconel material. All but very earliest of this group have torroidal type swirl guides.

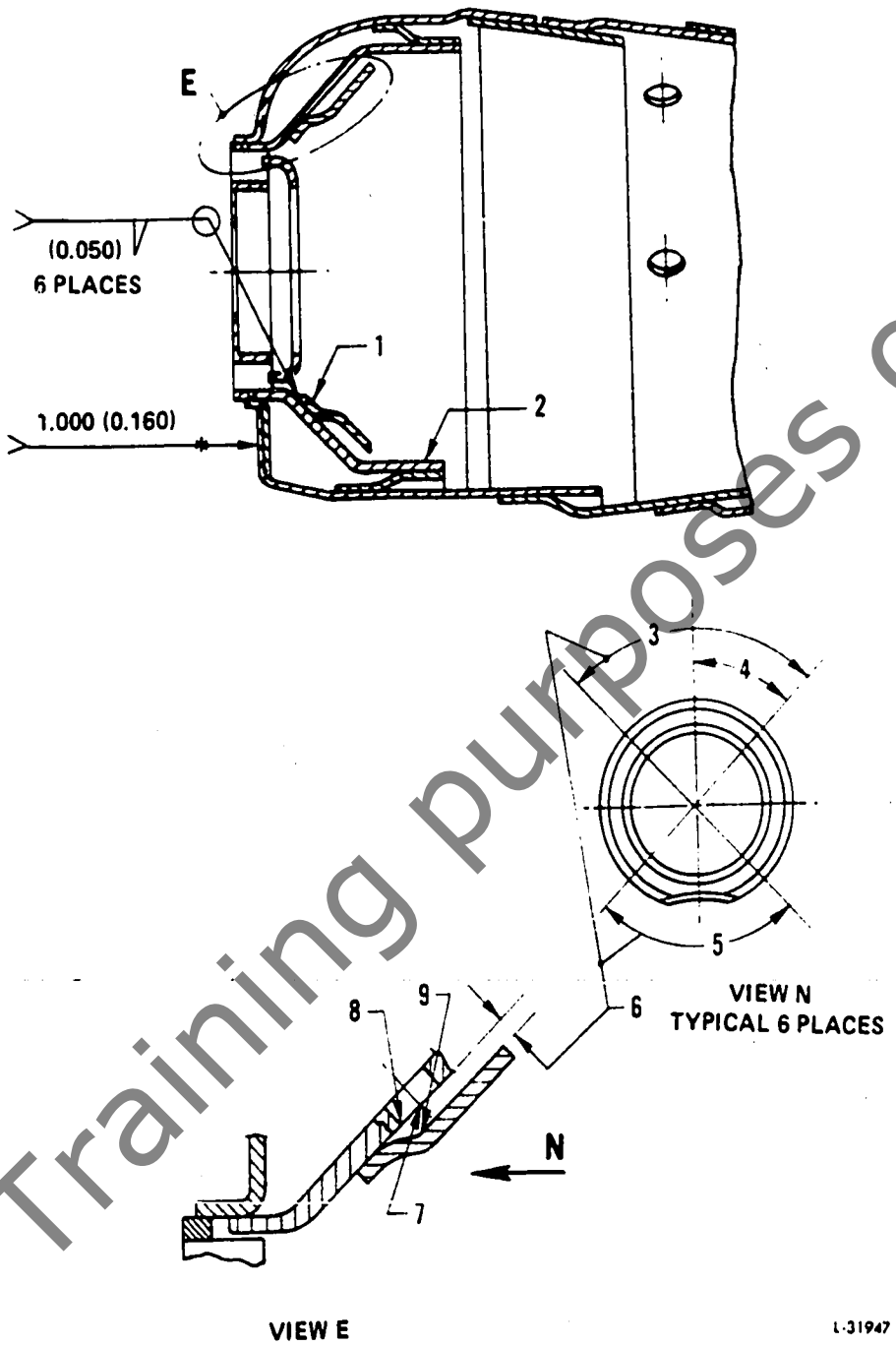
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ENGINE - INSPECTION/CHECK



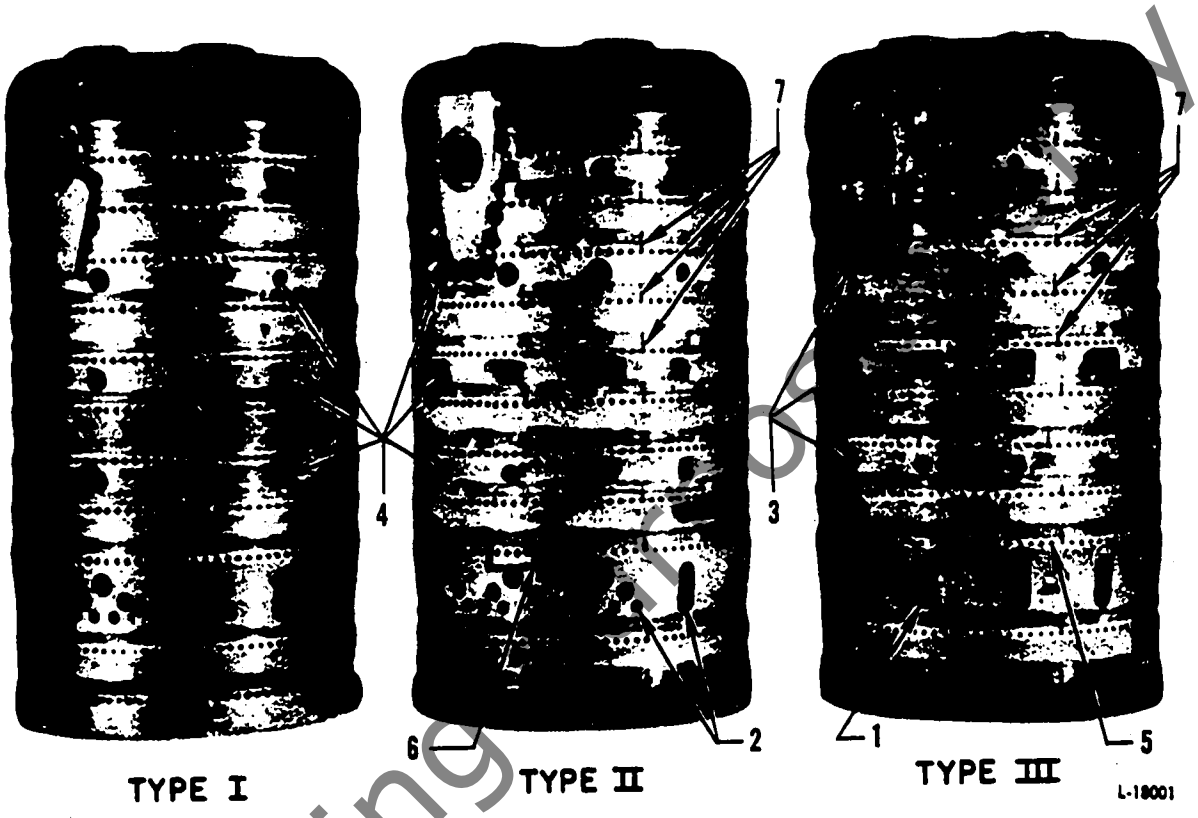
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Combustion Chamber (Louver Cooled Swirl Cup)
Figure 623



1. P/N 698309 Baffle
2. Fuel Nozzle Swirl Cup
3. 90°
4. 45°
5. 90°
6. 0.045 To 0.080 Inch Within Of Nos. 3 And 5. 0.045 To 0.095 For Remainder.
7. No Weld Expulsion In Holes.
8. Reference Surface
9. This Surface Must Not Overlap Edges Of Surrounding Holes. See No. 8.

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Type II and Type I

2. Combination of combustion air slots and holes. Note that early Type I (Not Illustrated) has slots only but slots are narrow.

4. Combustion holes in any one liner are of different diameters around chamber.

6. In any one liner, Nos. 1 thru 9, two groups of cooling air holes are slightly larger in diameter.

7. Seam weld interruptions only in later Type II and not in Type I.

Type III

1. Slots only. Note that slots are wider than those in Type II and Type I.

3. Holes same diameter in any one liner.

5. Holes same diameter in any one liner.

7. Seam weld interruptions in all Type III.

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(b) Type II - Change from Inconel to Hastelloy material for increased durability was made gradually, starting with 453043 - 453046 series which incorporated at manufacture a full outer liner assembly of Hastelloy material. Latest of Type II chambers, P/N 490488 - 490491, Change letter K and subsequent, are all Hastelloy.

(c) Type III - Though physically interchangeable with Type I and Type II chambers, these chambers are definitely not functionally interchangeable due to entirely different pattern and size of combustion and cooling air holes in both inner and outer liner assemblies. Type III chambers are used in all JT3D-3B engines and only in those JT3D-1, JT3D-3, JT3D-1-MC6, and JT3D-1-MC7 engines which are in compliance with Service Bulletin Nos. 609 and 765.

(2) Following major features are used to distinguish between Type III chambers and those in combined Type II/Type I category:

(a) Combustion holes in No. 9 outer liner.

Type III chambers have slots only, completely around chamber. Type II/Type I chambers have a combination of slots and holes. Note that slots are wider in Type III chambers than in Type II/Type I. Very early Type I chambers had slots only, however, slots in early Type I chambers were of narrow variety and early Type I chambers had no seam weld interruptions.

(b) Combustion holes in Nos. 3, 5 and 7 outer liners.

In Type III chambers holes in any one liner are same diameter completely around chamber. In Type II/Type I chambers holes in any one liner are of different diameters.

(c) Cooling air holes in Nos. 1 through 9 outer liners.

In Type III chambers holes in any one liner are of same diameter. In Type II/Type I chambers there are a few cooling air holes at two places in each liner which are slightly larger than the others.

(3) Inner liners.

(a) Index No. 1 of Figure 618, illustrates the later slotless trailing edge inner liner, a design which will alleviate the conditions illustrated by Index Nos. 2, 3, and 4. Inner liner assemblies may be found with any number of slotless type individual liners interspersed among earlier slotted type. Inspection limits are the same for both slotted and slotless type liners and liner assemblies.

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ENGINE - INSPECTION/CHECK

5. Combustion Chamber Outer Case

A. Combustion Chamber Outer Case-to-Diffuser Case Flange Air Leakage Check.

(1) Minor air leakage during engine operation at flange between diffuser case and combustion chamber outer case is acceptable. Heavy, concentrated leakage probably indicates severe warpage or damage to flanges and should be investigated by disassembly sufficient to determine condition of flange. Air leakage can be determined by passing a cloth along flange.

CAUTION: MARKING IS NOT PERMITTED ON COMBUSTION CHAMBER OUTER CASE EXCEPT AT OD OF FRONT FLANGE.

(a) Inspect scallops in forward OD flange contacted by combustion chamber positioning lugs. Cases with scallops having hardface inlay worn 0.010 inch or more are unacceptable for further service until repaired.

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ENGINE - INSPECTION/CHECK

6. Combustion Chamber Outlet Duct

A. Anti-Rotation lug (P/N 570721)

(1) Inspect anti-rotation lug on outlet duct configuration incorporating louvered outer wall for bending and indications that outer wall has shifted in relation to diaphram of duct. Bent lug may be repaired in accordance with Section 72-0, Approved Repair.

7. Turbine Nozzle Outer Case

CAUTION: BECAUSE OF LIMITED SUCCESS AND RELIABILITY EXPERIENCED WITH THIS INSPECTION METHOD, IT IS URGED CAUTION BE USED IN ACTUAL OR CONTEMPLATED USE FOR FOLLOWING REASONS:

(1) INABILITY TO ACCURATELY CALIBRATE INSTRUMENTS DUE TO NON-AVAILABILITY OF CALIBRATION TOOL.

(2) PROBABLE "GRASSY" SIGNAL PRESENTATION DUE TO METALLURGIACAL CHANGES IN CASE MATERIAL RESULTING FROM SERVICE USAGE OR OXIDE/CONTAMINATION BUILDUP ON CASE EXTERNAL SURFACES.

(3) HIGH LEVEL OF OPERATOR SKILL REQUIRED TO CONDUCT INSPECTION.

A. Positioning Lugs (Third And Fourth Stages)

(1) Air seal and vane shroud positioning lugs may be inspected for cracks or missing pieces, without engine disassembly, by ultrasonic method if desired.

(2) Ultrasonic equipment, or equivalent, required:

NOTE: The names of companies provided below as a possible source for the required equipment is furnished for information purposes only. Pratt & Whitney Aircraft does not endorse equipment procured from these companies. Further, Pratt & Whitney Aircraft does not accept responsibility to any degree for the selection of such companies as a source of supply.

(a) Ultrasonic test unit, Branson 301.

(b) Search unit, Automation Industries type SMZ 5.0 MHz, 0.250 x 0.250 45°S or type SFZ 5.0 MHz 0.250 with special plexiglass guide.

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(c) Cable with UHF to transducer michrodot connectors.

(3) Other equipment required:

(a) PWA 30973 Template, third stage.

(b) PWA 30974 Template, fourth stage.

(c) Special slotted template, third stage.

(d) Special slotted template, fourth stage.

(e) Test sample containing both good and cracked lug.

(4) Ultrasonic test equipment calibration

NOTE: Refer to applicable operating instructions for specific ultrasonic equipment being used.

(a) If type SFZ (straight longitudinal) search unit (transducer) is to be used, couple with special plexiglass guide to establish proper angle of tranducer, using oil to couple unit to guide.

(b) Couple transducer to test piece aligning with undamaged lug of stage to be inspected.

NOTE: Location of transducer to lug is critical and its axial distance from reference flange should be noted when established to adjust PWA 30973 and 30974 Templates. See Figure 626.

(c) Calibrate instrument so that pip return representing rear surface of lug lip appears slightly to left of center on screen while recessed lug surface appears on far left of screen.

NOTE: Calibration must be made with a known cracked turbine nozzle case.

(d) Move transducer circumferentially over case toward adjacent lug, stopping between lugs. Observe new pip appear on screen right of center.

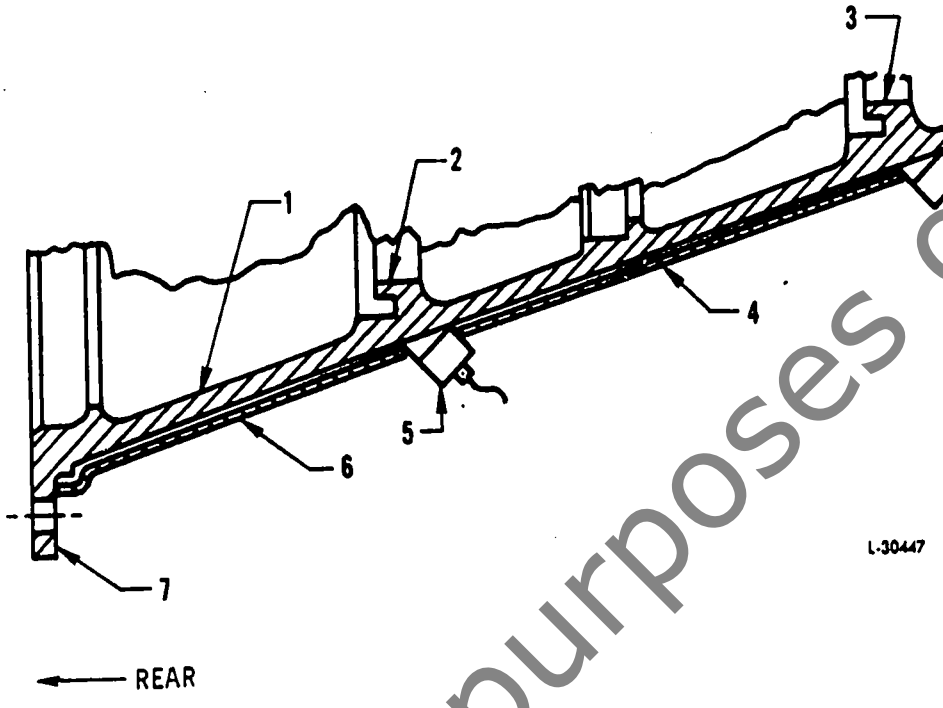
NOTE: With transducer properly positioned over lug, pip patterns may be moved to any position of screen by adjusting material calibrate knob. Assure they appear as described in substeps (a) through (d). See Figure 627.

(e) Continue moving transducer to cracked lug and observe pip for lug lip rear face disappear while traversing crack.

NOTE: Loss of pip from screen where lug lip rear face should be indicates sound energy is not reaching that surface, being interupted by either a cracked or broken lug lip. See Figure 627.

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ENGINE - INSPECTION/CHECK

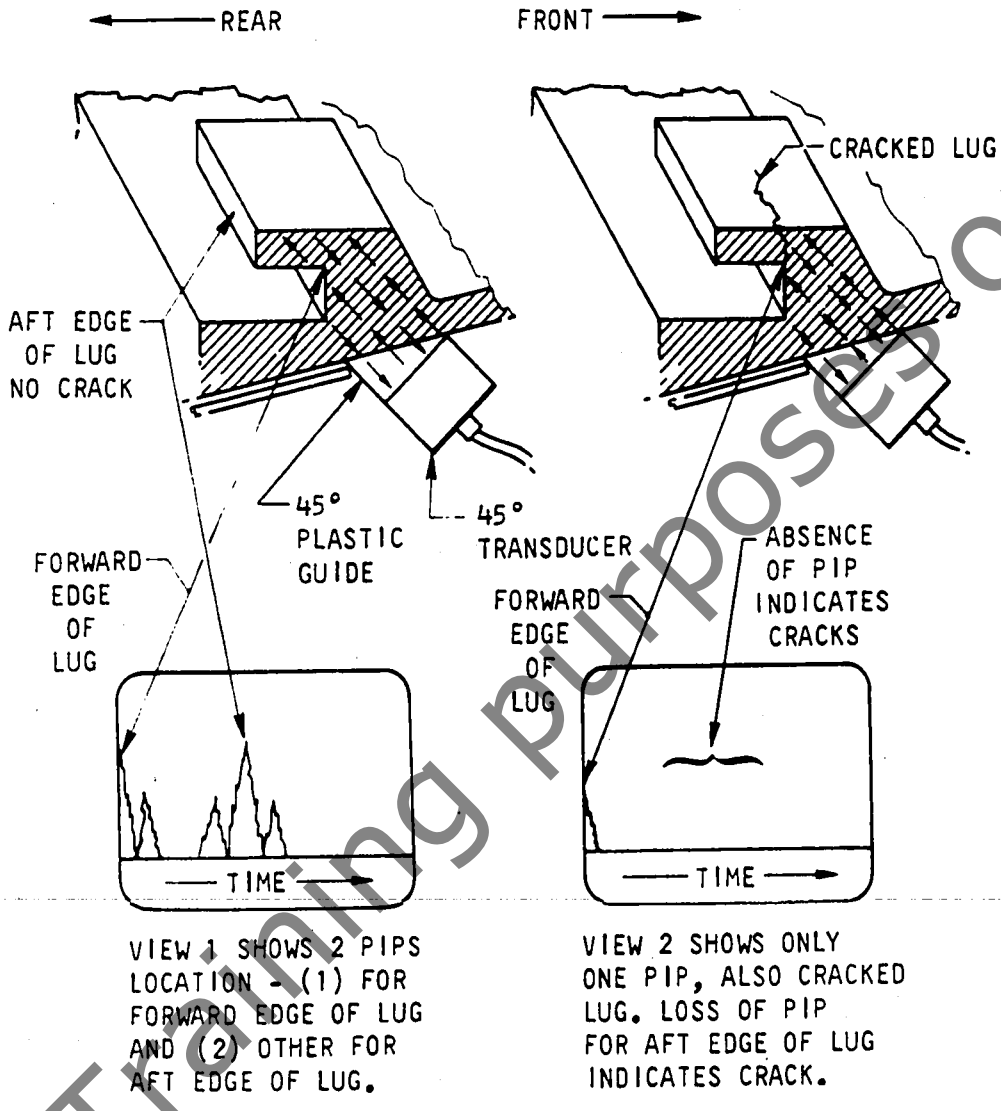


1. Turbine Nozzle Case
2. Fourth Stage Lug.
3. Third Stage Lug.
4. Template For Third Stage Lug Here
5. Transducer
6. Template For Fourth Stage Lug Here
7. Forward Surface of Turbine Nozzle Case.

Turbine Nozzle Case - Ultrasonic Test Template Locations
(3rd and 4th Stages)
Figure 626

For Training purposes only

ENGINE - INSPECTION/CHECK



Ultrasonic Inspection of 3rd and 4th Stage Turbine Nozzle Case Lugs
Figure 627

For Training purposes only

(f) Move transducer again over good lug, translating back and forth, noting pip patterns previously described to establish extremities of lug. Measure this distance on nozzle case to establish dimension of a slot to be cut in locally fabricated template (equipment item 3c and 3d). Template slot will represent lug width.

(5) Lug inspection procedure.

(a) Remove scale and other foreign matter from exterior of turbine nozzle case in area to be inspected.

NOTE: It is important that case surface be sufficiently clean to allow positive coupling of transducer with case metal.

(b) Affix appropriate PWA template (third or fourth stage) on nozzle case which will serve as axial locating guide for transducer.

(c) Couple transducer (with plexiglass guide if applicable) to case, using sutiable couplant.

(d) Move transducer circumferentially over case area to be inspected noting pip patterns.

(e) Identify lug lip rear face, recessed lug face, vane positioning pin hole area, and slot between lugs.

NOTE: Slight adjustments of equipment may be necessary to properly position pips (see calibration) due to tolerence differences. Axial positioning templates may also require adjustment.

(f) Using slotted template (equipment item 3c or 3d) scan each lug with transducer over its entire width.

(g) Except for vane pin area, about 0.250 inch, continuous and consistant pip pattern should appear for each lug traversed. If pip for lug lip rear face does not appear or disappears while traversing a lug (pin area excepted), a cracked or broken lug is indicated.

NOTE: Some nozzle cases will show indication of two vane pin recesses per lug, third stage only. This is due to pin relocation and if consistant in their relative lug, location shall be considered satisfactory.

(h) Note findings and locations of suspect lugs, if any.

(i) Upon completion of lug inspection, clean couplant from case.

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ENGINE - INSPECTION/CHECK

B. Third Stage Turbine Nozzle Vane Retention Lugs - On Wing Radiographic Inspection

See Figures 627A, 627B, and 627C.

(1) Equipment Required

(a) Radiation Source - Iridium-192 such as Technical Operation, Inc., Burlington, Mass. Model A-424-1 (capsule diameter 0.250 inches, 100 curie source dimension 0.100 inch diameter x 0.100 inches long).

(b) Source Positioning Tube

1 Obtain a radiation source positioning tube by any one of following methods:

a Locally fabricate a capped source positioning tube to accept an Iridium-192 source. Source positioning tube length should be approximately 116 inches. Diameter of section of source positioning tube (26 inches) that is passed into turbine shaft bearing oil pressure tube and heatshield assembly (bazooka) stiffener holes must be less than 0.490 inches. In order to clear internal structure, diameter of remaining length (90 inches) must be two inches or less.

b Procure a capped source positioning tube such as Technical Operations Model 583 (80 inch) source switch assembly and modify by addition of about 36 inches of 2 inch or less diameter pipe to compressor end of positioning tube.

c Procure a capped source positioning tube such as Technical Operations Model 727 (with a total 3-section length of 120 inches) commercially used on JT3D engines.

2 Locally fabricate tooling necessary to support compressor end of source positioning tube.

(c) Gamma Ray Projector

1 Obtain following gamma-ray projector equipment or equivalent:

a Technical Operations Model 529 - Gamma Ray Projector Control

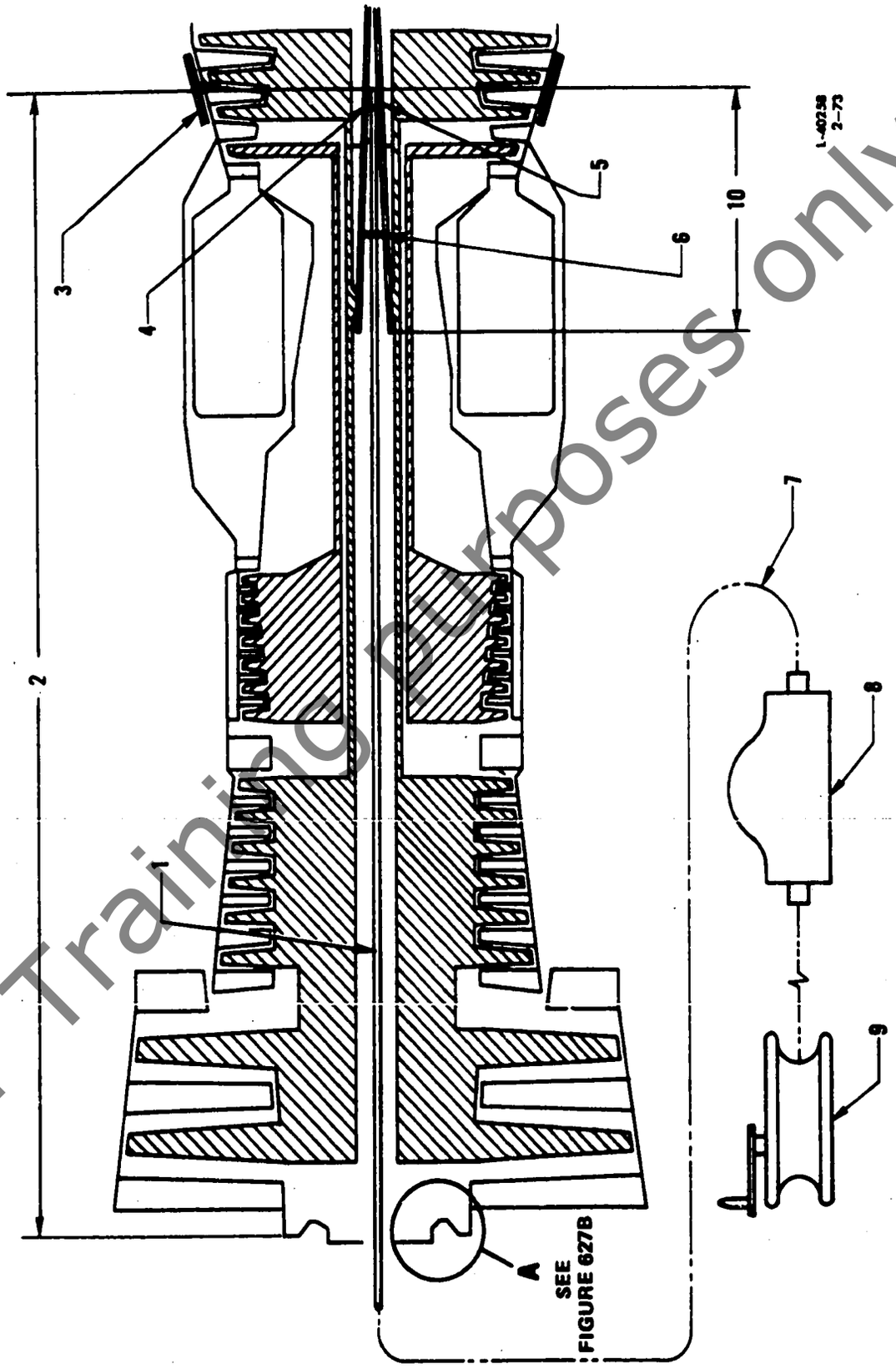
b Technical Operations Model 533 - Shielded Container

c Technical Operations Flexible Source Guide Tube

(d) Film - such as Kodak Type "M" or equivalent.

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ENGINE - INSPECTION/CHECK



Isotope Inspection of Third Stage Turbine
Nozzle Case Vane Retention Lugs
Figure 627A

For Training Purposes only

ENGINE - INSPECTION/CHECK

1. Capped Source Positioning Tube (Source Travels Inside)
2. Source Position As Determined From Figure 627B.
3. Kodak Type M Film or Equivalent (7 x 17 Inches), 7 Sheets Per Stage
4. Iridium - 192 Source
5. Cap
6. 0.490 To 0.510 Inch Diameter Hole In Turbine Shaft Bearing Oil Pressure Tube And Heatshield Assembly (Bazooka).
7. Flexible Guide Tube
8. Shielded Container
9. Gamma Ray Projector Control
10. Approximately 24.320 ± 0.250 Inches

Key To Figure 627A

(2) Radiography Procedure

(a) Move aircraft to remote area that affords protection from radioactivity.

WARNING: ISOTOPE RADIOGRAPHY MUST BE PERFORMED BY QUALIFIED PERSONNEL, AND ALL APPROPRIATE SAFETY PRECAUTIONS MUST BE OBSERVED.

(b) Remove compressor inlet cone assembly, front accessory drive cover, and main front accessory drivegear in accordance with 72-00, Dismantling/Assembly.

(c) Insert source positioning tube into engine core for a distance as selected from Figure 627B or 24.300 ±0.250 inches aft of bazooka tube forward face. See Figures 627A and 627B.

NOTE: Insertion dimensions are for reference only. It is suggested that trial X-rays be made to determine best position for radiograph definition. Mark tube for future reference.

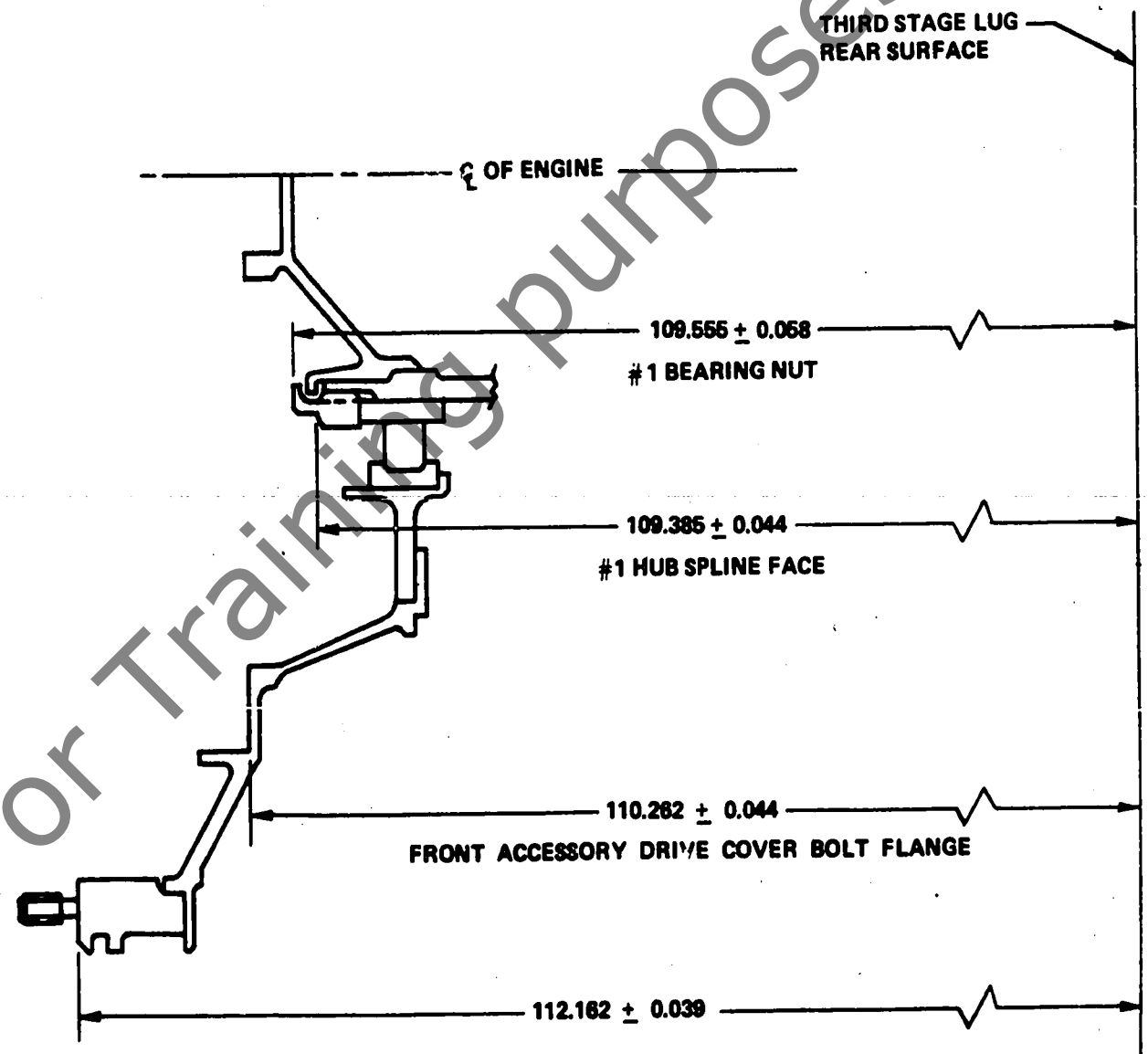
For Training purposes only

ENGINE - INSPECTION/CHECK

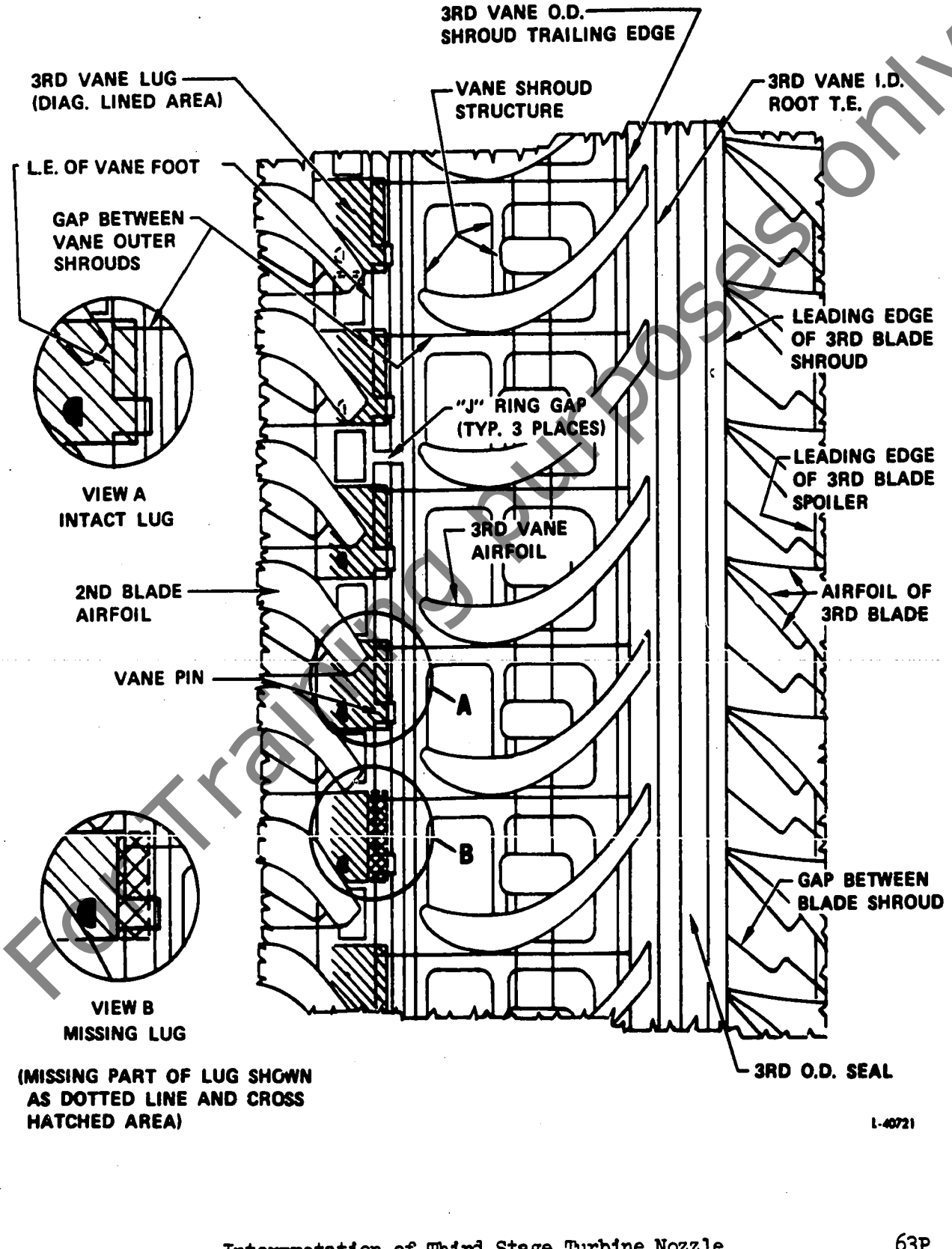
(d) Tape seven films, 7 x 17 inches, end to end around circumference of turbine nozzle case with rear edge of film in contact with forward face of "L" flange. Place 5 mil lead screens in front and back of film. Number films one through seven, clockwise from rear, starting at twelve o'clock position. Place numbers one inch aft of hinge of film holder. Mark engine number on No. 1 film.

(e) Using projector equipment, position Iridium-192 source fully into source positioning tube.

NOTE: If source positioning tube without source switch is used third light, labeled "ON", on gamma ray projector control will not operate.



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Interpretation of Third Stage Turbine Nozzle Case Vane Retention Lug Radiograph
Figure 627C

(f) Expose film as follows for type of film being used:

NOTE: Exposure times based on operator supplied information except as noted.

RADIOGRAPHIC EXPOSURE INFORMATION

FILM TYPE	RELATIVE SPEED	EXPOSURE CURIE-MINUTES
Kodak Type "M"	35	240
Kodak (Great Britain) Industrix "D"	520*	130
Dupont 75	12	114
Kodak Type "AA"	100	160**

*Approximate relative to AA per Kodak
**Estimated

TABLE I

(g) Develop film per manufacturer's recommendations.

(3) Radiograph Interpretation

(a) Evaluate radiograph film as follows:

1 Using Figure 627C as a guideline, identify on radiograph, following structure and part images.

a 3rd vane airfoil.

b 3rd vane foot leading edge line - directly rearward of 2nd stage blade trailing edge.

c 3rd vane pin.

d Line representing spacing between 3rd vane outer shrouds or vane shroud gap line - dark line perpendicular to vane foot leading edge line just below convex side of 3rd vane airfoil.

2 Turbine nozzle case vane retention lugs are spaced vertically between trailing edge of 2nd stage blades and leading edge of 3rd vanes, one for each vane. As illustrated in two circular "blow-ups" in Figure 627C, lug area is shaded with diagonal lines. Portion of lug which breaks is shown by cross-hatched lines.

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3 If lug is intact, its upper and lower image lines will cross over and continue aft of vane foot leading edge image line for approximately one-half depth of vane foot pin image. Lug rear edge image line, connecting upper and lower lug image lines, will be parallel to vane foot leading edge image line, running vertically through vane foot pin image. These lines are shown as dotted lines in missing lug "blow-up."

4 If lug is missing, vane foot leading edge line image will be defined sharper than when lug is present. Amount of improved definition of vane foot leading edge line will be equivalent in definition to foot leading edge image line between lug area.

5 It is also noted in interpreting radiographs that a small, approximately 1/8 inch long, dark image will show up three times, in a full set of seven radiographs, in lug area. These images are caused by gaps between 3 segments of "J" ring, P/N 513539, positioned directly inboard of retention lugs.

(4) Resultant Action

(a) Remove nozzle cases that show evidence of one (1) or more broken third stage turbine nozzle vane retention lugs for visual confirmation and corrective action.

NOTE: This procedure may not lend itself to detection of cracked lugs.

8. Turbine Vanes - Inspection Procedures

A. Disruptions in the chromalized surfaces of the 1st stage vane are not cause for rejection. Vanes having nicks or dents should be replaced. Visually inspect vanes for signs of bowing. Replace vanes which are bowed in excess of 0.075 inch on the trailing edge with vanes of the same classification. A straight edge and feeler gage stock shall be used to measure bowing. Any or all vanes may be replaced with vanes of the same class without measuring the nozzle guide vane area.

B. First Stage Nozzle Vanes Cracks - Trailing Edge

(1) First stage turbine guide vanes exhibiting cracks in trailing edge may be continued in service provided:

(a) Cracks do not exceed 0.400 inch in length.

(b) Cracks are separated by a minimum of 1.000 inch.

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ENGINE - INSPECTION/CHECK

(c) Cracks are not within 0.500 inch of fillet area of OD and ID buttresses.

NOTE: Cracks in trailing edge only, exceeding 0.400 inch but less than 0.500 inch may remain in service for 200 hours maximum.

C. First Stage Turbine Nozzle Vanes Bow Detection - On The Wing Radiography Inspection (JT3D-3B Engines).

NOTE: Inspect all engines which show performance deterioration as determined by flight log monitoring.

(1) Move aircraft to remote area that affords protection from radioactivity.

WARNING: ISOTOPE RADIOGRAPHY MUST BE PERFORMED BY QUALIFIED PERSONNEL, AND ALL APPROPRIATE SAFETY PRECAUTIONS MUST BE OBSERVED.

(2) Remove front accessory drive support and front accessory drive main gear in accordance with 72-00 Disassembly.

(3) Locally fabricate a tube to accept Iridium-192, type 100C source to fit through 0.490 inch diameter hole in turbine shaft bearing oil pressure tube and heatshield assembly. See Figure 628. Insert a cap in inner end of tube to provide locating stop for source when it is in position. Mark tube 107.125 inches from capped end for reference on depth of insertion.

(4) Locally fabricate tooling necessary to support tube in position.

(5) Place film, Kodak type "M" 7x17 inches, around front of turbine nozzle case. Butt film against aft side of "K" flange and attach to flange by hinge on film holder. See Figure 628.

NOTE: Equivalent type film may be used when exposures are adjusted to give same results.

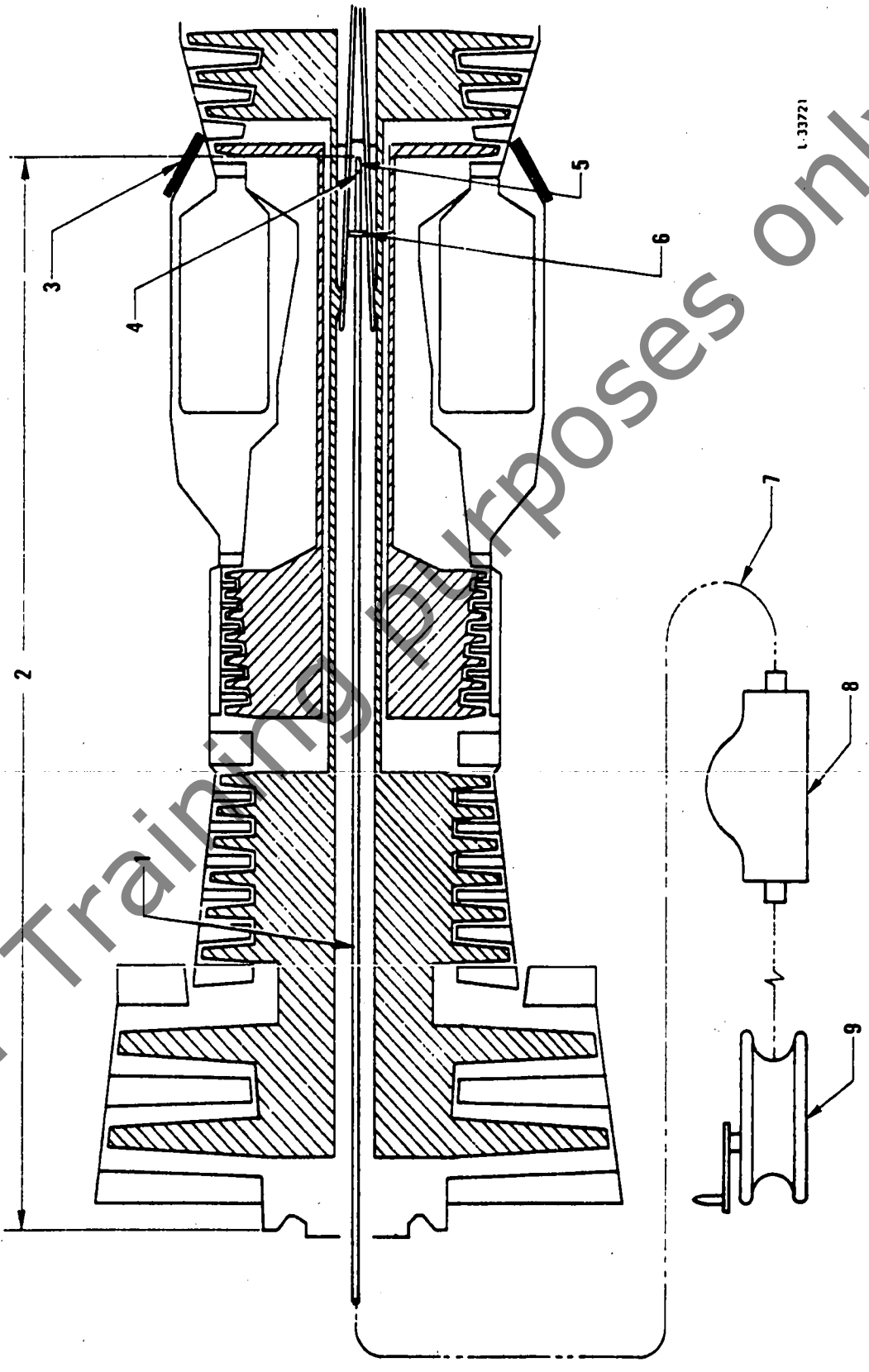
(a) Tape film to turbine nozzle case.

(b) Number films one through seven clockwise from rear starting at twelve o'clock position and placing numerals one inch aft of hinge of film holder. Mark engine number on No. 1 film.

(6) Crank source tube into core of engine until 107.125 inch mark on tube lines up with front face of compressor inlet cone support assembly.

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ENGINE - INSPECTION/CHECK



Isotope Inspection of First Stage
Turbine Nozzle Vanes (JT3D-3B)
Figure 628

For Training Purposes only

ENGINE - INSPECTION/CHECK

1. Capped Tube (Source Travels Inside)
2. 107.125 Inches
3. Kodak Type M Film (7 x 17 Inches), 7 Sheets.
4. Iridium-192 Source
5. Cap
6. 0.490 - 0.510 Inch Diameter Hole In Turbine Shaft Bearing Oil Pressure Tube And Heatshield Assembly.
7. Flexible Guide Tube
8. Shielded Container
9. Gamma Ray Projector Control

Key to Figure 628

(7) Obtain following gamma-ray projector equipment or equivalent.

(a) Technical Operations Model 529-Gamma Ray Projector Control.

(b) Technical Operations Model 533-Shielded Container.

(c) Flexible Guide Tube

NOTE: Technical Operations Inc., Burlington, Mass. have indicated they would be willing to furnish equipment required.

NOTE: Third light on control box is not used since source switch for this light cannot be used. Source switch will not pass through 0.490 inch diameter hole in turbine shafts bearing oil pressure tube and heatshield assembly.

(8) Using projector equipment crack source out and expose film for 875 curie/minutes.

NOTE: Curie/minutes are determined from actual exposure in minutes multiplied by power source - type 100C power rated at time of exposure.

(9) Develop film per manufacturers recommendations.

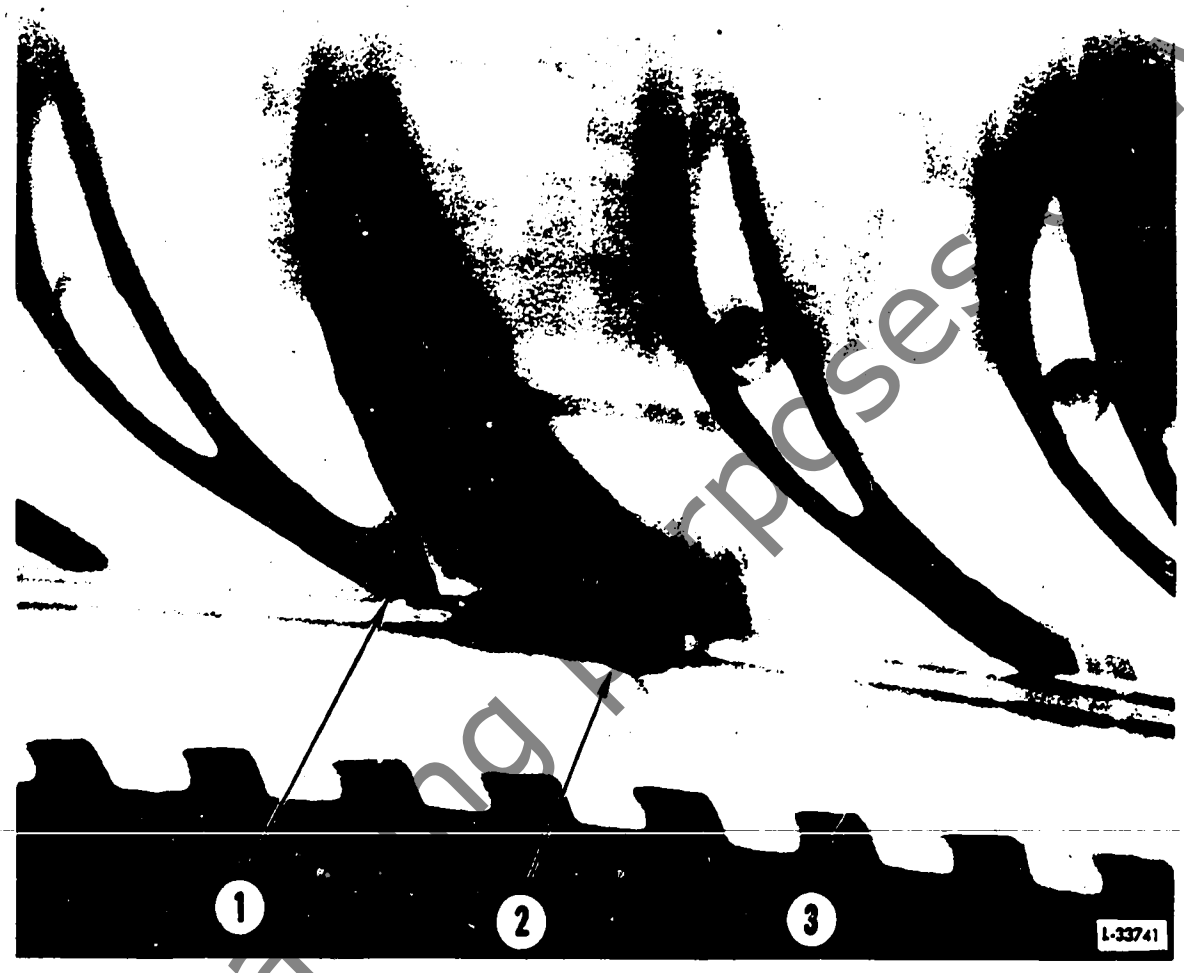
(10) Analyze first stage turbine blade turbine nozzle vane condition and relationship.

(11) Replace all vanes that show evidence of abnormal bow. See Figure 629 No. 2.

NOTE: Limits of abnormal bow will be determined by each operator, which can only be arrived at by experience and repeated isotope inspections. Magnification factor will vary due to location of maximum bow along trailing edge of vanes.

For Training purposes only

ENGINE - INSPECTION/CHECK



1. Trailing Edge Turbine Nozzle Vane
2. Bowed Turbine Nozzle Vane
3. Leading Edge Turbine Blade

First Stage Turbine Vane Bow (JT3D-3B)
Figure 629

For Training Purposes Only

ENGINE - INSPECTION/CHECK

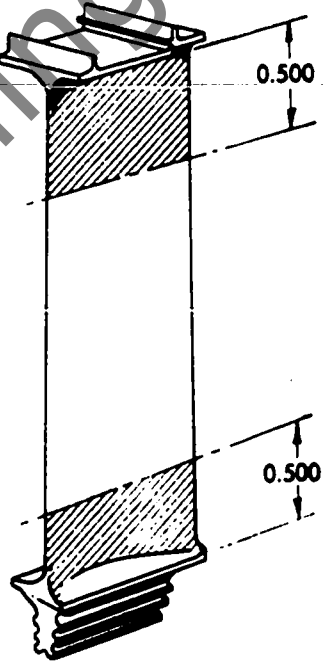
9. Turbine Blades - Inspection Procedure

A. Blades with nicks or dents in the airfoil within one-half inch of either the shroud or root platform (see Figure 630) can be blended if the damage is not detectable on the opposite side of the airfoil from which they were struck and the repair will not reduce the local airfoil thickness by more than 0.006 inch or chord length by more than 0.010 inch. Blades with nicks or dents in the airfoil (but not in the above areas) may be blended if the damage is not detetable on the opposite side of the airfoil from which they were struck, and the repair will not reduce the local airfoil thickness by more than 0.010 inch or the chord length by more than 0.020 inch. Any number of turbine blades may have axial play up to 0.015 inch at blade root and disk, providing the rivet heads are sound and undamaged.

B. Turbine Blade Inspection

(1) Inspect the first stage turbine blades for deformation of the leading edge as follows:

(a) With a strong spot light (150 watts minimum) inspect each turbine blade for waviness or deformation of the leading edge.



Turbine Blade Repair Limits
Figure 630

For Training purposes only

(b) Deformation due to overtemperature, may appear as a waviness and/or areas of varying airfoil thickness along the leading edge (see Figure 631). The leading edge must be straight and of uniform thickness.

NOTE: Do not confuse deformation of the leading edge with blending repairs to the blade. If confusion exists, check the blade for stretch.

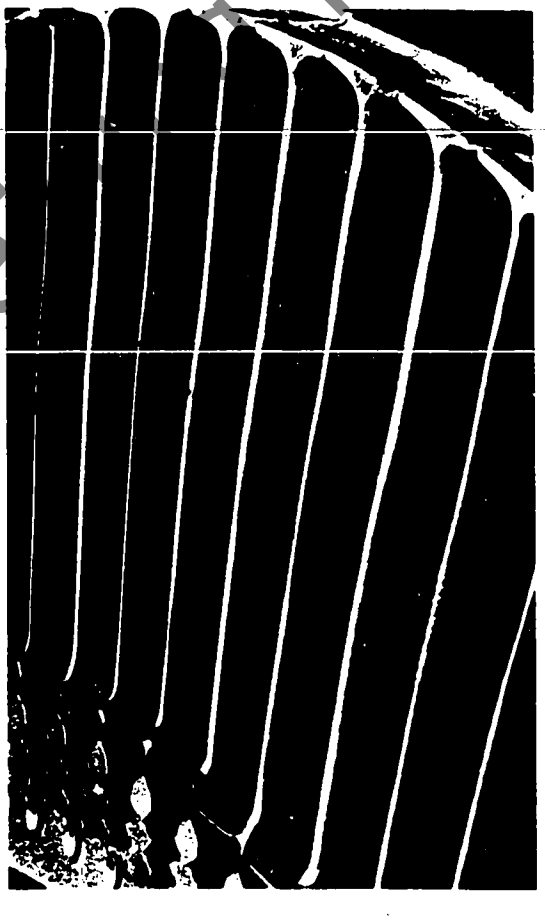
(c) Remove a segment of the first stage vanes to facilitate inspection of the blades.

(d) When any deformation of the leading edge of first stage turbine blades is found, an overtemperature conditon has occurred. Therefore, reject all the blades.

10. First Stage Turbine Blade Stretch

A. To check the first stage turbine blades for stretch, proceed as follows:

(1) Push back the combustion chamber outer cases and remove the combustion chambers. See 72-0, Approved Repair.



Turbine Blade Deformation
Figure 631

For Training purposes only

(2) Remove a segment of the 1st stage turbine vanes in the manner outlined in 72-0, Approved Repair.

(3) Insert appropriate gage detail through nozzle opening placing convex surface against machined step at root of blade. Gage details are as follows:

(a) For all blades except PN 516701 and PN 559101 use Detail 1 of PWA 16082 or PWA 30691 Stretch Gage having a length of 3.358 inches which is equivalent to 0.013 inch stretch. Length, 3.358 inches, is marked on gage. For these blades stretch limit is 0.013 inch.

(b) For PN 516701 blade use Detail 2 of PWA 31088 Gage having a length of 3.3515 inches which is equivalent to 0.0065 inch stretch. Length, 3.3515 inches, is marked on gage. For this blade stretch limit is 0.0065 inch.

(c) For PN 559101 blade use Detail 1 of PWA 31052 Stretch Gage having a length of 3.358 inches which is equivalent to 0.013 inch stretch. Length, 3.358 inches, is marked on gage. For this blade stretch limit is 0.013 inch.

NOTE: Stretch trend check may be made on PN 559101 blades in addition to stretch limit check, if desired. To accomplish check use PWA 31052 Gage, Detail 2. Detail 2 has a length of 3.3515 inches which is equivalent to 0.0065 inch stretch. Length 3.3515 inches, is marked on gage. PWA 31052 Detail 2 is used to check stretch trend only.

(4) Sweep other end of gage over blade shroud.

(5) Blade is excessively stregched if stretch limit gage interferes with blade shroud.

(6) Rotate high compressor drive turbine rotor to position blades to be measured.

NOTE: Due to removal of combustion chamber outer cases, difficulty may be experienced in turning rotor. This may be alleviated by supporting turbine nozzle case using PWA 17205 Supports (4) set 90 degrees apart.

B. Perform a stretch check on 1st stage blades when EGT exceeds established limit. If any blade exceeds maximum stretch limit entire turbine should receive overhaul inspection.

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11. Inspection of Engines Subjected to Overtemperature

A. Refer to 72-5-0, 500 page block

12. Inspection of Engines Subjected to Overspeeding

A. Refer to 72-5-0, 500 page block

For Training purposes only

ENGINE - INSPECTION/CHECK

13. Freedom of Rotation Check

A. The following procedure is intended to provide a freedom of rotation check in order to reduce the possibility of subsequent damage by foreign objects.

B. Prior to engine checkout, the high compressor must be rotated by turning the starter drive and the low compressor rotated manually by the first stage compressor blades.

CAUTION: THE ENGINE MUST BE TURNED IN THE NORMAL DIRECTION OF ROTATION ONLY (COUNTERCLOCKWISE WHEN FACING THE ENGINE INLET).

C. If there is any unusual resistance or unusual sound, an investigation must be made to determine the cause.

14. Front Compressor Case and Vane Assembly

A. First Stage Compressor Vane Spacer

(1) Cracked spacers may be continued in use until the crack extends completely across the spacer.

(2) Remove spacers which are cracked across entire spacers as follows:

(a) A maximum of six spacers may be removed.

(b) Do not remove two adjacent spacers or more than two spacers in same 90° quadrant.

B. Anti-Icing Air Ports

(1) Cracks in the area of anti-icing air ports up to two inches may be continued in service to the nearest repair facility.

(2) Weld repair cracks as soon as possible.

15. Inspection of Engines Shut Down in Flight

A. Inspect all engines which have windmilled as a result of shutdown in flight.

B. If there has been a continuous positive indication of oil pressure following shutdown, the engine may be continued in service after a satisfactory inspection of the main oil strainer following servicing of the engine and a ground run-up.

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ENGINE - INSPECTION/CHECK

C. An engine windmilling for 30 minutes or less with the oil supply interrupted (provided engine was operating at windmill speeds when oil was interrupted) may be continued in service after satisfactory inspection of main oil strainer, servicing, and ground run-up. Engines windmilling for more than 30 minutes under the same conditions shall be sent to overhaul for bearing inspection. Particular attention must be given to bearings No. 2, No.4, and No. 5.

NOTE: Operating conditions prior to and after interruption and windmilling should be accurately recorded to determine classification of windmills.

D. If oil supply was shut off or interrupted for more than 10 seconds at speeds in excess of windmilling or before engine decelerated to windmilling speed following engine shutdown, record conditions of operation and send the engine to overhaul for bearing inspection. Particular attention must be given to bearings No. 2, No. 4 and No. 5.

NOTE: Interrupted shall be zero oil pressure or flow.

CAUTION: ANY POWER ON OPERATION AT OR ABOVE IDLE WITH ZERO OIL PRESSURE SHALL REQUIRE THAT THE ENGINE BE SENT TO OVERHAUL FOR BEARING INSPECTION.

(1) Bearing cages must not show excessive wear.

(2) There must be no evidence of ball or roller skidding.

(3) There must be no evidence of adverse effects due to overheating as indicated by color, general appearance, and hardness.

(4) Satisfactory bearings may be continued in use otherwise they must be replacec.

16. No. 6 Bearing Support Rod

(1) If for any reason one or more No. 6 bearing support rods are broken an overhaul type inspection of the front compressor drive turbine shaft shall be made.

17. Limits of Acceptability for Diffuser Case

A. Cracks at the weld junction between struts and diffuser case outer skin may be repaired without disassembling engine provided following limits are met.

(1) Cracks must not exceed three inches.

(2) Not more than one crack is permitted at each of seven strut locations. No crack or repair is permitted at gearbox tower shaft strut.

For Training purposes only

(3) No crack may be repaired more than once. If a crack repair weld developes a crack, repair must be made at overhaul.

CAUTION: PROPER STRESS RELIEF, AS GIVEN IS VERY IMPORTANT.

(4) Weld repairs for cracks over two inches in length must be locally stress relieved at 1015°F ± 15°F (546°C ± 8°C) for a minimum of one hour using either a quartz lamp or a resistance blanket. Stress relieved area must overlap and extend three inches in all directions from crack.

B. Water Injection Bosses

(1) Cracks around water injection bosses may be repaired.

CAUTION: USE SMALL DIAMETER WELD ROD TO REDUCE HEAT AND MINIMIZE DISTORTION.

(2) Stress relieve in accordance with step A. (4) if crack in pad weld is over two inches in length or if crack extends into case parent material.

C. Diffuser Case Inner Mount Lug Bushing (P/N 524323)

(1) If outer face of flange on bushing shows a wear step of 0.002 inch or more, replace bushing and mating fuel manifold inner mount bushing. (See Section 73-5-1, Inspection/Check for replacement of fuel manifold bushing.)

D. Fuel Manifold Lock (P/N 524325)

(1) If fuel manifold lock shows a 0.002 inch or more wear step, replace it and mating fuel manifold inner mount bushing. (See Section 73-5-1, Inspection/Check for replacement of fuel manifold bushing.)

18. Periodic Inspection of Installed First Stage Fan Spacer.

(1) P/N 431119 spacer assembly must be inspected at successive 600 hour intervals (625 hours maximum) using either fan spacerscope or ultrasonics for life of part.

(2) P/N 431119 spacer assembly reoperated and reidentified to P/N 522094 in accordance with SB 747 must be given two successive inspections at 600 hour intervals (625 hours maximum) using ultrasonics. If no cracks are found, it will not be necessary to accomplish the next (installed) inspection until 1,200 hours later. If no cracks are found at this inspection, no further (installed) inspection between overhauls will be required for life of spacer.

NOTE: If a one hundred percent ultrasonics bench inspection in accordance with overhaul manual was accomplished on P/N 522094 spacer assembly after reoperation, no periodic (installed) inspections are required between overhaul.

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ENGINE - INSPECTION/CHECK

19. Tubes

A. Inspect all engine tubing, except where special instructions apply, for the following:

(1) Scratches

(a) Minor scratches having no appreciable depth are acceptable. A scratch, obviously produced by a cutting medium not greater than 0.003 inch deep shall be acceptable. Scratches to a maximum depth of 0.005 inch should be blended out.

(2) Nicks and Chafing

(a) Nicks and chafing are acceptable after blending provided three-quarters of the wall thickness remains. Each blended area must not exceed one half square inch.

(3) Dents

(a) All dents without sharp edges or corners are acceptable provided there is no flow restriction.

(b) No dents are permissible within 1/4 inch of ferrule.

(4) Pitting

(a) Minor isolated pitting is allowable providing pitting is not greater than 0.003 inch deep. Clusters of pitting should be blended out to a maximum of 0.005 inch deep.

(5) Corrosion

(a) Rust and stain shall be acceptable if removable by light polishing with crocus cloth.

20. Turbine Exhaust Fairing Bushing Wear

See Figure 632.

A. Wear Limits

(1) Maximum acceptable wear is 0.015 inch on OD.

(2) Reject any parts worn over maximum amount.

(3) Replace bushings in accordance with Overhaul Manual Section 72-54-2, Repair.

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ENGINE - INSPECTION/CHECK

21. No. 6 Bearing Oil Tube Heatshield Or Exhaust Strut Guide Wear

See Figure 632.

A. Wear Limits

(1) Maximum acceptable wear is 0.015 inch on the OD.

(2) Repair in accordance with Overhaul Manual Section 72-54-17 or 18.

22. Fairing Bushing To No. 6 Bearing Oil Heatshield Or Exhaust Strut Guide Clearance

See Figures 632 and 633.

A. Wear Limits

(1) Maximum acceptable clearance between bushings and oil tube heatshield is 0.030 inch.

(2) Procedures for checking wear.

(a) Check relative movement between each vane on exhaust case by securing a dial indicator to exhaust case as shown in Figure 633.

(b) As on alternate to Step (a), measure relative movement trailing edge of turbine exhaust fairing. See Figure 632. Maximum acceptable movement at top of tail cone is 0.050 inch in the horizontal or vertical directions. This indicates a heatshield or guide clearance of approximately 0.030 inch.

23. Fireseal - Boeing Installation

A. Cracks In Fireseal

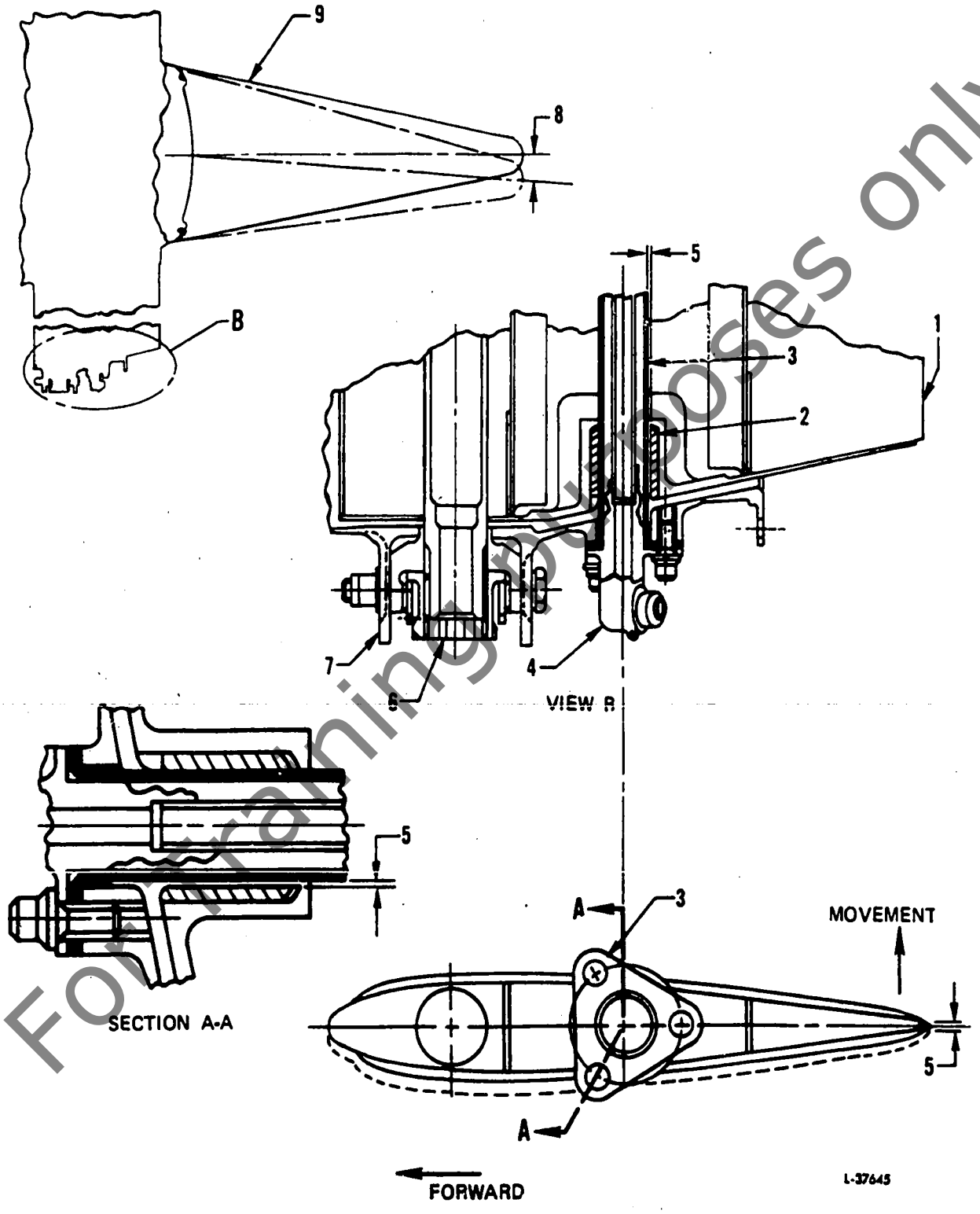
(1) Inspect lower fireseal assembly for circumferential cracking in six o'clock area, outboard of bolt circle. Cracks up to 15 inches in length are reparable. See Approved Repair. Parts with cracks in excess of 15 inches can be salvaged by repair in accordance with Overhaul Manual.

24. Numerical Tool List

PWA 16082 Gage	PWA 30458 Probe	PWA 30974 Template
PWA 17205 Support	PWA 30518 Probe	PWA 31052 Gage
PWA 30018 Gage	PWA 30691 Gage	PWA 31088 Gage
PWA 30455 Probe	PWA 30973 Template	

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ENGINE - INSPECTION/CHECK



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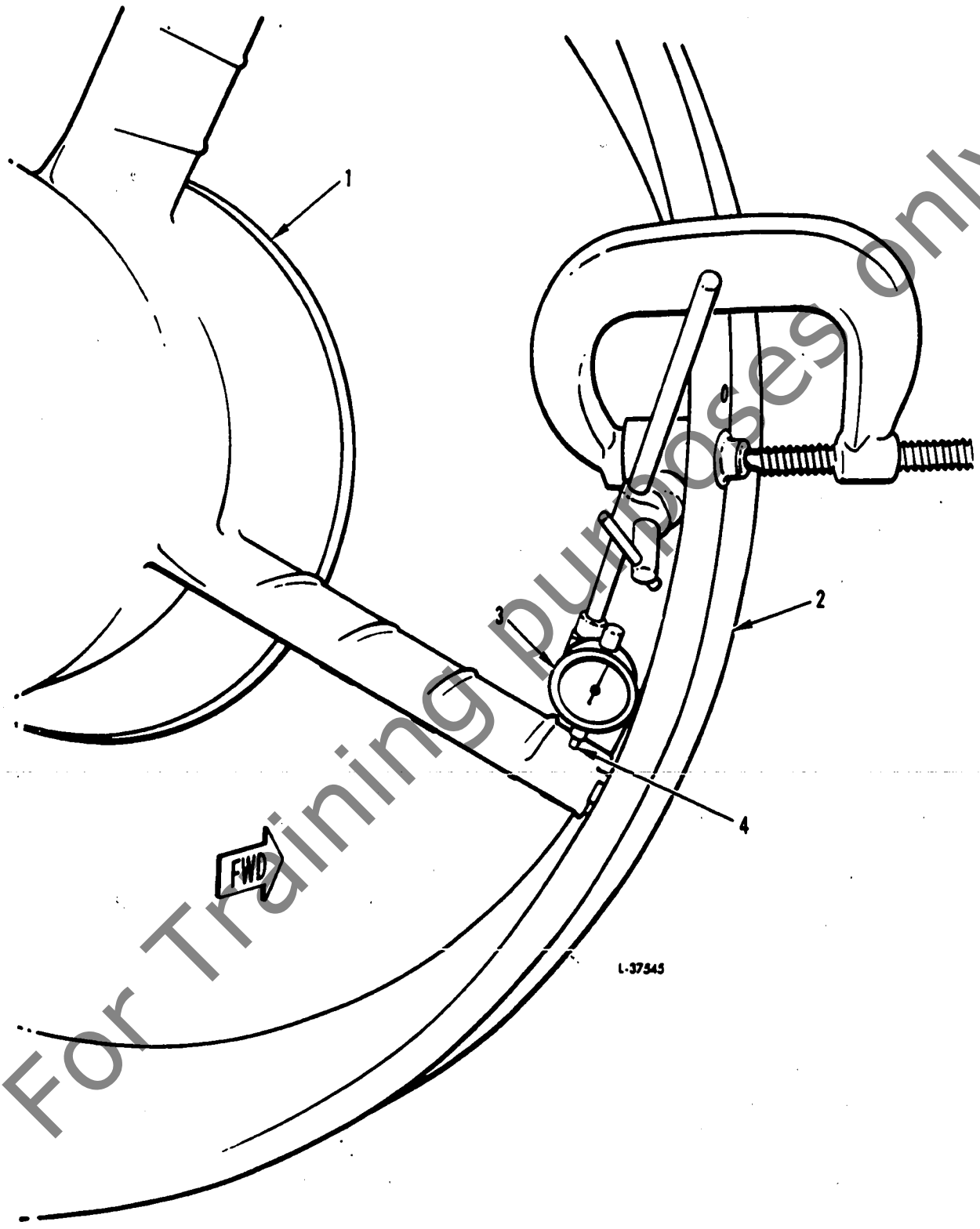
Turbine Exhaust Fairing Bushing Wear Check
Figure 632

ENGINE - INSPECTION/CHECK

1. Turbine Exhaust Fairing (Trailing Edge).
2. Bushing
3. No. 6 Bearing Tube Heatshield.
4. No. 6 Bearing Oil Scavenge Tube.
5. 0.030 Inch (Approx.) When Maximum Movement Is Reached (Typical Four Places).
6. No. 6 Bearing Support Rod.
7. Turbine Exhaust Case.
8. 0.050 Inch Maximum Acceptable Movement At Tip Of Tail Cone.
9. Tail Cone (Typical).

Key to Figure 632

For Training purposes only



1. Turbine Exhaust Fairing (Front).
2. Turbine Exhaust Case.
3. Dial Indicator.
4. Gage Contact Point At Centerline Of Fairing Bushing.

Turbine Exhaust Fairing Bushing Wear Check
Figure 633

For Training Purposes only

25. Gearbox Adapter Assembly, Sealing Surface and Mount Pin Bushing.

A. General

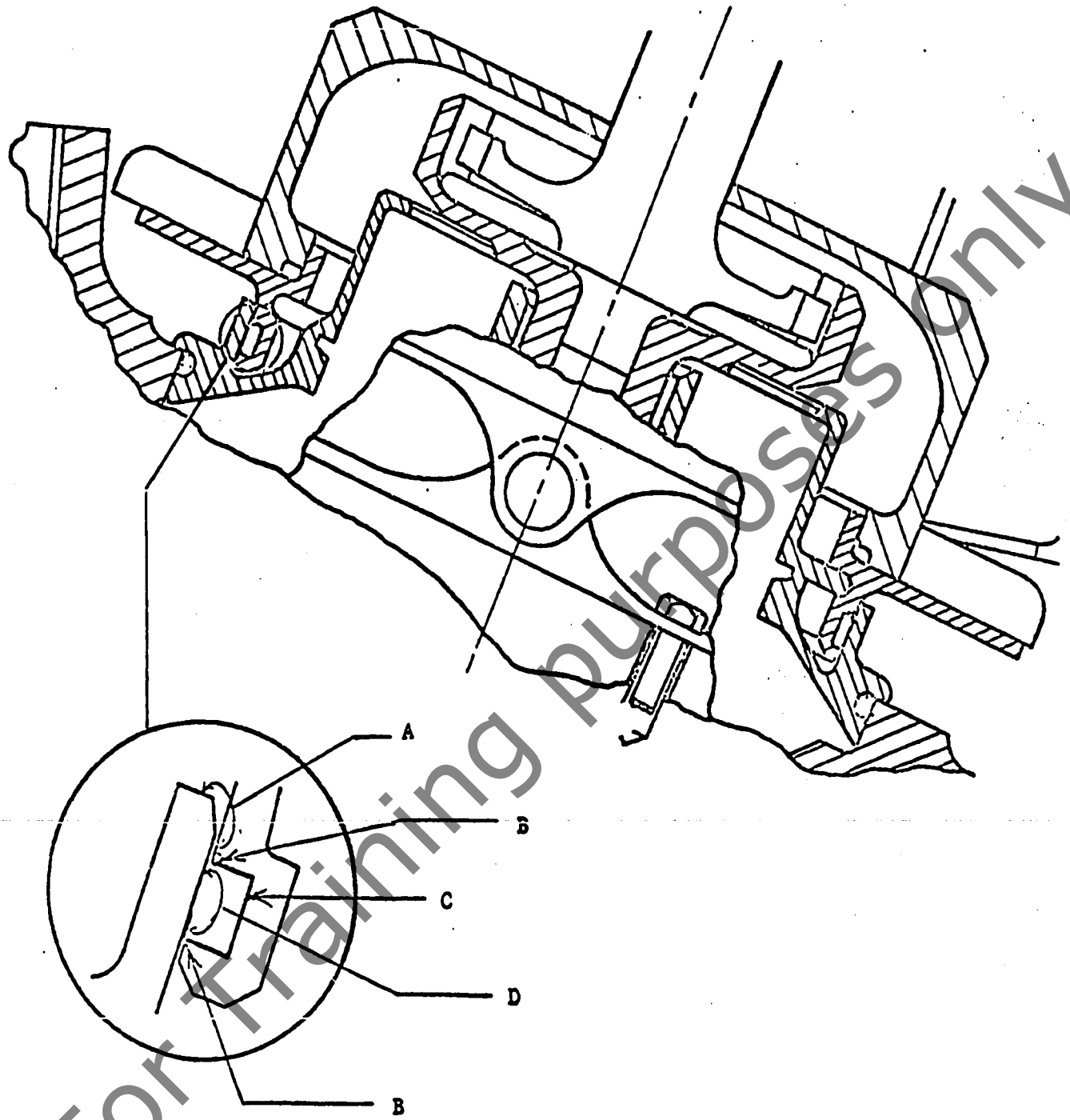
(1) Proper sealing between the gearbox adapter assembly halves is dependent upon maintaining the component parts in good condition. The two halves of this assembly are individually matched at overhaul and should not be intermixed.

(2) Inspect the gearbox mounted and diffuser case mounted halves of the gearbox adapter assembly for cleanliness and general condition. Check roller bearing for missing rollers, damaged cage, etc. Check ball bearing for roughness, binding or other evidence of damage.

(3) Inspect mounting pin bushings in both halves of the adapter assembly for wear. Measure the inner diameter of each bushing at the point of maximum and minimum diameters.

(4) Inspect the gearbox mounted half of the assembly sealing surface for condition. Inspect the diffuser case half of the assembly seal groove for condition. (Reference Figure 633A).

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A. Enclosed area to be smooth and free of nicks, dents and machine marks.
B. Edges to be clean smooth and free of nicks, dents and machine marks.
C. Seal groove must be clean and free of foreign material.
D. Point of seal contact must be clean, smooth and free of wear or damage. Fretting wear outside this area to a maximum depth of .005 inch is acceptable after blending with fine sandpaper to remove surface irregularities and polishing with crocus cloth to restore finish.

Gearbox Adapter Assembly, Sealing Surface and Mount Pin Bushing
Figure 633A

For Training Purposes Only

ENGINE CLEANING

CAUTION: DO NOT CLEAN ANY DIFFUSED NICKEL-CADMIUM PLATED SURFACE WITH AN ABRASIVE MATERIAL.

1. Main Oil Filter Housing

(1) Remove excessive oil by vapor degreasing.

(2) Immerse in carbon remover (cold type) for approximately one-half to one hour and repeat if necessary.

(3) Rinse in hot water.

(4) If necessary, clean by petroleum solvent spray.

2. Main Oil Filter Element Assembly

A. Main Oil Screens and Spacers

NOTE: Prior to cleaning, examine the screens and spacers for the presence of foreign matter which would indicate any unusual condition in the engine. Save the foreign matter and call it to the attention of proper personnel.

(1) Slide the screens and spacers on a suitable rod provided with stops to prevent the screens and spacers from sliding off during cleaning operations.

(2) Loosen the screens from the spacers by sliding the parts along the rod and immerse them for a few minutes in carbon remover (cold type).

(3) Rinse the parts in petroleum solvent and blow them dry with an air jet.

(4) Examine the parts for cleanliness and repeat the cleaning operations if necessary.

B. Main Oil Filter Cover and Oil Scavenge Pump Inlet Strainer

(1) Remove excessive oil by vapor degreasing.

(2) Immerse in carbon remover (cold type) for approximately one-half to one hour and repeat if necessary.

(3) Rinse in hot water.

(4) If necessary, clean by petroleum solvent spray.

3. Cleaning Flexible Tubes

(1) Remove all caps.

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(2) Clean the tubes by spraying with petroleum solvent, using a brush, if necessary.

(3) Drain the tubes thoroughly and remove all excess fluid with compressed air making absolutely certain no foreign material remains in the tubes.

(4) Reinstall caps.

4. Cleaning Steel Tubes

(1) Remove all caps.

(2) Clean steel tubes in accordance with the following procedure.

(a) Soak tube in cold carbon solvent (SPMC-9031, -9047, or -9084) for two hours at room temperature.

(b) Remove tube from solvent and pull a suitable size swab (or clean lint-free cloth) through inside of tube.

CAUTION: BE ABSOLUTELY SURE NO PART OF SWAB OR CLOTH REMAINS INSIDE AN OIL TUBE OR ELSE OIL FLOW CAN BE OBSTRUCTED.

(c) Rinse thoroughly with petroleum solvent (SPMC-9010) at room temperature.

(d) Air dry.

(3) Reinstall caps.

5. Procedure for Cleaning Engine Air Passages

A. General

(1) Field cleaning of the air passages is intended for use on engines displaying definite evidence of performance deterioration due to accumulation of foreign material deposits on compressor blading. Deterioration due to this cause may be detected by repeated necessity to increase high pressure rotor (N_2) speed in order to attain the necessary part power P_{t7} value. If after complying with the necessary procedures outlined in the test section and after field cleaning the engine, the N_2 speed is still over the maximum value, send the engine to overhaul.

B. Cleaning Agent

(1) The material approved by Pratt & Whitney Aircraft for use as the cleaning agent in the field cleaning process is "Carboblast-Jet Engine Type". "Carboblast" is manufactured by Turco Products Inc. It is important to note that there is a standard form of "Carboblast" which contains a sufficient amount of rock to be considered totally unacceptable.

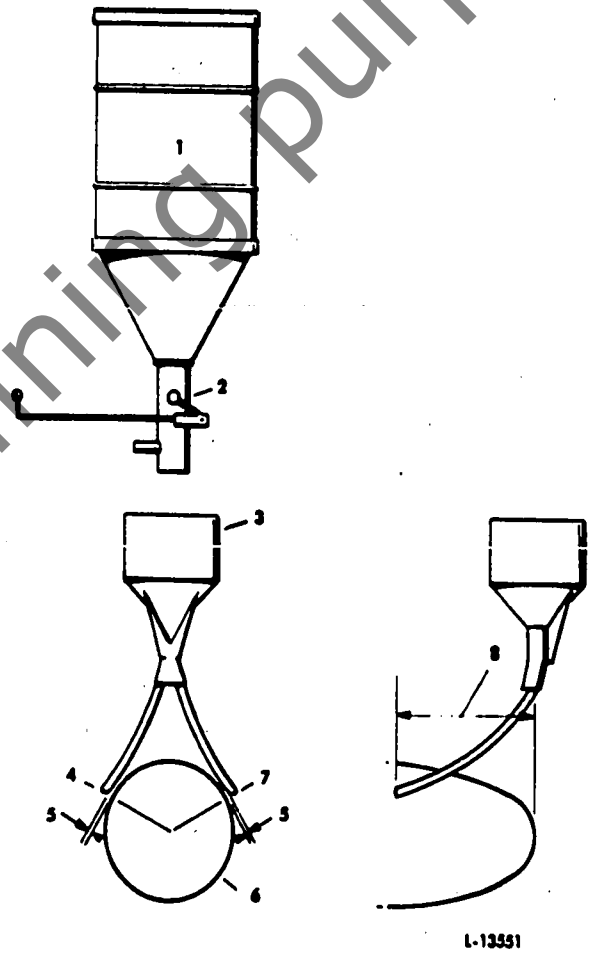
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ENGINE - CLEANING

CAUTION: IF THE CLEANING PROCEDURE IS DONE WITH THE ENGINE IN THE AIRFRAME, IT WILL BE NECESSARY TO REMOVE FROM THE AIR INLET DUCT OF THE AIRFRAME, ANY COOLERS AND INSTRUMENTATION WHICH MAY BE DAMAGED BY PASSAGE OF CLEANING MATERIAL.

C. Procedure

(1) Fabricate a drum of about 55 gallon capacity with a funnel outlet incorporating a sliding sheet metal valve, and a shut off valve. Attach a hopper, with two outlets of 3/4 inch tubing, to the drum with four lengths of chain. The complete equipment will then approximate the illustration shown in Figure 701. Position the equipment above and slightly forward of the engine inlet with the two hopper discharge tubes at the two and ten o'clock positions. Secure the discharge tubes to the inlet duct or to the screen if engine is on a test stand. The end of tubes must be as close as possible to the nose cone, not over 1/4 inch away, in order to keep carbo blast from going out fan discharge area.



1. Drum
2. Valve
3. Hopper
4. 10 O'clock
5. 1/4 Inch Maximum
6. Fairing
7. 2 O'clock
8. 12 to 14 Inches

Carbo-Blast Arrangement
Figure 701

For Training purposes only

ENGINE - CLEANING

CAUTION: ADJUST THE SLIDE VALVE TO PROVIDE A FLOW OF CLEANING MATERIAL NOT TO EXCEED THE MAXIMUM OF 100 POUNDS IN 15 MINUTES. PERSONNEL USING THIS PROCEDURE SHALL BE CAUTIONED AGAINST INCREASING THE INJECTION RATE OF THE MATERIAL, SINCE AN INCREASED RATE MAY RESULT IN A CONCENTRATION OF THE MATERIAL IN CONFINED AREAS OF THE ENGINE, WHERE A FIRE, WHICH MIGHT CONCEIVABLY DAMAGE ENGINE PARTS, MAY OCCUR. PRIOR TO ACTUAL ENGINE RUNNING, CHECK THE RATE OF DISCHARGE OF CARBOBLAST MATERIAL. RATE OF DISCHARGE WILL VARY CONSIDERABLY DEPENDING ON CARBOBLAST MOISTURE CONTENT.

(2) Remove or disconnect components from the engine in order to avoid damage during the cleaning operation. Complete removal of tubes which bleed air from the compressor is not necessary provided a stainless steel cover plate 0.032 inch thick is installed between the tube and the opening and the bolts tightened. This then blanks off systems which use compressor air and prevents accumulation of cleaning material in other equipment. Remove or blank off the following:

(a) Remove the compressor bleed control temperature bulb and bellows from the front accessory support.

(b) Remove the left and right anti-icing air valves, tubes, compressor bleed valve screen housing, compressor bleed valve actuator supply tubes and water shut-off valve air tube. Remove the pressure sensing tube from the front support case. Remove the two fuel drain valve assemblies from the combustion chamber outer case. Cap the openings in the cases and tube ends.

(c) Disconnect the high pressure compressor bleed manifold and cap the openings.

(d) It is not necessary to remove the pressure probes or the thermocouples from the turbine exhaust case for carboblast cleaning operation. No precautions are required for the thermocouples. 80 to 120 psi air pressure must be applied to the pressure probe manifold during the actual cleaning operation. If the probes or thermocouples are removed, cap the openings.

NOTE: Do not unfasten the compressor discharge pressure tube at the fuel pressurizing and dump valve.

(e) Remove any aircraft instrumentation in the gas path and cover the openings.

NOTE: The above operations are necessary to prevent accumulation of cleaning material in equipment or instrumentation, either engine or airframe mounted, which may cause malfunctioning of the equipment.

For Training purposes only

ENGINE - CLEANING

(f) Pour 200 pounds of the cleaning material into the drum.

(g) Start the engine; then, after warm-up at 85 percent, open the valve at the drum outlet without reducing power.

CAUTION: ENGINE MUST BE THOROUGHLY WARMED-UP AT 85 PERCENT FOR FIVE MINUTES BEFORE OPENING THE DRUM OUTLET.

NOTE: Provide for manual operation of compressor bleed valve utilizing external air source. Close bleed valve prior to introduction of carboblast and cycle valve every five minutes during process.

(h) Accelerate the engine to approximately 92 percent (Tach) N_2 speed; then slowly decelerate and accelerate between 85 percent and 92 percent (Tach) N_2 speed for a period of five minutes.

(i) Operate the engine at 90 percent to 92 percent (Tach) N_2 speed for five minutes.

(j) Then, repeat the acceleration and deceleration operation described above until the complete 200 pounds of cleaning material is consumed.

NOTE: If the desired P_{t7} cannot be obtained using 200 pounds of cleaning material, the steps outlined above should be repeated using another 200 pounds of cleaning material. The entire process for a single run should take 30 to 40 minutes of engine operation, but not less than 30 minutes.

(k) Run the engine for five minutes at idle; then shut down.

(l) If installed remove the caps and closures which were temporarily installed over the bleed and pressure line opening and operate the engine for five minutes at up to 90 percent N_2 speed; then run the engine for five minutes at idle and shut down.

NOTE: The purpose of this run is to permit any cleaning material accumulated in the bleed ports to be blown out.

CAUTION: MAKE CERTAIN THAT HIGH TEMPERATURE GASES ARE NOT DIRECTED AGAINST COMBUSTIBLE AIRCRAFT EQUIPMENT (SUCH AS WIRE BUNDLES).

(m) Install any aircraft instrumentation removed from the gas path and the high pressure compressor bleed manifold.

For Training Purposes only

ENGINE - CLEANING

(n) Install the left and right anti-icing air valves, tube, compressor bleed valve actuator supply tubes and water shut-off valve air tube as complete units.

(o) If removed, install the pressure probes and the thermocouples in the turbine exhaust case.

(p) Install the compressor bleed valve control temperature bulb on the front accessory drive front support and the pressure sensing tube on the inlet guide vane and shroud case. Install the two fuel drain valves in the combustion chamber outer case.

CAUTION: CARE MUST BE EXERCISED IN INSTALLING THE FUEL DRAIN VALVES IN THE COMBUSTION CHAMBER OUTER CASE. THE PIN HOLE IN THE VALVE ASSEMBLY MUST BE PROPERLY ALIGNED WITH THE LOCATING PIN IN THE CASE.

(q) Retrim the engine.

For Training purposes only

ENGINE - APPROVED REPAIR

1. General

A. Refer to Disassembly/Assembly section for information concerning standard engine maintenance practices.

B. Refer to Chapter 71, as required, for information concerning removal of airframe installed parts.

2. Combustion Chamber Outlet Duct

A. Anti-Rotation Lug (P/N 570721)

(1) Anti-rotation lug that is bent and does not extend out through center slot of duct flange may be repaired as follows.

(a) Tap end of lug, where it is welded to outer duct wall, to rotate outer wall and slip outer end of lug into center slot of duct flange. Straighten lug in center slot of flange as outer wall is slipped (rotated) back into position.

3. Compressor Inlet Case (For Cases P/N 502337, 515226, 633682)

A. Stripped Attaching Bolt Hole Threads - Rear Outer Flange

NOTE: This is an "on the wing" repair. See Overhaul Manual, Repair Section 72-21-1 for disassembled weld repair.

(1) Install Heli-Coil as shown on Figure 801.

(2) Remove damaged material front flange by using drill size Q.

(3) Plug tap each hole using Heli-Coil Tool 1193-5.

NOTE: Tools specified are proprietary items, it is suggested they may be purchased from Heli-Coil Corporation, Danbury Connecticut.

(4) Check threads in each hole using Heli-Coil thread gage 3694-5.

(5) Install insert MS 124657 in inserting tool, Heli-Coil 535-5, and install insert in threaded hole.

(6) Remove inserting tool and break off tang to notch, using Heli-Coil break off tool 1196-5.

4. Welded Braces To Reinforce Rear Outer Flange

NOTE: This is an "on the wing" repair. See Overhaul Manual Repair Section 72-21-1 for disassembled weld repair.

For Training purposes only

ENGINE - APPROVED REPAIR

A. Procedure

(1) Weld as shown on Figure 802.

(2) Stress relieve not required for this repair.

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4A. Inlet Case Repairs

NOTE: Field Stations are to comply with the following in lieu of welding inlet cases.

A. Procedure for repairing inlet case.

(1) Cracks on the inlet case inter and outer shrouds (vertical cracks on vanes excluded) may be stop-drilled (cracks exceeding limits must be welded).

NOTE: Locate crack ends using dye penetrate and stop-drill with #30 drill. Mark length of crack with blue dye marker. Refer to inlet case cracks limits of acceptability. (Inspection/Check section).

(2) Field welding which has re-cracked should be stop-drilled instead of rewelded. Identify and stop-drill crack as in foregoing note.

(3) Notify JEDMI of any crack in step #2 which exceeds Maintenance Manual limits. This will require special monitoring and handling.

NOTE: As in all jet engine inlet case cracking policies, under no circumstances should aircraft be dispatched when cracks are of a converging nature, or if there is a possibility of material breaking and being injested in the engine inlet.

B. Front Compressor Case Nose Cowl Bolt Hole Repair. Stripped holes may be repaired by tapping the hole and installing a helicoil.

(1) The heli-coil must be of such a length to allow the bolt to extend at least one thread beyond the end of the heli-coil. Do not attempt to install the heli-coil without using the proper heli-coil insertion tools. After installation, remove the tang from the heli-coil.

For Training purposes only

C. Inlet Case Aft Flange Repair Doubler Installation

(1) Cracks in the inlet case aft flange may be repaired by installing a four, five or six hole doubler in accordance with the following procedure. Choice of doubler configuration will be determined by the nature of the crack to be repaired. Cracks that originate in the reverser actuator attach bracket bolt holes and extend outward to the circumference of the flange will require a four hole doubler. Cracks of such a nature that a section of the flange is separated from the case will require a doubler which picks up two holes on each side of the missing part.

(2) Doubler installation shall be accomplished in accordance with the following:

(a) Stop drill all cracks in the inlet case shroud skin and cracks in the flange radius using a #30 drill.

(b) Using a 5/16 inch bit, drill out threaded holes in the inlet case aft flange that will be used to bolt the doubler into position. Deburr holes after removing threads.

(c) Position doubler in required location on inlet case and mark locations where vane weld beads on OD of inlet case interfere with doubler.

(d) Grind clearance slots in doubler in interference points and trim to desired length.

NOTE: Remove minimum amount of material required to obtain doubler fit to flange. Do not grind weld beads off of inlet case to obtain clearance.

(e) After clearance is obtained and proper fit is achieved, treat groundout areas with zinc chromate primer.

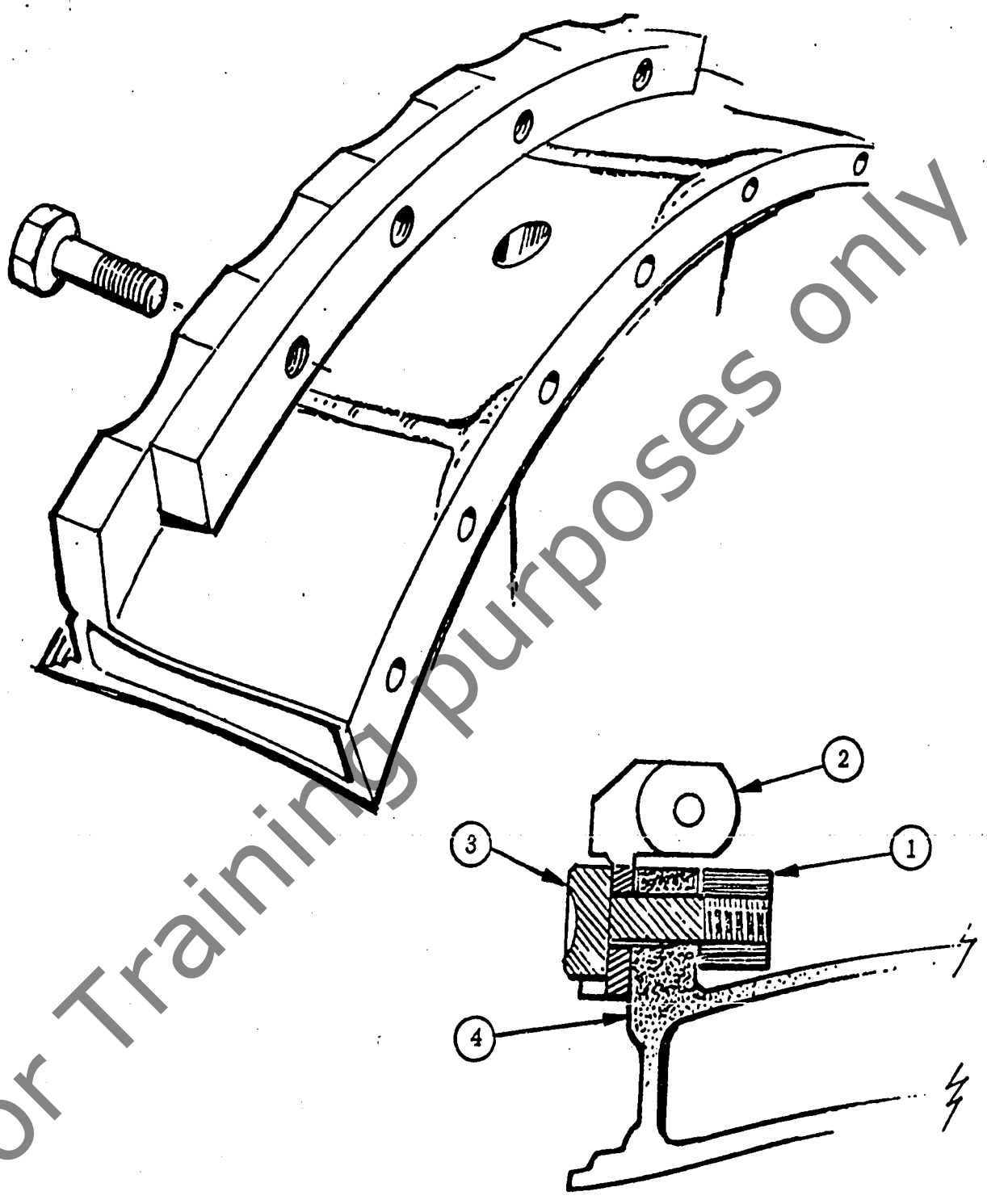
(f) Install forward reverser actuator bracket to inlet case aft flange using the doubler as a nut plate.

NOTE: See Figure 800.

(g) Install remaining bolts in a like manner. Torque and safety all bolts in the normal manner.

(h) Reinstall actuator tubing etc., removed or disconnected to gain access to the affected area.

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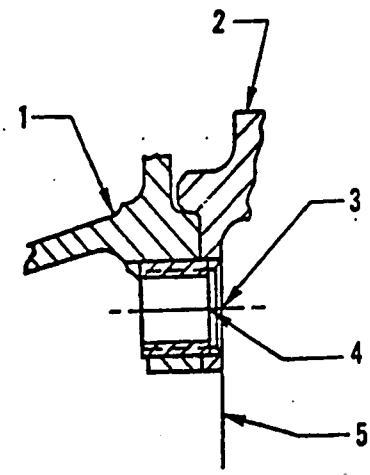


Nomenclature	Mfg. Nbr.	QTY
1. Doubler	1-85446-1	1
2. Bracket		
3. Bolt	NAS 1305-9HW	2 ea.
Bolt	305672	4 ea.
4. Inlet Case		

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5. First Stage Fan Blade F.O.D. "On Wing" Repair

(Relocated to 72-0, Page 600 Block)



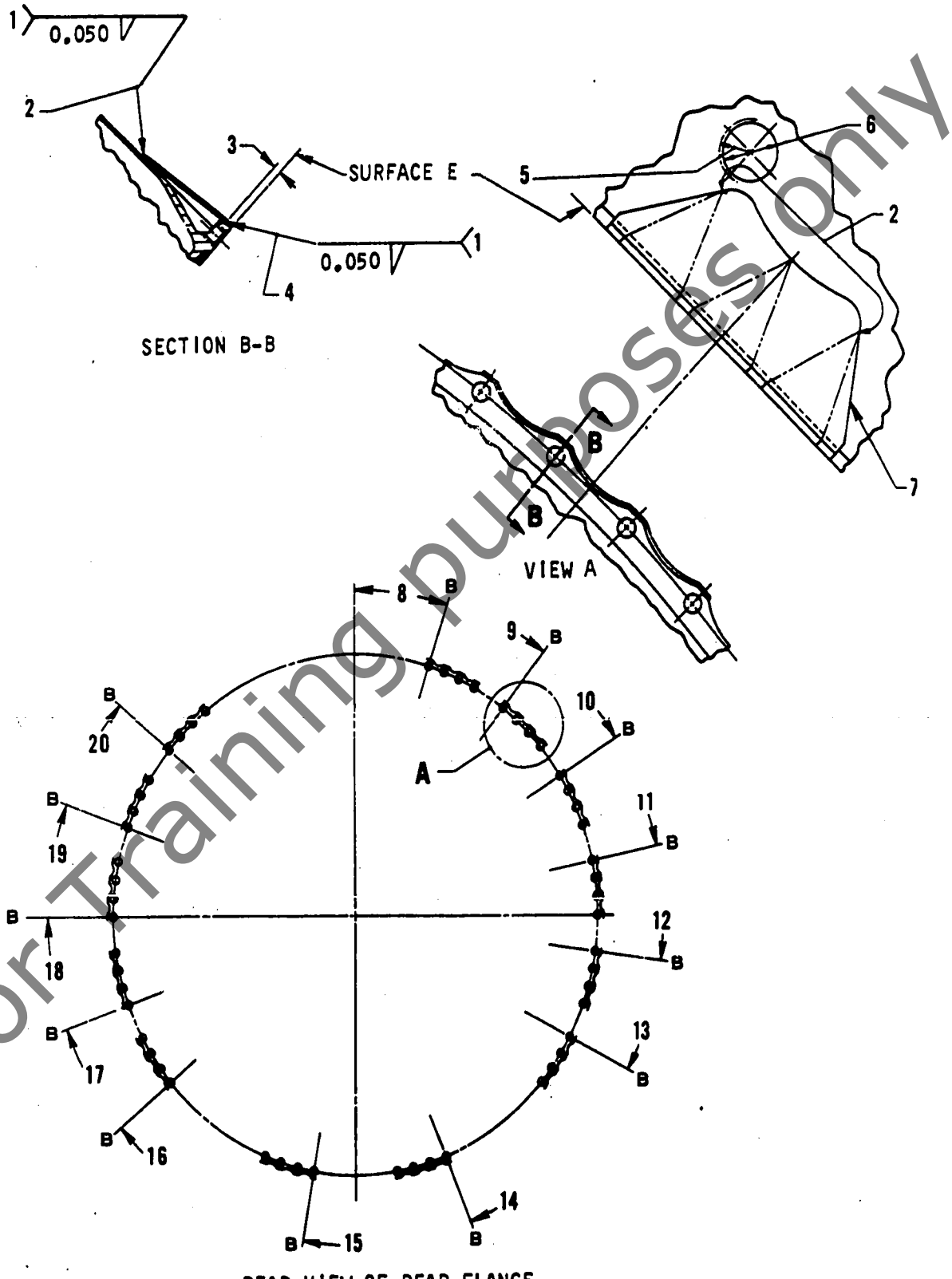
VIEW SHOWING THREAD REPAIR

t-31927

1. Rear Flange Compressor Inlet Case.
2. Front Flange Fan Case.
3. Thread For 0.3125-24 Helical Coil Insert Chamfer 120° ± 5° Inclusive To 0.360 - 0.400 Diameter.
4. MS 124675 Insert As Required.
5. Top Face Of First Coil To Be 0.75 To 1.00 Pitch Below This Surface, Break Off Tang At Notch.

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ENGINE - APPROVED REPAIR



For Training purposes only

ENGINE - APPROVED REPAIR

1. Weld Using AMS 4951 Filler Metal, Machine Gas Tungsten - Arc (TIG) In Accordance With Standard Practices Manual.
2. Weld For This Distance
3. 0.140 - 0.160 Inch
4. Weld Along Contour.
5. 0.531 - 0.594 Inch Radius - If Necessary Brace May Be Finished To This Dimension To Prevent Overlapping Diameter No. 6.
6. 1.028 - 1.048 Inch Diameter - Reference
7. Brace P/N 692736, Required At Locations B.
8. 18° Reference
9. 38° Reference
10. 58° Reference
11. 78° Reference
12. 98° Reference
13. 118° Reference
14. 158° Reference
15. 190° Reference
16. 230° Reference
17. 250° Reference
18. 270° Reference
19. 290° Reference
20. 310° Reference

Key to Figure 802

For Training purposes only

ENGINE - APPROVED REPAIR

6. Front Compressor Case and Vane Assembly

A. Procedure

(1) Weld cracks in the area of the anti-icing air ports using AMS-5680 weld rod and the heli-arc inert gas process.

(2) No stress relief is required.

For Training purposes only

ENGINE - APPROVED REPAIRS

6A. Front Compressor Rear Case Cracks

A. If the depth after blending of worn area is .025 or less paint the affected area with zinc chromate primer.

B. If the depth after blend is greater than .025, but less than .030, notify - by TELEX, JEDMI, who will originate follow-up action.

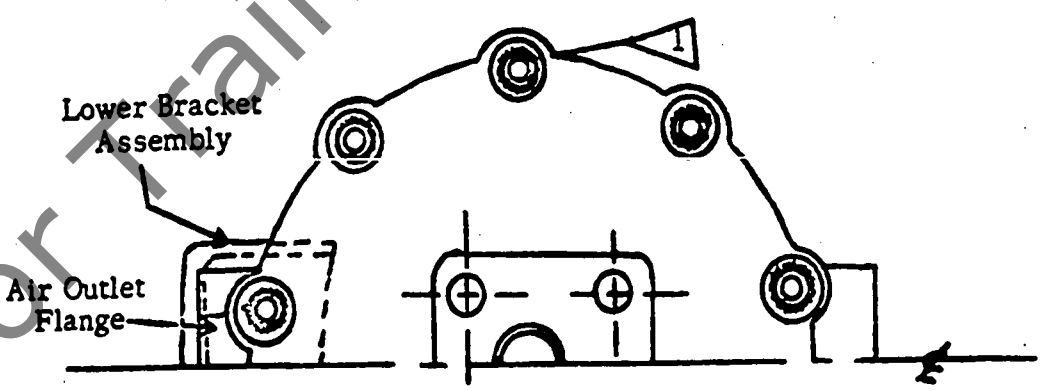
C. If the depth after blend is greater than .030, notify JEDMI, for schedule of engine change (engine must be removed within 50 hours).

NOTE: In all instances of wear on the case, the area must be dye checked for cracks after blending. If cracks are found, the following limits and procedures shall be followed:

D. If cracks 0.50 inch or less are found in the wear area, notify by TELEX, JEDMI, who will originate follow-up action.

E. If cracks exceed 0.50 inch, notify JEDMI for schedule of engine change. (Engine must be removed within 50 hours).

NOTE: Some relief in clearance may be gained by reversing the bolt closest to the case on the fuel heater lower flange. After reversing, the bolt head should be up as shown by Figure 803 Torque on the bolt shall be 55-70 inch pounds.



1 Reverse nut and bolt so that the nut is down when installing the air outlet flange to the heater body.

For Training purposes only

ENGINE - APPROVED REPAIR

7 Tubing Patch Repair

A. Suggested Flyback Repair Procedure For External Tubing.

NOTE: This repair does not include high pressure fuel lines: main pump to fuel control, fuel control to fuel oil cooler, fuel oil cooler to pressurizing and dump valve and pressurizing and dump valve signal line.

(1) See Table II for repair procedure.

(2) Use AMS 5510 SST for patch doubler material and AMS 5570 SST for sleeve doubler material.

(3) Edge of patch shall not extend into tube bend.

(4) Repair within 0.250 inch of a ferrule.

(5) Minimum overlap of repair area 0.250 inch.

(6) Braze per Standard Practices Manual, using AMS 3411 flux.

CAUTION: TUBES REPAIRED IN THIS MANNER SHALL BE REPLACED AFTER FLYBACK.

For Training purposes only

ENGINE - APPROVED REPAIR

TYPE OF DAMAGE	ACCEPTABLE DAMAGE	METHOD OF REPAIR	REPAIR PROCEDURE
Dents (Distorted wall, no thickness reduction).	1. No sharp edges 2. Free passage of ball 80% ID of tube 3. Not within 0.250 inch of ferrule	Doubler repair	1. Straighten tube to acceptable limits 2. Doubler repair: A. Patch doubler for repair area up tp 25% of tube OD wide and 50% of tube OD long. B. Sleeve doubler for repair area up to 50% of tube OD wide and 3x tube OD long.
Nicks-(scratches, sharp edges, gouges).	Minor scratches and pitting not exceeding 0.003 inch deep	Blending or or doubler repair	1. Blending: A. Blend out to maximum depth of 0.005 inch. B. 75% wall thickness must remain after blending. C. Blend area must not exceed exceed 0.50 square inch. 2. Doubler repair: (Same as dents).
Wear (thin areas, clamps etc).	Wear up to 0.003 inch deep	Doubler repair	1. Doubler repair: A. Same as dents except sleeve doubler under all clamp and clip areas.
Holes (worn, punched, or open cracks).		Doubler repair and fusion weld repair	1. Doubler repair: (same as dents) 2. Fusion weld repair: 0.025 maximum width, length to 1/2 tube diameter maximum circumference 25% tube diameter, 100% penetration, underbead cannot exceed 25% wall thickness under 2 inch diameter, 10% over 2 inches diameter.

Table II

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(7) See Figure 804 for typical repair procedure.

(8) Pressure test

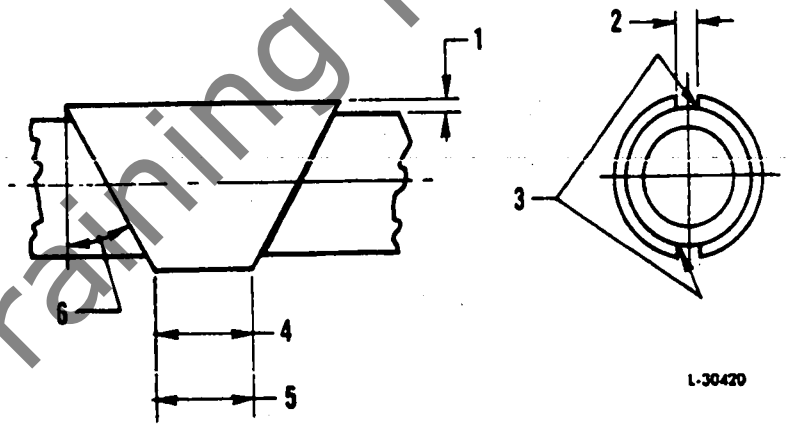
(a) Up to 0.500 OD at 700 psi

(b) Over 0.500 to 0.750 OD at 500 psi

(c) Over 0.750 to 1.000 OD at 300 psi

8. First Stage Fan Blades (Titanium) Blend Repair

(Relocated to 72-0 600 Block)



1. 0.030 Inch
2. Gap Permissable - Two Places
3. Silver Braze Using AMS 3411 Flux Per Standard Practices Manual.
4. 0.250 Inch Minimum
5. 1.000 Inch Minimum Under Clip Or Clamp.
6. 30° Approximately - 4 Places

For Training purposes only

ENGINE - APPROVED REPAIR

9. Fan Discharge Case Fairing

A. Tapped Holes - Helical Coil Reoperation

See Figure 805.

(1) If threaded hole(s) are damaged, rework to bring acceptable condition by installing a helical coil insert. See referenced figure.

(2) Clean per SPOP 203.

NOTE: Reidentify to P/N 701773.

B. Tapped Hole Rework

See Figure 805.

(1) Rework holes as per referenced figure. Clean per SPOP 203. Reidentify to P/N 701773.

(2) Use P/N 701774 at installation

For Training purposes only

9 A. Cracks in Fan Discharge Case Strut Welds

A. Total of 8 struts may be cracked in strut to shroud attach welds.

B. Maximum of 4 struts may be cracked consecutively provided the 4 consecutive vanes are separated from any other cracked vanes by at least 90° of the case.

C. Cracks are not to exceed 1-1/2 inches in weld on both sides of vane weld at shrouds.

D. Cracks must not progress over 3/4 inch in shroud area.

9B. Crack Repair in Fan Discharge Case Strut Welds

A. Carefully clean cracked area.

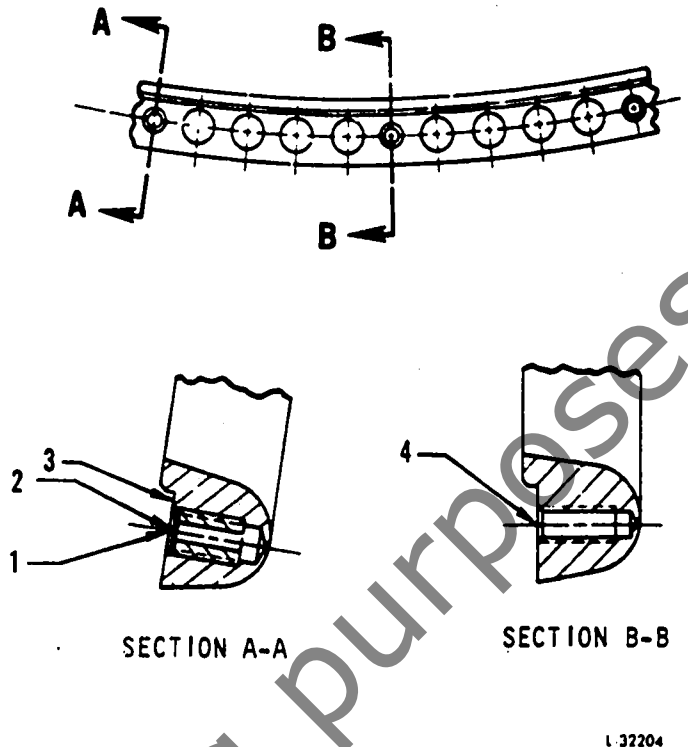
B. Dye check crack and determine crack ends.

C. Stop drill both crack ends.

D. In all instances of cracking, notify JEDMI of A/C and position number of struts stop drilled and length of crack.

For Training purposes only

ENGINE - APPROVED REPAIR



For Repair Of Damaged Threads (Section A-A)

1. Thread For 0.190-24 Helical Coil Insert Minor Diameter Depth 0.487 Inch Maximum. Drill Point 160° Minimum, Including Chamfer 120° ± 5° Included To 0.240 - 0.280 Diameter Minimum, Full Thread Depth 0.330 Inch.
2. MS122120 As Required. Before Assembling, Coat Mating Threads Of Insert And Fairing Per AMS 3110. (Zinc Oxide Primer). Assemble Wet.
3. Top Face Of First Coil To Be 1.0 To 1.5 Pitch Below This Surface. Break Off Tang At Notch.

For Holes Not Requiring Thread Inserts (Section B-B)

4. 0.190-24 NC-3B Minor Diameter. Depth 0.500 Inch Maximum, Drill Point 160° Minimum Included. Chamfer 90° ± 5° Included To 0.190 - 0.220 Inch Diameter. Minimum Full Thread Depth 0.407 Inch.

For Training purposes only

9C. CSD Removable Spline Replacement

A. Remove CSD and check for screw and special washer in the center of the engine drive. (Refer to Figure 806 for screw and washer location).

NOTE: This will signify if the engine is modified and if the doupling is replaceable. Drives without the screw and washer are not replaceable and will necessitate the engine to be removed and the gearbox replaced.

B. Remove attaching screw and special washer in the center of the engine drive. Refer to Figure 806.

C. Remove coupling and install new coupling.

NOTE: This is ordinarily removed by hand, however, in some extreme cases it may be necessary to fabricate a puller.

(1) Remove the capscrew and lock tab.

(2) Use two (2) each 10-32 bolts, one in each pre-threaded hole in the coupling, and thread until pressure is felt.

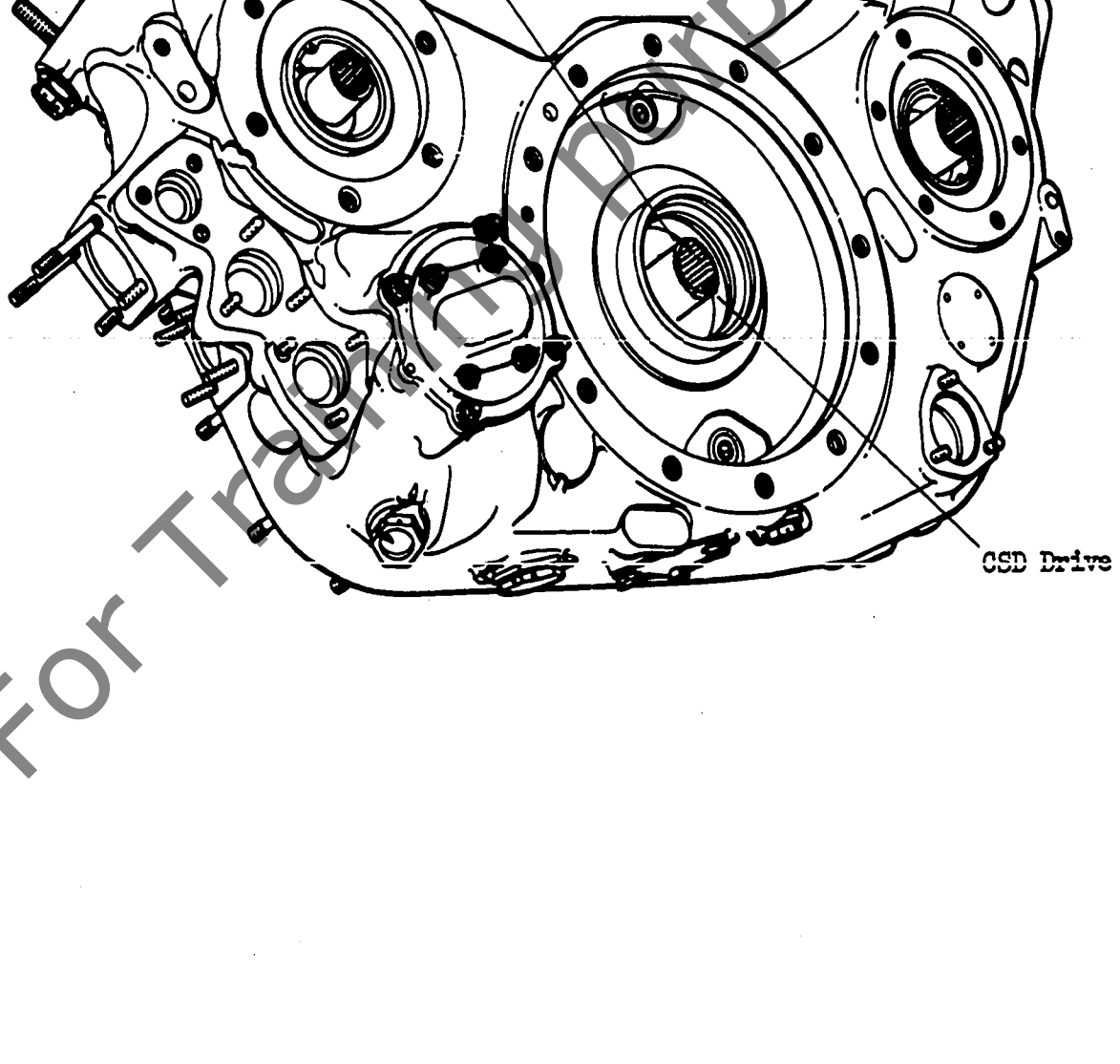
(3) Continue to exert pressure by alternately torqueing the threaded bolts until the drive gear female splines are free of the coupling or until the coupling can be removed by hand.

CAUTION: WHEN REINSTALLING COUPLING GEARS, EITHER INTERNAL THREADED EXTRACTOR HOLE MAY BE USED FOR STAKING TAB LOCK. CARE MUST BE EXERCISED TO PREVENT DAMAGE TO THE THREADS WHEN STAKING TAB LOCK.

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D. Reinstall attaching screw and special washer in the center of the new coupling and torque to 65-85 lbs. - inches.

E. Reinstall CSD.



For Training Purposes only

9D. Diffuser Case Repairs

A. General

(1) When arc welding the diffuser case, it is imperative that the welding equipment ground connection be attached directly to the part being welded. Under no circumstances shall the ground connection be attached in any manner which will permit current flow through the engine.

(2) Inert gas back-up is to be used on all repair welds whenever possible and shall be mandatory for repair welds to cracks in the diffuser case parent metal structure. Gas back-up for strut cracks to be accomplished by entering adjacent bleed air ports with gas back-up fixtures.

B. Weld Repairable Areas

(See Figures 807 and 808 for typical crack locations.)

(1) Water Injection Pads - Cracks in pad welds may be repaired up to two inches in length with no stress relief required. Any crack over this length or any crack that extends into the case parent material must be stress-relieved.

(2) Strut attachments to outer case, strut caps, bleed air bosses and oil system bosses - Cracks in boss or strut welds up to two inches in length may be weld repaired with no stress relief required. Any crack over this length or any crack extending into the case parent material must be stress-relieved.

(3) Cracks up to a maximum of two inches long at referenced locations A, C and D of Figure 808 may be weld repaired. Stress relief required only if crack has extended into parent metal.

(4) Case parent material - Cracks up to three inches in length in the case parent material may be weld repaired on the engine provided the crack width has not exceeded .015 inch. If crack exceeds these limits, remove case and route to MCI for repair. Any welding in case parent material requires stress relief.

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(5) No weld repair is allowed on the pressurizing and dump valve mounting pad area (Figure 808 Reference B) in the field.

(6) No welding is allowed in front or rear flange circumferential seam welds in the field.

(7) Remaining fusion welds not previously covered - Cracks in existing welds may be weld repaired up to two inches in length with no stress relief required. Any crack over this length or any crack that extends into the case parent material must be stress-relieved.

C. Weld Repair Procedure

(1) Vee out all cracks 1/2 wall thickness or approximately .050 inch and stop drill all cracks in parent metal. Wire brush area 1/2 inch each side of crack until metal is shiny.

(2) Accomplish weld repair using appropriate gas back-up and AMS 5776 (Bare 410) weld rod.

(3) If required according to previous limits in Paragraph B, stress relieve the weld repairs as soon as possible after welding by the following method:

(a) Install or position local stress relief equipment (either a quartz lamp or heat blanket) on or near area of part to be heat treated.

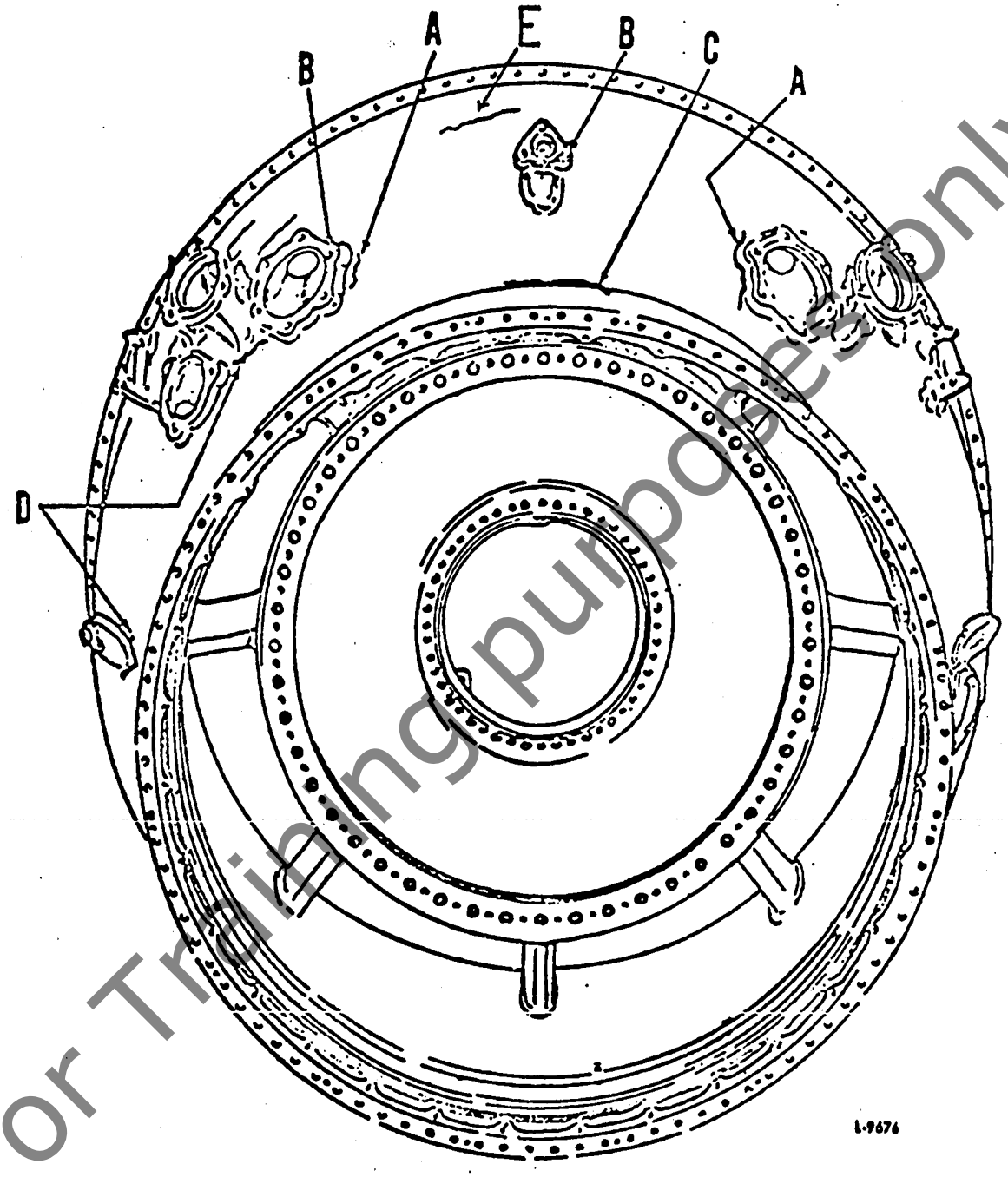
(b) Heat to 1015°F ± 15°F (546°C ± 8°C) not faster than 15 minutes elapsed time, and hold for one hour.

(c) Cool to 500°F not faster than 15 minutes elapsed time.

CAUTION: When accomplishing stress relief on the engine, wire harnesses and miscellaneous tubing in the area adjacent to the repair area are to be either well insulated or disconnected and removed during the stress relief procedure.

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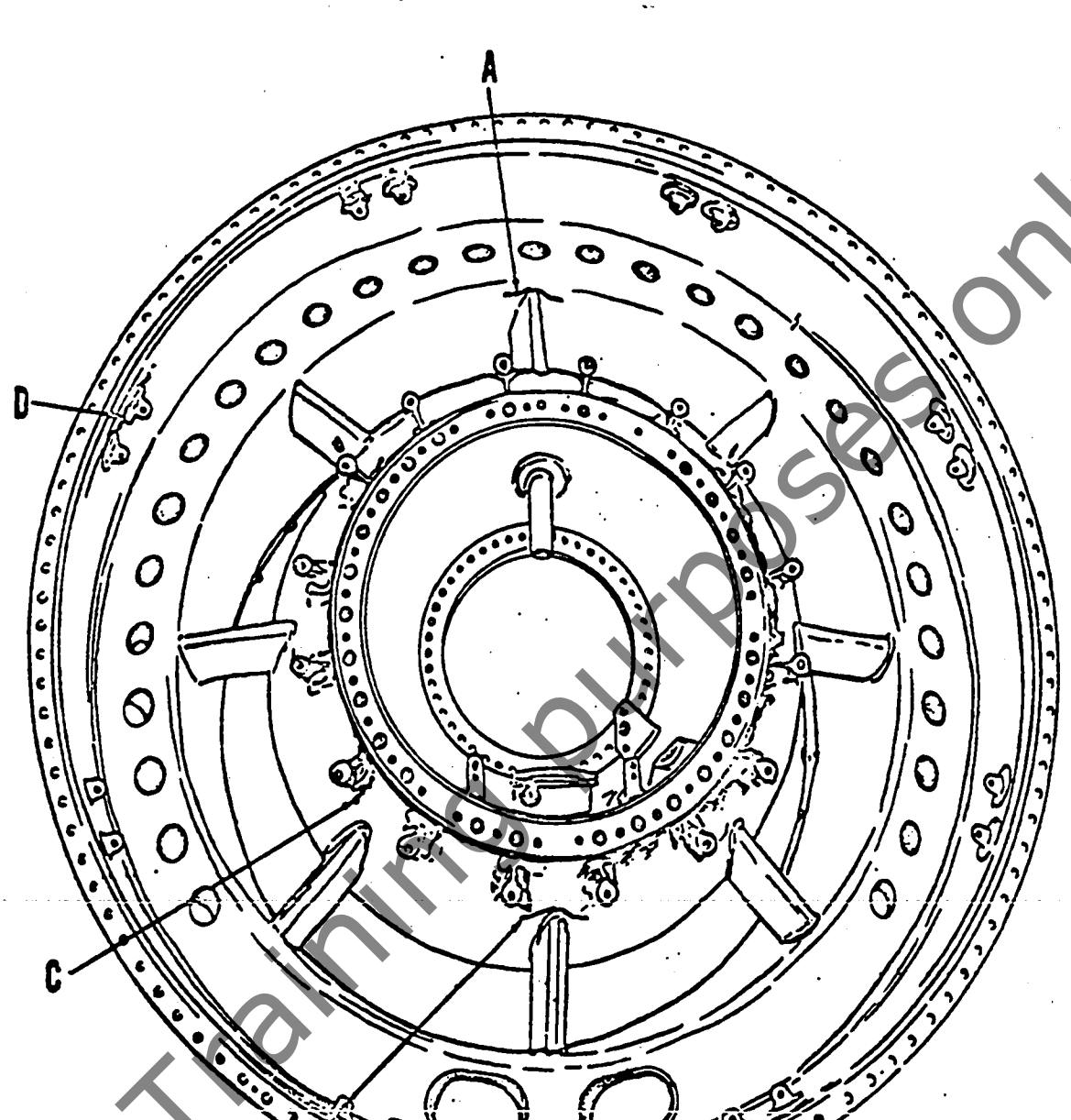
DIFFUSER CASE



A - CRACKS IN OUTER CASE AT PAD LOCATIONS
B - CRACKS IN THREADED HOLES AT PADS
C - CRACKS IN THE OUTER CASE
D - CRACKS OUTSIDE CASE WHERE STRUTS ARE WELDED TO CASE AND WHERE COVERS ARE WELDED TO STRUTS
E - CIRCUMFERENTIAL CRACKS AT JUNCTION OF BLEED AIR ANNULUS AND DIFFUSER CASE OUTER SKIN.

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DIFFUSER CASE



A - CRACKS INSIDE CASE AT STRUTS
B - CRACKS AT FUEL MANIFOLD MOUNTING PAD
C - FUEL MANIFOLD MOUNTING LUGS
D - FUEL MANIFOLD MOUNTING LUGS

Diffuser Case Weld Repair
Figure 808

For Training purposes only

9E. Approved Airworthy Repair - Engine Oil Tank

A. Oil leaks in the oil tank area may be corrected using "Oyl-Tite" stick if replacement tank is not available and/or an airworthy repair could save a flight cancellation or lengthy delay and if the oil leak is in an accessible area.

(1) Using "Oyl-Tite" stick cover crack thoroughly.

NOTE: For best results warm the stick in hand or underarm for five (5) to ten (10) minutes.

(2) After application reservice oil tank as required.

(3) Run engine for a minimum of three (3) to five (5) minutes and recheck oil tank for evidence of leakage.

(4) Notify JEDMI of engine and aircraft position for scheduling of oil tank change.

B. Alternate procedure for airworthy repair if use of "Oyl-Tite" stick is not satisfactory. Use this procedure if replacement tank is not available and/or airworthy repair could save a flight cancellation or lengthy delay and if oil leak is in accessible area.

(1) Drain oil from section of tank where leak is evident.

(2) Thoroughly clean area to be repaired with MEK.

NOTE: Oil or foreign material must be completely removed prior to repair.

(3) Cut strips of cloth fabric to permit at least 2 3/4 inch patch overlap in the leakage area.

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(4) Obtain adhesive kit and mix a minimum of 5 minutes. Add a few drops of water to expedite curing.

(5) Paint thin coat of adhesive mixture exceeding crack area by 1 inch on each side.

(6) Apply cloth strips over repair area.

(7) Reapply adhesive mixture to cover cloth edges and seal entire area to minimum thickness of 1/8 inch.

(8) Let dry until hardened.

NOTE: Under normal conditions, this will require two to three hours, however, the drying time can be expedited by applying slight heat to the repair area.

(9) Reservice oil tank.

(10) Run engine for a minimum of three to five minutes and recheck tank for evidence of oil leakage.

(11) Notify JEDMI of aircraft and engine position for scheduling of oil tank change.

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9F. Field Repair N2 Gearbox #6 Bearing Scavenge Line Fitting

A. Equipment required:

(1) 3/8" pipe tap and handle.

B. Parts required:

(1) Bushing, Mfg. P/N AN912-2

(2) 90° Elbow, Mfg. P/N AN822-6

C. Procedure:

(1) Coat 3/8" pipe tape with lubriplate or heavy grease and tap hole in accessory case.

NOTE: Remove pipe tap, clean off shavings and recoat with grease as tap becomes loaded with metal shavings.

(2) Install bushing and 90° elbow and connect to scavenge line.

(3) Run engine and check for oil leakage.

(4) Place small amount of zink chromate paste on elbow and close cowling-check for sufficient clearance between fitting and cowling.

NOTE: It may be necessary to file cowl former in the area to obtain clearance.

(5) Advise JEDMI of aircraft number and engine position.

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9G. N_2 Accessory Gear Box Front Housing Strainer Insert Repair.

NOTE: If the threads in the housing that secure the strainer are unserviceable the following repair should be made.

Exception: This repair cannot be made if twin heli-coils are present because the hole will be too large for 3/8 - 16 tapping.

A. Equipment Required.

Drill - size 9/32

NOTE: This drill required only when necessary to remove keensert.

Drill - size "Q" (.332 inch diameter)

Countersink 82 - 100 degree standard

Tap 3/8 - 16 (standard)

Keensert installation tool part number TD 420L

Fixture - Locating - For drilling and tapping.

B. Parts Required

Keensert Part Number 420
1/4 - 20 X 3/8 - 16

C. Procedure:

(1) If a heli-coil is presently installed, remove. If not proceed directly to next step.

To remove keensert:

(a) Drill the I.D. with a 9/32 inch drill to a depth of 3/16 inch.

(b) Deflect the kees inward and break off.

(c) Unscrew the insert with an E-Z out type tool.

(2) Secure drill and tap locating fixture to the gear box.

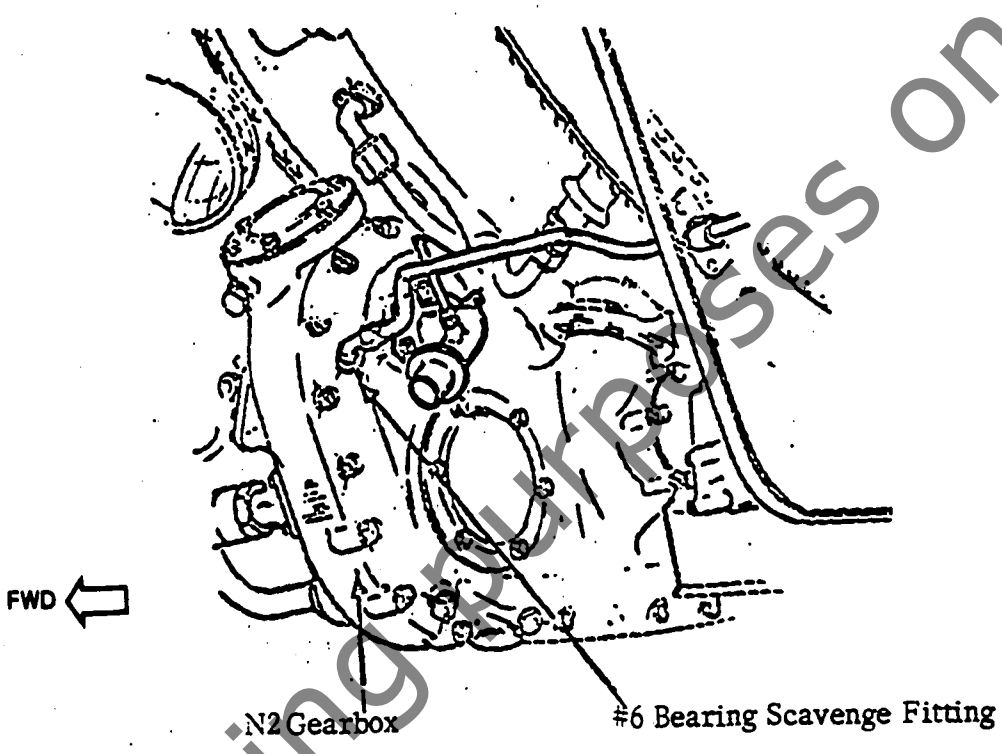
(3) Drill out hole using a "Q" size (.332 inch diameter) drill to 1/2 inch depth.

(4) Countersink with 82 - 100 degree standard countersink to .38 to .40 inch diameter.

(5) Tap hole with 3/8 - 16 standard tap to a minimum depth of .43 inch.

(6) Install keensert, P/N KN420 1/4-20 X 3/8 - 16 using installation tool P/N TD 420L. Position to .010 to .030 inch below surface and drive locking kees down.

For Training purposes only



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9H. Field Installation of Exhaust Case Engine Mount Flange Reinforcing Straps.

A. General

High time exhaust cases are subject to cracking in the aft mount link bolt holes. Reinforcing straps have been provided to be installed as required. There are three possible installation configurations. Where only one flange is cracked, it will be necessary to install only one strap to reinforce the affected flange. If both flanges are cracked, two straps will be required. Straps may also be installed over flanges having welded on doublers at mount link bolt holes.

B. Limitations:

Installation of reinforcing straps will be limited to engines having the following:

(1) No more than one crack per bolt hole.

(2) No cracks extending from the bolt hole toward the center of the engine.

(3) No more than two cracks per case. Forward and aft flange for same link may be cracked.

C. Equipment Required:

(1) Support equipment suitable for supporting the aft section of an installed engine while the aft mount link bolts are temporarily removed.

D. Procedure:

(1) Remove engine plumbing as required to permit removal of aft mount link bolts.

(2) If straps are to be installed with the engine on the wing, install aft engine support equipment and adjust to insure positive support of the aft engine section.

(3) Remove right and left mount link bolts.

(4) Position straps with chamfered edge adjacent to case flange and the two center holes over the trunnion mount attaching bolts (Ref. Fig. 810.

NOTE: It will be necessary to reposition EGT harness clamp support brackets by hand forming. Use care not to damage wiring or probe terminals.

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(5) Align and install new bolts through strap(s), case flange, and mount links.

NOTE: This note is to advise maintenance personnel that in the future engines from JEDMI (either with or without reinforcing straps) will have the long bolt installed in the engine aft mount links. These bolts will be shimmed with Mfg P/N 60-4956 shims and washers Mfg P/N AN960C1016L. This will permit the installation of the strap doubler assembly with existing bolts by removing shims as required. In most instances this may be accomplished without removing bolts or supporting the engine.

(6) Install bolts through holes provided in the strap(s) picking up additional holes in exhaust case flange.

(7) Install washers and nuts. Torque nuts as follows: Mount link bolts torque 600-780 inch-pounds to seat bolts, then back the nut off and retighten finger tight. Then back the nut off to the first castellation and install cotter pin.

Torque the two additional bolts 100-150 inch-pounds to seat bolts, then back the nuts off and retighten finger-tight. The back the nut off to the first castellation and install cotter pin.

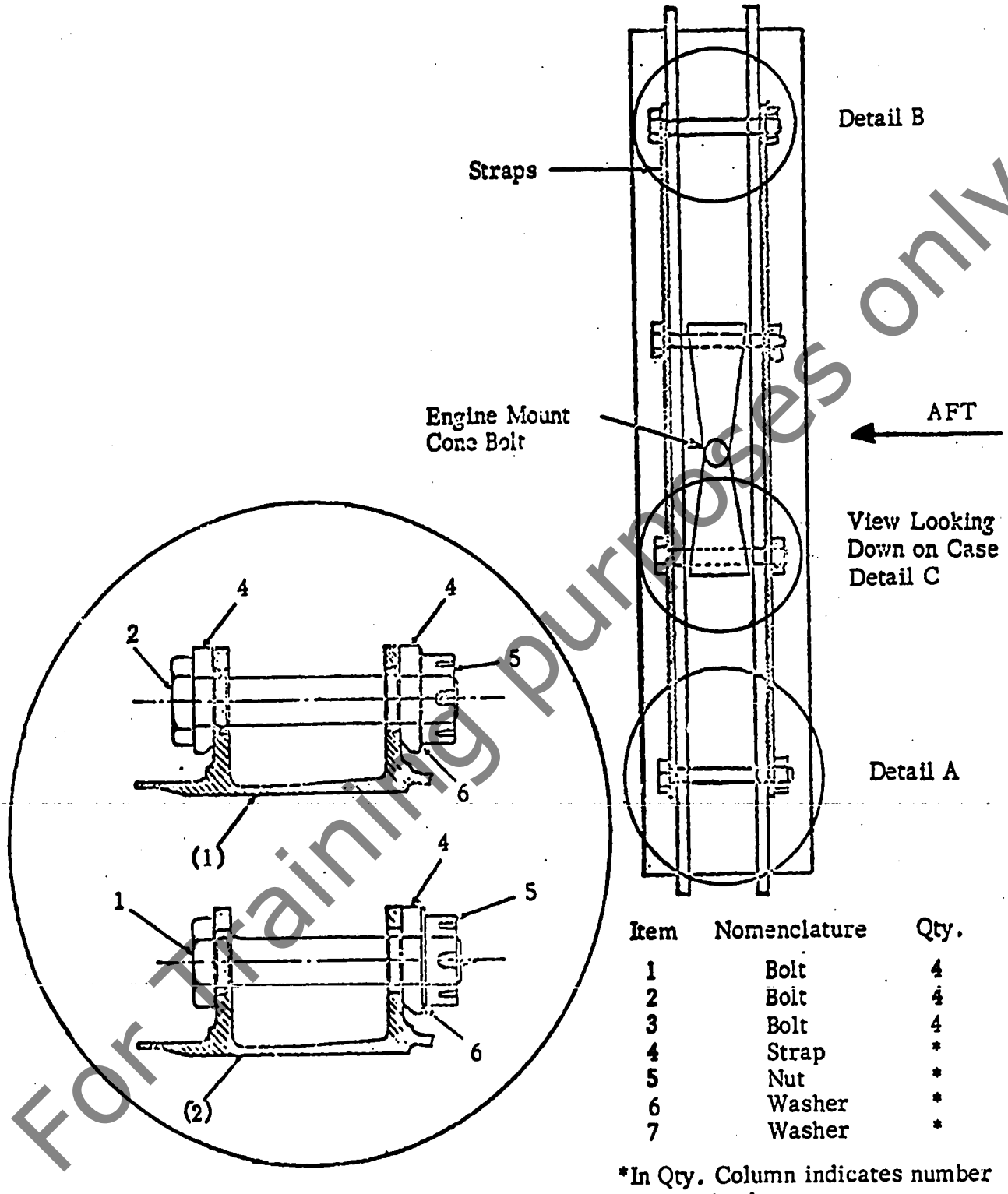
NOTE: The intent of the pretorque is to seat the bolts only. Excessive torque is to be avoided to prevent distortion to the exhaust case flange.

(8) Reinstall engine plumbing removed in step (1).

(9) Remove support equipment.

(10) Notify JEDMI by message indicating number and location of cracks and number of straps installed.

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Item	Nomenclature	Qty.
1	Bolt	4
2	Bolt	4
3	Bolt	4
4	Strap	*
5	Nut	*
6	Washer	*
7	Washer	*

*In Qty. Column indicates number as required.

DETAIL A

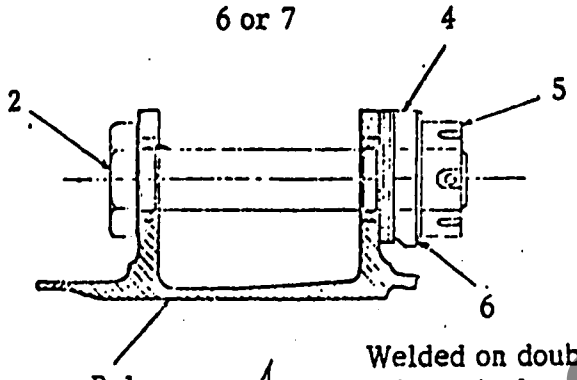
(1) Typical two strap installation on case without welded on doublers

(2) Typical one strap installation on case without welded on doublers

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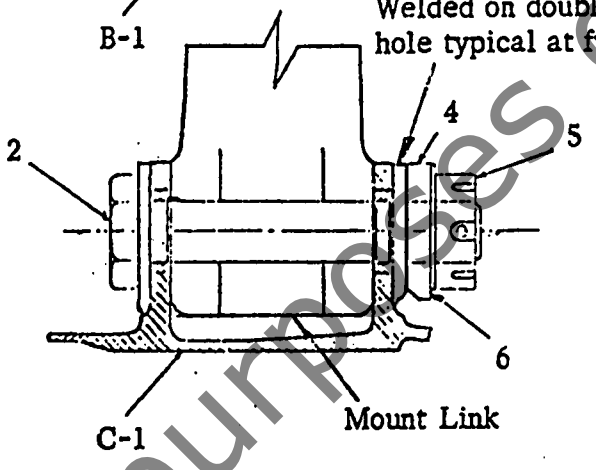
Detail B

(1) Typical one strap installation on case with welded on doublers. At each end of strap shim between strap and case to equivalent thickness of welded on doubler.



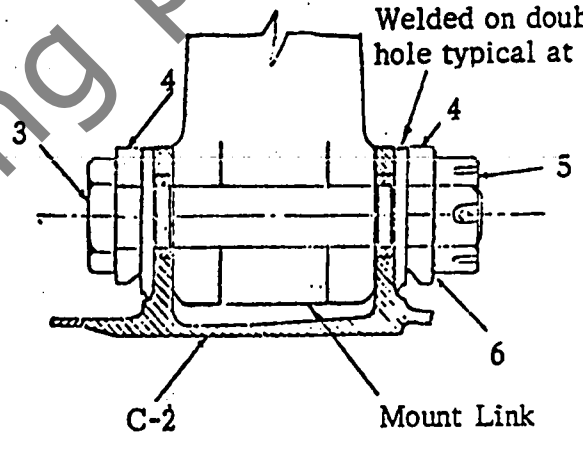
Detail C

(1) Typical one strap installation on case with welded on doublers at mount link hole.



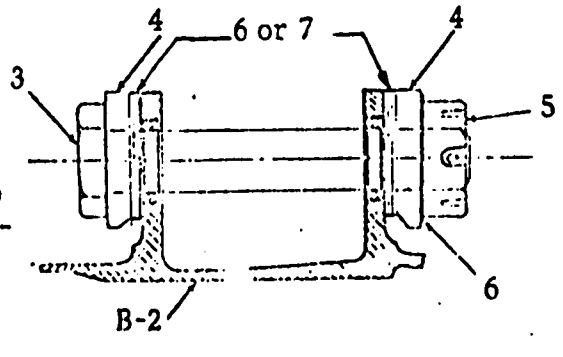
Detail C

(2) Typical two strap installation on case with welded on doublers at mount link hole.



Detail B

(2) Typical two strap installation on case with welded on doublers. At each end of strap shim between strap and case to equivalent thickness of welded on doubler.



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9I. Turbine Exhaust Strut Assembly

A. Inspection

(1) Cracks around the leading and trailing edge at the inner end of the strut assembly are repairable provided they do not exceed three (3) inches in length.

(2) Round bottom dents up to 0.125 inch deep and a diameter of 0.500 inch are acceptable without repair.

(3) Cracks at the rear heat shield attach flange adjacent to unused nut plates up to one (1) inch in length are repairable.

(4) Cracks in all other areas up to six inches in length are repairable.

B. Repair

(1) All repairable cracks may be welded as follows:

(a) Stop drill ends of crack with No. 40 drill.

(b) Rout crack and clean throughly.

(c) Weld with "Hastelloy W" rod with inert gas back up.

(d) Local stress relief at 600°F for 15 minutes or run engine within 8 hours after repair.

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9J. Replace Nut of Fuel Pump Drive Shaft Seals in N2 Gearbox

A. General

(1) A modification reworked in JT3D N2 main gearbox to provide pressure lubrication of the fuel pump drive splines.

(2) Part of the modification requires changing the fuel pump shaft seal housing to a new part. This new part cannot be removed from the gearbox for the purpose of changing the fuel pump drive shaft seal because the new part forms an oil manifold for the drive shaft and has an oil nozzle installed through the gearbox and into the seal housing.

(3) This new system may be identified by the presence of two snap rings located in the shaft seal area. The larger of the two retains the seal housing and the smaller one retains the seal assembly in the housing. (See Figure 812).

NOTE: Do not attempt to remove the seal housing.

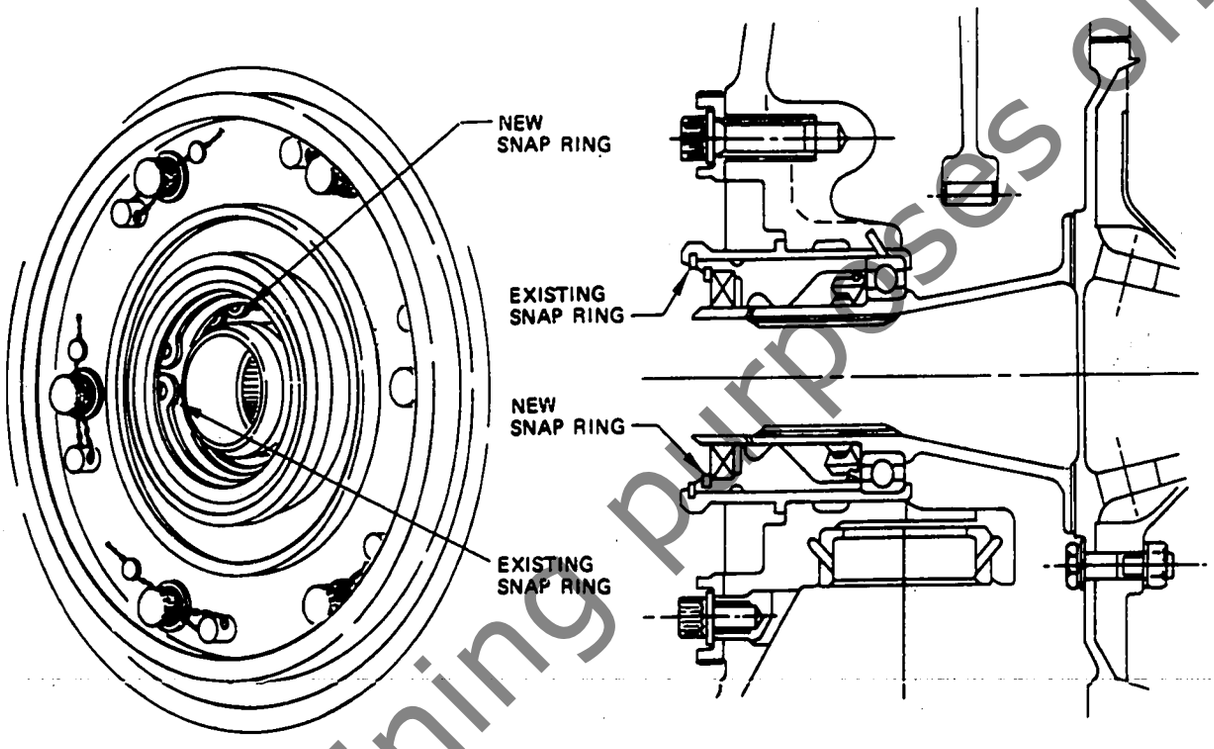
(4) With the snap ring removed the housing is still prevented from moving by the oil nozzle installed through the housing. In order to change the fuel pump shaft seal on gearboxes which have pressure lubricated fuel pump drive splines it will be necessary to remove and replace the seal without removing the housing in which it is installed. To accomplish this remove both the snap ring retaining the shaft seal and the snap ring retaining the seal housing. Remove the seal.

NOTE: It may be necessary to drive a sharp object through the metal body of the seal to provide a means of prying the seal out of the housing.

(5) Wet the new seal with engine oil and carefully install into position over the end of the shaft. Using a suitable drift drive seal assembly into final position.

(6) Install seal retainer snap ring and housing retainer snap ring.

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Replacement of Fuel Pump Drive Shaft Seals
Figure 812

9K. Field Repair - No. 1 Bearing Vent Line

A. Lines with damage within 13 inches of the line front flange can be repaired without removal of the line using the following procedure.

(1) Remove the inlet case anti-ice line front section for sawing of the vent line and installation of the fittings.

(2) Mark and cut the line removing the forward section.

NOTE: Do not destroy the forward fitting.

(3) Install B-nut.

(4) Attach fabricated line together with the existing rear section. Do not torque the B-nuts until the front flange bolts are pulled up to ensure proper alignment of the line.

10. Replacement of No. 6 Bearing Oil Pressure (Inner) and Oil Scavenge (Inner) Tube Assemblies

A. Procedure

(1) Remove turbine exhaust cone assembly.

(2) Unfasten screws and remove No. 6 bearing oil sump heatshield.

(3) Unfasten coupling nuts at both ends of inner oil tube assemblies using PWA 30634 wrench on wrenching hex on outer oil tubes to prevent transmitting torque load through tubing.

NOTE: For engines incorporating guides, P/N 654472, (Ref SB 2081), unfasten guides from brackets attached to sump assembly and slide guide down sleeve away from inner oil tube so wrenching hex is acceptable.

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(4) Using PWA 30635 Wrench to hold brazed nut on brackets, unfasten clamps securing tubes to brackets on exhaust strut assembly. Remove tubes. Reinstall new tube assemblies as required.

11. Diffuser Case Repair

A. Crack Repair

(1) A crack weld repair that redevelops cracks may be repaired by rewelding with AMS 5776 rod, See Standard Practice's Manual, followed by stress-relief in accordance with SPOP 455 Cycle No. 1. Otherwise repair must be made at overhaul.

NOTE: Use contact type pyrometer to gage temperature; stress-relieved area must overalp and extend three inches in all directions from crack.

B. Water Injection Bosses

CAUTION: USE SMALL WELD ROD IN THIS PROCEDURE TO REDUCE HEAT AND MINIMIZE DISTORTION.

(1) Weld and stress-relieve cracks around water injection bosses in accordance with Paragraph A., above.

12. Fireseal Crack Repair - Boeing Installation

A. Procedure - Circumferential Cracks (Six O'Clock Area), Lower Fireseal Assembly

See Figure 813.

(1) Stop drill end of cracks.

(2) Provide clearance cut in spacer and rivet spacer onto fireseal.

(3) Predrill boltholes in braze as shown in referenced figure.

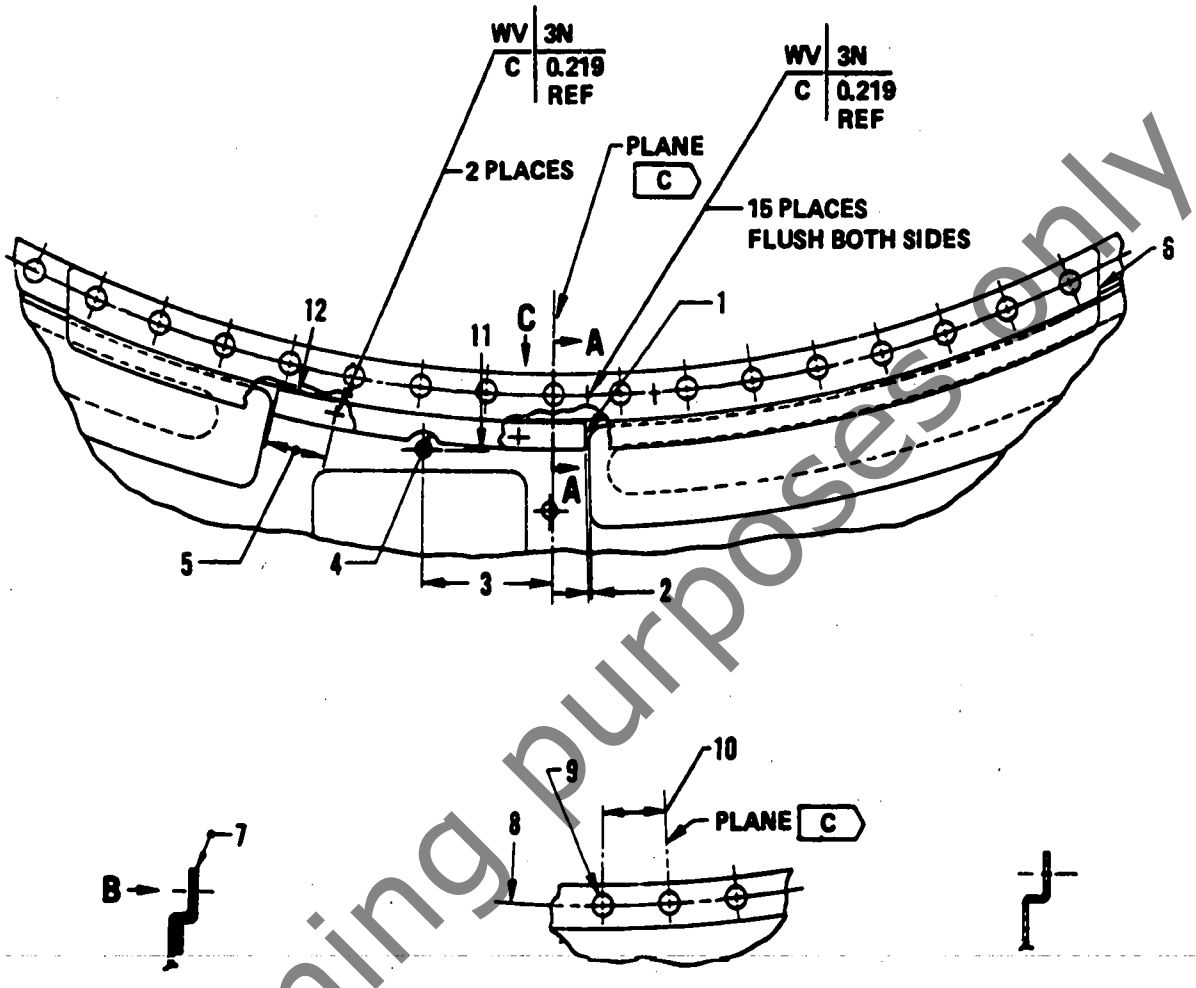
(4) Install brace over face of fireseal and bolt on.

NOTE: The use of brace on fireseal necessitates longer bolts in holes encompassed by brace.

(5) At assembly, replace 6 Bolts MS9035-12 with 6 Bolts MS9035-13; 8 Bolts MS9035-13 with 8 Bolts MS9035-14; 2 Bolts MS9035-14 with 2 Bolts MS9035-15, in area of lower fireseal.

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ENGINE - APPROVED REPAIR



1. Spacer PN 702096
2. 0.010 Inch Maximum. Two Places. Machine Spacer If Necessary.
3. 2.100 Inches
4. 0.250 - 0.281 Inch Radius, Located Within 0.005 Inch Radius Of True Position.
5. 1.000 Inch, Both Ends.
6. Brace, PN 702273
7. This ID Surface Of Brace, No. 6, Must Be Flush Or Below Adjacent ID Surface Of Fireseal.
8. 20.580 Inches Radius, Reference
9. 0.339 - 0.349 Inch Diameter Through Brace No. 6. 16 Holes Located From Holes In Fireseal.
10. 3° Reference
11. 21.430 Inches To Centerline
12. 21.110 - 21.150 Inches Radius

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ENGINE - APPROVED REPAIR

(6) At first convenient opportunity repaired part is to be reworked in accordance with Overhaul instructions.

13. Numerical Tool List

PWA 30634 Wrench

PWA 30635 Wrench

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ON THE WING MAINTENANCE

1. General

A. Procedures in this section are designed to be accomplished with engines installed on the aircraft unless otherwise specified.

B. Because this work is detailed and somewhat complicated in nature, it is to be accomplished under the direct supervision of a qualified powerplant foreman with mechanics and inspectors having received "on the job" training on the particular job.

C. While this section deals primarily with a complete check of the hot section; applicable portions may be used to perform fuel manifold lug clearance, exploratory checks, etc. and/or change out of any hot section components contained herein.

D. In recognition of the fact that certain limits contained in this section may become apparently overconservative as on wing maintenance experience builds, the following specification review procedure exists for properly evaluating any limit contained in this section:

(1) The powerplant specialty foreman shall call attention to the specification limit he thinks should be reevaluated.

(2) Powerplant engineering will review the limit and make any changes necessary to provide a realistic limit. If it is desireable to have service experience prior to changing a limit, powerplant engineering will authorize a new temporary limit apart from that contained in the specification for the purpose of service evaluation. This will be done by wire.

(3) The powerplant foreman receiving the wire authority will document in writing and with photographs if possible the condition existing at time the evaluation begins. This information will be sent to powerplant maintenance engineering.

(4) Powerplant maintenance engineering will set up follow-on inspections as required to further document any changes in condition that may develop.

(5) When adequate evidence has been gathered powerplant engineering will institute any specification changes necessary to improve the specification.

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2. Hot Section Inspection

A. General

(1) This procedure checks the condition of the fuel manifold, combustion chambers, transition duct, 1st-stage nozzle guide vanes, 1st-stage turbine, 4th-stage turbine, and all interior areas of the engine visible with the combustion case aft and combustion chambers removed.

(2) No deviations from procedures and/or limits contained in this section are permitted unless approved by Powerplant Engineering.

(3) Average time to slide combustion case aft and remove cans is 1-1/2 hours. Complete hot section will require 10 to 12 hours elapsed time. Should a fuel manifold change be required, an additional 2 hours will be necessary. Times are based on utilizing four mechanics and one full time inspector.

(4) Limits contained in the JT3D Light Overhaul Manual and the Overhaul Manual are applicable if not contained in this procedure.

B. Procedures and Definitions

(1) Condition "B" recheck.

(a) When condition "B" rechecks are scheduled only those items stipulated in the remarks section of the previous On-Wing Hot Section Inspection accomplishment message need to be inspected. Items not required for this purpose may be signed off as not applicable. To ensure the accomplishment of a condition "B" recheck based on the most recent information, JEDMP will originate a message to JEDMZ and JEDMI, advising the date of the On-Wing Hot Section Inspection accomplishment message to refer to for inspection requirements. If required, JEDMI will provide additional information on request.

(2) Deferring Hot Section Inspection Items

(a) Certain items may be deferred such as fuel manifold change due to lug wear, and a limited extension given until items are corrected, however, prior to deferment, JEDMI must be advised to determine the amount of extension. Deferred items must be corrected within this time to qualify for further time extension.

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(3) Engine Condition Definitions

(a) Condition A-6 - This designation shall be used to identify engines meeting all standards outlined in this procedure, has eight Type III combustion chamber clamps (Mfg P/N 622382) and in addition meets all criteria outlined in par. (b).

(b) Condition A-4 - This designation shall be used to identify engines meeting all standards outlined in this procedure and in addition meets the following criteria.

1) Fuel manifold must be modified (SB 852) with no more than 0.013-inch clearance between the diffuser case mount lugs.

2) No preceptible combustion case scallop wear - no more than 0.002 inch.

3) Basic interior of engine, diffuser case struts, No. 5 bearing support, etc., be free from cracks.

4) Reconditioned or inspected combustion chambers meeting "A" condition limits.

5) Combustion chamber clamps Type II must be MCI reconditioned or new. Type III clamps may be reused providing they are not cracked, bulged, or not more than 10% of plasma coating missing. This is the surface that mates with the combustion chamber 11th liner. Do not confuse polishing of the plasma coating as being missing coating. The loose heatshield may be reused providing it is not cracked or bulged.

NOTE: The heatshield and clamps are not matched assemblies and can be replaced separately.

6) Transition duct within acceptable limits outlined in this procedure.

7) First stage nozzle guide vanes uncracked except for 0.250 inch or less isolated to the vane trailing edge. Condition A6 only.

7A) First stage nozzle guide vanes cracks may not exceed 0.400 inch in length (Ref Page 1313A). Condition A4 only.

8) No looseness of 4th stage turbine blades.

9) Exterior of exhaust case free from cracks.

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10) Check oil cooler thermostat. If date on cover exceeds 1 year or if there is no date on the cover replace thermostat

NOTE: Before installing new thermostat vibropeen or stamp date on cover.

(b) Conditon B - on an engine is defined as one meeting minimum standards of inspection contained in this procedure. Refer to specific sections for details of limits. A summary of limits is as follows:

1) No foreign object damage to interior of engine.

2) Fuel manifold lug clearance no more than 0.020.

3) No more than 0.007 combustion case scallop wear.

4) Basic interior of engine, diffuser case struts, #5 bearing supports, etc., free from cracks.

5) Combustion cans and clamps inspected and meeting B condition limits outlined in this procedure.

NOTE: No wear is permissible on combustion chamber locating lug.

6) Transition duct within acceptable limits outlined in this procedure.

7) First stage nozzle guide vanes cracks are no more than 0.400 inch in length.

8) Loose 4th-stage blades are acceptable, advise MCIEE of quantity.

9) Fuel manifold nozzle sleeve diameter more than 1.190 inches.

(c) Condition C - On an engine is defined as one not meeting inspection standards contained in this procedure, however is serviceable for a minimum of 25 or less than 1000 flying hours. JEDMI must be advised and evaluate engine condition with local powerplant foreman prior to extending any Condition C engine more than 25 flying hours. After evaluation, engineering will advise maximum time engine is to be extended.

(d) Any engine with excessive foreign object damage to the interior as determined by local powerplant foreman will require engine removal. Powerplant engineering is to be advised prior to removal.

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(4) Notification procedure on completion of hot section inspection and/or any work performed on the engine interior requiring sliding the combustion case aft.

(a) On completion of on-wing hot section inspection, on-wing hot section recheck, exploratory inspection of engine hot section or any inspection which requires sliding the combustion chamber outer case aft exposing the internal parts of the engine hot section, all inspection items are to be reviewed by a qualified powerplant foreman and a message originated to JEDMI confirming inspection with the following details:

1) Date

2) Airplane Number

3) Engine Position

4) Engine S/N

5) Engine ATSO

6) Reason for OWHSI - routing cond A, cond B recheck, OWHS repair, exploratory OWHS, etc.

7) Engine condition A-6, A-4, B, or C.

8) Combustion case scallop wear

9) Burner can dragons tooth wear

10) Inspection write-ups and corrections: (Specify if no corrections made.)

11) Scallop area hardness after repair (List Rockwell "C" scale numbers.)

12) Type burner cans installed: A or B, Field-A or B.

13) Type combustion chamber clamps installed.

14) Remarks: (Include all pertinent information not in item 1) thru 13) above; however, you must list each item which limits the engine to condition B or C.

(b) All routine and nonroutine work forms must be returned to Production Control and Statistics Records at JEDDAH.

For Training purposes only

C. Equipment Required

(1) 3 air wrenches (90°).

(2) Ease-off 990 lubricant.

(3) Felt dye marker.

(4) Fuel manifold clearance check tool.

(5) Fuel manifold test jeep.

(6) Fuel manifold leak check clusters (8 clusters).

(7) 1st stage turbine blade stretch gage (P&W 16082) - 3 gages.

(8) Combustion case chafing band.

(9) MMP - On Wing Hot Section Check Sheet.

(10) Transition duct knocker.

(11) JT3D Engine Overhaul Manual.

(12) Fuel Manifold nozzle nut wrench PWA 17791.

(13) Magnetic base dial indicator.

D. Sliding Combustion Case Aft.

NOTE: To prevent marring combustion case when removing bolts from forward flange apply a chafing band -- commercial tape or thin material under the heads of the bolts around the case.

(1) Mark bracket locations on aft mounting flange of combustion case.

(2) Remove (12) bolts which secure lower portion of vertical fireseal over forward combustion case bolts at the 12 o'clock position. Slide fireseal left sufficiently to remove. Refer to Figure 1301, detail A.

(3) Disconnect thrust reverser actuator air lines (2 each) at the pylon end and remove the 90° elbows from their support bracket, position lines aft. Refer to Figure 1301, detail B.

(4) Combustion drain can removal -- Refer to Figure 1301, detail C.

(a) Remove the fire detection loop from the support clamps around the drain can and remove loop from engine.

CAUTION: DO NOT DAMAGE LOOP.

For Training purposes only

(b) Disconnect fore and aft drain lines from drain can.

(c) Remove attach bolts (4) at forward end of drain can and aft bolts (3) at turbine drain.

(d) Remove drain can.

(5) Remove Pylon drain line from the aft flange of the combustion case.

(6) Remove forward and aft bolts from fire-warning loop support brackets to allow clearance for combustion case to slide aft. Refer to Figure 1301, detail D.

(7) Remove left and right ignitor plugs.

(8) Remove the flange bolts and nuts securing the combustion chamber outer rear case to the shorter combustion chamber outer front case.

(9) Remove the nuts which attach the combustion chamber outer rear case to the turbine nozzle case front flange.

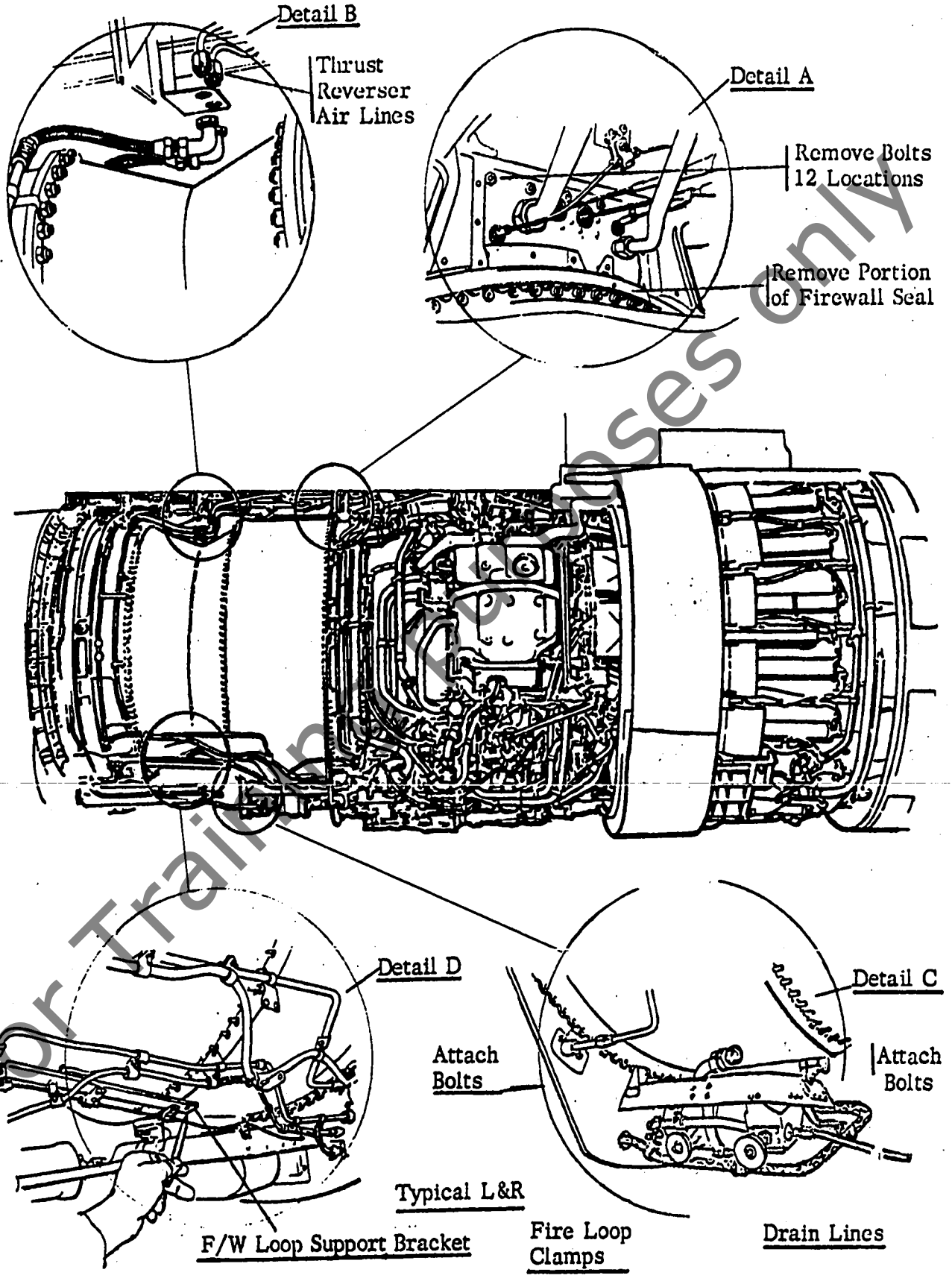
(10) Sharply rap the combustion case at the fore and aft attachment flange with fiber mallets and "pop" case loose.

CAUTION: DO NOT HIT COMBUSTION CASE OTHER THAN ON ATTACHMENT FLANGE AS DAMAGE TO THE CASE MAY RESULT.

(11) Place anti-chafing material, rag or sponge rubber on the aft flange at the 12 o'clock position of the turbine nozzle to prevent damage to the nozzle or combustion case when it is slid aft.

(12) Slide the combustion chamber case rearward over turbine nozzle as far as possible to expose combustion chambers.

For Training purposes only



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E. Removal of the Combustion Chambers.

(1) Check looseness of combustion chambers clamps by grasping each clamp at the bolt buttress and attempt to rotate. No movement of the clamp on the can is permitted.

(2) If looseness is detected in step (1), designate by marking the letter L on each clamp and chamber with felt dye marker.

NOTE: Slight looseness of the clamp on the transition duct is permitted.

(3) Number each combustion chamber and clamp with felt dye marker from one to eight (clockwise) starting with the right hand chamber as viewed from the rear.

(4) Clip and remove lock wire on the combustion chamber clamps.

CAUTION: USE EXTREME CARE TO INSURE THAT NO LOCK WIRE OR FOREIGN MATERIAL ENTERS ENGINE. LOCK WIRE ENTERING THE ENGINE MUST BE FOUND AND REMOVED PRIOR TO PROCEEDING WITH THE OPERATION.

(5) Remove all bolts and shims which secure the clamps to the chamber and reinstall bolts and shims loosely to the clamp nut to insure shims are not interchanged.

(6) Slide the clamps forward on all chambers.

(7) Starting with the 4 or 5 can and working up each side, slide combustion chambers rearward, moving the rear of the chamber outward to disengage the can lug (dragon's tooth) from the positioning bracket, to clear fuel nozzles; then rotate each chamber to disengage the cross-over tubes and allow chamber to rest on adjacent parts.

CAUTION: USE CARE IN DISENGAGING THE #4 CHAMBER TO PREVENT DAMAGE TO THE BURNER PRESSURE ELBOW.

(8) Allow all combustion chambers to shift downward to allow room at the top to remove either the No. 1 or No. 8 chamber. Refer to Figure 1302.

CAUTION: ALL CHAMBERS ARE NOW LOOSE, USE CARE NOT TO DAMAGE FUEL NOZZLES.

(9) Select either chamber step (8) and lift it slightly. Swing the aft portion of the chamber outward and up so that the inside edge of the chamber will clear the transition duct and remove chamber. See Figure 1303.

(10) Remove the remaining combustion chambers in the same manner.

For Training purposes only

F. Removal of First Stage Nozzle Guide Vanes.

(1) Mark the clamp plates on the inner ring of bolts in relation to the #5 bearing support to aid in reassembly.

(2) Mark the relative position of the transition duct to the turbine nozzle case to aid in reassembly.

(3) Remove the small screws securing the 8 gangbolt assemblies and remove gangbolts.

(4) Remove the bolts and clamp plates securing the center of the transition duct to the #5 bearing support.

(5) Install long (1 inch or more) 10/32 screws in the retaining screw holes for the gangbolts.

NOTE: This is to insure the shims between the duct and exhaust case do not drop out.

(6) Using knocker at the center portion, jar the duct loose and move it forward to expose the first stage nozzles.

NOTE: Some ducts will require considerable jarring to break loose.

(7) Using felt dye marker number 4 or 5 vanes at the 9 o'clock position in order to insure their return to the same location.

(8) Remove the lock wire from the vanes to be removed.

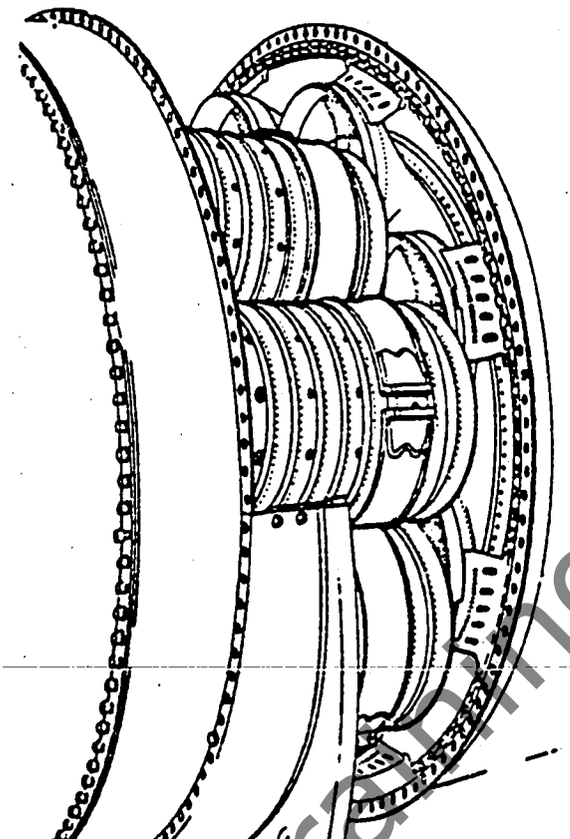
(9) Using a thin bladed screw driver, slip the forward edge of the first vane to be removed slightly over the adjacent one and pry out using a rocking motion.

(10) Pull the vane out until the slot in the outboard edge is in line with the pin on the turbine case. Insert a screwdriver between the case and vane and pry allowing pin to pass thru vane slot and remove vane. Continue removing vanes as required.

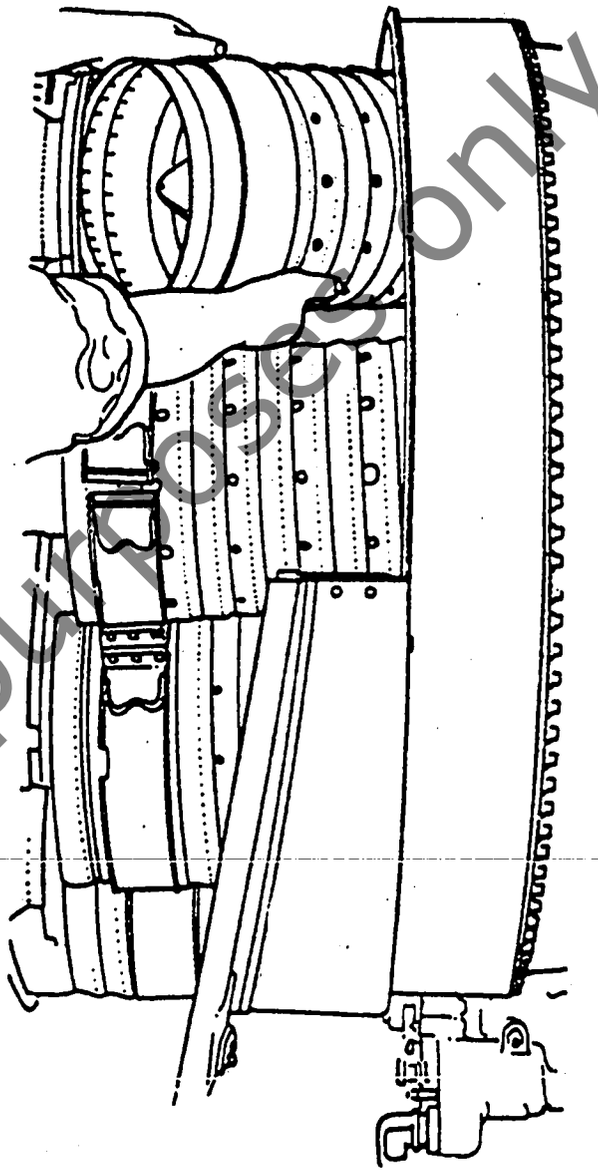
NOTE: The first vane is difficult to remove and at times take considerable working of the vane to remove.

NOTE: All vanes may be removed from the engine at one time if necessary to replace a complete set.

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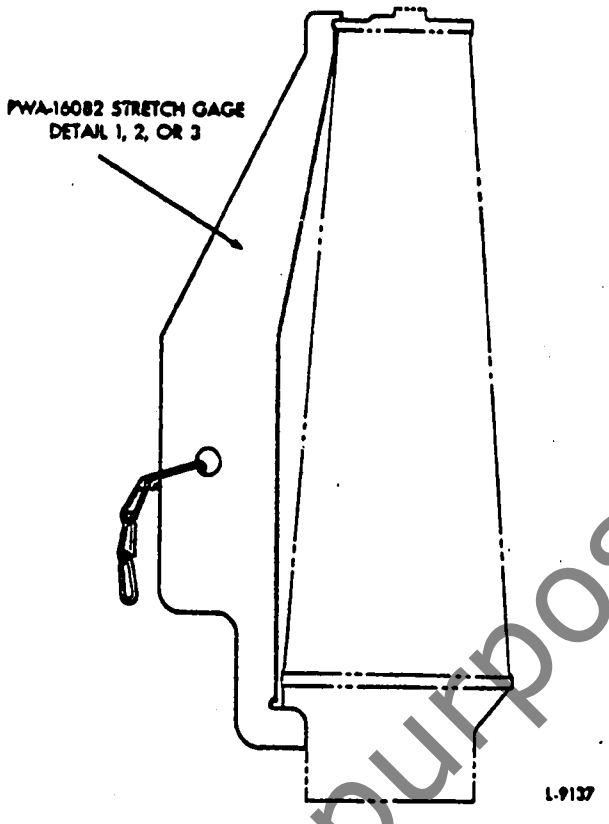


Positioning Combustion Chambers
for Removal
Figure 1302



Combustion Chamber Removal
Figure 1303

For Training purposes only



First Stage Turbine Blade
Figure 1304

G. First Stage Turbine Inspection and Repair

(1) First Stage Turbine inspection.

(a) Check each blade for cracks, heat distortion, nicks from foreign object damage, and looseness.

NOTE: Be particularly sensitive to cracks in leading and trailing edges -- any cracks will require immediate engine removal.

(b) Excessive stretch -- refer to time extension program.

(c) Turbine blade looseness.

1) Blades are considered loose if a very light hand pressure will move the blade circumferentially more than 0.025 between the shrouds of each adjacent blade. This check must be made with all blades in a relaxed condition, i.e., do not stack or pull the blades away from the questionable blades since this unloads the twist and creates a condition not representative of blade looseness.

For Training purposes only

2) Loose blades usually follow notch wear and unless worn notches are found, be absolutely sure the blades are loose before removing the engine. Objectable notch wear is easily detected by spreading the shrouds slightly and making a visual inspection for a wear step on the notch face. Another indication of notch wear is to feel the underside of the shroud at the edge of the notch for a feathered condition, however, do not interpret the rough weld buildup as a feathered edge.

3) Any number of blades may have axial play up to 0.015 inch at blade root and disk providing the rivet heads are sound and undamaged.

(2) First Stage Turbine Blade Repair.

NOTE: Excessive damage to first stage blades will require engine removal.

(a) Small nicks or dents within 1/2 inch of either the shroud or root platform (refer to Figure 1305) can be blended if the damage is not detectable on the opposite side of the airfoil from which they were struck providing repair does not reduce the local air foil thickness by more than 0.006 inch or chord length by more than 0.010 inch.

(b) Blades with nicks and dents in the airfoil, other than in item (a), Figure 1305 may be blended whether or not the damage is detectable on opposite side of airfoil from which they were struck provided following limits are maintained.

1) Airfoil thickness is not reduced more than 0.015 inch.

2) Chord length is not reduced more than 0.025 inch.

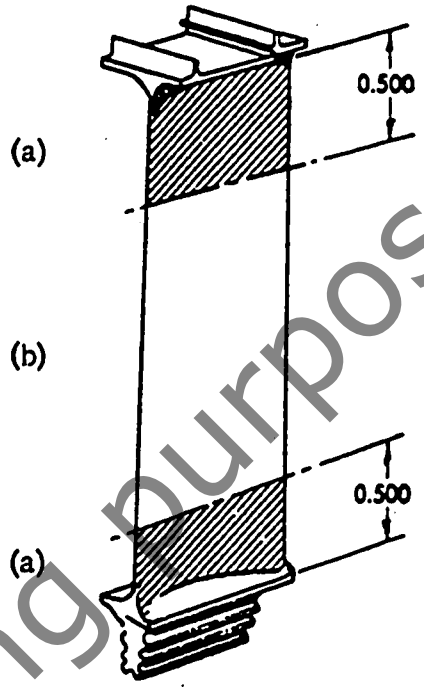
3) Detectable protrusion on opposite side of airfoil is not more than 0.010 inch above adjacent undamaged airfoil surface.

For Training purposes only

4) There are no more than three detectable protrusions per blade and they are separated by a minimum of 0.0250 inch.

5) Smooth dents need not be blended.

(c) All blades with nicks or dents should be checked with dye penetrant or a 5 power magnifying glass.



1st Stage Turbine Repair Limits
Figure 1305

(d) First stage turbine blades which have been rubbed by bowed NGV's are serviceable provided:

1) The wear depth is not more than 0.010 in. Measure this depth by putting straight edge along edge of blade and using feeler gage.

2) The blade shroud notches do not have deep wear or burrs visible from inside of shroud.

3) The rubbed area is penetrant dye checked and is not distressed. No cracks however minute are allowed.

4) The area is dressed down smooth. Use stone or crocus cloth.

For Training purposes only

H. Fourth Stage Turbine Inspection and Repair

(1) Fourth stage turbine inspection.

(a) Using a strong light, check third stage nozzle guide vanes and 4th stage turbine for damage. If damage is suspected proceed to step (b).

(b) Enter tail pipe and grasp each blade with thumb and forefinger and attempt to lightly shake blade -- rattling of one blade notch on another constitutes a loose blade and closely inspect for damage.

(2) Fourth stage turbine repair.

(a) Advise JEDMI of any loose 4th stage turbine blades.

I. First Stage Nozzle Guide Vane Inspection and Repair.

(1) Inspection of first stage nozzle guide vanes.

(a) Check for nicks and dents in trailing edge of vanes caused by foreign object damage.

(b) Check for cracking -- burning of the trailing edge. Small cracks 1/4 inch or less are acceptable.

(c) Slight peeling of plating from the trailing edge of vanes is acceptable.

(2) Following limits apply to Cond A4 and B Cond Engines.

(a

(a) First Stage Nozzle Vanes Cracks - Trailing Edge.

1) First Stage Turbine Guide Vanes exhibiting cracks in trailing edge may continue in service providing:

a) Cracks do not exceed 0.400 inch in length.

b) Cracks are separated by a minimum of 1.000 inch.

c) Cracks are not within 0.500 inch of fillet area of OD and ID buttresses.

NOTE: Cracks in the trailing edge only, exceeding 0.400 inch but less than 0.500 inch may remain in service for 200 hours maximum.

(3) Repair of First Stage Nozzle Guide Vanes.

(a) General

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1) Any or all vanes may be replaced with the same class or as a matched set received from MCI Overhaul.

2) If a vane of the same class is not available use class 20.0 vanes as standard replacement part for 9th stage bleed engines and class 17.0 as standard replacement part for 12th stage bleed engines. For 12th stage bleed engines with bolted in first stage nozzles use class 18.0 as standard replacement part. Any number of standard class vanes may be used to replace unserviceable parts.

NOTE: Refer to Parts Catalog for bolted in vane P/N.

3) If a vane of the same class is not available or standard class parts are not available, one vane may be replaced with a vane within 3 classes of unserviceable vane or a maximum of 7 vanes may be replaced with vanes within one class of unserviceable vanes.

NOTE: Class number is electric pencil etched on the outboard shroud aft edge.

4) Engines subsequent to P&WA S/N 668622B and engines modified in accordance with P&WA S/B 2150 use a bolted in first stage nozzle guide vane.

CAUTION: BOLTED IN VANES ARE PHYSICALLY BUT NOT FUNCTIONALLY INTERCHANGEABLE EXCEPT AS COMPLETE NOZZLE CASE, NOZZLE, AND NOZZLE INNER SUPPORT ASSEMBLIES.

5) For further information refer to JT3D Overhaul Manual Subassembly section 72-51-0.

(4) Installation procedure when changing all first stage nozzle guide vanes.

(a) Arrange all nozzle guide vanes on a bench in such a manner that no more than a 3 class spread exists between vanes.

(b) In this arrangement, mark each blade #1, 2, 3, 4, etc.

(c) Start at the 12 o'clock position, work in either direction keeping vanes in sequence marked in step (b).

NOTE: The last vane to install will be difficult and requires manipulation of all vanes to gain maximum space.

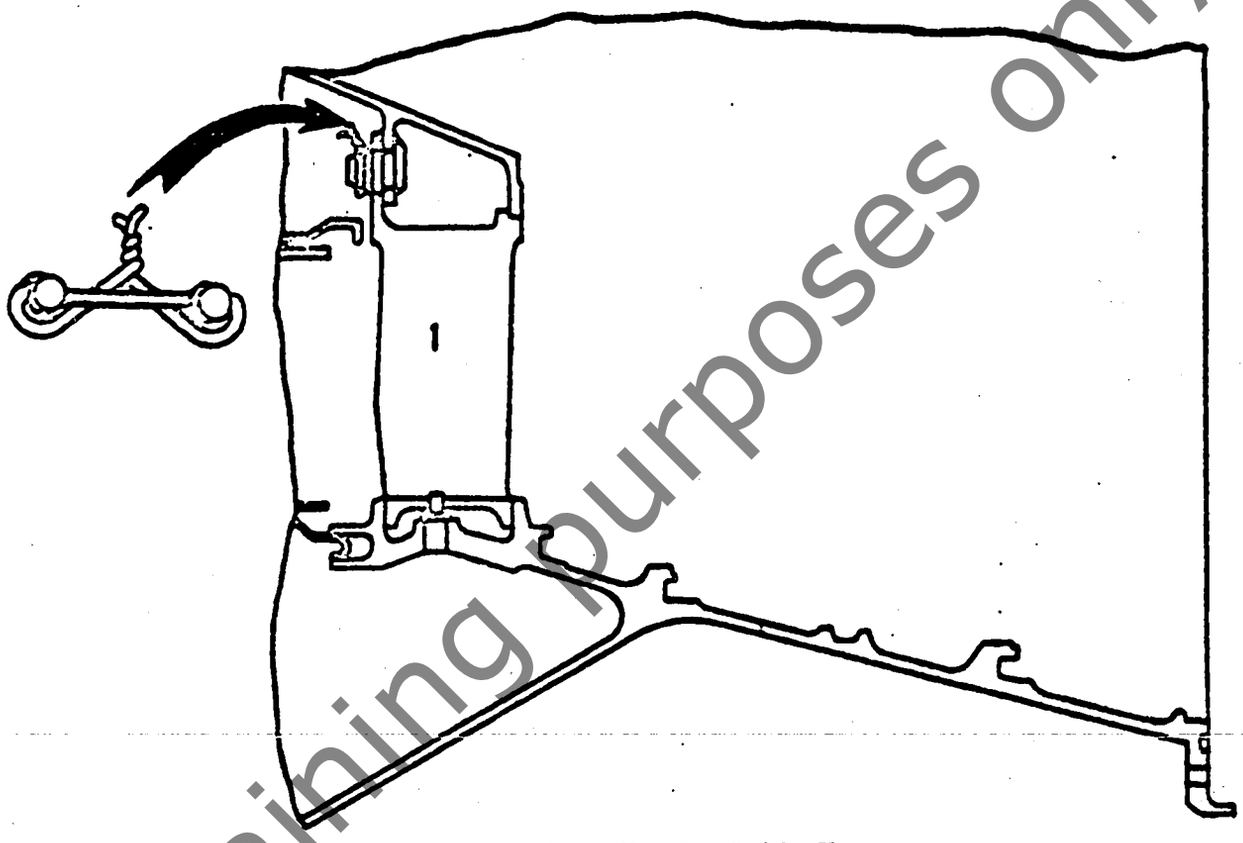
(d) Install the last vane by placing in position and lining vane slot on outboard end with pin in exhaust case. Using screwdriver, pry between case and vane until pin is on top of slot and rap vane sharply allowing it to go in place. Once the outboard end is in place continue working vane until inboard end goes in place.

For Training purposes only

(e) Lockwire the vanes in pairs using approved safety wire. Refer to Figure 1306.

NOTE: Due to uneven number of vanes, it will be necessary to lockwire the last three vanes together.

NOTE: Lockwire vanes with Inconel wire (.050).



Lock First Stage Nozzle Guide Vane
Retaining Pins
Figure 1306

J. Fuel Manifold Inspection Procedure and Repairs.

(1) Inner mount flange clearance inspection.

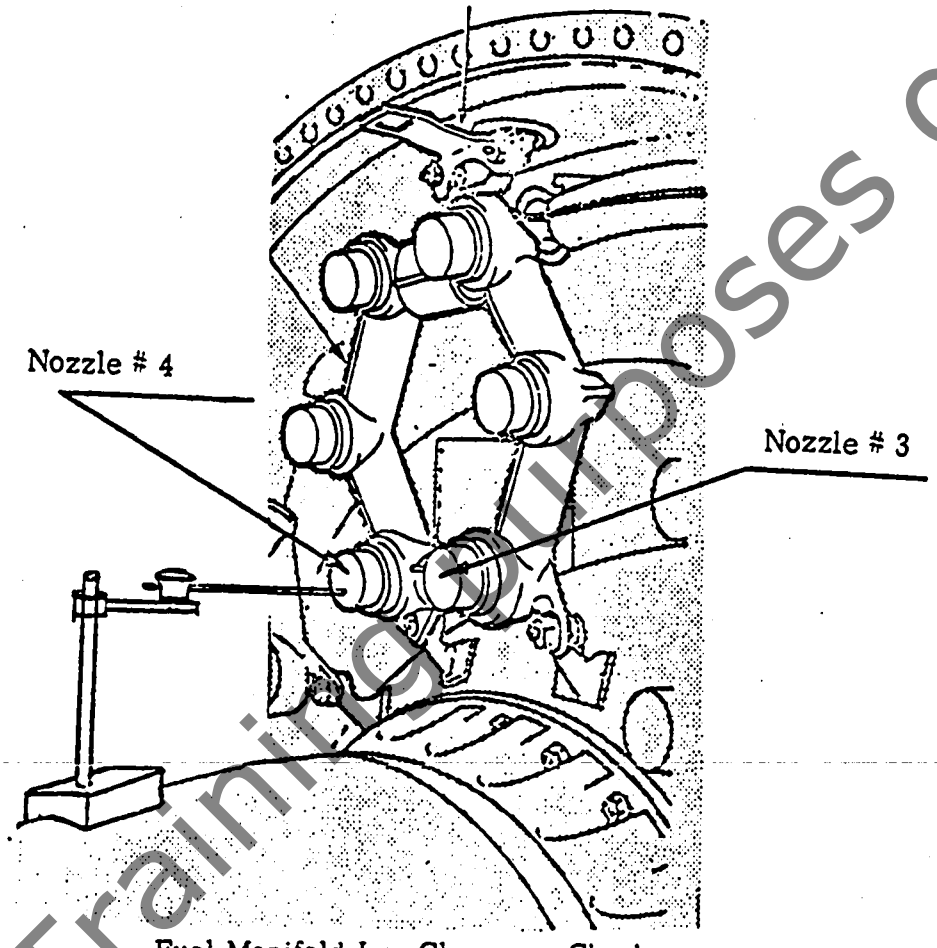
(a) Check the axial movement of the fuel manifold at the inner mount flange of each cluster by setting a dial indicator on the face of each inboard cluster. Refer to Figure 1307. Push the manifold in and hold. At this time 'O' out the indicator. Pull the manifold aft and record clearance on indicator.

NOTE: The #4 and 5 can clusters will require more force to pull to obtain movement due to the proximity to the P & D mount pad attachment.

For Training Purposes only

(b) Clearance must not exceed .013 for Condition A engines or .020 for Condition B engines -- minimum clearance .001.

(c) Individual lug clearance measurements must be included on Hot Section Accomplishment message to JEDMI. When sending message, start with clearance for #1 left lug first and continue until all 16 clearances are on the message -- example: Fuel manifold lug clearances .006/.007/ .008/ etc.



Fuel Manifold Lug Clearance Check
Figure 1307

(2) Repairs to Fuel Manifolds with excessive mounting lug clearance.

(a) Spacers and locks should be replaced on inner and outer lugs with excessive clearance. If clearance cannot be reduced to acceptable limits, the manifold should be replaced. Individual inner spacers can be replaced by removing nut, outer lock, and digging out circlip bolt lock retainer with sharp scribe. Slide bolt forward and pull manifold aft slightly to remove inner lock or spacer.

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(b) If bolt circlip cannot be removed, slip a hacksaw blade between manifold and spacer; saw bolt in two. Pull manifold aft slightly, replace spacer and install new inner mount lug bolt. Circlip need not be installed. It will not be necessary to remove manifold.

(3) Inspection of fuel manifold nozzle wear bands.

(a) Position nozzle Go - No - Go gage around each nozzle wear band. If gage slides on any wear band, the wear band must be replaced (See part (4) following, or manifold must be replaced (See 72-0, page 1302A), for condition A engine. Gage diameter is 1.195 inches.

(b) Minimum wear band diameter for a condition B engine is 1.190 inches. Use Vernier caliper to measure. Wear band must be replaced if any wear band is less than this at any point (see part (4) following), or manifold must be replaced (See 72-0, page 1303).

(4) Replacement of fuel nozzle wear band.

(a) Removal

1) Bend the nozzle nut key washer (interrupted flange which normally restricts removal of the wear band) radially in for about one half of the circumference or more as required.

2) Work wear band off.

NOTE: This can be done with a screwdriver or equivalent tool.

(b) Installation.

1) Slide new wear band in place on nozzle.

NOTE: Assure that dimpling holes in band align with mating holes in nozzle housing.

2) Using special pliers (CEN 2518) dimple the band at the 3 holes.

NOTE: This dimpling must eliminate any looseness between the wear band and nozzle housing.

3) Rebend the key washer to normal.

CAUTION: ASSURE THAT ONE TABLOCK IS ENGAGED IN NOTCH OF WEAR BAND.

For Training purposes only

(5) Inspection of inner and outer fuel manifold mounting bolts.

(a) Check for loose mounting bolts and proper safety techniques.

(6) Repairs of loose inner manifold mount bolts.

(a) Remove nut and tablock.

(b) Slightly enlarge inside diameter of new tablock in order that it might slip over bolt serrations. Install tablock, nut and torque (80/90 lbs inches) and bend tablock.

(c) If still loose, bolt is probably stretched and will have to be replaced.

(d) Bolt replacement is possible with manifold installed by removing nut and tablock, and using sharp scribe, dig out bolt retaining clip and remove and replace bolt. If circlip cannot be removed, slide hack saw between manifold and spacer and saw bolt in two. Replace bolt. Installation of circlip is not necessary.

(7) Inspect fuel manifold heat shields for cracking and looseness.

(a) Check intracluster shielding at points of contact with nozzle bodies. No movement is permitted between nozzle bodies and points of contact.

(b) Movement between the heat shield and adjacent nozzle clusters up to a maximum of 1/16 inches is permissible.

(8) Repairs to fuel manifold heat shield.

(a) Cracking of the heat shield spot welds at the cluster nozzle may be tack welded using Hastelloy "W" rod. Cracks need not be welded unless heat shield is found loose.

(9) Inspection of fuel manifold nozzle retaining nuts. Refer to Figure 1308.

(a) Check for evidence of flame erosion on the nut face around the center hole. Erosion must not exceed .020 inch depth.

(b) Check for evidence of radial cracking around the center hole. Cracks greater than .062 inch long are cause for replacement.

(c) Check for evidence of center hole elongation. Elongation greater than .030 is cause for replacement.

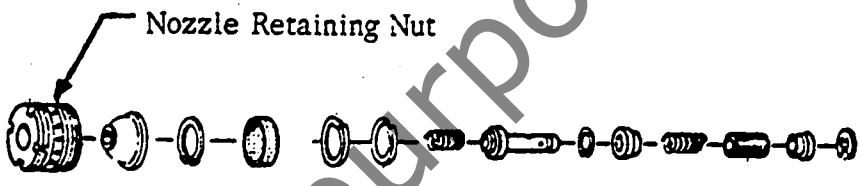
For Training purposes only

(10) Repair of fuel manifold nozzle nuts (Refer to Figure 1308).

(a) Fuel Manifold nozzle nuts not meeting inspection requirements may be replaced with serviceable nut.

(b) If necessary to change fuel manifold nozzle nut, perform Leak Check.

CAUTION: DO NOT REPLACE ANY UNITS IN THE FUEL NOZZLE OTHER THAN THE NUT AS ALL OTHER UNITS ARE CALIBRATED WITH THE MANIFOLD DURING ASSEMBLY.



Fuel Nozzle
Figure 1308

For Training purposes only

K. Transition Duct Inspection and Repair.

(1) General

(a) Transition duct inspection shall be accomplished visually and/or with the use of dye penetrant methods where required to determine condition of the entire part.

(b) Unless otherwise specified all limits are to be considered as the maximum allowable for service without additional corrective maintenance action.

(c) Where repair procedures are specified no limitation is imposed after repair. See paragraph K3 for repair procedures and limitations.

(2) Transition Duct Inspection

(a) Transition ducts conforming to the following limits qualify for condition "A".

1) Total length of cracking in the outer wall of the transition duct, both circumferential and axial, shall not exceed 4 inches with no single crack exceeding 2 inches. All cracks shall be stop drilled with a #30 drill. Axial cracks extending through the aft edge of the pilot ring are not acceptable. Reference Figure 1309, Item 1 and 2.

Converging cracks shall be separated by a minimum of 4 inches of sound material.

2) Cracked or broken cooling air baffles on the duct forward face are not acceptable. Reference Figure 1310, Item 1.

3) Circumferential cracks in the transition duct bowls are not acceptable. Reference Figure 1309, Item 3.

4) Axial cracks in the transition duct bowls are not acceptable. Reference Figure 1309, Item 3.

5) Cracks in the forward face of the transition duct surface are not acceptable. Reference Figure 1310.

6) Localized wear to the transition duct bowl lips caused by combustion chamber clamps is acceptable to a maximum of .100 inch deep.

7) Localized burning and erosion of the transition duct bowl lips is acceptable providing there are no cracks and the axial dimension of the lip is not reduced by more than 10% of original.

For Training Purposes only

8) Cracks in the combustion chamber inner outlet duct seam weld where it joins the forward face are acceptable up to a maximum of 4 inches providing no single crack exceeds 1 inch in length and a minimum of 2 inches of sound material separates each crack. Cracks which exceed this limit are weld repairable.

(b) Condition B Limits.

1) Total circumferential cracking in the pilot seam weld is limited to fifteen (15) cumulative inches. Length of any one crack is not to exceed total length of ten (10) inches and must be separated from other cracks by a minimum of four (4) inches of material. Refer to Figure 1309, Detail 1.

2) Axial cracks in the pilot ring are limited to two (2) inches provided they do not extend thru the aft edge of the pilot ring. Refer to Figure 1309, Detail 2.

3) Circumferential cracks in either the inner or outer portion of the combustion chamber bowl are limited to 5 inches for each bowl. Refer to Figure 1309, detail 3.

4) Axial cracks in the combustion chamber bowl into the forward face of the transition duct are limited to 1 inch provided crack does not extend thru the outer lip of the bowl. Refer to Figure 1309, Detail 4.

5) Cracks across the forward face of the transition duct are limited to 2 inches with no more than one crack at each bracket location. Refer to Figure 1310, Detail 3.

6) Cracked or broken cooling air baffles on the duct forward face are not acceptable. Refer to Figure 1310, Detail 1.

(3) Transition Duct Repairs

(a) Cracks in all areas, except cooling air baffles, may be repaired as follows:

1) Stop drill crack ends with a No. 40 drill.

2) Thoroughly clean area to be welded.

3) Weld by inert gas fusion welding using AMS 5798 or 5799 rod with full gas back up. No stress relief is required.

For Training purposes only

(b) Cracked or broken cooling air baffles must be removed by cutting the baffles at the relief cut-out nearest the welded area of the doubler. Ref. Figure 1310, detail 1. After removal the cooling holes in duct face must be spot welded closed using inert gas fusion welding with full gas back up using AMS 5798 or 5799 rod. No stress relief required.

(c) Circumferential cracks in the chamber outlet ducts (Burner Can Bowls) are limited to three inches in length and two in number with a minimum of two inches of sound metal separating the two cracks. Ref. Figure 1309, Detail 3.

(d) Circumferential cracks at the seam weld securing the AFT pilot ring are limited to nine (9) inches in length and two (2) in number with a minimum of eight (8) inches of sound metal separating the two cracked areas. Ref. Figure 1309, Detail 1.

(e) Axial cracks in the AFT pilot ring are limited to one (1) inch in length and eight in number provided they do not extend thru more than 50% of the pilot ring material. Ref. Figure 1309, detail 2.

(f) Axial cracks in the combustion can bowl into the forward face of the duct are limited to one (1) inch provided the crack does not extend thru the forward ring on the bowl. Ref. Figure 1309, Detail 4.

(g) Cracks across the forward face of the duct are limited to one (1) inch with no more than one (1) crack at each bracket location. Ref. Figure 1303, Detail 3.

(4) Sectional Repair of Transition Duct Porthole (Duct Lip).

(a) Remove warp using special tool in GEN 2774 kit.

1) Using a new duct lip ring as a guide check by placing new ring against forward edge of old ring.

2) Gap between rings should not exceed 0.030, except in local area where erosion has occurred.

3) If duct lip is warped place sections of tool 90° from each other and tighten through bolt. Remove tool and recheck for above limit.

(b) Cut a section from new duct ring.

1) Measure 1" on either side of the distorted area and/or circumferential crack a minimum of 4 inches. Maximum of 180° of ring can be repaired.

2) Cut a section from the new ring to the above dimension -- cut both ends square.

For Training purposes only

(c) Cut damaged section from transition duct lip.

1) Using section cut from new ring as a template place over outside of area to be removed. Mark edges with a scribe.

2) Using a high speed grinder (0.050 x 3 diameter wheel) cut out section. Cut total length about 0.030 shorter than new section. Clean face of duct about 1/4 inch all around area to be repaired, inside and out, lightly grind area. (Cut back to sound material only).

(d) Install special tool in GEN 2774 kit.

1) Insert expander tool and tap flat with forward face. Place expander on opposite side from repair so clamps can be used to hold new section.

2) Tighten expander nut until gap is 0.030 to 0.090 between the two halves.

3) Trim ends of new section until it fits repair; gap between new and old material should not exceed 0.030. No gap is preferred.

4) Form area on both sides of repair to fit contour of expander tool and clamp securely in place. Clamp new section of ring in place.

(e) Weld new section in place.

1) Tack weld outside about every 1 inch. (Use 0.040 diameter Hastelloy "W" rod.)

2) Weld from one end toward middle about 1/3 of total distance. Weld opposite end toward middle for 1/3. After weld has cooled off weld middle section. Do not attempt to penetrate 100% as this will cause distortion; penetrate approximately 50% per side.

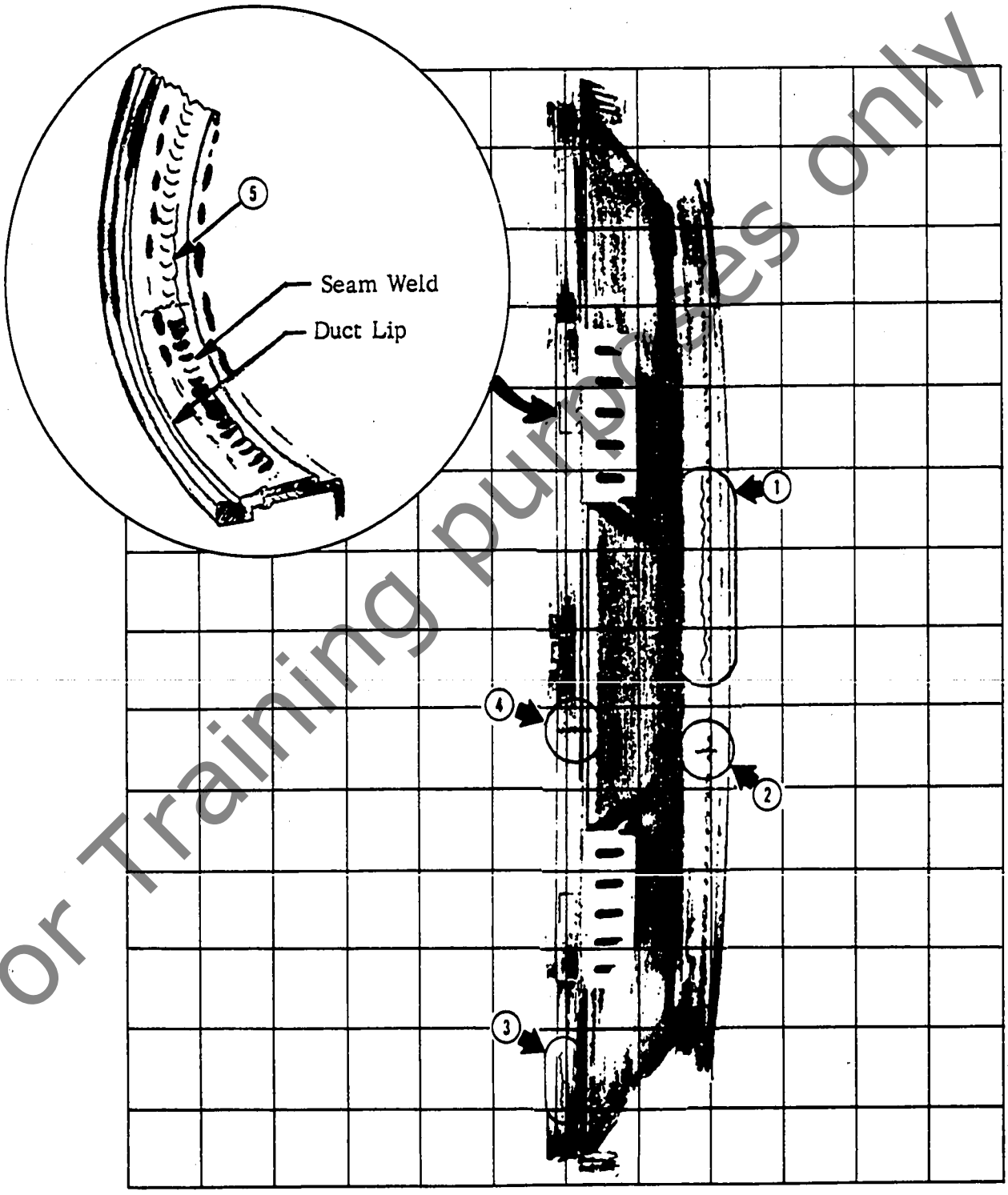
3) Remove expander tool.

4) Weld inside of ring, use gas back up or a copper back up plate.

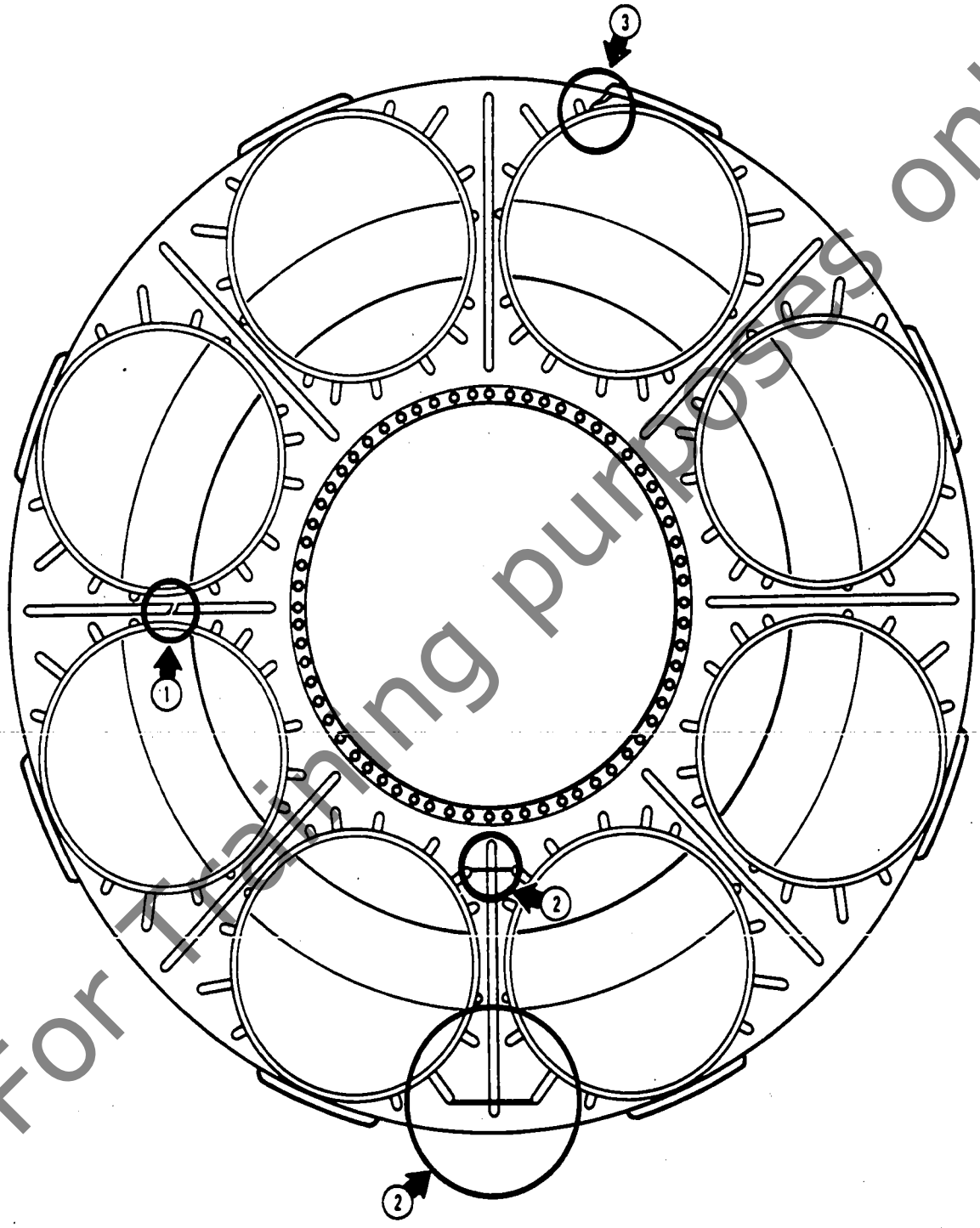
NOTE: If repair is between two adjacent rings where welding of outside is difficult, after tack welding, the inside may be welded first using gas back up outside then finishing the outside using gas back up or copper plate inside.

(f) Grind weld bead to original contour in area where clamp will contact duct lip. (Outside only.)

For Training Purposes only



For Training purposes only



For Training purposes only

L. Number 5 Bearing Support Inspection and Repairs.

(1) Number 5 bearing support inspection.

(a) Visually check entire exterior area noting any cracks.

(2) Number 5 bearing support repair.

(a) No repairs are permissible to the #5 bearing support installed in the engine.

M. Diffuser Case Interior Inspection and Repair.

(1) Diffuser Case interior inspection.

(a) Check interior struts and manifold attach lugs visually for cracks.

(b) Check 16th stage compressor exit guide vanes and 16th stage compressor for foreign object damage.

NOTE: Do not be misled by rework to vanes and exit vanes.

(2) Repairs to diffuser case interior.

(a) No repairs are permitted.

N. Combustion Case Inspection and Repair.

(1) Combustion chamber case inspection.

(a) Carefully inspect interior and exterior of combustion chamber front and rear outer cases for cracks in flange areas, (particularly in flange radii) case seam welds, and around drain boss welds. No cracking is permitted or can be repaired except minor cracks in the front combustion case scallop hardface areas.

(b) Inspect for wear at the eight scallop cutout areas on the front combustion case. Wear depth in these areas shall limit the engine as follows:

1) Wear 0.002 to 0.007 inch deep at any location shall cause the engine to be condition B.

2) Wear deeper than 0.007 inch shall cause the engine to be condition C.

For Training purposes only

(2) Front combustion case scallop repair.

(a) General.

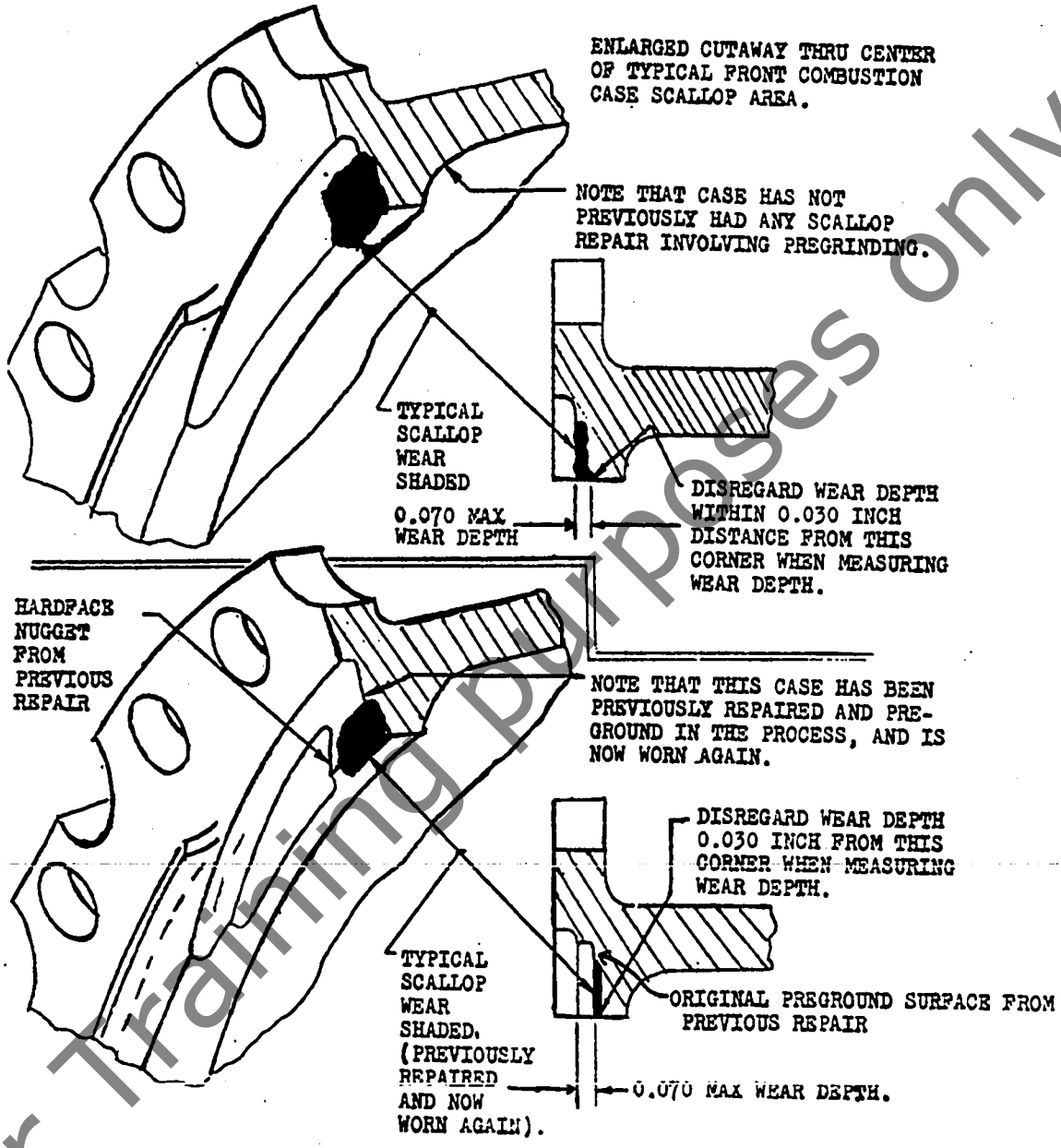
1) Scallop areas not worn beyond the 0.070 inch limit as shown in Fig. 1310A are repairable by this procedure. Wear beyond this limit is not repairable. Note that both previously repaired and previously unrepaired cases are shown in Fig. 1310A, but the limit is the same for both.

2) The front outer combustion case has a protective coating of nickel-cadmium plating to prevent corrosion. Care must be taken not to apply the heat of welding anywhere on case where the nickel-cadmium plating exists. If this occurs cadmium may diffuse into the case parent metal causing enbrittlement and resulting in cracking on this critical component.

(b) Repair procedure.

1) Strip all nickel-cadmium plating two inches in all directions from each scallop wear area to be repaired by sandblasting. Use crocus cloth and butterfly polish technique on case bolt holes in the repair area.

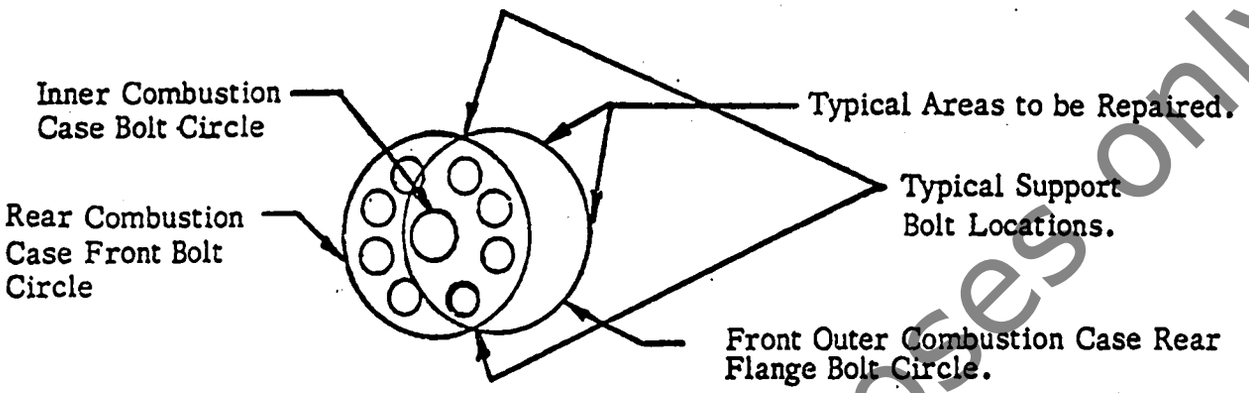
For Training purposes only



NOTE: SOME CASES MAY BE FOUND WORN 0.070 INCH OR LESS AND YET SHOW A SLIGHT AMOUNT OF WEAR BELOW THE ORIGINAL PREGROUND SURFACE SHOWN ABOVE.

For Training Purposes only

2) Support the case firmly and appropriately to the area/s being repaired. The rear combustion case can be used to support the front combustion case during repair by offset bolting at several points to gain maximum access for welding and grinding as shown in Fig. 1310B.



Front Combustion Case Support for Scallop Repair
Figure 1310B

3) Locate grinding tool on front combustion case with clamps provided. Connect cooling spray and add shims as required to position the grinding wheel for proper case clearance (refer to Fig. 1310C) if GEN 1983 tool is used.

NOTE: This adjustment is only required if the wheel circumference has been changed by dressing.

NOTE: Mechanically supported hand grinder may be used instead of GEN 1983 tool for minor wear of less than 0.020".

4) Pregrind the worn area of each scallop cut-out to be repaired only as required to cleanup the worn area, but not more than 0.110 inch. (Ref: Fig. 1310C).

NOTE: Some scallop wear at or near the 0.070 inch depth limit may not clean up at 0.110 inch pregrinding. This is acceptable provided the wear does not exceed 0.070 inch depth limit of Figure 1310A.

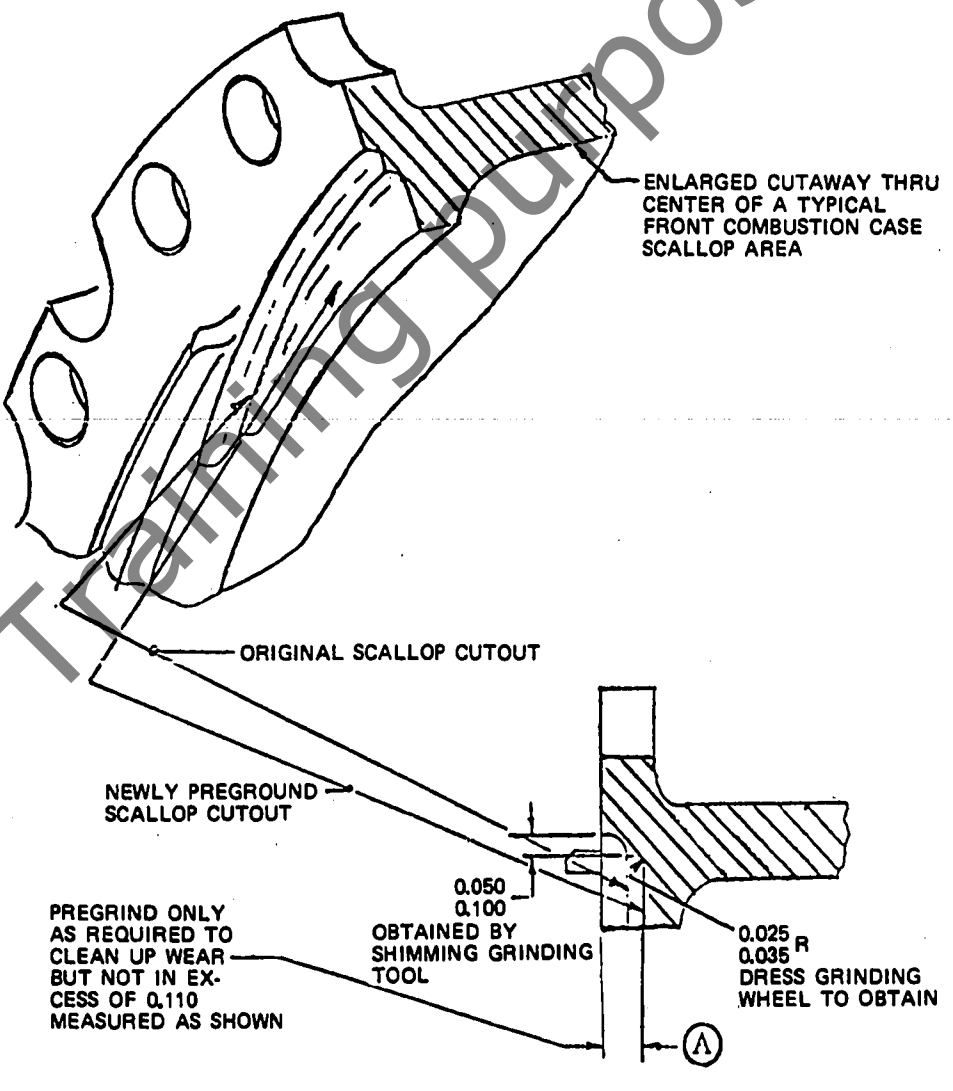
5) Check the hardness in the approximate location where the scallop wear existed prior to grind. This will not be necessary if the scallop is ground out to the 0.110 inch limit.

For Training purposes only

6) Measure the distance from the case front flange front face to the newly preground surface (Dimension marked (A) in Fig. 1310C).

7) If the hardness in a scallop repair area is Rockwell C-42 or higher, and the dimension (A) in Fig. 1310C. Measures between 0.055 and 0.070 inch, no further repair is required for that scallop area.

NOTE: This is possible only when scallop wear is shallow and case dimensional tolerance of 0.055 to 0.070 is on low side.



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8) If hardness is Rockwell C-42 or higher, but Dimension (A) Figure 1310C is larger than 0.070 inch, apply hardface PWA 694 per welding procedure outlined in this procedure.

9) If hardness is less than Rockwell C-42, at any repair location reinstall the grinding tool and pregrind to produce a dimension (A) Figure 1310C of 0.090 to 0.110 inch.

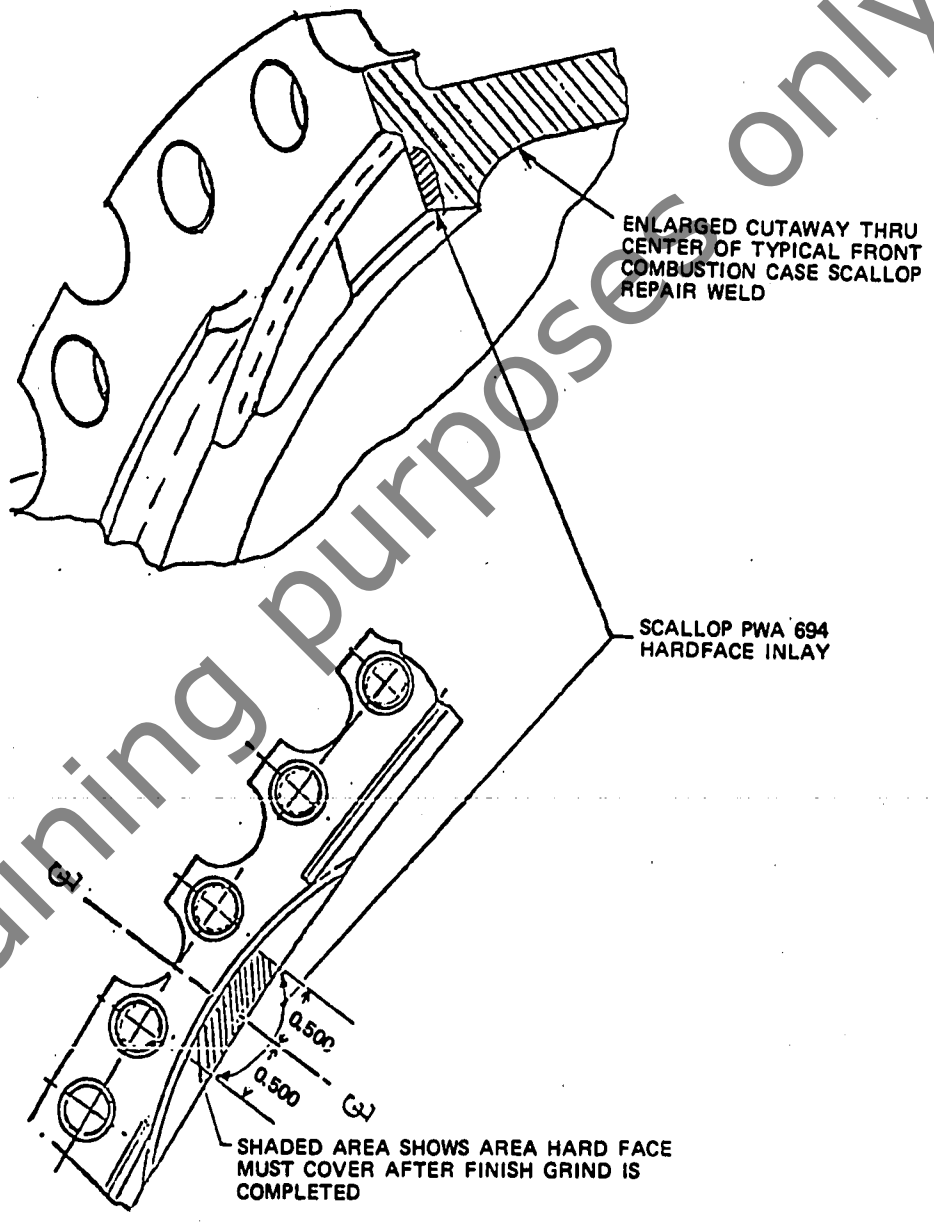
NOTE: This is necessary to prevent a mixture of soft metal and hardface too close to the scallop finished surface resulting in a soft scallop.

10) Apply PWA 694 hardface rod per Figure 4 and the following:

a) Make first pass with the 694 material approximately 0.020 inch deep. Subsequent passes to build up the scallop area may be made in the normal manner applying approximately 0.020 inch weld build up with each pass.

NOTE: It is not necessary to fill the entire pre-grind scallop with the hard face material. Coverage of an area at least 1/2 inch either side of the burner can lug center-line is sufficient. (Ref. Fig. 1310D).

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11) Reinstall grinding tool and finish grind scallop. Hand grind weld overlap to 0.000 min 0.030 max, (Ref. Fig. 1310E).

NOTE: Always dress grinding wheel cutting surface prior to finish grinding. Finish grinding slowly and with a minimum of feed pressure to prevent cracks.

12) Check the hardness of the PWA 694 finished surface.

NOTE: If hardness is less than 42C but greater than 32C, repeat steps 4 through 8. If time does not permit, engine may be operated on a limited basis. Advise JEDMI immediately if this is to be done.

13) Cracks in the new hard face inlay are acceptable providing cracks are in the hard face only and do not progress into the case material. Cracks must be separated by at least 0.25 inch of good material.

14) Stress relieve the repaired scallops with procedure a) or b).

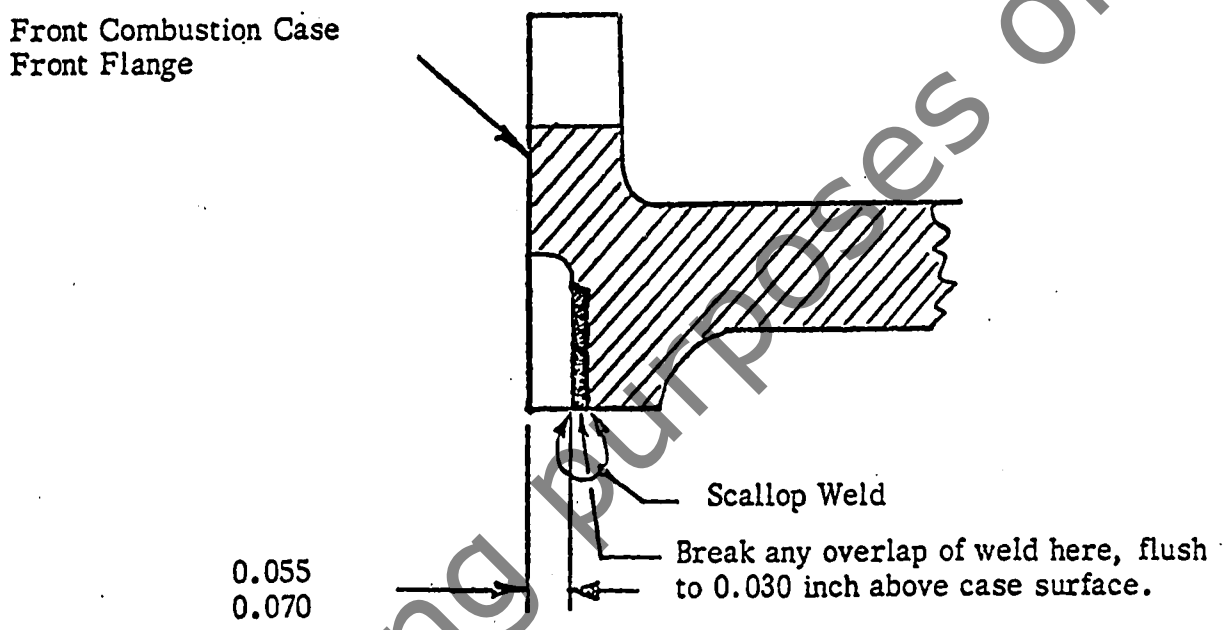
a) Run engine at idle speed for 30 minutes. Time elapsed since weld repair must not exceed 24 hours. Engine flight operation is satisfactory for stress relief.

b) Stress relieve with torch at 600 for 30 minutes.

15) Paint stripped area of the case with high temperature paint.

NOTE: Do not paint snap diameter or mating surface of the flange.

For Training purposes only



For Training purposes only

(3) Scallop Insert Replacement Procedure.

(a) General

1) Certain engines have replaceable scallop hardfaced inserts installed and wear found on these inserts must be repaired by replacing the insert.

(b) Insert Removal

1) Remove the pin securing the scallop insert by drifting a small drift thru the hole in the backside of the combustion case front flange.

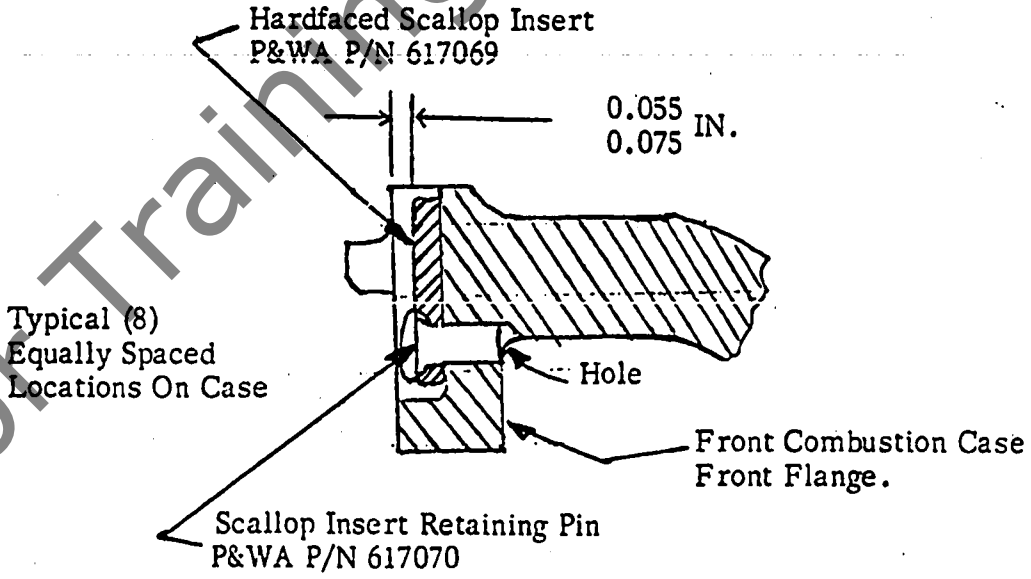
2) Remove the scallop insert from the scallop recess.

(c) Insert Installation

1) Position hardfaced scallop insert P&WA P/N 617069 in scallop recess.

2) Press the retaining pin into the hardfaced insert and the combustion case pin hole until it is flush against the insert. (Pin P&WA P/N 617070).

3) Depth from case flange (parting surface) to insert wear surface must be 0.055 to 0.075 in.



Front Combustion Case Scallop Insert Installation
Figure 1310F

For Training Purposes only

(4) Repair of combustion chamber front outer case scallops which have replaceable inserts worn through.

(a) Scallops with wear in excess of 0.140 inch as measured from the combustion chamber front outer case front flange parting surface are not repairable by this procedure.

(b) Repairable scallops must have all nickel cadmium plating removed by sandblasting, two inches in all directions from the wear area. Use crocus cloth and butterfly polish technique on case bolt holes in the repair area.

(c) Using hand grinder dress off worn area to remove foreign material.

(d) Using inert gas and Hastelloy "W" filler rod, build up entire worn area.

(e) Dress off repaired area until flush with unworn surface.

(f) Stress relieve the repaired scallops with procedure (a) or (b).

1) Run engine at idle speed for 30 minutes. Time elapsed since weld repair must not exceed 24 hours. Engine flight operation is satisfactory for stress relief.

2) Stress relieve repaired area of case with torch to 600°F for 30 minutes.

(g) Paint stripped area of case with high temperature paint.

NOTE: Do not paint snap diameter or mating surface of the flange.

For Training Purposes only

O. First Stage Nozzle Inner Support

(1) General

Detailed inspection of the first stage nozzle inner support is not required for normal on-wing hot section inspection. The following limits are provided for use when the area is exposed as a result of changing first stage nozzle guide vanes and shall be used only to the extent possible without removing additional first stage nozzle guide vanes specifically for this purpose.

(2) Inspection

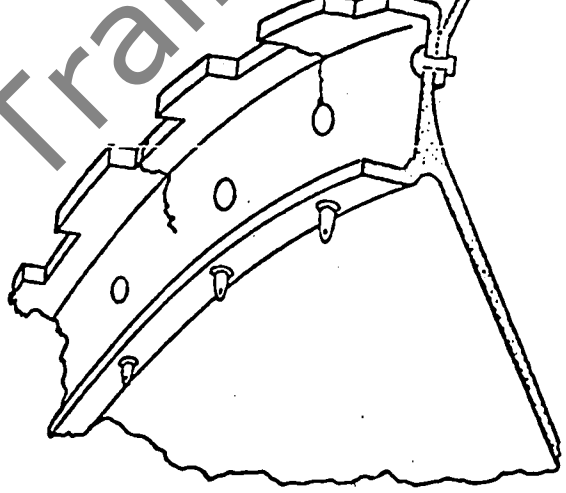
(a) Cracks in the first stage turbine nozzle guide vane inner support are not acceptable except as follows:

(1) For Condition A engines a maximum of three axial cracks originating at the aft flange and progressing forward are acceptable providing they are separated by 60° and do not extend past rivet holes.

(b) For Condition B engines a maximum of five axial cracks originating at the aft flange and progressing forward are acceptable providing they are separated by 45° and do not extend past rivet holes. Ref. Fig. 1310G.

(3) Repairs

(a) No repairs are permitted.



First Stage Nozzle Inner Support
Figure 1310G

For Training purposes only

P. Exhaust Case Inspection and Repairs

(1) Exhaust case inspection.

(a) Check complete exterior of exhaust case for cracking in flanges of mount bolt area, all other exhaust case flanges -- EPR -- EGT probes, etc.

(2) Exhaust case repairs.

(a) Refer to Light Overhaul Manual, Chapter 72-54-0 for Limits and Repair procedures.

Q. Combustion Chamber Inspection and Repair procedure

(1) General

(a) Cracks in combustion chamber surfaces are usually of stress relieving nature and, as such, are not serious in that the rate of growth decreases as the crack lengthens. Thermal stresses, in effect, relieve original stress condition. It is usually normal to observe repetitive occurrence of a given type of deterioration from chamber to chamber in a given engine.

(b) To ensure consistency and to eliminate confusion in reports or inspection standards, use the established nomenclature for the various components of the combustion chambers as shown in Figure 1311.

(c) Figures 1312 through 1316 show various types of combustion chamber deterioration which may be found in chambers at time of inspection. The following paragraphs will call out the deteriorated areas and tell whether or not they are acceptable.

(2) "A" condition combustion chamber limits.

(a) Buckling and/or cracking on the O.D. of the combustion chamber as shown in reference #1, Figure 1312 is acceptable without repair provided no cracks extend from the edge of the head.

(b) Burning of the louver inside the wall to the extent shown in reference #17, Figure 1316 is acceptable without repair.

(c) Burning of the inner liners to the degree shown in reference #8 and #10, Figure 1314 are acceptable without repair. Straighten any bent louver to provide .070 to .20 inch clearance between louver and liner segement inner diameter.

(d) Combustion chamber locating lugs (dragon tooth) are acceptable providing no wear step is detectable.

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(3) "B" Condition combustion chamber limits.

(a) Circumferential cracks (1 inch or less in length) immediately above or below the seam weld in the outer liners as shown in reference 15, Figure 1315 are acceptable without repair.

(b) Axial cracks (1 inch or less) in the outer liner as shown in reference 12, Figure 1315 are acceptable without repair.

(c) Cracks progressing forward from the swirl cup periphery (attaching point of outer brace) are permitted without repair providing the cracks are within the following limits and the cup is not slotted - Refer to Figure 1311.

1) Cracks are less than 1/2 inch long and separated by more than 3/4 of an inch.

2) Cracks are tight (not more than 0.003 inch of material separation).

3) The cracked area is not buckled. Refer to reference 2 and 4, Figure 1312.

(d) Swirl guides, with one crack through the outer wall (or outer ring) are acceptable providing the crack has not progressed thru the attaching weld. Refer to Figure 1311.

(e) Cracks shown in Figures 1312 and 1313, references 3-5-7 over 3/4 inch are not acceptable.

(f) Crack shown in Figure 1313, reference 6, is not acceptable.

(g) Condition shown in Figure 1314, reference 9, is not acceptable.

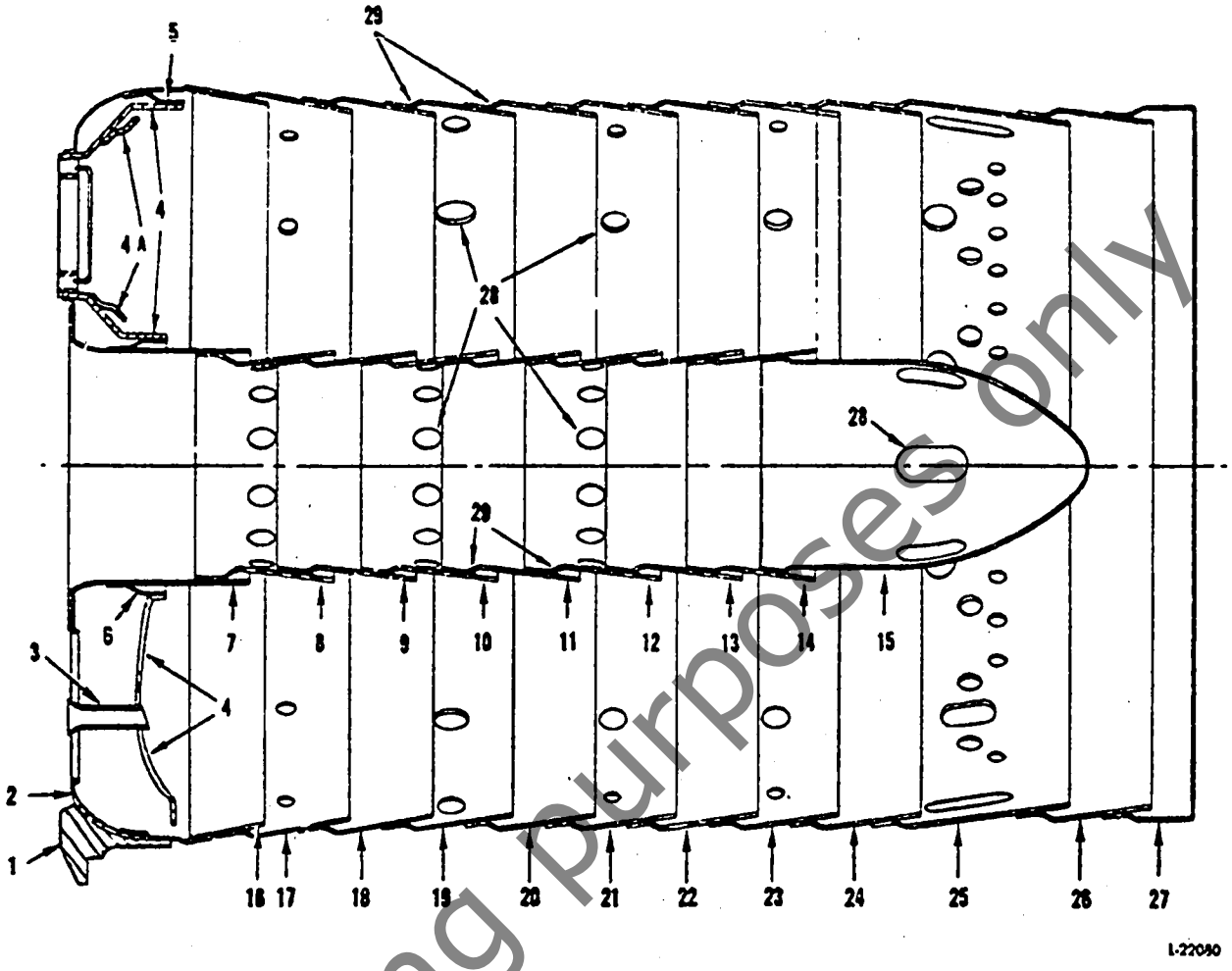
1) Cracks shown in Figure 1315, references 11-13-14 are not acceptable.

(4) Combustion Chamber repair.

(a) Combustion chambers not meeting inspection specifications are to be replaced with serviceable cans, no repairs are permitted in the field.

NOTE: Condition "A" burner cans that are rejected may be repaired to meet Condition "A" limits if repaired at MCI. Repair procedures in P&W Overhaul Manual shall be used to restore cans to Condition "A" Standards.

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Index No.	Dimensions and Notes	Index No.	Dimensions and Notes
1.	Locating Lug	15.	Rear End Inner Liner
2.	Cover	16.	Front Outer Liner
3.	Burner Transfer Tube	17.	No. 1 Outer Liner
4.	Swirl Cup	18.	No. 2 Outer Liner
4A.	Baffle	19.	No. 3 Outer Liner
5.	Outer Brace	20.	No. 4 Outer Liner
6.	Inner Brace	21.	No. 5 Outer Liner
7.	Front End Inner Liner	22.	No. 6 Outer Liner
8.	No. 1 Inner Liner	23.	No. 7 Outer Liner
9.	No. 2 Inner Liner	24.	No. 8 Outer Liner
10.	No. 3 Inner Liner	25.	No. 9 Outer Liner
11.	No. 4 Inner Liner	26.	No. 10 Outer Liner
12.	No. 5 Inner Liner	27.	No. 11 Outer Liner
13.	No. 6 Inner Liner	28.	Combustion Air Holes
14.	No. 7 Inner Liner	29.	Cooling Air Holes

NOTE: Head assembly includes Index Nos. 1 through 6. Inner liner assembly includes Index Nos. 7 through 15. Outer liner assembly includes Index Nos. 16 through 27.

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R. Combustion Chamber Clamp Inspection and Repair

(1) Combustion Chamber Clamp inspection.

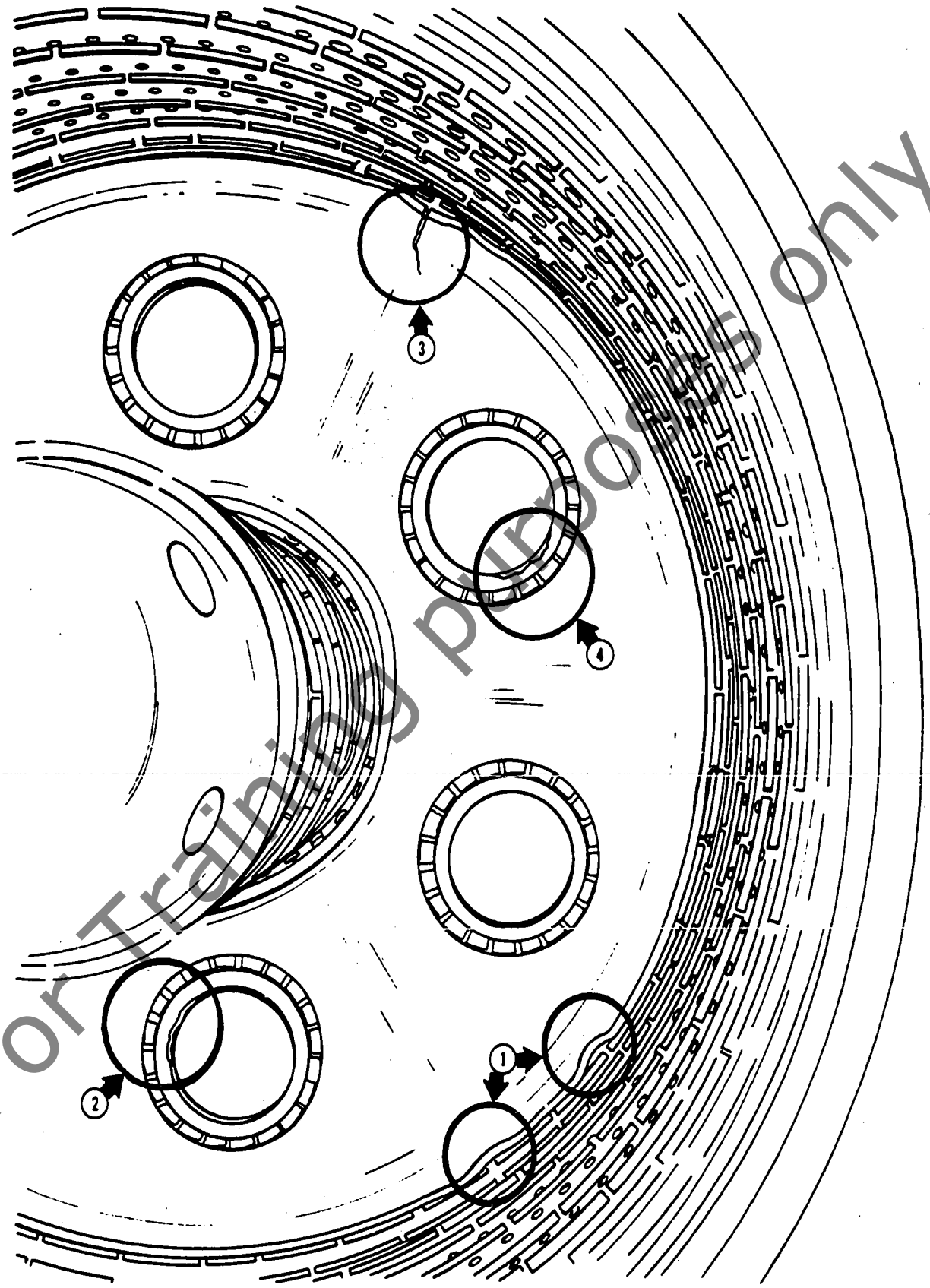
(a) Wear on the I.D. scallop is permitted provided no scallops are reduced to knife-edge thickness.

(b) No cracks in the clamps are permitted.

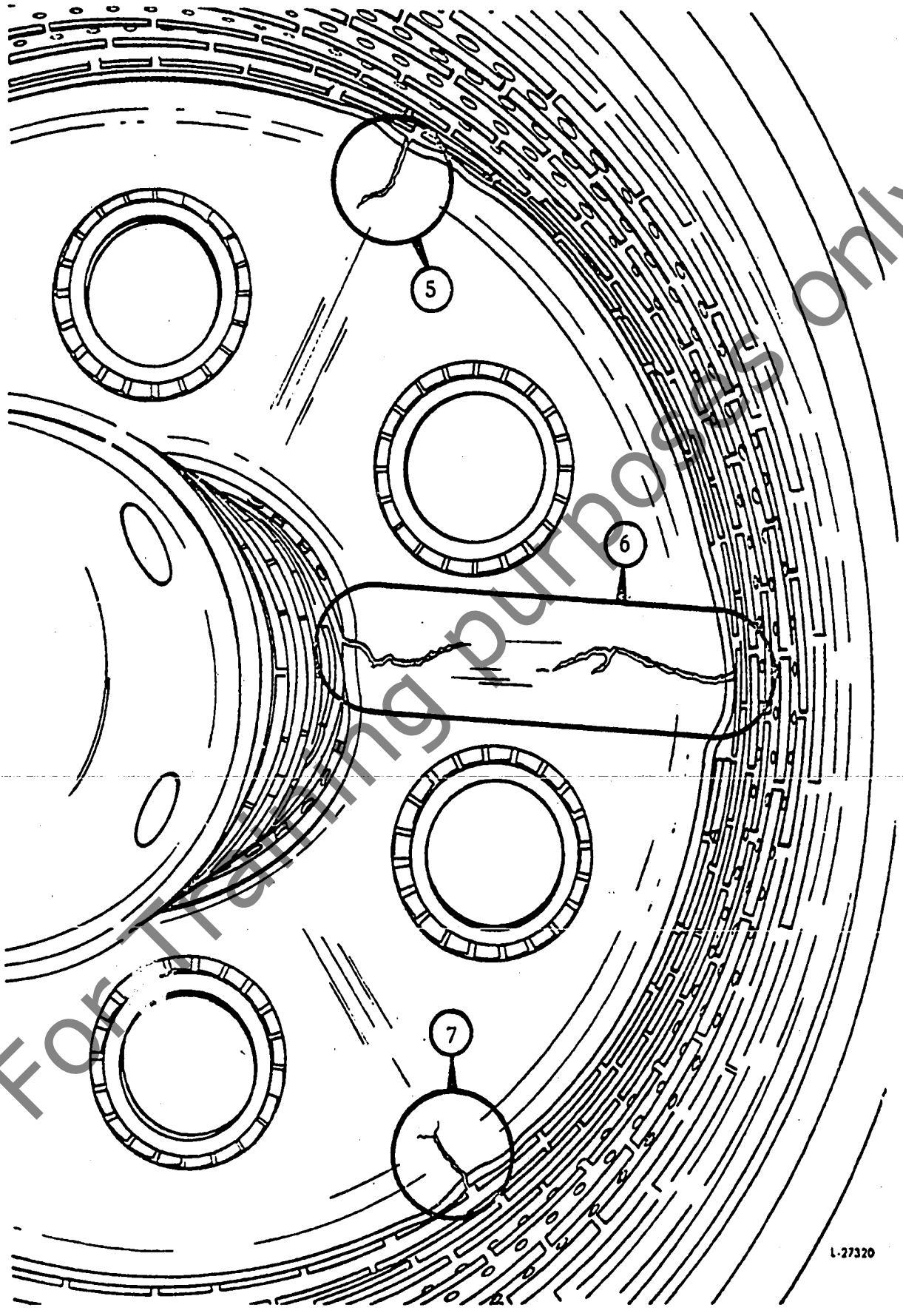
(2) Combustion Chamber clamp repair.

(a) Combustion chamber clamps not meeting inspection specifications are to be replaced with serviceable clamps -- no repairs are permitted.

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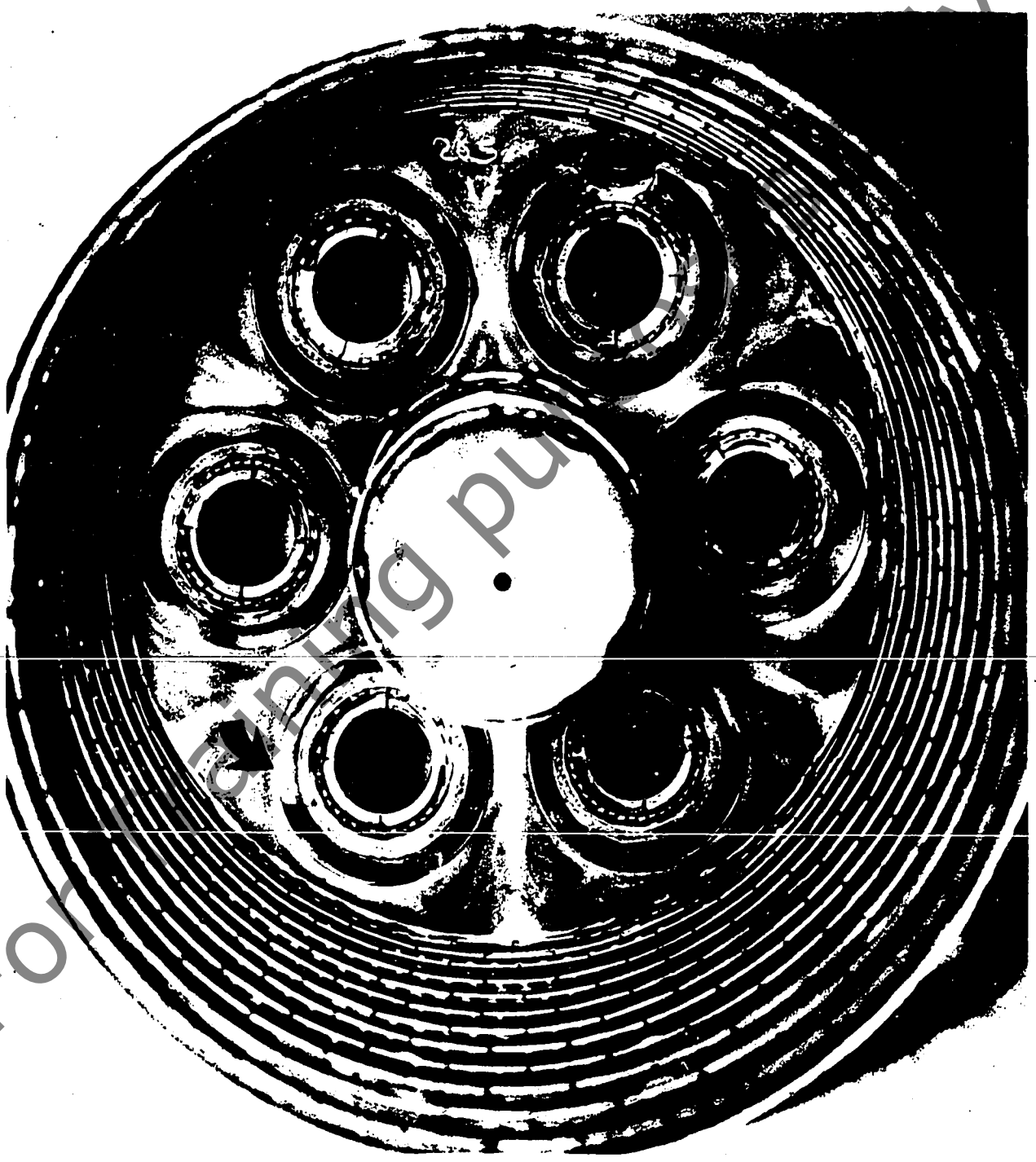
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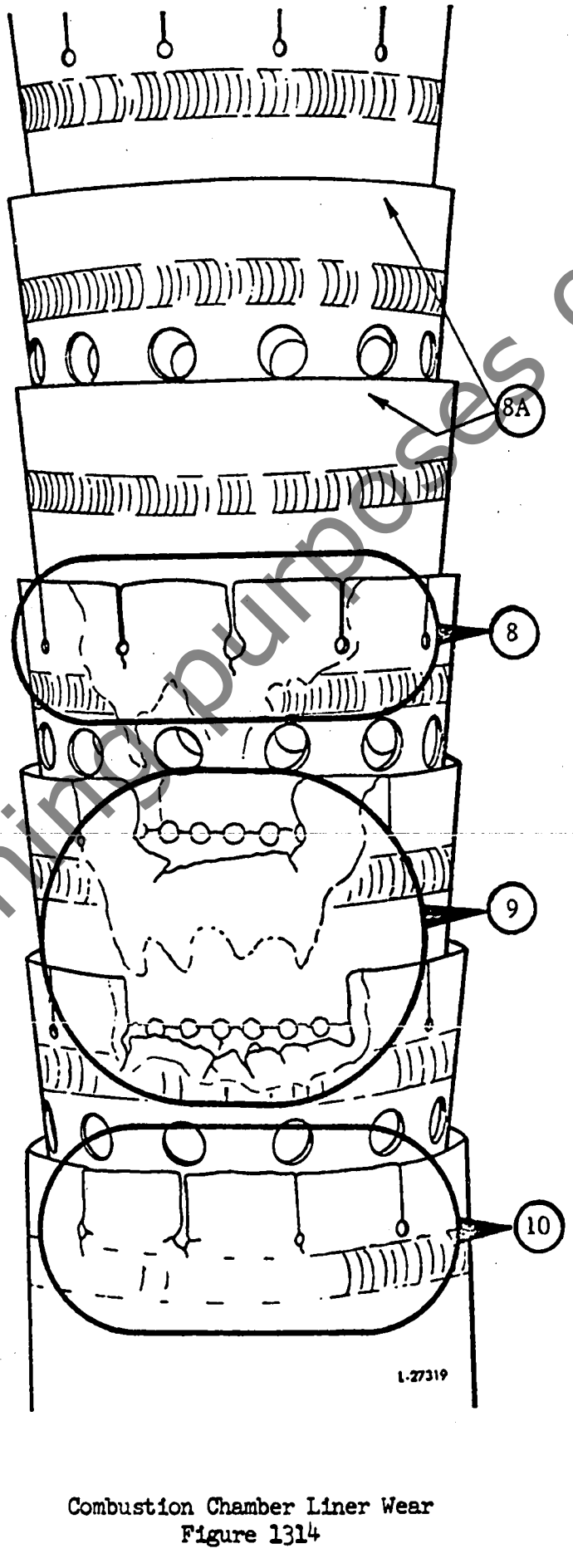
Combustion Chamber Wear
Figure 1313

ENGINE - INSPECTION/CHECK

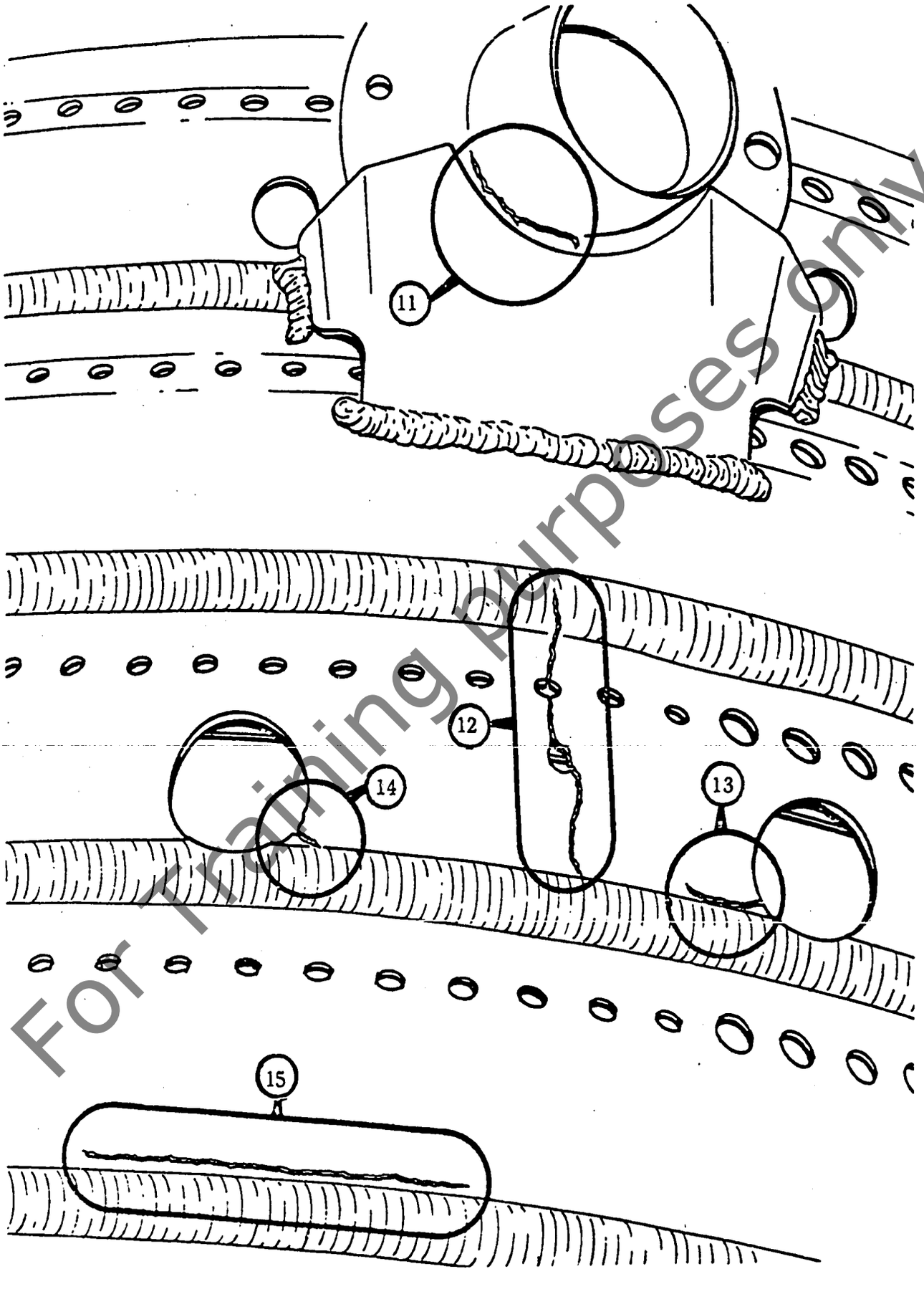


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Combustion Chamber (Louver Cooled Swirl Cup)
Figure 1313A

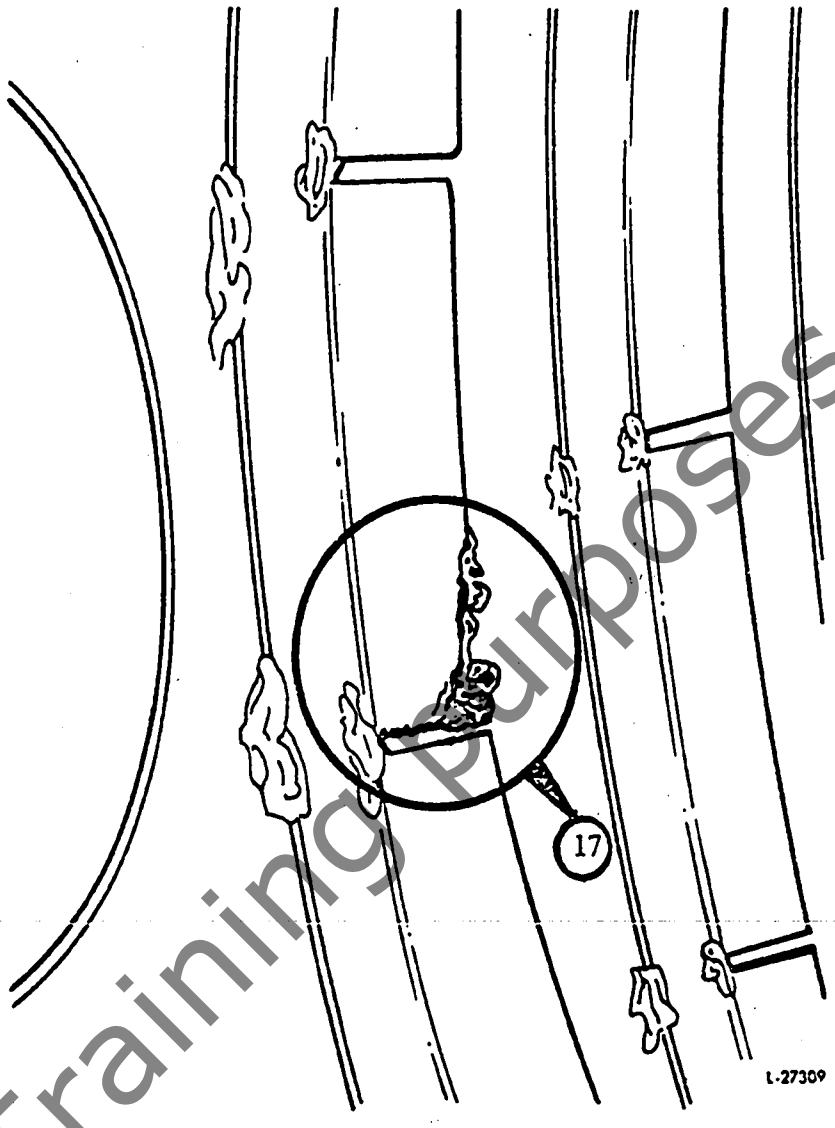


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For Training Purposes Only

Combustion Chamber Cracks
Figure 1315



Combustion Chamber Burning
Figure 1316

For Training Purposes only

S. Combustion Chamber Clamp Installation Procedure

(1) General

(a) Three types of combustion chamber clamps are in use. Figure 1317 shows the three types.

(b) Engines operating with Type II or Type III louver cooled clamps should not be converted over to Type I non-louver cooled clamps at on wing Hot-Section unless absolutely necessary.

(c) Engines operating with Type I non-louver cooled clamps should be converted to Type II or Type III louver cooled clamps when the supply becomes available.

(d) Clamp types may be mixed within sets if necessary but within the following limitations:

1) Type I clamps may be mixed with Type II clamps.

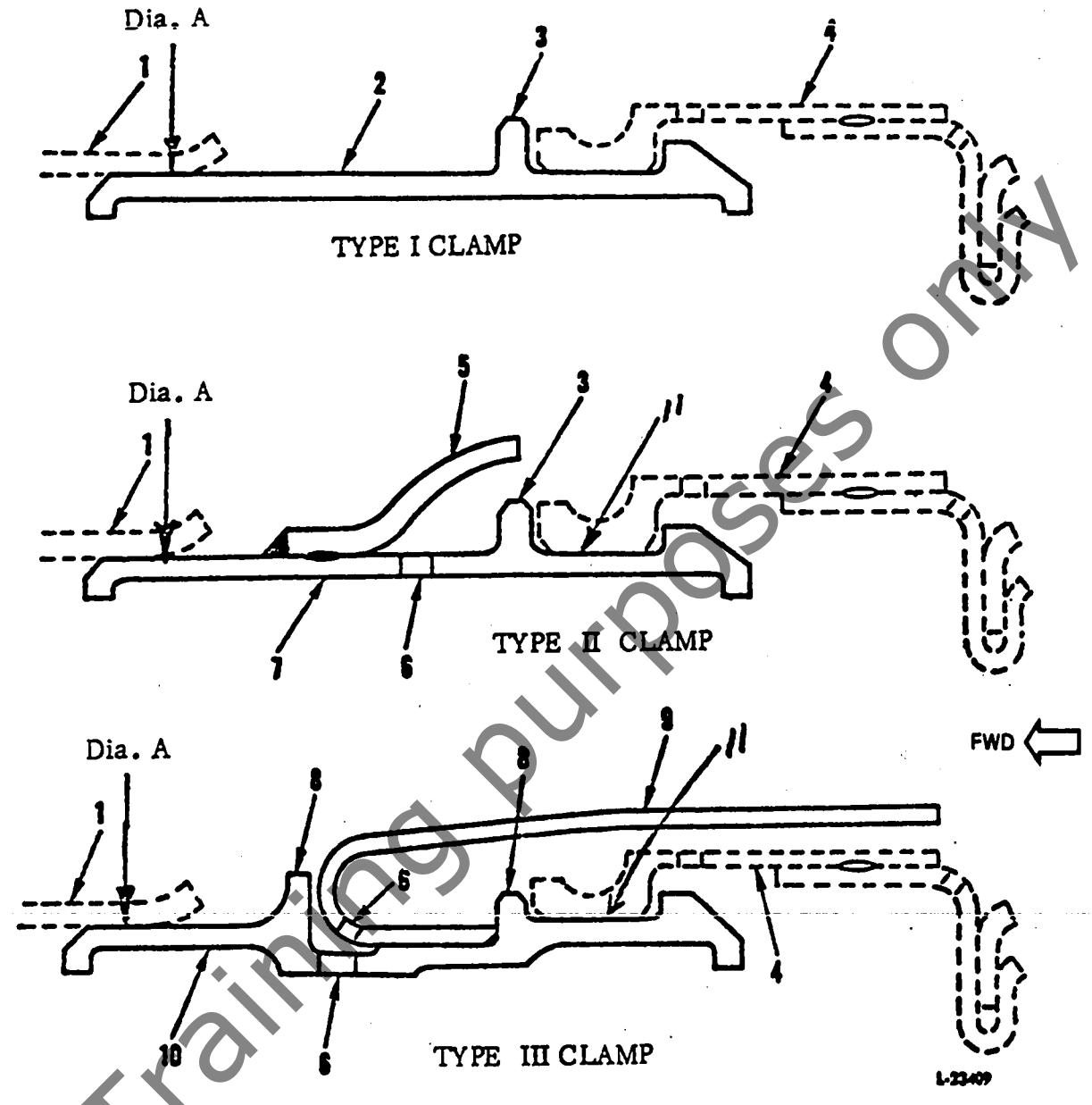
2) Types II clamps may be mixed with Type III clamps.

3) Type I clamps shall not be mixed with Type III clamps

(e) Type III clamps which have the snap-in louver heatshield must not be installed without the heatshield.

(f) All transition ducts and combustion chambers in use are totally compatible with all type clamps in use.

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Index No. — Dimensions and Notes

1. Combustion Chamber Eleventh Outer Liner.
2. Non-Heatshielded Clamp.
3. Scalloped Lip In Clamp ID.
4. Combustion Chamber Outlet Duct Porthole.
5. Heatshield, P/N 622377. Used Only In Welded-In Heatshield Clamp.
6. Cooling Air Holes.
7. Welded-In Heatshield Clamp.
8. Lips Are Not Scalloped.
9. Heatshield, P/N 622379. Must Be Used With Clamp, P/N 622382. Do Not Install Clamp Without Heatshield.
10. Loose (Trapped) Heatshield Clamps.
11. Circumferential Spacer Location (If Used)

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(2) Installation instructions for Type I and Type II clamps.

(a) Select the proper amount of shims to be used between the buttresses per marking on clamp buttress in ink.

NOTE: If clamp is not marked with proper shim size it should be rejected and returned to MCI tagged with information that shim size is absent or incorrect, as the case may be. If it is necessary to use the clamp shim size can be determined by using paragraph 3. procedure.

(b) Install the clamps on the transition duct retaining lug (bowl up) and the combustion chamber. Properly locate the clamp over the anti-rotation lug.

(c) Install proper amount of buttress shims and install three bolts on each clamp. Torque the bolts to 150 in-lbs and safety.

(3) Installation instructions for Type III clamps.

(a) Select the proper amount of shims to be used between the buttress per marking on clamp buttress in ink.

(b) Install the snap-in heatshield into the transition duct outlet ports at all locations.

(c) Install the Type III clamp on to the transition duct outlet port and combustion chamber seating the snap-in heatshield in the clamp as shown in Figure 1317 (Type III) properly locate clamp over anti-rotation lug.

(d) Pull ends of clamp together with fingers, check to be sure heat-shield is properly seated in clamp body and that clamp is properly engaging outlet port lip.

(e) Install buttress shims and three bolts on each clamp. Torque bolts to 150 in-lbs. No gap should exist between buttresses after torquing. If gap exist clamp or heatshield are not properly located.

(4) If it becomes necessary to use a clamp that does not have the proper shim size marked on the buttress the following procedure may be used to determine what amount of shims to use.

(a) Measure the clamp diameter A. (Ref. Figure 1317). use a Pi-Tape.

(b) Add 0.020 inch to the reading on the Pi-Tape. (This is required on all Pi-Tape ID measurements to correct for the thickness of the steel tape).

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(c) Subtract the sum from one of the following diameter A dimensions shown in Table I depending upon the clamp type and material.

TYPE I NON-LOUVER COOLED CLAMPS	
Hastelloy X Material (HX)	9.781 Dia.
Stainless Steel Material (S/S)	9.776 Dia.
TYPE II LOUVER COOLED WELDED HEATSHIELD CLAMPS	
Hastelloy X Material (HX)	9.786 Dia.
Stainless Steel Material (S/S)	9.781 Dia.
TYPE III LOUVER COOLED SNAP IN HEATSHIELD CLAMPS	
Hastelloy X Material	9.786 Dia.

NOTE: HX or S/S is marked on the clamp band of all Type I and II clamps 180° from the buttress in vibropen. All type III clamps are Hastelloy X.

TABLE I

(d) Multiply the difference by (3) to determine the proper shim thickness to use.

EXAMPLE: Hastelloy X non-louver cooled clamp must be checked to determine shim size.

Actual Dia A. Pi-Tape reading	9.772 Dia.
Correction for ID reading	+.020
sum	9.792 Dia.
Dia A. obtained from Table I For Hastelloy X non louvered clamp	9.781 Dia.
	0.011
	X3
	0.033 shim size

(Use single 0.030 inch shim)

NOTE: Whenever shim size is unobtainable using 0.020 and 0.030 shim combinations, use the next lower obtainable combination.

(e) Install the shims selected, bolt the buttresses together and recheck diameter A (Ref. Figure 1317). The new Pi-Tape reading plus 0.020 inch should fall into the tolerances for the clamp shown on Table II.

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TYPE I NON-LOUVER COOLED CLAMPS	
Hastelloy X Material (HX)	9.778 - 9.784 Dia.
Stainless Steel Material (S/S)	9.773 - 9.779 Dia.
TYPE II LOUVER COOLED WELDED HEATSHIELD CLAMPS	
Hastelloy X Material (HX)	9.783 - 9.789 Dia.
Stainless Steel Material (S/S)	9.778 - 9.784 Dia.
TYPE III LOUVER COOLED SNAP IN HEATSHIELD CLAMPS	
Hastelloy X Material	9.783 - 9.789 Dia.

TABLE II

For Training purposes only

T. Transition Duct Installation.

(1) Position the transition duct assembly to the turbine nozzle inner case and the turbine nozzle case front flange in the location marked at disassembly -- Refer to Section F item 2.

(2) Install the gang bolt assembly spacers and gang bolt assemblies on the turbine nozzle case front flange in the locations noted at disassembly and secure them in position. Refer to Section F, item 3.

NOTE: If transition duct will not gointo place, slightly lift engine at #5 bearing support by hand to allow duct to go into place.

(3) Tighten the screws to standard torque.

(4) Install the transition duct clamp plates on the inner circle securing them to the turbine nozzle inner case.

NOTE: Install top bolts first and do not tighten until all bolts are in place.

(5) Tighten bolts to standard torque and safety.

U. Combustion Chamber Installation.

(1) Apply a thin coat of Ease-Off 990 anti seize compound to the I.D. of the swirl cups of each combustion chamber.

(2) Apply Ease-Off 990 anti seize compound to the threads of all the combustion chamber clamp bolts.

(3) Call inspector for final check prior to chamber installation.

(4) Position the combustion chamber clamps around each combustion chamber with the rolled edge toward the nozzle end.

(5) Position the #4 combustion chamber loosely in the engine combustion case by twisting the chamber sideways until it clears the transition duct by allowing it to rest at the 6 o'clock position.

CAUTION: USE CARE NOT TO ALLOW CHAMBER TO STRIKE AND DAMAGE FUEL NOZZLES OR BURNER PRESSURE TUBE.

CAUTION: CHECK FOR PROPER ENGAGEMENT OF CLAMP ALL AROUND (360 DEGREES) ON FLANGE OF COMBUSTION CHAMBER OUTLET DUCT PORTHOLE AS CLAMP BOLTS ARE TIGHTENED.

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(6) Continue positioning all combustion chambers loosely in the engine as described in step (5), starting at the bottom and working up to the #8 and #1 chambers. Do not engage chambers on positioning brackets or nozzles at this time.

NOTE: On completion of initial installation, chambers should look similar to Figure 1302.

(7) Position the #1 combustion chamber dragon's tooth in its positioning bracket. (Refer to Figure 1318). Tilt the front inward to engage the positioning bracket and move the chamber forward to seat on the fuel nozzle cluster.

NOTE: With the chamber correctly positioned, the dragon's tooth must be recessed in the diffuser case slot.

(8) Using procedure in step (7), continue installing combustion chambers in their positioning brackets and on the fuel manifold. Sequence should start from the top chamber and work toward the bottom chambers on both sides of the engine.

CAUTION: THE LAST CHAMBER TO BE INSTALLED WILL PROBABLY BE THE #4 CHAMBER. USE CARE NOT TO TILT THE CHAMBER TO THE EXTENT THAT THE ELBOW MIGHT BECOME DAMAGED.

NOTE: On some newer type chambers only the #1 chamber contains 2 female cross over tubes. Installation sequence with these chambers is No. 1, 8, 2, 7, 3, 4, 6, and 5. Make sure the cross over tubes match.

(9) Slide each combustion chamber clamp rearward on the combustion chamber outlet duct flange.

NOTE: Position the anti-rotation lug in the slot between the two buttresses of the combustion chamber clamp. Do not use the slot in the clamp band areas.

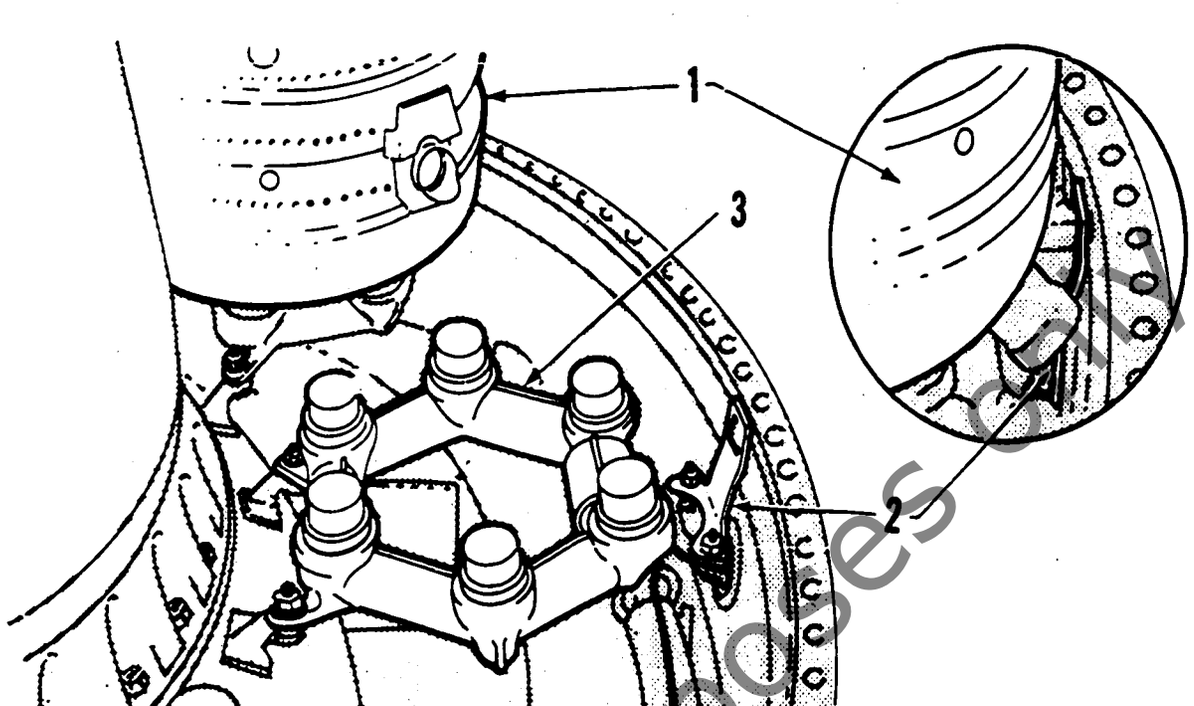
(10) Push each chamber forward to insure seating on the fuel nozzle manifold clusters. Check axial movement of each combustion chamber. When pushed rearward, the axial movement must be within the range of .025 to .107 inch to allow for growth during engine operation.

(11) Install L & R spark ignitors.

(12) Place washer P/N 43-0134 on each of the combustion chamber clamp bolts P/N 21-3948 and install in the clamp P/N 324-1013. Torque to 150 lbs/inches.

(13) Safety heads of all the combustion chamber clamp bolts using approved hot section safety wire (0.030 Inconel).

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1. COMBUSTION CHAMBER
2. COMBUSTION CHAMBER POSITIONING BRACKET
3. FUEL MANIFOLD CLUSTER

I 6423

Combustion Chamber Installation
Figure 1318

(14) Call inspector to check final installation prior to sliding case forward.

(15) Inspection prior to sliding combustion case forward.

(a) Check all combustion chamber clamps for looseness on chambers.

(b) Check combustion chamber clamps for proper safety and proper cross over tube mating between chambers.

(c) Check interior of engine for loose parts, loose lockwire, bolts, nuts, etc.

(d) Visually check each chamber for proper positioning and alignment on fuel nozzle cluster.

(e) Check #4 chamber for proper engagement of burner pressure tube to manifold.

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V. Installation of Combustion Case.

(1) Apply a thin coat of Ease-Off 990 on all combustion case bolts prior to installation on the case.

(2) Gently move the combustion case forward into position.

(3) Align the bolt holes of the combustion chamber outer case rear flange with the gang bolts in the turbine nozzle front flange until the front and rear flanges are joined.

(4) Install forward bolts and nuts.

(5) Install nuts and brackets on the rear flange bolts.

(6) Install fireseal at the 12 o'clock position. Refer to Figure 1301, detail A.

(7) Install P & D drain can and fire detection loop. Refer to Figure 1301, detail C.

(8) Reconnect the thrust reverser actuator air lines. Refer to Figure 1301, detail B.

(9) Reinstall pylon drain line and attach to brackets on combustion case.

(10) Torque forward combustion case bolts and nuts to 180 - 200 lb/inches.

NOTE: At the fireseal area, 12 o'clock position the bolt heads may be torqued instead of the nuts, using the same torque.

(11) Torque aft nuts on the rear flange bolts to 85-100 lb/inches.

(12) Remove old and install serviceable nose, left and right hand A/I valve motors and fuel heat valve motor.

(13) Call inspector to final installation.

(14) Perform engine run-up.

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are intentionally left Blank

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3. Fuel Manifold Removal and Installation

A. General

(1) All Fuel Manifolds incorporate S/B 852 and are interchangeable. Manifolds may be replaced by a half or complete set.

(2) If a manifold is replaced for any reason, all inner and outer lock and/or bushings are to be replaced on the inner attaching lugs.

B. Fuel Manifold Removal.

(1) Remove starter.

(2) Remove hydraulic pump (No. 2 & 3 engines).

(3) Remove P & D valve.

(4) Remove bolts attaching manifold adapters to the diffuser case at the 6 o'clock position.

(5) Straighten the tablocks and remove the nuts which secure the manifold on the inner and outer diameter of the diffuser case.

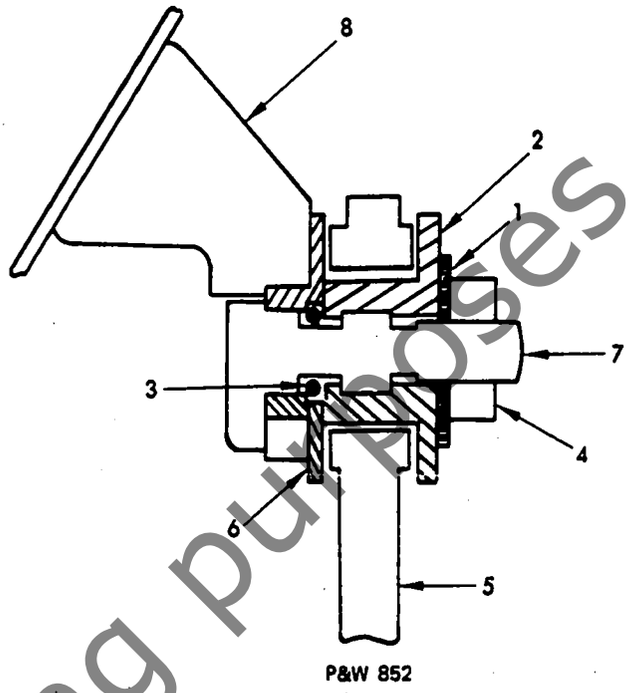
(6) Remove tablocks and discard.

(7) Remove the combustion can positioning brackets and spacer from the outer ring of bolts which secures the manifold to the diffuser case.

(8) Remove spacers from the inner ring of bolts which secures the manifold to the diffuser case.

(9) Carefully remove both fuel manifold halves and place them "immediately" in the PWA - 8376 fixture. Install fuel nozzle covers, make sure the manifolds are secured properly and place fixture in shipping box.

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FUEL MANIFOLD (SB 852)
INNER LUG CONFIGURATION

1. TAB WASHER
2. LOCK
3. SNAP RING
4. NUT
5. MANIFOLD LUG
6. BUSHING
7. BOLT
8. BRACKET-DIFFUSER CASE-INNER

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C. Fuel Manifold Installation

(1) Replace inner fuel manifold mount bushings (16) (P&W 852).

NOTE: Before bushing can be removed the circlip must be removed first. It will not be necessary to reinstall circlip.

(2) Transfer spring mounts from old to new manifold and safety double nut using Inconel wire (0.030).

(3) Apply Ease-Off 990 antiseize compound to the forward face of the inner support flanges of the manifold.

(4) Install gasket between the manifold adapters and diffuser case.

(5) Carefully position manifold halves in engine -- retaining manifold loosely by one or two nuts at the 12 o'clock position.

(6) Using the P&D valve adapter, position the fuel manifold attaching flanges in the center of the diffuser case opening at the 6 o'clock position.

NOTE: During this time make sure that the gasket between the adapters and diffuser case remains in place and lined up with the bolt holes.

(7) Coat the retaining bolts with Ease-Off 990 antiseize compound and start all bolts before tightening.

(8) After all bolts are started, tighten to recommended torque (150 lbs/inches) and secure with Inconel wire (0.030).

NOTE: Hold adapter in place until bolts are tightened enough to secure fuel manifold in place.

(9) With manifold in place continue installing parts in the following sequence on the outer ring of bolts at cluster positions 1-2-3-6-7-8 on diffuser case.

(a) Spacer

(b) Combustion chamber retaining bracket

(c) Tablock

(d) Nut - install finger-tight

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(10) Install following parts on the outer ring of bolts at clusters No. 4 and 5 (Detail B, Fig. 1320). (Parts are the same as removed from original configuration I.)

(a) Combustion chamber retaining bracket

(b) Tablock

(c) Nut - install finger-tight.

(11) Install following parts with fuel manifold in place on the diffuser case manifold retaining bolts inner ring.

(a) Lock P/N 21-2162 (P&W 852 installation).

(b) Tablock

(c) Nut - install finger-tight.

(12) Tighten the inner and outer ring for fuel manifold attaching nuts to recommended torque (80/90 inch/lbs). Do not bend tablocks at this time.

NOTE: Inner ring should be tightened first.

(13) Using new chevron seals, install P&D valve adapter and P&D valve, torque and safety (Ref P&D valve installation procedure 73-4-1, page 401). Part numbers of chron seals are as follows:

(a) 24-1751 - 3 each

(b) 24-1752 - 3 each

(c) 24-1753 - 1 each

(14) Install leakage clusters on fuel manifold and hook pressure jeep to P&D valve. Pressure check manifold for 5 minutes at 600 lbs pressure.

(15) Call inspector to observe leak check.

NOTE: Disregard leaks at cluster spiders, check area at P&D attachment to manifold 6 o'clock position. No leakage is allowed.

(16) Remove leakage check equipment and bend all tablocks on manifold attach bolts.

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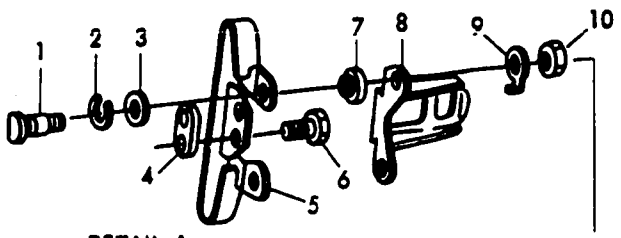
(17) Check clearance between the inner circle of the fuel manifold and mounting flange bushing with dial indicator - clearance should be Minimum - .001 Maximum - .006; record clearance on inspectors sheet.

(18) Call inspector to final manifold installation.

(19) Install starter.

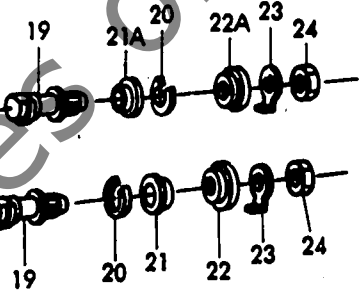
(20) Install hydraulic pump #2 or 3 position.

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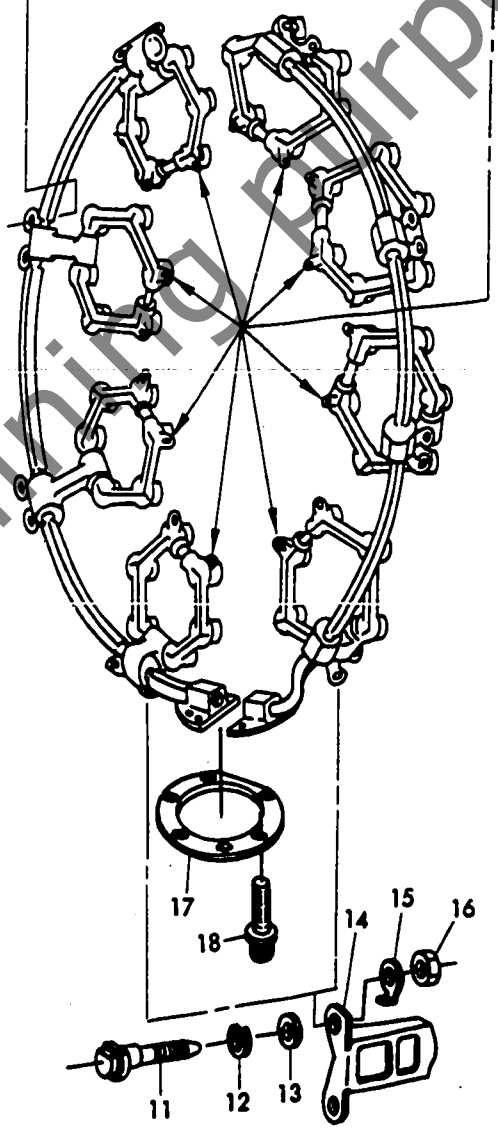
DETAIL A
(CLUSTERS 1-2-3-6-7-8)

1. BOLT 24-2096 852
2. SNAP RING 21-0306
3. SPACER 24-2291
4. NUT 24-2097
5. MOUNT 24-2125
6. BOLT 21-3063
7. SPACER 24-2099
8. BRACKET 24-2100
9. TABLOCK 21-0788
10. NUT 21-2210



DETAIL C

19. BOLT 24-2163
20. CLIP 21-0307
21. LOCK 24-2262
21A. SPACER 24-2161 PWA 852
22. LOCK 24-2263
22A. LOCK 24-2162 PWA 852
23. TABLOCK 21-0788
24. NUT 21-2210



DETAIL B
(CLUSTERS 4 & 5)

11. BOLT 21-0474
12. SNAP RING 21-0306
13. SPACER 24-2291
14. BRACKET 24-1682
15. TABLOCK 21-0788
16. NUT 21-2210
17. GASKET 21-0209
18. BOLT 21-0878

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4. Intentionally Deleted.

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5. Transition Duct Outer Wall Replacement

A. General

(1) This repair is to be used to correct transition duct outer wall cracking beyond limits acceptable for condition A or B.

(2) Covered and uncovered outer walls may be used interchangeably giving preference to the covered design.

(3) Report results of repair in accordance with the standard on wing maintenance notification procedure.

B. Damaged Outer Duct Wall Removal Procedure

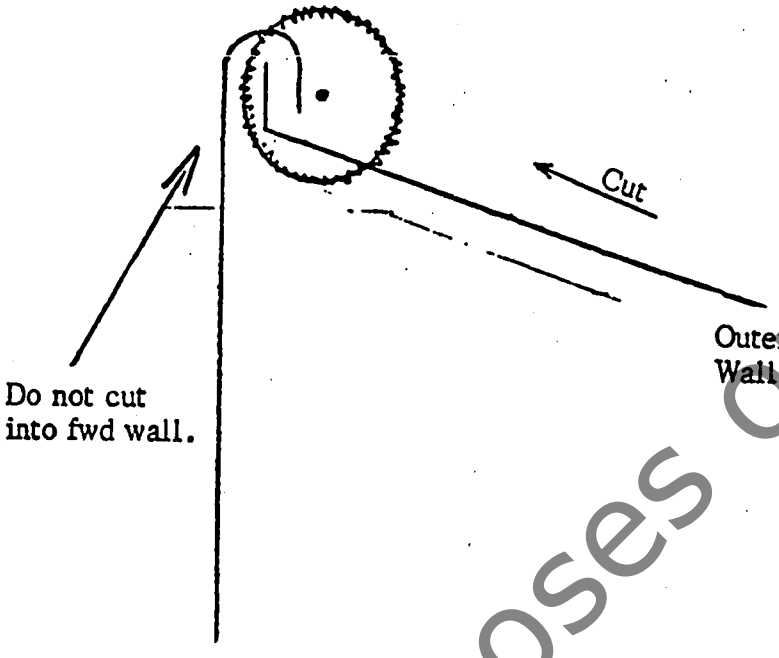
(1) Remove the combustion chambers, the transition duct inner and outer support bolts and slide the transition duct

(2) Drape cloth covers over the front combustion case and the rear combustion cases to isolate grinding chips forward or aft of the work area. Cover the inner combustion case with cloth to prevent damage to the case.

(3) Select a location to make an axial cut halfway between two combustion outlet ports.

(4) Using a hand grinder and a small flat grinding wheel. make an axial cut through the duct outer wall completely. Separating the duct axially. It will be necessary to cut the crimped lip but do not cut the front diaphragm wall. See illustration on next page.

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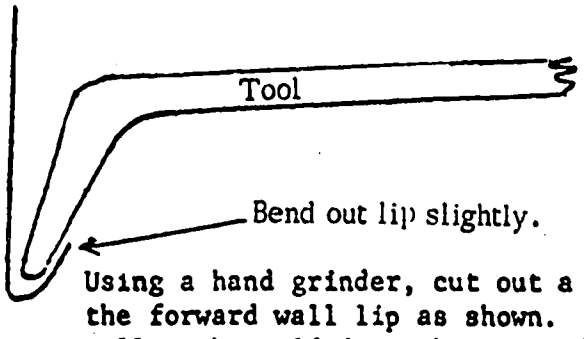
NOTE: At this point the duct should collapse inward and fall out of the circumferential crimped "U" channel. If not, a few raps with a soft mallet should release it. Keep hands clear of sharp edges when duct springs inward.

(5) Remove the damaged outer wall from the engine.

C. Outer Duct Wall Installation Procedure

(1) Select an appropriate replacement outer wall duct assembly consistent with the plasma sprayed or un-plasma sprayed condition of the nozzle case lip where the pilot ring rests.

(2) Using a suitable tool, open the crimped lip slightly to allow the new wall to seat properly. Do not use a sharp tool as it will damage the forward wall. See Drawing.



Using a hand grinder, cut out a "V" at the origina cut on the forward wall lip as shown. This allows the new outer wall to be welded to the very edge under the lip.

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(4) Clean out the lip area with a wire brush and coat with ease off 990.

(5) Install the new outer duct wall assembly over the inner combustion case by spreading the duct axial separation and manuevering the duct as required within the combustion section of the engine.

(6) Locate the axial separation in the outer duct wall at the cut out in the front diaphragm crimped "U" channel.

(7) Feed the outer duct wall into the front diaphragm crimped "U" channel, clamping at outlet port locations. Clamping is necessary to hold the duct in position in the "U" channel.

(8) Close the outer duct wall axial separation by adjusting a spring steel band located at the pilot ring. (Spring steel band and tools to adjust the band are the same as used to secure wooden shipping crates.)

(9) Adjust clamping and band as required to close axial separation. Separation ends should mate to provide a butt weld joint holding mismatch to absolute minimum.

(10) Inspect to be sure that the outer duct wall flange is properly positioned in the crimped "U" channel all around by measuring the gap between the wall and the "U" channel inner lip as shown with a feeler gauge. (Ref: Section A-A of Fig. 1322 or 1323). Max gap permissable is .100 inch.

(11) Tack weld at key locations along the outer duct wall axial separation to maintain the desired position during welding. Use AMS 5798 or 5786 weld filler for all welding. (Hastelloy X) or (W).

(12) Install thin copper plate beneath outer duct wall at axial separation. Secure with clamps. The purpose of this plate is to preclude fusion on the front diaphragm during welding.

(13) Butt weld axial separation. Weld slowly to minimize distortion. Use argon gas backup to improve penetration where possible.

(14) Dress all welding as close to flush as possible by grinding on both sides of outer duct wall. Avoid undercutting which would reduce the duct wall thickness.

(15) Burnish weld with rubber wheel on both sides of outer duct wall where accessible.

(16) Position and weld anti-rotation lug (on louvered design outer wall only) as shown in Figure 1323.

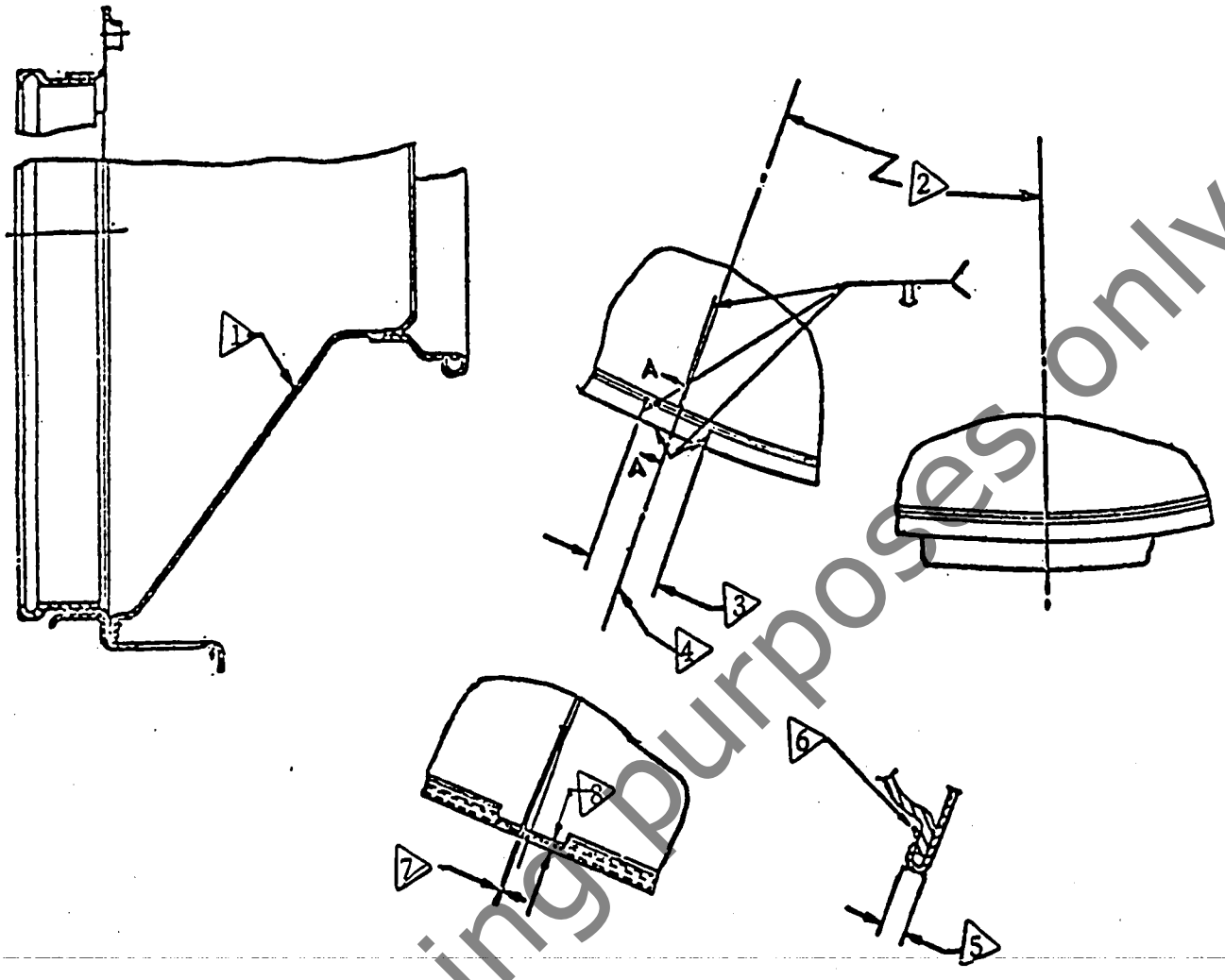
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(17) Inspect all welding completed visually using dye penetrant in questionable areas. No cracks permitted.

(18) Recrimp any portion of the front diaphram "U" channel at any location it was loosened to facilitate assembly. Use appropriate hand tools.

(19) Remove clamps, and steel band. Clean all chips from duct inner surfaces and inspect for the existence of foreign material inside.

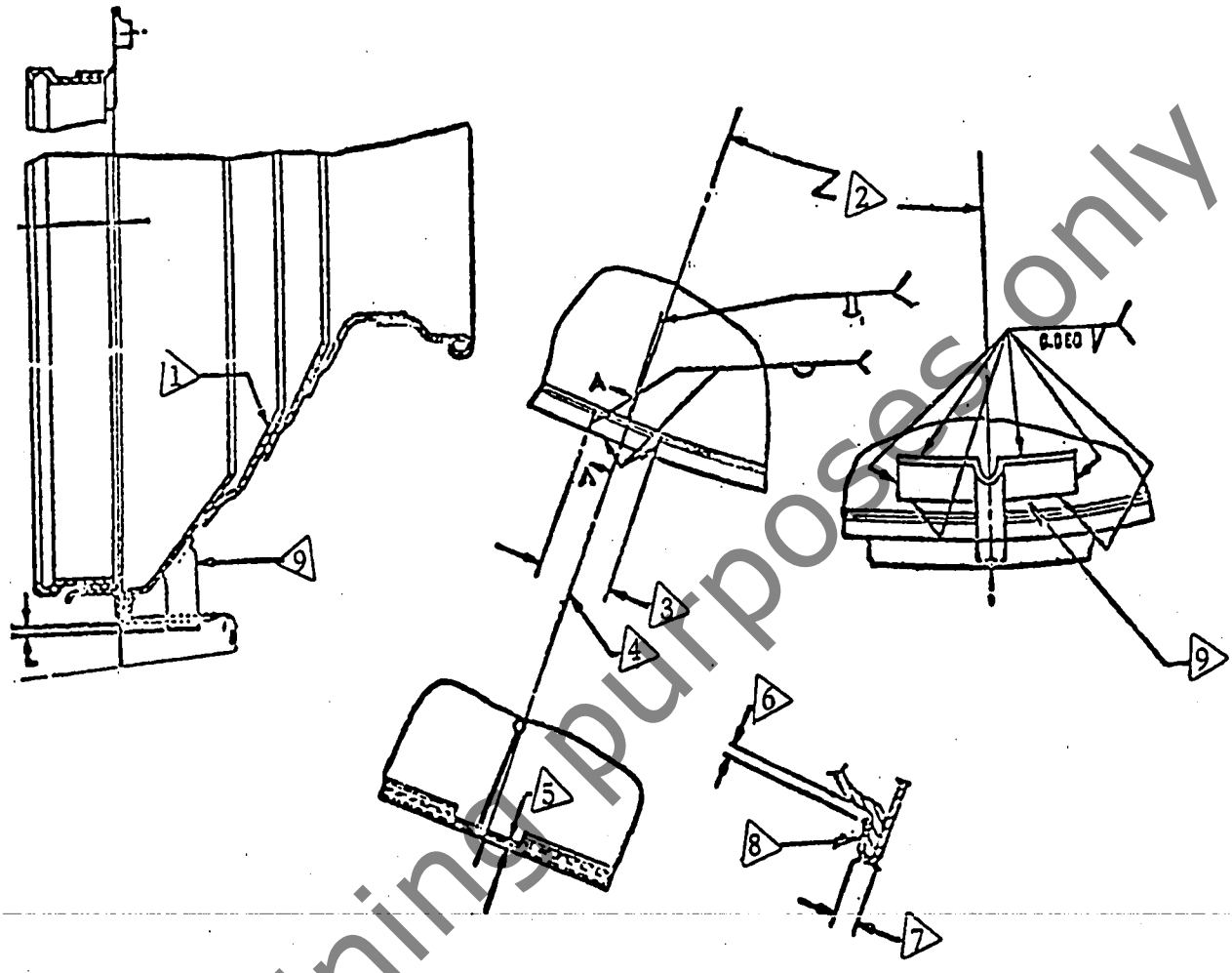
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SECTION A–A

Index	Notes and Dimensions
1	Outer Duct Wall Assy P/N 568058 (TWA 1-77414-1 or -2)
2	22 1/2 degrees from 6 o'clock position.
3	0.990 - 1.010 inch.
4	Locate axial separation 0.090 inch either side of true position.
5	0.150 - 0.180 inch
6	Patch P/N 568057 or piece previously cut out.
7	Close axial separation to minimum gap possible prior to welding.

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SECTION A–A

Index	Notes and Dimensions
1.	Outer Duct Wall Assy P/N 596651 (TWA 1-77414-3 or -4)
2.	22 1/2 degrees from 6 o'clock position.
3.	0.990 - 1.010 inch
4.	Locate axial separation 0.090 either side of true position.
5.	0.060 - 0.080 inch nominal
6.	0.100 inch maximum
7.	0.150 - 0.180 inch
8.	Patch P/N 568057 or piece previously cut out.
9.	Anti-rotation lug P/N 570721 (24-2672)

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6. Turbine Rotor Replacement (3rd and 4th stage)

A. Exhaust case and aft thrust reverser assembly removal.

(1) Disconnect the aft reverser air supply lines at the horizontal fire wall connectors.

(2) Disconnect the aft reverser follow-up control rods.

(3) Disconnect the aft reverser switch wire harness.

(4) Disconnect EGT wiring harness.

(5) Disconnect P_{T7} lines at the manifold at top and bottom of engine.

(6) Disconnect the number six bearing oil pressure and scavenge lines.

(7) Disconnect exhaust case drain line.

(8) Mark the location and identify all brackets mounted on the turbine nozzle aft flange.

(9) Install aft engine support equipment.

CAUTION: CAREFULLY INSPECT COWLING BRACKETS USED TO ATTACH SUPPORT EQUIPMENT. ANY EVIDENCE OF CRACKED OR DAMAGED BRACKETS MUST BE CORRECTED BEFORE ATTEMPTING TO SUPPORT THE WEIGHT OF THE ENGINE FROM THESE POINTS.

(10) Adjust support equipment to take the weight of the engine off of the aft engine mount.

(11) Remove the left and right engine mount link bolts at the exhaust case.

(12) Position and secure the exhaust case and thrust reverser assembly support equipment.

(13) Install mark to index turbine nozzle case to the engine exhaust case.

(14) Remove exhaust case attach bolts.

CAUTION: AS BOLTS ARE REMOVED, WATCH FOR EVIDENCE OF INSUFFICIENT SUPPORT OF THE EXHAUST CASE AND REVERSER ASSEMBLY. IF IMPROPERLY SUPPORTED, DAMAGE TO THE NUMBER SIX BEARING AND CARBON SEAL ASSEMBLY MAY RESULT AS THE LAST BOLTS ARE REMOVED AND THE ENGINE OR EXHAUST CASE SHIFTS.

(15) Carefully and slowly move the exhaust case aft approximately 1/2 inch.

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(16) Secure the fourth stage turbine outer air seal to the aft flange of the turbine nozzle case at two points 180° apart to prevent the fourth stage nozzle guide vanes from becoming dislocated while removing the exhaust case.

(17) Continue moving the exhaust case aft, being careful to keep the assembly centered.

B. Number six bearing and carbon seal assembly removal.

(1) Straighten the locking tabs for each of the six screws securing the number six bearing oil scavenge pump drive pinion gear.

(2) Remove the six drive pinion gear retaining screws and the gear. (P&WA 8041 puller)

(3) Install bearing puller and remove the number six bearing inner race and roller assembly. (P&WA 6614 puller)

CAUTION: THE NUMBER SIX BEARING CARBON SEALS AND SPACERS ARE A LOOSE FIT ON THE TURBINE REAR HUB JOURNAL. THIS ASSEMBLY IS A SPRING LOADED STACK UP AND MAY TEND TO JUMP OFF OF THE JOURNAL AS THE NUMBER SIX BEARING IS REMOVED. CARE SHOULD BE TAKEN TO INSURE THAT DAMAGE TO THESE PARTS DOES NOT OCCUR AS A RESULT OF BEING ALLOWED TO FALL, AS THE NUMBER SIX BEARING IS REMOVED.

(4) Carefully remove the number six carbon seal and spacer assembly.

(5) Remove the 4½ bearing oil tube rear seals sleeve.

C. Fourth stage turbine rotor and turbine rear hub removal.

(1) Install index mark on the fourth stage turbine rotor and turbine rear hub starting at the 12 o'clock position of the turbine nozzle case and extending down the turbine blade and across the disc and hub to the number one turbine tiebolt.

NOTE: The number one turbine tiebolt is located just to the right of the indentation mark found on the outer circumference of the turbine rear hub. The turbine should be rotated by hand to place the number one turbine tiebolt to the 12 o'clock position before installing index mark.

(2) Starting with the number one turbine tiebolt and moving in a clockwise direction number each tiebolt and its respective nut to insure that the nuts are reinstalled in the same location as removed.

(3) Straighten the tabs locking the 10 turbine tiebolt nuts.

(4) Loosen all tiebolt nuts until finger tight.

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(5) Remove 8 of the tiebolt nuts, leaving 2 nuts located 180° apart.

(6) Back off the 2 tiebolt nuts approximately 3/8 inch.

(7) Insert brass plugs in 4 unused turbine rear hub balance lug holes and install jack screws.

(8) Alternately tighten jack screws to loosen rear hub.

CAUTION: THE TURBINE REAR HUB IS SPRING LOADED AND WILL JUMP OFF OF THE TIEBOLTS WHEN THE SNAP FIT IS BROKEN, IF THE TWO TIEBOLT NUTS ARE NOT INSTALLED.

(9) Carefully remove the remaining two tiebolt nuts and remove the turbine rear hub.

(10) Reinstall two turbine tiebolt nuts, finger tight, 180° apart to prevent the fourth stage turbine rotor from coming off unexpectedly.

(11) Remove the 4 1/2 bearing oil tube and heatshield assembly.

(12) Install puller and loosen fourth stage turbine rotor. (P&WA 6573 puller)

(13) With two mechanics positioned to support the fourth stage turbine rotor remove puller and the two tiebolt nuts.

(14) Carefully work the fourth stage turbine rotor aft to clear the turbine tiebolts.

CAUTION: USE EXTREME CARE REMOVING THE FOURTH STAGE TURBINE ROTOR MANUALLY TO AVOID INJURY TO FINGERS AND TOES AS THIS ASSEMBLY IS QUITE HEAVY AND SOME-WHAT DIFFICULT TO GRASP SECURELY.

D. Fourth stage tubine nozzle guide vanes, inner support, and spacers removal.

(1) Install index mark on the fourth stage nozzle guide vane at the 12 o'clock position. Extend index mark down the vane to include the nozzle inner support.

(2) Starting at the index mark, consecutively number each fourth stage nozzle vane in a clockwise direction around the engine.

(3) Remove the fourth stage turbine rotor outer air seal.

CAUTION: AS THE FOURTH STAGE TURBINE ROTOR OUTER AIR SEAL IS REMOVED THE FOURTH STAGE TURBINE NOZZLE VANES ARE NO LONGER RETAINED AND WILL BE FREE TO FALL OUT UNLESS CARE IS TAKEN TO PREVENT IT.

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(4) Remove the fourth stage nozzle guide vanes by alternately removing a few vanes at a time in both directions starting at the 12 o'clock position.

(5) Remove the fourth stage nozzle guide vane inner support.

(6) Remove the fourth stage nozzle guide vane spacer.

(7) Remove the third to fourth stage turbine rotor inner spacer.

NOTE: The third to fourth stage turbine rotor inner spacer is a snap fit to both rotors. This part may come off with the fourth stage rotor or may remain with the third stage rotor. It will be necessary to remove this spacer from the rotor it remains with only if the spacer is damaged and must be replaced or the rotor is to be replaced and the spacer reinstalled.

E. Turbine rotor removal (3rd stage)

(1) Install puller and back the third stage turbine rotor off enough to break the snap fit between the second and third stage turbine rotors. (P&WA 6573 puller)

(2) With two mechanics positioned to support the third stage turbine rotor, remove the two tiebolt nuts and carefully work the third stage turbine rotor aft to clear the tiebolts.

(3) Reinstall the two nuts on their respective tiebolts.

F. Third stage turbine nozzle removal

(1) Remove the third stage turbine rotor outer air seal.

(2) Install an index mark on the third stage nozzle guide vane at the 12 o'clock position. Extend index mark down the vane to include the third stage nozzle inner support.

(3) Starting at the index mark consecutively number each third stage nozzle guide vane in a clockwise direction.

(4) Remove the third stage nozzle guide vane lock ring.

CAUTION: AS THE THIRD STAGE NOZZLE GUIDE VANE LOCK RING IS REMOVED THE THIRD STAGE NOZZLES ARE NO LONGER RETAINED AND MAY FALL OUT UNLESS CARE IS TAKEN TO PREVENT IT.

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(5) Remove the third stage nozzle guide vanes by alternately removing a few vanes at a time in both directions, starting at the 12 o'clock position.

NOTE: It may be necessary to tap the inner support forward to release the vanes at the nozzle case to facilitate removal. Use a rawhide or rubber mallet and reasonable care when tapping on the inner support.

(6) Remove third stage nozzle inner support.

(7) Remove the second to third stage turbine rotor inner air seal.

G. Second stage turbine rotor and low compressor drive shaft assembly removal.

(1) Position the number one turbine tiebolt to the 12 o'clock position.

(2) Install an index mark on the turbine nozzle case at the 12 o'clock position and the second stage turbine rotor blade which aligns with the nozzle case index mark.

(3) With the second stage turbine rotor index marks aligned, install an index mark on a convenient first stage fan blade and the first stage fan air flow duct.

NOTE: The above index marks will permit the reinstallation of the low compressor drive shaft and the low compressor in the exact relation as removed.

(4) One at a time remove the turbine tiebolts from the second stage turbine rotor rear hub flange and reinstall the forward tiebolt nut on the tiebolt.

CAUTION: EACH TIEBOLT MUST BE KEPT WITH ITS RESPECTIVE NUTS FOR BALANCE PURPOSES.

(5) Install the (SWE 84976) adapter on the rear face of the second stage disk engaging the adapter dowel pins with the holes in the disk.

(6) Insert the (SWE 8697) socket wrench through the adapter and into the turbine shaft until it rests against the coupling lock pins.

(7) Attach the (SWE 8100) power wrench to the adapter and lock into position with the two wing screws.

CAUTION: INSTALL AND MAKE CERTAIN THE SWE 67 RACHET ADAPTER IS SET TO TURN COUPLING WRENCH IN A CLOCKWISE DIRECTION.

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(8) With the installed tools held forward to take up all slack and the coupling wrench resting against the coupling lock pins make a reference mark on the splines of the coupling wrench where they enter the power wrench.

(9) Shift the coupling wrench forward against the lock pin stops and install another reference mark on the coupling wrench splines.

(10) Withdraw the coupling wrench enough to insure that the distance between the two reference marks is a minimum of 3/16 of an inch indicating that the coupling is unlocked.

(11) Reposition coupling wrench to the unlocked position according to the reference mark and using the power wrench disconnect the low compressor from the low compressor drive shaft.

NOTE: After several revolutions with the power wrench it should be possible to complete the uncoupling by hand using a "T" bar through the hole in the end of the coupling wrench.

CAUTION: THE COUPLING LOCK IS SPRING LOADED TO THE LOCKED POSITION AND MUST BE FORCED TO THE UNLOCKED POSITION. IT IS ESSENTIAL TO MAINTAIN THE COUPLING IN THE UNLOCKED POSITION AT ALL TIMES DURING THE UNCOUPLING PROCESS TO AVOID DAMAGE TO THE COUPLING AND LOCKING ASSEMBLIES.

(12) Remove the coupling wrench, power wrench, and wrench adapter.

(13) Install the second stage turbine rotor and low compressor drive shaft ground handling fixture and carefully withdraw the turbine and shaft assembly.

(14) Install the low compressor drive turbine and shaft assembly in the storage stand and install the P&WA 9029 cover and the P&WA 9010 protector on the shaft splines and the number 4 1/2 bearing and seals respectively.

H. Second stage nozzle guide vanes removal.

NOTE: Inspection of the 4 1/2 bearing inner and outer races and rollers and seals liner should be completed and determination of their condition established prior to proceeding with the second stage nozzle guide vane removal. If these parts are determined to be servicable it will not be necessary to remove the second stage nozzle guide vanes. It is only necessary to remove the second stage nozzle guide vanes to facilitate installation of the tooling adapter used to remove the seals liner.

(1) Remove the second stage turbine outer air seal.

(2) Install an index mark on the turbine nozzle case at the 12 o'clock position. Extend index mark down the second stage nozzle guide vane at the 12 o'clock position to include the nozzle inner support.

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(3) Starting at the index mark, consecutively number each vane in a clockwise direction.

(4) Remove the second stage nozzle guide vane lock ring.

(5) Starting at the 12 o'clock position remove the vanes a few at a time in both directions.

NOTE: It may be necessary to tap the inner support forward to release the vanes at the nozzle case to facilitate removal. Use a rawhide or rubber mallet and reasonable care when tapping on the inner support.

(6) Remove the second stage nozzle inner support.

I. 4-1/2 bearing, spacer, and seals liner removal. (Ref. Fig. 1325)

(1) Insert the seals liner wrench in the rear compressor drive turbine shaft until it engages the seal liner. (SWE 86981 liner wrench)

(2) Install the SWE 84986 adapter on the rear face of the turbine shaft.

(3) Position the power wrench over the liner wrench and lock to the adapter.

(4) Set the rachet adapter to turn the liner wrench in a clockwise direction.

NOTE: The seals liner has left hand threads and must be turned in a clockwise direction to remove.

(5) Using the power wrench loosen the seals liner until it can be turned by hand. Remove the power wrench and adapter and continue loosening the seals liner by hand until the threads are completely disengaged.

CAUTION: MAKE CERTAIN THE LINER THREADS ARE COMPLETELY DISENGAGED.

(6) Remove the liner wrench and install puller PWA 16055 puller to engage with the front side of the ring spacer.

(7) Remove the spacer, bearing race and seals liner.

(8) Clean the bore of the high compressor drive turbine shaft.

J. Number 4-1/2 bearing inner race, rollers, carbon seals, and spacers removal.

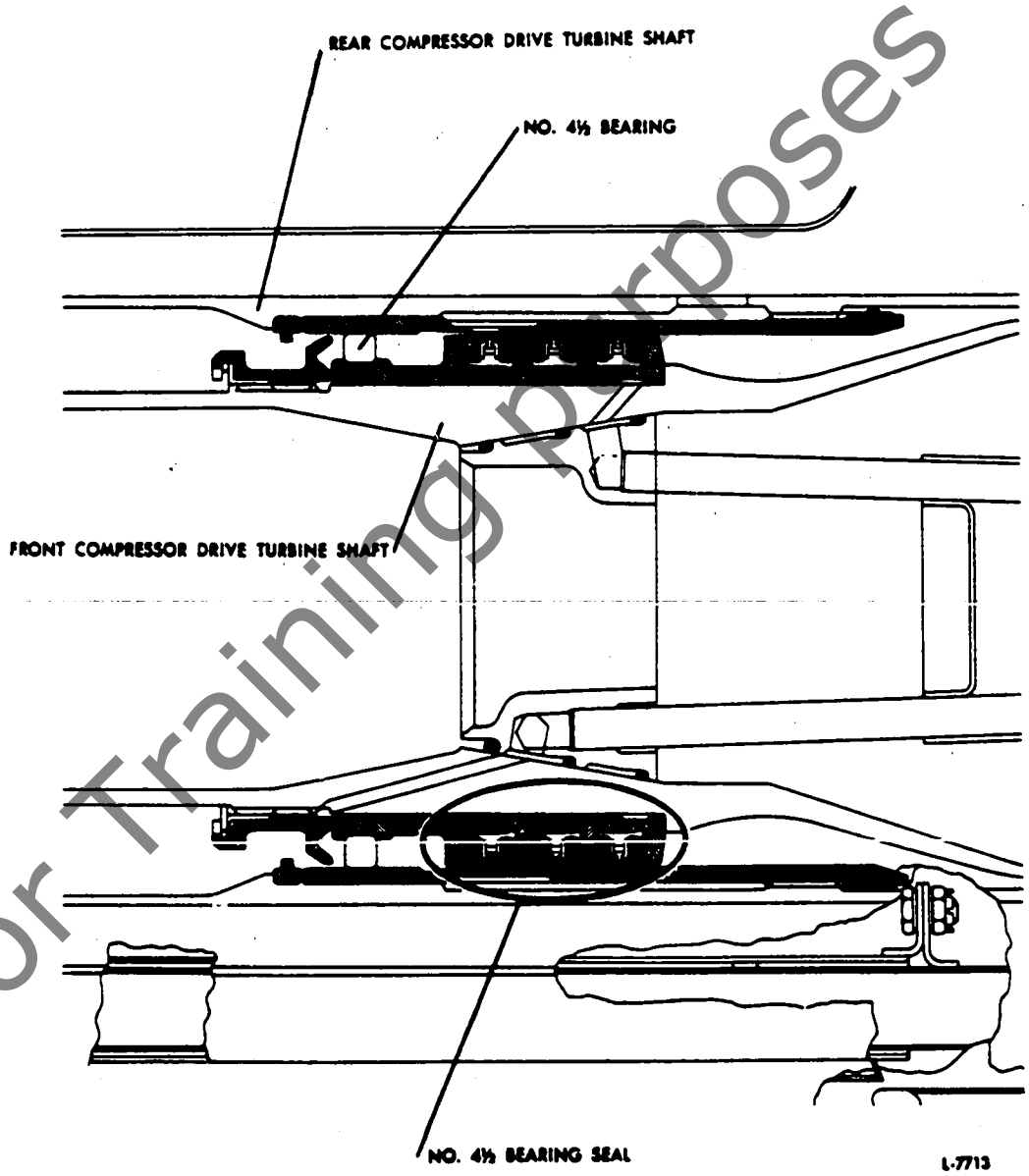
(1) Remove the snap ring and tabwasher securing the 4-1/2 bearing retaining nut.

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(2) Unfasten the 4 1/2 bearing retaining nut with the PWA 6613 wrench; then remove the nut from the turbine shaft.

(3) Clamp the PWA, 16116, 16117 puller around the seals and spacer engaging the two outside spacers.

(4) Using the knocker action of the puller, remove the seals and spacers. The knocker action will push the 4 1/2 bearing inner race from its journal.



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No. 4 1/2 Bearing and Seals Buildup
Figure 1325

K. Number 4 1/2 bearing inner race and rollers, seals and spacers installation.

NOTE: The position of the spacers can be determined by the size of the axial slots on their ID. When assembled, these spacers form tapered slots which decrease in area from front to rear. Therefore, the spacer with the shallowest slot is the rearmost when assembled.

(1) Install the aligning pin in the groove of the P&WA-16115 fixture.

(2) Place the rearmost spacer, small OD up, over the pilot of the fixture.

(3) Install the rear (small) graphite seal to seat on the rear spacer; then install a thrust ring with its flange facing up. Install the spring washer to seat on the thrust ring and install another thrust ring with its flange facing down. Finally, install the front (large) graphite seal with its flange down and its gap 90 degrees from the seal already installed.

(4) Install the next spacer as described in step (2) and install the seals and associated parts as described in step (3) positioning the gap of the first seal 90 degrees from the gap of the last seal installed.

(5) Repeat step (4) for the next spacer and seals and associated parts.

(6) Install the final spacer as described in step (2).

(7) Install the P&WA-16116 Clamp on the seals and spacer buildup and remove the buildup and the aligning pin from the fixture.

(8) Heat the No. 4 1/2 bearing inner race and rollers in hot oil for five minutes.

(9) With the aligning pin installed in its groove on the turbine shaft, install the clamp and seals and spacers buildup as a unit on the shaft.

NOTE: The aligning pin may be retained in the groove with petrolatum or held by an elastic which must be removed as assembly progresses.

(10) Remove the inner race and rollers from hot oil and wipe off the excess oil. Brush or spray a light coat of dgf-123 anti-galling lubricant on the shaft journal; then place the race and roller on the shaft with the serial numbers facing toward the rear. Portion of shaft to be lubricated must be free of oil.

CAUTION: DUE TO THE VARIANCE IN INTERNAL TOLERANCES. IT IS IMPORTANT THAT MATCHED BEARING DETAILS ARE NOT INTERMIXED AT ASSEMBLY: THEREFORE, MAKE CERTAIN ALL DETAIL PARTS OF THIS BEARING ARE FROM THE ORIGINAL BEARING ASSEMBLY.

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(11) Coat the retaining nut threads of the turbine shaft and the threads of the retaining nut with Ease-Off 990 or Fel-Pro C200 antiseize compound; then install the nut on the turbine shaft and tighten it hand tight.

(12) Using the P&WA-6613 Wrench and a suitable torque wrench, tighten the nut to recommended torque; then turn through the recommended angle, as specified in Ref. No. 895, Section 72-50, Clearances. (Overhaul)

(13) Remove the seals buildup clamp, being careful not to damage the carbon seals.

(14) Position the tabwasher aligning the tabs with the slots in the No. 4-1/2 bearing retaining nut. Position the P&WA-8693 Drift on the turbine shaft so that the teeth of the drift contact the tabs of the tabwasher that are to be bent into the nut. Next, place the P&WA-8692 Drift behind the P&WA-8693 Drift. Using the hammer action on the starting drift, start to bend the tabs into the slots of the nut. Remove both drifts.

(15) Position the P&WA-8694 Drift so that the teeth contact the previously bent tabs; then place the P&WA-8692 Drift behind the P&WA-8694 Drift. Using the hammer action on the bending drift, finish bending the tabs into the slots.

(16) Install the retaining nut snapring, and using the P&WA-8693 Drift and the P&WA-8692 Drift, bend the remaining tabs of the tabwasher to retain the snapring in the groove of the nut using the procedure outlined above.

(17) Install P&WA-9010 protector around No. 4-1/2 bearing and seals on front compressor drive turbine shaft.

L. 4-1/2 bearing outer race, spacer and seals liner installation.

(1) Using P&WA 6686 drift, install the ring spacer on the shoulder in the ID of the high compressor drive turbine shaft.

(2) Using P&WA 6686 drift, install the No. 4-1/2 bearing outer race in the ID of the turbine shaft with the serial number facing aft. Seat the bearing race against the rear face of the ring spacer.

(3) Place a new seal in the groove of the No. 4-1/2 bearing seals liner. Coat the liner threads with Molybdenum disulfide and install the liner in the turbine shaft; then turn the liner counterclockwise by hand to engage a few threads. P&WA 6686 drift may be used to assist in the installation of seals liner. Every precaution should be used to avoid damaging the liner O-ring seal. Visually inspect the liner after installation to insure that there is no evidence of damage to the seal during installation.

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(4) Using the SWE 86981 wrench, tighten the liner hand-tight.

(5) Install the SWE 84986 adapter over the liner wrench; then position the power wrench on the adapter and lock in place.

(6) Install the rachet to the power wrench and set to turn the liner wrench in a counter clockwise direction.

NOTE: The seals liner has left hand threads and must be turned in a counter clockwise direction for installation and torqueing.

(7) Using a suitable torque wrench tighten the seals liner in the following sequence to obtain proper installation torque.

a) Tighten to 2000 lb. inch; turn through angle of 20° min. 25° max. and then loosen to 0 lb. in.

b) Tighten liner to 2000 lb. in.

c) Mark location of liner wrench with reference to power wrench.

d) Turn liner through angle of 20° min. to 25° max.

e) Loosen liner to 0 lb. in. and repeat step b).

f) If mark on liner wrench aligns with or is beyond the reference mark on power wrench but not more than o.100 inch max., apply final angle of turn per step d).

g) If reference marks are not within limits, repeat steps c), d) and e) in order, until reference marks are within limits. Then perform step f).

M. Second stage turbine nozzle guide vanes installation.

(1) Position the first stage turbine outer seal spacer on the first stage turbine outer air seal.

(2) Install the second stage turbine inner air seal and second stage turbine nozzle guide vane inner support assembly. Position assembly with the index mark at the 12 o'clock position and check to see that the drain holes are at the 6 o'clock position.

CAUTION: CARE MUST BE TAKEN TO PREVENT INJURY TO THE HANDS ON THE SHARP EDGES ON THE TURBINE INNER SEAL.

(3) With the aid of an assistant, install the lower vanes one at a time. Start at the 6 o'clock position and alternate clockwise and then counterclockwise keeping the vanes in the same relative position to each other as marked during removal.

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WARNING: MAKE CERTAIN THAT EACH VANE INNER PLATFORM IS SEATED WITHIN THE INNER FACES OF THE FLANGES ON THE INNER SEALING RING SUPPORT. TO INSURE PROPER INSTALLATION, CHECK THE GAP AS SHOWN IN FIGURE 1328.

CAUTION: CARE MUST BE TAKEN TO MAKE CERTAIN THE AIR SEAL SPACER IS PROPERLY SEATED IN THE FORWARD GROOVE OF THE VANE OUTER SHROUD, ON THE NOZZLE INNER CASE SHOULDER AND FLUSH AGAINST THE REAR FACE OF THE TURBINE OUTER AIR SEAL.

(4) Center the second stage turbine nozzle inner seal assembly and install the remaining vanes.

NOTE: To facilitate installation, it may be necessary to lightly tap the outer vane shrouds toward the nozzle case with a fiber drift.

(5) Install the second stage turbine vane lockring in the rear shoulder of the vane outer shroud and on the step in the ID of the nozzle case. If necessary, tap the lockring slightly to ensure proper seating.

(6) Install deflection check adapter behind the stepped ID of the second stage nozzle inner support and expand the fingers to secure the tool in place.

(7) Install deflection check load frame on the aft flange of the turbine nozzle case and install tensionometer gauge between the adapter and load frame with quick release pins.

(8) Turn jackscrew knob on load frame to apply a 500 lb. rearward load.

(9) Place a parallel bar across the rear flange of the turbine nozzle case and using a depth gauge, measure dimension, index number 1 of applicable Figure 1331, 1332 or 1333 at a minimum of six places, equally located.

NOTE: Dimensions specified are to the rear face of the turbine nozzle case rear flange. Measurements are taken over the bar and the thickness of the bar must be subtracted from the total measurements. After calculations have been made and found to be within the limits specified, a recheck of the measurements and all calculations, by a second individual, must be made to determine that correct turbine rotor inner air sealing ring assembly positioning is obtained.

(10) If measurement taken in step (9) is within specified limits, record date and dimensions in the appropriate engine work sheets.

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(11) If an acceptable dimension cannot be obtained in step (9), check for incorrect assembly of parts and repeat second stage turbine nozzle position measurement. If still not within limits, contact MCI Engineering before continuing engine assembly.

(12) Remove deflection check tooling.

(13) Install the second stage turbine outer air seal ring damper in the location shown in Figure 1326.

NOTE: Engines incorporating segmented outer spacers and outer air sealing rings with air sealing rings with air loading slots do not require a damper assembly.

(14) Align the index marks and install the second stage turbine outer air sealing rings.

N. Front compressor drive turbine rotor installation.

CAUTION: RECHECK LINER INSTALLATION FOR EVIDENCE OF SEAL DAMAGE.

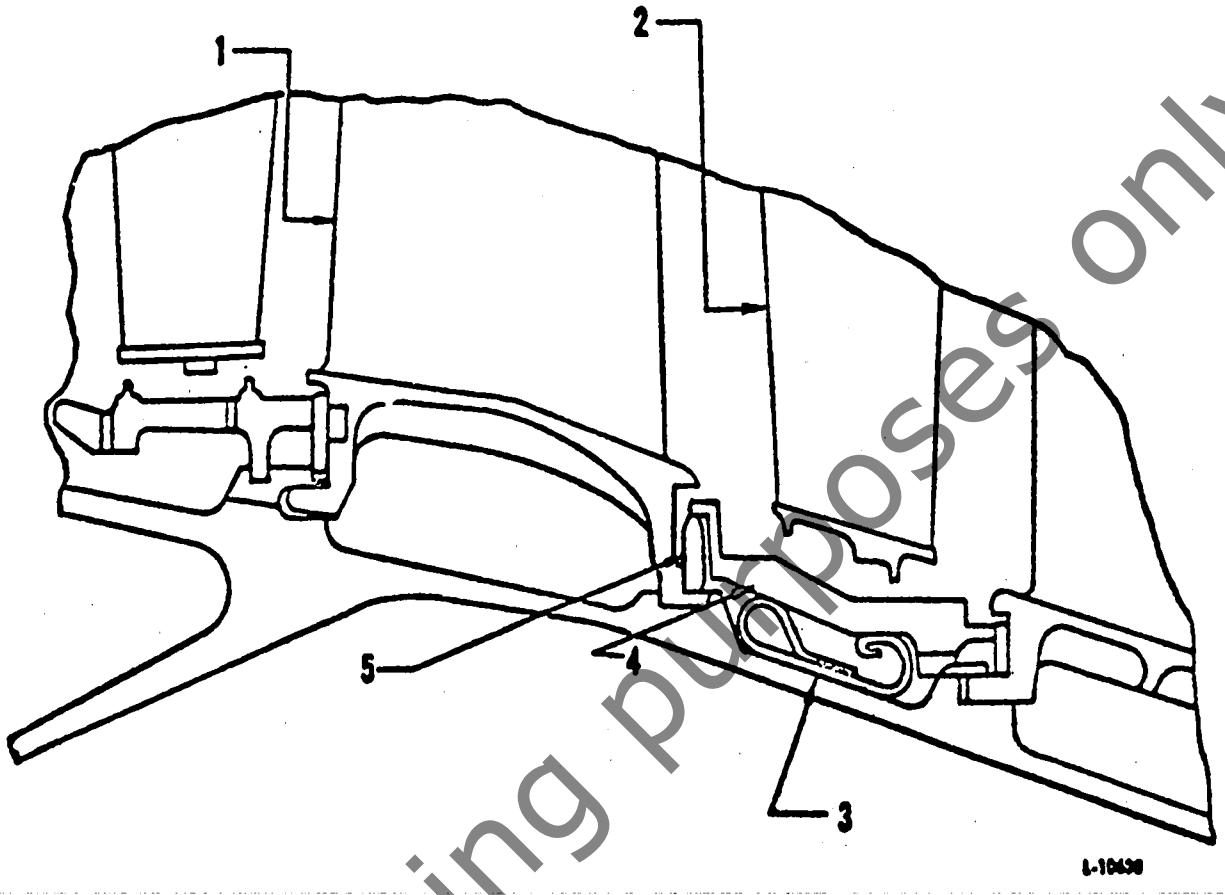
(1) Coat the internal threads and external splines with Fel-Pro C200 antiseize compound and coat the carbon seals (at the No. 4-1/2 bearing area) with engine oil.

(2) Coat the No. 4-1/2 bearing rollers with petrolatum, Esso Snow White Parmo No. 2F or the equivalent. Check index mark at 12 o'clock position and fan index marks.

(3) Raise the rotor from the truck or stand and insert the turbine shaft into the engine until the shaft spline engages the front compressor rear hub splines. Be particularly careful to guide the shaft to prevent damage to the spacer (on the forward end of the shaft).

CAUTION: ROTATE THE REAR COMPRESSOR SLOWLY THROUGH THE STARTER DRIVE AS THE TURBINE SHAFT IS BEING INSTALLED TO PREVENT "HANG UP" OF THE NO. 4-1/2 BEARING ROLLERS ON THE SEAL LINER OR OUTER RACE. IF "HANG UP" DOES OCCUR, THE SHAFT MUST BE WITHDRAWN AND THE CAGE OF THE NO. 4-1/2 BEARING CAREFULLY INSPECTED TO ENSURE THAT IT IS NOT DISTORTED OR BENT.

For Training purposes only



1. Second Stage Nozzle Vanes
2. Second Stage Turbine Blade
3. Air Sealing Ring Damper Assembly
4. Second Stage Turbine Rotor Outer Air Sealing Ring
5. Second Stage Turbine Vane Lockring

Outer Air Sealing Ring and Damper Installation
Figure 1326

For Training purposes only

(4) Support the turbine shaft by hand and carefully remove the lifting sling.

CAUTION: RECHECK TO INSURE INDEX MARKS ARE PROPERLY ALIGNED.

(5) Install the SWE 84976 SWE 8697 adapter on the rear flange of the second stage disk.

(6) Insert the coupling wrench through the adapter until it fully engages the coupling splines; then exert positive forward pressure to move the wrench forward approximately 3/16 of an inch to make certain the coupling lock is released.

(7) Place a bar through the eye in the end of the coupling wrench and while holding the handle of the adapter; turn the wrench by hand, counterclockwise, until the coupling is hand tight. Remove the bar. Recheck index marks on turbine and fan.

(8) Install the power wrench on the coupling wrench and lock to the adapter with the wing screws.

(9) Install the rachet adapter and set to turn the coupling wrench in a counter clockwise.

(10) Using a suitable torque wrench, tighten the coupling to 500 lb. in.

CAUTION: THE COUPLING WRENCH MUST BE HELD FORWARD AT ALL TIMES TO INSURE THAT THE COUPLING IS IN THE UNLOCKED POSITION.

NOTE: While tightening the coupling, the adapter must be held to prevent the turbine and compressor from rotating.

(11) With the 500 lb. inch torque load applied to the coupling wrench put a reference mark on the power wrench rear face and then turn the coupling wrench through an angle of 20° plus or minus two degrees.

(12) With the coupling wrench fully engaged to the unlock position place a reference mark on the splines, the coupling wrench at the rear face of the power wrench.

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(13) Reverse the ratchet adapter and back the coupling off to "0". Torque and repeat steps 10 and 11.

CAUTION: THE LOCKING OF THE COUPLING SHOULD BE CHECKED AS FOLLOWS: WITHDRAW THE COUPLING WRENCH 1/2 to 3/4 INCH TO RELEASE THE COUPLING LOCK; APPLY SUFFICIENT PRESSURE WITH THE COUPLING WRENCH TWO OR THREE DEGREES (TO TIGHTEN) AS INDICATED BY THE REFERENCE MARKS ON THE POWER WRENCH. THIS WILL ENSURE THE COUPLING AND THE COUPLING LOCK SPLINES ENGAGEMENT, IN THE EVENT THAT THE SPLINES WERE NOT ALIGNED WHEN THE COUPLING WAS TURNED THROUGH THE REQUIRED ANGLE AFTER THE TORQUING. IF THE SPLINES OF THE LOCK AND COUPLING WERE ALGINED, THE SCALE ON THE WRENCH WILL RETURN APPROXIMATELY TO ITS ORIGINAL POSITION. BEING PARTICULARLY CAREFUL NOT TC INSERT THE COUPLING WRENCH (THIS WILL UNLOCK THE COUPLING), REMOVE THE COUPLING WRENCH, POWER WRENCH AND ADAPTER.

(14) Rotate the second stage turbine to check for contact of turbine blades with the outer seal ring. Continuous contact or heavy intermittent rubbing sounds are not acceptable. Due to manufacturing tolerance in the length of blades, very slight, intermittent contact of one or two blades during a revolution of the turbine may be accepted.

O. Front compressor drive turbine rotor position measurement.

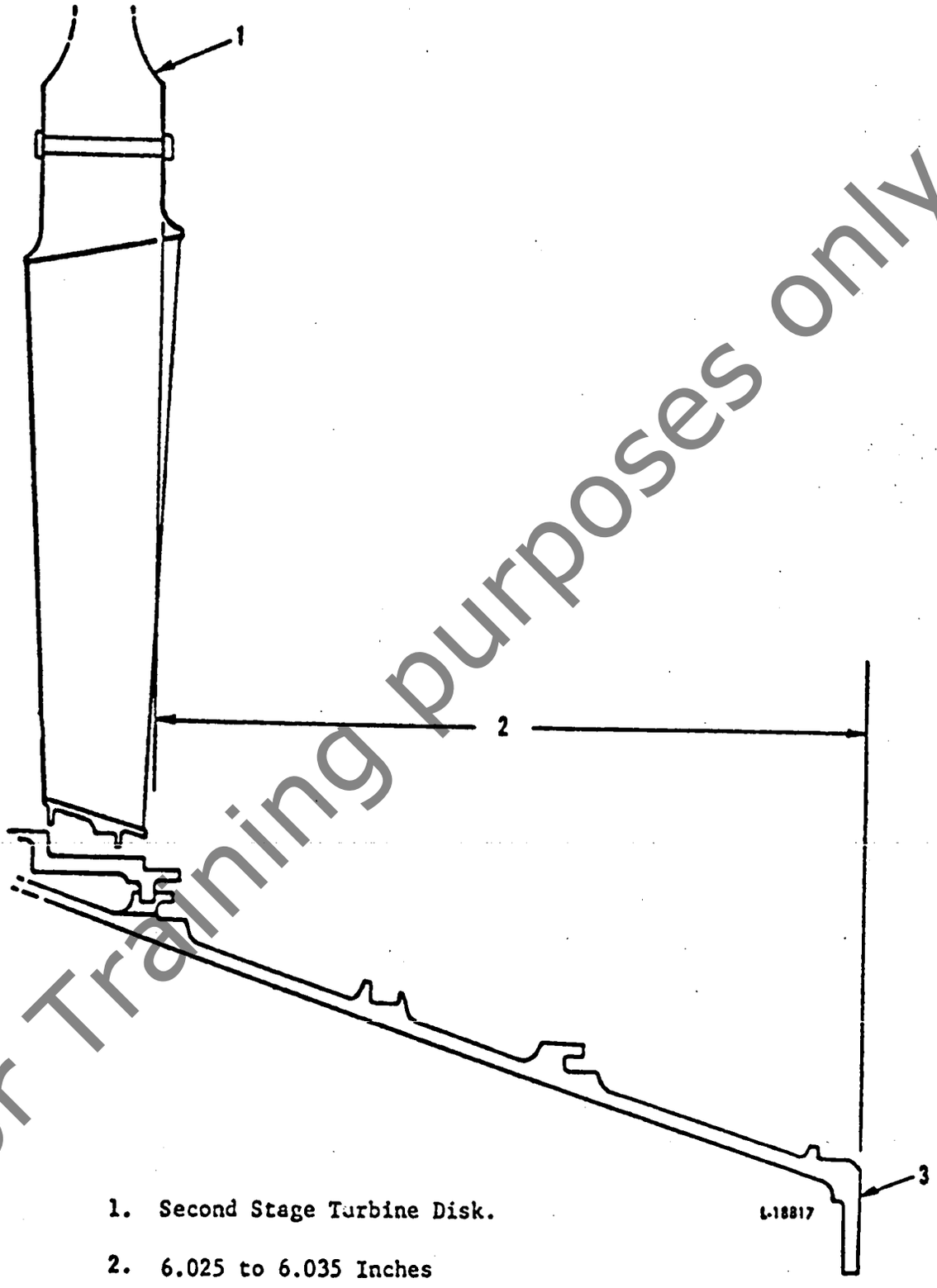
(1) Place a parallel bar across the rear flange of the nozzle case and using a suitable depth micrometer, measure and record the distance from the rear face of the second stage disk between the blade retaining rivets and also the distance from the rear face of the bar to the flange of the nozzle case. Subtract the latter dimension from the former.

(2) Repeat the same measurement in three other locations and calculate an average dimension. The resulting average dimension must be between 6.025 and 6.035 inches. See Figure 1327.

NOTE: The axial movement of the shaft has been considered in the above instructions. The average assembly dimension must be between 6.025 and 6.035 inches.

(3) If the four readings do not fall within specified limits, contact MCI Engineering for instructions prior to proceeding with further buildup.

For Training purposes only



1. Second Stage Turbine Disk.
2. 6.025 to 6.035 Inches
3. Turbine Nozzle Case Rear Flange.

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Front Compressor Drive Turbine Rotor Position Measurement
Figure 1327

P. Third Stage Turbine Nozzle Installation.

(1) Install inner seal on the rear shoulder of the second stage turbine disk with largest OD flange of seal toward front of engine. See Table II for parts interchangeability requirements.

CAUTION: ENSURE THAT LUGS ON INNER SEAL ARE PROPERLY MATED WITH SLOTS IN REAR FACE OF 2ND STAGE DISK.

WARNING: ANY SECOND STAGE DISK WHICH FEATURES EIGHT (8) ONE-HALF INCH HOLES IN THE WEB CAN BE USED WITH A VENTED OR UNVENTED SECOND TO THIRD STAGE AIR SEAL. HOWEVER, SECOND STAGE DISKS WHICH DO NOT HAVE VENT HOLES IN THE WEB MUST BE USED WITH AN UNVENTED SEAL.

(2) Position the second stage outer seal spacer on the rear face of the second stage turbine outer sealing ring.

(3) Being careful not to damage the knife-edge seals on the OD, center the third stage turbine inner air seal ring assembly in position. See Table II for parts interchangeability requirements.

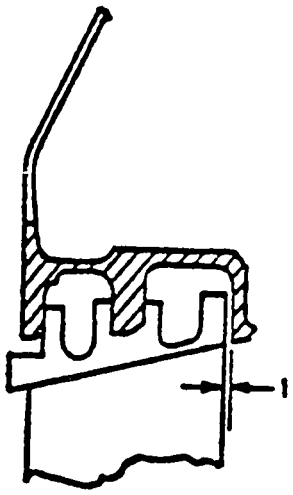
NOTE: Third stage inner airseal ring assembly, P/N 529773, is not interchangeable with other third stage inner airseal ring assemblies, but must be used with the matching set of parts listed in Table II.

(4) With the aid of an assistant holding the outer seal and inner seal ring, install the vanes one at a time. Start from the six o'clock position and alternate clockwise and then counterclockwise, keeping the vanes in the same relative position to each other as marked prior to removal.

WARNING: MAKE CERTAIN THAT EACH VANE INNER PLATFORM IS SEATED WITHIN THE INNER FACES OF THE FLANGES ON THE INNER SEALING RING SUPPORT. TO ENSURE PROPER INSTALLATION, CHECK GAP AS SHOWN IN FIGURE 1328.

(5) Install third stage vane lockring in rear shoulder of third stage vane outer shroud and steps in ID of nozzle case. If necessary, tap lockring lightly to ensure proper seating.

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Dimensions and Notes

Second & Third Stage	Minimum	.006T	Maximum	.006	Replace if over .009
Fourth Stage	Minimum	.004T	Maximum	.008	Replace if over .011

Turbine Vane Inner Platform Seating
(Third and Fourth Stage)
Figure 1328

NOTE: Do not install P/N 495253, 500853, 565753, and 566973 vanes (reindexed) in P/N 399065 turbine case (non-reindexed), or P/N 413853 and 446953 vanes (non-reindexed) in P/N 496859, 504992, 596859, or 669045 turbine cases (reindexed). See Figure 416 for only acceptable combination of reindexed parts. (Ref. SB 638).

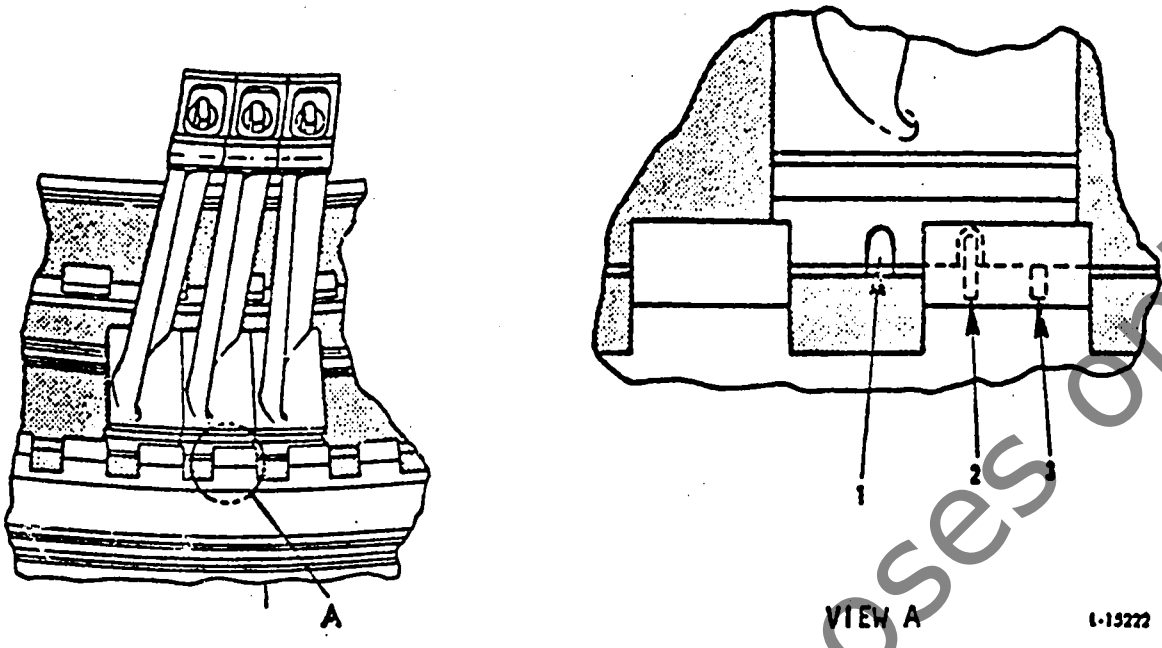
(6) Continue to install vanes one at a time until the complete stage is installed.

NOTE: To facilitate installation, it may be necessary to lightly tap the outer vane shrouds toward the nozzle case with a fiber drift.

	*SET "A"	*SET "B"
Third Stage Inner Seal	499790	413676-SB488, 440884-SB488, 466246-SB488, 473493
Third Stage Air Seal Ring	529773	418749-SB488, 473497, 562983

*NOTE: Parts must be used within the set shown and are interchangeable in complete sets only. Individual parts are not interchangeable into another set.

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1. Non-Reindexed Vane Retention Slot Plug Welded or Pinned. (No Indication On New Parts)

2. Reindexed Vane Retention Slot Engaged On Reindexed Case Anti-Rotation Pin

3. Non-Reindexed Case Anti-Rotation Pin Milled Off Flush With Groove. (No Indication On New Parts)

Installation of Reindexed Third Stage Vanes in Reindexed Turbine Case
Figure 1329

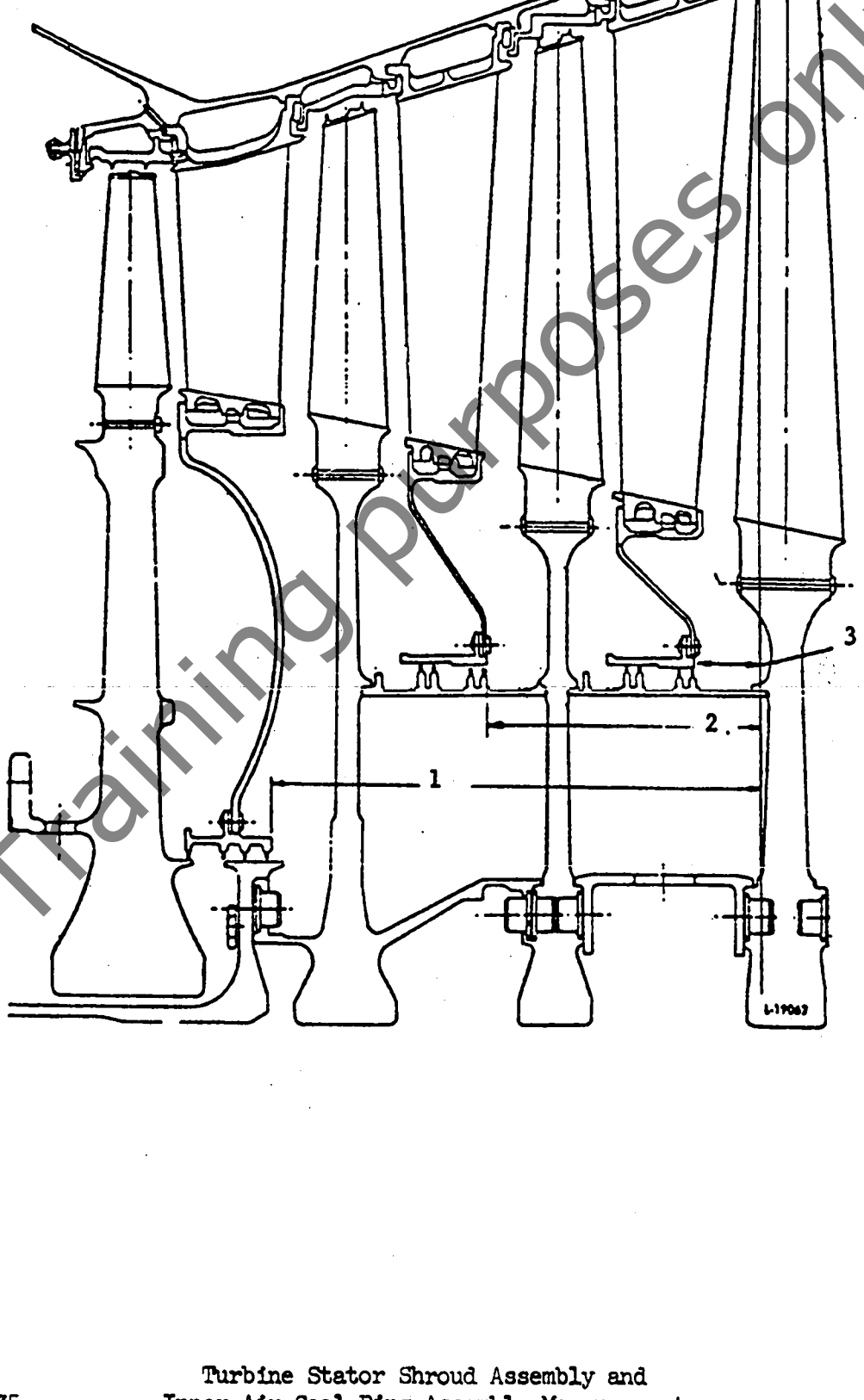
(7) Install third stage turbine outer air seal in turbine nozzle case, mating lugs with grooves in ID of case and flush against rear face of lockring.

(8) Install deflection check adapter behind the stepped ID of the third stage inner support and expand fingers to secure tool in place.

(9) Install deflection check load frame on the aft flange of the turbine nozzle case and install tensionometer gauge between the adapter and load frame with quick release pins.

(10) Turn jackscrew knob on load frame to apply a 500 lb rearward load.

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For Training Purposes only

REF. NO.	DESCRIPTION	LIMITS (INCHES) MIN	MAX
* 1	Second Stage Inner Air Seal-To-Turbine Case Dimension	7.904	8.021
** 2	Third Stage Inner Air Seal Ring-To-Turbine Case Dimension	4.225	4.339
*** 3	Fourth Stage Inner Air Seal Ring-To-Turbine Case Dimension	0.889	1.009

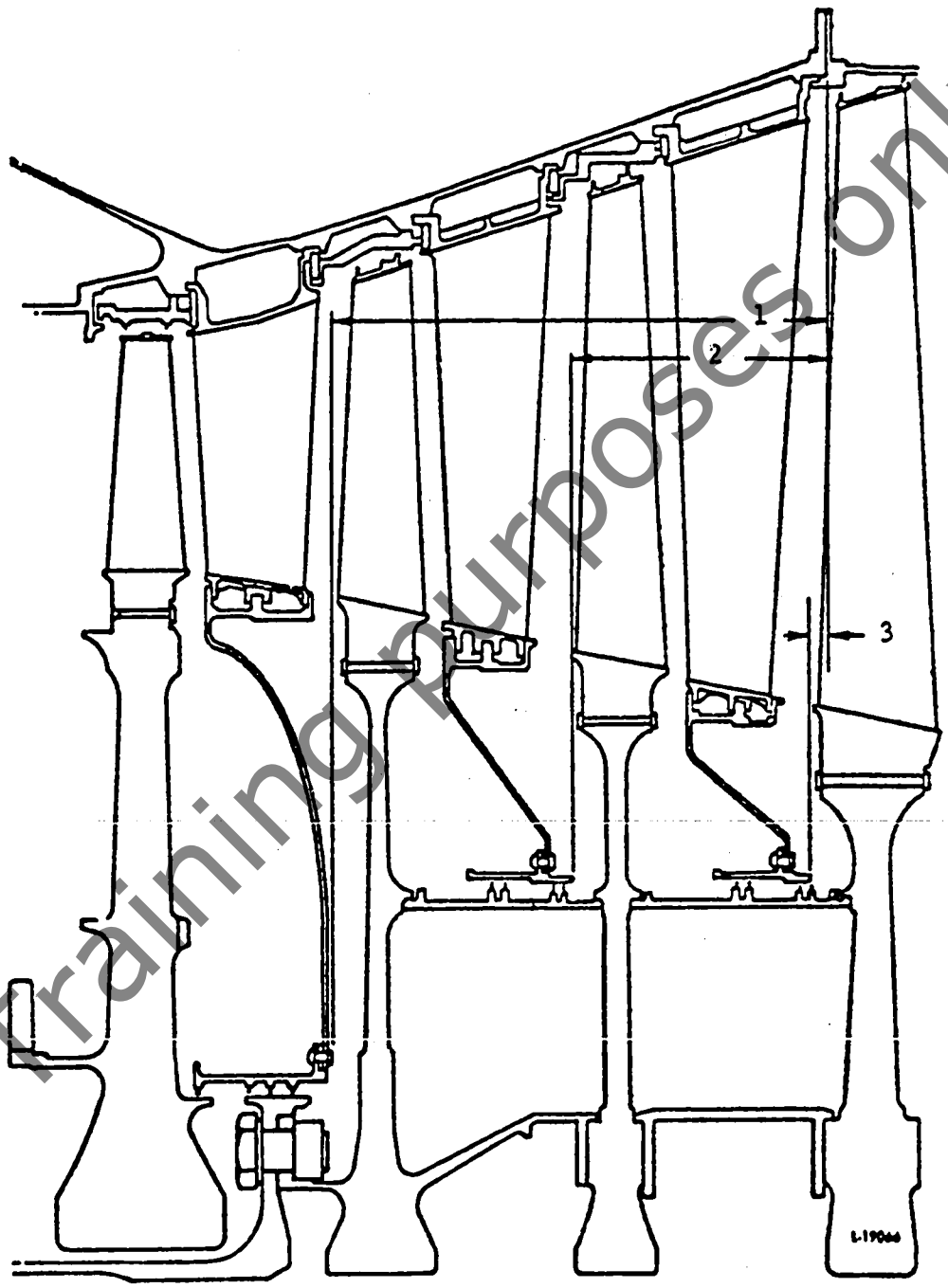
*This dimension applicable for engines incorporating first stage disk, P/N 496801 and second stage turbine storor shroud assembly, P/N 529772 or P/N P/N 599352. This dimension also applicable for engines incorporating first stage disk, P/N 400701, P/N 416301, or P/N 424301 and second stage turbine stator shroud assembly, P/N 599452.

**This dimension applicable for engines incorporating third stage stator shroud assembly, P/N 529773 and third stage inner air seal P/N 499790.

***This dimension applicable for engines incorporating fourth stage stator shroud assembly, P/N 529774 and fourth stage inner air seal, P/N 564921.

Key to Figure 1330

For Training Purposes only



For Training Purposes only

Turbine Inner Air Seal Assembly and
Inner Air Seal Ring Assembly Measurement
Figure 1332

REF. NO.	DESCRIPTION	LIMITS (INCHES) MIN	MAX
* 1	Second Stage Inner Air Seal-To-Turbine Case Dimension	7.301	7.492
** 2	Third Stage Inner Air Seal Ring-To-Turbine Case Dimension	3.940	4.054
*** 3	Fourth Stage Inner Air Seal Ring-To-Turbine Case Dimension	0.239	0.359

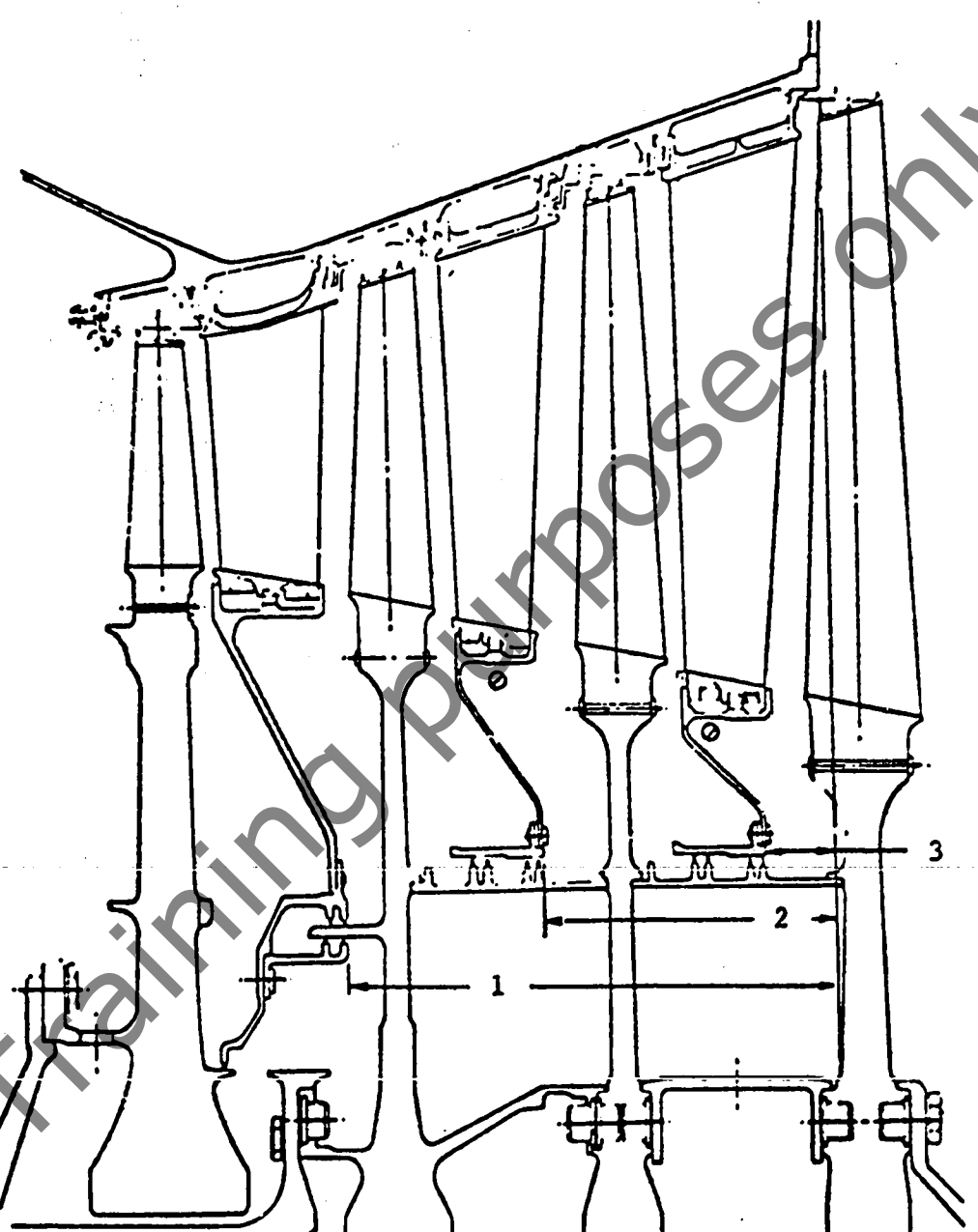
*This dimension applicable for engines incorporating first stage disk P/N 400701 (D-1), P/N 416301 (D-1, D-3, D-3B, MC7), or P/N 424301 (D-1) and second stage turbine rotor inner seal assembly, P/N 407279.

**This dimension applicable for engines incorporating third stage airsealing ring assembly, P/N 418749 - SB488, P/N 473497 or P/N 562983 and third stage airseal, P/N 413676 - SB488, P/N 440884 - SB488, P/N 466246 - SB488, or P/N 473493.

***This dimension applicable for engines incorporating fourth stage airsealing ring assembly, P/N 415618 - SB651, P/N 473495, or P/N 562984 and fourth stage inner airseal, P/N 413681 - SB488, P/N 440885 - SB488, or P/N 473491.

Key to Figure 1332

For Training purposes only



For Training Purposes only

REF. NO.	DESCRIPTION	MIN	MAX
* 1	Second Stage Inner Air Seal-to-Turbine Case Dimension	7.364	7.461
2	Third Stage Inner Air Seal Ring-to-Turbine Case Dimension.	(See Figure 1331 or 1332)	
3	Fourth Stage Inner Air Seal Ring-to-Turbine Case Dimension	(See Figure 1331 or 1332)	

*This dimension applicable for engines incorporating first stage disk, P/N 496801, and second stage turbine stator shroud assembly P/N 598272. This dimension also applicable for engines incorporating first stage disk, P/N 416301, and second stage turbine stator shroud assembly, P/N 598772.

Key to Figure 1333

For Training purposes only

(11) Place a parallel bar across the rear flange of the turbine nozzle case and using a depth gauge, measure dimension, index number 2 of applicable figure, at a minimum of six places, equally located.

NOTE: Dimensions specified are to rear face of turbine nozzle case rear flange. Measurements are taken over the bar and the thickness of bar must be subtracted from total measurements. After calculations have been made and found to be within limits specified, a recheck of the measurements and all calculations, by a second individual, must be made to determine that correct turbine rotor inner air sealing ring assembly positioning is obtained.

(12) If measurements taken in step (11) is within limits specified, record date and dimensions in the appropriate engine work sheets.

(13) If an acceptable dimension cannot be obtained in step (11), check for incorrect assembly of parts and repeat third stage turbine nozzle position measurement. If still not within limits, contact MCI Engineering before continuing engine assembly.

(14) Remove deflection check tooling.

Q. Turbine rotor installation (3rd stage)

(1) Install two PWA 16532 pins 180° apart in the second stage turbine aft flange.

(2) Check installation of the third stage turbine outer air seal in the turbine nozzle case for proper mating of the lugs with grooves in ID of case and that it is flush against the rear face of the lockring.

(3) Apply Ease-Off 990 to the snap diameters of the third stage rotor that mates with the second stage rear hub. Wipe off excess compound.

(4) Using two mechanics, position the third stage turbine rotor with the blade trailing edges aft and align the offset hole in the rotor with the number one tiebolt.

NOTE: Dimple or spherical indent on the face of the rotor near OD to be located toward the front of engine. Later rotors have the word "FRONT" marked on the face of the rotor between tiebolt holes.

(5) Move the third stage rotor forward over the guide pins and position the inner forward holder of the rotor on the rearward extension of the second stage rotor and the outer forward shoulder of the third stage rotor on the rear end of the third stage turbine rotor inner seal.

(6) Install eight tierods (splined holding end to the rear) in their numbered locations. Position the tierod stop nuts at the front of the rods and screw the rods in, making certain to bottom them in the stop nuts; then back off the tierod 1/2 to 3/4 turn.

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(7) Install two tiebolt nuts 180° apart as a safety precaution to prevent the third stage rotor from inadvertently falling free.

(8) Remove all loose details from the P&WA 17267 pusher; then reinstall the rod and swivel puck behind the forward face of the second stage turbine rotor.

(9) Holding the puck in place install the third stage plate and the retaining bushing over the rod and secure the tool in place with the lockscrew on the retaining bushing.

(10) Install the hydraulic ram, spacer, and retaining nut on the rod.

(11) Release the lockscrew on the retaining bushing and install P&WA 3755 pump to the ram.

(12) Apply pressure using the P&WA 3755 pump and push the third stage turbine rotor into place.

(13) With the pressure still applied, lock the lockscrew on the retaining bushing, thus securing the second and third stage rotors together; then release the pressure on the ram.

(14) Remove the nut, spacer, and ram from the rod.

R. Fourth stage turbine nozzle guide vanes inner support, and spacers installation.

(1) Apply Ease-Off 990 to the front and rear snap diameters of the third to fourth stage turbine rotor inner seal.

(2) Install the third to fourth stage turbine rotor inner seal on the rear shoulder of the third stage turbine rotor with the triangle mark approximately 180° away from the triangle mark on the third stage inner seal. Position largest diameter flange of seal toward the front of the engine. See Table I for parts interchangeability requirements.

CAUTION: ENSURE THAT THE LUGS ON THE INNER SEAL ARE PROPERLY ENGAGED WITH THE SLOTS IN THE REAR FACE OF THE THIRD STAGE TURBINE ROTOR.

	*Set "A"	*Set "B"
Fourth stage inner seal	564921	413681 S/B 488 440885 S/B 488 473491
Fourth stage nozzle inner support	529744	415618 S/B 651 473495 562984

*NOTE: Parts must be used within the set shown and are interchangeable in complete sets only. Individual parts are not interchangeable into other sets.

TABLE III

For Training purposes only

(3) Install the third stage nozzle guide vane outer seal spacer on the rear face of the third stage turbine rotor outer seal.

(4) Being careful not to damage the knife-edge seals on the OD, of the turbine rotor outer seal, position the fourth stage nozzle inner support with the index mark at the 12 o'clock location. See Table I for parts interchangeability requirements.

(5) With the aid of a mechanic to hold the outer seal spacer and the fourth stage nozzle inner support, install the fourth stage nozzle guide vanes one at a time. Start at the six o'clock position and alternate clockwise and then counterclockwise, keeping the nozzle vanes in the same relative position to each other as when the nozzles were removed.

WARNING: MAKE CERTAIN THAT EACH VANE INNER PLATFORM IS SEATED WITHIN THE INNER FACES OF THE FLANGES ON THE FOURTH STAGE NOZZLE INNER SUPPORT. ALSO, INSURE THAT EACH VANE OUTER PLATFORM PROPERLY SEATS AGAINST THE FOURTH STAGE NOZZLE GUIDE VANE OUTER SPACER.

(6) Continue to install vanes one at a time until the complete stage is installed.

NOTE: To facilitate installation it may be necessary to lightly tap the outer vane shrouds toward the nozzle case with a fiber drift.

(7) Install the fourth stage turbine outer seal, aligning the index marks and securing with screws or safety wire.

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NOTE: Be sure that the fourth stage turbine outer air seal is positioned with the proper hole located over the shouldered dowl pin guide at the 6 o'clock position of the turbine nozzle case.

(8) Install deflection check adapter, behind the stepped ID of the fourth stage nozzle inner support and expand fingers to secure tool in place.

(9) Install deflection check load frame on aft flange of turbine nozzle case and install tensionometer gauge between the adapter and load frame with quick release pins.

(10) Turn jackscrew knob on load frame to apply a 500 pound rearward load.

(11) Place a parallel bar across the rear flange of the turbine nozzle case and using depth gauge, measure dimension, index number 3 of applicable figure 1331 or 1332, at a minimum of six places, equally located.

NOTE: Dimensions specified are to the rear face of nozzle case rear flange. If measurement is taken over fourth stage turbine outer air seal, then the dimension of the fourth stage turbine outer air seal as measured from the rear face of the air seal to the face that mates with the turbine nozzle case aft flange, plus the width of the parallel bar, must be subtracted from the total measurement. After calculations have been made and found to be within the specified limits, a recheck of the measurements and all calculations by a second individual, must be made to ensure that correct fourth stage turbine nozzle inner support positioning is obtained.

(12) If measurements taken in step (11) is within limits specified, record date and dimensions in the appropriate engine work sheets.

(13) If dimension in step (11) cannot be obtained, check for incorrect assembly of parts and repeat fourth stage turbine nozzle position measurement. If still not within limits contact MCI Power Plant Engineering before continuing engine assembly.

(14) Remove deflection check tooling.

S. Fourth stage turbine rotor and turbine rear hub installation.

(1) Apply Ease-off 990 to the front and rear snap diameters of the third to fourth turbine rotor inner spacer. Wipe off excess compound.

(2) Align the offset hole in the third to fourth stage turbine rotor inner spacer with the number one turbine tiebolt and install the spacer on the rear face of the third stage turbine rotor.

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(3) With two mechanics to support the fourth stage turbine rotor, position rotor with blade trailing edges aft, to align the offset hole with the number one tiebolt.

(4) Remove the two safety tiebolt nuts and install the fourth stage turbine rotor over the tiebolts to position the inner forward shoulder of the rotor on the rearward face of the third to fourth stage turbine rotor inner spacer and the outer shoulder of the rotor on the third to fourth stage turbine rotor outer seal.

(5) Reinstall two tiebolt nuts 180° apart to prevent the fourth stage turbine rotor from falling free. Remove the two aligning pins and install the remaining two tiebolts in their numbered positions.

(6) With the rod of P&WA 17267 pusher in place, screw the detail plate into the plunger of the ram, then position the plate and ram over the rod and secure them with the nut.

NOTE: The detail spacer is not required for the above step.

(7) Using the P&WA 3755 pump, apply pressure to the ram and push the fourth stage turbine rotor into place.

(8) Carefully release the ram pressure and remove all details of the pusher.

CAUTION: WITH THE RAM PRESSURE RELEASED AND THE PUSHER DETAILS REMOVED THE ONLY THING HOLDING THE THIRD AND FOURTH STAGE TURBINE ROTORS IN POSITION WILL BE THE SNAP FIT BETWEEN THE ROTORS AND SPACERS. IT IS EXTREMELY IMPORTANT TO MAINTAIN THIS POSITION UNTIL THE TURBINE ROTOR REAR HUB IS INSTALLED AND SUFFICIENT TURBINE TIEBOLT NUTS ARE INSTALLED TO SECURE THE TURBINE STOCK UP.

(9) Position the turbine rear hub to align the off-set hole with the number one tiebolt and note the location of the 4-1/2 bearing oil tube shield aligning slot inside the hub.

(10) Install three new seals in the grooves at the forward end of the 4-1/2 bearing oil tube and heatshield assembly.

(11) Install two new oil seal rings in the grooves at the rear end of the 4-1/2 bearing oil tube and heatshield assembly.

(12) Install the oil tube and heatshield into the turbine shaft locating the lug on the heatshield so that it will align with the slot in the hub when the hub is installed.

CAUTION: WHENEVER THE 4-1/2 BEARING OIL TUBE AND HEATSHIELD ASSEMBLY IS PARTIALLY WITHDRAWN OR TWISTED, THE COMPLETE ASSEMBLY SHALL BE REMOVED AND THE OIL TRANSFER SEALS CHECKED FOR PROPER SEATING.

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(13) Install the washer and spring into the hub.

(14) Remove the two tiebolt safety nuts and install the turbine rear hub aligning off-set hole in the hub with the number one tiebolt and the 4½ bearing oil tube and heatshield aligning lug with the slot on the inside of the hub.

(15) Temporarily install two tiebolt nuts 180° apart and alternately tighten each to compress the spring and seat the turbine rear hub on the shoulder of the fourth stage turbine rotor.

(16) Inspect the turbine rotor and spacer stock up using a mirror and flashlight to determine that all snap diameters are properly seated.

NOTE: It will require considerably manipulation of a small mirror through the holes in the turbine rear hub to obtain a view of the second to third and third to fourth stage turbine rotor outer air seal snap diameters to determine if all are properly seated.

(17) Coat the mating face of tiebolt nut tabwashers with Ease-off 990.

(18) Install a tabwasher, single tab down, on each tiebolt, locating the single tab in its locking hole on the hub.

NOTE: When coating the tabwashers and tiebolt threads with Ease-off 990 make certain the hub flange face that contacts the tabwasher is clean and free of any coating, such as oil, vasoline, Ease-off 990, etc., also check tabwasher to ensure that the face that contacts the hub is also clean and free of any coating. Coating or unclean surfaces would contribute to the shearing of the tabwasher during the tightening procedure.

(19) Install the turbine tiebolt nuts, being careful to return each numbered nut to its respective tiebolt location.

CAUTION: OLD AND NEW TURBINE TIEBOLTS, P/N 418915, 492380, AND 558089, RESPECTIVELY ARE INDIVIDUALLY PHYSICALLY, INTERCHANGEABLE. HOWEVER, THEY MUST BE USED IN SETS. IF, FOR ANY REASON, ONE OR MORE OF THE TURBINE TIEBOLTS MUST BE CHANGED, THEN THEY MUST BE CHANGED AS COMPLETE SETS.

(20) Install the P&WA 30188 or P&WA 17666 gauge on the No. 6 hub, aligning the offset hole and secure with threaded plug.

NOTE: Use P&WA 30188 gauge with P&WA 30189 anvil assembly installed, or P&WA 17666 gauge, for tiebolts P/N 418915, and P/N 492380. P&WA 30188 gauge with P&WA 30190 anvil assembly installed must be used for tierod P/N 558089.

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(21) Using prescribed sequence, loosen two tiebolt nuts, diametrically opposite, zero respective indicators and stretch tiebolts as specified in reference No. 878, of the Fits and Clearances section of the JT3D Overhaul Manual, Chapter 72-50. Continue this operation until all tiebolts meet extension requirements.

NOTE: Indicators may be retracted to allow clearance for installing and removing wrenches during this operation.

CAUTION: DURING THIS STRETCH OPERATION, TIEBOLTS SHALL BE RESTRAINED FROM TURNING IN EITHER DIRECTION WHILE TIGHTENING TIEBOLT NUTS. ANY MOVEMENT OF TIEBOLTS WILL INDICATE STRETCH ON INDICATORS THUS FALSFYING INDICATED EXTENSION.

(22) Install dial indicator and check fourth stage turbine rotor run-out. Maximum deflection of indicator is .005 inch.

NOTE: It may be necessary to provide support of turbine assembly at the number six bearing journal to meet the .005 inch requirement of this check. If still unable to obtain proper run-out it will be necessary to repeat torque procedure of turbine tiebolt.

(23) Set the washer tabs to secure the tiebolt nuts.

CAUTION: WHILE SETTING THE WASHER TABS, CARE MUST BE TAKEN TO PREVENT DAMAGE TO THE HUB FACE AND TO AVOID MAKING TOOL MARKS ON THE TABS.

T. No. 6 Bearing Seals and Spacer Installation

See Figure

(1) Using layout dye, mark the rear face of the hub directly in line with the balance "X" marks on the hub and turbine disk.

(2) Install the front seal spacer, small OD rearward, aligning the "X" balance mark.

(3) Install the No. 6 bearing seals and spacers on the front compressor drive turbine rear hub in the following order: The carbon seal, grooved face to the rear; the seal spacer, small OD to the rear; the spring retaining ring; the spring washer carbon seal, grooved face to the rear; bearing spacer, puller groove to the rear.

NOTE: Align the "X" balance marks on the spacers with the layout dye marking on the rear face of the hub directly above the "X" balance marks on the hub and turbine disk.

(4) Heat the No. 6 bearing inner race and rollers in hot oil.

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(5) Spray on a light coat of DGF-123 anti-galling lubricant on the turbine rear hub journal to eliminate scoring of the hub when removing the No. 6 bearing inner race. Area to be lubricated must be clean and free of oil.

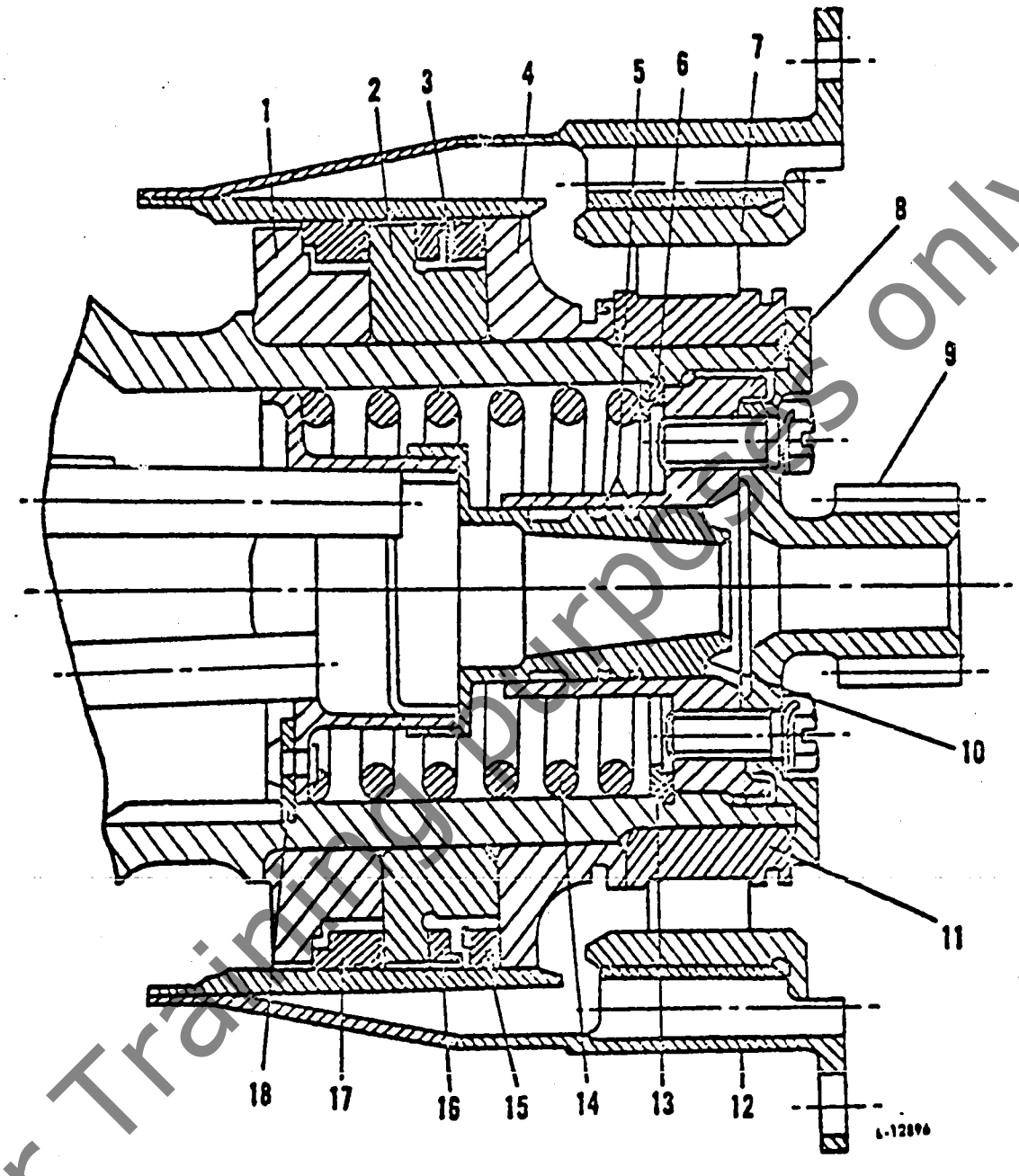
(6) Using the PWA-7172 Drift, install the No. 6 bearing inner race and rollers, puller groove to the rear, on the front compressor drive turbine rear hub.

CAUTION: DUE TO THE VARIANCE IN INTERNAL TOLERANCES IT IS OF THE UTMOST IMPORTANCE THAT MATCHED BEARING DETAILS ARE NOT INTERMIXED AT ASSEMBLY; THEREFORE, MAKE CERTAIN ALL THE DETAIL PARTS OF THIS BEARING ARE FROM THE ORIGINAL BEARING ASSEMBLY.

(7) Install the No. 6 bearing oil seal carrier sleeve in the ID of the hub and over the oil tube heatshield.

CAUTION: USE EXTREME CARE WHILE INSTALLING THE SLEEVE OVER THE NO. 4-1/2 BEARING OIL TUBE HEATSHIELD SO AS NOT TO DAMAGE OR DISPLACE THE TWO OIL SEAL RINGS ON THE OD OF THE OIL TUBE HEATSHIELD.

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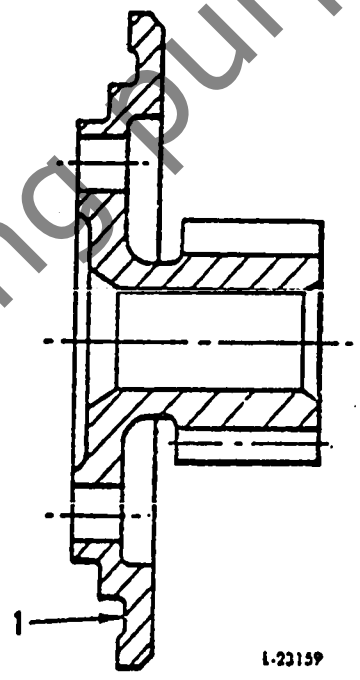
1. Seal Spacer
2. Seal Spacer
3. Spring Washer
4. Bearing Spacer
5. Oil Seal Rings
6. Lockring
7. Bearing Outer Race
8. Oil Seal Carrier Sleeve
9. Oil Suction Pump Drive Pinion
10. Carrier Seal Housing
11. Bearing Inner Race and Rollers
12. Bearing Housing
13. Washer
14. Coil Spring
15. Carbon Seal
16. Spring Retaining Ring
17. Carbon Seal
18. Oil Pressure Tube Heatshield Lock

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(8) Tighten the sleeve so that the distance measured from the rear-most face of the sleeve to the rear face of the hub is .265 - .2751 high. If necessary, turn the sleeve in a clockwise direction to algin the bolt holes.

(9) Secure the pinion to the sleeve with the bolts and three tabwashers. Tighten the bolts torque. 45-50 lb. in. P/N 302902 or 65-85 lb. in. for P/N 542016 pinion.

NOTE: Pinion, P/N 302902, may be distinguished from pinion, P/N 542016, by the clearance groove in the forward face of the tabs. See Figure 1335 Index No. 1 Pinion, P/N 542016, may be used only with hub, P/N 623465.



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No. 6 Bearing Oil Section Pump Drive Pinion (P/N 302902) 63T
Figure 1335

U. Exhaust Case & Aft Thrust Reverser Assembly Installation

(1) Apply Esso Snow White Parmo No. 2F petrolatum, or the equivalent to the No. 6 bearing inner race and roller with the fingers.

(2) Position the rollers radially inward against the inner race (where they will be held by the petrolatum while installing the turbine exhaust case).

(3) Align the turbine exhaust case mating hole with the locating pin in the turbine nozzle case and position the exhaust case slightly to the rear of the nozzle case.

(4) Carefully and slowly move the turbine exhaust case forward maintaining proper alignment.

CAUTION: THE TURBINE EXHAUST CASE MUST BE KEPT CENTERED WHILE BEING INSTALLED TO PREVENT THE POSSIBILITY OF DAMAGE TO THE CARBON SEALS ON THE REAR HUB AND HANG UP OF THE BEARING ROLLERS.

(5) When the mating flanges of the nozzle and exhaust cases are approximately two inches apart, slowly turn the front compressor drive turbine rotor closkwise by hand. While the rotor is turning move the exhaust case forward the remaining two inches, being careful to detect any binding or hang up on the rollers.

NOTE: If binding or roller hang up is experienced move the exhaust case rearward and correct the trouble.

(6) If safety wire was used to secure the fourth stage turbine rotor outer air seal in position, remove the wire at this point.

(7) Fasten the nozzle case and the fourth stage turbine rotor outer seal to the exhaust case with the bolts and locknuts, bolt heads to the rear. Tighten the bolts to the recommended torque. Reinstall all brackets as marked during exhaust case removal.

(8) Reconnect the exhaust case drain line.

(9) Reconnect the number six bearing oil pressure and scavenge lines.

(10) Reconnect the P_{t7} lines to the manifold at the top and bottom of the engine.

(11) Reconnect the EGT wiring harness.

(12) Reconnect the aft reverser switch wire harness.

(13) Reconnect the aft reverser follow up control rods.

(14) Reconnect the aft reverser air supply lines at the horizontal fire wall connector.

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